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

747-8

Flight Crew Operations Manual

The Boeing Company

Document Number D6-30151-8
March 1, 2011
Revision Number: 7
Revision Date: April 1, 2014

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Preface — Chapter 0
Chapter Table of Contents — Section TOC

Volume 1

Volume 2

Preface — Chapter 0
Model Identification — Section 1

General

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

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

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

Airplane Number	Registry Number
806	Intercontinental
914	Freighter

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General

This Flight Crew Operations Manual (FCOM) has been prepared by Boeing Commercial Airplanes, Commercial Aviation Services organization. The purpose of this manual is to:

- provide operating limitations, procedures, performance, and systems information the flight crew needs to safely and efficiently operate the 747 airplane during all anticipated airline operations
- serve as a comprehensive reference for use during transition training for the 747 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:

Please send all correspondence regarding content or use of this manual, including bulletin status, to the 747 Manager, Flight Technical Data through the Service Requests Application (SR App) on the MyBoeingFleet home page.

Organization

The FCOM is organized in the following manner.

Volume 1 –

- Preface – contains general information regarding the manual’s purpose, structure, and content. It also contains lists of abbreviations, a record of revisions, bulletins, and a list of effective pages
- Limitations and Normal Procedures chapters cover operational limitations and normal procedures. All operating procedures are based on a thorough analysis of crew activity required to operate the airplane, and reflect the latest knowledge and experience available
- Supplementary Procedures chapter covers those procedures accomplished as required rather than routinely on each flight
- Performance Dispatch chapter contains performance information necessary for self dispatch

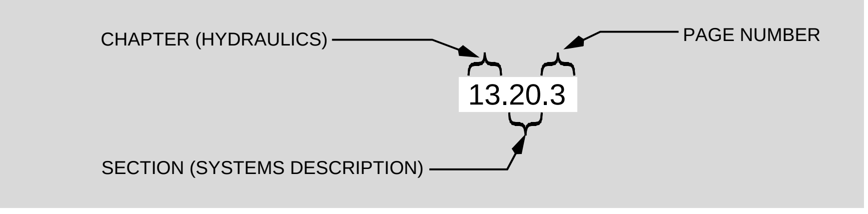
Volume 2 – Chapters 1 through 15 contain general airplane and systems information. These chapters are generally subdivided into sections covering controls and indicators and systems descriptions.

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

Page Numbering

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

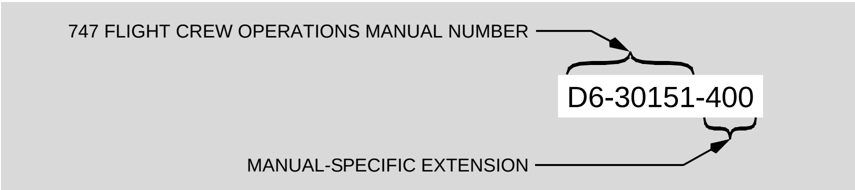
Example Page Number



Page Identification

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

Example Page Identification



Warnings, Cautions, and Notes

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

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

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

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

Flight Crew Operations Manual Configuration

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

Airplane Effectivities

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

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

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

   Example (with subordinate items):

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

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

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

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

   Example (without subordinate items):

   N-XX - N-YY
   Thrust reversers inoperative.

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

   Autobrake system inoperative.

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

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

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

FUEL STAB XFR

N-XX - N-YY

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

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

Example (‘before’ version):

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

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

Example (‘after’ version):

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

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

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

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Preface — Chapter 0
Abbreviations — Section 3

General

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

A	
AC	Alternating Current
ACARS	Aircraft Communications Addressing and Reporting System
ACT	Active
ADC	Air Data Computer
ADF	Automatic Direction Finder
ADIRU	Air Data Inertial Reference Unit
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
AMI	Airline Modifiable Information
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
BTL DISCH	Bottle Discharge (fire extinguishers)
B/C	Back Course
BRG	Bearing
BRT	Bright
BTB(S)	Bus Tie Breaker(s)

C	
C	Captain Celsius Center
CANC CANC/ RCL	Cancel Cancel/Recall
CAPT	Captain
CAS	Calibrated Airspeed
CB	Circuit Breaker
CDL	Configuration Deviation List
CDU	Control Display Unit
CG	Center of Gravity
CHKL	Checklist
CLB	Climb
CMD	Command
COMM	Communication
CON	Continuous
CONFIG	Configuration
CRS	Course
CRT	Cathode Ray Tube
CTR	Center
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
DN	Down

E	
E/D	End of Descent
EAI	Engine Anti-Ice
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
ELT	Emergency Locator Transmitter
EMER	Emergency
ENG	Engine
E/O or EO	Engine Out
EPR	Engine Pressure Ratio
ETOPS	Extended Operations
EXEC	Execute
EXT	Extend or External
E/E	Electrical and Electronic

F	
F	Fahrenheit
FAC	Final Appoach Course

FCC	Flight Control Computer
FCTL	Flight Control
FCU	Flap Control Unit
FD, F/D or FLT DIR	Flight Director
FL CH FLCH	Flight Level Change
FLT	Flight
FMA	Flight Mode Annunciations
FMC	Flight Management Computer
FMS	Flight Management System
F/O	First Officer
FPA	Flight Path Angle
FPM	Feet Per Minute
FPV	Flight Path Vector
FT	Feet
FWD	Forward
FWSOV	Fire Wall Shutoff Valve

G	
G/P	Glidepath
GA	Go–Around
GEN	Generator
GLS	GPS Landing System
GMT	Grenwich Mean Time
GND	Ground
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
G/S	Glideslope
GW or GR WT	Gross Weight

H	
H or HDG	Heading
HDG REF	Heading Reference
HDG SEL	Heading Select
HF	High Frequency
HI	High
HP	High Pressure
HPA	Hectopascals
HYD	Hydraulic

I	
IAF	Initial Approach Fix
IAN	Integrated Approach Navigation
IAP	Initial Approach Point
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organization
IDENT	Identification
IDG	Integrated Drive Generator
IDS	Integrated Display System
IFE	In-flight Entertainment System
ILS	Instrument Landing System
IN	Inches

INBD	Inboard
IND LTS	Indicator Lights
INFO	Information
INIT	Initialize/Initialization
INOP	Inoperative
INT or INTPH	Interphone
IP	Intermediate Pressure
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISFD	Integrated Standby Flight Display
ISLN	Isolation

K	
K/KTS	Knots
KGS	Kilograms
KIAS	Knots Indicated Airspeed

L	
L	Left
LBS	Pounds
LDA	Localizer-type Directional Aid
LDG ALT	Landing Altitude
LIM	Limit
LKD	Locked
L NAV LNAV	Lateral Navigation
LOC	Localizer
LWR	Lower
LWR CTR	Lower Center
LWR DSPL	Lower Display

M	
M	Mach
MAG	Magnetic
MAN	Manual
MAX	Maximum
MCP	Mode Control Panel
MDA(H)	Minimum Descent Altitude (Height)
MEL	Minimum Equipment List
MFD	Multifunction Display
MHZ	Megahertz
MIC	Microphone
MIN or MINS	Minimum(s)
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	
N	Navigation
N/A	Not Applicable
NAV	Navigation
NAV RAD	Navigation Radio
ND	Navigation Display
NGS	Nitrogen Generation System
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
OPT	Onboard Performance Tool
OVHD	Overhead
OVRD	Override
OXY	Oxygen

P	
PA	Passenger Address
PASS	Passenger
PERF INIT	Performance Initialization
PF	Pilot Flying
PFD	Primary Flight Display
PM or P/M	Pilot Monitoring
PLI	Pitch Limit Indicator
PNL	Panel
PROG	Progress
POS	Position
POS INIT	Position Initialization
PR or PRES or PRESS	Pressure
PSI	Pounds Per Square Inch
PSU	Passenger Service Unit
PTH	Path
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
RAT	Ram Air Turbine
RECIRC	Recirculation
REF	Reference
RET	Retract

RF	Refill
RMI	Radio Magnetic Indicator
RNP	Required Navigation Performance
RNV	Area Navigation (RNAV)
RPM	Revolutions Per Minute
RSV XFER	Reserve Transfer
R/T	Radio Transmit
RTA	Required Time of Arrival
RTE	Route
RTO	Rejected Takeoff
RTP	Radio Tuning Panel
RVSM	Reduced Vertical Separation Minimum
RWY	Runway

S	
SAT	Static Air Temperature
SAT/ SATCOM	Satellite Communication
SB	Service Bulletin
S/C	Step Climb
SDF	Simplified Directional Facility
SEL	Select
SELCAL	Selective Call
SERV	Service
SID	Standard Instrument Departure
SPD	Speed
STA	Station
STAB	Stabilizer
STAT	Status
STBY	Standby
STD	Standard
SUPR-NMRY	Supernumerary
SYNC	Synchronous
SYS	System

T	
T or TRU	True
T or TK or TRK	Track
TA	Traffic Advisory
TAS	True Airspeed
TAT	Total Air Temperature
T/C	Top-of-Climb
TCAS	Traffic Alert and Collision Avoidance System
T/D	Top of Descent
TERR	Terrain
TFC	Traffic
THR	Thrust
TO	Takeoff
TO/GA	Takeoff/Go–Around
TRU	Tru (reference to True North)
TRU	Transformer Rectifier Unit

U	
U/D	Upper Deck

UNLKD	Unlocked
UPR DSPL	Upper Display
UTC	Coordinated Universal Time

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

W	
WPT	Waypoint
WX or 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 The Boeing Company 747 Flight Crew Operations Manual, Boeing Document Number D6-30151-8.

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
0	March 1, 2011		1	May 18, 2011	
2	October 1, 2011		3	April 1, 2012	
4	October 1, 2012		5	April 1, 2013	
6	October 1, 2013		7	April 1, 2014	

General

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

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

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

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

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

Filing Instructions

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

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

Revision Highlights

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

Chapter 0 - Preface

Section 1 - Model Identification

0.1.1 - Revised to add/change an airplane entry.

Section 6 - Bulletin Record

0.6.2 - Revised to reflect current bulletin status.

Chapter L - Limitations

Section 10 - Operating Limitations

Operational Limitations

L.10.1 - Revised maximum takeoff and landing altitude for consistency with AFM.

L.10.1 - Added maximum field elevation for consistency with AFM.

L.10.1 - Revised Note for consistency with AFM.

Maximum Landing Weight

L.10.3 - Revised maximum landing weight for consistency with AFM.

Maximum Zero Fuel Weight

L.10.4 - Revised maximum zero fuel weight for consistency with AFM.

Auxiliary Power Unit (APU)

L.10.6 - Moved APU start cycle restrictions from chapter-section 7.31 to L.10 for consistency.

Fuel System

L.10.7 - Revised paragraph for editorial reasons with no change to technical content.

Chapter NP - Normal Procedures

Section 21 - Amplified Procedures

Takeoff Procedure

NP.21.35 - Revised to add step for enhanced safety.

Landing Procedure - ILS/GLS

NP.21.42 - Added LNAV as a mode that can be used to intercept the final approach course. This is to help prevent a possilbe misconception that the procedure requires the use of a heading or track mode to intercept the final approach course.

Chapter SP - Supplementary Procedures

Section 16 - Adverse Weather

Takeoff - Wet or Contaminated Runway Conditions

SP.16.1 - Revised the wet snow depth to match the data in the Performance Inflight (PI) chapter.

Operation in a Sandy or Dusty Environment

SP.16.20 - Revised to reflect 30% is correct for 747-8.

Chapter PD - Performance Dispatch

Section 10 - Table of Contents

PD.TOC.10.1,PD.ModID.10.1 - 747-8 GENX-2B67 KG M EASA TO1-10% TO2-20% was added as Section 10.

Section 10 - Takeoff

Takeoff

PD.10.1 - 747-8 GENX-2B67 KG M EASA TO1-10% TO2-20% was added as Section 10.

Section 20 - Table of Contents

PD.TOC.20.1,PD.ModID.20.1 - 747-8F GENX-2B67 LB FT FAA TO1-10% TO2-20% was added as Section 20.

Section 20 - Takeoff

Takeoff

PD.20.1 - 747-8F GENX-2B67 LB FT FAA TO1-10% TO2-20% was added as Section 20.

Chapter PI - Performance Inflight

Section 10 - Table of Contents

PI.TOC.10.1,PI.ModID.10.1 - 747-8 GENX-2B67 KG M EASA TO1-10% TO2-20% was added as Section 10.

Section 10 - General

General

PI.10.1 - 747-8 GENX-2B67 KG M EASA TO1-10% TO2-20% was added as Section 10.

Section 20 - Table of Contents

PI.TOC.20.1,PI.ModID.20.1 - 747-8F GENX-2B67 LB FT FAA TO1-10% TO2-20% was added as Section 20.

Section 20 - General

General

PI.20.1 - 747-8F GENX-2B67 LB FT FAA TO1-10% TO2-20% was added as Section 20.

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

Section 30 - Controls and Indicators

Exterior Lighting

1.30.16 - Revised illustration to reflect delivery configuration of switch position labels.

Chapter 2 - Air Systems

Section 20 - Air Conditioning System Description

Pack Normal Operation

2.20.2 - Revised text for consistency with chapter 2 and chapter 12.

Section 40 - Bleed Air System Description

Nitrogen Generation System (NGS)

2.40.2 - NGS installed.

2.40.2 - Reflects installation of nitrogen generation system for the center wing tank.

Chapter 4 - Automatic Flight

Section 10 - Controls and Indicators

Mode Control Panel (MCP)

4.10.1 - Added Mode Control Panel to reflect 747-8 configuration. Revised illustrations on following pages.

Section 20 - System Description

MCP Switches

4.20.2 - Deleted sentence; this functionality not installed on 747-8 airplanes.

Chapter 5 - Communications

Section 10 - Controls and Indicators

Cabin Chime Switch

5.10.22 - Revised switch nomenclature from Cabin Signal to Cabin Chime.

Section 30 - Interphone Systems

Flight Interphone System

5.30.1 - Revised paragraph to clarify two flight interphone jacks are installed on the nose landing gear.

Section 34 - Company Datalink

FMC Communications Page

5.34.3 - Added "data" for clarity.

Chapter 6 - Electrical

Section 10 - Controls and Indicators

AC Bus and Generator Controls

6.10.6-7 - Corrected nomenclature.

Section 30 - EICAS Messages

EICAS Alert Messages

6.30.1 - Deleted incorrect system logic.

6.30.1 - IDG oil pressure low, oil temperature high, or GCB open due to uncorrectable generator frequency fault.

Chapter 7 - Engines, APU

Section 10 - Controls and Indicators

Total Air Temperature (TAT), Thrust Reference, and Assummed Temperature Indications

7.10.6 - Revised title to reflect content.

7.10.6 - Revised title and description to reflect information displayed.

Section 20 - Engine System Description

Introduction

7.20.1 - Deleted unnecessary reference, "automatic", and "manual".

EEC Idle Selection

7.20.5 - EEC 060 software installed.

Autostart

7.20.6 - EEC 060 software installed.

Section 31 - APU System Description

APU Start

7.31.2 - Added table to reflect APU start transformer rectifier not installed.

Chapter 9 - Flight Controls

Section 20 - System Description

Stabilizer Trim

9.20.5 - Added section to describe the tail strike protection feature.

Chapter 10 - Flight Instruments, Displays

Section 10 - Controls and Indicators

Primary Flight Display (PFD)

10.10.1 - Deleted Deferred Systems Content paragraph; not applicable to chapter 10.

VNAV Speed Band

10.10.6 - Deleted lined-through paragraph that reflected FMCS BP 2.6.3 or later software is not installed.

Barometric Indications

10.10.28 - Added paragraph to describe barometric setting display warning.

Map Mode

10.10.34 - Revised graphic pointer to indicate display of current track.

Heading Reference Switch

10.10.65 - Added item to reflect 2015 MAG VAR table is installed.

Section 20 - System Description

Integrated Standby Flight Display (ISFD)

10.20.11 - Revised paragraph to reflect the ISFD displays true heading in polar regions.

Section 30 - Primary Flight Displays (PFDs)

Navigation Performance Indications

10.30.4 - Revised graphic by deleting UNABLE RNP EICAS message; message not applicable to vertical NPS display.

Section 40 - Navigation Displays

Introduction

10.40.1 - Deleted Deferred Systems Content paragraph; not applicable to chapter 10.

Heading

10.40.2 - Added paragraph to reflect 2015 MAG VAR table is installed.

ND Symbology

10.40.25 - Revised text to address airplanes configured with IDS 803 software and .25 nm range option.

10.40.31 - Deleted paragraph that reflected IDS 803 software with .25 nm range option is not installed.

10.40.31 - Added paragraph to reflect IDS 803 software with .25 nm range option is installed.

Section 50 - Electronic Checklist Displays

Normal Checklist

10.50.1 - Revised section for cross-model standardization.

Section 60 - Electronic Checklist Description

Introduction

10.60.1 - Revised section for cross-model standardization.

Chapter 11 - Flight Management, Navigation

Section 20 - Navigation Systems Description

Distance Measuring Equipment (DME)

11.20.6 - Changed "2/3" to "2" for clarity.

Instrument Landing System (ILS)

11.20.7 - Revised for clarity.

Transponder

11.20.10 - Added information to clarify ADS-B operation.

Section 31 - Flight Management System Operation

FMC Position Update

11.31.9 - Corrected "25" to "1.25" to clarify operation.

High Latitude Operations

11.31.10 - Added paragraph for 747-8 or 747-400NG airplanes with MAGVAR 2015.

11.31.10 - Added paragraph for 747 airplanes with TRK UP.

11.31.11 - Moved the word "flashing" from white box to amber box.

Areas of High Latitude Operations (1995 or 2005 MAGVAR)

11.31.12 - Revised to show 1995 or 2005 and not 2015 MAGVAR.

Areas of High Latitude Operations (2015 MAGVAR)

11.31.13 - Added illustration showing 2015 MAGVAR map.

Step Climb

11.31.29 - Revised callout for clarity.

11.31.31-32 - Revise Step Climb description for clarity.

11.31.32 - Added information about the EICAS message, VNAV STEP CLIMB; BP3.0 FMC software installed.

Section 32 - Flight Management Computer

Thrust Management

11.32.3 - Deleted "Q-CLB"; it is not a reference thrust limit.

Dual FMC Failure

11.32.8 - Added information about FMC failures.

Section 40 - FMC Preflight

ILS Tuning Status

11.40.37 - Revised for consistency with 11.20.

Takeoff Reference Page 1/2

11.40.52 - Added "data" for clarity.

Takeoff Reference Page 2/2

11.40.57 - Added Quiet Climb Note; BP3.0 software installed

11.40.58-59 - Added Q-CLB "ON" illustration.

Section 41 - FMC Takeoff and Climb

Climb Phase

11.41.3 - Deleted redundant paragraph.

Section 42 - FMC Cruise

Progress Page 1/4

11.42.27 - Added "TO" for clarity.

Progress Page 2/4

11.42.28 - Revised title for format consistency.

RTA Progress Page 3/4

11.42.31,34 - Revised to show waypoints shown on the Wind Data example and correct END waypoint to show speed/waypoint.

11.42.33 - Added information for clarity.

11.42.33 - Revised callout for clarity.

11.42.35 - Added information for clarity.

11.42.36 - Revised callout for clarity.

Section 44 - FMS Alternate Navigation System Description

Alternate Navigation CDU Pages

11.44.3 - Added sentence for clarity of operation.

Alternate Navigation Progress Page

11.44.7 - Revised title for format consistency.

Section 60 - EICAS Messages

EICAS Alert Messages

11.60.2 - Message is not inhibited in polar region.

11.60.2 - Revised Message Logic for clarity.

FMC Alert Messages

11.60.5 - Added Q-CLB message for airplanes not having BP3.0 FMC software.

FMC Communications Messages

11.60.7 - Added "data" for clarity.

Chapter 12 - Fuel

Section 20 - System Description

Nitrogen Generation System (NGS)

12.20.1-2 - Revised text for consistency with chapter 2 and chapter 12.

12.20.2 - Reflects installation of nitrogen generation system for the center wing tank.

Section 30 - EICAS Messages

EICAS Alert Messages

12.30.2 - Revised condition statement to clarify FUEL IMBALANCE message applies to longitudinal imbalances.

Chapter 13 - Hydraulics

Section 10 - Controls and Indicators

Hydraulic Panel

13.10.1 - Revised for clarity.

Section 30 - EICAS Messages

EICAS Messages

13.30.1 - Corrected "PRESS" to "PRES";.

13.30.1 - Deleted redundant message.

Chapter 15 - Warning Systems

Section 20 - System Description

EICAS Messages

15.20.2 - Deleted "may" to correct text.

Immediate Windshear Alerting System

15.20.31 - Added descripion sentence for consistency.

GPWS Non-Normal Operation

15.20.34 - Corrected spelling.

Alert Inhibits

15.20.35 - Added discription for consistency.

ND Display Alert Inhibits and Automatic Display

15.20.36-37 - Added "automatically" to reflect system operation with no flight crew action required.

Intentionally
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Preface — Chapter 0
V1V2 List of Effective Pages — Section 5

Volume 1

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Model Identification

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Abbreviations

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V1V2 List of Effective Pages

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Bulletins (tab)

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* = Revised, Added, or Deleted

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Performance Dispatch (tab)

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* PI.20.17	April 1, 2014	* PI.20.64	April 1, 2014
* PI.20.18	April 1, 2014	* PI.20.65	April 1, 2014
* PI.20.19	April 1, 2014	* PI.20.66	April 1, 2014
* PI.20.20	April 1, 2014	* PI.20.67	April 1, 2014
* PI.20.21	April 1, 2014	* PI.20.68	April 1, 2014
* PI.20.22	April 1, 2014	* PI.20.69	April 1, 2014
* PI.20.23	April 1, 2014	* PI.20.70	April 1, 2014
* PI.20.24	April 1, 2014	* PI.20.71	April 1, 2014
* PI.20.25	April 1, 2014	* PI.20.72	April 1, 2014
* PI.20.26	April 1, 2014	* PI.20.73	April 1, 2014
* PI.20.27	April 1, 2014	* PI.20.74	April 1, 2014
* PI.20.28	April 1, 2014	* PI.20.75	April 1, 2014
* PI.20.29	April 1, 2014	* PI.20.76	April 1, 2014
* PI.20.30	April 1, 2014	* PI.20.77	April 1, 2014
* PI.20.31	April 1, 2014	* PI.20.78	April 1, 2014
* PI.20.32	April 1, 2014	* PI.20.79	April 1, 2014
* PI.20.33	April 1, 2014	* PI.20.80	April 1, 2014
* PI.20.34	April 1, 2014	* PI.20.81	April 1, 2014
* PI.20.35	April 1, 2014	* PI.20.82	April 1, 2014
* PI.20.36	April 1, 2014	* PI.20.83	April 1, 2014
* PI.20.37	April 1, 2014	* PI.20.84	April 1, 2014
* PI.20.38	April 1, 2014	* PI.20.85	April 1, 2014
* PI.20.39	April 1, 2014	* PI.20.86	April 1, 2014
* PI.20.40	April 1, 2014	* PI.20.87	April 1, 2014
* PI.20.41	April 1, 2014	* PI.20.88	April 1, 2014
* PI.20.42	April 1, 2014	* PI.20.89	April 1, 2014
* PI.20.43	April 1, 2014	* PI.20.90	April 1, 2014
* PI.20.44	April 1, 2014	* PI.20.91	April 1, 2014
* PI.20.45	April 1, 2014	* PI.20.92	April 1, 2014
* PI.20.46	April 1, 2014	* PI.20.93	April 1, 2014
* PI.20.47	April 1, 2014	* PI.20.94	April 1, 2014
* PI.20.48	April 1, 2014	* PI.20.95	April 1, 2014
* PI.20.49	April 1, 2014	* PI.20.96	April 1, 2014
* PI.20.50	April 1, 2014	* PI.20.97	April 1, 2014
* PI.20.51	April 1, 2014	* PI.20.98	April 1, 2014
* PI.20.52	April 1, 2014	* PI.21.1	April 1, 2014
* PI.20.53	April 1, 2014	* PI.21.2	April 1, 2014
* PI.20.54	April 1, 2014	* PI.21.3	April 1, 2014
* PI.20.55	April 1, 2014	* PI.21.4	April 1, 2014
* PI.20.56	April 1, 2014	* PI.21.5	April 1, 2014
* PI.20.57	April 1, 2014	* PI.21.6	April 1, 2014
* PI.20.58	April 1, 2014	* PI.21.7	April 1, 2014
* PI.20.59	April 1, 2014	* PI.21.8	April 1, 2014

* = Revised, Added, or Deleted

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Volume 2

1 Airplane General, Emergency Equipment, Doors, Windows (tab)

* = Revised, Added, or Deleted

* 1.21.2	April 1, 2014	1.30.37	October 1, 2012
1.22.1	October 1, 2011	1.30.38	October 1, 2013
1.22.2	October 1, 2012	1.30.39	October 1, 2013
1.22.3	October 1, 2012	1.30.40	October 1, 2013
1.22.4	October 1, 2012	1.30.41	October 1, 2012
1.22.5	October 1, 2012	1.30.42	October 1, 2012
1.22.6	October 1, 2012	1.30.43	April 1, 2012
1.23.1	October 1, 2011	1.30.44	October 1, 2012
1.23.2	October 1, 2013	1.30.45	April 1, 2012
1.23.3	October 1, 2013	1.30.46	April 1, 2012
1.23.4	October 1, 2013	1.30.47	April 1, 2012
1.30.1	October 1, 2013	1.30.48	October 1, 2012
1.30.2	October 1, 2013	1.30.49	April 1, 2012
1.30.3	October 1, 2012	1.30.50	April 1, 2012
1.30.4	April 1, 2012	1.30.51	April 1, 2012
1.30.5	April 1, 2012	1.30.52	April 1, 2012
1.30.6	April 1, 2012	1.30.53	October 1, 2012
1.30.7	April 1, 2012	1.30.54	April 1, 2012
1.30.8	April 1, 2012	1.40.1	October 1, 2012
1.30.9	October 1, 2012	1.40.2	October 1, 2011
1.30.10	October 1, 2012	1.40.3	April 1, 2012
1.30.11	October 1, 2012	1.40.4	October 1, 2012
1.30.12	October 1, 2012	1.40.5	October 1, 2012
1.30.13	October 1, 2012	1.40.6	October 1, 2012
1.30.14	April 1, 2012	1.40.7	October 1, 2012
1.30.15	October 1, 2011	1.40.8	October 1, 2012
* 1.30.16	April 1, 2014	1.40.9	April 1, 2012
* 1.30.17	April 1, 2014	1.40.10	April 1, 2012
1.30.18	October 1, 2013	1.40.11	April 1, 2012
1.30.19	October 1, 2013	1.40.12	April 1, 2012
1.30.20	October 1, 2013	1.40.13	October 1, 2012
1.30.21	October 1, 2013	1.40.14	October 1, 2012
1.30.22	April 1, 2012	1.45.1	October 1, 2012
1.30.23	April 1, 2012	1.45.2	April 1, 2013
1.30.24	April 1, 2012	1.45.3	April 1, 2013
1.30.25	October 1, 2012	1.45.4	April 1, 2012
1.30.26	October 1, 2012	1.45.5	October 1, 2012
1.30.27	October 1, 2013	1.45.6	October 1, 2012
1.30.28	April 1, 2012	1.45.7	October 1, 2012
1.30.29	April 1, 2012	1.45.8	April 1, 2013
1.30.30	October 1, 2012	1.45.9	April 1, 2012
1.30.31	April 1, 2012	1.45.10	April 1, 2012
1.30.32	April 1, 2012	1.45.11	October 1, 2012
1.30.33	April 1, 2013	1.45.12	April 1, 2012
1.30.34	April 1, 2012	1.45.13	April 1, 2012
1.30.35	October 1, 2012	1.45.14	April 1, 2012
1.30.36	October 1, 2012	1.45.15	April 1, 2013

* = Revised, Added, or Deleted

1.45.16	April 1, 2012
1.50.1	October 1, 2012
1.50.2	October 1, 2012
1.50.3	October 1, 2012
1.50.4	April 1, 2012
1.50.5	October 1, 2012
1.50.6	October 1, 2012
1.50.7	October 1, 2012
1.50.8	October 1, 2012
1.50.9	April 1, 2012
1.50.10	October 1, 2012
1.50.11	October 1, 2012
1.50.12	October 1, 2012
1.50.13	October 1, 2012
1.50.14	October 1, 2011
1.50.15	October 1, 2011
1.50.16	October 1, 2012
1.50.17	October 1, 2012
1.50.18	October 1, 2012
1.60.1	October 1, 2012
1.60.2	October 1, 2012
1.60.3	October 1, 2012
1.60.4	October 1, 2011

2 Air Systems (tab)

* 2.TOC.1-2	April 1, 2014
2.10.1	October 1, 2012
2.10.2	April 1, 2012
2.10.3	April 1, 2012
2.10.4	April 1, 2012
2.10.5	April 1, 2012
2.10.6	October 1, 2012
2.10.7	April 1, 2012
2.10.8	October 1, 2012
2.10.9	October 1, 2013
2.10.10	October 1, 2013
2.10.11	October 1, 2013
2.10.12	October 1, 2013
2.10.13	October 1, 2013
2.10.14	October 1, 2013
2.10.15	October 1, 2013
2.10.16	October 1, 2013
2.10.17	October 1, 2013
2.10.18	October 1, 2013
2.10.19	October 1, 2013
2.10.20	October 1, 2013
2.10.21	October 1, 2013
2.10.22	October 1, 2013
2.10.23	October 1, 2013
2.10.24	October 1, 2013
2.10.25	October 1, 2013
2.10.26	October 1, 2013
2.10.27	October 1, 2013
2.10.28	October 1, 2013
* 2.20.1	April 1, 2014
* 2.20.2	April 1, 2014
* 2.20.3	April 1, 2014
* 2.20.4	April 1, 2014
* 2.20.5	April 1, 2014
* 2.20.6	April 1, 2014
* 2.20.7	April 1, 2014
* 2.20.8	April 1, 2014
* 2.20.9	April 1, 2014
* 2.20.10	April 1, 2014
* 2.20.11	April 1, 2014
* 2.20.12	April 1, 2014
* 2.20.13	April 1, 2014
* 2.20.14	April 1, 2014
* 2.20.15	April 1, 2014
* 2.20.16	April 1, 2014
2.30.1	October 1, 2011
2.30.2	October 1, 2012
2.30.3	October 1, 2012
2.30.4	October 1, 2011
2.40.1	October 1, 2013
* 2.40.2	April 1, 2014
* 2.40.3	April 1, 2014
* 2.40.4	April 1, 2014
2.50.1	April 1, 2013
2.50.2	October 1, 2012
2.50.3	October 1, 2013
2.50.4	October 1, 2013

3 Anti-Ice, Rain (tab)

3.TOC.1-2	October 1, 2013
3.10.1	April 1, 2012
3.10.2	April 1, 2012
3.10.3	April 1, 2012
3.10.4	October 1, 2011
3.20.1	October 1, 2013
3.20.2	April 1, 2013
3.20.3	April 1, 2012
3.20.4	October 1, 2011
3.30.1	October 1, 2012

* = Revised, Added, or Deleted

	3.30.2	October 1, 2011

4 Automatic Flight (tab)

*	4.TOC.1-2	April 1, 2014
*	4.10.1	April 1, 2014
	4.10.2	October 1, 2012
	4.10.3	October 1, 2011
*	4.10.4	April 1, 2014
*	4.10.5	April 1, 2014
*	4.10.6	April 1, 2014
*	4.10.7	April 1, 2014
*	4.10.8	April 1, 2014
*	4.10.9	April 1, 2014
*	4.10.10	April 1, 2014
*	4.10.11	April 1, 2014
*	4.10.12	April 1, 2014
*	4.10.13	April 1, 2014
*	4.10.14	April 1, 2014
	4.10.15	October 1, 2011
	4.10.16	October 1, 2011
	4.10.17	October 1, 2012
*	4.10.18	April 1, 2014
*	4.10.19	April 1, 2014
	4.10.20	October 1, 2011
*	4.20.1	April 1, 2014
*	4.20.2	April 1, 2014
*	4.20.3	April 1, 2014
*	4.20.4	April 1, 2014
*	4.20.5	April 1, 2014
*	4.20.6	April 1, 2014
*	4.20.7	April 1, 2014
*	4.20.8	April 1, 2014
*	4.20.9	April 1, 2014
*	4.20.10	April 1, 2014
*	4.20.11	April 1, 2014
*	4.20.12	April 1, 2014
*	4.20.13	April 1, 2014
*	4.20.14	April 1, 2014
*	4.20.15	April 1, 2014
*	4.20.16	April 1, 2014
*	4.20.17	April 1, 2014
*	4.20.18	April 1, 2014
*	4.20.19	April 1, 2014
*	4.20.20	April 1, 2014
	4.30.1	April 1, 2013
	4.30.2	April 1, 2013

5 Communications (tab)

*	5.TOC.1-4	April 1, 2014
	5.10.1	October 1, 2012
	5.10.2	October 1, 2012
	5.10.3	October 1, 2012
	5.10.4	April 1, 2012
	5.10.5	October 1, 2013
	5.10.6	October 1, 2013
	5.10.7	April 1, 2012
	5.10.8	April 1, 2012
	5.10.9	April 1, 2013
	5.10.10	October 1, 2012
	5.10.11	October 1, 2012
	5.10.12	October 1, 2012
	5.10.13	April 1, 2012
	5.10.14	October 1, 2012
	5.10.15	October 1, 2012
	5.10.16	October 1, 2012
	5.10.17	October 1, 2011
	5.10.18	October 1, 2011
	5.10.19	October 1, 2011
	5.10.20	October 1, 2011
	5.10.21	October 1, 2012
*	5.10.22	April 1, 2014
	5.10.23	October 1, 2012
	5.10.24	October 1, 2011
	5.10.25	October 1, 2013
	5.10.26	October 1, 2011
	5.20.1	October 1, 2013
	5.20.2	October 1, 2013
	5.20.3	October 1, 2013
	5.20.4	October 1, 2012
	5.20.5	April 1, 2013
	5.20.6	April 1, 2012
	5.20.7	October 1, 2012
	5.20.8	April 1, 2013
	5.20.9	April 1, 2013
	5.20.10	April 1, 2012
*	5.30.1	April 1, 2014
	5.30.2	April 1, 2013
	5.30.3	October 1, 2012
	5.30.4	April 1, 2013
	5.30.5	April 1, 2013
	5.30.6	April 1, 2013
	5.30.7	October 1, 2011
	5.30.8	October 1, 2011

* = Revised, Added, or Deleted

6 Electrical (tab)

7 Engines, APU (tab)

* = Revised, Added, or Deleted

	7.10.1	October 1, 2011
	7.10.2	October 1, 2011
	7.10.3	October 1, 2011
	7.10.4	October 1, 2011
	7.10.5	October 1, 2011
*	7.10.6	April 1, 2014
	7.10.7	October 1, 2011
	7.10.8	October 1, 2011
	7.10.9	April 1, 2012
	7.10.10	April 1, 2012
	7.10.11	October 1, 2012
	7.10.12	October 1, 2012
	7.10.13	October 1, 2011
	7.10.14	October 1, 2012
	7.10.15	October 1, 2011
	7.10.16	October 1, 2012
	7.10.17	April 1, 2012
	7.10.18	October 1, 2011
	7.10.19	October 1, 2012
	7.10.20	October 1, 2012
	7.10.21	October 1, 2013
	7.10.22	October 1, 2011
*	7.20.1	April 1, 2014
	7.20.2	April 1, 2012
	7.20.3	April 1, 2012
	7.20.4	October 1, 2011
*	7.20.5	April 1, 2014
*	7.20.6	April 1, 2014
*	7.20.7	April 1, 2014
*	7.20.8	April 1, 2014
	7.20.9	April 1, 2012
	7.20.10	April 1, 2012
	7.20.11	April 1, 2012
	7.20.12	April 1, 2012
	7.20.13	April 1, 2012
	7.20.14	April 1, 2012
	7.20.15	April 1, 2012
	7.20.16	April 1, 2012
	7.30.1	October 1, 2011
	7.30.2	October 1, 2011
	7.31.1	October 1, 2012
*	7.31.2	April 1, 2014
*	7.31.3-4	Deleted
	7.40.1	October 1, 2012
	7.40.2	October 1, 2012
	7.40.3	October 1, 2011
	7.40.4	October 1, 2011

8 Fire Protection (tab)

	8.TOC.1-2	October 1, 2013
	8.10.1	October 1, 2011
	8.10.2	October 1, 2011
	8.10.3	October 1, 2011
	8.10.4	October 1, 2012
	8.10.5	April 1, 2012
	8.10.6	October 1, 2012
	8.10.7	October 1, 2011
	8.10.8	October 1, 2011
	8.20.1	October 1, 2012
	8.20.2	October 1, 2012
	8.20.3	October 1, 2011
	8.20.4	October 1, 2013
	8.20.5	October 1, 2012
	8.20.6	October 1, 2012
	8.20.7	October 1, 2012
	8.20.8	October 1, 2011
	8.30.1	April 1, 2013
	8.30.2	October 1, 2013

9 Flight Controls (tab)

	9.TOC.1-2	October 1, 2013
	9.10.1	October 1, 2011
	9.10.2	October 1, 2011
	9.10.3	April 1, 2013
	9.10.4	April 1, 2012
	9.10.5	April 1, 2013
	9.10.6	October 1, 2011
	9.10.7	October 1, 2011
	9.10.8	October 1, 2011
	9.10.9	October 1, 2012
	9.10.10	October 1, 2012
	9.10.11	April 1, 2012
	9.10.12	October 1, 2011
	9.10.13	April 1, 2013
	9.10.14	April 1, 2013
	9.10.15	April 1, 2013
	9.10.16	October 1, 2012
	9.10.17	October 1, 2012
	9.10.18	October 1, 2012
	9.20.1	April 1, 2013
	9.20.2	October 1, 2013
	9.20.3	October 1, 2011
	9.20.4	April 1, 2013
*	9.20.5	April 1, 2014

* = Revised, Added, or Deleted

	9.20.6	October 1, 2012
	9.20.7	April 1, 2013
	9.20.8	October 1, 2011
	9.20.9	April 1, 2013
	9.20.10	October 1, 2012
	9.20.11	October 1, 2012
	9.20.12	April 1, 2013
	9.20.13	April 1, 2013
	9.20.14	April 1, 2013
	9.20.15	April 1, 2013
	9.20.16	April 1, 2013
	9.20.17	April 1, 2012
	9.20.18	April 1, 2012
	9.30.1	October 1, 2013
	9.30.2	October 1, 2013
	9.30.3	October 1, 2012
	9.30.4	October 1, 2011

10 Flight Instruments, Displays (tab)

*	10.TOC.1-6	April 1, 2014
*	10.10.1	April 1, 2014
*	10.10.2	April 1, 2014
*	10.10.3	April 1, 2014
*	10.10.4	April 1, 2014
*	10.10.5	April 1, 2014
*	10.10.6	April 1, 2014
	10.10.7	October 1, 2011
	10.10.8	October 1, 2011
	10.10.9	October 1, 2012
*	10.10.10	April 1, 2014
*	10.10.11	April 1, 2014
	10.10.12	October 1, 2012
	10.10.13	October 1, 2013
	10.10.14	October 1, 2011
	10.10.15	October 1, 2012
	10.10.16	October 1, 2011
	10.10.17	October 1, 2012
	10.10.18	October 1, 2011
	10.10.19	October 1, 2011
*	10.10.20	April 1, 2014
*	10.10.21	April 1, 2014
*	10.10.22	April 1, 2014
*	10.10.23	April 1, 2014
*	10.10.24	April 1, 2014
*	10.10.25	April 1, 2014
*	10.10.26	April 1, 2014
*	10.10.27	April 1, 2014
*	10.10.28	April 1, 2014
*	10.10.29	April 1, 2014
*	10.10.30	April 1, 2014
*	10.10.31	April 1, 2014
*	10.10.32	April 1, 2014
*	10.10.33	April 1, 2014
*	10.10.34	April 1, 2014
*	10.10.35	April 1, 2014
*	10.10.36	April 1, 2014
*	10.10.37	April 1, 2014
*	10.10.38	April 1, 2014
*	10.10.39	April 1, 2014
	10.10.40	October 1, 2011
	10.10.41	October 1, 2011
	10.10.42	October 1, 2012
	10.10.43	October 1, 2012
	10.10.44	October 1, 2012
	10.10.45	October 1, 2012
	10.10.46	April 1, 2012
	10.10.47	October 1, 2011
	10.10.48	October 1, 2011
	10.10.49	October 1, 2012
*	10.10.50	April 1, 2014
*	10.10.51	April 1, 2014
	10.10.52	October 1, 2011
	10.10.53	October 1, 2012
*	10.10.54	April 1, 2014
*	10.10.55	April 1, 2014
*	10.10.56	April 1, 2014
*	10.10.57	April 1, 2014
*	10.10.58	April 1, 2014
*	10.10.59	April 1, 2014
*	10.10.60	April 1, 2014
*	10.10.61	April 1, 2014
*	10.10.62	April 1, 2014
*	10.10.63	April 1, 2014
*	10.10.64	April 1, 2014
*	10.10.65	April 1, 2014
*	10.10.66	April 1, 2014
*	10.10.67	April 1, 2014
*	10.10.68	April 1, 2014
*	10.10.69	April 1, 2014
*	10.10.70	April 1, 2014
*	10.10.71	April 1, 2014
*	10.10.72	April 1, 2014
*	10.10.73	April 1, 2014
*	10.10.74	April 1, 2014

* = Revised, Added, or Deleted

* 10.10.75	April 1, 2014	10.40.13	October 1, 2012
* 10.10.76	April 1, 2014	10.40.14	October 1, 2012
* 10.10.77	April 1, 2014	10.40.15	October 1, 2012
* 10.10.78	April 1, 2014	* 10.40.16	April 1, 2014
* 10.10.79	April 1, 2014	* 10.40.17	April 1, 2014
* 10.10.80	April 1, 2014	* 10.40.18	April 1, 2014
* 10.10.81-82	Deleted	* 10.40.19	April 1, 2014
10.20.1	October 1, 2013	* 10.40.20	April 1, 2014
10.20.2	April 1, 2012	* 10.40.21	April 1, 2014
10.20.3	April 1, 2012	* 10.40.22	April 1, 2014
10.20.4	April 1, 2012	* 10.40.23	April 1, 2014
10.20.5	April 1, 2012	* 10.40.24	April 1, 2014
10.20.6	October 1, 2011	* 10.40.25	April 1, 2014
10.20.7	October 1, 2011	* 10.40.26	April 1, 2014
10.20.8	October 1, 2011	* 10.40.27	April 1, 2014
10.20.9	October 1, 2011	* 10.40.28	April 1, 2014
10.20.10	October 1, 2011	* 10.40.29	April 1, 2014
* 10.20.11	April 1, 2014	* 10.40.30	April 1, 2014
10.20.12	October 1, 2011	* 10.40.31	April 1, 2014
10.20.13	October 1, 2013	* 10.40.32	April 1, 2014
10.20.14	October 1, 2011	* 10.40.33	April 1, 2014
10.30.1	October 1, 2011	* 10.40.34	April 1, 2014
10.30.2	April 1, 2012	* 10.40.35	April 1, 2014
10.30.3	October 1, 2012	* 10.40.36	April 1, 2014
* 10.30.4	April 1, 2014	* 10.40.37-38	Deleted
10.30.5	October 1, 2011	* 10.50.1	April 1, 2014
10.30.6	October 1, 2012	* 10.50.2	April 1, 2014
10.30.7	October 1, 2012	* 10.50.3	April 1, 2014
10.30.8	October 1, 2011	* 10.50.4	April 1, 2014
10.30.9	October 1, 2011	* 10.50.5	April 1, 2014
10.30.10	October 1, 2011	* 10.50.6	April 1, 2014
10.30.11	October 1, 2012	* 10.50.7	April 1, 2014
10.30.12	October 1, 2012	* 10.50.8	April 1, 2014
10.30.13	October 1, 2012	* 10.50.9	April 1, 2014
10.30.14	October 1, 2012	* 10.50.10	April 1, 2014
* 10.40.1	April 1, 2014	* 10.50.11	April 1, 2014
* 10.40.2	April 1, 2014	* 10.50.12	April 1, 2014
* 10.40.3	April 1, 2014	* 10.50.13	April 1, 2014
* 10.40.4	April 1, 2014	* 10.50.14	April 1, 2014
10.40.5	October 1, 2012	* 10.50.15	April 1, 2014
10.40.6	October 1, 2012	* 10.50.16	April 1, 2014
10.40.7	October 1, 2012	* 10.60.1	April 1, 2014
10.40.8	October 1, 2012	* 10.60.2	April 1, 2014
10.40.9	October 1, 2012	* 10.60.3	April 1, 2014
10.40.10	October 1, 2012	* 10.60.4	April 1, 2014
10.40.11	October 1, 2012	* 10.60.5	April 1, 2014
10.40.12	October 1, 2012	* 10.60.6	April 1, 2014

* = Revised, Added, or Deleted

*	10.60.7	April 1, 2014
*	10.60.8	April 1, 2014
*	10.60.9	April 1, 2014
*	10.60.10	April 1, 2014
*	10.60.11	April 1, 2014
*	10.60.12	April 1, 2014
*	10.60.13	April 1, 2014
	10.60.14	October 1, 2012
	10.70.1	October 1, 2011
	10.70.2	October 1, 2011
	10.70.3	April 1, 2012
	10.70.4	October 1, 2011

11 Flight Management, Navigation (tab)

*	11.TOC.1-8	April 1, 2014
*	11.10.1	April 1, 2014
	11.10.2	October 1, 2011
	11.10.3	October 1, 2011
	11.10.4	October 1, 2011
	11.10.5	October 1, 2011
	11.10.6	April 1, 2012
	11.10.7	October 1, 2011
	11.10.8	October 1, 2012
*	11.10.9	April 1, 2014
*	11.10.10	April 1, 2014
	11.10.11	April 1, 2013
	11.10.12	October 1, 2011
	11.10.13	October 1, 2011
	11.10.14	October 1, 2011
	11.10.15	October 1, 2011
	11.10.16	October 1, 2011
	11.20.1	October 1, 2012
	11.20.2	October 1, 2011
	11.20.3	April 1, 2012
	11.20.4	April 1, 2012
	11.20.5	October 1, 2011
*	11.20.6	April 1, 2014
*	11.20.7	April 1, 2014
*	11.20.8	April 1, 2014
	11.20.9	October 1, 2012
*	11.20.10	April 1, 2014
	11.20.11	October 1, 2011
	11.20.12	October 1, 2011
	11.30.1	October 1, 2011
	11.30.2	October 1, 2012
*	11.31.1	April 1, 2014
	11.31.2	October 1, 2011
	11.31.3	October 1, 2011
*	11.31.4	April 1, 2014
*	11.31.5	April 1, 2014
*	11.31.6	April 1, 2014
	11.31.7	October 1, 2011
	11.31.8	October 1, 2011
*	11.31.9	April 1, 2014
*	11.31.10	April 1, 2014
*	11.31.11	April 1, 2014
*	11.31.12	April 1, 2014
*	11.31.13	April 1, 2014
*	11.31.14	April 1, 2014
*	11.31.15	April 1, 2014
*	11.31.16	April 1, 2014
*	11.31.17	April 1, 2014
*	11.31.18	April 1, 2014
*	11.31.19	April 1, 2014
*	11.31.20	April 1, 2014
*	11.31.21	April 1, 2014
*	11.31.22	April 1, 2014
*	11.31.23	April 1, 2014
*	11.31.24	April 1, 2014
*	11.31.25	April 1, 2014
*	11.31.26	April 1, 2014
*	11.31.27	April 1, 2014
*	11.31.28	April 1, 2014
*	11.31.29	April 1, 2014
*	11.31.30	April 1, 2014
*	11.31.31	April 1, 2014
*	11.31.32	April 1, 2014
*	11.31.33	April 1, 2014
*	11.31.34	April 1, 2014
*	11.31.35	April 1, 2014
*	11.31.36	April 1, 2014
*	11.31.37	April 1, 2014
*	11.31.38	April 1, 2014
*	11.31.39	April 1, 2014
*	11.31.40	April 1, 2014
*	11.31.41	April 1, 2014
*	11.31.42	April 1, 2014
*	11.31.43	April 1, 2014
*	11.31.44	April 1, 2014
*	11.31.45	April 1, 2014
*	11.31.46	April 1, 2014
*	11.31.47	April 1, 2014
*	11.31.48	April 1, 2014
*	11.31.49	April 1, 2014

* = Revised, Added, or Deleted

* 11.31.50	April 1, 2014	11.40.39	October 1, 2013
* 11.32.1	April 1, 2014	11.40.40	October 1, 2013
11.32.2	October 1, 2011	11.40.41	October 1, 2013
* 11.32.3	April 1, 2014	11.40.42	October 1, 2013
* 11.32.4	April 1, 2014	* 11.40.43	April 1, 2014
* 11.32.5	April 1, 2014	* 11.40.44	April 1, 2014
* 11.32.6	April 1, 2014	* 11.40.45	April 1, 2014
11.32.7	October 1, 2011	* 11.40.46	April 1, 2014
* 11.32.8	April 1, 2014	* 11.40.47	April 1, 2014
* 11.40.1	April 1, 2014	* 11.40.48	April 1, 2014
11.40.2	October 1, 2012	* 11.40.49	April 1, 2014
11.40.3	October 1, 2013	11.40.50	October 1, 2013
* 11.40.4	April 1, 2014	11.40.51	October 1, 2013
* 11.40.5	April 1, 2014	* 11.40.52	April 1, 2014
11.40.6	April 1, 2012	* 11.40.53	April 1, 2014
11.40.7	April 1, 2012	* 11.40.54	April 1, 2014
11.40.8	October 1, 2011	11.40.55	October 1, 2013
11.40.9	October 1, 2011	11.40.56	October 1, 2013
11.40.10	October 1, 2011	* 11.40.57	April 1, 2014
11.40.11	October 1, 2011	* 11.40.58	April 1, 2014
11.40.12	October 1, 2012	* 11.40.59	April 1, 2014
11.40.13	October 1, 2012	11.40.60	October 1, 2013
11.40.14	October 1, 2011	11.40.61	October 1, 2013
11.40.15	October 1, 2011	11.40.62	April 1, 2013
11.40.16	October 1, 2011	* 11.40.63	April 1, 2014
* 11.40.17	April 1, 2014	* 11.40.64	April 1, 2014
* 11.40.18	April 1, 2014	* 11.40.65	April 1, 2014
* 11.40.19	April 1, 2014	* 11.40.66	April 1, 2014
* 11.40.20	April 1, 2014	* 11.40.67	April 1, 2014
* 11.40.21	April 1, 2014	* 11.40.68	April 1, 2014
* 11.40.22	April 1, 2014	* 11.41.1	April 1, 2014
* 11.40.23	April 1, 2014	* 11.41.2	April 1, 2014
* 11.40.24	April 1, 2014	* 11.41.3	April 1, 2014
* 11.40.25	April 1, 2014	* 11.41.4	April 1, 2014
11.40.26	October 1, 2013	* 11.41.5	April 1, 2014
11.40.27	October 1, 2013	* 11.41.6	April 1, 2014
11.40.28	October 1, 2013	* 11.41.7	April 1, 2014
11.40.29	October 1, 2013	* 11.41.8	April 1, 2014
11.40.30	October 1, 2013	* 11.41.9	April 1, 2014
11.40.31	October 1, 2013	* 11.41.10	April 1, 2014
11.40.32	October 1, 2013	* 11.41.11	April 1, 2014
11.40.33	October 1, 2013	11.41.12	October 1, 2013
11.40.34	October 1, 2013	11.41.13	October 1, 2013
11.40.35	October 1, 2013	11.41.14	October 1, 2013
11.40.36	October 1, 2013	11.41.15	October 1, 2013
* 11.40.37	April 1, 2014	11.41.16	October 1, 2011
11.40.38	October 1, 2013	11.41.17	October 1, 2011

* = Revised, Added, or Deleted

11.41.18	October 1, 2011	* 11.43.1	April 1, 2014
11.41.19	October 1, 2011	11.43.2	April 1, 2013
* 11.41.20	April 1, 2014	11.43.3	April 1, 2013
* 11.41.21	April 1, 2014	* 11.43.4	April 1, 2014
11.41.22	October 1, 2011	11.43.5	October 1, 2011
11.41.23	October 1, 2013	11.43.6	October 1, 2011
11.41.24	October 1, 2011	11.43.7	October 1, 2011
* 11.42.1	April 1, 2014	* 11.43.8	April 1, 2014
* 11.42.2	April 1, 2014	11.43.9	October 1, 2011
* 11.42.3	April 1, 2014	* 11.43.10	April 1, 2014
* 11.42.4	April 1, 2014	* 11.43.11	April 1, 2014
* 11.42.5	April 1, 2014	* 11.43.12	April 1, 2014
* 11.42.6	April 1, 2014	* 11.43.13	April 1, 2014
* 11.42.7	April 1, 2014	* 11.43.14	April 1, 2014
* 11.42.8	April 1, 2014	* 11.43.15	April 1, 2014
* 11.42.9	April 1, 2014	* 11.43.16	April 1, 2014
* 11.42.10	April 1, 2014	* 11.43.17	April 1, 2014
* 11.42.11	April 1, 2014	* 11.43.18	April 1, 2014
* 11.42.12	April 1, 2014	* 11.43.19	April 1, 2014
* 11.42.13	April 1, 2014	* 11.43.20	April 1, 2014
* 11.42.14	April 1, 2014	* 11.43.21	April 1, 2014
* 11.42.15	April 1, 2014	* 11.43.22	April 1, 2014
* 11.42.16	April 1, 2014	* 11.43.23	April 1, 2014
* 11.42.17	April 1, 2014	* 11.43.24	April 1, 2014
* 11.42.18	April 1, 2014	* 11.43.25	April 1, 2014
* 11.42.19	April 1, 2014	* 11.43.26	April 1, 2014
* 11.42.20	April 1, 2014	* 11.43.27	April 1, 2014
* 11.42.21	April 1, 2014	* 11.43.28	April 1, 2014
* 11.42.22	April 1, 2014	* 11.43.29	April 1, 2014
* 11.42.23	April 1, 2014	* 11.43.30	April 1, 2014
* 11.42.24	April 1, 2014	* 11.43.31	April 1, 2014
* 11.42.25	April 1, 2014	* 11.43.32	April 1, 2014
* 11.42.26	April 1, 2014	* 11.43.33	April 1, 2014
* 11.42.27	April 1, 2014	* 11.43.34	April 1, 2014
* 11.42.28	April 1, 2014	* 11.43.35	April 1, 2014
* 11.42.29	April 1, 2014	* 11.43.36	April 1, 2014
* 11.42.30	April 1, 2014	* 11.43.37	April 1, 2014
* 11.42.31	April 1, 2014	* 11.43.38	April 1, 2014
* 11.42.32	April 1, 2014	* 11.43.39	April 1, 2014
* 11.42.33	April 1, 2014	* 11.43.40	April 1, 2014
* 11.42.34	April 1, 2014	* 11.43.41	April 1, 2014
* 11.42.35	April 1, 2014	* 11.43.42	April 1, 2014
* 11.42.36	April 1, 2014	* 11.43.43	April 1, 2014
* 11.42.37	April 1, 2014	* 11.43.44	April 1, 2014
* 11.42.38	April 1, 2014	* 11.43.45	April 1, 2014
* 11.42.39	April 1, 2014	* 11.43.46	April 1, 2014
* 11.42.40	April 1, 2014	* 11.43.47	April 1, 2014

* = Revised, Added, or Deleted

*	11.43.48	April 1, 2014
*	11.43.49	April 1, 2014
*	11.43.50	April 1, 2014
	11.44.1	October 1, 2011
	11.44.2	October 1, 2012
*	11.44.3	April 1, 2014
	11.44.4	October 1, 2011
	11.44.5	October 1, 2011
	11.44.6	April 1, 2012
*	11.44.7	April 1, 2014
*	11.44.8	April 1, 2014
*	11.44.9	April 1, 2014
*	11.44.10	April 1, 2014
*	11.44.11	April 1, 2014
*	11.44.12	April 1, 2014
	11.60.1	April 1, 2012
*	11.60.2	April 1, 2014
	11.60.3	April 1, 2012
	11.60.4	April 1, 2012
*	11.60.5	April 1, 2014
*	11.60.6	April 1, 2014
*	11.60.7	April 1, 2014
*	11.60.8	April 1, 2014
*	11.60.9	April 1, 2014
*	11.60.10	April 1, 2014

12 Fuel (tab)

	12.TOC.1-2	October 1, 2013
	12.10.1	October 1, 2012
	12.10.2	April 1, 2013
	12.10.3	October 1, 2012
	12.10.4	October 1, 2012
	12.10.5	October 1, 2012
	12.10.6	April 1, 2013
	12.10.7	October 1, 2012
	12.10.8	October 1, 2012
	12.10.9	October 1, 2012
	12.10.10	October 1, 2012
	12.10.11	October 1, 2012
	12.10.12	October 1, 2012
	12.10.13	October 1, 2012
	12.10.14	October 1, 2011
*	12.20.1	April 1, 2014
*	12.20.2	April 1, 2014
*	12.20.3	April 1, 2014
	12.20.4	April 1, 2013
	12.20.5	October 1, 2012
	12.20.6	October 1, 2012
	12.20.7	October 1, 2011
	12.20.8	October 1, 2011
	12.20.9	October 1, 2012
	12.20.10	October 1, 2012
	12.20.11	October 1, 2012
	12.20.12	October 1, 2013
*	12.20.13	April 1, 2014
*	12.20.14	April 1, 2014
	12.20.15	October 1, 2013
	12.20.16	April 1, 2013
	12.20.17	April 1, 2013
	12.20.18	April 1, 2013
	12.20.19	April 1, 2013
	12.20.20	April 1, 2013
*	12.30.1	April 1, 2014
*	12.30.2	April 1, 2014
*	12.30.3	April 1, 2014
*	12.30.4	April 1, 2014
*	12.30.5	April 1, 2014
*	12.30.6	April 1, 2014
*	12.30.7	April 1, 2014
	12.30.8	October 1, 2011

13 Hydraulics (tab)

	13.TOC.1-2	October 1, 2013
*	13.10.1	April 1, 2014
	13.10.2	April 1, 2012
	13.10.3	April 1, 2012
	13.10.4	October 1, 2012
	13.10.5	October 1, 2011
	13.10.6	October 1, 2011
	13.20.1	April 1, 2013
	13.20.2	October 1, 2013
	13.20.3	October 1, 2013
	13.20.4	October 1, 2013
	13.20.5	October 1, 2013
	13.20.6	October 1, 2013
*	13.30.1	April 1, 2014
	13.30.2	October 1, 2011

14 Landing Gear (tab)

	14.TOC.1-2	October 1, 2013
	14.10.1	October 1, 2011
	14.10.2	October 1, 2011
	14.10.3	October 1, 2011
	14.10.4	October 1, 2011

* = Revised, Added, or Deleted

	14.10.5	April 1, 2013
	14.10.6	October 1, 2011
	14.10.7	October 1, 2011
	14.10.8	April 1, 2012
	14.10.9	April 1, 2012
	14.10.10	October 1, 2011
	14.20.1	October 1, 2011
	14.20.2	October 1, 2011
	14.20.3	October 1, 2011
	14.20.4	October 1, 2011
	14.20.5	October 1, 2011
	14.20.6	October 1, 2011
	14.20.7	October 1, 2011
	14.20.8	October 1, 2011
	14.20.9	October 1, 2011
	14.20.10	October 1, 2011
	14.30.1	October 1, 2011
	14.30.2	April 1, 2013

15 Warning Systems (tab)

*	15.TOC.1-4	April 1, 2014
	15.10.1	April 1, 2012
	15.10.2	April 1, 2012
	15.10.3	April 1, 2012
	15.10.4	April 1, 2012
	15.10.5	October 1, 2012
	15.10.6	October 1, 2012
	15.10.7	October 1, 2012
	15.10.8	April 1, 2012
	15.10.9	April 1, 2012
	15.10.10	April 1, 2012
	15.10.11	October 1, 2012
	15.10.12	October 1, 2012
	15.10.13	October 1, 2012
	15.10.14	April 1, 2013
*	15.10.15	April 1, 2014
*	15.10.16	April 1, 2014
	15.10.17	October 1, 2013
	15.10.18	April 1, 2012
	15.10.19	April 1, 2012
	15.10.20	April 1, 2012
	15.10.21	April 1, 2012
	15.10.22	April 1, 2012
	15.20.1	October 1, 2012
*	15.20.2	April 1, 2014
	15.20.3	October 1, 2011
	15.20.4	October 1, 2012
	15.20.5	October 1, 2012
	15.20.6	October 1, 2012
	15.20.7	October 1, 2012
	15.20.8	April 1, 2012
	15.20.9	April 1, 2012
	15.20.10	October 1, 2012
	15.20.11	April 1, 2012
	15.20.12	April 1, 2012
	15.20.13	April 1, 2012
	15.20.14	April 1, 2012
	15.20.15	April 1, 2012
	15.20.16	April 1, 2012
	15.20.17	October 1, 2012
	15.20.18	April 1, 2012
	15.20.19	April 1, 2012
	15.20.20	October 1, 2012
	15.20.21	April 1, 2012
	15.20.22	October 1, 2012
	15.20.23	October 1, 2013
	15.20.24	October 1, 2013
	15.20.25	October 1, 2013
	15.20.26	October 1, 2013
	15.20.27	October 1, 2013
	15.20.28	October 1, 2013
	15.20.29	October 1, 2013
	15.20.30	October 1, 2013
*	15.20.31	April 1, 2014
*	15.20.32	April 1, 2014
*	15.20.33	April 1, 2014
*	15.20.34	April 1, 2014
*	15.20.35	April 1, 2014
*	15.20.36	April 1, 2014
*	15.20.37	April 1, 2014
	15.20.38	October 1, 2013
	15.20.39	October 1, 2013
	15.20.40	October 1, 2013
	15.20.41	October 1, 2013
	15.20.42	October 1, 2013
*	15.20.43	April 1, 2014
*	15.20.44	April 1, 2014
	15.30.1	October 1, 2013
	15.30.2	October 1, 2012
	15.30.3	October 1, 2012
	15.30.4	October 1, 2012

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* = Revised, Added, or Deleted

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
TB8-1	Horizontal Stabilizer Tank Deactivated	April 1, 2013	IE
TB8-2	Engine/APU/Cargo Fire/Overheat Test Supplementary Procedure	April 1, 2013	IE
TB8-3	Reference VOR DME Distance Anomaly on the Navigation Display (ND)	April 1, 2013	IE
TB8-4	Deactivated FMC Functionality	April 1, 2013	IE
TB8-5 R3	FMC Anomalies	October 11, 2013	IE
TB8-6	APU Generator Load Shedding	April 1, 2013	IE
TB8-7	Bowed Rotor Start Mitigation	June 26, 2013	IE
TB8-8 R1	Avoidance of Ice Crystal Icing Conditions	November 25, 2013	IE
TB8-9	Reduced Flight Control Cycling Requirement for HYD COLD SYS 1, 2, 3,4 Non-Normal Checklist	October 18, 2013	CANC
TB8-10	Further Reduced Flight Control Cycling Requirement for HYD COLD SYS 1, 2, 3, 4 Non Normal Checklist	November 11, 2013	INC
TB8-11	Airframe Buffet Due to FMC Loss of Gross Weight	November 11, 2013	CANC
TB8-12	Lack of Flight Envelope Protection During an IAN Landing	November 15, 2013	IE
TB8-13	Activation of Booster Anti-Ice In Flight	December 20, 2013	CANC
TB8-14	FMC Anomalies	December 23, 2013	IE

Number	Subject	Date	Status

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Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company Seattle, Washington 98124-2207	747-8

Number: TB8-1

IssueDate: April 1, 2013

Airplane Effectivity: 806

Subject: Horizontal Stabilizer Tank Deactivated

Reason: To advise flight crews that the horizontal stabilizer tank cannot contain any fuel.

> 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

Certification for the horizontal stabilizer tank has not yet been completed, therefore the horizontal stabilizer tank cannot contain fuel. The stabilizer tank refuel / transfer line has been sealed, preventing any fuel from being loaded into the tank.

All fuel quantity indications, the fuel synoptic, fuel jettison, and overhead fuel panel operate normally, and will indicate an empty horizontal stabilizer tank.

Operating Instructions

During preflight, confirm fuel load and distributiion are correct using normal methods. Fuel cannot be loaded into the horizontal stabilizer tank. Follow normal fuel management procedures.

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 TB8-1 as "In Effect" (IE) .

This bulletin will be updated when Service Bulletin information is available for activation of the horizontal stabilizer tank.

CS3 4864

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-2

IssueDate: April 1, 2013

Airplane Effectivity: All Airplanes

Subject: Engine/APU/Cargo Fire/Overheat Test Supplementary Procedure

Reason: To advise flight crews of potential for nuisance FIRE TEST FAIL message and latched FIRE WHEEL WELL checklist.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

During a fire warning test, the FIRE WHEEL WELL warning message may display momentarily. This may occur when the signal from the wheel well fire sensor is received before the signal from the test switch being pushed is received. Once the signal from the test switch is received, the FIRE WHEEL WELL warning message is removed. The checklist is latched however, and will remain in the ECL queue. The next time ECL is displayed, the FIRE WHEEL WELL checklist will show. The system is functioning per design. Although the Normal Procedures for the flight crew do not require this test to be done, the ECL latch may remain if the test was done earlier by maintenance.

Operating Instructions

If the Engine/APU/Cargo Fire/Overheat Test is needed, do the revised Supplementary Procedure. The FIRE WHEEL WELL checklist may be latched in the ECL queue. Depending on when the fire test is performed, RESET ALL, RESET NON-NORMAL, or CHKL OVRD should be selected to clear the nuisance checklist.

Flight Crew Operations Manual Information

The table below lists the pages attached to this bulletin. Remove existing and SP.8 pages corresponding to the pages listed below and replace them with the attached pages.

Page	Date
SP.8.1-2	October 5, 2011

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 TB8-2 as "In Effect" (IE) .

This bulletin will be updated with Service Bulletin information for the software revision to eliminate the nuisance FIRE TEST FAIL message.

CS3 4873

BOEING

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-3

IssueDate: April 1, 2013

Airplane Effectivity: All Airplanes

Subject: Reference VOR DME Distance Anomaly on the Navigation Display (ND)

Reason: To inform flight crews that the reference VOR's DME distance may not show in the upper right hand corner of the ND.

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 ND mode selector on the EFIS control panel is used to select VOR mode, the DME legend and distance for the reference (on side) VOR may not show in the upper right corner of the ND.

Operating Instructions

If in the VOR mode, and the DME legend and distance for the reference VOR are not shown on the Captain's ND, place the Captain's VOR/ADF switch to VOR L. The reference VOR's DME legend and distance are shown in the lower left corner of the ND.

If in the VOR mode, and the DME legend and distance for the reference VOR are not shown on the First Officer's ND, place the First Officer's VOR/ADF switch to VOR R. The reference VOR's DME legend and distance are shown in the lower right corner of the ND.

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 TB8-3 as "In Effect" (IE) .

This bulletin will be cancelled when the IDS software has been updated to correct this anomaly.

CS3 4881

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-4

IssueDate: April 1, 2013

Airplane Effectivity: All Airplanes

Subject: Deactivated FMC Functionality

Reason: This bulletin informs flight crews of several deactivated FMC functions.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

914

This bulletin applies to affected airplanes when modified by SB 747-34-2982 or SB 747-34-3004 or SB 747-34-3016 or their production equivalents.

Some FMC functions are deactivated in the initial FMC software load. These functions will be enabled in future FMC software loads:

- Quiet Climb (Q-CLB)
- Optimum Step Climb
- Recommended Altitude
- Cruise Speed Segment
- Required Time of Arrival (RTA)
- White shading for Modification (Reverse video of flight plan modifications)
- Offpath Descent
- Alternate Airport Diversion

The Flight Crew Operations Manual chapters that are affected are:

- Chapter 10, FLIGHT INSTRUMENTS, DISPLAYS

- Chapter 11, FLIGHT MANAGEMENT, NAVIGATION

Normal font indicates systems and functions that operate normally.

Strikethrough font indicates systems and functions that are deactivated.

- ~~For example, Callout 1 for VNAV Speed Band~~

Italics font indicates temporary descriptions or instructions.

- *For example, Section 40, ND Symbols, Flap Speed Proflle Points and Settings.*

Operating Instructions

Quiet Climb (Q-CLB)

The QUIET CLIMB function is deactivated. The Q-CLB prompt and the associated pages will not show on the CDU.

Optimum Step Climb

The Optimum Step Climb function is deactivated. The FMC calculation of step climbs (wind trade/optimized step) is inhibited.

A step climb must be entered on the LEGS pages as a Planned Step, as a constraint on a waypoint, using the format FLXXXS.

After the Planned Step is entered on the LEGS page, the CRZ page will show a prediction for reaching the entered altitude, either at or after the waypoint..

If there are no Planned steps for a long route, INSUFFICIENT FUEL message may show.

Recommended Altitude

RECMD - Recommended Altitude will not show on the CRZ page. All functions and indications associated with Recommended Altitude are deactivated.

Cruise Speed Segment

Cruise Speed Segment function is inhibited. Cruise speed is entered on the VNAV ECON CRZ page.

Entering a Mach cruise speed constraint on the LEGS page for a cruise waypoint will result in “INVALID ENTRY” FMC Advisory Message.

Required Time of Arrival

The Required Time of Arrival function is deactivated. The RTA prompt and the associated pages will not show on the CDU.

White shading for Modification (Reverse Video of flight plan modifications)

Flight plan data modifications will be reflected in (MOD) preceding page titles of modified pages without white shading (reverse video). The waypoint name will be displayed without white shading (reverse video).

Offpath Descent

OFFPATH DES prompt and function is deactivated. The OFFPATH DES prompt and associated pages will not show on the CDU.

Alternate Airport Diversion

Alternate Airports and the Diversion function are deactivated. The ALTN prompt and associated pages will not show on the CDU.

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 TB8-4 as "In Effect" (IE) .

This bulletin will be updated when the FMC software update becomes available.

CS3 4979

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-5 R3

IssueDate: October 11, 2013

Airplane Effectivity: All Airplanes

Subject: FMC Anomalies

Reason: To inform flight crews of an updated list of FMC anomalies.

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 affected airplanes when modified by SB 747-34-3016 or production equivalents.

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

- **Reference Airport on the POS INIT Page**

  After landing, the origin airport identifier will be incorrectly shown in the REF AIRPORT field (2L) on the POS INIT page.

  Operating Instructions

  Manually enter the current airport identifier in the REF AIRPORT field (2L) on the POS INIT page during the CDU Preflight Procedure - Captain and First Officer, if needed

- **Standard Instrument Departures (SID) May Not Load into the Flight Plan on the LEGS Page**

  Before departure, entering a “Direct To” to a waypoint in the active route before a SID is selected may cause the SID not to load into the flight plan. The SID waypoints will not be shown on the LEGS page.

  Operating Instructions

  When entering a Flight Plan, before entering a “Direct To” to a waypoint in the active route:

  - On the Departure page, select the entire departure route, starting with the runway
  - Execute the runway and the departure routing

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

- **Incorrect LNAV Path for a Standard Instrument Departure (SID) May be Shown on the Navigation Display (ND)**

  After a SID is selected, the LNAV path may be shown incorrectly. The LNAV path has a larger turn radius than the radius needed to fly the SID. Reselection of the SID should show the proper LNAV path.

  Operating Instructions

  If the LNAV path for the selected SID is shown incorrectly:

  - Reselect the entire departure route, starting with the runway
  - Execute the departure route
  - Verify that the LNAV path is shown correctly on the ND.

- **UNABLE NEXT ALT**

  The UNABLE NEXT ALT scratchpad message may not show when VNAV cannot achieve an altitude constraint. The altitude range arc will be shown correctly.

  Operating Instructions

  Monitor airplane performance. If altitude constraint compliance is not assured, advise ATC.

- **ATC Uplink of a Route Replacement**

  When ATC uplinks a route replacement, “CLEARED ROUTE CLEARANCE” will be shown on the EICAS ATC message block. If the ATC uplink includes the origin airport, the LOAD prompt will not be shown and a CDU scratchpad message UNABLE TO LOAD CLEARANCE shows. The crew cannot see or load the route. The remaining data link functions and other ATC uplink messages work correctly.

  Operating Instructions

  If the LOAD prompt is not shown on the CDU after “CLEARED ROUTE CLEARANCE” shows on the EICAS ATC message block, use other approved methods to obtain the route clearance.

- **LARGE ATC UPLINK**

  When a LARGE ATC UPLINK message is shown on the EICAS ATC message block, the ACCEPT and REJECT prompts erroneously show. The ACCEPT and REJECT prompts should not show until the crew has displayed the last page of the uplinked message on the CDU.

  Operating Instructions

  If the LARGE ATC UPLINK message is shown on the EICAS ATC message block, review all of the data for that clearance on the CDU page. After the last page of the data is reviewed, select ACCEPT or REJECT.

- **Erroneous CALCULATED Fuel Quantity (QTY) on Progress Page 2 and the PERF INIT Page After Executing an ATC or Company Uplink**

  The CALCULATED Fuel QTY on Progress Page 2 (6R) and on the PERF INIT page (2L) may display an erroneous fuel quantity after executing an uplink (ATC or company). The erroneous CALCULATED Fuel QTY will be displayed for the rest of the flight.

  Operating Instructions

  If the CALCULATED Fuel Qty on Progress Page 2 changes immediately after executing an uplink (ATC or company), select the USE TOTALIZER prompt on Progress Page 2.

  Note: The FUEL DISAGREE EICAS message may also show when totalizer fuel quantity and FMC-calculated fuel quantity disagree.

- **FIX INFO Page – Manually Entered Latitude/Longitudes**

  If latitude/longitude fixes are entered in full coordinate format (e.g., N4715.4W00803.4) on one of the FIX INFO pages and the fixes are not deleted before the end of the flight, they will be stored in the FMC temporary database at flight complete. On subsequent flights, entry of a matching short coordinate format latitude/longitude fix (e.g., as N47W008) on one of the FIX INFO pages will use the stored full coordinate format latitude/longitude fix (e.g., N4715.4W00803.4) as shown on the ND.

  Entry of a matching short coordinate format latitude/longitude waypoint on one of the LEGS pages is shown correctly and it does not use the stored full coordinate format latitude/longitude fix from the FIX INFO page.

  Operating Instructions

  All manually-entered latitude/longitude fixes on one of the FIX INFO pages should be entered in full coordinate format.

- **Maximum Number of Waypoints**

  The existing route cannot include more than 150 waypoints. This includes the sequenced waypoints as well as the waypoints remaining in the flight plan.

  Operating Instructions

  If a “ROUTE FULL” message is shown, re-entering the CRZ ALT on the VNAV CLB page will clear all the sequenced waypoints. For long routes containing more than 150 waypoints, manually enter a CRZ ALT on the VNAV CLB page after reaching the Top of Climb and more than 100 miles from the Top of Descent.

- **VNAV May Sequence to the Descent Phase Early**

  VNAV may sequence to the descent phase early if one or more of the following occurs:

  - An altitude constraint equal to the cruise altitude is entered on the LEGS page for a waypoint that is in the cruise phase
  - A Planned Step point (FLxxxS) (either step climb or step descent) is entered on the LEGS page, on a waypoint that is within 200 Nautical Miles (NM) of the Top of Descent (TOD)
  - The active flight plan is modified causing an existing Planned Step point to move within 200 NM of the TOD
  - An altitude constraint is entered on a HOLD waypoint that is in the cruise phase.

  After VNAV sequences to the descent phase, the following occur:

  - If the early descent is due to entry of an altitude constraint on the LEGS page that is equal to the cruise altitude, VNAV Speed Target will reduce to the planned descent speed
  - If the early descent is due to entry of an altitude constraint on the HOLD page the speed will reduce to best hold speed
  - The VNAV CDU page shows ACT xxxx DES
  - The INSUFFCNT FUEL EICAS advisory message may show.

  Operating Instructions

  To avoid early VNAV sequencing to the decent phase:

  - Do not enter an altitude constraint on a cruise waypoint on the LEGS page
  - A Planned Step entry on the legs page for a cruise waypoint must use the format FLxxxS and the distance from the waypoint to the TOD has to be greater than 200 NM
  - When modifying the active flight plan, before executing the modification, verify that there are no planned step points within 200 NM of the TOD. If a planned step point exists within 200 NM of the TOD, erase the planned step before executing the modification
  - Do not enter an altitude constraint on a HOLD waypoint that is in the cruise phase.

  If VNAV sequences to the decent phase early, do the following:

  - Open the IAS/MACH window and set appropriate speed
  - Delete any Planned Step points that are within 200 NM of the TOD
  - Re-enter the CRZ ALT on the VNAV CLB page. This causes VNAV to return to the CLB then CRZ mode and to target ECON speed. (Note: The FMC also replaces the Origin with the Destination on the RTE page)
  - If needed, re-enter the planned step on an along-track waypoint that is more than 200 NM from the TOD

- Reselect VNAV as needed
- Push the IAS/MACH selector to close the speed window as needed.

- **During Cruise with VNAV Engaged, the Spare FMC-Computed Mach Speed May Show ".000" Intermittently.**

  During cruise flight with VNAV engaged (IAS/MACH window blank), the spare FMC may intermittently send a Mach speed of ".000" which will be shown on the on-side PFD. The FMC-computed speed target may toggle between the VNAV-calculated Mach speed target and ".000" on the PFD.

  Operating Instructions

  No crew action is needed.

- **FMC Performance Prediction for AVAIL AT Temporarily Not Updated**

  When a step altitude is entered at a waypoint on the LEGS page, and MAX altitude at the waypoint is less than the STEP TO altitude, AVAIL AT will be shown on the VNAV CRZ page. Estimated Time of Arrival (ETA) and Distance To GO (DTG) will also show to indicate where MAX altitude will be equal to STEP TO altitude. Once that waypoint is sequenced, the following may occur:

  - FMC performance prediction Distance to GO (DTG) to the AVAIL AT prediction may temporarily not update.
  - The DTG shown on the left and right CDUs may be different.
  - The Step Climb (S/C) symbol will be shown on the ND.

  Operating Instructions

  Re-enter the current CRZ ALT on the VNAV CRZ page. If needed, re-enter the planned step on an along-track waypoint.

- **FMC Performance Predictions Temporarily Not Updated During Descent**

  When manually creating a holding pattern via the CDU on a waypoint that is in the descent phase, FMC performance predictions may not update for two minutes.

  During the two minutes, the following may be observed:

  - FMC Distance to Go (DTG) to the active waypoint, Estimated Time of Arrival (ETA), and fuel predictions may not update on the ND, CDU LEGS pages, VNAV pages, and PROGRESS 1/3 page.
  - Before the hold entry is sequenced, the deceleration to the hold speed target may not occur.

  After two minutes, performance predictions resume automatically.

  <u>Operating Instructions</u>

  - When manually entering a holding pattern during descent, if the FMC DTG, ETA, and fuel predictions stop updating, performance predictions will resume automatically after two minutes. During the two minutes that FMC performance predictions are not updating:
    - Before the hold entry is sequenced, if the deceleration to the hold speed target does not occur, set the appropriate speed in the IAS/MACH window.
    - If the airplane does not descend to meet the altitude constraint, select Flight Level Change (FLCH) and manually adjust the thrust levers to achieve the appropriate descent rate.
    - Entering a DIRECT TO the active waypoint or sequencing the hold, will cause the performance predictions to resume.

- **Unintended Acceleration After a Change to the End of Descent Point**

  When the airplane is in a VNAV descent, after the start of the deceleration to the transition speed (typically 250 knots below 10,000 feet), selecting an approach procedure that changes the end of descent point may cause VNAV to target a speed greater than the 250 knots below 10,000 feet.

  <u>Operating Instructions</u>

  When the airplane is in a VNAV descent after the start of the deceleration to the transition speed, if a new approach procedure is needed:

    - Open the IAS/MACH window and set the needed speed
    - Execute the approach procedure modification
    - Push the IAS/MACH selector to close the speed window.

- **Top of Descent (T/D)**

  During descent, additional T/D symbols may show on the ND.

  Operating Instructions

  No crew action is needed.

- **STAR Common Waypoint Constraints When Changing the Selected Approach**

  When a selected approach is changed to another approach associated with the same STAR, the FMC will use the higher constraint altitude for the common waypoint.

  Operating Instructions

  When a selected approach is changed for another approach associated with the same STAR, verify waypoint constraints after changing the selected approach.

- **FMC Failure or Reset Due to an ADS Ground Station Not Disconnecting on Approach**

  If an ADS ground station stays connected to the airplane and there is (or was) an offset in the flight plan, when only two waypoints are left in the flight plan, the FMC(s) may fail or reset.

  Operating Instructions

  The flight crew should terminate all ADS connections before descending through 10,000 feet. To terminate the ADS connections:

  - Go to ATC LOGON/STATUS page 2/2
  - Select 2L to turn ADS off
  - Verify OFF is shown in large font.

- **Altitudes Erroneously Shown in Flight Level Format (FLxxx) below TRANS LVL on the LEGS Page During Descent, Approach, and Missed Approach**

  When the origin airport transition altitude is lower than the destination airport transition level, for altitudes in the specified approach procedure that are higher than the origin airport transition altitude, the LEGS page will erroneously show the altitudes in flight level format. The Baro set alert, VNAV, and Integrated Approach Navigation (IAN) operation are correct. VNAV and IAN will fly the proper altitude and path.

  <u>Operating Instructions</u>

  When the origin airport transition altitude is lower than the destination airport transition level, before descent, select the VNAV CLB page and enter the destination airport transition level in the TRANS ALT field.

- **During Go-Around with All Engines Operating, After Selecting VNAV, the FMC Thrust Reference Limit May Stay in Go-Around (GA) Mode**

  During go-around with all engines operating, after selecting VNAV, the FMC thrust reference limit may stay in GA mode.

  <u>Operating Instructions</u>

  During go-around with all engines operating, after selecting VNAV, if the FMC thrust reference limit stays in GA mode, push the Thrust (THR) switch to change the reference thrust limit to CLB.

- **VNAV Engagement anomaly after an Engine Out Go-Around**

  If a go-around is accomplished after the ENG OUT prompt on the VNAV page has been selected and executed, VNAV engagement at the acceleration height functions normally. If a second go-around is accomplished, VNAV engagement at the acceleration height may cause the following:

  - The airplane levels off
  - VNAV ALT shows on the Flight Mode Annunciation (FMA)
  - The airplane speed stays at the selected approach speed.

  After flight, power to both FMCs must be cycled to clear the fault.

  <u>Operating Instructions</u>

  After an engine out go-around, if additional go-around is needed:

  - Do not engage VNAV during climb
  - At the acceleration height, select FLCH and the maneuvering speed for the planned flap setting.
  - Once reaching cruise altitude, re-enter the CRZ ALT on the VNAV CLB page. This allows the use of VNAV for descent and approach. Also it allows the use of IAN for approach.

Administrative Information

This bulletin replaces bulletin TB8-5 R2 dated June 10, 2013. Discard TB8-5 R2. Revise the Bulletin Record to show TB8-5 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 TB8-5 R3 as "In Effect" (IE) .

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 4980

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Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-6

IssueDate: April 1, 2013

Airplane Effectivity: 806

Subject: APU Generator Load Shedding

Reason: To revise the NP Before Start Procedure and the SP16 Cold Weather Operation procedure to prevent APU generator load shedding when disconnecting external power 1.

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

Hydraulic auxiliary pumps 1 and 4 are powered by the ground handling bus. The ground handling bus is powered by external power 1 when it is connected, whether it indicates ON or AVAIL. When external power 1 is disconnected, the ground handling bus automatically transfers to APU generator 1 with a momentary power interruption. If hydraulic auxiliary pumps 1 and 4 are running, this power interruption causes both pumps to momentarily shut down and restart at the same time, resulting in a large power spike that exceeds the overload limit of the APU generator. The overload causes automatic load shedding of the utility 1, utility 2, galley 1, and galley 2 busses.

Hydraulic auxiliary pumps 1 and 4 can be on with external power 1 connected and ON, connected and AVAIL, or disconnected. However, if external power 1 os ON or AVAIL, to prevent load shedding of the above busses, both pumps must be off when external power is being disconnected. Once external power 1 is disconnected, the pumps may be turned on again if needed.

This bulletin modifies the NP Before Start procedure to ensure that external power 1 is disconnected before pressurizing hydraulics. Also, the Flight Crew Operations Manual Bulletin “SP 16 Cold Weather Hydraulics Operation” allows the hydraulic demand and auxiliary pumps to be run during the Preflight Procedure - First Officer during cold weather operations to help maintain heat in the hydraulic systems. This bulletin makes a further modification to that procedure to ensure the hydraulic pumps are turned off before external power 1 is disconnected.

The above applies only if the APU is supplying electrical power before engine start. If the APU is inoperative and engine start is accomplished using external air and external power, once any engine generator is on, load shedding will not occur when disconnecting external power 1 with hydraulic auxiliary pumps running.

Operating Instructions

Do the revised NP Before Start procedure and SP16 Cold Weather Operation procedure.

Hydraulic auxiliary pumps 1 and 4 may be on with external power 1 not connected, or with external power 1 ON, or AVAIL. However, both pumps must be off before external power 1 is disconnected. After external power 1 is disconnected, the hydraulic auxiliary pumps may be turned on again.

At all times, per normal procedures, ensure that system 4 is pressurized first or depressurized last, to prevent hydraulic fluid transfer between systems.

Administrative Information

This bulletin replaces bulletin TB8-6 dated January 3, 2013. Discard TB8-6. Revise the Bulletin Record to show TB8-6 “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 TB8-6 as "In Effect" (IE) .

This bulletin will be cancelled when a fix is incorporated that prevents load shedding when external power 1 is disconnected.

CS3-5017

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

747-8

Number: TB8-7

IssueDate: June 26, 2013

Airplane Effectivity: All Airplanes

Subject: Bowed Rotor Start Mitigation

Reason: To provide a new Supplementary Procedure that mitigates the effects of bowed rotor starts.

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

GEnx-2B engine starts occurring between approximately 30 minutes and 6 hours after engine shutdown may result in increased core (N2) vibration due to a very small deflection (bow) of the core rotor system. This is referred to as a bowed-rotor start. This results from hot air accumulating on the top part of the core, causing the N2 rotor system components at the lower part of the engine to cool at a faster rate than the N2 rotor system components exposed to the warmer air at the top of the core.

Engine inspections have shown evidence of high-pressure compressor (HPC) airfoil tip rub as a result of the bowed-rotor starts. Dry motoring the engine prior to engine start allows airflow to normalize the heat in the rotor and surrounding components, reducing the rotor bow and associated effects.

Operating Instructions

For engine starts between approximately 30 minutes and 6 hours after engine shutdown, the attached new Engine Bowed Rotor Start Supplementary Procedure may be used to mitigate the effects of bowed rotor starts. This engine start procedure incorporates a dry motoring sequence to 20% N2 and deceleration to 10% N2 or less for each engine, before engine start. Up to two engines may be motored simultaneously.

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 TB8-7 as In Effect.

CS3-5340

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-8

IssueDate: October 2, 2013

Airplane Effectivity: All 747-8 Airplanes

Subject: Avoidance of Ice Crystal Icing Conditions

Reason: To inform flight crews of a new limitation associated with ice crystal icing avoidance.

> 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

<u>Summary</u>

Boeing and GE have received several reports of uncommanded thrust loss on 747-8 and 787 GEnx engines during cruise. Pilot reports and engine data indicate the events were associated with Ice Crystal Icing (ICI). The effects on the engines in these events were varied. In some cases, there was an uncommanded N1 speed reduction, with high vibration, that self-recovered within a few seconds with no engine damage. In one case, an engine did not self-recover and was operated at reduced thrust for the rest of the flight.

The Airplane Flight Manuals (AFM) for these airplanes have been revised to require avoidance of ICI conditions. Regulatory action is expected in early October 2013 to ensure prompt implementation of the AFM requirements. The next scheduled revisions of the 787 and 747-8 Flight Crew Operations Manuals (FCOM) will include this information.

Ice Crystal Icing

All of these ICI events occurred during cruise at FL330 or above, either within or after the airplane traversed a large Mesoscale Convective System (MCS). MCSs are areas where several thunderstorms have merged, with a continuous cloud layer larger than 100 km (62 mi) across.

Within or near MCSs, ICI events have occurred where convective activity has driven a significant quantity of moisture, in the form of ice crystals, to altitudes at or above the tropopause. ICI events tend to occur in warm geographic locations, usually in large areas of light weather radar returns at cruise altitudes. Ice crystals are difficult to detect because they do not cause significant weather radar returns.

MultiScan Weather Radar

The 747-8 is equipped with the Rockwell Collins MultiScan™ weather radar system. In AUTO mode, with the gain control in the 12 o'clock position, the gain is automatically enhanced to detect moisture at cruise altitude. With this enhanced gain feature, areas of significant moisture and high densities of ice crystals at cruise altitude are expected to be indicated by solid green (or amber or red) weather radar returns.

Pilot reports indicate that the ICI events occurred within high clouds. Data also indicate these events occurred while flying over convective areas that show as amber or red returns when the weather radar is tilted down to scan altitudes below the freezing level.

GEnx ICI Events

In all thrust loss events, data indicate that ice crystals entered and collected in the initial stages of the compressor. Engine temperature data indicate small ice accretions were shed.

During one 747-8 event, two engines experienced thrust losses and ENG x THRUST messages caused by multiple surges. One of the engines recovered to idle but would not accelerate and was left at idle for the rest of the flight. The other engine recovered and operated normally for the rest of the flight. Subsequent inspections revealed compressor damage on both event engines and a third engine.

In four events, one 787 event and three 747-8 events, uncommanded engine decelerations, approximately 20 seconds in duration, and ENG THRUST x or ENG x THRUST messages occurred. All engines automatically relit, attained commanded thrust without crew action, and operated normally for the rest of the flight.

In three 747-8 events, at least one engine showed elevated N1 vibrations. The vibrations on all engines stopped after the airplane exited the weather system, and the engines operated normally for the rest of the flight. Crews should be aware that, in icing tests, GEnx engines have demonstrated their abilities to withstand elevated vibrations for long durations.

Operating Instructions

The following limitation has been added to all 747-8 AFMs:

Avoidance of Ice Crystal Icing Conditions

In order to prevent loss of thrust due to ice crystal icing:

For operations at or above 30,000 feet pressure altitude, when approaching, or in, instrument meteorological conditions or visible moisture:

Operate weather radar in automatic mode, or if in manual mode adjust gain to maximum and set tilt between -1 and -3.

If areas of green, amber or red weather radar returns are observed along the flight path:

Use manual weather radar tilt control mode and vary the tilt between -3 and -5 degrees and set the gain knob to the 12 o'clock position to determine if amber or red returns are present below the airplane's flight path.

Avoid flying within 20NM of amber or red radar returns that are displayed below the airplane's flight path.

Amplified Information

Operational modes of the weather radar are selected at the flight crew's discretion. However, when above FL300, and approaching or in areas of high altitude clouds, compliance with the above limitation is necessary to limit the aircraft's exposure to ICI conditions. Steps in the limitation should be repeated as necessary. FL300 is the minimum altitude where compliance with the limitation is necessary because all events have occurred at or above FL330.

Step 1: Operate weather radar in automatic mode, or if in manual mode adjust gain to maximum and set tilt between -1 and -3. While automatic mode is preferred when looking for areas of possible ICI **at flight altitude** (to take advantage of the enhanced gain feature), manual mode can be used. When looking for areas of possible ICI at flight altitude in manual mode, the gain should be increased to maximum to show any areas of high altitude ice crystals. This is also needed if the auto-tilt feature of the weather radar is inoperative.

Step 2: Use manual weather radar tilt control mode and vary the tilt between -3 and -5 degrees and set the gain knob to the 12 o'clock position to determine if amber or red returns are present below the airplane's flight path. If areas of possible ICI are detected **at flight altitude** in step 1 (green, amber, or red weather radar returns), the crew should tilt the radar down in manual mode, return the gain control to the 12 o'clock position, and scan below the freezing level to identify areas of heavy precipitation, shown as amber or red weather radar returns. Tilt angles of approximately -3 to -5 degrees are suggested to scan below the freezing level. Other radar tilt angle techniques and operational experience can be used to increase the effectiveness of scanning below the freezing level. Any amber or red weather radar returns shown below the freezing level (with the gain control in the 12 o'clock position) indicate possible ICI conditions **at flight altitude**.

Step 3: Avoid flying within 20 NM of amber or red radar returns that are displayed below the airplane's flight path. Avoid flying within 20 NM of areas where amber or red weather radar returns are shown **below the airplane flight path** in step 2. This 20 NM buffer is added to account for variability in the weather radar returns (due to weather movement, tilt angle, distance, etc.) and variability in the airplane flight path (including altitude, speed, power setting, etc.) This 20 NM buffer can be applied in the same manner as the existing guidance to avoid a thunderstorm by a 20 NM buffer. In all situations, the flight crew must assess the situation and use good judgment to determine the safest course of action.

Once the flight crew has either cleared the area of possible ICI, or has confirmed there is no ICI threat, weather radar can be used at the flight crew's discretion.

Additional References

Additional information regarding ICI; including detailed meteorological data, identification of potential ICI areas, and event data collection by Boeing; can be found in the Flight Operations Technical Bulletin titled *Ice Crystal Icing* dated April 15, 2011.

For general information, see the following MyBoeingFleet websites:

AERO Magazine

Avoiding Convective Weather Linked to Ice-Crystal Icing Engine Events

["AERO Magazine", QTR_01 2010, "View Issue"]

Engine Power Loss in Ice Crystal Conditions

["AERO Magazine", QTR_04 2007, "View Issue"]

Air France Training Module

Ice Crystals at High Altitude: Engine Powerloss, TAT and Pitot Anomalies

["Flight Operations", "Events, Training & Resources", "Safety Tools & Training Aids", "Ice Crystals at High Altitude"]

Symposium Briefing

Ice Crystal Threat

[“Flight Operations”, “Past Flight Operations Conference Presentations”, “More...”, 2008, “Regional Flight Operations Conferences”, “Ice Crystal Threat” and “Ice Crystal Threat - FAQ”]

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 TB8-8 as "In Effect" (IE) .

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

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
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-8 R1

IssueDate: November 25, 2013

Airplane Effectivity: All 747-8 Airplanes

Subject: Avoidance of Ice Crystal Icing Conditions

Reason: To inform flight crews of a revision to the limitation associated with ice crystal icing avoidance.

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

<u>Summary</u>

Boeing and GE have received several reports of uncommanded thrust loss and damage on GEnx engines. Pilot reports and engine data indicate the events were associated with Ice Crystal Icing (ICI).

The Airplane Flight Manuals (AFM) have been revised to require further avoidance of ICI conditions. To ensure prompt implementation of the AFM revision, regulatory action is expected.

<u>Ice Crystal Icing</u>

All of the GEnx ICI events have occurred during cruise at FL330 or above, either within or after the airplane traversed a large Mesoscale Convective System (MCS). MCSs are areas where several thunderstorms have merged, with a continuous cloud layer larger than 100 km (62 mi) across.

Within or near MCSs, ICI events have occurred where convective activity has driven a significant quantity of moisture, in the form of ice crystals, to altitudes at or above the tropopause. ICI events tend to occur in warm geographic locations, usually in large areas of light weather radar returns at cruise altitudes. Ice crystals are difficult to detect because they do not cause significant weather radar returns.

MultiScan Weather Radar

The 747-8 is equipped with the Rockwell Collins MultiScan™ weather radar system. In AUTO mode, with gain control in the 12 o'clock position, the gain is automatically enhanced to detect moisture at cruise altitude. With this enhanced gain feature, areas of significant moisture and high densities of ice crystals at cruise altitude are expected to be indicated by solid green (or amber or red) weather radar returns.

Pilot reports indicate that the ICI events occurred within high clouds. Data also indicate these events occurred while flying over or near convective areas that show as amber or red returns when the weather radar is tilted down to scan altitudes below the freezing level.

GEnx ICI Events

ICI events have included increased engine vibration, uncommanded temporary thrust loss, and uncommanded unrecoverable thrust loss during cruise. In some events, significant engine compressor damage was found after landing.

Event data indicate that ice crystals entered and collected in the compressor. Engine temperature data indicate small ice accretions were shed.

Operating Instructions

The Certificate Limitations chapter of all 747-8 AFMs has been revised to state:

> ***Avoidance of Ice Crystal Icing***
>
> *In order to prevent loss of thrust and engine damage due to ice crystal icing*, for operations at or above 30,000 feet, when approaching, or in, instrument meteorological conditions or visible moisture:
>
> > *The flight crew must comply with the Avoidance of Ice Crystal Icing procedure contained in the Operating Procedures chapter of this manual.*
> >
> > *When following the Avoidance of Ice Crystal Icing procedure, flight is prohibited within 50NM of amber or red radar returns that are displayed below the airplane's flight path.*

The Operating Procedures chapter of all 747-8 AFMs has been revised to state:

> ***Avoidance of Ice Crystal Icing***
>
> *This procedure is required by the AVOIDANCE OF ICE CRYSTAL ICING limitation contained in the Certificate Limitations chapter of this manual. The language below shall not be modified.*
>
> *Operations in ice crystal icing can cause unrecoverable loss of thrust and engine damage due to ice crystal icing.*
>
> *For operations at or above 30,000 feet, when approaching, or in, instrument meteorological conditions or visible moisture:*
>
> > *Operate weather radar in automatic mode and gain knob set to the 12 o'clock position, or if in manual mode adjust gain to maximum and set tilt between -1 and -3.*
>
> *If areas of green, amber or red weather radar returns are observed along the flight path:*
>
> *Use manual weather radar tilt control mode and vary the tilt between -3 and -5 degrees and set the gain knob to the 12 o'clock position to determine if amber or red returns are present below the airplane's flight path.*
>
> > *Flight is prohibited within 50NM of amber or red radar returns that are displayed below the airplane's flight path.*

<u>Amplified Information</u>

Operational modes of the weather radar are selected at the flight crew's discretion. However, when at or above FL300, and approaching or in instrument meteorological conditions or visible moisture, compliance with the Avoidance of Ice Crystal Icing procedure is necessary to limit the aircraft's exposure to ICI. Steps in the procedure should be repeated as necessary. FL300 is the minimum altitude where compliance with the procedure is necessary because all ICI events have occurred at or above FL330.

Step 1: At or above FL300, and approaching or in areas of high altitude clouds, look for areas of possible ICI along the flight path.

Operate weather radar in automatic mode with gain control in the 12 o'clock position, or if in manual mode adjust gain to maximum and set tilt between -1 and -3 degrees. Green, amber or red weather radar returns indicate areas where ICI may be a threat.

While automatic mode is preferred when looking for areas of possible ICI along the flight path (to take advantage of the enhanced gain feature), manual mode can be used. When looking for areas of possible ICI along the flight path in manual mode, the gain should be increased to maximum to show any areas of high altitude ice crystals. This is also needed if the auto-tilt feature of the weather radar is inoperative.

Step 2: Look for amber or red weather radar returns **below flight altitude**.

If areas of possible ICI are detected **along the flight path** in step 1, use manual weather radar tilt control mode and vary the tilt between -3 and -5 degrees with gain control in the 12 o'clock position. Identify areas where amber or red weather radar returns are shown below the airplane's flight altitude.

Tilt angles of approximately -3 to -5 degrees are suggested to scan below the freezing level. Shallower tilt angles allow scanning below the freezing level at further distances. Other radar tilt angle techniques and operational experience can be used to increase the effectiveness of scanning below the freezing level.

Step 3: Do not fly within 50NM of areas of possible ICI.

When flying in areas of green, amber or red weather radar returns (step 1), flight within 50 NM of areas where amber or red weather radar returns are shown below flight altitude (step 2) is prohibited.

<u>Additional Information</u>

Once the flight crew has either cleared the area of possible ICI, or has confirmed there is no ICI threat, weather radar can be used at the flight crew's discretion.

At any time, if ICI is suspected, exit the ICI conditions and do the Ice Crystal Icing non-normal checklist.

The Aircraft Maintenance Manual (AMM) is being revised to add an engine inspection if ICI conditions are encountered and engine performance is affected. Flight crews should report these events to Maintenance.

Additional References

Additional information regarding ICI; including detailed meteorological data, identification of potential ICI areas, and event data collection by Boeing; can be found in the Flight Operations Technical Bulletin titled *Ice Crystal Icing* dated April 15, 2011.

For general information, see the following MyBoeingFleet websites:

AERO Magazine

Avoiding Convective Weather Linked to Ice-Crystal Icing Engine Events

["AERO Magazine", QTR_01 2010, "View Issue"]

Engine Power Loss in Ice Crystal Conditions

["AERO Magazine", QTR_04 2007, "View Issue"]

Air France Training Module

Ice Crystals at High Altitude: Engine Powerloss, TAT and Pitot Anomalies

["Flight Operations", "Events, Training & Resources", "Safety Tools & Training Aids", "Ice Crystals at High Altitude"]

Symposium Briefing

Ice Crystal Threat

[“Flight Operations”, “Past Flight Operations Conference Presentations”, “More...”, 2008, “Regional Flight Operations Conferences”, “Ice Crystal Threat” and “Ice Crystal Threat - FAQ”]

Administrative Information

This bulletin replaces bulletin TB8-8 dated October 2, 2013. Discard TB8-8. Revise the Bulletin Record to show TB8-8 “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 TB8-8 R1 as "In Effect" (IE) .

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

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
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-10

IssueDate: November 11, 2013

Airplane Effectivity: 747-8 Airplanes with IDS-802 or Later Software

Subject: Further Reduced Flight Control Cycling Requirement for HYD COLD SYS 1, 2, 3, 4 Non-Normal Checklist

Reason: To provide a revised checklist that further reduces the flight control cycling requirement for the HYD COLD SYS messages.

> 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 includes a revised HYD COLD SYS 1, 2, 3, 4 non-normal checklist, based on recent performance analyses, that requires the flight crew to verify that the affected hydraulic system temperature is at or above 14°C before takeoff.

Analyses have shown that, when OAT is at or above -46°C and the engine driven pump is running, turning on the associated demand pump provides sufficient heating for the hydraulic system temperature to reach 14°C within 10 minutes. For these temperatures, cycling of the flight controls is not needed. This change reduces crew workload. With the OAT below -46°C, primary flight control cycling is still needed for the affected hydraulic system temperature to reach 14°C before takeoff.

Primary flight control cycling should be done slowly and deliberately with 1/3 to 1/2 of full deflection, no faster than 4 seconds per cycle. A cycle is defined as beginning at the neutral position, reaching up to 1/2 deflection in each direction, and then returning to neutral. For example, one cycle of the ailerons begins at neutral, then 1/3 to 1/2 deflection left, then 1/3 to 1/2 deflection right, and ends at neutral.

Different flight controls may be moved simultaneously. If rudder is used, hold the nose wheel tiller to prevent unwanted nose wheel movement. Do **not** use flaps, speedbrakes, stabilizer trim, or thrust reversers for the flight control cycling procedure. Spoiler movement associated with control wheel input is acceptable.

When the affected hydraulic system temperature is 14°C or above, flight control cycling, if being done, may be stopped. However, to maintain the hydraulic system temperature above the 14°C threshold as long as possible, leave the demand pump selector ON as long as practicable until ready for takeoff.

The current message logic requires that the airplane be in flight or that the affected hydraulic system temperature reach 32°C or 29°C for the message to blank. Thus, completion of this revised checklist may not blank the HYD COLD SYS message before takeoff.

Operating Instructions

If the HYD COLD SYS message shows, do the attached HYD COLD SYS 1, 2, 3, 4 non-normal checklist when all engines are running. Do not takeoff until the affected hydraulic system temperature is 14°C or above.

Contrary to normal EICAS message management, the HYD COLD SYS message can stay active until after takeoff.

Flight Crew Operations Manual Information

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

Quick Reference Handbook	
Page	**Date**
13.TOC.1-2	November 11, 2013
13.1-50	November 11, 2013

Administrative Information

This bulletin replaces bulletin TB8-9, dated October 18, 2013. Discard TB8-9. Revise the Bulletin Record to show TB8-9 "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 TB8-10 as "Incorporated" (INC) .

This bulletin will be canceled when the IDS software has been updated to include the 14°C threshold.

The Electronic Checklist (ECL) will be updated in four to six weeks.

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.

CS3-5416

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Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-12

IssueDate: November 15, 2013

Airplane Effectivity: All Airplanes

Subject: Lack of Flight Envelope Protection During an IAN Landing

Reason: To advise flight crews that the autothrottle will not automatically activate with an autopilot or flight director in glide path mode.

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 747-8 airplanes with automatic autothrottle engagement for low speed conditions.

Flight Crew Operations Manual (FCOM) Chapter 4 includes the following information under *Flight Envelope Protection*:

> With A/T armed, the A/T automatically activates if no autopilot or F/D active, or an autopilot or F/D is in VNAV PTH, VNAV ALT, ALT, V/S, or G/S, and:
>
> - speed less than an FMC calculated value for one second
> - thrust below reference thrust
> - airplane altitude above 100 feet RA on approach, or airplane barometric altitude 400 feet above airport on takeoff.

The above information correctly details the capabilities of the current FMC software. With the autothrottle disconnected but armed, the autothrottle will not automatically activate with an autopilot or F/D in glide path (G/P) mode during an IAN landing.

Operating Instructions

During an IAN landing with the autothrottle armed but disconnected, do not rely on the autothrottle to automatically activate. As with all Autopilot Flight Director System (AFDS) procedures, the flight crew must always monitor airplane course, vertical path, and speed.

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 TB8-12 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.

CS3-5424

Flight Crew Operations Manual Bulletin
for
The Boeing Company

The Boeing Company **Seattle, Washington 98124-2207**	747-8

Number: TB8-14

IssueDate: December 23, 2013

Airplane Effectivity: All 747-8 Airplanes With FMC Block Point 3.0

Subject: FMC Anomalies

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

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 747-8 airplanes when modified by Boeing Service Bulletin (SB) 747-34-3031 or the production equivalent.

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

- **Uplinked Takeoff Flap Setting Not Sent to the Before Takeoff Normal Checklist in the ECL**

  When a takeoff data uplink is accepted, the uplinked flap setting that is shown on TAKEOFF REF Page 1/2 does not show on the BEFORE TAKEOFF normal checklist in the Electronic Checklist (ECL). The BEFORE TAKEOFF normal checklist shows dashes “--”. If the flap setting is manually entered in 1L on TAKEOFF REF Page 1/2, it shows correctly on the BEFORE TAKEOFF normal checklist. However, manual entry of the flap setting, deletes the uplinked V speeds.

Operating Instructions

After a takeoff data uplink is accepted, record the uplinked takeoff flap setting, V1, VR, and V2. Manually enter the recorded takeoff flap setting, V1, VR, and V2 on TAKEOFF REF Page 1/2. Both crewmembers should verify that the correct flap setting and V speeds have been entered. Execute the change.

- **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.

- **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, starting a step altitude change early, or starting a step altitude change after the planned step waypoint is sequenced, can cause the ETA and distance to go for the next planned step in 2R on the CRZ page to erroneously show NOW. ETA and DTG on PROGRESS Page 1/4 and the Step Climb (S/C) symbol on the ND are correct.

Operating Instructions

If NOW is shown in 2R on the CRZ page, verify that the STEP TO altitude in 1R and the AT title in 2R are correct by comparing them to the ETA and DTG on PROGRESS Page 1/4. If the NOW indication 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.

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 TB8-14 as "In Effect" (IE) .

The following Flight Crew Operations Manual chapters include ~~strikethrough~~ font for systems and functions that were deactivated, and *italics* font for temporary descriptions or instructions. After installation of SB 747-34-3031 or the production equivalent, all ~~strikethrough~~ systems and functions are active, and the *italics* temporary descriptions and instructions do not apply. The ~~strikethrough~~ font will be changed to normal font and the *italics* font will be deleted in the next available block revision after Boeing is notified that all airplanes in your fleet have Block Point 3.0 installed.

- Chapter 10; Flight Instruments, Displays
- Chapter 11; Flight Management, Navigation

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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Limitations Chapter L
Table of Contents Section TOC

General

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

Note: Information shown in this chapter is representative of typical limitations applicable to the 747-8 airplane and may not apply to airplanes in an operator's fleet. Refer to the FAA approved AFM to determine operating limitations applicable to specific airplanes.

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 Takeoff Steady-State Crosswind Component due to GEnx-2B limitation	30 knots
Maximum Speed with Landing Gear Extended	320K/.82M
Maximum Operating Altitude	43,100 feet pressure altitude
Maximum Takeoff and Landing Altitude	10,000 feet pressure altitude
Maximum Field Elevation	9,500 feet

Note: The capability of the airplane has been satisfactorily demonstrated for takeoff, and manual and automatic landings with tailwinds up to 15 knots. This finding does not constitute operational approval to conduct takeoffs and landings with tailwind components in excess of 10 knots.

Non–AFM Operational Information

#The turbulent air penetration speed is approximately 310 KIAS/.83M, whichever is lower.

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

Do not operate HF radios during refueling operations.

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

Note: The hangar restriction does not apply to the weather radar test mode.

Altitude Display Limits for RVSM Operations

Do no operate the airplane on the standby altimeter in RVSM airspace. The standby altimeter is not qualified for primary operation in 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

806
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.

914
The upper deck escape slide must be in the forward locked position during taxi, takeoff, and landing whenever the upper deck cabin is occupied.

Flight Deck Security Door

806

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

Ladder Enclosure Door

914

The ladder enclosure door must be closed during taxi, takeoff, and landing.

The ladder enclosure door must be closed in-flight except when entering or leaving the main deck cargo compartment.

Main Deck Occupancy

914

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

Weight Limitations

Maximum Taxi Weight

914

990,000 Pounds

806

443,613 Kilograms

Maximum Takeoff Weight

914

987,000 Pounds

806

442,252 Kilograms

Maximum Landing Weight

806

312,071 Kilograms

914

763,000 Pounds

Maximum Zero Fuel Weight

914

727,000 Pounds

806

295,288 Kilograms

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.

Autopilot

#The autopilot must not be engaged below 200 feet after takeoff.

#Without LAND 2 or LAND 3 annunciated, the autopilot must be disengaged below 100 feet RA.

Autoland capability may only be used for operations into runways at or below 9,500 feet airport field elevation.

Automatic Landing

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

#Headwind	25 knots
#Tailwind	15 knots
#Crosswind	25 knots

#The maximum glideslope angle is 3.25 degrees.

#The minimum glideslope angle is 2.5 degrees.

#The autoland capability may be used with flaps 25 or 30.

Communications

ACARS

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

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

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

Air Traffic Control Datalink

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

SATCOM Phone

Non-AFM Operational Information

Do not use SwiftBroadband service for ATC communications.

Engines, APU

Engine Limit Display Markings

Maximum and minimum limits are red.

Caution limits are amber.

Reverse Thrust

#Intentional selection of reverse thrust in flight is prohibited.

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

Tailwind and Crosswind Ground Operations

Non-AFM Operational Information

For tailwinds above 15 knots, limit engine power levels to taxi power.

For 90 degree crosswind components between 45 and 55 knots, limit engine power levels to taxi power.

CAUTION: Engines must be shut down when the 90 degree crosswind component exceeds 55 knots.

Ground Operations in Icing Conditions

If engine vibration indications are available and above 4 units, do not takeoff.

Auxiliary Power Unit (APU)

Non-AFM Operational Information

APU start cycle restrictions are:

Between starts	TR wait:	Battery wait:
1 and 2	1 minute	1 minute
2 and 3	10 minutes	5 minutes
3 and 4	20 minutes	1 minute
4 and 5	20 minutes	20 minutes
5 and 6	20 minutes	1 minute
For additional starts with TR power, wait 20 minutes between each start. For additional starts with battery power, wait 20 minutes then alternate between 1 and 20 minutes for further starts.		

If the TR should overheat with the start source switch in TR, starting power is transferred to the battery and the start continued on battery power. Any further start attempts with an overheated TR are inhibited.

A failure of the TR, other than an overheat, does not provide automatic switching to the APU battery. Under these conditions, moving APU Start Source switch to BATTERY removes the TR from the starting circuit and allows APU starting on battery power.

Flight Controls

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

Flap Operation

#Do not extend flaps above 20,000 feet.

Flight Maneuvering Load Acceleration Limits

Flaps Up: +2.5g to -1.0g.
Flaps Down: +2.0g to 0.0g.

Note: With flaps at 25 and 30, positive limits vary linearly from +2.0g at Maximum Landing Weight to +1.5g at Maximum Takeoff Weight.

Non-AFM Operational Information

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

Flight Instruments, Displays

ISFD

In the event of loss of primary air data, standby system corrections must be provided to, and applied by, the flight crew.

Flight Management, Navigation

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.

Fuel System

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

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

In-flight tank fuel temperature must be maintained at not less than -48°C (-55°F) or 3°C (5.4°F) above the fuel freezing point of the fuel being used, whichever is higher. The use of Fuel System Icing Inhibitor additives does not change the minimum fuel tank temperature limit.

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).

Runway Awareness and Advisory System (RAAS)

806

Non-AFM Operational Information

Do not use RAAS voice annunciations or alerts for navigation.

Do not use RAAS voice annunciations or alerts as a substitute for NOTAM or ATIS information.

Normal Procedures — Chapter NP
Table of Contents — Section TOC

Normal Procedures — Chapter NP
Introduction — Section 11

General

This chapter gives:

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

Normal Procedures Philosophy and Assumptions

Normal procedures for each phase of flight verify:

- 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 system controls are set correctly

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

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

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

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

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

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

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

Crew Duties

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

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

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

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

The general PF phase of flight responsibilities are:

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

The general PM phase of flight responsibilities are:

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

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

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

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

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

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

Control Display Unit (CDU) Procedures

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

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

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

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

Autopilot Flight Director System (AFDS) Procedures

The crew must always monitor:

- airplane course
- vertical path
- speed

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

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

- autopilot
- flight director
- autothrottle

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

- course
- vertical path
- thrust
- speed

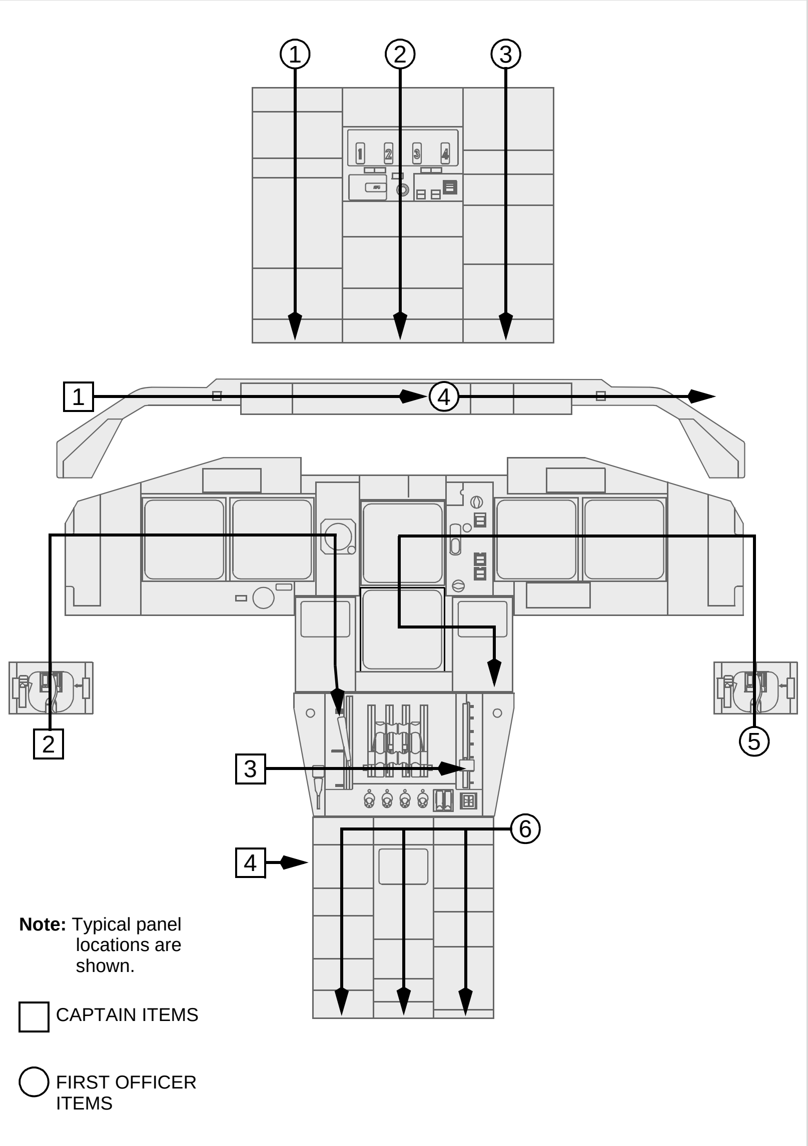
Announcing changes on the FMA and thrust mode display when they occur is a good CRM practice.

Scan Flow and Areas of Responsibility

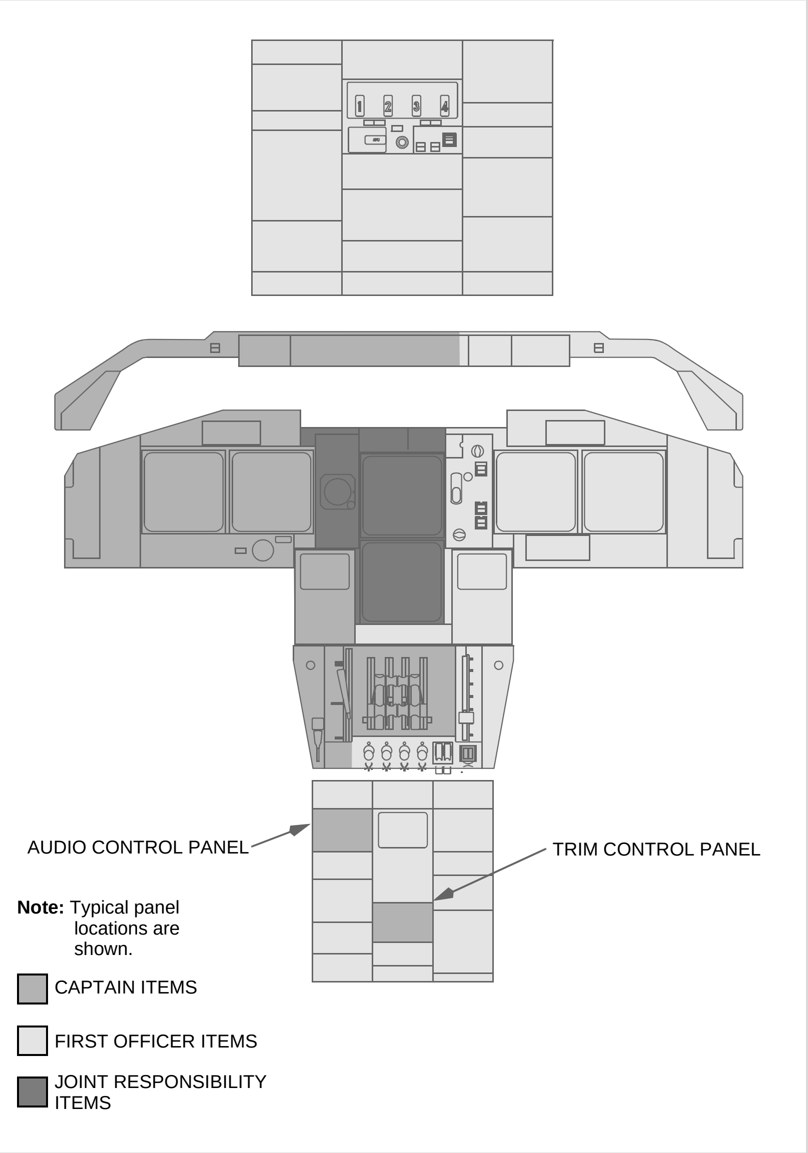
The scan flow and areas of responsibility diagrams shown below are representative and may not match the configuration(s) of your airplanes.

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

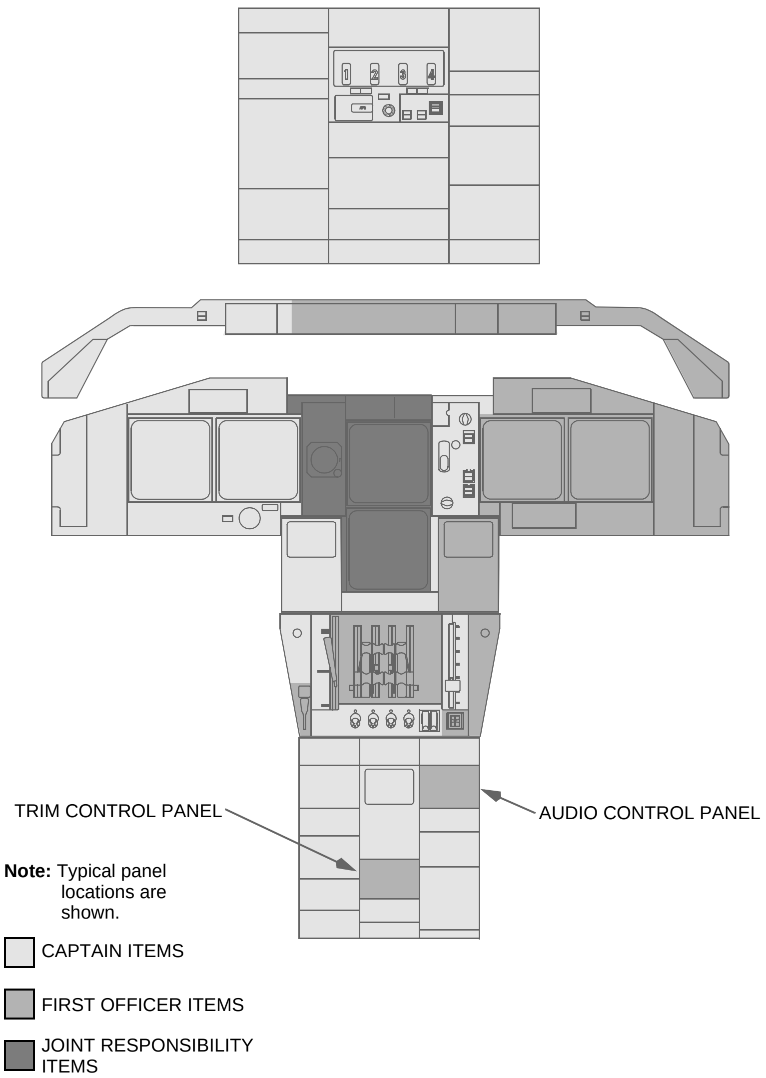
Preflight and Postflight Scan Flow



Areas of Responsibility - Captain as Pilot Flying or Taxiing



Areas of Responsibility - First Officer as Pilot Flying or Taxiing



Intentionally
Blank

Normal Procedures — Chapter NP
Amplified Procedures — Section 21

Preliminary Preflight Procedure - Captain or First Officer

The Preliminary Preflight Procedure assumes 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.

806
VOICE RECORDER switch ....As needed

STATUS display .... Check

Verify only expected messages are shown.

Verify that the Airport Map Database is current.

Verify 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

806
FLIGHT DECK ACCESS SYSTEM switch .... NORM

Circuit breakers .... Check

Emergency equipment .... Check

Fire extinguisher – Checked and stowed

Crash axe – Stowed

Emergency escape devices - Stowed

Other needed equipment - Checked and stowed

806
Hatch .... Closed and locked

Overhead maintenance panel .... Guards closed

The split system breaker OPEN light may be illuminated.

Verify all other lights are extinguished.

APU START SOURCE switch .... TR/APU BATT

LOWER LOBE AFT CARGO HT selector .... As needed.

TOWING POWER switch .... OFF

Verify the ON BAT light is extinguished.

Circuit Breakers .... Check

Parking brake .... As needed

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

CDU Preflight Procedure - Captain and First Officer

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

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

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

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

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

Initial data ....Set

IDENT page:

Verify the MODEL is correct.

Verify the ENGINES are correct.

Verify the navigation database ACTIVE date range is current.

POS INIT page:

Verify the time is correct.

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

Navigation data .... Set

RTE page:

Enter the route.

Enter the FLIGHT NUMBER.

Activate and execute the route.

DEPARTURES page:

Select the runway and departure routing.

Execute the runway and departure routing.

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

Verify or enter correct RNP for departure.

NAV RADIO page:

Tune the navigation radios, as needed.

Performance data .... Set

PERF INIT page:

Enter the ZFW.

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

Verify fuel is sufficient for flight.

Verify GR WT on CDU and dispatch papers agree.

THRUST LIM page:

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

Select a full or a derated climb thrust as needed.

TAKEOFF REF page:

Make data entries on page 2/2 before page 1/2.

806
CG - Enter

914
CG - Select

Select or enter the takeoff V speeds.

Exterior Inspection

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

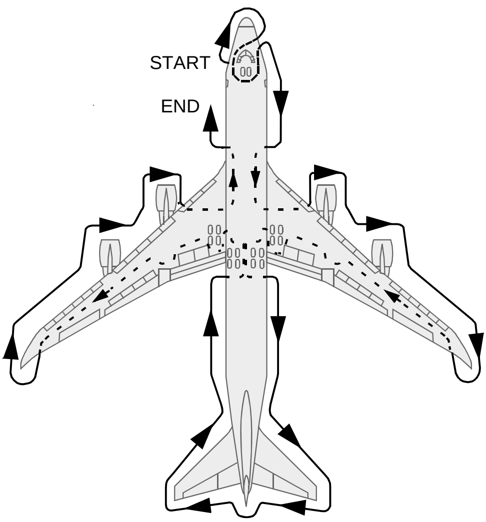
Items at each location may be checked in any sequence.

Use the detailed inspection route below to check:

- 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

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

Nose

914
Nose Cargo Door (not in use) ....Latched

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

Ram Air Turbine Door .... Check

Number 3 and 4 Engines

Access panels .... Latched

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

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

Thrust reversers .... Stowed

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

Wing Tip Rear Facing Marker light .... 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 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

806
Fuel measuring sticks .... Flush and secure

806
Fuel tank vent .... Check

APU exhaust outlet .... Check

Static discharge wicks .... Check

Left Aft Fuselage

914
Side Cargo door and access panels (not in use) .... Latched

806
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 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

Wing Tip Rear Facing Marker light .... Check

Left Wing and Leading Edge

Wing Surfaces .... Check

Fuel tank vent .... Check

Fuel measuring sticks .... Flush and secure

Leading edge flaps .... Check

Access panels .... Latched

Number 1 and 2 Engines

Exhaust area and tailcone .... Check

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

Thrust reversers .... Stowed

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

Left Wing Root, Pack, and Lower Fuselage

Fuel measuring sticks .... Flush and secure

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

Exterior lights .... Check

Pack inlet and pneumatic access doors .... Secure

Leading edge flaps .... Check

Positive pressure relief doors .... Closed

Preflight Procedure – First Officer

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

806
BROADBAND COM switch .... Guard closed

ELT switch .... Guard closed

ELECTRONIC ENGINE CONTROL switches .... NORM

Verify that the ALTN lights are extinguished.

Electrical panel .... Set

STANDBY POWER selector - AUTO

UTILITY power switches - ON

Verify the OFF lights are extinguished.

BATTERY switch – ON

Verify the OFF light is extinguished.

BUS TIE switches - AUTO

Verify ISLN lights are extinguished.

GENERATOR CONTROL switches - ON

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

APU GENERATOR 1 switch – Push

Verify the ON light is illuminated.

914
APU GENERATOR 2 switch – Push when main deck cargo handling equipment is no longer needed.

Verify the ON light is illuminated.

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

806
APU GENERATOR 2 switch – Push

Verify the ON light is illuminated.

HYDRAULIC panel ....Set

DEMAND pump selectors - OFF

Verify the hydraulic SYS FAULT lights are illuminated.

Verify the demand pump PRESS lights are illuminated.

ENGINE pump switches - ON

Verify the engine pump PRESS lights are illuminated.

EMERGENCY LIGHTS switch ....Guard closed

CAPTAIN'S AUDIO SYSTEM switch ....NORM

OBSERVER'S AUDIO SYSTEM switch ....NORM

SERVICE INTERPHONE switch .... OFF

914
CARGO INTERPHONE switch ....As needed

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

806
CARGO FIRE DISCH light - Extinguished

914
CARGO FIRE DEPRESS/DISCH lights - Extinguished

CARGO FIRE ARM switches - Off

806
Verify the FWD and AFT lights are extinguished.

914
Verify the MAIN DECK, FWD, and AFT lights are extinguished.

Engine START switches .... In

FUEL JETTISON panel .... Set

Fuel jettison selector - OFF

Fuel jettison NOZZLE valve switches - Off

Verify the VALVE lights are extinguished.

Fuel panel .... Set

All CROSSFEED valve switches - On

Verify the VALVE lights are extinguished.

All fuel pump switches – Off

Verify the main pump PRESS lights are illuminated.

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

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

806
Verify the stabilizer pump PRESS lights are extinguished.

Anti-ice panel ....Set

ENGINE ANTI-ICE switches - AUTO

WING ANTI-ICE switch - AUTO

Windshield protection panel ....Set

WINDOW HEAT switches - ON

Verify the INOP lights are extinguished.

Windshield WIPER selectors - OFF

Lighting panel ....Set

LANDING light switches - OFF

RUNWAY TURNOFF light switches - OFF

TAXI lights switch - OFF

FUEL XFER RESERVE 1&4 switch ....Guard closed

WARNING: Do not push the RAM AIR TURBINE switch. The switch causes deployment of the ram air turbine.

RAM AIR TURBINE UNLOCK light .... Verify extinguished

CENTER ADC selector ....NORM

806

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

914

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

806
PASSENGER OXYGEN switch ....Guard closed

914
SUPERNUMERARY OXYGEN switch ....Guard closed

YAW DAMPER switches ....ON

INOP lights remain illuminated until first IRU aligns.

CABIN ALTITUDE panel .... Set

LANDING ALTITUDE switch - AUTO

Verify AUTO displayed after landing altitude on Primary EICAS.

Outflow valve manual switches - Off

Cabin Altitude AUTO SELECT - NORM

806

ECS panel .... Set

PASSENGER TEMPERATURE selector - AUTO

FLIGHT DECK TEMPERATURE selector - AUTO

AFT CARGO TEMP selector - As needed

ALTERNATE VENTILATION switch - Off

ALTN VENT control selector - 12 o’clock position

TRIM AIR switch - ON

UPPER and LOWER RECIRCULATION fan switches - ON

EQUIPMENT COOLING selector - NORM

HIGH FLOW switch - Off

914

ECS panel .... Set

FLIGHT DECK FAN switch - As needed

FLIGHT DECK TEMP selector - AUTO

MAIN DECK (FWD and AFT) TEMP selectors - AUTO

ALTERNATE VENTILATION switch - Off

ALTN VENT control selector - 12 o’clock position

LOWER LOBE (FWD and AFT) TEMP selectors - As needed

EQUIPMENT COOLING selector - NORM

HIGH FLOW switch - Off

TRIM AIR switches - ON

Bleed air panel .... Set

Pack SYS FAULT light - Extinguished

PACK switches - ON

LEFT and RIGHT ISOLATION valve switches - On

Verify the VALVE lights are extinguished.

APU bleed air switch - ON

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

Map switches – As needed

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 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 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%

806
Crew and passenger oxygen pressure - Check EICAS

Verify that the pressure is adequate for dispatch.

914
Crew and supernumerary oxygen pressure - Check EICAS

Verify the pressure is adequate for dispatch.

SOURCE SELECT panel ....Set

FLIGHT DIRECTOR source selector - R

NAVIGATION source selector - FMC R

EIU source selector - AUTO

IRS source selector - AUTO

AIR DATA source selector - AUTO

INBOARD DSPL selector ....MFD

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 the flight instrument indications are correct.

Verify 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

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

806
GROUND PROXIMITY
RUNWAY 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

AUTOBRAKES selector - RTO

DISPLAY BRIGHTNESS controls .... As needed

EIU selector .... AUTO

HEADING reference switch .... NORM

FMC selector L

EICAS display .... Check

Verify the primary engine indications display existing conditions.

Verify no exceedance is shown.

MFD .... Check

Secondary ENGINE indications – Check

Verify the secondary engine indications display existing conditions.

Verify no exceedance is shown.

Status display switch - Push

Status messages – Check

CHKL display switch - Push

RESETS - Select

Verify the CHECKLIST DATABASE is current.

RESET ALL - Select

Left radio tuning panel ....Set

Center radio tuning panel ....Set

Observer audio control panel...As needed

Cabin signs ....Set

914

MAIN DECK ALERT - Off

SEATBELTS selector - AUTO or ON

Weather radar panel ....Set

Right radio tuning panel ....Set

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

Transponder panel ....Set

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

Seat .... Adjust

Position the seat for optimum eye reference.

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

Rudder pedals .... Adjust

Adjust to permit full rudder pedal and brake application.

Accomplish the PREFLIGHT checklist on the captain's command.

Preflight Procedure – Captain

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

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

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 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 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

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 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 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 the yellow cross no longer appears in the flow indicator.

Normal/100% selector - 100%

806
Crew and passenger oxygen pressure - Check EICAS

Verify the pressure is adequate for dispatch.

914
Crew and supernumerary oxygen pressure - Check EICAS

Verify the pressure is adequate for dispatch.

SOURCE SELECT panel .... Set

FLIGHT DIRECTOR source selector - L

NAVIGATION source selector - FMC L

EIU source selector - AUTO

IRS source selector - AUTO

AIR DATA source selector - AUTO

INBOARD DSPL .... MFD

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 the flight instrument indications are correct.

Verify 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.

Integrated standby flight display ....Set

Verify the approach mode display is blank.

Set the altimeter.

Verify the flight instrument indications are correct.

Verify no flags or messages are shown.

SPEEDBRAKE lever ....DN

Reverse thrust levers ....Down

Forward thrust levers ....Closed

Flap lever ....Set

The flap position indicator does not show when the flaps are up.

Set the flap lever to agree with the flap position.

PARKING BRAKE .... Set

Verify the PARK BRAKE SET message shows.

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

FUEL CONTROL switches .... CUTOFF

FUEL CONTROL switch fire warning lights .... Extinguished

STABILIZER TRIM cutout switches .... Guard closed

ALTERNATE STABILIZER TRIM switches .... Neutral

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

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

Seat .... Adjust

Position seat for optimum eye reference.

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

Rudder pedals .... Adjust

Adjust to permit full rudder pedal and brake application.

Call "PREFLIGHT CHECKLIST".

Before Start Procedure

Start the Before Start Procedure after papers are on board.

806
Flight deck door .... Closed and locked F/O

Verify that the LOCK FAIL light is extinguished.

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

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

Normally the PF selects the TAKEOFF REF page.

Normally the PM selects the LEGS page.

MCP .... Set C

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

IAS/MACH selector – Set V2

Arm LNAV as needed.

Arm VNAV.

Initial heading or track – Set

Initial altitude – Set

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

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

Exterior doors .... Verify closed F/O

If pushback is needed:

Verify the nose gear steering is locked out.

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

914
Ensure that the main deck nose cargo door Control Panel and Latch Annunciator Panel lights have been verified to confirm nose cargo door closed, latched, and locked. Ensure that both APU GENERATOR ON lights are illuminated.

806
Ensure that external power is disconnected before hydraulic auxiliary pumps 1 or 4 are pressurized.

Obtain a clearance to pressurize hydraulic systems.

Obtain a clearance to start the engines.

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

HYDRAULIC panel.. Set F/O

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

Hydraulic demand pump 4 selector – AUX

Verify the SYS FAULT light is extinguished.

Verify the PRESS light stays illuminated.

Hydraulic demand pump 1 selector - AUX

Verify the SYS FAULT light is extinguished.

Verify the PRESS light stays illuminated.

Hydraulic demand pump 2 and 3 selectors - AUTO

Verify the SYS FAULT light is extinguished.

Verify the PRESS light is extinguished.

Fuel panel .... Set F/O

All main tank FUEL PUMP switches – ON

Verify the PRESS lights are extinguished.

914
If there is 17,000 lbs or more of fuel in the center wing tank:

CENTER FUEL PUMP switches - ON

Verify the PRESS lights are extinguished.

806
If there is 7,700 kgs or more of fuel in the center wing tank:

CENTER FUEL PUMP switches - ON

Verify PRESS lights extinguished.

806
If there is fuel in the STAB tank:

STAB FUEL PUMP switches – ON

Verify the PRESS lights are extinguished.

BEACON light switch ....BOTH F/O

CANC RCL switch ....Push F/O

Verify only the expected alert messages are shown.

914
If FUEL TANK/ENG message shows:

Verify:
- main 1 + reserve 1 $\geq$ main 2, or
- main 4 + reserve 4 $\geq$ main 3, or
- main 2 or main 3 < approximately 45,700 lbs, and
- crossfeed valve 1 or 4 open

or, on ground and completion of one of the following and
- initial electrical power application, or
- refueling, or
- fuel system CMC ground test, and
- main 1 + reserve 1 + 1,000 lbs > main 2, and main 4 + reserve 4 + 1,000 lbs > main 3, and crossfeed valve 1 or 4 open

OVERRIDE pumps 2 (both) switches - Off

OVERRIDE pumps 3 (both) switches - Off

CROSSFEED valve 1 and 4 switches - Off

806
If FUEL TANK/ENG message shows:

Verify:
- main 1 + reserve 1 ≥ main 2, or
- main 4 + reserve 4 ≥ main 3, or
- main 2 or main 3 < approximately 20,700 kgs, and
- crossfeed valve 1 or 4 open

or, on ground and completion of one of the following and
- initial electrical power application, or
- refueling, or
- fuel system CMC ground test, and
- main 1 + reserve 1 + 500 kgs > main 2, and main 4 + reserve 4 + 500 kgs > main 3, and crossfeed valve 1 or 4 open

OVERRIDE pumps 2 (both) switches - Off

OVERRIDE pumps 3 (both) switches - Off

CROSSFEED valve 1 and 4 switches - Off

CANC RCL switch .... Push F/O

Verify messages cancelled

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

Stabilizer trim – ___ UNITS

Set the trim for takeoff.

Check that the trim is in the greenband.

Aileron trim – 0 units

Rudder trim – 0 units

Call “BEFORE START CHECKLIST.” C

Do the BEFORE START checklist. F/O

Pushback or Towing Procedure

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

Establish communications with ground handling personnel. C

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

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

Transponder ....As needed F/O

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

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

When pushback or towing is complete:

Verify the tow bar is disconnected. C

Verify the nose gear steering is not locked out. C

Engine Start Procedure

Select the secondary engine indications. F/O

PACK switches...SET F/O

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

Start sequence..Announce C

Call “START ___ ENGINE” C

Engine START switch .... Pull F/O

FUEL CONTROL switch ....RUN C

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

Autostart does corrective steps for:

- no EGT rise
- a hot start
- a hung start
- compressor stall
- no light-off
- starter shaft shear
- low/no starter pressure
- no N1 rotation
- starter duty cycle exceedance
- EGT exceedance
- no oil pressure rise

Before Taxi Procedure

APU selector .... OFF		F/O
Hydraulic demand pump selectors .... AUTO		F/O
ENGINE ANTI–ICE switches .... As needed		F/O
PACK switches .... ON		F/O
Select the FCTL display.		F/O
Verify the ground equipment is clear.		C, F/O
Call “FLAPS___” as needed for takeoff.		C
Flap lever .... Set takeoff flaps		F/O
Flight controls .... Check		C

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

Move the control wheel and the control column to full travel in both directions and verify:

- freedom of movement
- that the controls return to center
- correct flight control movement on EICAS display.

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

Move the rudder pedals to full travel in both directions and verify:

- freedom of movement
- that the rudder pedals return to center
- correct flight control movement on the EICAS display

Blank the lower MFD.	F/O
Transponder .... As needed	F/O

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

Recall .... Check	C, F/O

Verify only expected alert messages shown.

Update changes to the taxi briefing, as needed.	C or PF
Call "BEFORE TAXI CHECKLIST."	C
Do the BEFORE TAXI checklist.	F/O

Before Takeoff Procedure

Engine warm up requirements:

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

Engine warm up recommendations:

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

Pilot Flying	Pilot Monitoring
	806 Notify cabin crew to prepare for takeoff. Verify the cabin is secure. **914** Notify supernumerary(s) to prepare for takeoff. Verify the upper deck is secure.
The pilot who will do the takeoff updates changes to takeoff briefing as needed.	
Set the weather radar display as needed. Set the terrain display as needed.	
Call "BEFORE TAKEOFF CHECKLIST."	Do the BEFORE TAKEOFF checklist.

Takeoff Procedure

Pilot Flying	Pilot Monitoring
Before entering the departure runway, verify that the runway and runway entry point are correct.	
	When entering the departure runway, set the STROBE light switch to ON. Use other lights as needed. Position transponder mode selector to TA/RA.
Verify the brakes are released. Align the airplane with the runway.	
Verify that the airplane heading agrees with the assigned runway heading.	
	When cleared for takeoff, set the inboard LANDING lights switches to ON.
Advance the thrust levers to approximately 45% N1. Allow the engines to stabilize.	
Push the TO/GA switch.	
Verify 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 captain’s hand must be on the thrust levers until V1.	
Monitor airspeed. Maintain light forward pressure on the control column.	Monitor airspeed indications and call out any abnormal indications.

Pilot Flying	Pilot Monitoring
Verify 80 knots and call “CHECK”.	Call “80 KNOTS”.
Verify V1 speed.	Call “V1”.
At VR rotate toward 15° pitch attitude. After liftoff, follow F/D commands.	At VR, call “ROTATE”. Monitor airspeed and vertical speed.
Establish a positive rate of climb.	
	Verify a positive rate of climb on the altimeter and call “POSITIVE RATE”.
Verify a positive rate of climb on the altimeter and call “GEAR UP”.	
	Position 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 active.
Verify 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.	
	After flap retraction is complete: Position the ENGINE ANTI-ICE switches to AUTO Verify air conditioning packs operating.
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
* Full maneuver capability is available at all weights at or above the "UP" symbol.		

Climb and Cruise Procedure

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

914

Pilot Flying	Pilot Monitoring
	At or above 10,000 feet, position Inboard Landing Light switches OFF.
	Set the passenger signs as needed.
At transition altitude, set and crosscheck the altimeters to standard.	
	When the FUEL LOW CTR L or R message is shown and the tank quantity is approximately 7,000 lbs in climb (pitch 5° or greater), set both Center L and R Pump switches off.
	When the FUEL OVD CTR L or R message is shown and the tank quantity is 4,000 lbs or more in cruise (pitch less than 5°), set both Center L and R Pump switches ON.

Pilot Flying	Pilot Monitoring
	When the FUEL LOW CTR L or R message is shown and the tank quantity is approximately 3,000 lbs in cruise (pitch less than 5°), set both Center L and R Pump switches off.
	When the FUEL TANK/ENG message is shown, and • main 1 + reserve 1 ≥ main 2, or • main 4 + reserve 4 ≥ main 3, and • crossfeed valve 1 or 4 open set both OVERRIDE pumps 2 switches - Off set both OVERRIDE pumps 3 switches - Off set CROSSFEED valve 1 and 4 switches - Off
	Before the top of descent, modify the active route as needed for the arrival and approach. Verify or enter the correct RNP for arrival.

806

Pilot Flying	Pilot Monitoring
	At or above 10,000 feet, position Inboard Landing Light switches OFF.
	Set the passenger signs as needed.
At transition altitude, set and crosscheck the altimeters to standard.	
	When the FUEL LOW CTR L or R message is shown and the tank quantity is approximately 3,200 kgs in climb (pitch 5° or greater), set both Center L and R Pump switches off.

Pilot Flying	Pilot Monitoring
	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 LO STAB L or R message is shown and the tank quantity is approximately 1,100 kgs or less, set Stabilizer Tank L and R Pump switches off.
	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 • main 1 + reserve 1 ≥ main 2, or • main 4 + reserve 4 ≥ main 3, and • crossfeed valve 1 or 4 open set both OVERRIDE pumps 2 switches - Off set both OVERRIDE pumps 3 switches - Off set CROSSFEED valve 1 and 4 switches - Off
	Before the top of descent, modify the active route as needed for the arrival and approach. Verify or enter the correct RNP for arrival.

Descent Procedure

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

Complete the Descent Procedure by 10,000 feet MSL.

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

Approach Procedure

The Approach Procedure is normally started at transition level.

Complete the Approach Procedure before:

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

Pilot Flying	Pilot Monitoring
	Set the cabin signs as needed.
	At or above 10,000 feet MSL, set the inboard landing light switches to ON.
At transition level, set and crosscheck the altimeters.	
Update changes to the arrival and approach, as needed. Update the RNP, as needed.	
Update the approach briefing as needed.	
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
**Flaps 10 and Command Speed “10” are optional.			

Landing Procedure - ILS/GLS

Pilot Flying	Pilot Monitoring

806

	Notify cabin crew to prepare for landing. Verify that the cabin is secure.

914

	Notify supernumerary(s) to prepare for landing. Verify that the cabin is secure.

Call “FLAPS __” according to the flap extension schedule.	Set the flap lever as directed.
When on localizer intercept heading: • verify that the ILS/GLS is tuned and identified • verify that the LOC and G/S pointers are shown	
Arm the APP mode.	

914

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.

806

Note: When using LNAV to intercept the final approach course, LNAV might parallel the localizer without capturing it.

Use LNAV, HDG SEL, or HDG HOLD to intercept the final approach course, as needed.	
Verify that the localizer is captured.	
	Call “GLIDE SLOPE ALIVE.”
At glideslope alive, call: • “GEAR DOWN” • “FLAPS 20”	

Pilot Flying	Pilot Monitoring
	Set the landing gear lever to DN. Set the flap lever to 20.
Set the speedbrake lever to ARM.	
At glideslope capture, call "FLAPS __" as needed for landing.	Set the flap lever as directed.
Set the missed approach altitude on the MCP.	
Call "LANDING CHECKLIST."	Do the LANDING checklist.
At final approach fix or OM, verify the crossing altitude.	
Monitor the approach. Verify the autoland status at 500 feet AGL.	

Landing Procedure - IAN

This procedure is not authorized using QFE.

Select the approach procedure on the ARRIVALS page. Do not manually build the approach or add waypoints to the selected FMC procedure. Add cold temperature corrections to waypoint altitude constraints as appropriate.

Pilot Flying	Pilot Monitoring

806

	Notify cabin crew to prepare for landing. Verify that the cabin is secure.

914

	Notify supernumerary(s) to prepare for landing. Verify that the cabin is secure.

Call “FLAPS __” according to the flap extension schedule.	Set the flap lever as directed.
When on Final Approach Course intercept heading: • verify the intended approach is indicated on the PFD • verify the LOC/FAC and and GP pointers are shown in the correct position	
Arm the APP mode.	
Note: When using LNAV to intercept the final approach course, LNAV might parallel the localizer without capturing it. Use HDG SEL or HDG HOLD to intercept the final approach course if needed.	
Use appropriate roll mode to capture FAC.	
Verify that the LOC/FAC is captured.	
	Approximately 2 NM before the final approach fix, call “APPROACHING GLIDE PATH.”
Approximately 2 NM before the final approach fix, call: • “GEAR DOWN” • “FLAPS 20”	

Pilot Flying	Pilot Monitoring
	Set the landing gear lever to DN. Set the flap lever to 20.
Set the speedbrake lever to ARM.	
At glidepath capture, call “FLAPS __” as needed for landing.	Set the flap lever as directed.
Set the missed approach altitude on the MCP.	
Call “LANDING CHECKLIST.”	Do the LANDING checklist.
At final approach fix or OM, verify the crossing altitude.	
Monitor the approach. If suitable visual reference is established at MDA(H), DA(H), or the missed approach point, disengage the autopilot in accordance with regulatory requirements, and disconnect theautothrottle at the same time. Maintain the glide path to landing.	

Instrument Approach Using VNAV

Use the autopilot during the approach to give:

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

This procedure is not authorized using QFE.

Pilot Flying	Pilot Monitoring

806

	Notify cabin crew to prepare for landing. Verify that the cabin is secure.

914

	Notify supernumerary(s) to prepare for landing. Verify that the cabin is secure.

Call "FLAPS __" according to the flap extension schedule.	Set the flap lever as directed.
The recommended roll modes for the final approach are: • for a RNAV or GPS approach use LNAV • for a LOC-BC, VOR, or NDB approach use LNAV • for a LOC, SDF, or LDA approach use LNAV or LOC	
	Verify the VNAV glidepath angle is shown on the final approach segment of the LEGS page.
When on the final approach course intercept heading for LOC, LOC-BC, SDF, or LDA approaches: • verify the localizer is tuned and identified • verify the anticipation cue or LOC pointer is shown	
Arm the LNAV or LOC mode.	
Note: When using LNAV to intercept the final approach course, LNAV might parallel the localizer without capturing it. Use HDG SEL or HDG HOLD to intercept the final approach course if needed.	
Use LNAV, HDG SEL or HDG HOLD to intercept the final approach course as needed.	

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

Go–Around and Missed Approach Procedure

Pilot Flying	Pilot Monitoring
At the same time: • push the TOGA switch • call “FLAPS 20”	Set the flap lever to 20.
Verify: • the rotation to go-around attitude • that the thrust increases	
	Verify 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, verify or select a roll mode.	Verify the missed approach altitude is set.
Verify the missed approach route is being tracked.	
At acceleration height, select FLCH or VNAV. If FLCH is selected, set speed to the maneuvering speed for the planned flap setting. If VNAV is selected: • select speed intervention as needed • set speed to the maneuvering speed for the planned flap setting	
Call “FLAPS ___” according to the flap retraction schedule.	Set the flap lever as directed.
After flap retraction to the planned flap setting, if FLCH was selected, push the THRUST switch.	
Verify climb thrust is set.	
Verify the missed approach altitude is captured.	

Pilot Flying	Pilot Monitoring
Call “AFTER TAKEOFF CHECKLIST.”	Do the AFTER TAKEOFF checklist.

Landing Roll Procedure

Pilot Flying	Pilot Monitoring
Verify the thrust levers are closed. Verify the SPEEDBRAKE lever is UP.	Verify the SPEEDBRAKE lever is UP. Call “SPEEDBRAKES UP.” If the SPEEDBRAKE lever is not UP, 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.	
Without delay, move the reverse thrust levers to the interlocks and hold light pressure until the interlocks release.	Verify that the forward thrust levers are closed. When all REV indications are green, call "REVERSERS NORMAL." If there is no REV indication(s) or the indications(s) stays amber, call “NO REVERSER(S) ENGINE NUMBER ___” or “NO REVERSERS”.
Apply reverse thrust as needed.	
By 60 knots, start movement of the reverse thrust levers to be at the reverse idle detent before taxi speed.	Call “60 KNOTS”.
After the engines are at reverse idle, move the reverse thrust levers full down.	
Before taxi speed, disarm the autobrakes. Use manual braking as needed.	
Before turning off the runway, disengage the autopilot.	

After Landing Procedure

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

Engine cool down recommendations:

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

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

Shutdown Procedure

Start the Shutdown Procedure after taxi is complete.

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

Verify the PARK BRAKE SET message is shown.

806

Electrical power .... Set F/O

If APU power is needed:

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

APU GENERATOR 1 switch - Push

Verify the ON light is illuminated

APU GENERATOR 2 switch - Push

Verify the ON light is illuminated

If external power is needed:

Verify 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 the respective ON light is illuminated.

914

Electrical power .... Establish

If APU power is needed:

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

APU GENERATOR 1 switch - Push

Verify the ON light is illuminated.

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

Verify the ON light is illuminated.

If external power is needed:

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

EXTERNAL POWER 1 switch - Push

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

Verify the respective ON light is illuminated.

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

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

If pushback or towing is needed:

Hydraulic demand pump 1 selector .... AUX F/O

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

If parked (pushback or towing is not needed):

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

FUEL CONTROL switches ....CUTOFF C

If pushback or towing is needed:

Establish communications with ground handling personnel. C

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

Verify that the nose gear steering is locked out.

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

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

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

When parked (pushback or towing is complete):

Hydraulic demand pump 1selector .... OFF F/O

SEATBELTS selector .... OFF F/O

Fuel pump switches .... Off F/O

BEACON light switch .... OFF F/O

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

Status messages .... Check F/O

Record shown status messages in maintenance log.

Transponder mode selector .... STANDBY F/O

After wheel chocks are in place:

Parking brake .... Release C

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

APU selector .... As needed F/O

Call “SHUTDOWN CHECKLIST.” C

Do the SHUTDOWN checklist. F/O

Secure Procedure

IRS mode selectors ....OFF		F/O
EMERGENCY LIGHTS switch ....OFF		F/O
PACK switches .... Off		F/O
Call “SECURE CHECKLIST.”		C
Do the SECURE checklist.		F/O

Supplementary Procedures — Chapter SP
Table of Contents — Section TOC

Supplementary Procedures — Chapter SP
Introduction — Section 05

General

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

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

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

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

Intentionally
Blank

Flight Deck Door Access System Test

806

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.

Low Gross Weight, Aft CG Takeoff

914

Pilot Flying	Pilot Monitoring
Before entering the departure runway, verify that the runway and runway entry point are correct.	
	Confirm 15% (or greater) derate thrust for takeoff, or the equivalent using assumed temperature thrust reduction, or the equivalent using any fixed derate thrust and assumed temperature thrust reduction.
Align airplane with runway centerline*.	Position Inboard Landing Lights and Strobe Light switches ON. Position Transponder Mode selector to TA/RA.
Verify that the airplane heading agrees with the assigned runway heading.	
Release brakes*. Advance Thrust levers to approximately 45% N1. Allow engines to stabilize. Push TO/GA switch to advance Thrust levers to takeoff thrust or manually advance Thrst levers to takeoff thrust.	
Verify correct takeoff thrust set.	Monitor engine instruments throughout takeoff.
Apply full forward control column deflection to approximately 80 knots to improve nose wheel steering.	Adjust takeoff thrust prior to 80 knots if required.
Note: After takeoff thrust is set, the captain's hand must be on Thrust levers until V1.	
Verify 80 knots.	Call "80 KNOTS."
Monitor airspeed noting V1. Rotate at VR. Establish a positive rate of climb.	Call "V1." At VR, call "ROTATE." Monitor airspeed and vertical speed.
Call for "GEAR UP" when positive rate of climb established.	Verify positive rate of climb; then, position Landing Gear lever UP.

Pilot Flying	Pilot Monitoring
	Verify LNAV, VNAV active.
When above minimum altitude for autopilot engagement, engage A/P.	
Verify acceleration at acceleration height. Call for “FLAPS ____” according to flap retraction schedule.	Position Flap lever as directed.
Verify climb thrust set.	
Call for “AFTER TAKEOFF CHECKLIST.”	Accomplish AFTER TAKEOFF checklist.

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

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

Intentionally
Blank

Air Conditioning Packs

APU-to-Pack Takeoff

After engine start:

LEFT and RIGHT ISOLATION valve switches - Off

Leave APU running to supply air to pack 2.

Before takeoff:

PACKS 1 and 3 switches - Off

After takeoff:

PACK switch (One only) - ON

After engine thrust is reduced from takeoff to climb, position one Pack switch to ON.

PACK switch (Remaining pack) - ON

When cabin pressurization stabilizes, position remaining Pack switch to ON.

LEFT and RIGHT ISOLATION valve switches - On

APU selector - OFF

Packs Off Takeoff

Before Takeoff:

Pack switches - Off

After takeoff:

Pack switch (One only) - ON

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

Pack switches (Remaining packs) - ON

When cabin pressurization stabilizes, position remaining Pack switches to ON.

Ground Conditioned Air Use

Before connecting ground air conditioning cart:

PACK switches - 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.

806
RECIRCULATION FANS switches - OFF

Allows conditioned air unit to operate at maximum efficiency.

After disconnecting ground air conditioning cart:

PACK switches - ON

806
RECIRCULATION FANS switches - ON

High or Low Cabin Temperatures During Cruise

If cabin temperatures stabilize above or below 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

This procedure may be repeated as needed.

Flight Deck Fan
914

During preflight:

FLIGHT DECK FAN switch - As required

Turn Flight Deck Fan switch ON when extra cooling required.

Before takeoff:

FLIGHT DECK FAN switch - Off

During shutdown:

FLIGHT DECK FAN switch - As required

Turn Flight Deck Fan switch ON when extra cooling required.

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

Before start:

Landing Altitude switch .... MAN

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.

Intentionally
Blank

AFDS

AFDS Operation

FLIGHT DIRECTOR switches ....ON

Verify flight director pitch and roll bars display.

If autopilot desired:

AUTOPILOT engage switch ....Push

Verify CMD displays on AFDS status.

Heading Hold

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

HEADING reference switch .... TRUE

HEADING HOLD switch ....Push

Verify HDG HOLD displays on flight mode annunciation.

Heading Select

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

HEADING reference switch .... TRUE

HEADING SELECT switch ....Push

Verify HDG SEL displays on flight mode annunciation.

HEADING selector .... Rotate

Set desired heading in Heading 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 Altitude 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 Altitude window.

VERTICAL SPEED switch .... Push

Verify V/S displays on flight mode annunciation.

VERTICAL SPEED selector ....Rotate

Set desired vertical speed in Vertical Speed window.

If climb desired:

Select climb thrust limit on CDU THRUST LIM page.

Autothrottle Operation

To activate or reactivate an autothrottle mode:

AUTOTHROTTLE ARM switch ....ARM

If pitch mode TO/GA:

TO/GA switch ....Push

Verify THR REF displays on flight mode annunciation.

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

SPEED switch ....Push

Verify SPD displays on flight mode annunciation.

To set desired airspeed:

IAS/MACH selector ....Rotate

Set desired speed in IAS/MACH window.

If FLCH desired:

FLCH switch ....Push

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

If VNAV desired:

VNAV switch ....Push

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

If TO/GA is desired:

TO/GA switch ....Push

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

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

AUTOTHROTTLE ARM switch ....OFF, then ARM

Verify THR REF, THR, SPD, IDLE, or HOLD displays on flight mode annunciation.

Instrument Approach Using Vertical Speed (V/S)

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

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

Recommended roll modes:

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

Note: When using LNAV to intercept the final approach course, 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 prior to commencing the approach.

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

Allows appropriate alerting to occur if ANP exceeds RNP.

Before descent to MDA(H):

MCP altitude .... Set

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

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

At descent point:

VERTICAL SPEED switch .... Push

Verify V/S displays on flight mode annunciation.

Desired vertical speed .... Set

Set desired vertical speed to descend to MDA(H). Use a vertical speed that results in no level flight segment at MDA(H).

Approximately 300 feet above MDA(H):

MCP altitude .... Set Missed Approach Altitude

At MDA(H)/missed approach point:

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

After suitable visual reference is established:

AUTOPILOT Disengage switch .... Push

Disengage autopilot in accordance with regulatory requirements.

AUTOTHROTTLE Disconnect switch .... Push

Disconnect autothrottle when disengaging the autopilot.

Circling Approach

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

MCP altitude .... 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):

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

Enables level off at MDA(H). Verify ALT displays on flight mode annunciation.

MCP altitude ....Set Missed Approach Altitude

HEADING SELECT switch .... Push

Verify HDG SEL displays on flight mode annunciation.

Intercepting the landing profile:

AUTOPILOT Disengage switch .... Push

AUTOTHROTTLE Disconnect switch .... Push

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

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

Pre-Departure Clearance

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

Digital-Automatic Terminal Information Service

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

Oceanic Clearances

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

Weight and Balance

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

Takeoff Data

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

Intentionally
Blank

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

The flap position on EICAS will show amber X for the left flaps because the position sensor system is not fully powered. If the flap position indication for the right flaps agrees with the flap lever, the flap configuration is acceptable.

Electrical power .... Establish

BUS TIE switches – AUTO

If external power desired:

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

806
EXTERNAL POWER 1 and/or
EXTERNAL POWER 2 switches – Push

Verify ON light(s) illuminated.

914
EXTERNAL POWER 1 and/or
EXTERNAL POWER 2 switches – Push

Push if main deck cargo handling equipment power not required.

Verify ON light(s) illuminated.

914

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

If APU power desired:

APU Start Source switch - TR/APU BAT

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.

806
APU GENERATOR 2 switch - Push

Verify ON light illuminated.

914
APU GENERATOR 2 switch - Push

Push if main deck cargo handling equipment power not required.

Verify ON light illuminated.

Electrical Power Down

This procedure assumes the Secure procedure is complete.

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

STANDBY POWER selector ....OFF

When APU has completed shutdown cycle:

BATTERY switch – OFF

Standby Power Test

Airplane must be on ground with all busses powered.

STANDBY POWER selector .... BAT

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

STANDBY POWER selector ....AUTO

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

Intentionally
Blank

Before Start Procedure Without APU Generators

This procedure assumes the following:

- both APU generators are not available,
- if APU bleed air is not available, external air is available,
- galley equipment is configured for reduced electrical load,
- at least EXT PWR 1 is connected and on, and
- if only EXT PWR 1 is on or only one engine is started before disconnecting external power, the L UTILITY power switch is off according to this procedure.

Using two external power sources and starting at least two engines before disconnecting external power will maximize electrical capability for cabin loads.

If pushback or towing is needed and engine 1 is not running, body gear steering will not be available.

Do this procedure in lieu of the normal Before Start procedure.

Start the Before Start Procedure Without APU Generators after papers are on board.

806

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

Verify that the LOCK FAIL light is extinguished.

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

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

Normally the PF selects the TAKEOFF REF page.

Normally the PM selects the LEGS page.

MCP .... Set C

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

IAS/MACH selector – Set V2

Arm LNAV as needed.

Arm VNAV.

Initial heading or track – Set

Initial altitude – Set

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

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

Exterior doors .... Verify closed F/O

If pushback is needed:

Verify the nose gear steering is locked out.

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

914
Ensure that the main deck nose cargo door Control Panel and Latch Annunciator Panel lights have been verified to confirm nose cargo door closed, latched, and locked.

Ensure that at least the EXT PWR 1 ON light is illuminated.

Obtain a clearance to pressurize hydraulic systems.

Obtain a clearance to start the engines.

If only EXT PWR 1 is ON or only one engine will be started before disconnecting external power:

Electrical panel .... Set F/O

L UTILITY power switch - Off

Verify galley equipment is configured for reduced electrical load until after engine start.

Note: The ELEC UTIL L or ELEC UTIL R messages may show. Do not accomplish the ELEC UTIL L or ELEC UTIL R checklist unless the message stays shown after the Before Taxi procedure is complete.

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

HYDRAULIC panel .... Set F/O

WARNING: If the tow bar is connected, ensure the nose gear steering is locked out before starting engines. Unwanted tow bar movement can occur. With hydraulic demand pump 1 selector OFF, nose gear steering will be pressurized when engine 1 starts.

Hydraulic demand pump 4 selector – AUX

Verify the SYS FAULT light is extinguished.

Verify the PRESS light stays illuminated.

Hydraulic demand pump 3 selector - AUTO

Verify the SYS FAULT light is extinguished.

Verify the PRESS light is extinguished.

Hydraulic demand pump 1 and 2 selectors - OFF

Verify the SYS FAULT lights are illuminated.

Verify the PRESS light are illuminated.

Fuel panel .... Set F/O

MAIN 2 AFT and MAIN 3 AFT FUEL PUMP switches – ON

Verify the PRESS lights are extinguished.

All other fuel pump switches – Off

If FUEL TANK/ENG message shows:

Do not accomplish the FUEL TANK/ENG normal procedure until directed by this procedure.

Multiple fuel pump messages will be shown.

BEACON light switch ....BOTH F/O

Note: Stabilizer trim moves at half rate and the STAB TRIM 2 message may show when stabilizer trim is set because hydraulic system 2 is not pressurized. If the STAB TRIM 2 message shows, it stays shown until hydraulic system 2 is pressurized after engine start.

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

Stabilizer trim – ___ UNITS

Set the trim for takeoff.

Check that the trim is in the greenband.

Aileron trim – 0 units

Rudder trim – 0 units

CANC RCL switch .... Push F/O

Verify only the expected alert messages are shown.

CANC RCL switch .... Push F/O

Verify messages cancelled

Call "BEFORE START CHECKLIST." C

Do the BEFORE START checklist. F/O

Note: If L UTILITY power switch is ON, do not disconnect external power until at least two engines are running with their generators on.

Note: If L UTILITY power switch is off, do not disconnect external power until at least one engine is running with its generator on.

Start engine 4.

If two engines will be started before disconnecting external power:

Start engine 1.

If needed, complete pushback or towing. If engine 1 is not running, body gear steering will not be available.

Note: When engine 2 is started, the HYD PRESS DEM 2 message will show. Do not accomplish the HYD PRESS DEM 2 checklist unless the message stays shown after the Before Taxi procedure is complete.

Start the other engines.

After engine start is complete:

Electrical panel ....Set F/O

L UTILITY power switch - ON

Verify the OFF light is extinguished.

Fuel panel .... Set F/O

All main tank FUEL PUMP switches – ON

Verify the PRESS lights are extinguished.

914
If there is 17,000 lbs or more of fuel in the center wing tank:

CENTER FUEL PUMP switches - ON

Verify the PRESS lights are extinguished.

806
If there is 7,700 kgs or more of fuel in the center wing tank:

CENTER FUEL PUMP switches - ON

Verify PRESS lights extinguished.

806
If there is fuel in the STAB tank:

STAB FUEL PUMP switches – ON

Verify the PRESS lights are extinguished.

CANC RCL switch ....Push F/O

914
If FUEL TANK/ENG message shows:

Verify:
- main 1 + reserve 1 ≥ main 2, or
- main 4 + reserve 4 ≥ main 3, or
- main 2 or main 3 < approximately 45,700 lbs, and
- crossfeed valve 1 or 4 open

or, on ground and completion of one of the following and
- initial electrical power application, or
- refueling, or
- fuel system CMC ground test, and
- main 1 + reserve 1 + 1,000 lbs > main 2, and main 4 + reserve 4 + 1,000 lbs > main 3, and crossfeed valve 1 or 4 open

OVERRIDE pumps 2 (both) switches - Off

OVERRIDE pumps 3 (both) switches - Off

CROSSFEED valve 1 and 4 switches - Off

806
If FUEL TANK/ENG message shows:

Verify:
- main 1 + reserve 1 ≥ main 2, or
- main 4 + reserve 4 ≥ main 3, or
- main 2 or main 3 < approximately 20,700 kgs, and
- crossfeed valve 1 or 4 open

or, on ground and completion of one of the following and
- initial electrical power application, or
- refueling, or
- fuel system CMC ground test, and
- main 1 + reserve 1 + 500 kgs > main 2, and main 4 + reserve 4 + 500 kgs > main 3, and crossfeed valve 1 or 4 open

OVERRIDE pumps 2 (both) switches - Off

OVERRIDE pumps 3 (both) switches - Off

CROSSFEED valve 1 and 4 switches - Off

Do the normal Before Taxi Procedure.

Engine Bowed Rotor Start Procedure

(914 ; before SB, EEC 060 or later software not installed)

For engine starts between approximately 30 minutes and 6 hours after engine shutdown, this procedure may be used to mitigate the effects of bowed rotor starts.

Select the secondary engine indications. F/O

PACK switches ....SET F/O

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

Start sequence ....Announce C

Dry motor each engine to 20% N2 followed by deceleration to 10% N2 or less prior to starting. Motor the engines in the same sequence as the start sequence. Up to two engines may be motored simultaneously:

Engine START switch - Pull F/O

When N2 reaches 20%:

Engine START switch - Push F/O

After all engines have been motored, start the engines in the same sequence.

Call “START ___ ENGINE” C

Verify N2 is at or below 10%. Both

Engine START switch .... Pull F/O

FUEL CONTROL switch .... RUN C

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

Autostart does corrective steps for:
- no EGT rise
- a hot start
- a hung start
- compressor stall
- no light-off
- starter shaft shear
- low/no starter pressure
- no N1 rotation
- starter duty cycle exceedance
- EGT exceedance
- no oil pressure rise

Engine Crossbleed Start

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

Thrust lever (operating engine) ....Advance

Advance Thrust lever to approximately 82% N2.

Accomplish normal engine start.

Engine Ground Pneumatic Start

Duct pressure .... Observe

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

Accomplish normal engine start.

Engine/APU/Cargo Fire/Overheat Test

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

Note: EICAS warning message FIRE WHEEL WELL may momentarily display. A CHKL OVRD, RESET ALL, or RESET NON-NORMAL for the FIRE WHEEL WELL checklist may be required after the completion of the Engine/APU/Cargo Fire/Overheat Test.

Observe:

EICAS warning message TEST IN PROG displays.

Fire bell sounds.

Master WARNING lights illuminate.

Engine Fire Warning lights illuminate.

APU Fire Warning light illuminates.

Fuel Control switch Fire Warning lights illuminate.

CARGO FIRE FWD and AFT Warning lights illuminate.

914
CARGO FIRE MAIN DECK Warning light illuminates.

EICAS warning message FIRE TEST PASS displays.

FIRE/OVERHEAT TEST switch .... Release

Squib Test

Squib TEST 1 switch ....Push

Observe:

Engine squib lights illuminate.

APU squib light illuminates.

Cargo squib lights illuminate.

Squib TEST 2 switch ....Push

Observe:

Engine squib lights illuminate.

APU squib light illuminates.

Cargo squib lights illuminate.

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.

Intentionally
Blank

Departure or Destination Airport Not in the FMC Navigation Database

When departing from or landing at an airport 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
- Landing altitude reference bar (white/amber bar) on the PFD altitude tape
- Touchdown zone indicator (amber crosshatched area) on the PFD altitude tape

Use the following procedures when departing from or landing at an airport 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

Shows 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 landing altitude reference bar (white/amber bar) is not shown on the PFD altitude tape.

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 landing altitude automatically.

VNAV key .... Push

NEXT PAGE key .... Push

FORECAST> .... Select

Shows the DESCENT FORECAST page.

TRANS LVL .... Enter

Overwrites the manually entered departure airport transition altitude.

Destination Airport Not in the FMC Navigation Database

CDU Preflight Procedure - Captain and First Officer

The following steps can 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 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 landing altitude reference bar (white/amber bar) is not shown on the PFD altitude tape during approach.

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

ND Mode selector .... MAP

EFIS WXR switch .... Push

Weather Radar TEST switch .... Push

Verify radar test pattern displays on ND.

Observe the following sequence (approximately 20 seconds).

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

EFIS WXR switch .... Push

Removes Captain's and First Officer's weather radar displays.

Desired Mode switch .... Push

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.

Consider the quantity of fuel in reserve tanks 1 and 4 before balancing between main tanks 1 and 4.

Fuel may be balanced:

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

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

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

Intentionally
Blank

Introduction

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

Takeoff - Wet or Contaminated Runway Conditions

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

- For wet runways, reduced thrust (fixed derate, assumed temperature method, or both) is allowed provided suitable takeoff performance accountability is made for the increased stopping distance on a wet surface
- For runways contaminated by slush, snow, standing water, or ice, reduced thrust (fixed derate) is allowed provided takeoff performance accounts for the runway surface condition. Reduced thrust using assumed temperature method, whether alone or in combination with a fixed derate is not allowed
- V1 may be reduced to minimum V1 to provide increased stopping margin provided the field length required for a continued takeoff from the minimum V1 and obstacle clearance meet the regulatory requirements. The determination of such minimum V1 may require a real-time performance calculation tool or other performance information supplied by dispatch
- Takeoffs are not recommended when slush or standing water depth is more than 0.5 inches (13 mm), wet snow depth is more than 1.18 inches (30 mm), or dry snow depth is more than 5.12 inches (130mm).

Cold Weather Operation

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

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

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

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

Preliminary Preflight Procedure - Captain or First Officer

Do the normal Preliminary Preflight Procedure - Captain or First Officer with the following modifications:

If taxi-in on the previous flight occurred in visible moisture (fog with visibility of one statute mile (1600 m) or less, rain, snow, sleet, ice crystals, and so on), and the temperature stayed below 3°C, the taxi-in time from the previous flight in the airplane logbook or other approved document must be included in the total taxi time. If the engine is considered free of ice before engine start, only the taxi-out time should be included in the total taxi 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

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

Engine inlets .... Clear

Verify inlet cowling is free of snow and ice.

Fuel tank vents .... Clear

Verify 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.

Preflight Procedure - First Officer

Do the normal Preflight Procedure - First Officer with the following modifications:

If the ambient temperature is at or below -18 degrees C, and running the hydraulic demand or auxiliary pumps is desired to help maintain hydraulic system temperature:

WARNING: Ensure personnel and equipment remain clear of all flight control surfaces, landing gear, and thrust reversers when any hydraulic pump is operating.

WARNING: Do not operate any hydraulic pump with the flight deck unattended.

Note: The system 1 and 4 air driven demand pumps generate significant ramp noise.

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Do not disconnect external power when either hydraulic auxiliary pump 1 or 4 is running. Both hydraulic auxiliary pumps 1 and 4 must be off when disconnecting external power 1. They may be turned on again after external power 1 is disconnected. Ensure that system 4 is pressurized first, or depressurized last, to prevent hydraulic fluid transfer between systems.

Obtain a clearance to pressurize the hydraulic systems.

Hydraulic demand pump selectors .... AUX or ON F/O

If the engines have been cold soaked for more than four hours at ambient temperatures at or below -35°C:

GENERATOR CONTROL switches (all) ....Off

Do not turn on the generator control switches until engines have been at stable idle for a minimum of 2 minutes.

Engine Start Procedure

Do the normal Engine Start Procedure with the following considerations:

- If the APU is running, the engine anti-ice switches must be OFF or AUTO when any engine starter is engaged.
- 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.

Engine Anti–Ice Operation – On the Ground

Engine 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 engine 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 engine anti-ice when OAT is above 10° C.

When engine anti–ice is needed:

Engine Anti-ice switches ....ON F/O

When engine anti-ice is no longer needed:

Engine Anti-ice switches .... AUTO F/O

Before Taxi Procedure

Do the normal Before Taxi Procedure with the following modifications:

If the engines have been cold soaked for more than four hours at ambient temperatures at or below -35°C:

After the engines have been at stable idle for a minimum of 2 minutes:

GENERATOR CONTROL switches (all) ....ON

If taxi route is through 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 snow and slush accumulations from the main gear wheels. Leading edge flaps are also susceptible to slush accumulations.

Call “FLAPS ___” as needed. C

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

Taxi-Out

CAUTION: Taxi at a reduced speed. Use smaller tiller and rudder inputs, and apply minimum thrust smoothly. Differential thrust may be used to help maintian 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.

CAUTION: Precautions must be taken for:

- Jet blast up to 700 feet (220 m) 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.

When both of the following exist, do an engine run-up to minimize ice build-up: C

- OAT is 3°C or below
- Visible moisture (fog with visibility of one statute mile (1600 m) or less, rain, snow, sleet, ice crystals, and so on)

Use the following procedure:

Check that the area behind the airplane is clear.

Run-up to a minimum of 40% N1 for at least 5 seconds duration at intervals no greater than 60 minutes.

Note: Operation in icing conditions may result in engine vibration indications above the normal operating range during ice shedding. If engine vibration indications are available and high engine vibration indications occur, run-up to 55% N1 or higher for at least 20 seconds duration.

If takeoff is not completed within 120 minutes total taxi time (including taxi-in, taxi-out, and ground holds), the engines must be inspected according to the AMM before takeoff and, if needed, manually de-iced.

De-icing / Anti-icing

Testing of undiluted de-icing/anti-icing fluids has shown some of the fluid remains on the wing during takeoff rotation and initial climb. The residual fluid causes a temporary decrease in lift and increase in drag, however, the effects are temporary. Takeoff operations with reduced thrust (assumed temperature method or fixed derate) are permitted provided takeoff performance accounts for the runway surface condition. Use the normal takeoff rotation rate.

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

If de-icing / anti-icing is needed:

APU ....As needed F/O

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

Call “FLAPS UP”. C

Flaps .... UP F/O

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

Thrust levers .... Idle C

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

PACK switches ....Off F/O

Reduces the possibility of fumes entering the air conditioning system.

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

Reduces the possibility of fumes entering the air conditioning system.

After de-icing / anti-icing is completed:

APU ....As needed F/O

APU bleed 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 switches .... ON F/O

Before Takeoff Procedure

Do the normal Before Takeoff Procedure with the following modification:

Call "FLAPS ___" as needed for takeoff. PF

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

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

Takeoff Procedure

Do the normal Takeoff Procedure with the following modifications.

When engine 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

Note: Operation in icing conditions may result in engine vibration indications above the normal operating range during ice shedding.

Run-up to a minimum of 40% N1 for at least 5 seconds duration, confirm stable engine operation and, if engine vibration indications are available, ensure engine vibration indications are below 4 units before the start of the takeoff roll. If high engine vibration indications occur, a run-up to 55% N1 may be done.

Engine Anti-ice Operation - In flight

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

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

Manual Use of Engine Anti-ice

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

WARNING: If using the engine anti-ice system manually, do not rely on airframe visual icing cues before activating engine 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 engine anti-ice is needed:

Engine anti-ice switches ....ON PM

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

Engine anti-ice switches .... AUTO PM

Fan Ice Removal

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

If moderate to severe icing conditions are encountered:

Note: Operation in icing conditions may result in engine vibration indications above the normal operating range during ice shedding.

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

Wing Anti-ice Operation - In flight

Wing anti-ice must be AUTO or ON during all flight operations when icing conditions exist or are anticipated.

WARNING: If using the wing anti-ice system manually do not rely on airframe visual icing cues before activating wing anti-ice. Use the temperature and visible moisture criteria because late activation of wing anti-ice may allow ice to accumulate on the wing.

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

Note: Wing anti-icing is inhibited with leading edge flaps extended. If icing conditions exist, turn anti-icing on after retraction of leading edge flaps.

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

Manual Use of Wing Anti-ice

When manual use of wing anti-ice is needed:

WING ANTI-ICE switch .... ON PM

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

WING ANTI-ICE switch .... AUTO PM

Cold Temperature Altitude Corrections

Extremely low temperatures create significant altimeter errors and greater potential for reduced terrain clearance. When the temperature is colder than ISA, true altitude will be lower than indicated altitude.

The following altitude correction procedures should be considered when operating at or near airports where high terrain and/or obstacles exist in combination with very cold temperatures (-30°C or colder), or when enroute minimum altitudes are affected by terrain clearance:

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

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

Altitude Correction Table (Heights and Altitudes in Feet)

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

Altitude Correction Table (Heights and Altitudes in Meters)

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

After Landing Procedure

CAUTION: Taxi at a reduced speed. Use smaller tiller and rudder inputs, and apply minimumthrust smoothly. Differential thrust may be used to help maintian 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.

CAUTION: Precautions must be taken for:

- Jet blast up to 700 feet (220 m) 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.

Do the normal After Landing Procedure with the following modifications:

If the ambient temperature is at or below -18 degrees C, and running the hydraulic demand pumps during taxi-in is desired to help maintain hydraulic system temperature:

Hydraulic demand pump selectors .... ON F/O

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

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

Engine 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 engine 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 engine anti-ice when OAT is above 10°C.

When engine anti-ice is needed:

Engine anti-ice switches..ON F/O

When engine anti-ice is no longer needed:

Engine anti-ice switches.................................. AUTO F/O

When both of the following exist, do an engine run-up to minimize ice build-up: C

- OAT is 3°C or below
- Visible moisture (fog with visibility of one statute mile (1600 m) or less, rain, snow, sleet, ice crystals, and so on)

Use the following procedure:

Check that the area behind the airplane is clear.

Run-up to a minimum of 40% N1 for at least 5 seconds duration at intervals no greater than 60 minutes.

Note: Operation in icing conditions may result in engine vibration indications above the normal operating range during ice shedding. If engine vibration indications are available and high engine vibration indications occur, run-up to 55% N1 or higher for at least 20 seconds duration.

If the next takeoff will not be completed within 120 minutes total taxi time (including taxi-in, taxi-out, and ground holds), the engines must be inspected according to the AMM before takeoff and, if needed, manually de-iced.

If taxi-in occurs when both of the following exist, make an entry of the taxi-in and ground hold time in the airplane logbook or other approved document. F/O

- OAT stays below 3°C
- Visible moisture (clouds, fog with visibility of one statute mile (1600 m) or less, rain, snow, sleet, ice crystals, and so on)

Secure Procedure

Do the normal Secure Procedure with the following modifications:

If the airplane will be attended:

PACK switches..ON F/O

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

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

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

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

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

Parking brake ....Released C

Reduces the possibility of frozen brakes.

Cold weather maintenance procedures for securing the airplane may be needed. These procedures are normally done by maintenance personnel according to the approved Aircraft Maintenance Manual, and include, but are not limited to:

- protective covers and plugs installed
- water storage containers drained
- toilets drained
- doors closed
- batteries removed. If the batteries will be exposed to temperatures below -18°C, the batteries should be removed and stored in an area warmer than -18°C, but below 40°C. Subsequent installation of the warm batteries ensures the starting capability of the APU.

Hot Weather Operation

During flight planning, consider the following:

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

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

- all packs should be used (when possible) for maximum cooling

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- recirculation fans should be off because the fans add warm air to the conditioned air

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

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

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

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

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

Moderate to Heavy Rain, Hail, or Sleet

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

If heavy rain or hail encountered or anticipated:

During descent:

Autothrottle ....Disconnect

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

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, ram turbine doors, 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 - First Officer

Do the normal Preflight Procedure - First Officer 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 F/O

APU .... START F/O

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

APU bleed air switch .... ON F/O

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.

Engine START switch .... Pull F/O

Verify that the N2 RPM increases. C, F/O

Allow maximum motoring for 2 minutes to help remove contaminants.

FUEL CONTROL switch ....RUN C

Before Taxi Procedure

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

Conditions permitting, use the APU-to-Pack Takeoff or Packs Off Takeoff procedure.

If the APU-to-Pack Takeoff procedure will be used :

Limit APU bleed air use as much as possible to reduce sand and dust ingestion.

If the APU is not running:

APU bleed air switch .... Off F/O

APU ....START F/O

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

APU bleed air switch .... ON F/O

Flight controls ....Check C

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 30% 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 fixed derate and/or assumed temperature thrust reduction that meets performance requirements.
- Prior to takeoff, allow sand and dust to settle.
- 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 permit.
- Use maximum climb power to minimize time spent in dusty conditions.

Landing

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

- Use autobrakes on landing to help minimize the need for reverse thrust.
- Performance permitting, 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.

After Landing Procedure

Do the normal After Landing 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.

If the APU must be started:

APU bleed air switch .... Off F/O

APU ....START F/O

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

APU bleed air switch .... ON F/O

Taxi-In

Do the following, conditions permitting, 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 30% 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 thrust on the outboard engine 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: 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.

Secure Procedure

Do the normal Secure Procedure with the following modifications:

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

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

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.

806
Passenger Signs switches ....ON

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

914
Supernumerary Signs switches ....ON

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

Severe Turbulence

The turbulent air penetration speed of approximately 310 KIAS or .83 Mach provides ample protection from stall and high speed buffet, while also providing protection from exceeding the structural limit.

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

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

Climb and Cruise

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

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

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

Descent

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

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

Manual Flight in Severe Turbulence

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

Windshear

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

Avoidance

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

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

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

Precautions

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

Takeoff

- Takeoff with full rated takeoff thrust is recommended, unless the use of a fixed derate is required to meet a dispatch performance requirement.
- For optimum takeoff performance, use flaps 20 for takeoff unless limited by obstacle clearance and/or climb gradient.
- Use the longest suitable runway provided it is clear of areas of known windshear.
- Use the flight director after takeoff.
- increasing the Vr speed to the performance limited gross weight rotation speed, not to exceed actual gross weight Vr + 20 knots. Set V speeds for the actual gross weight. Rotate at the adjusted (higher) rotation speed. This increased rotation speed results in an increased stall margin, and meets takeoff performance requirements. If windshear is encountered at or beyond the actual gross weight Vr, do not attempt to accelerate to the increased Vr, but rotate without hesitation.

- Be alert for any airspeed fluctuations during takeoff and initial climb. Such fluctuations may be the first indication of windshear.
- Know the all-engine initial climb pitch attitude. Rotate at the normal rate to this attitude for all non-engine failure takeoffs. Minimize reductions from the initial climb pitch attitude until terrain and obstruction clearance is assured, unless stick shaker activates.
- Crew coordination and awareness are very important. Develop an awareness of normal values of airspeed, attitude, vertical speed, airspeed buildup. Closely monitor vertical flight path instruments such as vertical speed and altimeters. The pilot not flying should be especially aware of vertical path instruments and call out any deviations from normal.
- Should airspeed fall below the trim airspeed, unusual control column forces may be required to maintain the desired pitch attitude. Stick shaker and Pitch Limit Indication must be respected at all times.

Approach and Landing

- Use Flaps 25 or 30 for landing.
- Establish a stabilized approach no lower than 1,000 feet above the airport to improve windshear recognition capability.
- Use the most suitable runway that avoids the areas of suspected windshear and is compatible with crosswind or tailwind limitations. Use ILS G/S, VNAV path or VASI/PAPI indications to detect flight path deviations and help with timely detection of windshear.
- If the autothrottle is disconnected, or is planned to be disconnected prior to landing, add an appropriate airspeed correction (correction applied in the same manner as gust), up to a maximum of 20 knots.
- Avoid large thrust reductions or trim changes in response to sudden airspeed increases, as these may by followed by airspeed decreases.
- Crosscheck flight director commands using vertical flight instruments.
- Crew coordination and awareness are very important, particularly at night or in marginal weather conditions. Closely monitor the vertical flight path instruments such as vertical speed, altimeters and glide slope displacement. The pilot not flying should call out any deviations from normal. Use of the autopilot and autothrottle for the approach may provide more monitoring and recognition time.

Recovery

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

Windshield Washer

Note: Do not use windshield wipers on dry window.

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

Windshield Wiper selector .... As required

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:

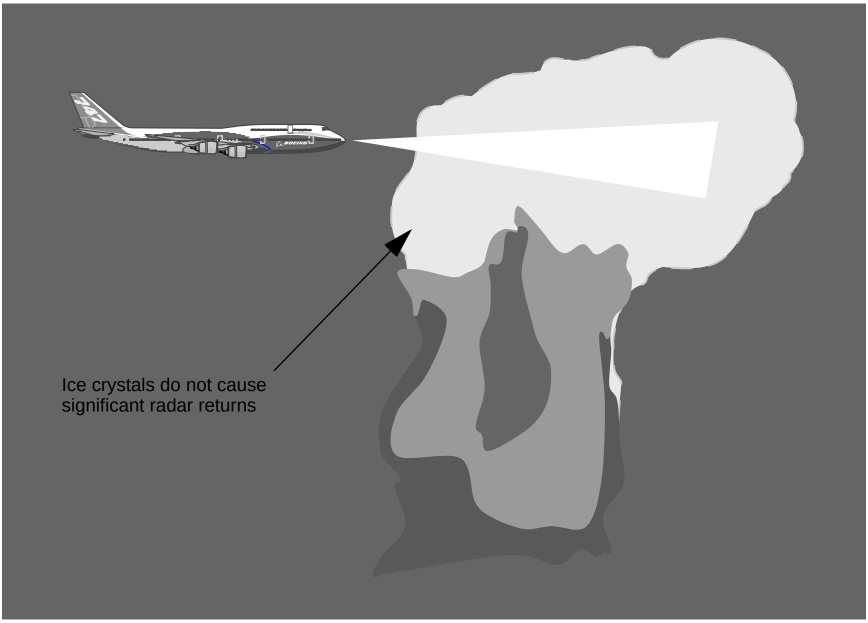
- Appearance of rain on the windshield at temperatures too cold for liquid water to exist. This is due to ice crystals melting on the heated windows (sounds different than rain)
- Airplane TAT indication remains near 0 degrees C due to TAT probe icing
- Areas of light to moderate turbulence
- In IMC 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 detection 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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Performance Dispatch — Chapter PD

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Performance Dispatch — Chapter PD
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747-8 GENX-2B67 KG M EASA TO1-10% TO2-20%

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
806	Intercontinental

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Performance Dispatch — Chapter PD
Takeoff — Section 10

Takeoff Field Corrections - Dry Runway
Table 1 of 3: Slope Corrections

FIELD LENGTH AVAILABLE (M)	SLOPE CORRECTED FIELD LENGTH (M) RUNWAY SLOPE (%)								
	-2.0	-1.5	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0
1800	1900	1870	1850	1820	1800	1770	1740	1710	1680
2000	2120	2090	2060	2030	2000	1960	1920	1890	1850
2200	2350	2310	2270	2240	2200	2160	2110	2070	2020
2400	2570	2530	2490	2440	2400	2350	2300	2240	2190
2600	2800	2750	2700	2650	2600	2540	2480	2420	2360
2800	3020	2970	2910	2860	2800	2730	2670	2600	2540
3000	3250	3190	3120	3060	3000	2930	2850	2780	2710
3200	3470	3400	3340	3270	3200	3120	3040	2960	2880
3400	3700	3620	3550	3470	3400	3310	3230	3140	3050
3600	3920	3840	3760	3680	3600	3510	3410	3320	3220
3800	4150	4060	3970	3890	3800	3700	3600	3500	3400
4000	4370	4280	4190	4090	4000	3890	3780	3680	3570
4200	4600	4500	4400	4300	4200	4080	3970	3850	3740
4400	4830	4720	4610	4510	4400	4280	4160	4030	3910
4600	5050	4940	4830	4710	4600	4470	4340	4210	4080
4800	5280	5160	5040	4920	4800	4660	4530	4390	4250
5000	5500	5380	5250	5130	5000	4860	4710	4570	4430

Table 2 of 3: Wind Corrections

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M) WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
1800	1410	1540	1670	1800	1890	1970	2060	2160
2000	1580	1720	1860	2000	2090	2180	2280	2380
2200	1760	1910	2050	2200	2300	2400	2500	2610
2400	1930	2090	2240	2400	2500	2610	2720	2830
2600	2110	2270	2440	2600	2710	2820	2940	3050
2800	2280	2450	2630	2800	2910	3030	3150	3280
3000	2460	2640	2820	3000	3120	3240	3370	3500
3200	2630	2820	3010	3200	3330	3460	3590	3730
3400	2810	3000	3200	3400	3530	3670	3810	3950
3600	2980	3190	3390	3600	3740	3880	4030	4180
3800	3160	3370	3590	3800	3940	4090	4240	4400
4000	3330	3550	3780	4000	4150	4300	4460	4620
4200	3500	3740	3970	4200	4360	4510	4680	4850
4400	3680	3920	4160	4400	4560	4730	4900	5070
4600	3850	4100	4350	4600	4770	4940	5120	5300
4800	4030	4290	4540	4800	4970	5150	5330	5520
5000	4200	4470	4730	5000	5180	5360	5550	5750

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
1860	351.3	325.1	323.2	321.3	319.4	317.6	315.7	308.6	300.2	290.6	272.4
2000	364.4	337.1	335.2	333.2	331.3	329.3	327.4	320.0	311.3	301.4	282.5
2200	382.1	353.5	351.4	349.4	347.3	345.3	343.3	335.5	326.4	316.0	296.1
2400	398.6	368.7	366.6	364.4	362.3	360.1	358.0	349.9	340.4	329.4	308.6
2600	413.5	382.2	380.0	377.8	375.5	373.3	371.1	362.6	352.7	341.3	319.6
2800	428.8	396.4	394.1	391.7	389.4	387.1	384.8	376.0	365.6	353.8	331.2
3000	444.7	411.1	408.7	406.3	403.9	401.5	399.1	390.0	379.3	367.0	343.6
3200	457.9	423.2	420.7	418.2	415.7	413.2	410.8	401.3	390.2	377.6	353.4
3400	466.7	434.8	432.3	429.7	427.1	424.5	422.0	412.3	400.9	387.8	362.8
3600	466.7	446.5	443.8	441.2	438.5	435.9	433.3	423.2	411.5	398.0	372.3
3800	466.7	457.9	455.2	452.5	449.7	447.1	444.4	434.0	421.9	408.0	381.6
4000	466.7	466.7	466.1	463.3	460.4	457.7	454.9	444.3	431.9	417.6	390.5
4200	466.7	466.7	466.7	466.7	466.7	466.7	465.2	454.3	441.6	426.9	399.1
4400	466.7	466.7	466.7	466.7	466.7	466.7	466.7	464.0	451.0	436.0	407.5
4600	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	460.2	444.9	415.7
4800	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	453.6	423.7
5000	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	462.0	431.5
5200	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	439.0
CLIMB LIMIT WT (1000 KG)	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	438.5

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
1860	331.5	306.9	305.2	303.4	301.6	299.9	293.5	286.4	278.0	269.5	252.9
2000	343.8	318.3	316.5	314.6	312.8	311.0	304.4	297.0	288.3	279.5	262.3
2200	360.5	333.7	331.8	329.8	327.9	326.0	319.1	311.3	302.1	292.9	274.8
2400	376.0	348.0	346.0	344.0	342.0	340.0	332.7	324.6	315.0	305.4	286.4
2600	389.9	360.7	358.5	356.4	354.4	352.3	344.7	336.2	326.2	316.2	296.4
2800	404.3	374.0	371.7	369.6	367.4	365.2	357.3	348.6	338.1	327.7	307.2
3000	419.3	387.9	385.6	383.3	381.1	378.9	370.7	361.6	350.8	340.0	318.7
3200	431.7	399.1	396.8	394.4	392.1	389.8	381.3	371.9	360.8	349.6	327.6
3400	443.6	410.0	407.6	405.2	402.8	400.4	391.7	382.0	370.4	358.9	336.2
3600	455.5	420.9	418.4	415.9	413.5	411.0	402.0	392.0	380.1	368.2	344.8
3800	466.7	431.7	429.1	426.5	424.0	421.5	412.2	401.9	389.7	377.4	353.4
4000	466.7	441.9	439.2	436.6	434.0	431.4	421.9	411.3	398.7	386.2	361.5
4200	466.7	451.8	449.1	446.4	443.7	441.1	431.3	420.5	407.6	394.7	369.4
4400	466.7	461.5	458.7	455.9	453.2	450.5	440.5	429.4	416.2	403.0	377.0
4600	466.7	466.7	466.7	465.3	462.5	459.7	449.5	438.1	424.6	411.1	384.5
4800	466.7	466.7	466.7	466.7	466.7	466.7	458.3	446.6	432.8	419.1	391.9
5000	466.7	466.7	466.7	466.7	466.7	466.7	466.7	454.9	440.8	426.7	399.0
5200	466.7	466.7	466.7	466.7	466.7	466.7	466.7	462.8	448.5	434.1	405.9
CLIMB LIMIT WT (1000 KG)	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	465.3	444.0	404.8

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
1860	312.3	288.9	287.3	285.7	284.2	278.4	272.4	265.2	257.7	250.2	235.2
2000	323.9	299.6	297.9	296.3	294.7	288.7	282.5	275.0	267.2	259.4	243.9
2200	339.6	314.0	312.3	310.6	308.9	302.6	296.0	288.2	280.1	271.8	255.6
2400	354.1	327.4	325.6	323.8	322.0	315.5	308.6	300.4	291.9	283.3	266.3
2600	367.0	339.2	337.3	335.4	333.6	326.7	319.6	311.0	302.1	293.1	275.4
2800	380.6	351.6	349.7	347.7	345.8	338.7	331.2	322.4	313.1	303.8	285.3
3000	394.7	364.7	362.7	360.7	358.7	351.3	343.6	334.4	324.8	315.2	296.0
3200	406.2	375.2	373.1	371.0	369.0	361.3	353.3	343.8	333.9	323.9	304.1
3400	417.4	385.4	383.2	381.1	378.9	371.0	362.8	353.0	342.7	332.4	312.0
3600	428.5	395.5	393.3	391.1	388.8	380.7	372.2	362.1	351.6	341.0	319.9
3800	439.4	405.5	403.2	400.9	398.6	390.3	381.6	371.2	360.3	349.4	327.7
4000	449.8	415.0	412.6	410.3	408.0	399.4	390.4	379.8	368.6	357.4	335.1
4200	460.0	424.3	421.8	419.4	417.0	408.3	399.1	388.1	376.7	365.2	342.4
4400	466.7	433.3	430.8	428.3	425.9	416.9	407.5	396.2	384.5	372.7	349.4
4600	466.7	442.1	439.5	437.0	434.5	425.3	415.7	404.2	392.2	380.2	356.3
4800	466.7	450.7	448.1	445.5	443.0	433.6	423.7	412.0	399.7	387.4	363.0
5000	466.7	459.0	456.4	453.8	451.1	441.5	431.5	419.5	407.0	394.4	369.5
5200	466.7	466.7	464.3	461.7	459.0	449.2	439.0	426.8	414.0	401.2	375.8
CLIMB LIMIT WT (1000 KG)	466.7	466.7	466.7	466.7	466.7	466.7	466.7	449.7	429.3	409.7	375.6

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
1860	293.7	272.3	270.9	269.5	265.0	259.9	252.1	245.7	239.2	231.9	218.5
2000	304.6	282.4	280.9	279.4	274.8	269.5	261.4	254.8	248.0	240.5	226.6
2200	319.3	296.0	294.4	292.9	288.0	282.4	273.9	267.0	259.9	252.0	237.4
2400	333.0	308.6	306.9	305.3	300.1	294.3	285.5	278.2	270.8	262.5	247.2
2600	344.9	319.5	317.8	316.1	310.7	304.7	295.4	287.8	280.1	271.4	255.5
2800	357.6	331.2	329.4	327.6	322.0	315.7	306.1	298.2	290.2	281.2	264.6
3000	370.9	343.6	341.7	339.8	334.1	327.6	317.6	309.4	301.1	291.8	274.6
3200	381.6	353.3	351.4	349.5	343.5	336.8	326.5	318.0	309.4	299.8	282.0
3400	392.0	362.8	360.8	358.8	352.6	345.7	335.0	326.3	317.5	307.5	289.2
3600	402.3	372.2	370.2	368.1	361.8	354.6	343.6	334.7	325.5	315.3	296.4
3800	412.5	381.5	379.4	377.3	370.8	363.4	352.1	342.9	333.5	322.9	303.5
4000	422.2	390.4	388.2	386.1	379.4	371.8	360.2	350.7	341.0	330.2	310.3
4200	431.6	399.0	396.8	394.6	387.7	379.9	368.1	358.3	348.4	337.3	316.9
4400	440.8	407.4	405.1	402.9	395.8	387.9	375.7	365.7	355.6	344.2	323.3
4600	449.8	415.6	413.3	411.0	403.8	395.6	383.2	373.0	362.6	351.0	329.5
4800	458.6	423.7	421.3	418.9	411.6	403.2	390.5	380.1	369.5	357.6	335.7
5000	466.7	431.4	429.0	426.6	419.1	410.6	397.6	387.0	376.1	364.0	341.6
5200	466.7	438.9	436.5	434.0	426.4	417.7	404.5	393.6	382.6	370.2	347.4
CLIMB LIMIT WT (1000 KG)	466.7	466.7	466.7	466.7	464.3	451.1	431.2	413.2	396.0	378.1	348.2

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
1860	274.8	254.9	253.5	249.6	244.9	237.8	232.3	226.6	220.5	214.4	202.8
2000	285.0	264.3	262.8	258.8	254.0	246.5	240.9	235.0	228.7	222.3	210.3
2200	298.7	277.0	275.4	271.2	266.1	258.3	252.4	246.2	239.5	232.9	220.2
2400	311.4	288.7	287.0	282.6	277.3	269.1	262.9	256.4	249.5	242.5	229.3
2600	322.5	298.7	297.1	292.5	286.9	278.4	271.9	265.1	257.9	250.6	236.8
2800	334.2	309.6	307.8	303.0	297.3	288.4	281.7	274.7	267.1	259.6	245.2
3000	346.7	321.2	319.4	314.4	308.4	299.3	292.2	285.0	277.2	269.3	254.5
3200	356.6	330.2	328.3	323.2	317.0	307.5	300.2	292.7	284.7	276.6	261.2
3400	366.1	338.9	336.9	331.6	325.3	315.5	308.0	300.3	291.9	283.6	267.7
3600	375.7	347.6	345.6	340.1	333.6	323.5	315.8	307.8	299.2	290.6	274.3
3800	385.1	356.2	354.2	348.5	341.8	331.4	323.5	315.2	306.4	297.5	280.7
4000	394.1	364.4	362.3	356.5	349.6	338.9	330.8	322.3	313.2	304.1	286.9
4200	402.8	372.4	370.2	364.3	357.2	346.2	337.9	329.2	319.9	310.6	292.9
4400	411.3	380.1	377.9	371.8	364.5	353.4	344.8	335.9	326.4	316.8	298.7
4600	419.6	387.7	385.4	379.2	371.8	360.3	351.6	342.5	332.7	323.0	304.4
4800	427.7	395.1	392.8	386.5	378.8	367.1	358.2	348.9	338.9	329.0	310.0
5000	435.5	402.3	399.9	393.5	385.7	373.7	364.6	355.1	345.0	334.8	315.4
5200	443.1	409.2	406.8	400.2	392.3	380.1	370.8	361.2	350.8	340.4	320.7
CLIMB LIMIT WT (1000 KG)	444.5	443.6	443.4	435.0	423.4	408.4	394.3	379.6	364.4	350.1	322.7

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(f) of 3: 10000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
1860	255.2	236.7	232.3	227.7	222.8	218.0	213.2	208.2	202.7	196.7	185.3
2000	264.7	245.5	240.9	236.1	231.0	226.0	221.0	215.9	210.2	204.0	192.1
2200	277.4	257.2	252.4	247.4	242.0	236.7	231.5	226.1	220.1	213.6	201.1
2400	289.1	268.0	263.0	257.7	252.1	246.6	241.1	235.4	229.2	222.4	209.3
2600	299.2	277.1	271.9	266.4	260.6	254.8	249.2	243.2	236.7	229.6	215.9
2800	310.0	287.1	281.7	276.0	270.0	263.9	258.0	251.9	245.1	237.7	223.5
3000	321.7	297.9	292.3	286.4	280.1	273.9	267.8	261.4	254.4	246.7	232.0
3200	330.7	306.1	300.3	294.2	287.7	281.3	274.9	268.3	261.1	253.2	237.9
3400	339.4	314.1	308.1	301.7	295.1	288.4	281.9	275.1	267.6	259.4	243.7
3600	348.1	322.0	315.9	309.3	302.5	295.6	288.9	281.8	274.1	265.7	249.5
3800	356.7	329.9	323.5	316.8	309.7	302.7	295.8	288.5	280.6	271.9	255.3
4000	364.9	337.4	330.8	323.9	316.7	309.4	302.3	294.9	286.7	277.8	260.8
4200	372.9	344.6	338.0	330.9	323.4	316.0	308.7	301.1	292.7	283.6	266.1
4400	380.7	351.7	344.9	337.6	330.0	322.4	314.9	307.1	298.6	289.2	271.3
4600	388.3	358.6	351.7	344.2	336.4	328.6	321.0	313.0	304.3	294.7	276.3
4800	395.7	365.4	358.3	350.7	342.7	334.8	327.0	318.8	309.8	300.1	281.3
5000	402.9	372.0	364.7	356.9	348.8	340.7	332.7	324.4	315.3	305.3	286.1
5200	409.8	378.3	370.9	363.0	354.7	346.5	338.3	329.8	320.5	310.4	290.8
CLIMB LIMIT WT (1000 KG)	411.8	410.4	403.4	393.7	382.3	370.7	358.7	346.5	333.0	319.3	293.5

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field Corrections - Wet Runway

Table 1 of 3: Slope Corrections

FIELD LENGTH AVAILABLE (M)	SLOPE CORRECTED FIELD LENGTH (M)								
	RUNWAY SLOPE (%)								
	-2.0	-1.5	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0
1800	1890	1870	1840	1820	1800	1770	1740	1710	1680
2000	2120	2090	2060	2030	2000	1960	1920	1890	1850
2200	2340	2310	2270	2240	2200	2160	2110	2070	2020
2400	2570	2530	2490	2440	2400	2350	2300	2240	2190
2600	2800	2750	2700	2650	2600	2540	2480	2420	2360
2800	3030	2970	2910	2860	2800	2730	2670	2600	2540
3000	3250	3190	3130	3060	3000	2930	2850	2780	2710
3200	3480	3410	3340	3270	3200	3120	3040	2960	2880
3400	3710	3630	3560	3480	3400	3310	3230	3140	3050
3600	3940	3850	3770	3680	3600	3510	3410	3320	3220
3800	4170	4070	3980	3890	3800	3700	3600	3500	3400
4000	4390	4300	4200	4100	4000	3890	3780	3680	3570
4200	4620	4520	4410	4310	4200	4080	3970	3850	3740
4400	4850	4740	4630	4510	4400	4280	4160	4030	3910
4600	5080	4960	4840	4720	4600	4470	4340	4210	4080
4800	5310	5180	5050	4930	4800	4660	4530	4390	4250
5000	5530	5400	5270	5130	5000	4860	4710	4570	4430

Table 2 of 3: Wind Corrections

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M)							
	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
1800	1410	1540	1670	1800	1880	1970	2060	2160
2000	1590	1720	1860	2000	2090	2180	2280	2380
2200	1760	1910	2050	2200	2300	2400	2500	2610
2400	1940	2090	2250	2400	2500	2610	2720	2830
2600	2110	2270	2440	2600	2710	2820	2940	3060
2800	2280	2460	2630	2800	2910	3030	3150	3280
3000	2460	2640	2820	3000	3120	3240	3370	3500
3200	2630	2820	3010	3200	3330	3460	3590	3730
3400	2810	3010	3200	3400	3530	3670	3810	3950
3600	2980	3190	3390	3600	3740	3880	4030	4180
3800	3160	3370	3590	3800	3940	4090	4240	4400
4000	3330	3550	3780	4000	4150	4300	4460	4620
4200	3510	3740	3970	4200	4360	4510	4680	4850
4400	3680	3920	4160	4400	4560	4730	4900	5070
4600	3850	4100	4350	4600	4770	4940	5110	5300
4800	4030	4290	4540	4800	4970	5150	5330	5520
5000	4200	4470	4730	5000	5180	5360	5550	5740

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
2680	421.5	389.7	387.4	385.1	382.8	380.6	378.4	369.2	358.5	346.9	324.9
2800	430.2	397.6	395.3	393.0	390.6	388.3	386.0	376.7	365.7	353.8	331.3
3000	446.1	412.3	410.0	407.5	405.1	402.7	400.3	390.6	379.3	367.0	343.6
3200	459.4	424.4	422.0	419.5	417.0	414.5	412.0	402.0	390.3	377.6	353.4
3400	466.7	436.2	433.6	431.0	428.4	425.9	423.4	413.0	400.9	387.8	362.8
3600	466.7	447.9	445.3	442.6	439.9	437.3	434.7	424.0	411.6	398.0	372.3
3800	466.7	459.4	456.7	453.9	451.2	448.5	445.8	434.8	422.0	408.1	381.6
4000	466.7	466.7	466.7	464.8	461.9	459.2	456.4	445.1	432.0	417.7	390.5
4200	466.7	466.7	466.7	466.7	466.7	466.7	466.7	455.1	441.7	427.0	399.1
4400	466.7	466.7	466.7	466.7	466.7	466.7	466.7	464.9	451.1	436.0	407.5
4600	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	460.3	444.9	415.7
4800	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	453.6	423.8
5000	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	462.0	431.5
5200	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	439.0
5400	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	446.2
5600	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	453.1
5800	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	459.7
6000	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.1
CLIMB LIMIT WT (1000 KG)	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	438.5

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
2680	396.3	366.9	364.8	362.7	360.6	358.5	350.4	341.8	331.6	321.4	301.3
2800	404.4	374.3	372.1	370.0	367.8	365.7	357.4	348.6	338.2	327.7	307.2
3000	419.3	388.2	386.0	383.7	381.5	379.2	370.7	361.6	350.8	340.0	318.7
3200	431.7	399.5	397.2	394.8	392.5	390.2	381.3	371.9	360.8	349.6	327.6
3400	443.6	410.4	408.0	405.6	403.2	400.8	391.7	382.0	370.4	358.9	336.2
3600	455.6	421.4	418.9	416.4	414.0	411.5	402.1	392.0	380.2	368.3	344.9
3800	466.7	432.1	429.5	427.0	424.5	421.9	412.2	401.9	389.7	377.4	353.3
4000	466.7	442.3	439.7	437.1	434.5	431.9	421.9	411.3	398.8	386.2	361.5
4200	466.7	452.3	449.6	446.9	444.2	441.6	431.3	420.5	407.6	394.7	369.4
4400	466.7	462.0	459.2	456.4	453.7	451.0	440.5	429.4	416.2	403.0	377.0
4600	466.7	466.7	466.7	465.8	463.0	460.2	449.5	438.1	424.6	411.1	384.6
4800	466.7	466.7	466.7	466.7	466.7	466.7	458.3	446.7	432.9	419.1	391.9
5000	466.7	466.7	466.7	466.7	466.7	466.7	466.7	454.9	440.8	426.7	399.0
5200	466.7	466.7	466.7	466.7	466.7	466.7	466.7	462.8	448.5	434.1	405.9
5400	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	455.8	441.2	412.5
5600	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	462.9	448.1	418.9
5800	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	454.6	425.0
6000	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	460.9	430.9
CLIMB LIMIT WT (1000 KG)	466.7	466.7	466.7	466.7	466.7	466.7	466.7	466.7	465.3	444.0	404.8

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
2680	373.1	344.8	342.8	341.0	339.1	332.1	324.8	316.2	307.1	298.0	279.9
2800	380.6	351.7	349.7	347.8	345.8	338.7	331.3	322.4	313.1	303.8	285.4
3000	394.7	364.7	362.7	360.7	358.7	351.3	343.6	334.4	324.8	315.2	296.0
3200	406.2	375.2	373.1	371.1	369.0	361.3	353.4	343.9	333.9	323.9	304.2
3400	417.4	385.4	383.2	381.1	378.9	371.0	362.8	353.0	342.7	332.4	312.0
3600	428.5	395.6	393.3	391.1	388.9	380.8	372.3	362.2	351.6	341.0	320.0
3800	439.5	405.5	403.2	400.9	398.7	390.3	381.6	371.2	360.3	349.4	327.7
4000	449.9	415.0	412.7	410.3	408.0	399.4	390.4	379.8	368.6	357.4	335.1
4200	460.0	424.3	421.8	419.5	417.1	408.3	399.1	388.1	376.7	365.2	342.4
4400	466.7	433.3	430.8	428.4	425.9	416.9	407.5	396.3	384.5	372.7	349.4
4600	466.7	442.1	439.6	437.1	434.5	425.3	415.7	404.2	392.2	380.2	356.3
4800	466.7	450.7	448.1	445.6	443.0	433.6	423.7	412.0	399.7	387.4	363.0
5000	466.7	459.0	456.4	453.8	451.1	441.5	431.5	419.5	407.0	394.4	369.5
5200	466.7	466.7	464.3	461.7	459.0	449.2	439.0	426.8	414.0	401.2	375.8
5400	466.7	466.7	466.7	466.7	466.5	456.6	446.1	433.8	420.8	407.8	381.9
5600	466.7	466.7	466.7	466.7	466.7	463.6	453.1	440.5	427.3	414.1	387.8
5800	466.7	466.7	466.7	466.7	466.7	466.7	459.7	446.9	433.5	420.1	393.5
6000	466.7	466.7	466.7	466.7	466.7	466.7	466.0	453.1	439.5	425.9	399.0
CLIMB LIMIT WT (1000 KG)	466.7	466.7	466.7	466.7	466.7	466.7	466.7	449.7	429.3	409.7	375.6

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
2680	350.6	324.8	323.0	321.3	315.9	309.7	300.3	292.6	284.7	275.9	259.7
2800	357.7	331.2	329.4	327.6	322.1	315.8	306.2	298.3	290.3	281.3	264.7
3000	370.9	343.6	341.7	339.8	334.1	327.6	317.6	309.4	301.1	291.8	274.6
3200	381.6	353.3	351.4	349.5	343.5	336.8	326.5	318.0	309.4	299.8	282.0
3400	392.0	362.8	360.8	358.8	352.7	345.7	335.1	326.3	317.5	307.5	289.2
3600	402.4	372.2	370.2	368.2	361.8	354.6	343.7	334.7	325.5	315.3	296.4
3800	412.5	381.5	379.4	377.3	370.8	363.4	352.1	342.9	333.5	322.9	303.5
4000	422.2	390.4	388.2	386.1	379.4	371.8	360.2	350.7	341.0	330.2	310.2
4200	431.7	399.0	396.8	394.6	387.7	380.0	368.1	358.3	348.4	337.3	316.8
4400	440.9	407.4	405.2	402.9	395.9	387.9	375.7	365.7	355.6	344.2	323.2
4600	449.8	415.6	413.3	411.0	403.8	395.7	383.2	373.0	362.6	351.0	329.5
4800	458.6	423.7	421.3	418.9	411.6	403.3	390.5	380.1	369.5	357.6	335.7
5000	466.7	431.4	429.0	426.6	419.1	410.6	397.6	387.0	376.1	364.0	341.6
5200	466.7	438.9	436.5	434.0	426.3	417.7	404.5	393.6	382.6	370.2	347.4
5400	466.7	446.1	443.6	441.1	433.3	424.5	411.0	400.0	388.8	376.2	353.0
5600	466.7	453.0	450.5	447.9	440.0	431.1	417.4	406.2	394.8	382.0	358.5
5800	466.7	459.6	457.0	454.5	446.5	437.4	423.5	412.1	400.6	387.6	363.7
6000	466.7	466.0	463.4	460.7	452.6	443.4	429.4	417.9	406.1	393.0	368.8
CLIMB LIMIT WT (1000 KG)	466.7	466.7	466.7	466.7	464.3	451.1	431.2	413.2	396.0	378.1	348.2

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
2680	327.8	303.7	302.0	297.3	291.6	283.0	276.4	269.5	262.2	254.8	240.8
2800	334.3	309.6	307.9	303.1	297.3	288.5	281.7	274.7	267.2	259.6	245.3
3000	346.7	321.2	319.4	314.4	308.4	299.3	292.2	285.0	277.2	269.3	254.5
3200	356.6	330.2	328.3	323.2	317.0	307.5	300.2	292.7	284.7	276.6	261.2
3400	366.1	338.9	337.0	331.7	325.3	315.5	308.0	300.3	291.9	283.6	267.7
3600	375.7	347.6	345.6	340.2	333.6	323.5	315.8	307.8	299.2	290.6	274.3
3800	385.1	356.2	354.1	348.5	341.8	331.4	323.4	315.2	306.4	297.5	280.7
4000	394.1	364.4	362.3	356.5	349.5	338.9	330.7	322.3	313.2	304.1	286.9
4200	402.8	372.4	370.2	364.3	357.2	346.2	337.9	329.2	319.9	310.6	292.9
4400	411.3	380.1	377.9	371.8	364.5	353.3	344.8	335.9	326.4	316.8	298.7
4600	419.6	387.7	385.4	379.2	371.8	360.3	351.6	342.5	332.7	322.9	304.4
4800	427.7	395.1	392.8	386.5	378.8	367.1	358.2	348.9	338.9	328.9	310.0
5000	435.6	402.3	399.9	393.5	385.7	373.7	364.6	355.1	345.0	334.8	315.4
5200	443.1	409.2	406.8	400.2	392.3	380.1	370.8	361.2	350.8	340.4	320.7
5400	450.4	415.9	413.4	406.7	398.7	386.3	376.8	367.0	356.5	345.9	325.9
5600	457.3	422.3	419.8	413.0	404.8	392.3	382.6	372.7	362.0	351.2	330.9
5800	464.0	428.5	426.0	419.1	410.8	398.0	388.3	378.2	367.3	356.4	335.8
6000	466.7	434.4	431.9	424.9	416.5	403.5	393.7	383.4	372.4	361.4	340.5
CLIMB LIMIT WT (1000 KG)	444.5	443.6	443.4	435.0	423.4	408.4	394.3	379.6	364.4	350.1	322.7

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(f) of 3: 10000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
2680	304.1	281.7	276.5	270.8	265.0	259.1	253.3	247.3	240.6	233.4	219.6
2800	310.1	287.2	281.8	276.0	270.0	264.0	258.1	251.9	245.1	237.8	223.6
3000	321.7	297.9	292.3	286.4	280.1	273.9	267.8	261.4	254.4	246.7	232.0
3200	330.7	306.1	300.3	294.2	287.7	281.3	274.9	268.3	261.1	253.2	237.9
3400	339.4	314.1	308.1	301.7	295.1	288.4	281.9	275.1	267.6	259.4	243.7
3600	348.1	322.0	315.9	309.3	302.5	295.6	288.9	281.8	274.1	265.7	249.5
3800	356.7	329.9	323.5	316.8	309.7	302.7	295.7	288.5	280.5	271.9	255.2
4000	364.9	337.3	330.8	323.9	316.6	309.4	302.3	294.8	286.7	277.8	260.7
4200	372.9	344.6	338.0	330.9	323.4	316.0	308.7	301.1	292.7	283.6	266.1
4400	380.7	351.7	344.9	337.6	330.0	322.4	314.9	307.1	298.5	289.2	271.2
4600	388.3	358.6	351.6	344.2	336.4	328.6	321.0	313.0	304.2	294.7	276.3
4800	395.7	365.4	358.3	350.7	342.7	334.8	326.9	318.8	309.8	300.1	281.3
5000	402.9	372.0	364.7	356.9	348.8	340.7	332.7	324.4	315.2	305.3	286.1
5200	409.8	378.4	370.9	363.0	354.7	346.5	338.4	329.8	320.5	310.4	290.9
5400	416.5	384.5	376.9	368.9	360.5	352.1	343.8	335.2	325.7	315.4	295.5
5600	423.0	390.4	382.7	374.6	366.0	357.5	349.1	340.3	330.7	320.2	300.0
5800	429.2	396.2	388.4	380.1	371.4	362.7	354.2	345.3	335.6	324.9	304.5
6000	435.1	401.7	393.8	385.4	376.6	367.8	359.2	350.2	340.3	329.5	308.8
CLIMB LIMIT WT (1000 KG)	411.8	410.4	403.4	393.7	382.3	370.7	358.7	346.5	333.0	319.3	293.5

With engine bleed for packs off, increase field limit weight by 1100 kg and climb limit weight by 5100 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 500 kg and climb limit weight by 600 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 2500 kg and climb limit weight by 4100 kg.

Takeoff Obstacle Limit Weight

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 1 of 4: Sea Level, 30°C & Below, Zero Wind

OBSTACLE HEIGHT (M)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)											
	DISTANCE FROM BRAKE RELEASE (100 M)											
	25	30	35	40	45	50	55	60	65	70	75	80
5	361.1	394.2	423.2	450.5								
20	348.8	380.7	408.6	433.6	456.8							
40	334.5	364.4	391.8	415.7	437.2	457.1						
60	321.7	350.6	376.9	400.3	421.1	439.9	457.3					
80	309.6	338.4	363.5	386.7	407.0	425.3	442.2	458.1				
100	298.7	327.4	351.7	374.1	394.3	412.7	429.5	445.4	459.1			
120	286.2	317.0	341.1	362.7	383.1	401.4	418.0	433.2	447.8			
140	273.7	307.2	331.4	352.6	372.7	391.1	407.5	422.5	436.2	449.8	460.5	
160	262.9	298.1	322.2	343.5	363.1	381.4	397.7	412.6	426.2	438.7	451.3	461.0
180	253.0	288.2	313.7	335.1	354.3	372.1	388.6	403.3	416.8	429.3	440.9	452.7
200	243.8	278.1	305.7	327.3	346.1	363.5	379.9	394.6	408.1	420.5	431.9	442.6
220	235.5	268.9	298.3	319.7	338.5	355.6	371.5	386.4	399.8	412.2	423.6	434.2
240	227.8	260.6	290.4	312.4	331.3	348.1	363.7	378.5	392.0	404.3	415.7	426.3
260	220.8	252.7	282.1	305.5	324.4	341.1	356.5	371.0	384.5	396.8	408.2	418.7
280		245.4	274.3	298.9	317.7	334.4	349.7	363.8	377.3	389.7	401.0	411.6
300		238.6	267.2	292.2	311.3	328.1	343.2	357.2	370.4	382.8	394.2	404.7

Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.

Table 2 of 4: OAT Adjustment

OAT (°C)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)							
	200	240	280	320	360	400	440	460
30 & Below	0	0	0	0	0	0	0	0
32	-2.9	-3.7	-4.5	-5.3	-6.1	-6.9	-7.7	-8.1
34	-5.8	-7.4	-9.0	-10.6	-12.2	-13.8	-15.4	-16.2
36	-8.7	-11.1	-13.5	-15.9	-18.3	-20.7	-23.1	-24.3
38	-11.6	-14.8	-18.0	-21.2	-24.4	-27.6	-30.8	-32.4
40	-14.5	-18.5	-22.5	-26.5	-30.5	-34.5	-38.4	-40.4
42	-17.7	-22.5	-27.3	-32.1	-36.9	-41.7	-46.5	-48.9
44	-20.9	-26.5	-32.1	-37.7	-43.3	-48.9	-54.5	-57.3
46	-24.2	-30.6	-36.9	-43.3	-49.7	-56.1	-62.5	-65.7
48	-27.4	-34.6	-41.8	-49.0	-56.1	-63.3	-70.5	-74.1
50	-30.7	-38.6	-46.6	-54.6	-62.6	-70.5	-78.5	-82.5

Table 3 of 4: Pressure Altitude Adjustment

ALT (FT)	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)							
	200	240	280	320	360	400	440	460
S.L. & Below	0	0	0	0	0	0	0	0
1000	-7.4	-8.9	-10.4	-12.0	-13.5	-15.0	-16.6	-17.3
2000	-14.8	-17.8	-20.9	-24.0	-27.0	-30.1	-33.2	-34.7
3000	-21.3	-25.8	-30.3	-34.9	-39.4	-43.9	-48.5	-50.8
4000	-27.8	-33.8	-39.8	-45.8	-51.8	-57.8	-63.8	-66.8
5000	-34.0	-41.5	-48.9	-56.4	-63.8	-71.3	-78.7	-82.4
6000	-40.3	-49.2	-58.1	-67.0	-75.8	-84.7	-93.6	-98.1
7000	-46.8	-57.0	-67.3	-77.5	-87.7	-97.9	-108.2	-113.3
8000	-53.3	-64.9	-76.4	-88.0	-99.6	-111.1	-122.7	-128.5
9000	-59.3	-72.1	-85.0	-97.9	-110.7	-123.6	-136.5	-142.9
10000	-65.3	-79.4	-93.6	-107.7	-121.9	-136.1	-150.2	-157.3

Takeoff Obstacle Limit Weight

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 4 of 4: Wind Adjustment

WIND (KTS)	OAT & ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)							
	200	240	280	320	360	400	440	460
15 TW	-41.5	-41.4	-41.3	-41.2	-41.1	-41.0	-41.0	-40.9
10 TW	-27.6	-27.6	-27.5	-27.5	-27.4	-27.4	-27.3	-27.3
5 TW	-13.8	-13.8	-13.8	-13.7	-13.7	-13.7	-13.7	-13.6
0	0	0	0	0	0	0	0	0
10 HW	6.5	6.3	6.1	6.0	5.8	5.7	5.5	5.4
20 HW	12.9	12.6	12.3	12.0	11.6	11.3	11.0	10.9
30 HW	19.8	19.3	18.7	18.2	17.6	17.1	16.5	16.3
40 HW	26.7	25.9	25.1	24.4	23.6	22.8	22.1	21.7

With engine bleed for packs off, increase weight by 1500 kg.
With engine anti-ice on below 10000 ft pressure altitude, decrease weight by 1000 kg.
With engine anti-ice on at 10000 ft pressure altitude, decrease weight by 3300 kg.

Tire Speed Limit

Flaps 10

AIRPORT OAT (°C)	TIRE SPEED LIMIT WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	433.9	401.1	370.3	343.1	318.0	294.1
52	437.3	404.2	373.1	345.5	320.2	296.2
50	440.6	407.2	375.9	347.9	322.4	298.3
48	444.0	410.3	378.7	350.3	324.7	300.4
46	451.5	413.5	381.6	352.7	326.9	302.5
44	454.7	416.7	384.6	355.2	329.2	304.6
42	458.0	419.9	387.6	357.7	331.6	306.7
40	461.3	423.2	390.6	360.3	333.9	308.9
38	464.6	426.5	393.7	363.0	336.3	311.2
36	466.7	429.9	396.8	365.7	338.7	313.4
34	466.7	433.3	400.0	368.6	341.2	315.6
32	466.7	436.7	403.1	371.5	343.6	317.9
30	466.7	440.1	406.3	374.5	346.1	320.2
28	466.7	443.4	409.4	377.5	348.6	322.4
26	466.7	450.9	412.6	380.6	351.1	324.8
24	466.7	453.8	415.7	383.5	353.6	327.1
22	466.7	456.7	418.9	386.5	356.4	329.4
20	466.7	459.7	421.8	389.4	358.9	331.8
18	466.7	462.7	424.8	392.3	361.4	334.2
16	466.7	465.7	427.8	395.2	363.9	336.7
14	466.7	466.7	430.9	398.0	366.7	339.1
12	466.7	466.7	434.0	400.9	369.4	341.5
10	466.7	466.7	437.1	403.8	372.1	344.0
-40	466.7	466.7	466.7	466.7	458.0	418.3

Increase tire speed limit weight by 2400 kg per knot headwind.
Decrease tire speed limit weight by 6300 kg per knot tailwind.

Brake Energy Limits VMBE

Flaps 10

Table 1 of 2: Maximum Brake Energy Speed

OAT (°C)	REFERENCE VMBE (KIAS)					
	PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	189					
50	190	183				
46	190	184	177			
42	191	184	178	172		
38	192	185	179	172	166	
34	192	186	179	173	167	158
30	193	186	180	174	168	159
26	194	187	181	174	168	161
22	196	189	182	175	169	162
18	198	190	183	177	170	164
14	199	192	185	178	171	165
10	201	194	186	179	173	166
6	203	195	188	181	174	168
2	204	197	190	182	176	169
-2	206	199	191	184	177	170
-6	208	200	193	186	179	172
-10	210	202	195	187	180	173

Table 2 of 2: Weight Adjusted VMBE

WEIGHT (1000 KG)	REFERENCE VMBE (KIAS)										
	160	165	170	175	180	185	190	195	200	205	210
240	194	200	207	210	210	210	210	210	210	210	210
260	185	191	197	203	209	210	210	210	210	210	210
280	178	184	189	195	201	206	210	210	210	210	210
300	171	177	182	187	193	198	204	209	210	210	210
320	165	171	176	181	186	191	197	202	207	210	210
340	160	165	170	175	180	185	190	195	200	205	210
360	155	160	165	170	174	179	184	189	194	198	203
380	151	155	160	165	169	174	179	183	188	192	197
400	147	151	156	160	165	169	174	178	183	187	191
420	143	147	152	156	160	165	169	173	178	182	186
440	140	144	148	152	157	161	165	169	173	177	182
460	137	141	145	149	153	157	161	165	169	173	177

Increase VMBE by 2 knots per 1% uphill runway slope. Decrease VMBE by 5 knots per 1% downhill runway slope.
Increase VMBE by 4 knots per 10 knots headwind. Decrease VMBE by 20 knots per 10 knots tailwind.
Decrease VMBE by 16 knots for two brakes deactivated.

Decrease brake release weight by 2500 kg for each knot V1 exceeds VMBE.
Determine V1, VR, V2 speeds for lower brake release weight.

Long Range Cruise Maximum Operating Altitude
Max Climb Thrust

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
460	29000	28700	32500	31300	29600
440	30000	29600	33700	32800	31000
420	31000	30700	34800	34100	32500
400	32100	31700	35800	35500	33900
380	33200	32800	36800	36600	35500
360	34300	34000	38000	37700	36700
340	35500	35200	39200	38800	37800
320	36800	36400	40400	40000	38900
300	38100	37800	41700	41200	40100
280	39600	39200	43100	42400	41300
260	41100	40800	43100	43100	42600
240	42800	42400	43100	43100	43100
220	43100	43100	43100	43100	43100
200	43100	43100	43100	43100	43100

***Based on 1.3g/39° bank maneuver capability.**
****300 ft/min residual rate of climb.**

Long Range Cruise Trip Fuel and Time

Table 1 of 3: 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
528	497	469	443	421	400	383	367	352	339	326
1042	984	930	882	839	800	767	736	708	682	658
1555	1469	1391	1321	1258	1200	1151	1106	1064	1026	990
2067	1954	1851	1759	1676	1600	1536	1476	1421	1370	1323
2576	2437	2310	2197	2094	2000	1920	1846	1777	1714	1656
3084	2920	2769	2634	2512	2400	2305	2217	2135	2059	1989
3591	3401	3227	3071	2930	2800	2690	2587	2491	2403	2322
4097	3881	3684	3508	3348	3200	3074	2957	2848	2747	2654
4601	4361	4141	3944	3765	3600	3459	3327	3205	3091	2987
5105	4841	4598	4380	4183	4000	3844	3697	3561	3436	3320
5607	5319	5054	4816	4600	4400	4228	4067	3918	3779	3652
6109	5797	5510	5251	5017	4800	4613	4437	4274	4123	3985
6611	6274	5965	5687	5434	5200	4997	4808	4631	4468	4317
7111	6751	6419	6122	5851	5600	5382	5178	4988	4812	4650
7611	7227	6874	6556	6267	6000	5766	5548	5344	5156	4983
8110	7703	7328	6991	6684	6400	6151	5918	5701	5500	5316
8608	8178	7782	7426	7101	6800	6535	6288	6057	5844	5649
9106	8653	8236	7860	7517	7200	6920	6658	6414	6189	5981
9603	9127	8689	8294	7934	7600	7304	7028	6771	6533	6314
10099	9601	9142	8728	8350	8000	7689	7398	7127	6876	6646

Table 2 of 3: Reference Fuel and Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	27		29		31		33		35	
	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)
400	10.2	1:03	9.9	1:03	9.7	1:02	9.6	1:02	9.5	1:01
800	18.8	1:55	18.0	1:54	17.5	1:52	17.1	1:51	16.8	1:50
1200	27.4	2:47	26.2	2:44	25.3	2:42	24.7	2:41	24.2	2:39
1600	36.2	3:38	34.5	3:34	33.3	3:32	32.4	3:30	31.7	3:28
2000	45.0	4:29	43.0	4:24	41.3	4:21	40.3	4:18	39.3	4:17
2400	53.9	5:19	51.6	5:14	49.6	5:10	48.3	5:07	47.1	5:05
2800	63.0	6:09	60.4	6:03	57.9	5:59	56.4	5:55	55.0	5:53
3200	72.3	6:58	69.3	6:52	66.4	6:47	64.6	6:43	63.1	6:42
3600	81.7	7:47	78.3	7:41	75.1	7:36	73.0	7:32	71.4	7:31
4000	91.3	8:36	87.5	8:29	83.8	8:24	81.6	8:20	79.9	8:19
4400	101.2	9:25	97.0	9:17	92.9	9:12	90.5	9:08	88.8	9:08
4800	111.1	10:13	106.5	10:05	102.0	9:59	99.4	9:56	97.7	9:56
5200	121.2	11:01	116.3	10:53	111.3	10:47	108.6	10:44	107.0	10:45
5600	131.5	11:49	126.2	11:41	120.9	11:35	118.1	11:32	116.7	11:34
6000	141.9	12:37	136.2	12:28	130.5	12:23	127.6	12:21	126.3	12:22
6400	152.8	13:24	146.7	13:16	140.7	13:10	137.9	13:09		
6800	163.6	14:12	157.2	14:03	150.8	13:58	148.1	13:57		
7200	174.8	14:59	168.0	14:50	161.4	14:46				
7600	186.2	15:46	179.1	15:38	172.3	15:34				
8000	197.7	16:33	190.3	16:25	183.2	16:22				

Long Range Cruise Trip Fuel and Time

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	LANDING WEIGHT (1000 KG)						
	200	220	240	260	280	300	320
20	-3.2	-2.4	-1.6	-0.8	0.0	0.9	2.0
40	-6.1	-4.5	-2.9	-1.4	0.0	2.0	4.3
60	-8.9	-6.6	-4.3	-2.1	0.0	3.3	7.3
80	-11.9	-8.8	-5.8	-2.9	0.0	4.9	10.7
100	-15.0	-11.1	-7.4	-3.7	0.0	6.7	14.6
120	-18.1	-13.5	-9.0	-4.5	0.0	8.7	19.1
140	-21.4	-16.0	-10.7	-5.4	0.0	11.0	24.1
160	-24.7	-18.6	-12.5	-6.3	0.0	13.5	29.6
180	-28.1	-21.3	-14.4	-7.3	0.0	16.3	35.7
200	-31.6	-24.0	-16.4	-8.4	0.0	19.3	42.2

Based on 340/.84 climb, Long Range Cruise speed and .84/290/250 descent.

Long Range Cruise Step Climb

Table 1 of 2: Ground to Air Miles Conversion

AIR DISTANCE (NM) HEAD WIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAIL WIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
1038	980	927	881	838	800	765	733	703	676	651
1538	1456	1382	1316	1255	1200	1149	1103	1060	1020	984
2039	1933	1837	1751	1672	1600	1534	1473	1417	1365	1316
2540	2410	2293	2186	2089	2000	1918	1843	1774	1709	1649
3042	2887	2748	2621	2506	2400	2303	2213	2130	2053	1982
3543	3365	3203	3056	2923	2800	2687	2583	2487	2398	2315
4045	3842	3658	3492	3339	3200	3072	2953	2844	2742	2647
4547	4320	4114	3927	3756	3600	3456	3323	3200	3086	2980
5049	4797	4570	4363	4173	4000	3840	3693	3557	3430	3312
5551	5275	5025	4798	4590	4400	4225	4063	3913	3774	3644
6054	5753	5481	5234	5007	4800	4609	4433	4269	4118	3976
6557	6232	5937	5669	5425	5200	4993	4802	4626	4461	4308
7061	6711	6394	6105	5842	5600	5378	5172	4982	4805	4640
7564	7189	6850	6541	6259	6000	5762	5542	5338	5148	4972
8069	7669	7307	6977	6676	6400	6146	5911	5694	5492	5303
8573	8148	7763	7413	7093	6800	6530	6280	6049	5835	5635
9078	8628	8220	7850	7511	7200	6914	6650	6405	6178	5966
9584	9108	8678	8286	7928	7600	7298	7019	6760	6520	6297
10090	9589	9135	8723	8346	8000	7682	7388	7116	6863	6627

Table 2 of 2: Trip Fuel and Time Required

AIR DIST (NM)	TRIP FUEL (1000 KG) BRAKE RELEASE WEIGHT (1000 KG)												TIME (HR:MIN)
	240	260	280	300	320	340	360	380	400	420	440	460	
800	14.3	15.1	15.8	16.7	17.5	18.5	19.5	20.4	21.5	22.7	23.9	25.0	1:50
1200	20.1	21.2	22.2	23.6	24.8	26.2	27.6	29.0	30.5	32.1	33.9	35.5	2:38
1600	25.8	27.2	28.6	30.3	31.9	33.7	35.6	37.3	39.2	41.3	43.6	45.4	3:27
2000	31.4	33.1	34.9	36.9	38.9	41.0	43.3	45.5	47.8	50.3	53.0	55.6	4:15
2400	36.9	38.9	41.0	43.3	45.8	48.2	50.9	53.5	56.2	59.1	62.2	65.3	5:04
2800	42.3	44.6	47.0	49.7	52.4	55.2	58.3	61.3	64.4	67.6	71.1	74.7	5:52
3200	47.7	50.2	52.9	55.9	58.9	62.2	65.5	68.9	72.4	76.0	79.9	83.8	6:41
3600	52.9	55.8	58.7	62.0	65.3	69.0	72.6	76.4	80.3	84.0	88.4	92.7	7:30
4000	58.1	61.2	64.4	68.0	71.6	75.5	79.6	83.7	87.9	92.3	96.8	101.4	8:19
4400	63.2	66.6	70.1	73.9	77.8	82.0	86.4	90.8	95.4	100.1	105.0	109.9	9:08
4800	68.3	71.9	75.6	79.7	83.9	88.4	93.1	97.8	102.7	107.8	113.1	118.3	9:57
5200	73.2	77.1	81.1	85.4	89.9	94.6	99.6	104.7	109.8	115.2	120.9	126.5	10:46
5600	78.1	82.2	86.4	91.0	95.7	100.7	106.0	111.4	116.8	122.5	128.5	134.5	11:35
6000	82.9	87.3	91.7	96.5	101.5	106.8	112.3	117.9	123.7	129.7	135.9	142.2	12:25
6400	87.6	92.2	96.9	102.0	107.2	112.7	118.4	124.3	130.5	136.7	143.2	149.8	13:14
6800	92.2	97.1	102.1	107.3	112.7	118.5	124.5	130.7	137.0	143.6	150.4	157.2	14:04
7200	96.8	101.9	107.1	112.6	118.2	124.2	130.4	136.9	143.4	150.3	157.4	164.5	14:54
7600	101.3	106.6	112.1	117.8	123.7	129.8	136.3	143.0	149.8	156.9	164.1	171.6	15:44
8000	105.7	111.3	116.9	122.9	129.0	135.4	142.1	148.9	156.0	163.3	171.0	178.6	16:35

Based on 340/.84 climb, Long Range Cruise speed and .84/290/250 descent.
Valid for all pressure altitudes with 4000 ft step climb to 2000 ft above optimum altitude.

Short Trip Fuel and Time

Table 1 of 2: 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
102	84	72	63	56	50	45	42	38	36	33
162	144	130	118	108	100	93	87	81	77	72
225	204	187	173	161	150	141	132	125	118	113
287	264	245	228	213	200	189	178	169	161	153
350	324	302	282	265	250	237	224	214	204	195
411	383	358	336	317	300	285	271	258	247	236
473	442	415	391	369	350	333	317	303	290	278
536	502	472	445	421	400	381	363	347	333	319
598	561	529	500	473	450	429	409	392	376	361
662	622	586	554	526	500	477	455	436	418	402

Table 2 of 2: Trip Fuel and Time Required

AIR DIST (NM)		LANDING WEIGHT (1000 KG)							TIME (HRS:MIN)
		200	220	240	260	280	300	320	
50	FUEL (1000 KG)	2.2	2.3	2.4	2.5	2.6	2.7	2.9	0:15
	ALT (FT)	11000	11000	9000	9000	9000	9000	9000	
100	FUEL (1000 KG)	3.3	3.4	3.5	3.7	3.8	4.0	4.1	0:23
	ALT (FT)	19000	19000	17000	17000	17000	17000	17000	
150	FUEL (1000 KG)	4.2	4.4	4.6	4.8	5.0	5.2	5.4	0:30
	ALT (FT)	31000	29000	29000	25000	23000	23000	23000	
200	FUEL (1000 KG)	5.0	5.2	5.4	5.7	5.9	6.2	6.5	0:36
	ALT (FT)	35000	35000	35000	35000	33000	31000	31000	
250	FUEL (1000 KG)	5.7	6.0	6.2	6.5	6.8	7.1	7.4	0:42
	ALT (FT)	41000	41000	37000	37000	35000	35000	35000	
300	FUEL (1000 KG)	6.4	6.7	7.0	7.3	7.7	8.0	8.4	0:48
	ALT (FT)	41000	41000	41000	39000	37000	35000	35000	
350	FUEL (1000 KG)	7.1	7.4	7.8	8.2	8.6	9.0	9.4	0:54
	ALT (FT)	41000	41000	41000	39000	37000	37000	35000	
400	FUEL (1000 KG)	7.8	8.1	8.6	9.0	9.4	9.9	10.4	1:00
	ALT (FT)	41000	41000	41000	39000	39000	37000	35000	
450	FUEL (1000 KG)	8.4	8.9	9.3	9.8	10.3	10.8	11.4	1:06
	ALT (FT)	41000	41000	41000	39000	39000	37000	35000	
500	FUEL (1000 KG)	9.1	9.6	10.1	10.6	11.2	11.8	12.4	1:13
	ALT (FT)	41000	41000	41000	39000	39000	37000	35000	

Holding Planning

Flaps Up

WEIGHT (1000 KG)	TOTAL FUEL FLOW (KG/HR)									
	PRESSURE ALTITUDE (FT)									
	1500	5000	10000	15000	20000	25000	30000	35000	40000	43000
460	13200	13090	13050	13060	13750	14120	14300			
440	12580	12450	12410	12400	13040	13360	13590			
420	11970	11830	11780	11750	12340	12620	12850			
400	11380	11230	11170	11110	11660	11890	12070	12340		
380	10800	10640	10560	10490	10990	11170	11310	11470		
360	10240	10070	10230	10130	10550	10660	10580	10710		
340	9980	9790	9680	9580	9930	9990	9890	10120		
320	9470	9280	9150	9030	9330	9350	9210	9380	9940	
300	8970	8770	8630	8490	8730	8730	8540	8670	9110	
280	8480	8270	8120	7970	8140	8130	7890	7990	8410	8860
260	8010	7780	7630	7470	7570	7550	7480	7500	7910	8150
240	7540	7300	7140	6980	7010	6960	6890	6860	7220	7450
220	7090	6840	6660	6500	6470	6390	6330	6230	6550	6820
200	6680	6420	6230	6060	5960	5860	5790	5660	5910	6120

Includes 5% additional fuel for holding in a race track pattern.

Flaps 1

WEIGHT (1000 KG)	TOTAL FUEL FLOW (KG/HR)				
	PRESSURE ALTITUDE (FT)				
	1500	5000	10000	15000	20000
460	15940	15900	15930	16170	16440
440	15210	15180	15160	15380	15590
420	14490	14460	14420	14600	14770
400	13770	13740	13690	13820	13980
380	13070	13020	12980	13050	13200
360	12380	12300	12270	12310	12440
340	11730	11620	11580	11600	11710
320	11090	10950	10910	10890	10990
300	10460	10290	10480	10430	10490
280	10090	9920	9830	9750	9790
260	9480	9300	9180	9090	9100
240	8880	8690	8560	8450	8430
220	8320	8110	7960	7830	7780
200	7830	7600	7440	7280	7180

Includes 5% additional fuel for holding in a race track pattern.

Oxygen Requirements

Flight Crew System

Table 1 of 5

NO. OF CREW	OXYGEN REQUIRED (LITERS)
2	710
3	1040
4	1370

Includes normal usage allowance of one person for 15 minutes at 8000 ft.

Table 2 of 5

NO. OF CREW	OXYGEN REQUIRED FOR LEVEL OFF AT 14000 FT (LITERS)			
	TOTAL POST DECOMPRESSION TIME (HR)			
	2	3	4	5
2	1170	1640	3000	2570
3	1750	2450	3150	3860
4	2330	3260	4200	5140

Includes normal usage allowance of one person for 15 minutes at 8000 ft cabin altitude.

Table 3 of 5

NO. OF CREW	ADDITIONAL LITERS REQUIRED FOR EACH MINUTE HELD AT INTERMEDIATE ALTITUDES OTHER THAN 14000 FT				
	INTERMEDIATE PRESSURE ALTITUDE (FT)				
	8000 TO 13999	14000	14001 TO 17999	18000 TO 21999	22000 TO 25000
	REGULATOR ON "NORMAL" OR (100%)				
2	2 (22)	0 (19)	1 (18)	2 (16)	4 (14)
3	2 (33)	0 (29)	2 (27)	3 (24)	7 (21)
4	3 (44)	0 (38)	2 (36)	4 (32)	9 (27)

Instructions:

1. **Determine protective breathing requirements from Table 1.**
2. **Determine sustenance requirements for level off at 14000 ft from Table 2 and adjust for level off altitudes other than 14000 ft using Table 3.**
3. **Flight crew system oxygen requirements are the larger of protective breathing (Table 1) or sustenance requirements (Table 2).**

Includes normal usage allowance of one person for 15 minutes at 8000 ft cabin altitude.

Oxygen Requirements

Table 4 of 5: Cylinder Volume to Pressure Conversion
Based on 2 Cylinders (114 Cubic Foot Bottles) Installed

CYLINDER PRESSURE AT 21°C (70°F) (PSI)	OXYGEN IN CYLINDERS (1000 LITER)
200	0.3
300	0.7
400	1.0
500	1.4
600	1.7
700	2.1
800	2.4
900	2.8
1000	3.1
1100	3.5
1200	3.8
1300	4.2
1400	4.5
1500	4.9
1600	5.2
1700	5.5
1800	5.9
1900	6.2
2000	6.6

Check minimum/maximum pressure in shaded area.
Minimum cylinder pressure = 680 psi at 21°C (70°F).
Maximum cylinder pressure = 1850 psi at 21°C (70°F).
For maximum cylinder pressure at hotter or colder temperatures add or subtract 32 PSI per 5°C (10°F) respectively.

Table 5 of 5: Temperature Corrections

CYLINDER PRESSURE AT 21°C (70°F) (PSI)	PRESSURE CORRECTION FOR EACH 5°C (10°F) (PSI)
400	7
600	11
800	14
1000	17
1200	21
1400	24
1600	28
1800	31
2000	34

If ambient temperature above 21°C (70°F), add increment shown. If ambient temperature below 21°C (70°F), subtract increment shown.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Net Level Off Weight

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 KG)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
32	199.9	199.8	191.0
30	219.2	217.4	208.2
28	239.9	233.2	223.6
26	258.7	249.8	239.0
24	276.0	266.1	255.0
22	293.9	283.1	270.9
20	313.2	301.1	288.4
18	332.3	319.0	305.8
16	351.7	337.8	323.0
14	371.9	357.5	341.0
12	395.2	379.0	361.1
10	419.6	400.6	381.5
8	438.2	418.4	398.6
6	457.9	436.7	416.1

Anti-Ice Adjustments

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 KG)												
	PRESSURE ALTITUDE (1000 FT)												
	6	8	10	12	14	16	18	20	22	24	26	28	30
ENGINE ONLY	-2.6	-3.1	-3.3	-3.4	-3.5	-2.0	-2.0	-2.1	-1.8	-2.0	-1.9	-1.7	-1.4
ENGINE AND WING	-8.7	-9.0	-11.9	-11.3	-12.2	-8.1	-7.8	-7.7	-6.9	-7.2	-6.7	-6.2	-5.6

Intentionally
Blank

Landing Field Limit Weight - Dry Runway

Flaps 30

Table 1 of 2: Wind Adjusted Field Length (M)

FIELD LENGTH AVAILABLE (M)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
1600	1230	1330	1480	1600	1680	1770	1870	1970
1800	1390	1500	1670	1800	1890	1990	2090	2200
2000	1560	1680	1860	2000	2100	2200	2310	2430
2200	1720	1850	2040	2200	2310	2420	2540	2660
2400	1880	2030	2230	2400	2510	2630	2760	2890
2600	2040	2200	2410	2600	2720	2850	2980	3120
2800	2210	2380	2600	2800	2930	3060	3210	3360
3000	2370	2550	2790	3000	3140	3280	3430	3590
3200	2530	2730	2970	3200	3340	3490	3650	3820
3400	2690	2900	3160	3400	3550	3710	3880	4050
3600	2850	3080	3340	3600	3760	3920	4100	4280
3800	3020	3250	3530	3800	3970	4140	4320	4510
4000	3180	3430	3720	4000	4170	4360	4550	4740
4200	3340	3600	3900	4200	4380	4570	4770	4970
4400	3500	3780	4090	4400	4590	4790	4990	5210
4600	3670	3950	4270	4600	4800	5000	5210	5440
4800	3830	4130	4460	4800	5000	5220	5440	5670
5000	3990	4300	4640	5000	5210	5430	5660	5900

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
1600	246.4	229.9	214.1	198.9	184.4	
1800	287.6	272.1	253.9	236.6	220.0	204.1
2000	314.2	301.7	289.8	274.5	255.8	237.9
2200	340.0	326.5	313.4	300.7	288.4	271.8
2400	364.4	351.4	336.2	322.6	309.4	296.6
2600	385.7	372.0	358.7	345.2	329.9	316.1
2800	406.3	391.9	377.8	364.1	350.8	335.0
3000	426.1	411.1	396.3	381.9	368.0	354.2
3200	445.2	429.6	414.2	399.1	384.5	370.2
3400	463.8	447.5	431.5	415.7	400.5	385.6
3600	466.7	464.8	448.3	431.9	416.1	400.5
3800		466.7	464.5	447.7	431.1	414.7
4000			466.7	460.8	443.8	427.2
4200				466.7	455.2	438.1
4400				466.7	466.1	448.6
4600					466.7	458.8
4800						466.7
5000						466.7

With manual speedbrakes, decrease weight by 21500 kg.
With 2 brakes deactivated, decrease weight by 35600 kg.

Landing Field Limit Weight - Wet Runway

Flaps 30

Table 1 of 2: Wind Adjusted Field Length (M)

FIELD LENGTH AVAILABLE (M)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
1600	1220	1310	1480	1600	1690	1780	1880	1990
1800	1380	1490	1670	1800	1900	2000	2100	2220
2000	1550	1660	1860	2000	2100	2210	2330	2450
2200	1710	1840	2040	2200	2310	2430	2550	2680
2400	1870	2010	2230	2400	2520	2640	2770	2910
2600	2030	2190	2410	2600	2730	2860	3000	3140
2800	2200	2360	2600	2800	2930	3070	3220	3370
3000	2360	2540	2790	3000	3140	3290	3440	3600
3200	2520	2710	2970	3200	3350	3500	3670	3840
3400	2680	2890	3160	3400	3560	3720	3890	4070
3600	2840	3060	3340	3600	3760	3930	4110	4300
3800	3010	3240	3530	3800	3970	4150	4330	4530
4000	3170	3410	3710	4000	4180	4360	4560	4760
4200	3330	3590	3900	4200	4390	4580	4780	4990
4400	3490	3760	4090	4400	4590	4790	5000	5220
4600	3660	3940	4270	4600	4800	5010	5230	5450
4800	3820	4110	4460	4800	5010	5220	5450	5690
5000	3980	4290	4640	5000	5220	5440	5670	5920

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
1600	200.0	186.1	172.5			
1800	238.7	222.6	207.1	192.3	178.2	164.6
2000	276.1	259.2	241.8	225.1	209.2	193.9
2200	302.6	290.8	276.0	257.9	240.2	223.2
2400	325.5	312.6	300.1	287.5	271.4	252.6
2600	348.2	333.8	320.4	307.4	294.9	280.8
2800	368.2	355.0	340.6	326.3	313.0	300.0
3000	386.6	372.9	359.5	346.0	330.7	317.0
3200	404.5	390.2	376.2	362.5	348.9	333.4
3400	421.8	406.9	392.3	378.1	364.3	350.6
3600	438.6	423.2	408.0	393.1	378.8	364.7
3800	455.0	439.0	423.3	407.8	392.9	378.3
4000	466.7	454.3	438.1	422.1	406.7	391.5
4200		466.7	452.5	436.1	420.1	404.2
4400		466.7	466.6	449.5	432.9	416.5
4600			466.7	460.8	443.8	427.2
4800				466.7	453.7	436.7
5000				466.7	463.3	445.9
5200					466.7	454.8
5400					466.7	463.5
5600						466.7
5800						466.7

With manual speedbrakes, decrease weight by 21500 kg.
With 2 brakes deactivated, decrease weight by 35600 kg.

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	LANDING CLIMB LIMIT WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	330.7					
52	338.6					
50	347.6	335.9				
48	355.8	344.6				
46	364.0	352.9	329.9			
44	372.3	361.2	337.0			
42	380.6	369.6	345.5	317.1		
40	389.2	377.9	353.1	324.3		
38	398.6	386.4	360.7	331.7	304.5	
36	407.5	394.9	368.4	338.4	310.4	
34	415.4	403.3	376.2	345.6	316.4	284.8
32	422.1	410.8	383.9	352.0	322.1	289.7
30	428.9	417.6	389.8	358.5	327.4	294.7
28	429.1	423.7	395.5	365.2	332.7	299.5
26	429.3	429.6	401.1	373.8	338.0	304.1
24	429.6	429.8	406.6	378.4	343.9	308.7
22	429.8	430.0	411.7	382.7	353.0	313.0
20	430.0	430.1	411.9	386.7	357.4	317.3
18	430.3	430.3	412.0	390.5	361.2	321.9
16	430.5	430.5	412.1	390.5	364.6	326.1
14	430.6	430.6	412.2	390.6	367.6	329.8
12	430.8	430.8	412.3	390.7	367.7	333.1
10	430.9	430.9	412.4	390.7	367.7	336.2
-40	431.7	431.7	415.2	391.9	368.6	337.3

With engine bleed for packs off, increase weight by 3700 kg.
With engine anti-ice on, decrease weight by 4500 kg.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10°C, decrease weight by 21900 kg.

ENGINE INOP

ADVISORY INFORMATION

Go-Around Climb Gradient

Flaps 20, Gear Up

Based on engine bleeds for packs on and anti-ice off.

Table 1 of 3: Reference Go-Around Gradient (%)

AIRPORT OAT (°C)	REFERENCE GO-AROUND GRADIENT (%)					
	PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	4.29	3.95	3.50	2.77	1.98	0.75
50	5.07	4.55	4.09	3.35	2.56	1.30
46	5.87	5.31	4.71	3.94	3.14	1.85
42	6.67	6.10	5.44	4.58	3.74	2.40
38	7.51	6.90	6.20	5.34	4.37	2.96
34	8.28	7.69	6.96	6.00	5.00	3.53
30	8.86	8.31	7.60	6.64	5.57	4.05
26	8.89	8.89	8.15	7.39	6.12	4.53
22	8.91	8.90	8.71	7.86	6.83	5.00
18	8.93	8.92	8.73	8.29	7.27	5.46
14	8.95	8.94	8.74	8.29	7.61	5.87
10	8.96	8.95	8.75	8.30	7.62	6.21
8	8.96	8.96	8.75	8.30	7.62	6.21
6	8.97	8.96	8.76	8.30	7.62	6.22
4	8.98	8.96	8.76	8.30	7.62	6.22
2	8.98	8.97	8.77	8.30	7.62	6.22
0	8.99	8.97	8.77	8.31	7.62	6.22

Table 2 of 3: Weight Adjustment

WEIGHT (1000 KG)	REFERENCE GO-AROUND GRADIENT (%)							
	2	3	4	5	6	7	8	9
350	-1.51	-1.64	-1.76	-1.89	-2.01	-2.13	-2.25	-2.35
340	-1.21	-1.30	-1.40	-1.50	-1.59	-1.69	-1.77	-1.85
330	-0.85	-0.92	-0.98	-1.05	-1.12	-1.18	-1.24	-1.30
320	-0.45	-0.49	-0.52	-0.55	-0.59	-0.62	-0.65	-0.68
310	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
300	0.43	0.47	0.50	0.54	0.57	0.61	0.65	0.68
290	0.90	0.98	1.05	1.12	1.20	1.28	1.35	1.42
280	1.41	1.53	1.63	1.74	1.86	1.99	2.11	2.22
270	1.94	2.11	2.26	2.40	2.57	2.75	2.91	3.06
260	2.53	2.74	2.93	3.12	3.34	3.58	3.79	3.98
250	3.17	3.44	3.68	3.92	4.20	4.49	4.75	4.99
240	3.87	4.20	4.50	4.79	5.13	5.49	5.81	6.10
230	4.63	5.02	5.38	5.74	6.15	6.58	6.96	7.30

ENGINE INOP

ADVISORY INFORMATION

Go-Around Climb Gradient

Flaps 20, Gear Up

Based on engine bleeds for packs on and anti-ice off.

Table 3 of 3: Speed Adjustment

SPEED (KIAS)	WEIGHT ADJUSTED GO-AROUND GRADIENT (%)								
	1	3	5	7	9	11	13	15	17
VREF30	-0.14	-0.14	-0.15	-0.15	-0.15	-0.16	-0.16	-0.16	-0.14
VREF30+5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VREF30+10	0.04	0.02	0.01	0.00	-0.02	-0.03	-0.03	-0.02	0.00
VREF30+15	0.03	0.00	-0.03	-0.06	-0.09	-0.11	-0.11	-0.10	-0.07
VREF30+20	-0.03	-0.07	-0.12	-0.18	-0.22	-0.25	-0.26	-0.24	-0.19
VREF30+25	-0.12	-0.18	-0.27	-0.36	-0.42	-0.46	-0.47	-0.46	-0.39
VREF30+30	-0.21	-0.32	-0.47	-0.59	-0.67	-0.73	-0.75	-0.74	-0.68

When operating in icing conditions during any part of the flight with forecast landing temperatures at or below 10°C, decrease gradient by 1.0%
With engine bleed for packs off, increase gradient by 0.2%
With engine anti-ice on, decrease gradient by 0.2%

Quick Turnaround Limit Weight

Flaps 30 Limit Weight (1000 KG)

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	316.6					
50	318.7	305.9				
45	321.4	308.4	295.8			
40	324.1	311.0	298.3	286.0		
35	326.9	313.7	300.9	288.4	276.6	
30	329.7	316.4	303.5	290.9	278.9	267.3
25	332.7	319.2	306.2	293.5	281.3	269.6
20	335.7	322.1	309.0	296.1	283.7	272.0
15	338.8	325.0	311.8	298.8	286.3	274.5
10	342.5	328.1	314.7	301.7	289.0	276.9
5	347.5	331.2	317.7	304.5	291.8	279.5
0	350.9	334.4	320.8	307.5	294.6	282.1
-5	354.4	337.7	323.9	310.5	297.5	284.8
-10	358.0	341.2	327.2	313.6	300.5	287.7
-15	361.7	346.9	330.5	316.8	303.6	290.7
-20	365.5	350.6	334.0	320.1	306.8	293.7
-30	373.4	358.3	341.2	327.0	313.4	300.1
-40	382.0	366.4	351.3	334.4	320.4	306.8
-50	391.1	375.1	359.6	343.2	328.0	314.0
-54	394.9	378.7	363.1	347.9	331.1	317.0

Increase weight by 3300 kg per 1% uphill slope. Decrease weight by 6700 kg per 1% downhill slope. Increase weight by 7800 kg per 10 knots headwind. Decrease weight by 40900 kg per 10 knots tailwind. Decrease weight by 25200 kg with two brakes deactivated.

After landing at weights exceeding those shown above, adjusted for slope and wind, wait at least 49 minutes and check that wheel thermal plugs have not melted before executing a takeoff.

As an alternate procedure, if the BRAKE TEMP advisory message on EICAS is not displayed 10 to 15 minutes after parking, then no waiting period is required.

GEAR DOWN

Takeoff Climb Limit Weight

Flaps 10

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	TAKEOFF CLIMB WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	299.6	285.5	272.9	259.1	237.8	
52	307.6	285.4	272.8	259.0	244.4	
50	315.6	287.0	272.7	258.9	244.9	223.3
48	323.5	294.3	272.6	258.8	244.8	229.0
46	331.6	301.9	274.3	258.7	244.7	228.9
44	340.1	309.2	280.9	258.7	244.6	228.8
42	349.3	316.5	287.7	260.3	244.5	228.7
40	357.0	323.9	294.5	266.5	244.4	228.6
38	365.1	331.4	301.4	272.8	246.2	228.5
36	373.6	339.4	308.5	279.4	252.5	228.4
34	382.2	348.8	315.7	286.1	258.7	230.1
32	390.9	356.7	323.0	292.9	264.9	236.0
30	399.9	364.9	330.7	299.8	271.3	241.9
28	408.0	373.4	338.9	307.0	277.8	248.0
26	416.0	381.9	348.2	314.2	284.3	254.4
24	420.1	390.0	356.1	321.4	291.1	260.5
22	420.2	398.2	364.1	329.1	298.0	266.8
20	420.3	402.2	372.2	337.2	305.2	273.2
18	420.5	402.3	380.2	346.0	312.4	279.9
16	420.6	402.3	384.0	353.9	319.8	286.7
14	420.6	402.4	384.0	361.6	327.2	293.5
12	420.6	402.5	384.0	365.0	334.6	300.4
10	420.6	402.5	384.0	365.0	342.2	307.2
0	420.6	402.3	383.7	364.7	345.6	322.6
-40	417.5	399.1	380.2	361.2	340.9	317.8

With engine bleed for packs off, increase weight by 2150 kg.
With engine anti-ice on, decrease weight by 4650 kg.
With engine and wing anti-ice on, decrease weight by 11600 kg.

GEAR DOWN

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	LANDING CLIMB LIMIT WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	313.7					
52	321.3					
50	328.8	318.8				
48	336.5	326.3				
46	347.4	334.0	321.8			
44	355.4	342.9	328.8			
42	363.4	352.9	336.1	317.1		
40	371.7	360.9	346.5	324.3		
38	380.6	369.0	354.0	331.7	304.5	
36	389.2	377.2	361.7	338.4	310.4	
34	396.8	385.3	369.5	345.6	316.4	284.8
32	403.2	392.5	377.1	352.0	322.1	289.7
30	409.8	399.0	383.0	358.5	327.4	294.7
28	410.0	404.9	388.7	365.2	332.7	299.5
26	410.2	410.5	394.3	373.8	338.0	304.1
24	410.4	410.7	399.6	378.4	343.9	308.7
22	410.7	410.9	404.6	382.7	353.0	313.0
20	410.9	411.0	404.7	386.7	357.4	317.3
18	411.1	411.2	404.9	390.5	361.2	321.9
16	411.3	411.4	405.0	390.5	364.6	326.1
14	411.5	411.5	405.1	390.6	367.6	329.8
12	411.6	411.7	405.2	390.7	367.7	333.1
10	411.7	411.8	405.3	390.7	367.7	336.2
-40	412.5	412.6	408.0	391.9	368.6	337.3

With engine bleed for packs off, increase weight by 3750 kg.
With engine anti-ice on, decrease weight by 4500 kg.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10°C, decrease weight by 40250 kg.

GEAR DOWN

Takeoff Obstacle Limit Weight

Based on engine bleed for packs on and anti-ice off

Flaps 10

Table 1 of 4: Sea Level, 30°C & Below, Zero Wind

OBSTACLE HEIGHT (M)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)										
	DISTANCE FROM BRAKE RELEASE (100 M)										
	25	30	35	40	45	50	55	60	65	70	75
5	360.4	393.2									
20	346.7	377.4	403.9								
40	331.2	359.8	385.6	407.0							
60	317.6	345.3	369.6	391.3							
80	305.2	332.7	356.0	377.1	395.6						
100	293.3	321.4	344.2	364.4	382.8	398.7					
120	279.8	310.8	333.6	353.3	371.1	387.2	401.1				
140	267.7	301.1	323.9	343.3	360.6	376.5	390.6	402.9			
160	257.1	291.2	314.7	334.1	351.2	366.5	380.8	393.4	404.1		
180	247.4	280.6	306.0	325.6	342.5	357.6	371.5	384.3	395.6	405.1	
200	238.5	270.8	298.0	317.5	334.4	349.4	363.0	375.7	387.2	397.5	405.0
220	230.4	262.1	289.6	309.8	326.8	341.7	355.2	367.6	379.1	389.6	399.0
240	223.0	254.0	280.8	302.5	319.6	334.5	347.9	360.1	371.5	382.0	391.6
260		246.3	272.6	295.6	312.6	327.6	341.0	353.1	364.3	374.9	384.5
280		239.1	265.3	288.2	306.0	321.1	334.4	346.6	357.7	368.0	377.7
300		232.5	258.3	280.8	299.7	314.8	328.2	340.3	351.4	361.6	371.2

Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.

Table 2 of 4: OAT Adjustment

OAT (°C)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)									
	240	260	280	300	320	340	360	380	400	420
30 & Below	0	0	0	0	0	0	0	0	0	0
32	-4.0	-4.4	-4.9	-5.3	-5.7	-6.2	-6.6	-7.0	-7.4	-7.8
34	-8.1	-8.9	-9.8	-10.6	-11.4	-12.3	-13.1	-14.0	-14.9	-15.7
36	-12.1	-13.4	-14.6	-15.9	-17.2	-18.5	-19.7	-21.0	-22.3	-23.5
38	-16.1	-17.8	-19.5	-21.2	-22.9	-24.6	-26.3	-28.0	-29.7	-31.4
40	-20.1	-22.2	-24.4	-26.5	-28.6	-30.8	-32.9	-35.0	-37.1	-39.2
42	-24.1	-26.6	-29.2	-31.7	-34.2	-36.8	-39.3	-41.8	-44.3	-46.8
44	-28.1	-31.0	-34.0	-36.9	-39.8	-42.8	-45.7	-48.6	-51.5	-54.5
46	-32.1	-35.5	-38.8	-42.1	-45.4	-48.8	-52.1	-55.4	-58.7	-62.0
48	-36.1	-39.8	-43.6	-47.3	-51.0	-54.8	-58.5	-62.2	-65.9	-69.7
50	-40.1	-44.2	-48.4	-52.5	-56.6	-60.8	-64.9	-69.0	-73.1	-77.2

GEAR DOWN

Takeoff Obstacle Limit Weight

Based on engine bleed for packs on and anti-ice off

Flaps 10

Table 3 of 4: Pressure Altitude Adjustment

ALT (FT)	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)									
	240	260	280	300	320	340	360	380	400	420
S.L. & Below	0	0	0	0	0	0	0	0	0	0
1000	-9.0	-10.1	-11.1	-12.2	-13.3	-14.3	-15.4	-16.4	-17.5	-18.6
2000	-18.0	-20.1	-22.3	-24.4	-26.5	-28.6	-30.8	-32.9	-35.0	-37.1
3000	-27.1	-29.7	-32.3	-34.9	-37.6	-40.2	-42.8	-45.4	-48.1	-50.7
4000	-36.1	-39.2	-42.4	-45.5	-48.6	-51.8	-54.9	-58.0	-61.1	-64.2
5000	-43.1	-46.9	-50.8	-54.6	-58.5	-62.3	-66.2	-70.0	-73.8	-77.7
6000	-50.0	-54.6	-59.1	-63.7	-68.3	-72.9	-77.4	-82.0	-86.6	-91.1
7000	-59.0	-64.0	-69.1	-74.1	-79.1	-84.2	-89.2	-94.2	-99.3	-104.3
8000	-68.0	-73.5	-79.0	-84.5	-90.0	-95.5	-101.0	-106.5	-112.0	-117.5
9000	-75.8	-81.9	-88.0	-94.1	-100.2	-106.4	-112.5	-118.6	-124.8	-130.9
10000	-83.5	-90.2	-97.0	-103.8	-110.5	-117.2	-124.0	-130.8	-137.5	-144.2

Table 4 of 4: Wind Adjustment

WIND (KTS)	OAT & ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)									
	240	260	280	300	320	340	360	380	400	420
15 TW	-40.3	-40.0	-39.7	-39.4	-39.1	-38.9	-38.6	-38.3	-38.0	-37.7
10 TW	-26.9	-26.7	-26.5	-26.3	-26.1	-25.9	-25.7	-25.5	-25.3	-25.1
5 TW	-13.4	-13.3	-13.2	-13.1	-13.0	-13.0	-12.9	-12.8	-12.7	-12.6
0	0	0	0	0	0	0	0	0	0	0
10 HW	5.6	5.2	4.9	4.5	4.1	3.8	3.4	3.0	2.6	2.2
20 HW	11.2	10.5	9.8	9.0	8.2	7.5	6.8	6.0	5.2	4.5
30 HW	17.6	16.8	15.9	15.0	14.1	13.2	12.4	11.5	10.6	9.8
40 HW	24.0	23.0	22.0	21.0	20.0	19.0	18.0	17.0	16.0	15.0

With engine bleed for packs off, increase weight by 1550 kg.
With engine anti-ice on, decrease weight by 4500 kg.

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
460	20300	19000	17400
440	21400	20200	18500
420	22400	21100	19600
400	23700	22200	20700
380	25400	24000	22400
360	27000	25800	24200
340	28300	27400	26000
320	30000	29300	27900
300	31300	31100	29800
280	32500	32400	31400
260	33900	33800	32800
240	35300	35200	34200
220	36700	36700	35700
200	38000	38000	37000

GEAR DOWN

Long Range Cruise Trip Fuel and Time

Table 1 of 3: 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
632	569	514	470	433	400	375	352	332	315	300
945	851	770	704	648	600	563	530	500	473	450
1255	1132	1025	937	864	800	752	707	668	632	601
1564	1411	1279	1170	1080	1000	940	885	835	791	753
1870	1689	1532	1403	1295	1200	1128	1062	1003	951	905
2174	1966	1784	1635	1510	1400	1316	1240	1172	1111	1057
2477	2241	2035	1867	1725	1600	1505	1418	1340	1271	1210
2778	2515	2286	2098	1940	1800	1693	1596	1509	1431	1363
3077	2788	2536	2329	2154	2000	1882	1775	1678	1592	1517
3374	3060	2786	2560	2369	2200	2071	1954	1848	1754	1671
3670	3331	3034	2790	2583	2400	2260	2133	2018	1916	1826
3964	3600	3282	3019	2797	2600	2449	2312	2188	2078	1981
4258	3870	3530	3249	3011	2800	2638	2491	2358	2240	2136
4553	4140	3778	3479	3225	3000	2828	2671	2529	2403	2291
4847	4410	4026	3709	3439	3200	3017	2850	2700	2565	2447
5142	4680	4274	3938	3653	3400	3207	3030	2871	2729	2603
5435	4949	4522	4168	3867	3600	3396	3210	3042	2892	2759
5727	5217	4769	4397	4081	3800	3586	3390	3213	3055	2915
6018	5484	5016	4626	4295	4000	3775	3569	3384	3217	3071

Table 2 of 3: Reference Fuel and Time Required

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)
400	19.5	1:34	18.5	1:31	17.8	1:27	17.2	1:23	16.9	1:21
600	28.9	2:17	27.4	2:12	26.1	2:06	25.2	2:00	24.5	1:56
800	38.3	3:00	36.2	2:53	34.4	2:45	33.1	2:37	32.2	2:31
1000	48.1	3:42	45.4	3:33	43.1	3:23	41.3	3:13	40.2	3:06
1200	57.8	4:24	54.5	4:13	51.7	4:02	49.6	3:49	48.1	3:40
1400	67.9	5:05	64.0	4:53	60.6	4:39	58.1	4:25	56.4	4:14
1600	78.0	5:46	73.5	5:32	69.6	5:16	66.7	5:00	64.7	4:48
1800	88.4	6:26	83.4	6:10	78.8	5:53	75.5	5:34	73.2	5:21
2000	98.9	7:07	93.3	6:48	88.1	6:29	84.4	6:09	81.8	5:54
2200	109.8	7:46	103.5	7:26	97.7	7:05	93.6	6:42		
2400	120.7	8:25	113.7	8:03	107.4	7:40	102.8	7:16		
2600	131.9	9:04	124.4	8:40	117.4	8:15	112.4	7:49		
2800	143.2	9:42	135.0	9:17	127.4	8:50	122.0	8:22		
3000	154.9	10:21	146.0	9:53	137.8	9:24				
3200	166.5	11:00	157.0	10:30	148.2	9:58				
3400	178.6	11:38	168.4	11:06	159.0	10:33				
3600	190.7	12:17	179.8	11:42	169.8	11:07				
3800	203.2	12:56	191.6	12:19	180.9	11:41				
4000	215.8	13:34	203.4	12:55	192.1	12:16				

GEAR DOWN

Long Range Cruise Trip Fuel and Time

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	LANDING WEIGHT (1000 KG)						
	200	220	240	260	280	300	320
20	-2.7	-2.3	-1.5	-0.8	0.0	1.0	2.0
40	-5.7	-4.6	-3.1	-1.5	0.0	2.0	4.1
60	-8.7	-6.9	-4.6	-2.3	0.0	3.1	6.3
80	-11.8	-9.2	-6.2	-3.1	0.0	4.1	8.5
100	-14.9	-11.6	-7.8	-3.9	0.0	5.2	10.9
120	-18.0	-14.0	-9.4	-4.7	0.0	6.4	13.4
140	-21.1	-16.4	-11.0	-5.5	0.0	7.5	16.0
160	-24.3	-18.8	-12.6	-6.3	0.0	8.7	18.7
180	-27.5	-21.2	-14.2	-7.1	0.0	10.0	21.5
200	-30.8	-23.7	-15.8	-8.0	0.0	11.2	24.4
220	-34.1	-26.1	-17.5	-8.8	0.0	12.5	27.5

Based on climb at Flaps Up Maneuver Speed, Long Range Cruise and descent at Flaps Up Maneuver Speed.

GEAR DOWN

Short Trip Fuel and Time

Table 1 of 2: Ground to Air Miles Conversion

AIR DISTANCE (NM) HEAD WIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAIL WIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
113	90	75	64	56	50	45	41	37	35	32
179	154	136	121	110	100	92	85	79	74	69
248	219	197	178	163	150	139	130	121	114	107
317	284	257	235	216	200	186	174	164	154	146
385	347	317	291	269	250	234	219	207	195	185
453	411	376	347	322	300	281	264	250	236	224
520	474	436	403	375	350	328	309	293	277	264
588	538	495	459	427	400	376	355	336	318	303
657	602	555	515	480	450	423	400	378	359	342
727	667	615	571	533	500	471	444	421	400	381

Table 2 of 2: Trip Fuel and Time

AIR DIST (NM)		LANDING WEIGHT (1000 KG)							TIME (HRS:MIN)
		200	220	240	260	280	300	320	
50	FUEL (1000 KG)	3.0	3.1	3.2	3.4	3.5	3.7	3.8	0:17
	ALT (FT)	11000	9000	9000	9000	9000	9000	9000	
100	FUEL (1000 KG)	4.7	4.9	5.2	5.4	5.6	5.9	6.2	0:27
	ALT (FT)	23000	21000	21000	19000	19000	19000	17000	
150	FUEL (1000 KG)	6.2	6.5	6.9	7.2	7.5	7.9	8.3	0:36
	ALT (FT)	29000	29000	29000	27000	25000	23000	23000	
200	FUEL (1000 KG)	7.6	8.0	8.4	8.9	9.3	9.8	10.3	0:45
	ALT (FT)	31000	31000	31000	29000	29000	27000	27000	
250	FUEL (1000 KG)	8.9	9.4	10.0	10.5	11.1	11.7	12.3	0:53
	ALT (FT)	35000	33000	31000	31000	29000	29000	27000	
300	FUEL (1000 KG)	10.3	10.9	11.5	12.2	12.9	13.6	14.3	1:01
	ALT (FT)	35000	33000	33000	31000	31000	29000	27000	
350	FUEL (1000 KG)	11.6	12.3	13.0	13.8	14.6	15.5	16.3	1:09
	ALT (FT)	35000	35000	33000	31000	31000	29000	27000	
400	FUEL (1000 KG)	12.9	13.7	14.6	15.5	16.4	17.4	18.4	1:17
	ALT (FT)	35000	35000	33000	31000	31000	29000	27000	
450	FUEL (1000 KG)	14.3	15.2	16.1	17.1	18.1	19.3	20.4	1:25
	ALT (FT)	35000	35000	33000	31000	31000	29000	27000	
500	FUEL (1000 KG)	15.6	16.6	17.7	18.8	20.1	21.2	22.5	1:34
	ALT (FT)	35000	35000	33000	31000	29000	29000	27000	

GEAR DOWN

Holding Planning
Flaps Up

WEIGHT (1000 KG)	TOTAL FUEL FLOW (KG/HR)						
	PRESSURE ALTITUDE (FT)						
	1500	5000	10000	15000	20000	25000	30000
460	19160	19290	19670	20070			
440	18220	18290	18680	19330			
420	17380	17370	17660	18140	19320		
400	16580	16560	16710	17090	18080		
380	15780	15760	15840	16170	16840		
360	14990	14980	15000	15330	15850	16620	
340	14290	14270	14270	14550	15060	15710	
320	13570	13540	13530	13710	13980	14440	
300	12850	12790	12770	12880	13110	13500	13940
280	12130	12050	12030	12090	12280	12590	12870
260	11440	11330	11300	11330	11470	11720	11900
240	10760	10620	10590	10580	10910	11070	11000
220	10130	9970	10160	10110	10170	10280	10160
200	9900	9710	9610	9520	9550	9610	9450

Includes 5% additional fuel for holding in a racetrack pattern.

GEAR DOWN
ENGINE INOP
MAX CONTINUOUS THRUST

Net Level Off Weight

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 KG)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
28	202.4	200.6	192.9
26	220.7	215.5	207.3
24	238.3	230.9	221.6
22	254.6	246.2	236.0
20	271.3	262.0	251.5
18	288.4	277.8	266.5
16	305.8	294.2	281.5
14	324.1	311.4	297.7
12	344.0	330.1	315.4
10	364.5	349.3	333.6
8	381.7	365.2	348.4
6	398.6	381.4	363.6
4	415.2	397.3	379.1
2	431.2	413.4	394.3

Anti-Ice Adjustment

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 KG)												
	PRESSURE ALTITUDE (1000 FT)												
	2	4	6	8	10	12	14	16	18	20	22	24	26
ENGINE ONLY	-2.9	-2.7	-2.8	-3.0	-2.9	-2.8	-2.8	-2.7	-2.7	-2.8	-2.6	-2.4	-2.2
ENGINE AND WING	-8.8	-8.0	-7.7	-7.9	-7.5	-7.3	-7.1	-6.8	-6.6	-6.5	-6.5	-6.0	-5.7

Performance Dispatch Chapter PD
Text Section 14

Introduction

This chapter contains self dispatch performance data intended primarily for use by flight crews in the event that information cannot be obtained from the airline dispatch office. Data are provided for a single takeoff flap and max takeoff thrust. The range of conditions covered is limited to those normally encountered in airline operation. In the event of conflict between data presented in this chapter and that contained in the Airplane Flight Manual (AFM), the AFM takes precedence.

Takeoff

The maximum allowable takeoff weight is the least of the Field, Climb, Obstacle, Brake Energy, and Tire Speed Limit Weights as determined from the following tables.

Regulations require that runway length be adjusted to account for alignment of the airplane prior to takeoff. The table below provides TORA, TODA and ASDA adjustments for both 90 degree taxiway entry and 180 degree turnaround. For the 180 degree turnaround case, adjustments are provided for a nominal 60 m (200 ft) runway pavement width. These values may be used when obtaining takeoff weights from the AFM or a takeoff analysis program. When using line-up allowances with the Field Length Limit chart, the field length available must be reduced by the ASDA adjustment.

	90 DEGREE TAXIWAY ENTRY	180 DEGREE TURNAROUND
	MINIMUM LINE-UP DISTANCE M (FT)	NOMINAL LINE-UP DISTANCE (60 M RUNWAY) M (FT)
TORA & TODA	22 (72)	55 (179)
ADSA	53 (174)	86 (281)

Field Limit Weight - Slope and Wind Corrections

Tables for dry and wet runways provide corrections to the field length available for the effects of runway slope and wind component along the runway. Enter the Slope Correction table (Table 1) with available field length and runway slope to determine the slope corrected field length. Next, enter the Wind Correction table (Table 2) with slope corrected field length and wind component to determine slope and wind corrected field length.

Field and Climb Limit Weight

Tables are presented for selected airport pressure altitudes and runway condition and show both Field and Climb Limit Weights. Enter the appropriate table (Table 3) for pressure altitude and runway condition with “Slope and Wind Corrected Field Length” determined above and airport OAT to obtain Field Limit Weight. Also read Climb Limit Weight for the same OAT. Field and Climb limit weights at intermediate altitudes can be determined by interpolation or by use of next higher altitude.

When finding a maximum weight for a wet runway, the dry runway limit weight must also be determined and the lower of the two weights used.

Obstacle Limit Weight

Table 1 provides obstacle limit weights for reference airport conditions based on obstacle height above the runway surface and distance from brake release. Enter the correction tables to correct the reference Obstacle Limit Weight for the effects of OAT (Table 2), pressure altitude (Table 3) and wind (Table 4) as indicated. In the case of multiple obstacles, enter the tables successively with each obstacle and determine the most limiting weight.

Tire Speed Limit

Maximum tire speed limited weights are presented for 235 MPH tires. To determine the tire speed limit weight, enter the table with OAT and airport pressure altitude. Adjust the tire speed limit weight according to the notes below the table to account for wind.

Brake Energy Limit VMBE

The Maximum Brake Energy Speed table (Table 1) provides the Reference VMBE for a variety of airport pressure altitudes and temperatures. Enter the Weight Adjusted VMBE table (Table 2) to adjust the Reference VMBE for actual brake release gross weight. Correct VMBE for slope and wind. If V1 exceeds VMBE, decrease brake release weight as indicated for each knot that V1 exceeds VMBE and determine V1, VR, and V2 for the lower brake release weight.

Brakes Deactivated

When operating with one or two brakes deactivated, the field/obstacle and brake energy limit weights and the V1 and VMBE speeds must be adjusted to account for reduced braking capability. A simplified method which conservatively accounts for the reduced braking capability is to adjust the normal field length/obstacle limited weight by the amount shown in the table below. Then adjust the V1 associated with the reduced weight by the amount shown in the table below. Note: Wet runway analysis is based on the more critical of all engine or engine inoperative stop distance. The all engine stop distance takes credit for four thrust reversers and the engine inoperative stop distance takes credit for two symmetric thrust reversers.

2 BRAKES DEACTIVATED ADJUSTMENTS				
FIELD LENGTH (M)	DRY RUNWAY		WET RUNWAY*	
	WEIGHT (1000 KG)	V1(KTS)	WEIGHT (1000 KG)	V1 (KTS)
2500	-3	-4		
3000	-3	-4	-3	-3
3500	-5	-4	-5	-3
4000	-4	-4	-5	-3
4500	-2	-3	-4	-3
5000	-2	-3	-4	-3

*** Based on the more critical thrust reverser condition.**

If the resulting V1 is less than V1MCG, takeoff is permitted with V1 set equal to VIMCG provided the accelerate stop distance corrected for wind and slope exceeds approximately 2200 m for dry runways and 2950 m for wet runways.

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Thrust Reverser Inoperative

Wet runway V1 speeds with anti-skid and all wheel brakes operating are based on two engine reverse thrust. A simplified method which conservatively accounts for the reduced stopping capability is to reduce the normal field length/obstacle limited weight by the amount shown in the table below; then reduce the V1 associated with the reduced weight by the amount shown.

If the resulting V1 is less than V1MCG, takeoff is permitted with V1 set equal to V1MCG provided the accelerate stop distance available exceeds approximately 3150 m.

NO REVERSERS ADJUSTMENTS*		
FIELD LENGTH (M)	WEIGHT (1000 KG)	V1 (KTS)
3000	-1	-7
3500	-1	-7
4000	-1	-7
4500	-1	-7
5000	-1	-6

*** Based on wet runway with all brakes activated.**

Enroute

Long Range Cruise Maximum Operating Altitude

The Long Range Cruise Maximum Operating Altitude tables provide both optimum altitude and climb thrust limited pressure altitude for a given weight at Long Range Cruise. Buffet limits corresponding to a maneuver margin of 1.3g (39° bank) are also shown. The altitude shown in the table is limited by the maximum certified altitude of 43100 ft.

Long Range Cruise Trip Fuel and Time

These tables are provided to determine trip fuel and time required to destination. Data are based on economy climb and descent speeds, and Long Range Cruise. Tables are presented for low altitudes for shorter trip distances and high altitudes for longer trip distances.

To determine trip fuel and time for a constant altitude cruise, first enter the Ground to Air Miles Conversion table (Table 1) to convert ground distance and enroute wind to an equivalent still-air distance. Next, enter the Reference Fuel and Time table (Table 2) 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 (Table 3) with the reference fuel and the planned landing weight to obtain fuel required at the planned landing weight.

Long Range Cruise Step Climb Trip Fuel and Time

These tables are provided to determine trip fuel and time required to destination when flying a step climb profile. Step climb profiles are based on 4000 ft step climbs to keep the flight within 2000 ft of the optimum altitude for the current cruise weight. To determine trip fuel and time, enter the Ground to Air Miles Conversion table (Table 1) and determine air distance as discussed above. Then enter the Trip Fuel and Time Required table (Table 2) with air distance and planned landing weight to read trip fuel. Continue across the table to read trip time.

Short Trip Fuel and Time

Short Trip Fuel and Time charts include fuel and time for climb to cruise altitude, cruise, descent and straight in approach. The chart is based on the altitude that yields minimum fuel for trip distances up to 500 nm. For distances greater than 500 nm, or other altitudes, use the Trip Fuel and Time charts.

To determine fuel and time, enter the Ground to Air Miles Conversion table (Table 1) with ground distance; adjust for wind and determine air distance. Enter the Trip Fuel and Time table (Table 2) with this air distance and the planned landing weight and read fuel required, cruise altitude, and time required.

Holding Planning

These tables provide total fuel flow information necessary for planning Flaps Up and Flaps 1 holding and reserve fuel requirements. Data are based on the FMC holding speed schedule which is the higher of the maximum endurance and flaps up maneuver speeds. As noted, the fuel flow is based on flight in a racetrack holding pattern. For holding in straight and level flight, reduce table values by 5%.

Crew Oxygen Requirements

Tables are provided to determine the minimum dispatch crew oxygen pressure required. Table 1 shows minimum oxygen quantity necessary to ensure that protective breathing requirements are satisfied. The protective breathing requirement guarantees that a fixed amount of oxygen will be available to each crew member to use for situations such as cabin smoke or harmful gases.

The sustenance requirement (Table 2) is the crew member oxygen required for loss of pressurization, emergency descent and total post-decompression flight time above 8000 ft.

Table 3 gives adjustments that must be applied to Table 2 crew member sustenance requirements for situations where the enroute altitude after decompression will exceed 14000 ft. The increments shown in Table 3 reflect only the increase in oxygen flow rate associated with periods of post-decompression flight at altitudes other than 14000 ft. Hence, this time must also be included in the Table 2 time value used.

Table 1, Table 2 and Table 3 values are based on "NORMAL" regulator settings. Table 3 also shows "100%" regulator setting adjustments that can be used if the operator chooses to schedule oxygen dispatch requirements based on pure oxygen availability. To protect the oxygen supply for emergency purposes, an allowance equivalent to one crew member for 15 minutes at 8000 ft cabin altitude has been included in the protective breathing (Table 1) and sustenance (Table 2) oxygen values. Additional adjustments for more extensive normal crew usage and mask checks can be made by adding 2 liters/per person/minute.

After determining the total volume (liters) required for the flight crew by using the larger value from Table 1 or 2, isolate the crew system cylinder configuration on the Liters to Pressure Conversion table (Table 4) and read dispatch pressure required. Adjust this reading for ambient temperature as required, using the adjustments given (Table 5).

Net Level Off Weight

The Net Level Off Weight table is provided to determine terrain clearance capability based on the Airplane Flight Manual two engines inoperative enroute climb speed. Regulations require terrain clearance planning based on net performance, which is the gross (or actual) gradient performance degraded by 0.5%. In addition, the net level off pressure altitude must clear terrain by 1000 ft.

To determine maximum weight for terrain clearance, enter the table with required net level off pressure altitude and expected ISA deviation to obtain weight. Adjust weight for anti-ice operation as noted below the table.

Landing

Tables are provided for determining maximum landing weight as limited by field length or climb requirements for Flaps 30.

Maximum landing weight is the lowest of field length limit weight, climb limit weight, or maximum certified landing weight.

Landing Field Limit Weight

Obtain wind corrected field length by entering the Wind Corrected Field Length table (Table 1) with field length available and wind component along the runway. Next, enter the Field Limit Weight table (Table 2) with wind corrected field length and pressure altitude to read field limit weight for the expected runway condition.

Landing Climb Limit Weight

Enter the Landing Climb Limit Weight table with airport OAT and pressure altitude and read landing climb limit weight. Apply the noted adjustments as required.

Go-Around Climb Gradient

Enter the Reference Go-around Gradient table (Table 1) with airport OAT and pressure altitude to determine the reference Go-Around Gradient. Next, adjust the reference gradient for airplane weight (Table 2) and speed (Table 3) using the tables provided to determine the weight and speed adjusted Go-Around Gradient. Apply the necessary corrections for A/C and icing conditions as noted.

Quick Turnaround Limit Weight

Enter the Quick Turnaround Limit Weight table with airport pressure altitude and OAT and read maximum quick turnaround weight. Apply the noted adjustments as required.

If the landing weight exceeds the maximum quick turnaround weight, wait the specified time and then check that the wheel thermal plugs have not melted before executing a subsequent takeoff, or ensure the brake temperature is within limits using the alternate procedure described on the page.

Gear Down

This section provides flight planning data for revenue operation with gear down.

Takeoff Climb Limit Weight

Enter the Takeoff Climb Limit Weight table with airport OAT and pressure altitude and determine Takeoff Climb Limit Weight with gear down. Correct for engine bleed configuration as required.

The remaining gear down tables in this section are identical in format and usage to the corresponding gear up tables previously described.

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Performance Dispatch — Chapter PD
Table of Contents — Section 20

747-8F GENX-2B67 LB FT FAA TO1-10% TO2-20%

Performance Dispatch — Chapter PD

Pkg Model Identification — Section 20

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
914	Freighter

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Performance Dispatch — Chapter PD

Takeoff — Section 20

Takeoff Field Corrections - Dry Runway

Table 1 of 3: Slope Corrections

FIELD LENGTH AVAILABLE (FT)	SLOPE CORRECTED FIELD LENGTH (FT)								
	RUNWAY SLOPE (%)								
	-2.0	-1.5	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0
5400	5650	5590	5530	5460	5400	5320	5240	5150	5070
5800	6100	6030	5950	5880	5800	5700	5610	5510	5410
6200	6550	6460	6380	6290	6200	6090	5980	5870	5760
6600	7000	6900	6800	6700	6600	6480	6350	6230	6100
7000	7450	7340	7230	7110	7000	6860	6720	6580	6440
7400	7900	7780	7650	7530	7400	7250	7090	6940	6790
7800	8360	8220	8080	7940	7800	7630	7470	7300	7130
8200	8810	8660	8500	8350	8200	8020	7840	7660	7470
8600	9260	9090	8930	8760	8600	8400	8210	8010	7820
9000	9710	9530	9350	9180	9000	8790	8580	8370	8160
9400	10160	9970	9780	9590	9400	9180	8950	8730	8500
9800	10610	10410	10210	10000	9800	9560	9320	9080	8850
10200	11060	10850	10630	10420	10200	9950	9690	9440	9190
10600	11510	11280	11060	10830	10600	10330	10070	9800	9530
11000	11960	11720	11480	11240	11000	10720	10440	10160	9880
11400	12410	12160	11910	11650	11400	11100	10810	10510	10220
11800	12870	12600	12330	12070	11800	11490	11180	10870	10560

Table 2 of 3: Wind Corrections

SLOPE CORR'D FIELD LENGTH (FT)	SLOPE & WIND CORRECTED FIELD LENGTH (FT)							
	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5400	4190	4590	5000	5400	5670	5940	6220	6520
5800	4530	4960	5380	5800	6080	6360	6660	6960
6200	4880	5320	5760	6200	6490	6790	7100	7410
6600	5230	5690	6140	6600	6900	7210	7530	7860
7000	5580	6050	6530	7000	7310	7630	7970	8310
7400	5930	6420	6910	7400	7720	8060	8400	8760
7800	6280	6780	7290	7800	8130	8480	8840	9210
8200	6630	7150	7680	8200	8550	8900	9270	9650
8600	6970	7520	8060	8600	8960	9330	9710	10100
9000	7320	7880	8440	9000	9370	9750	10140	10550
9400	7670	8250	8820	9400	9780	10170	10580	11000
9800	8020	8610	9210	9800	10190	10600	11020	11450
10200	8370	8980	9590	10200	10600	11020	11450	11890
10600	8720	9350	9970	10600	11020	11440	11890	12340
11000	9070	9710	10360	11000	11430	11870	12320	12790
11400	9420	10080	10740	11400	11840	12290	12760	13240
11800	9760	10440	11120	11800	12250	12710	13190	13690

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
6100	779.7	718.8	714.7	710.5	706.3	702.3	698.2	682.5	664.2	643.1	601.7
6200	786.3	725.0	720.8	716.6	712.4	708.3	704.2	688.4	669.9	648.7	607.0
6600	811.4	748.2	743.9	739.6	735.2	731.0	726.8	710.5	691.4	669.6	626.6
7000	835.4	770.3	765.9	761.5	757.0	752.6	748.3	731.5	711.9	689.4	645.2
7400	858.2	791.3	786.8	782.2	777.7	773.2	768.7	751.5	731.3	708.2	662.7
7800	880.1	811.4	806.8	802.1	797.4	792.8	788.2	770.5	749.8	726.1	679.4
8200	901.1	830.6	825.9	821.1	816.3	811.5	806.8	788.7	767.5	743.1	695.3
8600	921.3	849.2	844.4	839.4	834.5	829.6	824.8	806.2	784.5	759.6	710.6
9000	941.0	867.3	862.3	857.2	852.2	847.3	842.3	823.3	801.1	775.6	725.5
9400	961.5	886.2	881.1	875.9	870.8	865.7	860.7	841.3	818.6	792.6	741.4
9800	982.1	905.2	900.1	894.8	889.5	884.4	879.2	859.4	836.3	809.7	757.5
10200	1000.7	922.3	917.0	911.7	906.3	901.1	895.8	875.6	852.0	824.9	771.6
10600	1017.9	938.0	932.7	927.2	921.7	916.4	911.0	890.4	866.4	838.8	784.4
11000	1029.0	953.5	948.0	942.5	936.9	931.4	926.0	905.0	880.5	852.4	797.1
11400	1029.0	968.8	963.2	957.5	951.9	946.3	940.8	919.4	894.5	865.9	809.5
11800	1029.0	983.8	978.1	972.3	966.6	960.9	955.3	933.6	908.2	879.1	821.8
12200	1029.0	998.6	992.8	986.9	981.1	975.3	969.6	947.6	921.8	892.2	834.0
12600	1029.0	1013.1	1007.3	1001.4	995.4	989.5	983.7	961.3	935.1	905.1	845.9
CLIMB LIMIT WT (1000 LB)	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	966.8

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
6100	732.9	678.9	675.0	671.1	667.3	663.4	649.4	633.6	614.3	595.4	559.0
6200	739.3	684.8	680.9	676.9	673.1	669.2	655.1	639.1	619.7	600.6	563.9
6600	762.9	706.8	702.7	698.7	694.7	690.7	676.1	659.7	639.6	620.0	582.2
7000	785.5	727.7	723.5	719.4	715.2	711.1	696.2	679.3	658.6	638.4	599.5
7400	806.9	747.5	743.2	739.0	734.7	730.5	715.1	697.7	676.5	655.7	615.8
7800	827.4	766.5	762.1	757.7	753.4	749.0	733.2	715.4	693.6	672.2	631.2
8200	847.0	784.6	780.0	775.5	771.1	766.6	750.4	732.1	709.8	687.9	645.8
8600	866.0	802.0	797.4	792.8	788.2	783.7	767.1	748.3	725.4	703.0	659.9
9000	884.4	819.0	814.3	809.5	804.9	800.2	783.3	764.1	740.7	717.8	673.7
9400	903.7	836.9	832.0	827.2	822.4	817.7	800.4	780.8	756.9	733.5	688.5
9800	923.1	854.9	850.0	845.1	840.2	835.4	817.7	797.7	773.3	749.4	703.5
10200	940.6	871.0	866.0	861.0	856.0	851.1	833.0	812.7	787.8	763.4	716.6
10600	956.6	885.8	880.6	875.5	870.4	865.4	847.0	826.3	800.9	776.1	728.3
11000	972.5	900.3	895.0	889.8	884.7	879.6	860.8	839.7	813.9	788.5	739.9
11400	988.1	914.6	909.2	903.9	898.7	893.5	874.4	852.9	826.6	800.9	751.4
11800	1003.3	928.7	923.2	917.8	912.5	907.2	887.8	865.9	839.2	813.0	762.7
12200	1018.5	942.5	937.0	931.5	926.1	920.7	901.0	878.8	851.6	825.0	773.8
12600	1029.0	956.2	950.6	945.0	939.6	934.1	914.0	891.4	863.8	836.8	784.8
CLIMB LIMIT WT (1000 LB)	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1025.8	979.3	893.6

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
6100	690.7	639.3	635.7	632.1	628.5	615.3	601.7	585.7	569.0	553.3	519.8
6200	696.7	644.9	641.2	637.6	634.0	620.7	607.0	590.8	574.0	558.2	524.5
6600	719.0	665.6	661.8	658.1	654.4	640.7	626.6	609.9	592.6	576.3	541.5
7000	740.3	685.3	681.4	677.6	673.8	659.7	645.2	628.0	610.2	593.4	557.6
7400	760.5	704.0	700.0	696.1	692.1	677.6	662.7	645.1	626.8	609.5	572.7
7800	779.8	721.8	717.7	713.7	709.6	694.7	679.4	661.3	642.5	624.8	587.0
8200	798.2	738.7	734.5	730.4	726.2	710.9	695.2	676.7	657.4	639.2	600.5
8600	816.0	755.0	750.8	746.5	742.2	726.6	710.6	691.6	671.8	653.2	613.5
9000	833.3	771.0	766.6	762.3	757.9	741.9	725.5	706.1	685.8	666.8	626.3
9400	851.4	787.8	783.3	778.9	774.4	758.1	741.3	721.5	700.8	681.4	640.0
9800	869.8	804.9	800.3	795.8	791.2	774.6	757.5	737.2	716.1	696.3	654.0
10200	886.2	820.0	815.3	810.7	806.0	789.1	771.6	751.0	729.4	709.2	666.1
10600	901.2	833.7	828.9	824.3	819.5	802.2	784.4	763.4	741.5	720.8	676.9
11000	916.0	847.3	842.4	837.6	832.8	815.2	797.1	775.6	753.3	732.3	687.6
11400	930.6	860.6	855.7	850.8	845.9	828.0	809.5	787.7	765.0	743.6	698.1
11800	945.0	873.8	868.8	863.8	858.8	840.6	821.8	799.6	776.5	754.8	708.5
12200	959.1	886.8	881.7	876.6	871.5	853.0	833.9	811.4	787.9	765.8	718.7
12600	973.1	899.5	894.4	889.3	884.1	865.3	845.9	823.0	799.1	776.7	728.8
CLIMB LIMIT WT (1000 LB)	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	991.4	946.9	904.3	830.0

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
6100	649.9	601.7	598.4	595.2	585.1	573.7	557.3	543.3	528.8	512.4	482.4
6200	655.6	606.9	603.7	600.4	590.3	578.8	562.2	548.1	533.5	517.0	486.7
6600	676.6	626.5	623.1	619.8	609.3	597.5	580.4	565.9	550.8	533.8	502.6
7000	696.7	645.1	641.6	638.2	627.4	615.2	597.6	582.7	567.2	549.7	517.6
7400	715.6	662.7	659.1	655.5	644.5	631.9	613.9	598.5	582.5	564.6	531.6
7800	733.7	679.3	675.7	672.0	660.7	647.8	629.3	613.5	597.1	578.7	544.8
8200	751.0	695.2	691.4	687.7	676.0	662.8	643.8	627.6	610.8	591.9	557.1
8600	767.6	710.5	706.6	702.8	690.9	677.4	657.9	641.3	624.1	604.7	569.1
9000	783.8	725.4	721.5	717.6	705.4	691.6	671.6	654.7	637.1	617.3	580.9
9400	800.9	741.3	737.3	733.2	720.8	706.7	686.3	669.0	651.1	630.8	593.7
9800	818.3	757.4	753.3	749.2	736.5	722.1	701.3	683.7	665.3	644.7	606.7
10200	833.6	771.5	767.3	763.2	750.2	735.5	714.4	696.4	677.6	656.6	617.9
10600	847.6	784.3	780.1	775.8	762.6	747.6	726.1	707.7	688.6	667.2	627.7
11000	861.4	797.0	792.6	788.3	774.8	759.6	737.6	718.9	699.5	677.7	637.5
11400	875.1	809.4	805.0	800.6	786.9	771.4	749.0	730.0	710.2	688.0	647.1
11800	888.5	821.7	817.2	812.7	798.8	783.0	760.3	740.9	720.8	698.2	656.6
12200	901.7	833.9	829.3	824.7	810.6	794.5	771.4	751.7	731.3	708.3	666.0
12600	914.7	845.8	841.2	836.5	822.1	805.9	782.4	762.4	741.6	718.2	675.3
CLIMB LIMIT WT (1000 LB)	1029.0	1029.0	1029.0	1029.0	1023.6	994.5	951.3	912.1	874.4	835.4	769.4

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
6100	607.2	563.1	560.2	552.0	541.5	525.5	513.2	500.6	486.9	472.8	444.9
6200	612.5	568.1	565.1	556.9	546.3	530.2	517.8	505.0	491.2	477.0	448.9
6600	632.2	586.5	583.4	574.9	564.0	547.4	534.7	521.5	507.3	492.6	463.6
7000	651.0	603.9	600.7	592.0	580.8	563.7	550.6	537.0	522.4	507.3	477.5
7400	668.7	620.3	617.0	608.1	596.6	579.0	565.5	551.6	536.5	521.0	490.4
7800	685.6	635.8	632.5	623.3	611.5	593.4	579.6	565.3	549.9	533.9	502.5
8200	701.5	650.6	647.1	637.7	625.6	607.1	592.9	578.2	562.4	546.0	513.8
8600	717.0	664.8	661.3	651.6	639.2	620.3	605.7	590.7	574.5	557.8	524.7
9000	732.1	678.7	675.1	665.2	652.6	633.2	618.3	602.9	586.4	569.3	535.5
9400	748.1	693.6	689.9	679.8	666.9	647.0	631.9	616.2	599.2	581.8	547.3
9800	764.3	708.7	705.0	694.6	681.4	661.2	645.7	629.7	612.4	594.6	559.4
10200	778.6	721.9	718.1	707.5	694.1	673.5	657.6	641.3	623.7	605.5	569.6
10600	791.6	733.7	729.8	719.1	705.4	684.4	668.3	651.6	633.7	615.1	578.6
11000	804.3	745.4	741.5	730.6	716.6	695.2	678.8	661.8	643.5	624.6	587.4
11400	816.9	757.0	753.0	741.8	727.6	705.8	689.1	671.9	653.3	634.0	596.1
11800	829.3	768.4	764.3	753.0	738.5	716.3	699.3	681.8	662.9	643.3	604.7
12200	841.6	779.6	775.4	764.0	749.3	726.7	709.5	691.6	672.4	652.5	613.3
12600	853.7	790.7	786.5	774.8	759.9	737.0	719.4	701.3	681.8	661.6	621.7
CLIMB LIMIT WT (1000 LB)	980.4	978.2	977.8	959.5	934.0	901.2	870.4	838.6	805.6	773.8	713.6

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Dry Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(f) of 3: 10000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
6100	563.9	523.2	513.4	502.9	492.0	481.1	469.8	457.7	444.7	431.3	405.7
6200	568.9	527.8	517.9	507.4	496.4	485.4	474.1	461.9	448.7	435.3	409.5
6600	587.3	545.0	534.8	523.9	512.6	501.3	489.6	477.0	463.4	449.6	423.0
7000	604.7	561.2	550.7	539.5	527.9	516.2	504.2	491.2	477.3	463.0	435.6
7400	621.1	576.4	565.6	554.2	542.2	530.2	517.8	504.5	490.2	475.5	447.4
7800	636.7	590.8	579.7	568.0	555.7	543.4	530.6	517.0	502.3	487.2	458.3
8200	651.4	604.3	593.0	580.9	568.3	555.7	542.6	528.6	513.6	498.1	468.5
8600	665.7	617.5	605.9	593.5	580.6	567.7	554.3	540.0	524.5	508.7	478.4
9000	679.6	630.3	618.4	605.8	592.6	579.4	565.7	551.0	535.3	519.1	488.1
9400	694.5	644.1	632.0	619.1	605.6	592.1	578.1	563.2	547.0	530.5	498.8
9800	709.7	658.2	645.9	632.7	618.9	605.2	590.9	575.6	559.2	542.3	510.0
10200	722.9	670.4	657.8	644.4	630.3	616.3	601.7	586.1	569.4	552.2	519.2
10600	734.7	681.3	668.4	654.7	640.4	626.1	611.3	595.4	578.3	560.8	527.2
11000	746.5	692.0	678.9	665.0	650.4	635.8	620.7	604.5	587.1	569.3	535.0
11400	758.0	702.6	689.3	675.1	660.3	645.4	630.0	613.6	595.8	577.7	542.8
11800	769.4	713.1	699.5	685.1	670.0	654.9	639.3	622.5	604.5	586.0	550.6
12200	780.7	723.4	709.6	694.9	679.6	664.3	648.4	631.3	613.0	594.2	558.2
12600	791.8	733.6	719.6	704.7	689.1	673.5	657.4	640.1	621.5	602.4	565.8
CLIMB LIMIT WT (1000 LB)	908.8	905.9	890.5	869.0	844.6	819.2	792.8	765.4	735.9	706.4	649.5

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field Corrections - Wet Runway

Table 1 of 3: Slope Corrections

FIELD LENGTH AVAILABLE (FT)	SLOPE CORRECTED FIELD LENGTH (FT)								
	RUNWAY SLOPE (%)								
	-2.0	-1.5	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0
5400	5620	5560	5510	5450	5400	5320	5240	5150	5070
5800	6070	6000	5940	5870	5800	5700	5610	5510	5410
6200	6530	6450	6360	6280	6200	6090	5980	5870	5760
6600	6980	6890	6790	6700	6600	6480	6350	6230	6100
7000	7440	7330	7220	7110	7000	6860	6720	6580	6440
7400	7900	7770	7650	7520	7400	7250	7090	6940	6790
7800	8350	8210	8080	7940	7800	7630	7470	7300	7130
8200	8810	8650	8500	8350	8200	8020	7840	7660	7470
8600	9260	9100	8930	8770	8600	8400	8210	8010	7820
9000	9720	9540	9360	9180	9000	8790	8580	8370	8160
9400	10170	9980	9790	9590	9400	9180	8950	8730	8500
9800	10630	10420	10210	10010	9800	9560	9320	9080	8850
10200	11080	10860	10640	10420	10200	9950	9690	9440	9190
10600	11540	11300	11070	10830	10600	10330	10070	9800	9530
11000	12000	11750	11500	11250	11000	10720	10440	10160	9880
11400	12450	12190	11930	11660	11400	11100	10810	10510	10220
11800	12910	12630	12350	12080	11800	11490	11180	10870	10560

Table 2 of 3: Wind Corrections

SLOPE CORR'D FIELD LENGTH (FT)	SLOPE & WIND CORRECTED FIELD LENGTH (FT)							
	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5400	4190	4600	5000	5400	5670	5940	6220	6520
5800	4540	4960	5380	5800	6080	6360	6660	6970
6200	4890	5330	5760	6200	6490	6790	7090	7410
6600	5240	5690	6150	6600	6900	7210	7530	7860
7000	5590	6060	6530	7000	7310	7630	7970	8310
7400	5940	6430	6910	7400	7720	8060	8400	8760
7800	6290	6790	7300	7800	8130	8480	8840	9210
8200	6630	7160	7680	8200	8550	8900	9270	9650
8600	6980	7520	8060	8600	8960	9330	9710	10100
9000	7330	7890	8440	9000	9370	9750	10140	10550
9400	7680	8250	8830	9400	9780	10170	10580	11000
9800	8030	8620	9210	9800	10190	10600	11020	11450
10200	8380	8990	9590	10200	10600	11020	11450	11900
10600	8730	9350	9980	10600	11010	11440	11890	12340
11000	9080	9720	10360	11000	11430	11870	12320	12790
11400	9420	10080	10740	11400	11840	12290	12760	13240
11800	9770	10450	11120	11800	12250	12710	13190	13690

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
8800	932.7	860.9	856.0	851.0	846.0	841.1	836.2	816.3	793.0	767.7	718.2
9000	942.7	870.1	865.1	860.0	855.0	850.0	845.1	824.9	801.4	775.8	725.7
9400	963.1	888.9	883.8	878.7	873.5	868.4	863.4	842.8	818.8	792.6	741.4
9800	983.7	908.0	902.8	897.5	892.3	887.1	882.0	861.0	836.4	809.8	757.5
10200	1002.2	925.1	919.9	914.5	909.1	903.8	898.6	877.1	852.1	824.9	771.6
10600	1019.6	940.9	935.5	930.1	924.6	919.2	913.9	892.0	866.5	838.8	784.4
11000	1029.0	956.5	951.0	945.4	939.8	934.4	928.9	906.6	880.7	852.4	797.1
11400	1029.0	971.8	966.2	960.5	954.9	949.3	943.7	921.1	894.7	865.9	809.6
11800	1029.0	986.9	981.2	975.4	969.7	964.0	958.3	935.3	908.4	879.2	821.9
12200	1029.0	1001.8	996.0	990.1	984.2	978.5	972.7	949.3	922.0	892.2	834.0
12600	1029.0	1016.3	1010.4	1004.4	998.6	992.7	986.9	963.1	935.3	905.1	845.9
13000	1029.0	1029.0	1024.7	1018.7	1012.6	1006.6	1000.7	976.6	948.5	917.8	857.7
13400	1029.0	1029.0	1029.0	1029.0	1026.5	1020.5	1014.6	990.0	961.4	930.3	869.3
13800	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1028.0	1003.0	974.1	942.6	880.7
14200	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1016.1	986.7	954.7	891.9
14600	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1028.6	999.0	966.5	903.0
15000	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1011.0	978.2	913.9
15400	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1022.9	989.7	924.5
CLIMB LIMIT WT (1000 LB)	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	966.8

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
8800	875.3	811.4	806.7	802.1	797.5	792.9	775.3	756.3	733.2	710.5	667.0
9000	884.6	820.0	815.2	810.5	805.9	801.3	783.4	764.3	740.9	718.0	673.9
9400	903.7	837.7	832.9	828.1	823.3	818.6	800.4	780.8	756.9	733.5	688.5
9800	923.1	855.8	850.8	845.9	841.1	836.3	817.7	797.7	773.3	749.4	703.5
10200	940.6	871.9	866.8	861.8	856.9	852.0	833.0	812.7	787.8	763.4	716.6
10600	956.7	886.6	881.5	876.4	871.4	866.3	847.0	826.3	800.9	776.1	728.3
11000	972.5	901.2	895.9	890.8	885.6	880.5	860.8	839.7	813.9	788.6	739.9
11400	988.1	915.5	910.2	904.9	899.7	894.5	874.5	852.9	826.6	800.9	751.4
11800	1003.5	929.6	924.2	918.8	913.5	908.2	887.9	866.0	839.2	813.0	762.7
12200	1018.5	943.5	938.0	932.6	927.2	921.8	901.1	878.8	851.6	825.0	773.8
12600	1029.0	957.2	951.6	946.1	940.6	935.1	914.1	891.5	863.9	836.8	784.8
13000	1029.0	970.7	965.0	959.4	953.8	948.3	926.9	904.0	875.9	848.4	795.7
13400	1029.0	984.0	978.2	972.5	966.8	961.2	939.5	916.2	887.8	859.9	806.3
13800	1029.0	997.0	991.2	985.4	979.7	973.9	952.0	928.3	899.5	871.2	816.8
14200	1029.0	1009.7	1004.0	998.1	992.3	986.5	964.2	940.2	911.0	882.3	827.2
14600	1029.0	1022.5	1016.5	1010.6	1004.6	998.8	976.2	951.9	922.3	893.2	837.4
15000	1029.0	1029.0	1029.0	1022.7	1016.8	1010.8	988.0	963.4	933.4	903.9	847.4
15400	1029.0	1029.0	1029.0	1029.0	1029.0	1022.7	999.7	974.7	944.3	914.5	857.2
CLIMB LIMIT WT (1000 LB)	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1025.8	979.3	893.6

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
8800	824.7	763.1	758.8	754.5	750.2	734.4	718.2	699.0	679.0	660.2	620.1
9000	833.5	771.2	766.8	762.4	758.1	742.1	725.7	706.3	686.0	667.0	626.5
9400	851.5	787.9	783.4	779.0	774.5	758.2	741.4	721.6	700.9	681.5	640.1
9800	869.8	804.9	800.3	795.8	791.2	774.6	757.5	737.2	716.1	696.3	654.1
10200	886.2	820.0	815.3	810.7	806.0	789.1	771.6	751.0	729.4	709.2	666.1
10600	901.2	833.7	829.0	824.3	819.5	802.2	784.4	763.4	741.5	720.8	676.9
11000	916.1	847.3	842.4	837.7	832.8	815.2	797.1	775.6	753.3	732.3	687.6
11400	930.7	860.6	855.7	850.9	845.9	828.0	809.5	787.7	765.0	743.6	698.1
11800	945.0	873.8	868.8	863.9	858.8	840.6	821.8	799.6	776.5	754.8	708.5
12200	959.2	886.8	881.7	876.7	871.6	853.0	834.0	811.4	787.9	765.8	718.7
12600	973.1	899.6	894.4	889.3	884.1	865.3	845.9	823.0	799.1	776.7	728.8
13000	986.9	912.2	906.9	901.7	896.5	877.4	857.7	834.4	810.2	787.4	738.8
13400	1000.3	924.6	919.3	914.0	908.7	889.2	869.3	845.7	821.1	797.9	748.6
13800	1013.7	936.8	931.4	926.0	920.6	900.9	880.7	856.7	831.8	808.3	758.3
14200	1026.7	948.8	943.3	937.9	932.4	912.5	891.9	867.6	842.3	818.5	767.8
14600	1029.0	960.6	955.1	949.6	944.0	923.8	903.0	878.3	852.7	828.6	777.2
15000	1029.0	972.2	966.6	961.1	955.4	934.9	913.8	888.9	862.9	838.5	786.4
15400	1029.0	983.7	978.0	972.3	966.6	945.9	924.5	899.3	873.0	848.2	795.5
CLIMB LIMIT WT (1000 LB)	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	1029.0	991.4	946.9	904.3	830.0

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Wet Runway
Flaps 10
Based on engine bleed for packs on and anti-ice off
Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
8800	775.8	718.1	714.2	710.3	698.3	684.6	664.9	648.2	630.8	611.2	575.2
9000	784.0	725.6	721.7	717.7	705.6	691.7	671.8	654.9	637.3	617.5	581.1
9400	801.0	741.3	737.3	733.3	720.9	706.8	686.4	669.1	651.1	630.9	593.7
9800	818.3	757.4	753.3	749.2	736.5	722.1	701.3	683.7	665.3	644.7	606.7
10200	833.6	771.5	767.4	763.2	750.2	735.5	714.4	696.4	677.6	656.6	617.9
10600	847.7	784.3	780.1	775.8	762.6	747.6	726.1	707.7	688.6	667.2	627.7
11000	861.5	797.0	792.7	788.3	774.9	759.6	737.6	718.9	699.5	677.6	637.5
11400	875.1	809.5	805.0	800.6	786.9	771.4	749.0	730.0	710.2	688.0	647.1
11800	888.5	821.8	817.3	812.8	798.8	783.1	760.3	740.9	720.8	698.2	656.6
12200	901.7	833.9	829.3	824.7	810.6	794.5	771.4	751.7	731.3	708.3	666.0
12600	914.8	845.8	841.2	836.5	822.2	805.9	782.4	762.4	741.6	718.2	675.3
13000	927.6	857.6	852.9	848.2	833.6	817.0	793.2	772.9	751.8	728.0	684.4
13400	940.2	869.2	864.4	859.6	844.8	828.0	803.8	783.2	761.8	737.7	693.4
13800	952.7	880.6	875.8	870.9	855.9	838.8	814.3	793.4	771.7	747.2	702.3
14200	964.9	891.8	886.9	882.0	866.8	849.5	824.6	803.4	781.4	756.6	711.1
14600	976.9	902.9	897.9	892.9	877.5	860.0	834.7	813.2	790.9	765.8	719.7
15000	988.8	913.7	908.7	903.6	888.0	870.3	844.7	822.9	800.3	774.9	728.2
15400	1000.3	924.4	919.3	914.2	898.4	880.4	854.5	832.5	809.6	783.8	736.5
CLIMB LIMIT WT (1000 LB)	1029.0	1029.0	1029.0	1029.0	1023.6	994.5	951.3	912.1	874.4	835.4	769.4

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
8800	724.7	671.9	668.4	658.6	646.1	626.9	612.2	597.0	580.6	563.7	530.4
9000	732.3	678.9	675.3	665.4	652.8	633.4	618.5	603.1	586.6	569.5	535.7
9400	748.1	693.6	690.0	679.9	666.9	647.1	631.9	616.2	599.3	581.9	547.4
9800	764.3	708.7	705.0	694.7	681.5	661.2	645.7	629.7	612.5	594.6	559.4
10200	778.6	721.9	718.1	707.5	694.1	673.5	657.6	641.3	623.7	605.5	569.6
10600	791.6	733.7	729.8	719.1	705.4	684.4	668.3	651.6	633.7	615.1	578.5
11000	804.4	745.4	741.5	730.6	716.6	695.2	678.8	661.8	643.5	624.6	587.4
11400	817.0	757.0	753.0	741.8	727.6	705.8	689.1	671.8	653.2	634.0	596.1
11800	829.4	768.4	764.3	753.0	738.5	716.3	699.3	681.8	662.8	643.3	604.7
12200	841.6	779.6	775.5	764.0	749.2	726.7	709.4	691.6	672.3	652.5	613.2
12600	853.7	790.7	786.5	774.8	759.9	737.0	719.4	701.3	681.7	661.5	621.7
13000	865.6	801.6	797.3	785.5	770.3	747.1	729.2	710.8	691.0	670.5	630.0
13400	877.3	812.4	808.0	796.0	780.6	757.0	738.9	720.2	700.1	679.3	638.2
13800	888.8	823.0	818.6	806.4	790.7	766.8	748.5	729.5	709.1	688.0	646.3
14200	900.2	833.4	828.9	816.6	800.7	776.5	757.9	738.6	717.9	696.5	654.3
14600	911.3	843.7	839.1	826.6	810.5	785.9	767.1	747.6	726.6	704.9	662.1
15000	922.3	853.8	849.2	836.5	820.2	795.3	776.2	756.4	735.2	713.2	669.9
15400	933.1	863.7	859.0	846.2	829.7	804.5	785.1	765.1	743.6	721.4	677.5
CLIMB LIMIT WT (1000 LB)	980.4	978.2	977.8	959.5	934.0	901.2	870.4	838.6	805.6	773.8	713.6

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Field & Climb Limit Weights - Wet Runway

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3(f) of 3: 10000 FT Pressure Altitude

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	10	14	18	22	26	30	34	38	42	50
8800	672.8	624.1	612.3	599.8	586.8	573.8	560.2	545.7	530.1	514.1	483.5
9000	679.8	630.5	618.6	606.0	592.8	579.6	565.9	551.3	535.5	519.3	488.3
9400	694.6	644.2	632.1	619.2	605.7	592.2	578.2	563.3	547.1	530.6	498.9
9800	709.7	658.3	645.9	632.7	619.0	605.2	590.9	575.6	559.2	542.3	510.0
10200	722.9	670.4	657.8	644.4	630.3	616.3	601.7	586.1	569.4	552.2	519.2
10600	734.7	681.3	668.4	654.7	640.4	626.1	611.3	595.4	578.3	560.7	527.1
11000	746.5	692.0	678.9	665.0	650.4	635.8	620.7	604.5	587.1	569.2	535.0
11400	758.0	702.6	689.3	675.1	660.2	645.4	630.0	613.5	595.8	577.6	542.8
11800	769.4	713.1	699.5	685.0	670.0	654.9	639.2	622.5	604.4	585.9	550.5
12200	780.7	723.4	709.6	694.9	679.6	664.2	648.3	631.3	613.0	594.2	558.1
12600	791.8	733.6	719.6	704.7	689.1	673.5	657.3	640.0	621.4	602.3	565.7
13000	802.7	743.6	729.4	714.3	698.5	682.6	666.2	648.7	629.7	610.4	573.2
13400	813.5	753.5	739.1	723.7	707.7	691.6	675.0	657.1	637.9	618.3	580.6
13800	824.1	763.3	748.6	733.1	716.8	700.5	683.6	665.5	646.0	626.1	587.8
14200	834.6	772.9	758.0	742.2	725.7	709.2	692.1	673.7	654.0	633.8	595.0
14600	844.8	782.3	767.3	751.3	734.5	717.8	700.4	681.8	661.8	641.3	602.0
15000	855.0	791.6	776.4	760.1	743.2	726.2	708.7	689.8	669.5	648.8	609.0
15400	864.9	800.8	785.3	768.9	751.7	734.6	716.7	697.7	677.1	656.1	615.8
CLIMB LIMIT WT (1000 LB)	908.8	905.9	890.5	869.0	844.6	819.2	792.8	765.4	735.9	706.4	649.5

With engine bleed for packs off, increase field limit weight by 2500 lb and climb limit weight by 11300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease field limit weight by 1100 lb and climb limit weight by 1400 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease field limit weight by 5600 lb and climb limit weight by 9100 lb.

Takeoff Obstacle Limit Weight

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 1 of 4: Sea Level, 30°C & Below, Zero Wind

OBSTACLE HEIGHT (FT)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 LB)											
	DISTANCE FROM BRAKE RELEASE (1000 FT)											
	8	10	12	14	16	18	20	22	24	26	28	30
10	793.1	881.5	957.2	1024.3								
50	770.3	857.0	929.8	998.0								
100	745.1	828.7	899.7	961.4	1017.0							
150	722.6	803.0	873.0	932.8	988.9							
200	702.4	779.5	848.8	907.3	958.9	1006.6						
250	681.8	758.5	826.0	884.0	934.6	980.6	1021.9					
300	662.6	739.2	804.9	862.7	912.5	958.1	1001.6					
350	641.4	721.5	785.3	842.7	892.9	938.0	978.7	1015.9				
400	618.4	705.2	767.2	823.9	874.7	919.4	959.3	998.0	1027.8			
450	597.5	688.7	750.5	806.8	857.6	901.8	941.4	977.0	1010.8			
500	578.4	672.8	734.7	790.6	841.2	885.2	924.6	960.0	994.8	1021.8		
550	560.6	657.8	720.6	775.3	825.5	869.5	908.6	943.8	975.7	1006.6		
600	544.3	640.9	707.5	761.1	810.4	854.6	893.4	928.5	960.3	991.8	1016.8	
650	529.2	623.8	694.3	747.6	796.2	840.2	879.0	913.9	945.6	974.4	1002.9	1025.6
700	515.2	607.7	681.2	734.7	782.5	826.3	865.2	900.0	931.5	960.3	989.0	1012.2
750	502.1	592.6	668.8	722.5	769.6	812.9	851.9	886.6	918.1	946.8	973.1	999.6
800	489.9	578.2	656.7	711.1	757.3	800.1	839.1	873.7	905.2	933.8	960.1	985.9
850	478.4	564.7	643.6	699.9	745.6	787.8	826.6	861.4	892.7	921.4	947.6	971.8
900		552.1	630.1	688.4	734.3	776.0	814.6	849.5	880.8	909.4	935.6	959.8
950		540.2	617.3	677.4	723.5	764.8	803.0	837.9	869.2	897.8	924.0	948.2
1000		528.9	605.0	666.8	713.5	754.0	791.8	826.6	858.0	886.5	912.8	936.9

Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.

Table 2 of 4: OAT Adjustment

OAT (°C)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 LB)									
	550	600	650	700	750	800	850	900	950	1000
30 & Below	0	0	0	0	0	0	0	0	0	0
32	-8.6	-9.6	-10.6	-11.5	-12.5	-13.5	-14.4	-15.4	-16.4	-17.4
34	-17.2	-19.2	-21.1	-23.0	-25.0	-26.9	-28.9	-30.8	-32.8	-34.7
36	-25.8	-28.7	-31.7	-34.6	-37.5	-40.4	-43.3	-46.2	-49.2	-52.1
38	-34.4	-38.3	-42.2	-46.1	-50.0	-53.9	-57.8	-61.6	-65.5	-69.4
40	-43.0	-47.9	-52.8	-57.6	-62.5	-67.3	-72.2	-77.1	-81.9	-86.8
42	-52.4	-58.2	-64.1	-69.9	-75.7	-81.5	-87.4	-93.2	-99.0	-104.8
44	-61.8	-68.6	-75.4	-82.2	-88.9	-95.7	-102.5	-109.3	-116.1	-122.9
46	-71.2	-79.0	-86.7	-94.4	-102.2	-109.9	-117.7	-125.4	-133.2	-140.9
48	-80.6	-89.3	-98.0	-106.7	-115.4	-124.1	-132.8	-141.5	-150.2	-158.9
50	-90.0	-99.7	-109.3	-119.0	-128.7	-138.3	-148.0	-157.6	-167.3	-177.0

Takeoff Obstacle Limit Weight

Flaps 10

Based on engine bleed for packs on and anti-ice off

Table 3 of 4: Pressure Altitude Adjustment

ALT (FT)	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 LB)									
	550	600	650	700	750	800	850	900	950	1000
S.L. & Below	0	0	0	0	0	0	0	0	0	0
1000	-20.6	-22.4	-24.3	-26.1	-28.0	-29.8	-31.7	-33.5	-35.4	-37.2
2000	-41.2	-44.9	-48.6	-52.3	-55.9	-59.6	-63.3	-67.0	-70.7	-74.4
3000	-59.6	-65.1	-70.6	-76.0	-81.5	-87.0	-92.4	-97.9	-103.4	-108.9
4000	-78.1	-85.3	-92.6	-99.8	-107.1	-114.3	-121.6	-128.8	-136.0	-143.3
5000	-95.9	-104.9	-113.8	-122.8	-131.8	-140.7	-149.7	-158.7	-167.6	-176.6
6000	-113.7	-124.4	-135.1	-145.8	-156.5	-167.2	-177.9	-188.6	-199.3	-209.9
7000	-132.4	-144.7	-157.0	-169.3	-181.6	-193.9	-206.2	-218.5	-230.8	-243.1
8000	-151.2	-165.1	-179.0	-192.8	-206.7	-220.6	-234.5	-248.4	-262.3	-276.2
9000	-168.9	-184.3	-199.7	-215.1	-230.6	-246.0	-261.4	-276.9	-292.3	-307.7
10000	-186.5	-203.5	-220.5	-237.4	-254.4	-271.4	-288.4	-305.3	-322.3	-339.3

Table 4 of 4: Wind Adjustment

WIND (KTS)	OAT & ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 LB)									
	550	600	650	700	750	800	850	900	950	1000
15 TW	-92.4	-92.0	-91.7	-91.3	-91.0	-90.6	-90.3	-90.0	-89.6	-89.3
10 TW	-61.6	-61.3	-61.1	-60.9	-60.7	-60.4	-60.2	-60.0	-59.7	-59.5
5 TW	-30.8	-30.7	-30.6	-30.4	-30.3	-30.2	-30.1	-30.0	-29.9	-29.8
0	0	0	0	0	0	0	0	0	0	0
10 HW	13.8	13.5	13.3	13.0	12.8	12.5	12.3	12.0	11.8	11.5
20 HW	27.5	27.0	26.5	26.0	25.5	25.0	24.5	24.0	23.6	23.1
30 HW	42.3	41.5	40.7	39.8	39.0	38.2	37.3	36.5	35.6	34.8
40 HW	57.1	56.0	54.8	53.6	52.4	51.3	50.1	48.9	47.7	46.6

With engine bleed for packs off, increase weight by 3300 lb.
With engine anti-ice on below 10000 ft pressure altitude, decrease weight by 1800 lb.
With engine anti-ice on at 10000 ft pressure altitude, decrease weight by 7100 lb.

Tire Speed Limit
Flaps 10

AIRPORT OAT (°C)	TIRE SPEED LIMIT WEIGHT (1000 LB)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	958.0	888.0	822.1	760.8	707.7	655.3
52	965.2	894.5	828.2	766.2	712.1	659.9
50	972.4	901.1	834.2	771.5	716.4	664.6
48	984.7	907.7	840.2	776.8	720.7	669.3
46	995.4	914.4	846.4	782.5	725.1	673.9
44	1002.5	921.3	852.7	788.2	730.2	678.7
42	1009.7	928.2	859.1	794.1	735.3	683.5
40	1017.0	935.2	865.6	800.2	740.6	688.4
38	1024.4	942.3	872.2	806.3	745.9	693.3
36	1029.0	949.4	878.9	812.4	751.2	698.3
34	1029.0	956.7	885.6	818.6	756.6	703.3
32	1029.0	964.0	892.4	824.8	762.0	707.6
30	1029.0	971.1	899.1	831.1	767.5	712.0
28	1029.0	980.8	905.8	837.5	773.0	716.4
26	1029.0	994.1	912.5	844.2	778.6	720.8
24	1029.0	1000.5	919.2	850.5	784.6	725.4
22	1029.0	1006.9	926.0	856.7	790.9	730.6
20	1029.0	1013.5	932.3	863.0	796.9	735.9
18	1029.0	1020.1	938.6	869.3	802.8	741.2
16	1029.0	1026.8	945.0	875.3	808.7	746.6
14	1029.0	1029.0	951.5	881.3	814.6	752.0
12	1029.0	1029.0	958.1	887.5	820.4	757.3
10	1029.0	1029.0	964.8	893.7	826.1	762.8
-40	1029.0	1029.0	1029.0	1029.0	1009.8	924.6

Increase tire speed limit weight by 5300 lb per knot headwind.
Decrease tire speed limit weight by 13500 lb per knot tailwind.

Brake Energy Limits VMBE

Flaps 10

Table 1 of 2: Maximum Brake Energy Speed

OAT (°C)	REFERENCE VMBE (KIAS)					
	PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	189					
50	190	183				
46	190	184	177			
42	191	184	178	172		
38	192	185	179	172	166	
34	192	186	179	173	167	158
30	193	186	180	174	168	159
26	194	187	181	174	168	161
22	196	189	182	175	169	162
18	198	190	183	177	170	164
14	199	192	185	178	171	165
10	201	194	186	179	173	166
6	203	195	188	181	174	168
2	204	197	190	182	176	169
-2	206	199	191	184	177	170
-6	208	200	193	186	179	172
-10	210	202	195	187	180	173

Table 2 of 2: Weight Adjusted VMBE

WEIGHT (1000 LB)	REFERENCE VMBE (KIAS)										
	160	165	170	175	180	185	190	195	200	205	210
500	200	207	210	210	210	210	210	210	210	210	210
550	190	196	202	208	210	210	210	210	210	210	210
600	181	186	192	198	204	210	210	210	210	210	210
650	173	178	184	189	195	200	206	210	210	210	210
700	166	171	177	182	187	192	197	203	208	210	210
750	160	165	170	175	180	185	190	195	200	205	210
800	155	159	164	169	174	178	183	188	193	198	202
850	150	154	159	163	168	173	177	182	186	191	196
900	145	150	154	158	163	167	172	176	181	185	189
950	141	146	150	154	158	163	167	171	175	180	184
1000	138	142	146	150	154	158	162	166	171	175	179

Increase VMBE by 2 knots per 1% uphill runway slope. Decrease VMBE by 5 knots per 1% downhill runway slope.
Increase VMBE by 4 knots per 10 knots headwind. Decrease VMBE by 20 knots per 10 knots tailwind.
Decrease VMBE by 16 knots for two brakes deactivated.

Decrease brake release weight by 5500 lb for each knot V1 exceeds VMBE.
Determine V1, VR, V2 speeds for lower brake release weight.

Long Range Cruise Maximum Operating Altitude

Max Climb Thrust

ISA + 10°C and Below

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
1000	28900	2	32200	30300
950	30100	0	33300	31400
900	31200	-3	34400	32600
850	32500	-6	35600	33800
800	33800	-9	36900	35100
750	35100	-12	38200	36400
700	36600	-14	39700	37900
650	38100	-14	41200	39400
600	39800	-14	42900	41100
550	41600	-14	43100	42900
500	43100	-14	43100	43100
450	43100	-14	43100	43100

***Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.**

ISA + 15°C

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
1000	28900	8	31900*	30300
950	30100	5	33300	31400
900	31200	3	34400	32600
850	32500	0	35600	33800
800	33800	-3	36900	35100
750	35100	-6	38200	36400
700	36600	-8	39700	37900
650	38100	-8	41200	39400
600	39800	-8	42900	41100
550	41600	-8	43100	42900
500	43100	-8	43100	43100
450	43100	-8	43100	43100

***Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb**

ISA + 20°C

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
1000	28900	14	30400*	30300
950	30100	11	32000*	31400
900	31200	9	33600*	32600
850	32500	6	35200*	33800
800	33800	3	36600*	35100
750	35100	0	37900*	36400
700	36600	-2	39200*	37900
650	38100	-2	40600*	39400
600	39800	-2	42100*	41100
550	41600	-2	43100	42900
500	43100	-2	43100	43100
450	43100	-2	43100	43100

***Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.**

Long Range Cruise Trip Fuel and Time

Table 1 of 3: 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
531	499	470	444	421	400	383	367	352	339	326
1050	989	933	884	840	800	767	736	708	681	657
1567	1478	1397	1324	1260	1200	1152	1106	1064	1025	989
2083	1966	1859	1764	1679	1600	1536	1476	1420	1369	1321
2597	2452	2320	2203	2097	2000	1920	1845	1776	1712	1654
3110	2938	2782	2642	2516	2400	2305	2215	2133	2056	1986
3621	3423	3242	3080	2934	2800	2689	2585	2488	2399	2318
4131	3907	3702	3518	3353	3200	3073	2955	2845	2743	2650
4639	4389	4160	3956	3770	3600	3458	3325	3201	3087	2982
5145	4870	4617	4392	4188	4000	3842	3695	3558	3431	3314
5651	5350	5075	4829	4606	4400	4227	4065	3914	3774	3646
6155	5830	5532	5265	5023	4800	4611	4434	4270	4118	3978
6658	6309	5988	5701	5440	5200	4995	4804	4626	4461	4310
7160	6787	6444	6137	5858	5600	5379	5173	4981	4804	4641
7660	7263	6899	6572	6274	6000	5764	5543	5337	5147	4973
8159	7739	7353	7006	6691	6400	6148	5912	5693	5491	5305
8657	8214	7806	7440	7107	6800	6532	6282	6050	5835	5637
9155	8689	8260	7875	7524	7200	6917	6652	6406	6178	5969
9653	9164	8714	8309	7941	7600	7301	7022	6762	6521	6301
10151	9639	9167	8743	8357	8000	7685	7391	7118	6865	6632

Table 2 of 3: Reference Fuel and Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	25		27		29		31		33	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
(NM)	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME	FUEL	TIME
400	22.7	1:04	22.4	1:04	22.0	1:03	21.3	1:02	21.0	1:01
800	41.7	1:59	41.0	1:57	39.9	1:55	38.3	1:53	37.5	1:51
1200	61.0	2:53	59.6	2:50	58.0	2:47	55.4	2:44	54.3	2:40
1600	80.5	3:47	78.4	3:43	76.3	3:38	72.9	3:34	71.2	3:29
2000	100.3	4:41	97.6	4:35	94.8	4:29	90.6	4:23	88.5	4:18
2400	120.6	5:33	117.1	5:27	113.7	5:20	108.7	5:12	106.1	5:07
2800	141.4	6:26	137.1	6:18	133.0	6:09	127.2	6:01	124.0	5:56
3200	162.5	7:17	157.4	7:08	152.7	6:59	146.0	6:50	142.2	6:45
3600	183.8	8:08	178.0	7:58	172.6	7:48	165.0	7:38	160.8	7:33
4000	205.4	8:59	198.8	8:48	192.8	8:36	184.3	8:27	179.7	8:22
4400	227.8	9:49	220.3	9:37	213.7	9:24	204.2	9:15	199.2	9:11
4800	250.3	10:39	241.9	10:25	234.5	10:12	224.2	10:03	218.7	10:00
5200	273.3	11:28	264.0	11:14	255.9	11:01	244.7	10:52	238.9	10:48
5600	296.8	12:17	286.7	12:02	277.9	11:49	265.7	11:40	259.8	11:37
6000	320.4	13:05	309.3	12:49	299.9	12:37	286.8	12:29	280.7	12:26
6400	345.1	13:53	333.0	13:37	323.0	13:25	309.1	13:17	303.2	13:15
6800	369.8	14:41	356.8	14:25	346.0	14:12	331.5	14:05	325.6	14:04
7200	395.1	15:28	381.2	15:12	369.8	15:01	354.6	14:54		
7600	421.0	16:15	406.2	16:00	394.3	15:49	378.6	15:42		
8000	446.9	17:03	431.2	16:48	418.8	16:37	402.6	16:31		

Long Range Cruise Trip Fuel and Time

Table 3 of 3: Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	LANDING WEIGHT (1000 LB)								
	460	500	540	580	620	660	700	740	780
50	-7.0	-5.2	-3.5	-1.8	0.0	2.0	4.1	6.4	8.9
100	-13.6	-10.1	-6.8	-3.5	0.0	4.1	8.5	13.4	19.3
150	-20.3	-15.2	-10.2	-5.2	0.0	6.5	13.8	22.0	31.6
200	-27.3	-20.5	-13.7	-7.0	0.0	9.4	19.9	32.3	46.1
250	-34.4	-25.9	-17.4	-8.8	0.0	12.7	27.0	44.2	62.6
300	-41.7	-31.4	-21.2	-10.8	0.0	16.5	35.0	57.8	81.1
350	-49.1	-37.2	-25.1	-12.8	0.0	20.6	43.9	73.0	101.8
400	-56.8	-43.1	-29.2	-14.9	0.0	25.2	53.7	89.9	124.5
450	-64.6	-49.1	-33.4	-17.0	0.0	30.2	64.4	108.5	149.3

Based on 340/.84 climb, Long Range Cruise speed and .84/290/250 descent.

Long Range Cruise Step Climb

Table 1 of 2: Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEAD WIND COMPONENT (KTS)						TAIL WIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
1040	981	929	881	839	800	765	732	703	675	650
1543	1460	1385	1317	1256	1200	1149	1102	1059	1019	982
2046	1938	1841	1753	1673	1600	1533	1472	1415	1362	1313
2550	2417	2297	2189	2090	2000	1917	1841	1771	1706	1645
3054	2896	2754	2625	2507	2400	2301	2211	2127	2049	1977
3558	3375	3211	3061	2925	2800	2686	2580	2483	2392	2308
4063	3855	3667	3497	3342	3200	3070	2949	2838	2735	2639
4568	4335	4125	3933	3759	3600	3454	3319	3194	3078	2970
5074	4815	4582	4370	4177	4000	3838	3688	3549	3421	3301
5580	5296	5039	4807	4594	4400	4221	4057	3905	3763	3632
6087	5777	5497	5243	5012	4800	4605	4426	4260	4106	3962
6594	6258	5955	5680	5430	5200	4989	4795	4615	4448	4293
7102	6740	6414	6117	5847	5600	5373	5163	4970	4790	4623
7610	7222	6872	6555	6265	6000	5756	5532	5324	5132	4952
8119	7705	7331	6992	6683	6400	6140	5900	5679	5473	5282
8629	8188	7791	7430	7101	6800	6524	6269	6033	5814	5611
9139	8672	8250	7868	7519	7200	6907	6637	6387	6155	5940
9650	9156	8710	8306	7937	7600	7290	7005	6741	6496	6268
10162	9641	9171	8744	8355	8000	7674	7373	7094	6837	6597

Table 2 of 2: Trip Fuel and Time Required

AIR DIST (NM)	TRIP FUEL (1000 LB)												TIME (HR:MIN)
	BRAKE RELEASE GROSS WEIGHT (1000 LB)												
	450	500	550	600	650	700	750	800	850	900	950	1000	
800	28.0	29.8	31.7	33.8	36.2	38.2	40.6	43.2	45.4	48.2	51.2	54.2	1:50
1200	39.3	41.8	44.5	47.5	51.0	54.0	57.4	61.2	64.4	68.3	72.6	76.9	2:39
1600	50.3	53.7	57.1	60.9	65.5	69.5	73.9	78.8	83.0	87.8	93.3	98.8	3:29
2000	61.4	65.3	69.5	74.1	79.6	84.8	90.0	95.9	101.2	107.0	113.5	120.2	4:18
2400	72.3	76.8	81.7	87.1	93.4	99.7	105.7	112.6	119.1	125.7	133.2	141.0	5:08
2800	83.1	88.0	93.6	99.8	106.9	114.1	121.2	129.0	136.4	144.1	152.5	161.3	5:57
3200	93.8	99.1	105.4	112.3	120.1	128.3	136.0	145.0	153.4	162.1	171.3	181.1	6:47
3600	104.2	110.2	117.1	124.6	133.1	142.1	151.3	160.6	169.9	179.7	189.8	200.3	7:37
4000	114.5	121.2	128.5	136.7	145.9	155.7	165.8	176.0	186.1	196.8	207.9	219.2	8:27
4400	124.7	132.0	139.7	148.6	158.5	168.9	179.9	191.2	201.9	213.5	225.5	237.7	9:17
4800	134.6	142.6	150.8	160.3	170.9	182.0	193.7	205.9	217.5	229.8	242.7	255.9	10:08
5200	144.5	153.1	161.8	171.9	183.0	194.8	207.2	220.2	232.7	245.8	259.5	273.6	10:58
5600	154.1	163.4	172.8	183.2	195.0	207.4	220.4	234.2	247.7	261.4	275.9	290.8	11:49
6000	163.6	173.6	183.6	194.4	206.8	219.7	233.4	247.9	262.3	276.8	292.0	307.7	12:41
6400	173.0	183.6	194.2	205.4	218.4	231.9	246.2	261.4	276.5	291.9	307.7	324.1	13:32
6800	182.2	193.4	204.7	216.4	229.8	243.9	258.8	274.5	290.3	306.6	323.1	340.2	14:24
7200	191.3	203.1	215.0	227.3	241.0	255.7	271.1	287.5	303.9	320.9	338.4	356.0	15:16
7600	200.2	212.6	225.1	238.0	252.0	267.3	283.3	300.2	317.2	334.9	353.2	371.4	16:09
8000	209.0	222.0	235.1	248.6	263.1	278.7	295.2	312.7	330.3	348.6	367.6		17:02

Based on 340/.84 climb, Long Range Cruise speed and .84/290/250 descent.
Valid for all pressure altitudes with 4000 ft step climb to 2000 ft above optimum altitude.

Short Trip Fuel and Time

Table 1 of 2: 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
102	84	72	63	56	50	45	42	38	36	33
162	144	130	118	108	100	93	87	81	77	72
225	204	187	173	161	150	141	132	125	118	113
287	264	245	228	213	200	189	178	169	161	153
350	324	302	282	265	250	237	224	214	204	195
411	383	358	336	317	300	285	271	258	247	236
473	442	415	391	369	350	333	317	303	290	278
536	502	472	445	421	400	381	363	347	333	319
598	561	529	500	473	450	429	409	392	376	361
662	622	586	554	526	500	477	455	436	418	402

Table 2 of 2: Trip Fuel and Time Required

AIR DIST (NM)		LANDING WEIGHT (1000 LB)									TIME (HRS:MIN)
		460	500	540	580	620	660	700	740	780	
50	FUEL (1000 LB)	4.7	4.9	5.2	5.4	5.6	5.9	6.2	6.4	6.9	0:14
	ALT (FT)	11000	11000	9000	9000	9000	9000	9000	9000	9000	
100	FUEL (1000 LB)	7.1	7.4	7.7	8.0	8.3	8.6	9.0	9.4	10.0	0:22
	ALT (FT)	19000	17000	17000	17000	17000	15000	17000	17000	15000	
150	FUEL (1000 LB)	9.3	9.7	10.1	10.4	10.9	11.3	11.7	12.2	12.9	0:29
	ALT (FT)	31000	23000	23000	23000	23000	23000	23000	21000	21000	
200	FUEL (1000 LB)	11.0	11.5	11.9	12.4	12.9	13.5	14.0	14.7	15.5	0:36
	ALT (FT)	35000	35000	35000	35000	33000	31000	31000	29000	29000	
250	FUEL (1000 LB)	12.6	13.2	13.7	14.3	14.9	15.5	16.1	16.9	17.7	0:42
	ALT (FT)	41000	41000	37000	35000	35000	35000	35000	35000	35000	
300	FUEL (1000 LB)	14.2	14.8	15.5	16.1	16.8	17.5	18.2	19.1	20.1	0:48
	ALT (FT)	41000	41000	37000	39000	37000	37000	35000	35000	35000	
350	FUEL (1000 LB)	15.7	16.4	17.2	17.9	18.8	19.6	20.4	21.4	22.5	0:54
	ALT (FT)	41000	41000	41000	39000	37000	37000	35000	35000	35000	
400	FUEL (1000 LB)	17.3	18.1	18.9	19.7	20.7	21.6	22.6	23.7	24.9	1:00
	ALT (FT)	41000	41000	41000	39000	39000	37000	35000	35000	35000	
450	FUEL (1000 LB)	18.8	19.7	20.7	21.6	22.6	23.6	24.7	26.0	27.2	1:06
	ALT (FT)	41000	41000	41000	39000	39000	37000	35000	35000	35000	
500	FUEL (1000 LB)	20.4	21.4	22.4	23.4	24.5	25.7	26.9	28.2	29.6	1:13
	ALT (FT)	41000	41000	41000	39000	39000	37000	35000	35000	35000	

Decompression Diversion Planning

Table 1 of 2: 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
288	265	245	228	213	200	189	178	169	161	153
569	525	487	454	425	400	378	357	339	323	308
851	785	729	680	638	600	567	537	510	485	463
1133	1046	971	907	850	800	756	716	680	648	618
1414	1306	1213	1133	1062	1000	945	895	850	810	773
1696	1567	1455	1359	1275	1200	1134	1074	1021	972	928
1978	1827	1698	1585	1487	1400	1323	1254	1191	1135	1083
2260	2087	1940	1812	1699	1600	1512	1433	1362	1297	1238
2541	2348	2182	2038	1912	1800	1701	1612	1532	1459	1394

Table 2 of 2: Critical Fuel (1000 LB)

AIR DISTANCE (NM)	WEIGHT AT DECOMPRESSION POINT (1000 LB)												
	400	450	500	550	600	650	700	750	800	850	900	950	1000
200	12.2	12.6	13.1	13.5	14.1	14.6	15.0	15.6	16.1	16.7	17.3	17.9	18.5
300	17.2	17.9	18.4	19.0	19.8	20.5	21.2	21.9	22.7	23.5	24.3	25.1	25.9
400	22.2	23.1	23.8	24.5	25.5	26.5	27.4	28.3	29.3	30.3	31.3	32.4	33.4
500	27.2	28.3	29.2	30.1	31.2	32.4	33.5	34.6	35.9	37.1	38.4	39.6	40.8
600	32.2	33.6	34.6	35.6	36.9	38.3	39.7	41.0	42.4	43.9	45.4	46.8	48.2
700	37.3	38.8	39.9	41.1	42.6	44.2	45.8	47.4	49.0	50.7	52.4	54.0	55.6
800	42.3	44.0	45.3	46.6	48.4	50.2	52.0	53.7	55.6	57.5	59.4	61.2	62.9
900	47.3	49.3	50.7	52.1	54.1	56.1	58.1	60.0	62.0	64.1	66.2	68.2	70.1
1000	52.3	54.5	56.0	57.6	59.7	61.8	64.0	66.1	68.4	70.7	73.0	75.2	77.4
1100	57.3	59.6	61.3	62.9	65.2	67.5	70.0	72.3	74.7	77.2	79.8	82.2	84.6
1200	62.3	64.6	66.5	68.3	70.7	73.3	75.9	78.5	81.1	83.8	86.5	89.2	91.8
1300	67.4	69.6	71.7	73.7	76.2	79.0	81.8	84.6	87.4	90.4	93.3	96.2	99.0
1400	72.4	74.6	77.0	79.0	81.7	84.7	87.7	90.8	93.8	97.0	100.1	103.2	106.2
1500	77.4	79.7	82.2	84.4	87.2	90.4	93.7	96.9	100.1	103.5	106.9	110.2	113.3
1600	82.4	84.7	87.4	89.8	92.7	96.1	99.6	103.1	106.5	110.0	113.5	117.0	120.3
1700	87.4	89.7	92.7	95.2	98.2	101.8	105.5	109.2	112.7	116.4	120.1	123.8	127.3
1800	92.4	94.7	97.9	100.5	103.7	107.5	111.3	115.1	118.9	122.7	126.7	130.6	134.4

Based on: Emergency descent to 10000 ft, level cruise at 10000 ft, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included.

Adjustments:
- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
-Increase fuel required by 0.7% per 10°C above ISA.

Holding Planning

Flaps Up

WEIGHT (1000 LB)	TOTAL FUEL FLOW (LB/HR)									
	PRESSURE ALTITUDE (FT)									
	1500	5000	10000	15000	20000	25000	30000	35000	40000	43000
1000	28810	28520	28350	28250	29690	30330	30850			
950	27280	26960	26760	26610	27930	28480	29150			
900	25790	25400	25200	25050	26140	26670	27120	27810		
850	24340	23890	23650	23470	24410	24900	25250	25570		
800	22940	22450	22710	22470	23280	23600	23440	23720		
750	21640	21680	21310	21030	21750	21900	21720	22190		
700	20970	20400	19990	19660	20240	20240	20060	20340	21470	
650	19730	19160	18690	18320	18740	18740	18420	18630	19510	
600	18500	17950	17440	17030	17270	17280	16850	16970	17960	18870
550	17260	16760	16230	15780	15860	15810	15780	15720	16540	17030
500	16030	15540	15050	14570	14500	14360	14310	14170	14850	15470
450	14860	14340	13910	13450	13180	12950	12910	12700	13250	13730

Includes 5% additional fuel for holding in a race track pattern.

Flaps 1

WEIGHT (1000 LB)	TOTAL FUEL FLOW (LB/HR)				
	PRESSURE ALTITUDE (FT)				
	1500	5000	10000	15000	20000
1000	34500	34350	34480	34940	35470
950	32680	32610	32520	32980	33390
900	30880	30810	30650	31060	31380
850	29130	29000	28860	29160	29420
800	27410	27210	27120	27240	27520
750	25760	25500	25420	25410	25720
700	24140	23830	23730	23660	23960
650	22550	22190	22600	22470	22580
600	21590	21180	20970	20800	20780
550	20100	19640	19380	19170	19140
500	18670	18170	17820	17590	17500
450	17390	16880	16430	16120	15910

Includes 5% additional fuel for holding in a race track pattern.

Oxygen Requirements
Flight Crew System
Table 1 of 5

NO. OF CREW	OXYGEN REQUIRED (LITERS)
2	680
3	1020
4	1340

Includes normal usage allowance of one person for 15 minutes at 8000 ft.

Table 2 of 5

NO. OF CREW	OXYGEN REQUIRED FOR LEVEL OFF AT 14000 FT (LITERS)			
	TOTAL POST DECOMPRESSION TIME (HR)			
	2	3	4	5
2	650	960	1260	1570
3	980	1440	1900	2360
4	1310	1920	2530	3150

Includes normal usage allowance of one person for 15 minutes at 8000 ft cabin altitude.

Table 3 of 5

NO. OF CREW	ADDITIONAL LITERS REQUIRED FOR EACH MINUTE HELD AT INTERMEDIATE ALTITUDES OTHER THAN 14000 FT				
	INTERMEDIATE PRESSURE ALTITUDE (FT)				
	8000 TO 13999	14000	14001 TO 17999	18000 TO 21999	22000 TO 25000
	REGULATOR ON "NORMAL" OR (100%)				
2	0 (22)	0 (16)	1 (16)	3 (12)	4 (11)
3	0 (33)	0 (24)	1 (24)	4 (18)	6 (16)
4	0 (43)	0 (32)	2 (32)	5 (25)	8 (21)

Instructions:
1. **Determine protective breathing requirements from Table 1.**
2. **Determine sustenance requirements for level off at 14000 ft from Table 2 and adjust for level off altitudes other than 14000 ft using Table 3.**
3. **Flight crew system oxygen requirements are the larger of protective breathing (Table 1) or sustenance requirements (Table 2).**

Includes normal usage allowance of one person for 15 minutes at 8000 ft cabin altitude.

Oxygen Requirements
Table 4 of 5: Cylinder Volume to Pressure Conversion
Based on 3 Cylinders (114 Cubic Foot Bottles) Installed

CYLINDER PRESSURE AT 21°C (70°F) (PSI)	OXYGEN IN CYLINDERS (1000 LITER)
100	0
200	0.5
300	1.1
400	1.6
500	2.1
600	2.6
700	3.1
800	3.7
900	4.2
1000	4.7
1100	5.2
1200	5.7
1300	6.3
1400	6.8
1500	7.3
1600	7.8
1700	8.3
1800	8.9
1900	9.4
2000	9.9

Check minimum/maximum pressure in shaded area.
Minimum cylinder pressure = 680 psi at 21°C (70°F).
Maximum cylinder pressure = 1850 psi at 21°C (70°F).
For maximum cylinder pressure at hotter or colder temperatures add or subtract 32 PSI per 5°C (10°F) respectively.

Table 5 of 5: Temperature Corrections

CYLINDER PRESSURE AT 21°C (70°F) (PSI)	PRESSURE CORRECTION FOR EACH 5°C (10°F) (PSI)
400	7
600	11
800	14
1000	17
1200	21
1400	24
1600	28
1800	31
2000	34

If ambient temperature above 21°C (70°F), add increment shown. If ambient temperature below 21°C (70°F), subtract increment shown.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Net Level Off Weight

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 LB)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
32	440.8	440.7	421.2
30	483.4	479.5	459.1
28	529.0	514.3	493.0
26	570.7	550.8	526.9
24	610.7	588.0	562.3
22	650.4	626.4	599.1
20	692.9	666.1	638.1
18	734.1	705.7	676.5
16	777.0	746.3	713.9
14	821.8	789.9	753.4
12	879.9	837.2	797.9
10	925.8	884.2	842.7
8	966.5	923.2	879.9
6	1009.6	963.0	918.1
4	1029.0	1002.9	953.4
2	1029.0	1029.0	989.9
0	1029.0	1029.0	1027.0

Anti-Ice Adjustments

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 LB)												
	PRESSURE ALTITUDE (1000 FT)												
	6	8	10	12	14	16	18	20	22	24	26	28	30
ENGINE ONLY	-5.6	-6.8	-6.8	-7.3	-7.5	-4.4	-4.3	-4.6	-4.2	-4.4	-4.2	-3.7	-3.0
ENGINE AND WING	-19.3	-19.7	-25.8	-24.8	-26.9	-17.8	-17.0	-17.1	-16.2	-15.8	-14.7	-13.7	-12.3

Performance Dispatch — Chapter PD
Landing — Section 22

Landing Field Limit Weight - Dry Runway
Flaps 30

Table 1 of 2: Wind Adjusted Field Length (FT)

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5000	3830	4180	4550	5000	5270	5560	5860	6180
5400	4160	4530	4920	5400	5690	5990	6310	6640
5800	4490	4880	5290	5800	6100	6420	6750	7100
6200	4810	5220	5660	6200	6520	6850	7200	7560
6600	5140	5570	6030	6600	6930	7280	7640	8020
7000	5470	5920	6400	7000	7350	7710	8090	8480
7400	5800	6260	6770	7400	7760	8140	8530	8950
7800	6130	6610	7140	7800	8170	8570	8980	9410
8200	6460	6960	7510	8200	8590	9000	9420	9870
8600	6790	7300	7880	8600	9000	9430	9870	10330
9000	7120	7650	8250	9000	9420	9860	10310	10790
9400	7450	8000	8620	9400	9830	10290	10760	11250
9800	7770	8340	8990	9800	10250	10710	11200	11710
10200	8100	8690	9360	10200	10660	11140	11650	12180
10600	8430	9040	9730	10600	11080	11570	12090	12640

Table 2 of 2: Field Limit Weight (1000 LB)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
4200	386.2					
4600	446.0	415.1				
5000	506.0	471.6	438.7	406.8		
5400	565.7	528.2	492.1	457.5	424.6	
5800	624.6	584.9	545.6	508.2	472.5	438.1
6200	660.3	634.5	599.4	558.9	520.3	483.3
6600	696.0	668.4	642.0	610.0	568.6	528.7
7000	731.1	702.0	674.0	646.4	616.9	574.3
7400	768.3	734.6	705.0	676.4	648.8	619.9
7800	798.1	769.6	735.7	705.9	677.0	649.0
8200	827.0	797.6	768.8	734.6	704.8	675.5
8600	855.4	825.0	795.2	766.3	731.9	701.5
9000	883.0	851.6	821.2	791.2	761.9	726.9
9400	910.1	877.9	846.4	815.7	785.9	751.3
9800	936.5	903.5	871.0	839.5	808.9	778.5
10200	962.5	928.6	895.3	862.7	831.4	800.3
10600	987.9	953.3	919.1	885.6	853.2	821.4
11000	1013.0	977.3	942.3	907.9	874.8	842.2
11400	1028.9	1000.9	965.2	929.9	896.0	862.7
11800	1028.9	1024.0	987.7	951.5	916.7	882.5
12200		1028.9	1009.5	972.9	937.2	901.7
12600		1028.9	1028.9	993.8	956.8	920.7
13000			1028.9	1010.8	973.6	937.0
13400				1026.9	989.0	952.0
13800				1028.9	1004.2	966.5
14200				1028.9	1019.0	980.8
14600					1028.9	994.7

With manual speedbrakes, decrease weight by 47400 lb.
With 2 brakes deactivated, decrease weight by 78500 lb.

Landing Field Limit Weight - Wet Runway

Flaps 30

Table 1 of 2: Wind Adjusted Field Length (FT)

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5000	3790	4160	4540	5000	5290	5590	5900	6240
5400	4110	4510	4910	5400	5700	6020	6350	6700
5800	4440	4850	5280	5800	6120	6450	6790	7160
6200	4770	5200	5650	6200	6530	6880	7240	7620
6600	5100	5550	6020	6600	6940	7310	7690	8080
7000	5430	5890	6390	7000	7360	7740	8130	8550
7400	5760	6240	6760	7400	7770	8170	8580	9010
7800	6090	6590	7130	7800	8190	8600	9020	9470
8200	6420	6930	7500	8200	8600	9020	9470	9930
8600	6750	7280	7870	8600	9020	9450	9910	10390
9000	7070	7630	8240	9000	9430	9880	10360	10850
9400	7400	7970	8610	9400	9850	10310	10800	11310
9800	7730	8320	8980	9800	10260	10740	11250	11780
10200	8060	8670	9350	10200	10680	11170	11690	12240
10600	8390	9010	9720	10600	11090	11600	12140	12700

Table 2 of 2: Field Limit Weight (1000 LB)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
5000	408.3					
5400	460.3	428.6	397.9			
5800	512.4	477.7	444.5	412.3		
6200	564.4	526.9	491.0	456.4	423.5	
6600	615.8	576.3	537.5	500.4	465.2	431.2
7000	650.1	622.4	584.2	544.5	506.8	470.5
7400	681.4	654.3	628.5	588.9	548.7	509.9
7800	712.1	683.9	656.5	629.4	590.6	549.6
8200	742.1	712.5	684.1	656.3	628.3	589.1
8600	774.0	740.8	711.2	682.3	654.3	626.1
9000	799.8	771.4	737.7	707.7	678.8	650.8
9400	825.2	795.6	766.3	732.8	702.8	673.7
9800	849.9	819.7	790.1	759.5	726.6	696.4
10200	873.9	843.0	812.8	783.3	749.8	718.7
10600	897.7	866.0	834.9	804.7	775.1	740.5
11000	921.1	888.5	856.7	825.6	795.4	764.8
11400	944.0	910.7	877.9	846.1	815.3	784.6
11800	966.5	932.3	899.0	866.2	834.7	803.4
12200	988.6	953.7	919.5	886.0	853.6	821.9
12600	1010.2	974.7	939.8	905.4	872.4	840.0
13000	1028.9	995.4	959.7	924.8	890.9	857.8
13400	1028.9	1015.7	979.3	943.6	909.2	875.2
13800		1028.9	998.7	962.3	927.0	892.0
14200		1028.9	1017.7	980.6	944.5	908.7
14600			1028.9	998.0	961.0	924.8

With manual speedbrakes, decrease weight by 47400 lb.
With 2 brakes deactivated, decrease weight by 78500 lb.

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	LANDING CLIMB LIMIT WEIGHT (1000 LB)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	729.1					
52	746.6					
50	766.5	740.7				
48	784.4	759.8				
46	802.6	778.0	727.3			
44	820.8	796.3	743.0			
42	839.2	814.9	761.7	699.1		
40	858.2	833.2	778.5	715.0		
38	878.7	851.9	795.2	731.2	671.4	
36	898.4	870.6	812.3	746.1	684.3	
34	915.9	889.2	829.4	762.0	697.6	627.9
32	930.6	905.6	846.4	776.2	710.2	638.8
30	945.5	920.6	859.3	790.5	721.8	649.8
28	946.1	934.1	871.9	805.1	733.5	660.3
26	946.6	947.1	884.4	824.2	745.1	670.5
24	947.1	947.5	896.5	834.3	758.2	680.5
22	947.6	947.9	907.6	843.8	778.2	690.1
20	948.1	948.3	908.0	852.7	788.0	699.6
18	948.6	948.7	908.3	860.9	796.5	709.7
16	949.1	949.1	908.6	861.1	803.8	718.9
14	949.5	949.4	908.8	861.2	810.5	727.1
12	949.7	949.8	909.0	861.3	810.7	734.5
10	950.0	950.1	909.2	861.4	810.8	741.3
-40	951.8	951.8	915.3	864.1	812.7	743.7

With engine bleed for packs off, increase weight by 8200 lb.
With engine anti-ice on, decrease weight by 9900 lb.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10°C, decrease weight by 48300 lb.

ENGINE INOP

ADVISORY INFORMATION

Go-Around Climb Gradient

Flaps 20, Gear Up

Based on engine bleeds for packs on and anti-ice off.

Table 1 of 3: Reference Go-Around Gradient (%)

AIRPORT OAT (°C)	REFERENCE GO-AROUND GRADIENT (%) PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	4.37	4.03	3.58	2.84	2.04	
52	4.76	4.32	3.86	3.13	2.33	
50	5.15	4.63	4.16	3.42	2.63	1.36
48	5.55	5.01	4.47	3.71	2.92	1.64
46	5.95	5.40	4.79	4.02	3.21	1.92
44	6.36	5.79	5.16	4.33	3.50	2.19
42	6.76	6.19	5.53	4.66	3.81	2.47
40	7.17	6.59	5.91	5.04	4.13	2.74
38	7.61	7.00	6.29	5.42	4.45	3.03
36	8.03	7.40	6.67	5.77	4.76	3.33
34	8.38	7.79	7.05	6.09	5.08	3.61
32	8.67	8.11	7.40	6.41	5.38	3.86
30	8.97	8.41	7.70	6.73	5.66	4.12
28	8.98	8.71	7.97	7.08	5.93	4.37
26	8.99	8.99	8.25	7.49	6.21	4.61
24	9.00	9.00	8.54	7.72	6.52	4.85
22	9.01	9.01	8.82	7.95	6.92	5.08
20	9.02	9.02	8.82	8.18	7.16	5.31
18	9.03	9.02	8.83	8.39	7.36	5.55
16	9.04	9.03	8.83	8.39	7.54	5.76
14	9.05	9.04	8.84	8.39	7.71	5.96
12	9.06	9.05	8.84	8.39	7.71	6.13
10	9.06	9.05	8.85	8.40	7.71	6.30
8	9.07	9.06	8.85	8.40	7.71	6.30
6	9.07	9.06	8.86	8.40	7.71	6.30
4	9.08	9.07	8.86	8.40	7.71	6.31
2	9.09	9.07	8.87	8.40	7.71	6.31
0	9.09	9.07	8.87	8.41	7.71	6.31

ENGINE INOP

ADVISORY INFORMATION

Go-Around Climb Gradient

Flaps 20, Gear Up

Based on engine bleeds for packs on and anti-ice off.

Table 2 of 3: Weight Adjustment

WEIGHT (1000 LB)	REFERENCE GO-AROUND GRADIENT (%)								
	2	3	4	5	6	7	8	9	10
800	-1.91	-2.07	-2.24	-2.41	-2.57	-2.72	-2.87	-3.02	-3.19
780	-1.68	-1.82	-1.96	-2.11	-2.24	-2.38	-2.51	-2.63	-2.74
760	-1.42	-1.53	-1.65	-1.76	-1.88	-1.99	-2.10	-2.19	-2.27
740	-1.12	-1.21	-1.30	-1.39	-1.48	-1.56	-1.65	-1.72	-1.78
720	-0.79	-0.85	-0.91	-0.97	-1.03	-1.09	-1.15	-1.20	-1.24
700	-0.41	-0.45	-0.48	-0.51	-0.54	-0.57	-0.60	-0.63	-0.66
680	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
660	0.39	0.42	0.46	0.49	0.52	0.55	0.59	0.62	0.64
640	0.81	0.88	0.94	1.01	1.08	1.15	1.22	1.28	1.33
620	1.26	1.37	1.47	1.56	1.67	1.78	1.90	1.99	2.06
600	1.74	1.89	2.03	2.16	2.31	2.47	2.62	2.75	2.85
580	2.27	2.46	2.63	2.80	3.00	3.20	3.40	3.57	3.69
560	2.83	3.06	3.28	3.50	3.74	4.00	4.24	4.45	4.60
540	3.43	3.72	3.98	4.25	4.55	4.86	5.15	5.40	5.58
520	4.09	4.43	4.74	5.06	5.42	5.79	6.14	6.43	6.63
500	4.79	5.19	5.56	5.94	6.36	6.80	7.21	7.55	7.77

Table 3 of 3: Speed Adjustment

SPEED (KIAS)	WEIGHT ADJUSTED GO-AROUND GRADIENT (%)								
	1	3	5	7	9	11	13	15	17
VREF30	-0.14	-0.14	-0.15	-0.15	-0.15	-0.16	-0.16	-0.16	-0.14
VREF30+5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VREF30+10	0.04	0.02	0.01	0.00	-0.02	-0.03	-0.03	-0.02	0.00
VREF30+15	0.03	0.00	-0.03	-0.06	-0.09	-0.11	-0.11	-0.10	-0.07
VREF30+20	-0.03	-0.07	-0.12	-0.18	-0.22	-0.25	-0.26	-0.24	-0.19
VREF30+25	-0.12	-0.18	-0.27	-0.36	-0.42	-0.46	-0.47	-0.46	-0.39
VREF30+30	-0.21	-0.32	-0.47	-0.59	-0.67	-0.73	-0.75	-0.74	-0.68

When operating in icing conditions during any part of the flight with forecast landing temperatures at or below 10°C, decrease gradient by 1.0%
With engine bleed for packs off, increase gradient by 0.2%
With engine anti-ice on, decrease gradient by 0.2%

Quick Turnaround Limit Weight

Flaps 30 Limit Weight (1000 LB)

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	698.1					
50	702.7	674.4				
45	708.5	680.0	652.3			
40	714.5	685.8	657.8	630.5		
35	720.7	691.7	663.5	635.9	609.8	
30	727.0	697.7	669.2	641.4	614.9	589.4
25	733.4	703.8	675.2	647.0	620.1	594.5
20	740.1	710.2	681.2	652.9	625.6	599.8
15	746.9	716.7	687.5	658.9	631.3	605.1
10	755.1	723.4	693.9	665.1	637.2	610.6
5	766.1	730.3	700.5	671.5	643.3	616.2
0	773.8	737.3	707.2	678.0	649.6	622.0
-5	781.4	744.6	714.2	684.6	656.0	628.0
-10	789.3	752.3	721.3	691.5	662.6	634.3
-15	797.4	764.8	728.7	698.6	669.4	640.8
-20	805.8	773.1	736.3	705.8	676.4	647.6
-30	823.3	789.9	752.4	721.1	691.0	661.6
-40	842.1	807.8	774.5	737.3	706.5	676.5
-50	862.2	826.9	792.8	756.6	723.1	692.3
-54	870.6	835.0	800.5	767.1	730.1	698.9

**Increase weight by 7300 lb per 1% uphill slope. Decrease weight by 14800 lb per 1% downhill slope.
Increase weight by 17200 lb per 10 knots headwind. Decrease weight by 90200 lb per 10 knots tailwind.
Decrease weight by 55600 lb with two brakes deactivated.**

After landing at weights exceeding those shown above, adjusted for slope and wind, wait at least 49 minutes and check that wheel thermal plugs have not melted before executing a takeoff.

As an alternate procedure, if the BRAKE TEMP advisory message on EICAS is not displayed 10 to 15 minutes after parking, then no waiting period is required.

GEAR DOWN

Takeoff Climb Limit Weight

Flaps 10

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	TAKEOFF CLIMB WEIGHT (1000 LB)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	661.8	630.7	602.7	571.4	524.2	
52	679.4	630.5	602.5	571.2	538.8	
50	697.1	634.0	602.3	570.9	539.9	492.2
48	714.2	650.1	602.0	570.7	539.6	504.8
46	732.1	666.8	605.8	570.5	539.4	504.6
44	750.6	683.2	620.6	570.3	539.2	504.4
42	770.9	699.3	635.5	574.3	539.0	504.1
40	788.1	715.1	650.5	588.4	538.8	503.9
38	806.2	731.4	665.7	602.7	542.7	503.7
36	824.7	749.3	681.4	617.0	556.6	503.5
34	843.4	769.8	697.3	632.0	570.5	507.2
32	862.4	787.4	713.1	646.8	584.6	520.0
30	882.2	805.7	730.1	662.2	599.2	533.2
28	899.9	824.3	748.2	678.1	613.5	546.7
26	917.5	842.8	768.7	694.0	628.0	560.8
24	926.6	859.5	785.2	709.2	642.2	574.0
22	926.8	877.6	803.1	725.5	657.6	588.1
20	927.0	887.3	820.7	743.6	673.2	602.7
18	927.2	887.3	838.4	763.2	689.3	617.5
16	927.4	887.5	847.4	780.6	705.4	632.5
14	927.7	887.8	847.4	796.7	720.6	646.8
12	927.7	888.0	847.4	806.0	737.0	662.0
10	927.7	888.0	847.4	806.0	753.9	677.0
0	927.4	887.3	846.7	805.3	763.2	712.3
-40	920.8	880.5	839.0	797.4	752.6	702.1

With engine bleed for packs off, increase weight by 4800 lb.
With engine anti-ice on, decrease weight by 10300 lb.
With engine and wing anti-ice on, decrease weight by 25600 lb.

GEAR DOWN

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	LANDING CLIMB LIMIT WEIGHT (1000 LB)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	691.5					
52	708.3					
50	724.8	702.8				
48	741.8	719.3				
46	765.8	736.3	709.4			
44	783.5	755.9	724.8			
42	801.1	778.0	740.9	699.0		
40	819.4	795.6	763.8	714.9		
38	839.0	813.4	780.4	731.2	671.3	
36	858.0	831.5	797.4	746.0	684.3	
34	874.7	849.4	814.5	761.9	697.5	627.8
32	888.8	865.3	831.3	776.0	710.1	638.6
30	903.4	879.6	844.3	790.3	721.7	649.6
28	903.8	892.6	856.9	805.1	733.4	660.2
26	904.3	904.9	869.2	824.0	745.1	670.4
24	904.7	905.4	880.9	834.2	758.1	680.5
22	905.4	905.8	891.9	843.7	778.2	690.0
20	905.8	906.0	892.2	852.5	787.9	699.5
18	906.3	906.5	892.6	860.8	796.3	709.6
16	906.7	906.9	892.8	860.8	803.7	718.9
14	907.1	907.1	893.0	861.1	810.4	727.0
12	907.4	907.6	893.3	861.3	810.6	734.3
10	907.6	907.8	893.5	861.3	810.6	741.1
-40	909.3	909.6	899.4	863.9	812.6	743.6

With engine bleed for packs off, increase weight by 8300 lb.
With engine anti-ice on, decrease weight by 10000 lb.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10°C, decrease weight by 88800 lb.

GEAR DOWN

Takeoff Obstacle Limit Weight

Based on engine bleed for packs on and anti-ice off

Flaps 10

Table 1 of 4: Sea Level, 30°C & Below, Zero Wind

OBSTACLE HEIGHT (FT)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 LB)								
	DISTANCE FROM BRAKE RELEASE (1000 FT)								
	8	10	12	14	16	18	20	22	24
10	792.1	880.1							
50	766.6	851.2							
100	739.1	819.3	886.3						
150	715.6	791.7	857.7						
200	693.7	767.3	831.7	885.2					
250	672.4	745.8	808.1	861.5					
300	652.7	726.1	786.8	839.7	884.0				
350	627.7	708.7	767.3	819.4	863.9				
400	605.1	691.5	749.5	800.6	845.1	882.9			
450	584.4	674.8	733.0	783.0	827.3	865.3			
500	565.6	659.1	718.0	766.8	810.6	848.9	881.7		
550	548.4	641.9	703.8	751.7	794.9	833.1	866.2		
600	532.7	624.0	689.5	737.5	780.0	818.1	851.5	880.5	
650	518.1	607.3	675.7	724.1	766.1	803.8	837.3	866.6	892.1
700	504.5	591.6	662.7	711.9	753.0	790.3	823.8	853.3	879.4
750	491.8	576.8	649.6	699.8	740.5	777.4	810.8	840.5	866.7
800	480.0	562.8	635.0	687.6	728.6	765.2	798.4	828.2	854.6
850		549.8	621.1	675.9	717.6	753.6	786.5	816.3	842.9
900		537.5	607.9	664.7	707.0	742.5	775.0	804.8	831.6
950		525.9	595.1	653.8	696.4	731.8	764.2	793.8	820.6
1000		514.9	583.0	641.9	685.8	721.7	753.8	783.1	809.9

Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.

Table 2 of 4: OAT Adjustment

OAT (°C)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 LB)									
	500	550	600	650	700	750	800	850	900	950
30 & Below	0	0	0	0	0	0	0	0	0	0
32	-8.3	-9.3	-10.4	-11.4	-12.5	-13.6	-14.6	-15.7	-16.8	-17.8
34	-16.5	-18.6	-20.8	-22.9	-25.0	-27.1	-29.3	-31.4	-33.5	-35.6
36	-24.8	-28.0	-31.1	-34.3	-37.5	-40.7	-43.9	-47.1	-50.3	-53.5
38	-33.0	-37.3	-41.5	-45.8	-50.0	-54.3	-58.5	-62.8	-67.0	-71.3
40	-41.3	-46.6	-51.9	-57.2	-62.5	-67.8	-73.2	-78.5	-83.8	-89.1
42	-49.5	-55.8	-62.1	-68.4	-74.8	-81.1	-87.4	-93.7	-100.0	-106.3
44	-57.7	-65.1	-72.4	-79.7	-87.0	-94.3	-101.6	-108.9	-116.2	-123.6
46	-66.0	-74.3	-82.6	-90.9	-99.2	-107.5	-115.9	-124.2	-132.5	-140.8
48	-74.2	-83.5	-92.8	-102.2	-111.5	-120.8	-130.1	-139.4	-148.7	-158.0
50	-82.5	-92.8	-103.1	-113.4	-123.7	-134.0	-144.3	-154.6	-165.0	-175.3

GEAR DOWN

Takeoff Obstacle Limit Weight

Based on engine bleed for packs on and anti-ice off

Flaps 10

Table 3 of 4: Pressure Altitude Adjustment

ALT (FT)	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 LB)									
	500	550	600	650	700	750	800	850	900	950
S.L. & Below	0	0	0	0	0	0	0	0	0	0
1000	-18.3	-21.0	-23.6	-26.3	-28.9	-31.6	-34.2	-36.9	-39.6	-42.2
2000	-36.6	-42.0	-47.3	-52.6	-57.9	-63.2	-68.5	-73.8	-79.1	-84.4
3000	-55.9	-62.4	-69.0	-75.6	-82.1	-88.7	-95.2	-101.8	-108.4	-114.9
4000	-75.1	-82.9	-90.7	-98.5	-106.3	-114.2	-122.0	-129.8	-137.6	-145.4
5000	-89.3	-99.0	-108.6	-118.2	-127.8	-137.4	-147.1	-156.7	-166.3	-175.9
6000	-103.6	-115.0	-126.4	-137.9	-149.3	-160.7	-172.1	-183.6	-195.0	-206.4
7000	-122.7	-135.3	-147.9	-160.5	-173.1	-185.7	-198.3	-210.9	-223.5	-236.0
8000	-141.9	-155.7	-169.4	-183.2	-196.9	-210.7	-224.4	-238.2	-251.9	-265.7
9000	-158.1	-173.4	-188.7	-204.0	-219.3	-234.6	-250.0	-265.3	-280.6	-295.9
10000	-174.3	-191.1	-208.0	-224.9	-241.8	-258.6	-275.5	-292.4	-309.3	-326.1

Table 4 of 4: Wind Adjustment

WIND (KTS)	OAT & ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 LB)									
	500	550	600	650	700	750	800	850	900	950
15 TW	-89.2	-88.5	-87.8	-87.1	-86.4	-85.7	-84.9	-84.2	-83.5	-82.8
10 TW	-59.5	-59.0	-58.5	-58.1	-57.6	-57.1	-56.6	-56.2	-55.7	-55.2
5 TW	-29.7	-29.5	-29.3	-29.0	-28.8	-28.6	-28.3	-28.1	-27.8	-27.6
0	0	0	0	0	0	0	0	0	0	0
10 HW	12.9	12.0	11.1	10.1	9.2	8.3	7.3	6.4	5.4	4.5
20 HW	25.9	24.0	22.1	20.3	18.4	16.5	14.6	12.8	10.9	9.0
30 HW	40.1	37.9	35.8	33.6	31.4	29.2	27.0	24.8	22.6	20.4
40 HW	54.4	51.9	49.4	46.9	44.4	41.9	39.4	36.9	34.4	31.9

With engine bleed for packs off, increase weight by 3400 lb.
With engine anti-ice on, decrease weight by 10000 lb.

GEAR DOWN

Long Range Cruise Altitude Capability

Max Climb Thrust, 100 ft/min residual rate of climb

WEIGHT (1000 LB)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
1000	20600	19300	17600
950	21800	20500	19000
900	22900	21600	20100
850	24900	23500	21900
800	26800	25500	23900
750	28300	27300	25900
700	30100	29600	28100
650	31600	31400	30200
600	33000	32900	31900
550	34500	34500	33500
500	36100	36100	35100
450	37800	37800	36700

GEAR DOWN

Long Range Cruise Trip Fuel and Time

Table 1 of 3: 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
632	569	514	470	433	400	375	352	332	315	300
945	851	770	704	648	600	563	530	500	473	450
1255	1132	1025	937	864	800	752	707	668	632	601
1564	1411	1279	1170	1080	1000	940	885	835	791	753
1870	1689	1532	1403	1295	1200	1128	1062	1003	951	905
2174	1966	1784	1635	1510	1400	1316	1240	1172	1111	1057
2477	2241	2035	1867	1725	1600	1505	1418	1340	1271	1210
2778	2515	2286	2098	1940	1800	1693	1596	1509	1431	1363
3077	2788	2536	2329	2154	2000	1882	1775	1678	1592	1517
3374	3060	2786	2560	2369	2200	2071	1954	1848	1754	1671
3670	3331	3034	2790	2583	2400	2260	2133	2018	1916	1826
3964	3600	3282	3019	2797	2600	2449	2312	2188	2078	1981
4258	3870	3530	3249	3011	2800	2638	2491	2358	2240	2136
4553	4140	3778	3479	3225	3000	2828	2671	2529	2403	2291
4847	4410	4026	3709	3439	3200	3017	2850	2700	2565	2447
5142	4680	4274	3938	3653	3400	3207	3030	2871	2729	2603
5435	4949	4522	4168	3867	3600	3396	3210	3042	2892	2759
5727	5217	4769	4397	4081	3800	3586	3390	3213	3055	2915
6018	5484	5016	4626	4295	4000	3775	3569	3384	3217	3071

Table 2 of 3: Reference Fuel and Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		25	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
400	42.8	1:33	40.7	1:30	39.1	1:26	37.9	1:23	37.1	1:20
600	63.5	2:16	60.2	2:11	57.5	2:05	55.4	1:59	54.0	1:55
800	84.2	2:59	79.7	2:52	75.8	2:44	72.9	2:36	70.9	2:30
1000	105.6	3:41	99.9	3:32	94.8	3:22	91.0	3:12	88.5	3:05
1200	127.0	4:23	120.1	4:12	113.8	4:01	109.2	3:48	106.0	3:39
1400	149.3	5:04	141.1	4:51	133.5	4:38	128.1	4:23	124.3	4:13
1600	171.6	5:45	162.2	5:31	153.3	5:15	147.0	4:58	142.5	4:47
1800	194.6	6:25	183.8	6:09	173.7	5:51	166.5	5:33	161.5	5:20
2000	217.6	7:05	205.5	6:47	194.2	6:28	186.1	6:07	180.4	5:53
2200	241.6	7:45	228.0	7:25	215.3	7:03	206.4	6:41		
2400	265.5	8:24	250.5	8:02	236.5	7:39	226.6	7:15		
2600	290.4	9:02	274.0	8:39	258.6	8:14	247.7	7:48		
2800	315.2	9:41	297.4	9:15	280.7	8:48	268.9	8:21		
3000	340.9	10:20	321.7	9:52	303.7	9:23				
3200	366.6	10:58	345.9	10:28	326.6	9:57				
3400	393.3	11:37	371.1	11:05	350.3	10:31				
3600	419.9	12:16	396.2	11:41	374.0	11:06				
3800	447.8	12:54	422.4	12:17	398.7	11:40				
4000	475.7	13:33	448.5	12:54	423.3	12:14				

GEAR DOWN

Long Range Cruise Trip Fuel and Time

Table 3 of 3: Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	LANDING WEIGHT (1000 LB)								
	460	500	540	580	620	660	700	740	780
50	-6.3	-5.2	-3.4	-1.7	0.0	2.0	4.0	6.3	8.5
100	-13.2	-10.4	-6.9	-3.5	0.0	4.1	8.3	12.7	17.1
150	-20.1	-15.7	-10.5	-5.3	0.0	6.2	12.6	19.1	25.7
200	-27.2	-21.1	-14.1	-7.1	0.0	8.3	16.9	25.6	34.4
250	-34.4	-26.5	-17.8	-8.9	0.0	10.5	21.2	32.1	43.3
300	-41.6	-32.0	-21.5	-10.8	0.0	12.6	25.5	38.7	52.2
350	-49.0	-37.6	-25.2	-12.7	0.0	14.8	29.9	45.4	61.1
400	-56.4	-43.2	-29.0	-14.6	0.0	17.0	34.2	52.1	70.2
450	-64.0	-48.9	-32.8	-16.6	0.0	19.2	38.6	58.9	79.4
500	-71.6	-54.7	-36.7	-18.6	0.0	21.4	42.9	65.8	88.6

Based on climb at Flaps Up Maneuver Speed, Long Range Cruise and descent at Flaps Up Maneuver Speed.

GEAR DOWN

Short Trip Fuel and Time

Table 1 of 2: Ground to Air Miles Conversion

AIR DISTANCE (NM) HEAD WIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAIL WIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
113	90	75	64	56	50	45	41	37	35	32
179	154	136	121	110	100	92	85	79	74	69
248	219	197	178	163	150	139	130	121	114	107
317	284	257	235	216	200	186	174	164	154	146
385	347	317	291	269	250	234	219	207	195	185
453	411	376	347	322	300	281	264	250	236	224
520	474	436	403	375	350	328	309	293	277	264
588	538	495	459	427	400	376	355	336	318	303
657	602	555	515	480	450	423	400	378	359	342
727	667	615	571	533	500	471	444	421	400	381

Table 2 of 2: Trip Fuel and Time

AIR DISTANCE (NM)		LANDING WEIGHT (1000 LB)									TIME (HRS:MIN)
		460	500	540	580	620	660	700	740	780	
50	FUEL(1000LB)	6.6	6.8	7.1	7.4	7.7	8.0	8.3	8.7	9.2	0:16
	ALT(FT)	5000	9000	9000	9000	9000	9000	9000	9000	7000	
100	FUEL(1000LB)	10.5	10.9	11.4	11.9	12.4	12.9	13.4	14.0	14.7	0:26
	ALT(FT)	21000	21000	19000	19000	19000	19000	17000	17000	17000	
150	FUEL(1000LB)	13.8	14.5	15.2	15.9	16.6	17.3	18.0	18.9	19.8	0:35
	ALT(FT)	29000	29000	27000	27000	25000	23000	23000	21000	21000	
200	FUEL(1000LB)	16.9	17.8	18.7	19.6	20.6	21.5	22.5	23.6	24.7	0:43
	ALT(FT)	31000	31000	31000	29000	29000	27000	27000	25000	25000	
250	FUEL(1000LB)	20.0	21.1	22.1	23.3	24.5	25.6	26.8	28.3	29.6	0:52
	ALT(FT)	33000	33000	31000	31000	29000	29000	27000	27000	25000	
300	FUEL(1000LB)	23.0	24.3	25.6	26.9	28.3	29.8	31.2	33.0	34.4	1:00
	ALT(FT)	35000	33000	31000	31000	31000	29000	27000	25000	25000	
350	FUEL(1000LB)	26.0	27.5	29.1	30.6	32.2	33.9	35.6	37.7	39.3	1:08
	ALT(FT)	35000	33000	33000	31000	31000	29000	27000	25000	25000	
400	FUEL(1000LB)	29.1	30.8	32.5	34.3	36.1	38.1	40.1	42.4	44.5	1:16
	ALT(FT)	35000	33000	33000	31000	31000	29000	27000	25000	23000	
450	FUEL(1000LB)	32.1	34.1	36.0	38.0	40.3	42.3	44.5	47.2	49.6	1:24
	ALT(FT)	35000	33000	33000	31000	29000	29000	27000	25000	23000	
500	FUEL(1000LB)	35.2	37.4	39.5	41.7	44.3	46.5	49.0	52.0	54.6	1:33
	ALT(FT)	35000	33000	33000	31000	29000	29000	27000	25000	23000	

GEAR DOWN

Holding Planning
Flaps Up

WEIGHT (1000 LB)	TOTAL FUEL FLOW (LB/HR)						
	PRESSURE ALTITUDE (FT)						
	1500	5000	10000	15000	20000	25000	30000
1000	41590	41980	42790	43790			
950	39410	39390	40150	41360	43230		
900	37470	37220	37720	38510	40930		
850	35500	35250	35510	36160	37740		
800	33530	33360	33320	33950	35030	36700	
750	31750	31590	31400	32010	33130	34540	
700	29950	29750	29530	29930	30440	31430	
650	28150	27870	27680	27860	28310	29140	30100
600	26350	26030	25860	25860	26260	26910	27520
550	24590	24240	24050	23960	24320	24760	25200
500	22850	22470	22830	22660	22810	23110	23030
450	21980	21540	21270	21030	20970	21210	21000

Includes 5% additional fuel for holding in a racetrack pattern.

GEAR DOWN
ENGINE INOP
MAX CONTINUOUS THRUST

Net Level Off Weight

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 LB)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
28	446.2	442.2	425.3
26	486.6	475.1	457.0
24	525.4	509.0	488.5
22	561.3	542.8	520.3
20	599.4	578.1	554.5
18	637.1	613.8	588.4
16	675.7	649.9	621.9
14	715.6	687.8	657.6
12	759.5	728.6	696.7
10	804.9	771.0	736.3
8	842.6	806.2	769.0
6	879.4	841.7	802.7
4	915.8	876.6	836.7
2	951.1	911.8	869.9
0	1020.1	947.8	904.3

Anti-Ice Adjustment

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 LB)												
	PRESSURE ALTITUDE (1000 FT)												
	2	4	6	8	10	12	14	16	18	20	22	24	26
ENGINE ONLY	-6.6	-5.9	-6.1	-6.5	-6.5	-6.3	-6.0	-6.1	-6.2	-6.1	-5.8	-5.2	-4.9
ENGINE AND WING	-19.5	-17.6	-16.8	-17.3	-16.8	-16.1	-15.5	-15.1	-15.0	-14.4	-14.3	-13.2	-12.5

Performance Dispatch — Chapter PD

Text — Section 24

Introduction

This chapter contains self dispatch performance data intended primarily for use by flight crews in the event that information cannot be obtained from the airline dispatch office. Data are provided for a single takeoff flap and max takeoff thrust. The range of conditions covered is limited to those normally encountered in airline operation. In the event of conflict between data presented in this chapter and that contained in the Airplane Flight Manual (AFM), the AFM takes precedence.

Takeoff

The maximum allowable takeoff weight is the least of the Field, Climb, Obstacle, Brake Energy, and Tire Speed Limit Weights as determined from the following tables.

Field Limit Weight - Slope and Wind Corrections

Tables for dry and wet runways provide corrections to the field length available for the effects of runway slope and wind component along the runway. Enter the Slope Correction table (Table 1) with available field length and runway slope to determine the slope corrected field length. Next, enter the Wind Correction table (Table 2) with slope corrected field length and wind component to determine slope and wind corrected field length.

Field and Climb Limit Weight

Tables are presented for selected airport pressure altitudes and runway condition and show both Field and Climb Limit Weights. Enter the appropriate table (Table 3) for pressure altitude and runway condition with "Slope and Wind Corrected Field Length" determined above and airport OAT to obtain Field Limit Weight. Also read Climb Limit Weight for the same OAT. Field and Climb limit weights at intermediate altitudes can be determined by interpolation or by use of next higher altitude.

When finding a maximum weight for a wet runway, the dry runway limit weight must also be determined and the lower of the two weights used.

Obstacle Limit Weight

Table 1 provides obstacle limit weights for reference airport conditions based on obstacle height above the runway surface and distance from brake release. Enter the correction tables to correct the reference Obstacle Limit Weight for the effects of OAT (Table 2), pressure altitude (Table 3) and wind (Table 4) as indicated. In the case of multiple obstacles, enter the tables successively with each obstacle and determine the most limiting weight.

Tire Speed Limit

Maximum tire speed limited weights are presented for 235 MPH tires. To determine the tire speed limit weight, enter the table with OAT and airport pressure altitude. Adjust the tire speed limit weight according to the notes below the table to account for wind.

Brake Energy Limit VMBE

The Maximum Brake Energy Speed table (Table 1) provides the Reference VMBE for a variety of airport pressure altitudes and temperatures. Enter the Weight Adjusted VMBE table (Table 2) to adjust the Reference VMBE for actual brake release gross weight. Correct VMBE for slope and wind. If V1 exceeds VMBE, decrease brake release weight as indicated for each knot that V1 exceeds VMBE and determine V1, VR, and V2 for the lower brake release weight.

Brakes Deactivated

When operating with one or two brakes deactivated, the field/obstacle and brake energy limit weights and the V1 and VMBE speeds must be adjusted to account for reduced braking capability. A simplified method which conservatively accounts for the reduced braking capability is to adjust the normal field length/obstacle limited weight by the amount shown in the table below. Then adjust the V1 associated with the reduced weight by the amount shown in the table below. Note: Wet runway analysis is based on the more critical of all engine or engine inoperative stop distance. The all engine stop distance takes credit for four thrust reversers and the engine inoperative stop distance takes credit for two symmetric thrust reversers.

2 BRAKES DEACTIVATED ADJUSTMENTS				
FIELD LENGTH (FT)	DRY RUNWAY		WET RUNWAY*	
	WEIGHT (1000 LB)	V1 (KTS)	WEIGHT (1000 LB)	V1 (KTS)
6000	-5	-4		
8000	-6	-4	-6	-3
10000	-9	-4	-9	-3
12000	-9	-4	-9	-3
14000	-4	-3	-8	-3
16000	-4	-3	-8	-3

*** Based on the more critical thrust reverser condition.**

If the resulting V1 is less than V1MCG, takeoff is permitted with V1 set equal to VIMCG provided the accelerate stop distance corrected for wind and slope exceeds approximately 7100 ft for dry runways and 9700 ft for wet runways.

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Thrust Reverser Inoperative

Wet runway V1 speeds with anti-skid and all wheel brakes operating are based on two engine reverse thrust. A simplified method which conservatively accounts for the reduced stopping capability is to reduce the normal field length/obstacle limited weight by the amount shown in the table below; then reduce the V1 associated with the reduced weight by the amount shown.

If the resulting V1 is less than V1MCG, takeoff is permitted with V1 set equal to V1MCG provided the accelerate stop distance available exceeds approximately 10400 ft.

NO REVERSERS ADJUSTMENTS*		
FIELD LENGTH (FT)	WEIGHT (1000 LB)	V1 (KTS)
10000	-2	-7
12000	-2	-7
14000	-2	-7
16000	-2	-6

*** Based on wet runway with all brakes activated.**

Enroute

Long Range Cruise Maximum Operating Altitude

These tables provide maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. This table considers both thrust and buffet limits, providing the more limiting of the two. Data that are thrust limited are denoted by an asterisk and represents only a thrust limited condition in level flight with 300 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude. The maximum altitude shown in the table is limited by the maximum certified altitude of 43100 ft.

Long Range Cruise Trip Fuel and Time

These tables are provided to determine trip fuel and time required to destination. Data are based on economy climb and descent speeds, and Long Range Cruise. Tables are presented for low altitudes for shorter trip distances and high altitudes for longer trip distances.

To determine trip fuel and time for a constant altitude cruise, first enter the Ground to Air Miles Conversion table (Table 1) to convert ground distance and enroute wind to an equivalent still-air distance. Next, enter the Reference Fuel and Time table (Table 2) 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 (Table 3) with the reference fuel and the planned landing weight to obtain fuel required at the planned landing weight.

Long Range Cruise Step Climb Trip Fuel and Time

These tables are provided to determine trip fuel and time required to destination when flying a step climb profile. Step climb profiles are based on 4000 ft step climbs to keep the flight within 2000 ft of the optimum altitude for the current cruise weight. To determine trip fuel and time, enter the Ground to Air Miles Conversion table (Table 1) and determine air distance as discussed above. Then enter the Trip Fuel and Time Required table (Table 2) with air distance and planned landing weight to read trip fuel. Continue across the table to read trip time.

Short Trip Fuel and Time

Short Trip Fuel and Time charts include fuel and time for climb to cruise altitude, cruise, descent and straight in approach. The chart is based on the altitude that yields minimum fuel for trip distances up to 500 nm. For distances greater than 500 nm, or other altitudes, use the Trip Fuel and Time charts.

To determine fuel and time, enter the Ground to Air Miles Conversion table (Table 1) with ground distance; adjust for wind and determine air distance. Enter the Trip Fuel and Time table (Table 2) with this air distance and the planned landing weight and read fuel required, cruise altitude, and time required.

Decompression Diversion Planning

Regulations for enroute fuel supply include a provision that states airplanes with more than two engines, when flying more than 90 minutes from an airport, shall carry sufficient fuel to safely reach an adequate airport in the event of decompression and diversion at low altitude, where fuel consumption is increased. Information in this section is intended to assist the operator with this planning.

Data are based on a descent profile consisting of an all-engine emergency descent to 10000 ft, level cruise at LRC, 250 KIAS descent to 1500 ft, 15-minute hold, approach and land. To use the table, enter the Ground to Air Miles Conversion table (Table 1) with ground distance (diversion distance), adjust for wind and determine air distance. With this air distance and the weight at the critical point, enter the Critical Fuel table (Table 2) and determine critical fuel. Adjust this value for wind and temperature per the notes below the table.

Holding Planning

These tables provide total fuel flow information necessary for planning Flaps Up and Flaps 1 holding and reserve fuel requirements. Data are based on the FMC holding speed schedule which is the higher of the maximum endurance and flaps up maneuver speeds. As noted, the fuel flow is based on flight in a racetrack holding pattern. For holding in straight and level flight, reduce table values by 5%.

Crew Oxygen Requirements

Tables are provided to determine the minimum dispatch crew oxygen pressure required. Table 1 shows minimum oxygen quantity necessary to ensure that protective breathing requirements are satisfied. The protective breathing requirement guarantees that a fixed amount of oxygen will be available to each crew member to use for situations such as cabin smoke or harmful gases.

The sustenance requirement (Table 2) is the crew member oxygen required for loss of pressurization, emergency descent and total post-decompression flight time above 8000 ft.

Table 3 gives adjustments that must be applied to Table 2 crew member sustenance requirements for situations where the enroute altitude after decompression will exceed 14000 ft. The increments shown in Table 3 reflect only the increase in oxygen flow rate associated with periods of post-decompression flight at altitudes other than 14000 ft. Hence, this time must also be included in the Table 2 time value used.

Table 1, Table 2 and Table 3 values are based on "NORMAL" regulator settings. Table 3 also shows "100%" regulator setting adjustments that can be used if the operator chooses to schedule oxygen dispatch requirements based on pure oxygen availability. To protect the oxygen supply for emergency purposes, an allowance equivalent to one crew member for 15 minutes at 8000 ft cabin altitude has been included in the protective breathing (Table 1) and sustenance (Table 2) oxygen values. Additional adjustments for more extensive normal crew usage and mask checks can be made by adding 2 liters/per person/minute.

After determining the total volume (liters) required for the flight crew by using the larger value from Table 1 or 2, isolate the crew system cylinder configuration on the Liters to Pressure Conversion table (Table 4) and read dispatch pressure required. Adjust this reading for ambient temperature as required, using the adjustments given (Table 5).

Net Level Off Weight

The Net Level Off Weight table is provided to determine terrain clearance capability based on the Airplane Flight Manual two engines inoperative enroute climb speed. Regulations require terrain clearance planning based on net performance, which is the gross (or actual) gradient performance degraded by 0.5%. In addition, the net level off pressure altitude must clear terrain by 1000 ft.

To determine maximum weight for terrain clearance, enter the table with required net level off pressure altitude and expected ISA deviation to obtain weight. Adjust weight for anti-ice operation as noted below the table.

Landing

Tables are provided for determining maximum landing weight as limited by field length or climb requirements for Flaps 30.

Maximum landing weight is the lowest of field length limit weight, climb limit weight, or maximum certified landing weight.

Landing Field Limit Weight

Obtain wind corrected field length by entering the Wind Corrected Field Length table (Table 1) with field length available and wind component along the runway. Next, enter the Field Limit Weight table (Table 2) with wind corrected field length and pressure altitude to read field limit weight for the expected runway condition.

Landing Climb Limit Weight

Enter the Landing Climb Limit Weight table with airport OAT and pressure altitude and read landing climb limit weight. Apply the noted adjustments as required.

Go-Around Climb Gradient

Enter the Reference Go-around Gradient table (Table 1) with airport OAT and pressure altitude to determine the reference Go-Around Gradient. Next, adjust the reference gradient for airplane weight (Table 2) and speed (Table 3) using the tables provided to determine the weight and speed adjusted Go-Around Gradient. Apply the necessary corrections for A/C and icing conditions as noted.

Quick Turnaround Limit Weight

Enter the Quick Turnaround Limit Weight table with airport pressure altitude and OAT and read maximum quick turnaround weight. Apply the noted adjustments as required.

If the landing weight exceeds the maximum quick turnaround weight, wait the specified time and then check that the wheel thermal plugs have not melted before executing a subsequent takeoff, or ensure the brake temperature is within limits using the alternate procedure described on the page.

Gear Down

This section provides flight planning data for revenue operation with gear down.

Takeoff Climb Limit Weight

Enter the Takeoff Climb Limit Weight table with airport OAT and pressure altitude and determine Takeoff Climb Limit Weight with gear down. Correct for engine bleed configuration as required.

The remaining gear down tables in this section are identical in format and usage to the corresponding gear up tables previously described.

Performance Inflight Chapter PI

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747-8 GENX-2B67 KG M EASA TO1-10% TO2-20%

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Performance Inflight — Chapter PI

Pkg Model Identification — Section 10

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
806	Intercontinental

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Performance Inflight — Chapter PI
General — Section 10

Minimum Takeoff Weight
Maximum Takeoff Thrust

Based on engine bleed for packs on and anti-ice off

Flaps 10

Weight Limit (1000 KG)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
45	185.0	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
40	195.5	188.1	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
35	205.7	197.9	190.5	183.0	182.3	182.3	182.3	182.3	182.3	182.3	182.3
30	213.3	205.5	197.9	190.5	183.4	182.3	182.3	182.3	182.3	182.3	182.3
25	213.5	208.4	203.5	197.3	189.9	182.5	182.3	182.3	182.3	182.3	182.3
20	213.7	208.6	203.7	198.6	193.6	189.0	182.3	182.3	182.3	182.3	182.3
15	213.9	208.8	203.8	198.7	193.7	189.0	184.1	182.3	182.3	182.3	182.3
10	214.0	208.8	203.9	198.8	193.8	189.0	184.1	182.3	182.3	182.3	182.3
0 & BELOW	214.1	208.9	203.9	198.8	193.8	189.0	184.1	182.3	182.3	182.3	182.3

Flaps 20

Weight Limit (1000 KG)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	196.2	188.6	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
45	207.7	199.7	191.9	184.7	182.3	182.3	182.3	182.3	182.3	182.3	182.3
40	219.4	211.1	202.9	195.0	187.7	182.3	182.3	182.3	182.3	182.3	182.3
35	230.9	222.2	213.8	205.4	196.9	189.3	182.3	182.3	182.3	182.3	182.3
30	239.3	230.6	222.1	213.8	205.9	197.7	189.8	182.5	182.3	182.3	182.3
25	239.6	233.9	228.4	221.4	213.1	204.8	199.0	190.8	182.3	182.3	182.3
20	239.8	234.1	228.6	222.9	217.3	212.0	204.6	197.4	188.7	182.3	182.3
15	240.1	234.3	228.7	223.0	217.4	212.1	206.6	201.5	193.3	184.6	182.3
10	240.1	234.4	228.8	223.1	217.4	212.1	206.6	201.5	194.1	186.9	182.3
0 & BELOW	240.3	234.4	228.9	223.1	217.5	212.1	206.6	201.4	194.0	186.9	182.3

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability. For weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

Takeoff Speeds - Dry Runway
Max Takeoff Thrust
Flaps 10
Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 10		
	V1	VR	V2
460	168	184	197
440	164	180	194
420	160	175	190
400	156	170	186
380	151	165	182
360	146	159	178
340	141	154	173
320	136	148	168
300	129	142	163
280	123	136	158
260	116	128	152
240	109	122	146
220	101	115	141
200	92	107	134

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	16	17						8	8						-2	-3					
60	12	12	15	17				6	6	8	9				-2	-2	-2	-3			
50	7	8	11	13	15	18	21	4	4	6	7	8	9	12	-1	-1	-2	-2	-2	-3	-3
40	3	4	7	9	12	14	18	2	2	4	5	7	8	9	-1	-1	-1	-1	-2	-2	-3
35	1	1	3	7	10	13	15	1	1	3	4	6	7	9	0	0	-1	-1	-1	-2	-2
30	0	0	3	6	8	11	14	0	0	2	4	5	7	8	0	0	0	-1	-1	-2	-2
20	0	0	1	3	5	8	12	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-2
10	0	0	2	4	5	8	10	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-40	0	0	3	5	7	9	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-60	1	1	4	6	7	10	12	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
460	-6	-3	0	3	6	-4	-3	-1	0	1	2	3	4
440	-6	-3	0	3	5	-4	-3	-1	0	1	2	3	3
420	-5	-2	0	3	5	-4	-3	-1	0	1	2	3	3
400	-5	-2	0	2	5	-4	-3	-1	0	1	2	2	3
380	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
360	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
340	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
320	-3	-2	0	2	3	-4	-2	-1	0	1	2	2	3
300	-3	-2	0	2	3	-4	-2	-1	0	1	2	2	3
280	-3	-1	0	2	3	-3	-2	-1	0	1	2	2	3
260	-3	-1	0	2	3	-3	-2	-1	0	1	2	2	3
240	-3	-1	0	1	3	-3	-2	-1	0	1	2	2	3
220	-2	-1	0	1	3	-3	-2	-1	0	1	2	2	3
200	-2	-1	0	1	2	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

Takeoff Speeds - Dry Runway

Max Takeoff Thrust

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	122	126	121	124										
50	126	129	124	127	119	123	116	120	114	118				
40	133	136	132	135	126	129	121	125	116	120	111	116	108	112
30	138	141	138	140	132	135	127	130	121	125	116	120	110	114
20	138	141	138	141	134	137	130	134	126	130	121	125	114	118
0	139	141	138	141	135	137	131	134	127	130	123	127	118	122
-60	140	141	139	140	135	137	131	134	128	131	123	127	119	122

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)							
	110	115	120	125	130	135	140	145
320	166	167	167	167	167	168	168	168
300	160	160	161	161	161	161	162	165
280	155	155	155	156	156	156	160	165
260	148	149	149	150	150	154	159	164
240	142	143	143	144	148	153	158	163
220	136	137	138	143	147	152	156	161
200	127	132	137	141	146	151	155	160

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 20		
	V1	VR	V2
460	157	170	182
440	153	166	179
420	149	162	175
400	145	157	172
380	141	152	168
360	136	147	164
340	131	142	160
320	125	137	155
300	119	131	151
280	114	125	146
260	107	118	140
240	99	112	135
220	92	106	130
200	84	98	124

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Takeoff Speeds - Dry Runway

Max Takeoff Thrust

Flaps 20

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	16	17						8	8						-2	-3					
60	12	12	15	17				6	6	8	9				-2	-2	-2	-3			
50	7	8	11	13	15	18	21	4	4	6	7	8	9	12	-1	-1	-2	-2	-2	-3	-3
40	3	4	7	9	12	14	18	2	2	4	5	7	8	9	-1	-1	-1	-1	-2	-2	-3
35	1	1	3	7	10	13	15	1	1	3	4	6	7	9	0	0	-1	-1	-1	-2	-2
30	0	0	3	6	8	11	14	0	0	2	4	5	7	8	0	0	0	-1	-1	-2	-2
20	0	0	1	3	5	8	12	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-2
10	0	0	2	4	5	8	10	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-40	0	0	3	5	7	9	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-60	1	1	4	6	7	10	12	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
460	-6	-3	0	3	6	-4	-3	-1	0	1	2	3	4
440	-6	-3	0	3	5	-4	-3	-1	0	1	2	3	3
420	-5	-2	0	3	5	-4	-3	-1	0	1	2	3	3
400	-5	-2	0	2	5	-4	-3	-1	0	1	2	2	3
380	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
360	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
340	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
320	-3	-2	0	2	3	-4	-2	-1	0	1	2	2	3
300	-3	-2	0	2	3	-4	-2	-1	0	1	2	2	3
280	-3	-1	0	2	3	-3	-2	-1	0	1	2	2	3
260	-3	-1	0	2	3	-3	-2	-1	0	1	2	2	3
240	-3	-1	0	1	3	-3	-2	-1	0	1	2	2	3
220	-2	-1	0	1	3	-3	-2	-1	0	1	2	2	3
200	-2	-1	0	1	2	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), and Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	122	126	121	124										
50	126	129	124	127	119	123	116	120	114	118				
40	133	136	132	135	126	129	121	125	116	120	111	116	108	112
30	138	141	138	140	132	135	127	130	121	125	116	120	110	114
20	138	141	138	141	134	137	130	134	126	130	121	125	114	118
0	139	141	138	141	135	137	131	134	127	130	123	127	118	122
-60	140	141	139	140	135	137	131	134	128	131	123	127	119	122

Takeoff Speeds - Dry Runway
Max Takeoff Thrust
Flaps 20
Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)							
	110	115	120	125	130	135	140	145
360	162	163	163	163	163	164	164	164
340	157	157	157	158	158	158	159	162
320	152	152	153	153	153	154	157	161
300	147	148	148	148	149	151	156	161
280	142	143	143	144	146	150	155	160
260	137	137	137	140	144	149	154	159
240	131	132	134	139	144	149	153	158
220	124	128	133	138	143	147	152	157
200	123	128	132	137	142	146	151	156

Takeoff Speeds - Wet Runway

Max Takeoff Thrust

Flaps 10

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 10		
	V1	VR	V2
460	156	184	197
440	151	180	194
420	146	175	190
400	141	170	186
380	135	165	182
360	130	159	178
340	124	154	173
320	118	148	168
300	111	142	163
280	105	136	158
260	97	128	152
240	90	122	146
220	83	115	141
200	75	107	134

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	19	19						8	8						-2	-3					
60	14	15	17	19				6	6	8	9				-2	-2	-2	-3			
50	8	9	13	15	18	20	23	4	4	6	7	9	10	11	-1	-1	-2	-2	-2	-3	-3
40	3	4	7	10	13	15	20	2	2	4	5	7	8	10	-1	-1	-1	-1	-2	-2	-3
30	0	0	3	5	8	12	15	0	0	2	4	5	6	8	0	0	0	-1	-1	-2	-2
20	0	0	2	4	6	9	13	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-2
10	0	0	2	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
0	1	1	3	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-20	2	2	4	5	7	9	12	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-60	4	4	6	7	9	11	14	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
460	-6	-2	0	5	8	-5	-3	-1	0	2	4	5	6
440	-6	-2	0	5	8	-5	-3	-1	0	2	4	5	6
420	-6	-2	0	4	8	-6	-3	-1	0	2	4	5	7
400	-6	-2	0	4	7	-6	-4	-1	0	2	4	5	7
380	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
360	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
340	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
320	-4	-2	0	4	6	-7	-4	-1	0	2	4	6	7
300	-4	-1	0	4	6	-7	-4	-1	0	2	4	6	7
280	-4	-1	0	4	6	-7	-4	-1	0	2	4	6	7
260	-3	-1	0	3	6	-7	-4	-1	0	2	4	6	7
240	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
220	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
200	-2	0	0	3	5	-6	-4	-1	0	2	4	6	7

***V1 not to exceed VR**

Takeoff Speeds - Wet Runway

Max Takeoff Thrust

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	122	126	121	124										
50	126	129	124	127	119	123	116	120	114	118				
40	133	136	132	135	126	129	121	125	116	120	111	116	108	112
30	138	141	138	140	132	135	127	130	121	125	116	120	110	114
20	138	141	138	141	134	137	130	134	126	130	121	125	114	118
0	139	141	138	141	135	137	131	134	127	130	123	127	118	122
-60	140	141	139	140	135	137	131	134	128	131	123	127	119	122

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)							
	110	115	120	125	130	135	140	145
320	166	167	167	167	167	168	168	168
300	160	160	161	161	161	161	162	165
280	155	155	155	156	156	156	160	165
260	148	149	149	150	150	154	159	164
240	142	143	143	144	148	153	158	163
220	136	137	138	143	147	152	156	161
200	127	132	137	141	146	151	155	160

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 20		
	V1	VR	V2
460	145	170	182
440	141	166	179
420	136	162	175
400	131	157	172
380	126	152	168
360	120	147	164
340	115	142	160
320	109	137	155
300	103	131	151
280	97	125	146
260	90	118	140
240	83	112	135
220	76	106	130
200	69	98	124

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Takeoff Speeds - Wet Runway
Max Takeoff Thrust
Flaps 20
Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	18	18						8	8						-2	-3					
60	12	13	15	17				6	6	8	9				-2	-2	-2	-3			
50	7	8	11	13	15	18	21	4	4	6	7	8	9	12	-1	-1	-2	-2	-2	-3	-3
40	3	4	6	8	12	14	18	2	2	4	5	7	8	9	-1	-1	-1	-1	-2	-2	-3
30	0	0	3	5	8	10	15	0	0	2	4	5	6	8	0	0	0	-1	-1	-2	-2
20	0	0	2	4	6	9	13	0	0	1	2	4	5	7	0	0	0	0	-1	-1	-2
10	0	0	2	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
0	0	0	2	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-20	1	1	3	5	7	9	12	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-60	2	2	4	6	8	10	13	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
460	-6	-2	0	5	8	-5	-3	-1	0	2	4	5	6
440	-6	-2	0	5	8	-5	-3	-1	0	2	4	5	6
420	-6	-2	0	4	8	-6	-3	-1	0	2	4	5	7
400	-6	-2	0	4	7	-6	-4	-1	0	2	4	5	7
380	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
360	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
340	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
320	-4	-2	0	4	6	-7	-4	-1	0	2	4	6	7
300	-4	-1	0	4	6	-7	-4	-1	0	2	4	6	7
280	-4	-1	0	4	6	-7	-4	-1	0	2	4	6	7
260	-3	-1	0	3	6	-7	-4	-1	0	2	4	6	7
240	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
220	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
200	-2	0	0	3	5	-6	-4	-1	0	2	4	6	7

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	122	126	121	124										
50	126	129	124	127	119	123	116	120	114	118				
40	133	136	132	135	126	129	121	125	116	120	111	116	108	112
30	138	141	138	140	132	135	127	130	121	125	116	120	110	114
20	138	141	138	141	134	137	130	134	126	130	121	125	114	118
0	139	141	138	141	135	137	131	134	127	130	123	127	118	122
-60	140	141	139	140	135	137	131	134	128	131	123	127	119	122

Takeoff Speeds - Wet Runway
Max Takeoff Thrust
Flaps 20
Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)							
	110	115	120	125	130	135	140	145
360	162	163	163	163	163	164	164	164
340	157	157	157	158	158	158	159	162
320	152	152	153	153	153	154	157	161
300	147	148	148	148	149	151	156	161
280	142	143	143	144	146	150	155	160
260	137	137	137	140	144	149	154	159
240	131	132	134	139	144	149	153	158
220	124	128	133	138	143	147	152	157
200	123	128	132	137	142	146	151	156

Maximum Allowable Clearway

FIELD LENGTH (M)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (M)
2000	230
2500	270
3000	310
3500	340
4000	370
4500	400
5000	430

Clearway and Stopway V1 Adjustments

CLEARWAY MINUS STOPWAY (M)	NORMAL V1 (KIAS)									
	DRY RUNWAY					WET RUNWAY				
	100	120	140	160	180	100	120	140	160	180
300	-4	-7	-7	-4	-4					
200	-2	-5	-5	-3	-3					
100	-1	-2	-2	-2	-2					
0	0	0	0	0	0	0	0	0	0	0
-100	1	1	1	1	1	2	2	2	2	2
-200	1	1	1	1	1	2	2	2	2	2
-300	1	1	1	1	1	2	2	2	2	2

Use of clearway not allowed on wet runways.
V1 not to exceed VR.

VREF (KIAS)

WEIGHT (1000 KG)	FLAPS	
	30	25
460	187	191
440	183	187
420	178	182
400	173	177
380	169	172
360	164	167
340	160	163
320	155	158
300	150	153
280	144	147
260	139	141
240	133	136
220	127	130
200	121	124

Flap Maneuver Speed
Sea Level Pressure Altitude

WEIGHT (1000 KG)	MANEUVER SPEED (KIAS)						
	FLAPS						
	UP	1	5	10	20	25	30
460	266	244	224	204	194	191	187
440	260	240	220	201	190	187	183
420	256	236	216	198	186	182	178
400	252	232	212	195	181	177	173
380	247	227	207	192	177	172	169
360	243	223	202	190	174	167	164
340	239	219	199	186	172	163	160
320	234	214	194	180	166	158	155
300	229	209	189	174	161	153	150
280	224	204	184	168	155	147	144
260	219	199	178	162	150	141	139
240	213	193	173	155	144	136	133
220	208	188	168	149	138	130	127
200	205	185	164	144	134	124	121

10000 FT Pressure Altitude

WEIGHT (1000 KG)	MANEUVER SPEED (KIAS)						
	FLAPS						
	UP	1	5	10	20	25	30
460	271	247	227	211	197	191	187
440	265	243	223	207	193	187	183
420	259	238	218	204	189	182	178
400	254	234	213	200	184	177	173
380	249	229	209	197	180	172	169
360	244	224	206	194	176	167	164
340	240	220	204	190	173	163	160
320	235	215	197	184	168	158	155
300	230	210	190	177	162	153	150
280	225	205	185	170	156	147	144
260	220	200	179	163	150	141	139
240	214	194	174	157	144	136	133
220	208	188	168	150	138	130	127
200	205	185	164	144	134	124	121

Flaps 25 maneuver speed based on VREF25.
Flaps 30 maneuver speed based on VREF30.

Flap Maneuver Speed
20000 FT Pressure Altitude and Above

WEIGHT (1000 KG)	MANEUVER SPEED (KIAS)						
	FLAPS						
	UP	1	5	10	20	25	30
460	288	252	232	219	202	191	187
440	280	247	227	215	198	187	183
420	271	242	222	209	194	182	178
400	263	237	217	204	189	177	173
380	255	232	214	200	184	172	169
360	250	227	214	197	180	167	164
340	246	223	211	193	177	163	160
320	238	218	203	186	171	158	155
300	233	213	196	180	165	153	150
280	227	207	188	173	159	147	144
260	221	201	181	166	153	141	139
240	215	195	175	158	146	136	133
220	209	189	169	151	139	130	127
200	205	185	164	145	134	124	121

Flaps 25 maneuver speed based on VREF25.
Flaps 30 maneuver speed based on VREF30.

ADVISORY INFORMATION

Slush/Standing Water Takeoff

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-7.4	-11.7	-16.0	-17.4	-25.3	-33.3	-40.1	-55.5	-70.9
440	-6.5	-10.8	-15.1	-15.5	-23.5	-31.4	-36.0	-51.5	-66.9
420	-5.7	-10.0	-14.3	-13.7	-21.6	-29.6	-32.1	-47.6	-63.0
400	-4.9	-9.2	-13.5	-12.0	-19.9	-27.9	-28.4	-43.8	-59.2
380	-4.2	-8.5	-12.8	-10.4	-18.3	-26.2	-24.8	-40.2	-55.6
360	-3.5	-7.8	-12.1	-8.9	-16.8	-24.7	-21.3	-36.7	-52.2
340	-2.9	-7.2	-11.5	-7.4	-15.4	-23.3	-18.0	-33.5	-48.9
320	-2.4	-6.7	-11.0	-6.1	-14.0	-22.0	-14.9	-30.3	-45.7
300	-1.9	-6.2	-10.5	-4.9	-12.8	-20.7	-11.9	-27.3	-42.7
280	-1.5	-5.8	-10.1	-3.7	-11.7	-19.6	-9.1	-24.5	-39.9
260	-1.1	-5.4	-9.7	-2.7	-10.6	-18.6	-6.4	-21.8	-37.2
240	-0.8	-5.1	-9.4	-1.8	-9.7	-17.6	-3.8	-19.3	-34.7
220	-0.5	-4.8	-9.1	-0.9	-8.9	-16.8	-1.5	-16.9	-32.3
200	-0.3	-4.6	-9.0	-0.2	-8.1	-16.0	0.0	-14.7	-30.1

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2000							193.1		
2200	191.2			213.7			246.7		
2400	249.9			271.2			301.3	178.0	
2600	310.9	174.8		330.7	197.7		356.9	231.3	
2800	374.5	232.9		392.6	254.6		413.8	285.6	162.9
3000	441.1	293.3		457.1	313.5	181.8	471.8	341.0	216.0
3200		356.1	216.1		374.7	238.2		397.5	270.0
3400		421.8	275.8		438.4	296.5		455.2	325.1
3600		490.2	337.9			357.0			381.2
3800			402.8			420.0			438.6
4000			470.6			485.2			496.9

1. **Enter Table 1 with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -140 m/+140 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-20	-17	-15	-16	-13	-11	-5	-3	0
440	-21	-18	-16	-17	-14	-12	-7	-5	-2
420	-22	-19	-17	-18	-16	-13	-9	-6	-4
400	-23	-20	-18	-19	-17	-14	-11	-8	-6
380	-23	-21	-18	-20	-18	-15	-12	-10	-7
360	-24	-22	-19	-21	-19	-16	-14	-11	-9
340	-25	-22	-20	-22	-19	-17	-15	-13	-10
320	-25	-23	-20	-23	-20	-18	-16	-14	-11
300	-25	-23	-20	-23	-21	-18	-18	-15	-13
280	-26	-23	-21	-24	-21	-19	-19	-16	-14
260	-26	-23	-21	-24	-21	-19	-20	-17	-15
240	-26	-23	-21	-24	-22	-19	-21	-18	-16
220	-26	-23	-21	-24	-22	-19	-22	-19	-17
200	-25	-23	-20	-24	-22	-19	-22	-20	-17

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-12.2	-17.0	-21.8	-22.3	-30.4	-38.6	-45.5	-61.6	-77.7
440	-11.3	-16.1	-20.9	-20.4	-28.6	-36.8	-41.4	-57.5	-73.6
420	-10.4	-15.2	-19.9	-18.6	-26.8	-34.9	-37.4	-53.5	-69.6
400	-9.5	-14.2	-19.0	-16.8	-24.9	-33.1	-33.5	-49.6	-65.7
380	-8.5	-13.2	-18.0	-14.9	-23.1	-31.2	-29.6	-45.7	-61.8
360	-7.4	-12.2	-17.0	-13.1	-21.2	-29.4	-25.9	-42.0	-58.1
340	-6.4	-11.1	-15.9	-11.2	-19.4	-27.5	-22.2	-38.3	-54.4
320	-5.3	-10.0	-14.8	-9.3	-17.5	-25.7	-18.6	-34.7	-50.8
300	-4.1	-8.9	-13.6	-7.5	-15.6	-23.8	-15.0	-31.1	-47.2
280	-2.9	-7.7	-12.4	-5.6	-13.8	-21.9	-11.6	-27.7	-43.8
260	-1.7	-6.5	-11.2	-3.7	-11.9	-20.0	-8.2	-24.3	-40.4
240	-0.4	-5.2	-10.0	-1.8	-10.0	-18.2	-4.9	-21.0	-37.1
220	0.0	-3.9	-8.7	0.0	-8.1	-16.3	-1.7	-17.8	-33.9
200	0.0	-2.6	-7.3	0.0	-6.2	-14.4	0.0	-14.7	-30.8

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2600							206.2		
2800							276.1		
3000				243.1			344.2	196.8	
3200	246.4			331.9			410.9	266.9	
3400	352.2			414.1	230.8		476.1	335.3	187.4
3600	443.2	230.8		491.6	320.6			402.1	257.7
3800		339.1			403.5	218.3		467.5	326.3
4000		431.8	214.8		481.4	309.1			393.3
4200			325.9			392.9			458.9
4400			420.2			471.2			

1. **Enter Table 1 with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -165 m/+165 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2)**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-28	-23	-18	-23	-18	-13	-11	-6	-1
440	-29	-24	-19	-25	-20	-15	-13	-8	-3
420	-31	-26	-21	-26	-21	-16	-15	-10	-5
400	-32	-27	-22	-28	-23	-18	-18	-13	-8
380	-33	-28	-23	-29	-24	-19	-20	-15	-10
360	-34	-29	-24	-31	-26	-21	-22	-17	-12
340	-35	-30	-25	-32	-27	-22	-24	-19	-14
320	-36	-31	-26	-33	-28	-23	-26	-21	-16
300	-37	-32	-27	-34	-29	-24	-28	-23	-18
280	-38	-33	-28	-35	-30	-25	-30	-25	-20
260	-39	-34	-29	-37	-32	-27	-32	-27	-22
240	-39	-34	-29	-38	-33	-28	-34	-29	-24
220	-40	-35	-30	-39	-34	-29	-36	-31	-26
200	-40	-35	-30	-39	-34	-29	-37	-32	-27

1. **1. Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Dry Snow Takeoff

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-1.9	-5.1	-8.3	-6.6	-11.4	-16.1	-22.5	-34.7	-47.0
440	-1.8	-5.0	-8.1	-6.0	-10.8	-15.6	-20.4	-32.6	-44.9
420	-1.7	-4.8	-8.0	-5.5	-10.3	-15.0	-18.4	-30.6	-42.9
400	-1.5	-4.7	-7.9	-5.0	-9.7	-14.5	-16.5	-28.7	-41.0
380	-1.4	-4.6	-7.8	-4.5	-9.3	-14.0	-14.7	-26.9	-39.2
360	-1.3	-4.5	-7.7	-4.1	-8.8	-13.6	-13.0	-25.3	-37.5
340	-1.3	-4.4	-7.6	-3.7	-8.4	-13.2	-11.5	-23.7	-35.9
320	-1.2	-4.4	-7.5	-3.3	-8.0	-12.8	-10.0	-22.2	-34.5
300	-1.1	-4.3	-7.5	-2.9	-7.7	-12.5	-8.7	-20.9	-33.1
280	-1.1	-4.3	-7.5	-2.6	-7.4	-12.2	-7.4	-19.7	-31.9
260	-1.1	-4.3	-7.4	-2.4	-7.1	-11.9	-6.3	-18.5	-30.8
240	-1.1	-4.3	-7.4	-2.1	-6.9	-11.6	-5.3	-17.5	-29.8
220	-1.1	-4.3	-7.4	-1.9	-6.7	-11.4	-4.4	-16.6	-28.9
200	-1.1	-4.3	-7.5	-1.7	-6.5	-11.3	-3.6	-15.8	-28.1

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1800							165.4		
2000	183.1			195.1			222.1		
2200	249.3			259.1			280.0	170.8	
2400	317.0	189.4		324.6	201.2		339.4	227.5	
2600	386.4	255.7		391.6	265.3		400.4	285.6	176.2
2800	457.6	323.5	195.6	460.4	330.9	207.2	463.0	345.1	233.0
3000		393.1	262.0		398.1	271.4		406.3	291.2
3200		464.5	330.1		467.0	337.2		469.0	350.9
3400			399.8			404.6			412.1
3600			471.3			473.6			475.0

1. **Enter Table 1 with dry snow depth and dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -100 m/+95 m ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Dry Snow Takeoff

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-14	-11	-9	-12	-9	-7	-5	-3	0
440	-16	-13	-11	-14	-11	-9	-7	-5	-2
420	-18	-15	-13	-16	-13	-11	-10	-7	-5
400	-19	-17	-14	-17	-15	-12	-12	-9	-7
380	-21	-18	-16	-19	-17	-14	-13	-11	-8
360	-22	-20	-17	-20	-18	-15	-15	-13	-10
340	-24	-21	-19	-22	-19	-17	-17	-14	-12
320	-25	-22	-20	-23	-20	-18	-18	-15	-13
300	-25	-23	-20	-24	-21	-19	-19	-16	-14
280	-26	-24	-21	-25	-22	-20	-20	-17	-15
260	-27	-24	-22	-25	-23	-20	-21	-18	-16
240	-27	-25	-22	-26	-23	-21	-21	-19	-16
220	-27	-25	-22	-26	-23	-21	-22	-19	-17
200	-27	-25	-22	-26	-23	-21	-22	-19	-17

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Dry Snow Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-4.9	-7.4	-9.9	-10.3	-14.2	-18.0	-26.7	-38.3	-49.9
440	-5.1	-7.6	-10.1	-9.9	-13.8	-17.6	-24.8	-36.3	-47.9
420	-5.2	-7.7	-10.2	-9.4	-13.3	-17.2	-22.8	-34.4	-46.0
400	-5.1	-7.6	-10.1	-8.9	-12.8	-16.6	-20.9	-32.4	-44.0
380	-4.9	-7.4	-9.9	-8.3	-12.1	-16.0	-18.9	-30.5	-42.1
360	-4.7	-7.2	-9.6	-7.6	-11.4	-15.3	-17.0	-28.6	-40.1
340	-4.3	-6.7	-9.2	-6.8	-10.7	-14.5	-15.0	-26.6	-38.2
320	-3.7	-6.2	-8.7	-5.9	-9.8	-13.6	-13.1	-24.7	-36.2
300	-3.1	-5.6	-8.1	-5.0	-8.8	-12.7	-11.2	-22.7	-34.3
280	-2.3	-4.8	-7.3	-4.0	-7.8	-11.7	-9.2	-20.8	-32.4
260	-1.5	-4.0	-6.5	-2.8	-6.7	-10.6	-7.3	-18.9	-30.4
240	-0.5	-3.0	-5.5	-1.7	-5.5	-9.4	-5.4	-16.9	-28.5
220	0.0	-1.9	-4.4	-0.4	-4.2	-8.1	-3.4	-15.0	-26.6
200	0.0	-0.6	-3.1	0.0	-2.9	-6.7	-1.5	-13.1	-24.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2400							215.5		
2600	178.5			223.5			290.2		
2800	298.0			322.5			363.6	234.1	
3000	398.0	210.5		411.8	249.1		435.8	308.5	177.3
3200	486.7	324.2		494.7	345.4	168.8		381.6	252.6
3400		420.7	240.8		432.7	273.9		453.5	326.7
3600			349.3			367.7			399.5
3800			442.7			453.1			471.2

1. **Enter Table 1 with dry snow depth and dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -105 m/+100 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Dry Snow Takeoff
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-21	-13	-6	-18	-11	-3	-10	-3	0
440	-23	-16	-8	-21	-13	-6	-13	-5	0
420	-25	-18	-10	-23	-15	-8	-15	-8	0
400	-27	-20	-12	-25	-18	-10	-18	-10	-3
380	-30	-22	-15	-27	-20	-12	-20	-13	-5
360	-32	-24	-17	-29	-22	-14	-23	-15	-8
340	-33	-26	-18	-31	-24	-16	-25	-17	-10
320	-35	-28	-20	-33	-26	-18	-27	-19	-12
300	-37	-29	-22	-35	-27	-20	-29	-21	-14
280	-38	-31	-23	-36	-29	-21	-30	-23	-15
260	-40	-32	-25	-38	-30	-23	-32	-24	-17
240	-41	-34	-26	-39	-32	-24	-33	-26	-18
220	-43	-35	-28	-41	-33	-26	-35	-27	-20
200	-44	-36	-29	-42	-34	-27	-36	-29	-21

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Wet Snow Takeoff

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-3.6	-6.3	-9.0	-12.2	-16.3	-20.4	-35.7	-45.3	-54.8
440	-3.3	-6.1	-8.8	-11.3	-15.4	-19.5	-33.2	-42.7	-52.3
420	-3.1	-5.8	-8.5	-10.5	-14.6	-18.7	-30.6	-40.2	-49.7
400	-2.9	-5.6	-8.3	-9.6	-13.7	-17.8	-28.0	-37.5	-47.0
380	-2.6	-5.3	-8.1	-8.7	-12.8	-16.9	-25.2	-34.8	-44.3
360	-2.4	-5.1	-7.8	-7.8	-11.9	-15.9	-22.4	-32.0	-41.5
340	-2.1	-4.9	-7.6	-6.8	-10.9	-15.0	-19.6	-29.1	-38.6
320	-1.9	-4.6	-7.3	-5.8	-9.9	-14.0	-16.6	-26.2	-35.7
300	-1.6	-4.4	-7.1	-4.8	-8.9	-13.0	-13.6	-23.2	-32.7
280	-1.4	-4.1	-6.8	-3.8	-7.9	-12.0	-10.6	-20.1	-29.6
260	-1.1	-3.9	-6.6	-2.7	-6.8	-10.9	-7.4	-16.9	-26.5
240	-0.9	-3.6	-6.3	-1.7	-5.7	-9.8	-4.2	-13.7	-23.3
220	-0.6	-3.3	-6.1	-0.6	-4.6	-8.7	-0.9	-10.4	-20.0
200	-0.4	-3.1	-5.8	0.0	-3.5	-7.6	0.0	-7.1	-16.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1800							167.2		
2000	184.3			199.3			223.4		
2200	250.4			262.7			280.3	163.9	
2400	317.9	180.5		327.3	195.7		337.7	220.2	
2600	386.9	246.5		392.9	259.1		395.8	277.0	160.7
2800	457.6	314.0	176.7	459.8	323.5	192.1	454.5	334.4	216.9
3000		382.9	242.7		389.1	255.4		392.4	273.7
3200		453.5	310.0		455.9	319.8		451.1	331.1
3400			378.9			385.3			389.1
3600			449.4			452.1			447.7

1. **Enter Table 1 with wet snow depth and dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -95 m/+95 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Wet Snow Takeoff
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-13	-10	-8	-10	-7	-5	-2	0	0
440	-15	-12	-10	-12	-9	-7	-4	-1	0
420	-17	-14	-12	-14	-11	-9	-5	-3	0
400	-19	-16	-14	-15	-13	-10	-7	-5	-2
380	-20	-18	-15	-17	-15	-12	-9	-6	-4
360	-22	-19	-17	-19	-16	-14	-11	-8	-6
340	-23	-21	-18	-20	-18	-15	-12	-10	-7
320	-24	-22	-19	-21	-19	-16	-14	-12	-9
300	-25	-23	-20	-23	-20	-18	-16	-14	-11
280	-26	-24	-21	-24	-21	-19	-18	-15	-13
260	-27	-24	-22	-25	-22	-20	-20	-17	-15
240	-27	-25	-22	-26	-23	-21	-22	-19	-17
220	-28	-25	-23	-27	-24	-22	-24	-21	-19
200	-28	-26	-23	-28	-25	-23	-26	-23	-21

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Wet Snow Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-7.0	-10.2	-13.4	-16.7	-21.7	-26.7	-40.9	-50.7	-60.4
440	-7.1	-10.2	-13.4	-16.0	-20.9	-25.9	-38.4	-48.1	-57.9
420	-7.0	-10.2	-13.4	-15.1	-20.1	-25.1	-35.7	-45.5	-55.2
400	-6.8	-10.0	-13.2	-14.2	-19.2	-24.2	-32.9	-42.7	-52.4
380	-6.5	-9.7	-12.9	-13.1	-18.1	-23.1	-30.0	-39.7	-49.5
360	-6.1	-9.2	-12.4	-11.9	-16.9	-21.8	-26.9	-36.7	-46.4
340	-5.5	-8.6	-11.8	-10.5	-15.5	-20.5	-23.7	-33.5	-43.2
320	-4.7	-7.9	-11.1	-9.0	-14.0	-19.0	-20.4	-30.1	-39.9
300	-3.9	-7.0	-10.2	-7.4	-12.4	-17.4	-16.9	-26.7	-36.4
280	-2.8	-6.0	-9.2	-5.7	-10.7	-15.7	-13.3	-23.1	-32.8
260	-1.7	-4.9	-8.0	-3.8	-8.8	-13.8	-9.6	-19.3	-29.1
240	-0.4	-3.6	-6.8	-1.8	-6.8	-11.8	-5.7	-15.4	-25.2
220	0.0	-2.2	-5.3	0.0	-4.7	-9.7	-1.7	-11.4	-21.2
200	0.0	-0.6	-3.8	0.0	-2.4	-7.4	0.0	-7.3	-17.0

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2400							228.0		
2600	186.1			241.5			300.6		
2800	303.1			335.0			370.1	235.0	
3000	401.2	198.4		419.5	250.9		436.8	307.3	166.6
3200	488.4	313.1		498.3	343.4			376.5	242.0
3400		409.9	210.4		427.1	260.1		443.0	314.0
3600		496.6	322.9			351.7			383.0
3800			418.4			434.7			449.2

1. **Enter Table 1 with wet snow depth and dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -100 m/+100 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Wet Snow Takeoff
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-20	-15	-10	-15	-10	-5	-6	-1	0
440	-22	-17	-12	-18	-13	-8	-8	-3	0
420	-24	-19	-14	-20	-15	-10	-10	-5	0
400	-27	-22	-17	-23	-18	-13	-12	-7	-2
380	-29	-24	-19	-25	-20	-15	-15	-10	-5
360	-31	-26	-21	-27	-22	-17	-17	-12	-7
340	-33	-28	-23	-29	-24	-19	-20	-15	-10
320	-35	-30	-25	-32	-27	-22	-23	-18	-13
300	-37	-32	-27	-34	-29	-24	-26	-21	-16
280	-39	-34	-29	-36	-31	-26	-29	-24	-19
260	-40	-35	-30	-38	-33	-28	-32	-27	-22
240	-42	-37	-32	-40	-35	-30	-35	-30	-25
220	-43	-38	-33	-42	-37	-32	-39	-34	-29
200	-45	-40	-35	-44	-39	-34	-43	-38	-33

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slippery Runway Takeoff

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	0.0	-0.6	-2.9	0.0	-0.6	-2.9	-13.4	-15.7	-17.9
440	0.0	-0.8	-3.1	0.0	-0.8	-3.1	-12.8	-15.0	-17.3
420	0.0	-1.0	-3.2	0.0	-1.0	-3.2	-12.0	-14.3	-16.6
400	0.0	-1.1	-3.4	0.0	-1.2	-3.4	-11.3	-13.5	-15.8
380	0.0	-1.3	-3.6	0.0	-1.3	-3.6	-10.4	-12.7	-14.9
360	0.0	-1.5	-3.8	0.0	-1.5	-3.8	-9.5	-11.7	-14.0
340	0.0	-1.7	-3.9	0.0	-1.7	-4.0	-8.4	-10.7	-13.0
320	0.0	-1.8	-4.1	0.0	-1.9	-4.1	-7.4	-9.6	-11.9
300	0.0	-2.0	-4.3	0.0	-2.0	-4.3	-6.2	-8.5	-10.7
280	0.0	-2.2	-4.4	0.0	-2.2	-4.5	-5.0	-7.2	-9.5
260	-0.1	-2.3	-4.6	-0.1	-2.3	-4.6	-3.7	-5.9	-8.2
240	-0.2	-2.5	-4.8	-0.2	-2.5	-4.8	-2.3	-4.5	-6.8
220	-0.4	-2.7	-5.0	-0.4	-2.6	-4.9	-0.8	-3.1	-5.4
200	-0.6	-2.8	-5.1	-0.5	-2.8	-5.1	0.0	-1.6	-3.8

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1800	168.7								
2000	252.1			172.8					
2200	331.4			240.6					
2400	407.1	234.9		310.0					
2600	479.9	315.1		381.3	226.2				
2800		391.5	217.6	454.5	295.3				
3000		464.7	298.6		366.2	211.9	180.4		
3200			375.7		439.0	280.6	212.0		
3400			449.6			351.1	244.6	173.9	
3600						423.5	278.4	205.3	
3800						497.5	313.5	237.6	167.3
4000							350.2	271.2	198.6
4200							388.5	306.0	230.8
4400							428.9	342.3	264.0
4600							471.2	380.3	298.6
4800								420.2	334.6
5000								462.3	372.2
5200									411.7
5400									453.3
5600									496.0

1. **Enter Table 1 with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -130 m/+130 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -130 m/+130 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -130 m/+130 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-11	-9	-6	-15	-13	-10	-49	-46	-44
440	-12	-10	-7	-17	-15	-12	-51	-48	-46
420	-13	-11	-8	-19	-17	-14	-53	-50	-48
400	-14	-12	-9	-21	-18	-16	-54	-52	-49
380	-15	-12	-10	-22	-20	-17	-56	-53	-51
360	-15	-13	-10	-24	-21	-19	-57	-55	-52
340	-16	-13	-11	-25	-22	-20	-58	-56	-53
320	-16	-13	-11	-26	-23	-21	-59	-57	-54
300	-16	-13	-11	-27	-24	-22	-60	-57	-55
280	-16	-13	-11	-28	-25	-23	-60	-58	-55
260	-15	-13	-10	-28	-26	-23	-61	-58	-56
240	-15	-12	-10	-28	-26	-23	-61	-58	-56
220	-14	-12	-9	-29	-26	-24	-61	-58	-56
200	-13	-11	-8	-29	-26	-24	-60	-58	-55

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slippery Runway Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	0.0	-0.7	-2.9	-0.8	-3.1	-5.4	-20.2	-22.5	-24.8
440	0.0	-0.9	-3.1	-1.4	-3.7	-6.0	-19.2	-21.4	-23.7
420	0.0	-1.0	-3.3	-1.9	-4.2	-6.4	-18.0	-20.3	-22.6
400	0.0	-1.2	-3.5	-2.2	-4.5	-6.8	-16.8	-19.1	-21.3
380	0.0	-1.4	-3.6	-2.4	-4.7	-6.9	-15.5	-17.8	-20.0
360	0.0	-1.5	-3.8	-2.4	-4.7	-7.0	-14.1	-16.4	-18.6
340	0.0	-1.7	-4.0	-2.3	-4.6	-6.9	-12.6	-14.9	-17.2
320	0.0	-1.9	-4.1	-2.1	-4.3	-6.6	-11.1	-13.4	-15.6
300	0.0	-2.0	-4.3	-1.7	-3.9	-6.2	-9.5	-11.8	-14.0
280	0.0	-2.2	-4.5	-1.1	-3.4	-5.7	-7.8	-10.1	-12.3
260	-0.1	-2.3	-4.6	-0.4	-2.7	-5.0	-6.0	-8.3	-10.6
240	-0.2	-2.5	-4.8	0.0	-1.9	-4.1	-4.2	-6.4	-8.7
220	-0.4	-2.6	-4.9	0.0	-0.9	-3.2	-2.2	-4.5	-6.8
200	-0.5	-2.8	-5.1	0.0	0.0	-2.0	-0.2	-2.5	-4.8

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2400	202.4								
2600	352.3								
2800	449.3			271.1					
3000		327.6		383.6					
3200		431.0		478.2	243.9				
3400			300.5		361.8				
3600			411.7		459.0	215.0			
3800			498.8			339.2			
4000						439.8			
5600							198.6		
5800							282.0		
6000							365.4	181.1	

1. **Enter Table 1 with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -150 m/+145 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -150 m/+145 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -150 m/+145 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-17	-12	-7	-23	-18	-13	-71	-66	-61
440	-18	-13	-8	-25	-20	-15	-74	-69	-64
420	-20	-15	-10	-27	-22	-17	-76	-71	-66
400	-21	-16	-11	-29	-24	-19	-78	-73	-68
380	-22	-17	-12	-31	-26	-21	-80	-75	-70
360	-22	-17	-12	-33	-28	-23	-82	-77	-72
340	-23	-18	-13	-35	-30	-25	-84	-79	-74
320	-24	-19	-14	-37	-32	-27	-85	-80	-75
300	-24	-19	-14	-39	-34	-29	-87	-82	-77
280	-24	-19	-14	-40	-35	-30	-88	-83	-78
260	-24	-19	-14	-42	-37	-32	-89	-84	-79
240	-24	-19	-14	-43	-38	-33	-90	-85	-80
220	-24	-19	-14	-44	-39	-34	-91	-86	-81
200	-24	-19	-14	-45	-40	-35	-91	-86	-81

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

Takeoff %N1

Max Takeoff Thrust

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)												
	-2	-1	0	1	2	3	4	5	6	7	8	9	10
70	89.7	90.1	90.6	90.6	90.6	90.5	90.4	90.4	90.3	90.3	89.7	89.2	88.5
60	92.5	93	93.4	93.4	93.4	93.3	93.3	93.2	93.2	93.2	92.6	92	91.4
55	93.9	94.4	94.8	94.8	94.8	94.7	94.6	94.6	94.6	94.5	94	93.4	92.8
50	95.2	95.7	96.2	96.1	96.1	96	96	95.9	95.9	95.9	95.3	94.7	94.2
45	96.5	97	97.5	97.4	97.3	97.3	97.3	97.2	97.2	97.2	96.6	96	95.5
40	97.5	98.2	98.9	98.7	98.5	98.4	98.4	98.5	98.4	98.4	97.9	97.3	96.7
35	97.8	98.9	99.8	99.7	99.7	99.5	99.3	99.3	99.2	99.3	98.8	98.4	98
30	97.2	98.8	100.4	100.4	100.4	100.4	100.4	100.1	100	99.9	99.5	99.2	98.8
25	96.4	98	99.6	100.1	100.7	101.1	101.1	101.1	101.7	101.3	100.3	99.9	99.5
20	95.6	97.2	98.8	99.3	99.9	100.5	101.1	101.8	102.2	102.4	102.1	101.5	100.3
15	94.8	96.3	97.9	98.4	99	99.6	100.2	101	101.7	102.5	102.5	102.2	101.2
10	93.9	95.5	97.1	97.6	98.2	98.8	99.4	100.1	100.8	101.6	101.8	102	102.3
5	93.1	94.7	96.2	96.7	97.3	97.9	98.5	99.2	99.9	100.7	100.9	101.2	101.4
0	92.3	93.8	95.3	95.8	96.4	97	97.6	98.3	99.1	99.8	100	100.3	100.6
-10	90.6	92.1	93.6	94.1	94.6	95.2	95.9	96.6	97.3	98	98.3	98.5	98.8
-20	88.8	90.3	91.8	92.3	92.8	93.4	94.1	94.8	95.5	96.3	96.5	96.7	97
-30	87.0	88.5	89.9	90.4	91	91.6	92.3	93	93.7	94.4	94.7	94.9	95.2
-40	85.2	86.7	88.1	88.6	89.1	89.8	90.5	91.2	91.9	92.6	92.8	93.1	93.4
-50	83.4	84.8	86.2	86.7	87.3	87.9	88.6	89.3	90	90.7	91	91.2	91.5

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)			
	-2	0	9	10
PACKS OFF	0.5	0.6	0.6	0.7
ENGINE ANTI-ICE ON	0.0	0.0	0.0	-0.4
ENGINE AND WING ANTI-ICE ON	0.0	0.0	0.0	-0.4

TO1 Minimum Takeoff Weight

10% Thrust Reduction

Based on engine bleed for packs on and anti-ice off

Flaps 10

Weight Limit (1000 KG)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
45	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
40	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
35	183.6	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
30	190.0	183.5	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
25	190.2	186.1	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
20	190.5	186.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
15	190.7	186.4	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
10	190.8	186.6	182.5	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
0 & BELOW	191.0	186.7	182.7	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3

Flaps 20

Weight Limit (1000 KG)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
45	187.6	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
40	198.2	190.4	182.7	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
35	206.1	198.8	191.4	183.7	182.3	182.3	182.3	182.3	182.3	182.3	182.3
30	213.3	206.0	198.6	191.1	184.4	182.3	182.3	182.3	182.3	182.3	182.3
25	213.6	208.9	204.3	198.2	191.2	184.1	182.3	182.3	182.3	182.3	182.3
20	213.8	209.1	204.5	199.7	194.4	189.6	183.7	182.3	182.3	182.3	182.3
15	214.0	209.3	204.7	199.9	194.6	189.7	185.1	182.3	182.3	182.3	182.3
10	214.2	209.4	204.9	200.0	194.7	189.8	185.2	182.3	182.3	182.3	182.3
0 & BELOW	214.4	209.6	205.0	200.2	194.9	190.0	185.4	182.3	182.3	182.3	182.3

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability. For weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

TO1 Takeoff Speeds - Dry Runway
10%Thrust Reduction
Flaps 10
Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 10		
	V1	VR	V2
460	175	187	197
440	171	183	194
420	167	178	190
400	162	173	186
380	157	167	181
360	152	162	177
340	147	156	172
320	141	150	168
300	135	144	162
280	128	138	157
260	121	131	151
240	114	124	145
220	106	117	140
200	97	110	133

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	15	15						8	8						-2	-2					
60	10	11	13	15				5	6	7	8				-1	-2	-2	-2			
50	6	7	9	11	14	16	18	3	4	5	7	8	9	11	-1	-1	-1	-2	-2	-2	-2
40	2	3	6	8	11	13	16	1	2	4	5	6	8	9	0	0	-1	-1	-1	-2	-2
30	0	0	2	5	8	11	13	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	1	3	6	8	11	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
10	0	0	1	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
0	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-20	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-40	1	1	2	4	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-60	1	1	2	4	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
460	-6	-3	0	3	5	-4	-3	-1	0	1	1	2	3
440	-6	-3	0	2	5	-4	-3	-1	0	1	1	2	3
420	-5	-2	0	2	5	-4	-2	-1	0	1	1	2	3
400	-5	-2	0	2	4	-4	-2	-1	0	1	1	2	3
380	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
360	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
340	-4	-2	0	2	3	-3	-2	-1	0	1	1	2	3
320	-3	-2	0	2	3	-3	-2	-1	0	1	1	2	3
300	-3	-1	0	2	3	-3	-2	-1	0	1	1	2	3
280	-3	-1	0	2	3	-3	-2	-1	0	1	1	2	3
260	-3	-1	0	1	3	-3	-2	-1	0	1	1	2	3
240	-3	-1	0	1	3	-3	-2	-1	0	1	1	2	3
220	-2	-1	0	1	3	-3	-2	-1	0	1	2	2	3
200	-2	-1	0	1	2	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

TO1 Takeoff Speeds - Dry Runway

10%Thrust Reduction

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	116	120	114	118	113	116	111	114						
50	119	123	118	121	113	117	111	114	108	113	106	110	102	107
40	126	129	125	128	119	123	115	118	110	114	106	110	102	107
30	130	133	130	133	125	128	120	124	115	118	110	114	104	109
20	130	133	130	133	127	130	123	127	120	123	115	119	108	113
-60	132	133	131	133	128	130	125	127	121	124	117	121	113	116

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)						
	105	110	115	120	125	130	135
280	155	155	155	155	156	156	157
260	148	148	149	149	150	150	154
240	142	142	143	143	144	148	153
220	136	136	137	138	142	147	152
200	130	130	132	136	141	146	151

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 20		
	V1	VR	V2
460	164	173	182
440	160	169	178
420	155	164	175
400	151	160	171
380	147	155	167
360	142	150	163
340	136	144	159
320	131	139	154
300	125	133	150
280	119	127	145
260	112	120	139
240	104	114	134
220	96	108	129
200	89	101	123

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

TO1 Takeoff Speeds - Dry Runway

10%Thrust Reduction

Flaps 20

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	15	15						8	8						-2	-2					
60	10	11	13	15				5	6	7	8				-1	-2	-2	-2			
50	6	7	9	11	14	16	18	3	4	5	7	8	9	11	-1	-1	-1	-2	-2	-2	-2
40	2	3	6	8	11	13	16	1	2	4	5	6	8	9	0	0	-1	-1	-1	-2	-2
30	0	0	2	5	8	11	13	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	1	3	6	8	11	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
10	0	0	1	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
0	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-20	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-40	1	1	2	4	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-60	1	1	2	4	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
460	-6	-3	0	3	5	-4	-3	-1	0	1	1	2	3
440	-6	-3	0	2	5	-4	-3	-1	0	1	1	2	3
420	-5	-2	0	2	5	-4	-2	-1	0	1	1	2	3
400	-5	-2	0	2	4	-4	-2	-1	0	1	1	2	3
380	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
360	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
340	-4	-2	0	2	3	-3	-2	-1	0	1	1	2	3
320	-3	-2	0	2	3	-3	-2	-1	0	1	1	2	3
300	-3	-1	0	2	3	-3	-2	-1	0	1	1	2	3
280	-3	-1	0	2	3	-3	-2	-1	0	1	1	2	3
260	-3	-1	0	1	3	-3	-2	-1	0	1	1	2	3
240	-3	-1	0	1	3	-3	-2	-1	0	1	1	2	3
220	-2	-1	0	1	3	-3	-2	-1	0	1	2	2	3
200	-2	-1	0	1	2	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	116	120	114	118	113	116	111	114						
50	119	123	118	121	113	117	111	114	108	113	106	110	102	107
40	126	129	125	128	119	123	115	118	110	114	106	110	102	107
30	130	133	130	133	125	128	120	124	115	118	110	114	104	109
20	130	133	130	133	127	130	123	127	120	123	115	119	108	113
-60	132	133	131	133	128	130	125	127	121	124	117	121	113	116

TO1 Takeoff Speeds - Dry Runway

10%Thrust Reduction

Flaps 20

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)						
	105	110	115	120	125	130	135
320	153	153	153	153	153	153	153
300	148	148	148	148	148	148	151
280	142	142	143	143	143	146	150
260	136	137	137	138	139	144	150
240	131	132	132	134	139	144	149
220	126	126	127	132	138	143	148
200	120	121	127	132	138	143	148

TO1 Takeoff Speeds - Wet Runway

10%Thrust Reduction

Flaps 10

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 10		
	V1	VR	V2
460	164	187	197
440	159	183	194
420	154	178	190
400	148	173	186
380	143	167	181
360	137	162	177
340	130	156	172
320	124	150	168
300	117	144	162
280	111	138	157
260	103	131	151
240	96	124	145
220	89	117	140
200	81	109	133

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	16	17						8	8						-2	-2					
60	12	12	15	17				5	6	7	8				-1	-1	-2	-2			
50	6	8	11	13	15	18	21	3	4	5	7	8	9	11	-1	-1	-1	-2	-2	-2	-2
40	2	3	6	9	12	14	17	1	2	4	5	6	8	9	0	-0	-1	-1	-1	-2	-2
30	0	0	2	5	8	11	14	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	1	2	4	7	11	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
10	0	0	1	3	4	6	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
0	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-20	1	1	3	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-40	2	2	4	4	6	8	11	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-60	3	3	4	5	6	9	11	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
460	-7	-3	0	4	8	-5	-3	-1	0	1	3	4	5
440	-7	-3	0	4	8	-5	-3	-1	0	1	3	4	5
420	-6	-3	0	4	7	-5	-3	-1	0	2	3	4	6
400	-6	-3	0	4	7	-6	-3	-1	0	2	3	4	6
380	-6	-3	0	4	7	-6	-4	-1	0	2	3	5	6
360	-6	-2	0	4	7	-6	-4	-1	0	2	3	5	6
340	-5	-2	0	4	6	-7	-4	-2	0	2	4	5	6
320	-5	-2	0	3	6	-7	-4	-2	0	2	4	5	6
300	-5	-2	0	3	6	-7	-4	-2	0	2	4	5	7
280	-4	-2	0	3	6	-7	-4	-2	0	2	4	5	7
260	-4	-1	0	3	5	-7	-4	-2	0	2	4	5	7
240	-3	-1	0	3	5	-7	-4	-2	0	2	4	5	7
220	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
200	-3	-1	0	3	4	-7	-4	-1	0	2	4	6	7

***V1 not to exceed VR**

TO1 Takeoff Speeds - Wet Runway

10%Thrust Reduction

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	116	120	114	118	113	116	111	114						
50	119	123	118	121	113	117	111	114	108	113	106	110	102	107
40	126	129	125	128	119	123	115	118	110	114	106	110	102	107
30	130	133	130	133	125	128	120	124	115	118	110	114	104	109
20	130	133	130	133	127	130	123	127	120	123	115	119	108	113
-60	132	133	131	133	128	130	125	127	121	124	117	121	113	116

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)						
	105	110	115	120	125	130	135
280	155	155	155	155	156	156	157
260	148	148	149	149	150	150	154
240	142	142	143	143	144	148	153
220	136	136	137	138	142	147	152
200	130	130	132	136	141	146	151

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 20		
	V1	VR	V2
460	154	173	182
440	148	169	178
420	143	164	175
400	138	160	171
380	133	155	167
360	127	150	163
340	121	144	159
320	115	139	154
300	109	133	150
280	103	127	145
260	96	120	139
240	89	114	134
220	81	107	129
200	74	100	123

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

TO1 Takeoff Speeds - Wet Runway

10%Thrust Reduction

Flaps 20

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	16	17						8	8						-2	-2					
60	12	12	15	17				5	6	7	8				-1	-1	-2	-2			
50	6	8	11	13	15	18	21	3	4	5	7	8	9	11	-1	-1	-1	-2	-2	-2	-2
40	2	3	6	9	12	14	17	1	2	4	5	6	8	9	0	-0	-1	-1	-1	-2	-2
30	0	0	2	5	8	11	14	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	1	2	4	7	11	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
10	0	0	1	3	4	6	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
0	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-20	1	1	3	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-40	2	2	4	4	6	8	11	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-60	3	3	4	5	6	9	11	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
460	-7	-3	0	4	8	-5	-3	-1	0	1	3	4	5
440	-7	-3	0	4	8	-5	-3	-1	0	1	3	4	5
420	-6	-3	0	4	7	-5	-3	-1	0	2	3	4	6
400	-6	-3	0	4	7	-6	-3	-1	0	2	3	4	6
380	-6	-3	0	4	7	-6	-4	-1	0	2	3	5	6
360	-6	-2	0	4	7	-6	-4	-1	0	2	3	5	6
340	-5	-2	0	4	6	-7	-4	-2	0	2	4	5	6
320	-5	-2	0	3	6	-7	-4	-2	0	2	4	5	6
300	-5	-2	0	3	6	-7	-4	-2	0	2	4	5	7
280	-4	-2	0	3	6	-7	-4	-2	0	2	4	5	7
260	-4	-1	0	3	5	-7	-4	-2	0	2	4	5	7
240	-3	-1	0	3	5	-7	-4	-2	0	2	4	5	7
220	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
200	-3	-1	0	3	4	-7	-4	-1	0	2	4	6	7

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	116	120	114	118	113	116	111	114						
50	119	123	118	121	113	117	111	114	108	113	106	110	102	107
40	126	129	125	128	119	123	115	118	110	114	106	110	102	107
30	130	133	130	133	125	128	120	124	115	118	110	114	104	109
20	130	133	130	133	127	130	123	127	120	123	115	119	108	113
-60	132	133	131	133	128	130	125	127	121	124	117	121	113	116

TO1 Takeoff Speeds - Wet Runway

10%Thrust Reduction

Flaps 20

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)						
	105	110	115	120	125	130	135
320	153	153	153	153	153	153	153
300	148	148	148	148	148	148	151
280	142	142	143	143	143	146	150
260	136	137	137	138	139	144	150
240	131	132	132	134	139	144	149
220	126	126	127	132	138	143	148
200	120	121	127	132	138	143	148

TO1 Maximum Allowable Clearway

10% Thrust Reduction

FIELD LENGTH (M)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (M)
2000	230
2500	280
3000	320
3500	340
4000	370
4500	390
5000	420

TO1 Clearway and Stopway V1 Adjustments

10% Thrust Reduction

CLEARWAY MINUS STOPWAY (M)	NORMAL V1 (KIAS)									
	DRY RUNWAY					WET RUNWAY				
	100	120	140	160	180	100	120	140	160	180
300	-3	-5	-6	-5	-3					
200	-2	-4	-5	-3	-2					
100	-1	-2	-3	-1	-1					
0	0	0	0	0	0	0	0	0	0	0
-100	1	1	1	1	1	1	1	1	1	1
-200	1	1	1	1	1	1	1	1	1	1
-300	1	1	1	1	1	1	1	1	1	1

Use of clearway not allowed on wet runways.
V1 not to exceed VR.

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-8.1	-12.4	-16.7	-18.7	-26.6	-34.5	-42.4	-57.9	-73.3
440	-7.2	-11.5	-15.8	-16.8	-24.7	-32.6	-38.4	-53.8	-69.2
420	-6.3	-10.6	-14.9	-14.9	-22.8	-30.7	-34.4	-49.8	-65.2
400	-5.4	-9.8	-14.1	-13.1	-21.0	-28.9	-30.5	-45.9	-61.3
380	-4.7	-9.0	-13.3	-11.3	-19.3	-27.2	-26.7	-42.2	-57.6
360	-3.9	-8.2	-12.5	-9.7	-17.7	-25.6	-23.2	-38.6	-54.0
340	-3.3	-7.6	-11.9	-8.2	-16.2	-24.1	-19.8	-35.2	-50.6
320	-2.7	-7.0	-11.3	-6.8	-14.7	-22.7	-16.5	-31.9	-47.4
300	-2.1	-6.4	-10.7	-5.5	-13.4	-21.4	-13.4	-28.8	-44.3
280	-1.7	-6.0	-10.3	-4.3	-12.2	-20.2	-10.5	-25.9	-41.3
260	-1.2	-5.6	-9.9	-3.2	-11.1	-19.1	-7.7	-23.1	-38.5
240	-0.9	-5.2	-9.5	-2.2	-10.1	-18.1	-5.1	-20.5	-35.9
220	-0.6	-4.9	-9.2	-1.3	-9.2	-17.2	-2.6	-18.0	-33.5
200	-0.4	-4.7	-9.0	-0.5	-8.4	-16.4	-0.3	-15.7	-31.2

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1800							175.3		
2000	177.2			200.0			233.5		
2200	241.6			263.1			293.6		
2400	309.5			329.4	182.6		355.7	216.8	
2600	381.6	222.9		399.5	244.8		420.1	276.3	
2800	458.4	289.8		473.5	310.2	165.2	486.5	337.8	200.1
3000		360.6	204.5		379.1	226.8		401.5	259.1
3200		436.0	270.4		452.1	291.2		467.4	320.1
3400			340.0			359.1			383.1
3600			414.0			430.8			448.4
3800			492.4						

1. **Enter Table 1 with slush/standing water depth and TO1 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -140 m/+140 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-18	-16	-13	-13	-11	-8	-1	0	0
440	-20	-17	-15	-15	-12	-10	-3	-1	0
420	-21	-18	-16	-16	-14	-11	-5	-3	0
400	-22	-19	-17	-18	-15	-13	-7	-5	-2
380	-23	-20	-18	-19	-16	-14	-9	-7	-4
360	-24	-21	-19	-20	-17	-15	-11	-9	-6
340	-24	-22	-19	-21	-18	-16	-13	-10	-8
320	-25	-22	-20	-22	-19	-17	-14	-12	-9
300	-25	-23	-20	-22	-20	-17	-16	-13	-11
280	-25	-23	-20	-23	-20	-18	-17	-15	-12
260	-26	-23	-21	-23	-21	-18	-19	-16	-14
240	-26	-23	-21	-24	-21	-19	-20	-17	-15
220	-25	-23	-20	-24	-21	-19	-21	-18	-16
200	-25	-23	-20	-24	-21	-19	-22	-19	-17

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-12.3	-17.1	-21.8	-22.8	-31.0	-39.1	-47.2	-63.3	-79.4
440	-11.4	-16.2	-20.9	-21.0	-29.1	-37.3	-43.1	-59.2	-75.3
420	-10.5	-15.3	-20.1	-19.1	-27.3	-35.5	-39.1	-55.2	-71.3
400	-9.7	-14.4	-19.2	-17.4	-25.6	-33.7	-35.2	-51.3	-67.4
380	-8.8	-13.5	-18.3	-15.6	-23.8	-32.0	-31.4	-47.5	-63.6
360	-7.8	-12.6	-17.4	-13.9	-22.0	-30.2	-27.6	-43.7	-59.8
340	-6.9	-11.6	-16.4	-12.1	-20.2	-28.4	-23.9	-40.0	-56.1
320	-5.8	-10.6	-15.3	-10.3	-18.4	-26.6	-20.3	-36.4	-52.5
300	-4.7	-9.5	-14.3	-8.4	-16.6	-24.8	-16.8	-32.9	-49.0
280	-3.6	-8.4	-13.1	-6.6	-14.8	-22.9	-13.3	-29.4	-45.5
260	-2.4	-7.2	-12.0	-4.7	-12.9	-21.1	-9.9	-26.0	-42.1
240	-1.2	-6.0	-10.7	-2.9	-11.0	-19.2	-6.6	-22.7	-38.8
220	0.0	-4.7	-9.5	-1.0	-9.2	-17.3	-3.3	-19.4	-35.5
200	0.0	-3.4	-8.1	0.0	-7.3	-15.4	-0.2	-16.3	-32.4

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2400							213.6		
2600				176.9			297.3		
2800	185.7			288.9			378.1	202.2	
3000	321.5			389.4	161.3		456.1	286.4	
3200	432.1	165.2		481.6	274.8			367.5	190.8
3400		305.3			376.6			445.9	275.4
3600		418.5			469.7	260.5			356.9
3800			288.6			363.7			435.7
4000			404.5			457.7			

1. **Enter Table 1 with slush/standing water depth and TO1 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -165 m/+165 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2)**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-25	-20	-15	-20	-15	-10	-5	0	0
440	-27	-22	-17	-22	-17	-12	-8	-3	0
420	-29	-24	-19	-23	-18	-13	-10	-5	0
400	-30	-25	-20	-25	-20	-15	-13	-8	-3
380	-31	-26	-21	-27	-22	-17	-15	-10	-5
360	-33	-28	-23	-28	-23	-18	-18	-13	-8
340	-34	-29	-24	-30	-25	-20	-20	-15	-10
320	-35	-30	-25	-31	-26	-21	-23	-18	-13
300	-36	-31	-26	-33	-28	-23	-25	-20	-15
280	-37	-32	-27	-34	-29	-24	-27	-22	-17
260	-38	-33	-28	-35	-30	-25	-30	-25	-20
240	-38	-33	-28	-37	-32	-27	-32	-27	-22
220	-39	-34	-29	-38	-33	-28	-34	-29	-24
200	-40	-35	-30	-39	-34	-29	-36	-31	-26

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff
10% Thrust Reduction
2 Engine Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-2.0	-5.1	-8.3	-6.8	-11.6	-16.3	-23.4	-35.7	-47.9
440	-1.8	-5.0	-8.2	-6.2	-11.0	-15.8	-21.3	-33.6	-45.8
420	-1.7	-4.8	-8.0	-5.7	-10.4	-15.2	-19.2	-31.5	-43.7
400	-1.5	-4.7	-7.9	-5.1	-9.9	-14.6	-17.3	-29.5	-41.7
380	-1.4	-4.6	-7.8	-4.6	-9.4	-14.1	-15.4	-27.6	-39.9
360	-1.3	-4.5	-7.6	-4.1	-8.9	-13.7	-13.6	-25.9	-38.1
340	-1.2	-4.4	-7.6	-3.7	-8.5	-13.2	-12.0	-24.2	-36.5
320	-1.1	-4.3	-7.5	-3.3	-8.1	-12.8	-10.4	-22.7	-34.9
300	-1.1	-4.2	-7.4	-3.0	-7.7	-12.5	-9.0	-21.3	-33.5
280	-1.0	-4.2	-7.4	-2.6	-7.4	-12.2	-7.7	-20.0	-32.2
260	-1.0	-4.2	-7.4	-2.3	-7.1	-11.9	-6.5	-18.8	-31.0
240	-1.0	-4.2	-7.3	-2.1	-6.8	-11.6	-5.5	-17.7	-29.9
220	-1.0	-4.2	-7.3	-1.9	-6.6	-11.4	-4.5	-16.7	-29.0
200	-1.0	-4.2	-7.4	-1.7	-6.4	-11.2	-3.7	-15.9	-28.2

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1800				167.8			197.4		
2000	223.5			234.2			257.5		
2200	293.7	161.2		302.0	174.0		318.9	203.0	
2400	365.4	230.1		371.3	240.6		381.9	263.2	
2600	438.9	300.4	167.8	442.3	308.5	180.3	446.5	324.9	208.7
2800		372.3	236.7		378.0	247.0		388.0	269.0
3000		446.0	307.2		449.1	315.1		452.8	330.8
3200			379.3			384.7			394.1
3400			453.1			456.0			459.0

1. **Enter Table 1 with dry snow depth and TO1 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -100 m/+95 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff
10% Thrust Reduction
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-11	-9	-6	-9	-6	-4	-2	0	0
440	-14	-11	-9	-11	-9	-6	-4	-2	0
420	-16	-13	-11	-13	-11	-8	-7	-4	-2
400	-18	-15	-13	-16	-13	-11	-9	-6	-4
380	-20	-17	-15	-18	-15	-13	-11	-8	-6
360	-21	-19	-16	-19	-17	-14	-13	-10	-8
340	-23	-20	-18	-21	-18	-16	-15	-12	-10
320	-24	-22	-19	-22	-20	-17	-16	-14	-11
300	-25	-23	-20	-23	-21	-18	-17	-15	-12
280	-26	-24	-21	-24	-22	-19	-18	-16	-13
260	-27	-24	-22	-25	-22	-20	-19	-17	-14
240	-27	-25	-22	-25	-23	-20	-20	-18	-15
220	-28	-25	-23	-26	-23	-21	-20	-18	-15
200	-28	-25	-23	-26	-23	-21	-21	-18	-16

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-4.1	-6.6	-9.1	-9.8	-13.6	-17.5	-27.0	-38.6	-50.1
440	-4.2	-6.7	-9.2	-9.4	-13.2	-17.1	-25.1	-36.6	-48.2
420	-4.4	-6.9	-9.4	-9.0	-12.8	-16.7	-23.2	-34.7	-46.3
400	-4.6	-7.0	-9.5	-8.6	-12.5	-16.3	-21.3	-32.9	-44.4
380	-4.6	-7.1	-9.6	-8.2	-12.0	-15.9	-19.4	-31.0	-42.5
360	-4.5	-7.0	-9.5	-7.6	-11.5	-15.3	-17.5	-29.1	-40.7
340	-4.2	-6.7	-9.2	-7.0	-10.8	-14.7	-15.6	-27.2	-38.8
320	-3.9	-6.4	-8.9	-6.2	-10.1	-13.9	-13.8	-25.3	-36.9
300	-3.4	-5.9	-8.4	-5.4	-9.2	-13.1	-11.9	-23.4	-35.0
280	-2.7	-5.2	-7.7	-4.4	-8.3	-12.1	-10.0	-21.5	-33.1
260	-2.0	-4.5	-7.0	-3.4	-7.3	-11.1	-8.1	-19.6	-31.2
240	-1.1	-3.6	-6.1	-2.3	-6.1	-10.0	-6.2	-17.7	-29.3
220	-0.1	-2.6	-5.1	-1.1	-4.9	-8.8	-4.2	-15.8	-27.4
200	0.0	-1.4	-3.9	0.0	-3.6	-7.5	-2.3	-13.9	-25.5

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2200							199.8		
2400				208.3			279.6		
2600	288.6			314.4			357.4	219.7	
2800	394.6	194.2		408.7	235.9		433.2	299.0	
3000	487.2	316.6		495.2	338.7			376.3	239.6
3200		418.5	227.1		430.6	262.6		451.7	318.3
3400			343.3			362.4			395.2
3600			441.5			452.0			470.1

1. **Enter Table 1 with dry snow depth and TO1 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -105 m/+100 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff
10% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-17	-9	-2	-14	-7	0	-5	0	0
440	-20	-12	-5	-17	-9	-2	-8	-1	0
420	-22	-15	-7	-19	-12	-4	-11	-4	0
400	-25	-17	-10	-22	-14	-7	-14	-6	0
380	-27	-19	-12	-24	-17	-9	-17	-9	-2
360	-29	-22	-14	-27	-19	-12	-19	-12	-4
340	-31	-24	-16	-29	-21	-14	-21	-14	-6
320	-33	-26	-18	-31	-23	-16	-24	-16	-9
300	-35	-28	-20	-33	-25	-18	-26	-18	-11
280	-37	-30	-22	-35	-27	-20	-28	-20	-13
260	-39	-31	-24	-37	-29	-22	-30	-22	-15
240	-41	-33	-26	-38	-31	-23	-31	-24	-16
220	-42	-35	-27	-40	-32	-25	-33	-26	-18
200	-43	-36	-28	-41	-34	-26	-35	-27	-20

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-3.5	-6.2	-9.0	-12.1	-16.2	-20.3	-35.6	-45.1	-54.7
440	-3.3	-6.0	-8.7	-11.3	-15.4	-19.4	-33.1	-42.6	-52.1
420	-3.1	-5.8	-8.5	-10.4	-14.5	-18.6	-30.6	-40.2	-49.7
400	-2.8	-5.5	-8.3	-9.6	-13.7	-17.8	-28.2	-37.8	-47.3
380	-2.6	-5.3	-8.1	-8.8	-12.9	-17.0	-25.8	-35.3	-44.8
360	-2.4	-5.1	-7.8	-8.0	-12.1	-16.2	-23.2	-32.7	-42.3
340	-2.2	-4.9	-7.6	-7.1	-11.2	-15.3	-20.6	-30.1	-39.6
320	-1.9	-4.6	-7.4	-6.2	-10.3	-14.4	-17.8	-27.3	-36.9
300	-1.7	-4.4	-7.1	-5.2	-9.3	-13.4	-15.0	-24.5	-34.0
280	-1.4	-4.2	-6.9	-4.3	-8.3	-12.4	-12.0	-21.6	-31.1
260	-1.2	-3.9	-6.6	-3.2	-7.3	-11.4	-9.0	-18.5	-28.1
240	-1.0	-3.7	-6.4	-2.2	-6.3	-10.4	-5.9	-15.4	-24.9
220	-0.7	-3.4	-6.1	-1.1	-5.2	-9.3	-2.7	-12.2	-21.7
200	-0.5	-3.2	-5.9	0.0	-4.1	-8.2	0.0	-8.9	-18.4

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1800				170.4			197.5		
2000	223.2			236.7			257.0		
2200	293.3			303.8	166.6		316.9	194.1	
2400	364.7	219.2		371.8	232.9		377.1	253.6	
2600	437.4	289.2		440.7	299.9	162.8	437.8	313.4	190.7
2800		360.5	215.2		367.9	229.1	498.5	373.6	250.1
3000		433.2	285.2		436.7	296.1		434.3	310.0
3200			356.4			363.9		495.0	370.2
3400			429.0			432.7			430.8
3600									491.6

1. **Enter Table 1 with wet snow depth and TO1 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -95 m/+95 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-11	-8	-6	-7	-5	-2	-1	0	0
440	-13	-10	-8	-9	-7	-4	-2	0	0
420	-15	-12	-10	-11	-9	-6	-3	-1	0
400	-17	-14	-12	-13	-11	-8	-5	-2	0
380	-19	-16	-14	-15	-12	-10	-6	-4	-1
360	-21	-18	-16	-17	-14	-12	-8	-6	-3
340	-22	-20	-17	-19	-16	-14	-10	-7	-5
320	-24	-21	-19	-20	-18	-15	-12	-9	-7
300	-25	-22	-20	-22	-19	-17	-14	-11	-9
280	-26	-24	-21	-23	-21	-18	-16	-14	-11
260	-27	-25	-22	-25	-22	-20	-18	-16	-13
240	-28	-25	-23	-26	-23	-21	-21	-18	-16
220	-28	-26	-23	-27	-24	-22	-23	-21	-18
200	-29	-26	-24	-28	-25	-23	-26	-23	-21

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-5.9	-9.1	-12.3	-15.8	-20.7	-25.7	-40.2	-49.9	-59.7
440	-6.0	-9.2	-12.4	-15.1	-20.0	-25.0	-37.7	-47.4	-57.2
420	-6.1	-9.3	-12.4	-14.4	-19.3	-24.3	-35.2	-45.0	-54.7
400	-6.2	-9.3	-12.5	-13.7	-18.7	-23.7	-32.8	-42.6	-52.3
380	-6.1	-9.3	-12.4	-12.9	-17.9	-22.9	-30.3	-40.0	-49.8
360	-5.9	-9.1	-12.2	-12.0	-16.9	-21.9	-27.6	-37.3	-47.1
340	-5.5	-8.7	-11.8	-10.8	-15.8	-20.8	-24.7	-34.4	-44.2
320	-5.0	-8.1	-11.3	-9.6	-14.6	-19.6	-21.6	-31.4	-41.2
300	-4.3	-7.4	-10.6	-8.2	-13.2	-18.1	-18.4	-28.2	-37.9
280	-3.4	-6.6	-9.7	-6.6	-11.6	-16.6	-15.0	-24.8	-34.5
260	-2.4	-5.6	-8.7	-4.9	-9.8	-14.8	-11.5	-21.2	-31.0
240	-1.2	-4.4	-7.6	-3.0	-8.0	-13.0	-7.7	-17.5	-27.2
220	0.0	-3.1	-6.2	-1.0	-5.9	-10.9	-3.8	-13.6	-23.3
200	0.0	-1.6	-4.8	0.0	-3.8	-8.8	0.0	-9.5	-19.3

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2200							208.2		
2400	161.6			222.6			287.2		
2600	289.8			324.0			361.6	215.9	
2800	394.6	174.9		413.6	232.9		432.1	294.5	
3000	485.7	300.6		495.8	332.9		499.8	368.5	223.6
3200		403.7	188.2		421.7	243.0		438.6	301.7
3400		494.1	311.1			341.8			375.3
3600			412.7			429.6			445.1

1. **Enter Table 1 with wet snow depth and TO1 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -100 m/+100 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-16	-11	-6	-12	-7	-2	-4	0	0
440	-19	-14	-9	-14	-9	-4	-5	0	0
420	-21	-16	-11	-17	-12	-7	-7	-2	0
400	-23	-18	-13	-19	-14	-9	-9	-4	0
380	-26	-21	-16	-21	-16	-11	-11	-6	-1
360	-28	-23	-18	-24	-19	-14	-14	-9	-4
340	-30	-25	-20	-26	-21	-16	-16	-11	-6
320	-33	-28	-23	-29	-24	-19	-19	-14	-9
300	-35	-30	-25	-31	-26	-21	-22	-17	-12
280	-37	-32	-27	-34	-29	-24	-26	-21	-16
260	-39	-34	-29	-36	-31	-26	-29	-24	-19
240	-41	-36	-31	-39	-34	-29	-33	-28	-23
220	-43	-38	-33	-41	-36	-31	-37	-32	-27
200	-45	-40	-35	-44	-39	-34	-42	-37	-32

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	0.0	-0.5	-2.8	0.0	-0.5	-2.7	-13.0	-15.3	-17.6
440	0.0	-0.7	-2.9	0.0	-0.6	-2.9	-12.4	-14.7	-16.9
420	0.0	-0.8	-3.1	0.0	-0.8	-3.1	-11.7	-14.0	-16.3
400	0.0	-1.0	-3.3	0.0	-1.0	-3.3	-11.1	-13.4	-15.6
380	0.0	-1.2	-3.5	0.0	-1.2	-3.5	-10.4	-12.6	-14.9
360	0.0	-1.4	-3.6	0.0	-1.4	-3.7	-9.6	-11.8	-14.1
340	0.0	-1.5	-3.8	0.0	-1.6	-3.8	-8.7	-10.9	-13.2
320	0.0	-1.7	-4.0	0.0	-1.7	-4.0	-7.7	-10.0	-12.2
300	0.0	-1.9	-4.1	0.0	-1.9	-4.2	-6.6	-8.9	-11.2
280	0.0	-2.1	-4.3	0.0	-2.1	-4.3	-5.5	-7.7	-10.0
260	0.0	-2.2	-4.5	0.0	-2.2	-4.5	-4.2	-6.5	-8.8
240	-0.1	-2.4	-4.7	-0.1	-2.4	-4.7	-2.9	-5.2	-7.5
220	-0.3	-2.6	-4.8	-0.3	-2.5	-4.8	-1.5	-3.8	-6.0
200	-0.5	-2.7	-5.0	-0.4	-2.7	-4.9	0.0	-2.3	-4.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1800	228.9								
2000	311.7			223.3					
2200	390.6	210.9		294.5					
2400	466.6	294.7		368.0	208.6				
2600		374.4	192.8	443.9	279.4				
2800		450.8	277.5		352.3	194.0	177.3		
3000			357.9		427.8	264.4	210.3		
3200			434.9			336.7	244.5	170.4	
3400						411.8	280.2	203.2	
3600						488.7	317.5	237.2	163.6
3800							356.8	272.6	196.2
4000							398.0	309.5	230.0
4200							442.0	348.4	265.0
4400							487.7	389.1	301.6
4600								432.5	340.1
4800								478.1	380.4
5000									423.2
5200									468.5

1. **Enter Table 1 with reported braking action and TO1 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -130 m/+130 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -130 m/+130 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -130 m/+130 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-11	-8	-6	-15	-12	-10	-46	-44	-41
440	-12	-10	-7	-17	-14	-12	-48	-46	-43
420	-13	-11	-8	-19	-16	-14	-50	-48	-45
400	-14	-11	-9	-20	-18	-15	-52	-49	-47
380	-15	-12	-10	-22	-19	-17	-53	-51	-48
360	-15	-13	-10	-23	-20	-18	-54	-52	-49
340	-15	-13	-10	-24	-22	-19	-55	-53	-50
320	-16	-13	-11	-25	-22	-20	-56	-54	-51
300	-16	-13	-11	-26	-23	-21	-57	-54	-52
280	-15	-13	-10	-26	-24	-21	-57	-55	-52
260	-15	-12	-10	-27	-24	-22	-58	-55	-53
240	-14	-12	-9	-27	-25	-22	-58	-55	-53
220	-14	-11	-9	-27	-25	-22	-58	-55	-53
200	-13	-10	-8	-27	-25	-22	-57	-55	-52

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	0.0	-0.6	-2.8	0.0	-2.0	-4.2	-19.9	-22.1	-24.4
440	0.0	-0.7	-3.0	-0.3	-2.6	-4.9	-18.8	-21.0	-23.3
420	0.0	-0.9	-3.2	-0.9	-3.2	-5.5	-17.7	-20.0	-22.3
400	0.0	-1.1	-3.4	-1.5	-3.7	-6.0	-16.7	-18.9	-21.2
380	0.0	-1.3	-3.5	-1.9	-4.1	-6.4	-15.5	-17.8	-20.1
360	0.0	-1.4	-3.7	-2.1	-4.4	-6.6	-14.3	-16.5	-18.8
340	0.0	-1.6	-3.9	-2.2	-4.5	-6.7	-12.9	-15.2	-17.5
320	0.0	-1.7	-4.0	-2.1	-4.4	-6.6	-11.5	-13.8	-16.1
300	0.0	-1.9	-4.2	-1.9	-4.1	-6.4	-10.0	-12.3	-14.5
280	0.0	-2.1	-4.3	-1.5	-3.7	-6.0	-8.4	-10.7	-12.9
260	0.0	-2.2	-4.5	-0.9	-3.2	-5.4	-6.7	-9.0	-11.3
240	-0.1	-2.4	-4.6	-0.2	-2.4	-4.7	-4.9	-7.2	-9.5
220	-0.3	-2.5	-4.8	0.0	-1.5	-3.8	-3.1	-5.3	-7.6
200	-0.4	-2.7	-5.0	0.0	-0.5	-2.8	-1.1	-3.4	-5.6

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2200	213.7								
2400	361.6								
2600	458.6	161.6		284.6					
2800		337.0		396.1					
3000		440.3		490.0	257.8				
3200			310.1		374.5				
3400			421.2		470.8	229.2			
3600						352.0			
3800						451.5			
5400							162.8		
5600							238.4		
5800							313.5		
6000							388.1	222.5	

1. **Enter Table 1 with reported braking action and TO1 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -150 m/+145 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -150 m/+145 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -150 m/+145 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
10% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-16	-11	-6	-21	-16	-11	-69	-64	-59
440	-17	-12	-7	-23	-18	-13	-72	-67	-62
420	-18	-13	-8	-26	-21	-16	-74	-69	-64
400	-19	-14	-9	-28	-23	-18	-76	-71	-66
380	-20	-15	-10	-30	-25	-20	-78	-73	-68
360	-21	-16	-11	-32	-27	-22	-80	-75	-70
340	-22	-17	-12	-34	-29	-24	-81	-76	-71
320	-22	-17	-12	-35	-30	-25	-83	-78	-73
300	-22	-17	-12	-37	-32	-27	-84	-79	-74
280	-23	-18	-13	-38	-33	-28	-85	-80	-75
260	-23	-18	-13	-40	-35	-30	-86	-81	-76
240	-23	-18	-13	-41	-36	-31	-87	-82	-77
220	-23	-18	-13	-42	-37	-32	-88	-83	-78
200	-22	-17	-12	-44	-39	-34	-89	-84	-79

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

TO1 Takeoff %N1

10% Thrust Reduction

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)												
	-2	-1	0	1	2	3	4	5	6	7	8	9	10
70	86.0	86.5	86.9	86.9	86.8	86.8	86.7	86.6	86.6	86.6	86.1	85.9	86.0
60	88.7	89.1	89.6	89.6	89.5	89.5	89.4	89.3	89.3	89.3	88.8	88.2	87.6
55	90.0	90.5	90.9	90.9	90.9	90.8	90.7	90.7	90.7	90.6	90.1	89.5	89.0
50	91.3	91.8	92.2	92.1	92.1	92.1	92.0	92.0	92.0	91.9	91.4	90.8	90.3
45	92.6	93.1	93.5	93.4	93.4	93.3	93.3	93.2	93.2	93.2	92.7	92.1	91.5
40	93.5	94.3	94.9	94.7	94.5	94.5	94.5	94.5	94.4	94.4	93.9	93.4	92.8
35	93.9	94.8	95.6	95.5	95.5	95.3	95.2	95.1	95.1	95.1	94.8	94.4	94.0
30	93.3	94.7	96.1	96.0	96.0	96.0	96.0	95.8	95.7	95.6	95.3	95.0	94.7
25	92.5	93.9	95.3	95.7	96.2	96.5	96.6	96.6	97.0	96.7	95.9	95.5	95.2
20	91.7	93.1	94.5	94.9	95.4	95.9	96.3	96.8	97.0	97.1	97.0	96.6	95.7
15	90.9	92.3	93.6	94.1	94.6	95.1	95.5	96.0	96.4	96.9	96.9	96.7	96.1
10	90.1	91.5	92.8	93.3	93.8	94.3	94.7	95.1	95.6	96.0	96.2	96.3	96.5
5	89.3	90.7	92.0	92.5	93.0	93.4	93.8	94.3	94.7	95.2	95.3	95.5	95.6
0	88.5	89.9	91.2	91.6	92.1	92.6	93.0	93.4	93.9	94.3	94.5	94.6	94.8
-10	86.9	88.2	89.5	89.9	90.4	90.9	91.3	91.8	92.2	92.6	92.8	92.9	93.1
-20	85.2	86.5	87.8	88.2	88.7	89.2	89.6	90.0	90.5	90.9	91.1	91.2	91.4
-30	83.5	84.8	86.0	86.4	86.9	87.4	87.9	88.3	88.7	89.2	89.3	89.5	89.6
-40	81.8	83.0	84.2	84.7	85.1	85.7	86.1	86.5	87.0	87.4	87.6	87.7	87.9
-50	80.0	81.2	82.4	82.9	83.4	83.9	84.3	84.7	85.2	85.6	85.7	85.9	86.1

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)			
	-2	0	9	10
PACKS OFF	0.5	0.6	0.6	0.7
ENGINE ANTI-ICE ON	0.0	0.0	0.0	-0.4
ENGINE AND WING ANTI-ICE ON	0.0	0.0	0.0	-0.4

TO2 Minimum Takeoff Weight

20% Thrust Reduction

Based on engine bleed for packs on and anti-ice off

Flaps 10

Weight Limit (1000 KG)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
45	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
40	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
35	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
30	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
25	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
20	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
15	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
10	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
0 & BELOW	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3

Flaps 20

Weight Limit (1000 KG)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
45	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
40	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
35	184.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
30	190.4	183.5	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
25	190.7	185.9	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
20	190.9	186.1	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
15	191.1	186.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
10	191.2	186.5	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3
0 & BELOW	191.5	186.7	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3	182.3

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability.

TO2 Takeoff Speeds - Dry Runway

20% Thrust Reduction

Flaps 10

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 10		
	V1	VR	V2
440	177	185	193
420	172	180	189
400	167	175	185
380	163	170	181
360	158	165	177
340	152	159	172
320	146	153	167
300	140	147	162
280	133	140	157
260	126	133	151
240	118	126	145
220	110	119	139
200	101	111	133

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	11	12						6	6						-2	-2					
60	9	10	13	15				5	5	7	8				-1	-1	-2	-2			
50	6	6	8	12	13	15	18	3	4	5	6	7	9	10	-1	-1	-1	-1	-2	-2	-2
40	3	3	6	8	10	13	15	2	2	3	5	6	7	9	0	0	-1	-1	-1	-2	-2
30	0	0	3	5	8	10	13	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	2	3	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-40	0	0	2	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1
-60	1	1	3	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
440	-5	-3	0	2	5	-4	-2	-1	0	1	2	2	3
420	-5	-2	0	2	5	-3	-2	-1	0	1	1	2	3
400	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
380	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	2
360	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	2
340	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	2
320	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	2
300	-3	-1	0	2	3	-2	-1	0	0	1	1	2	2
280	-3	-1	0	2	3	-2	-1	0	0	1	1	2	3
260	-2	-1	0	2	3	-2	-1	0	0	1	2	2	3
240	-2	-1	0	2	3	-2	-1	0	0	1	2	2	3
220	-2	-1	0	2	3	-2	-1	0	0	1	2	2	3
200	-2	-1	0	2	3	-3	-2	-1	0	1	2	3	3

***V1 not to exceed VR**

TO2 Takeoff Speeds - Dry Runway

20% Thrust Reduction

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	110	113	108	112	106	110	104	108						
50	113	116	111	115	107	110	104	108	102	107	100	104	97	101
40	119	122	118	121	113	116	108	112	104	108	100	104	97	101
30	122	126	122	125	117	121	113	117	108	112	103	107	98	103
20	123	126	122	126	119	123	116	120	112	116	108	112	102	106
-60	124	126	124	126	121	123	118	120	114	117	111	114	107	110

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)						
	100	105	110	115	120	125	130
260	148	149	149	150	150	150	151
240	143	143	143	143	143	144	148
220	137	137	137	137	138	143	148
200	130	131	131	132	137	141	147

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 20		
	V1	VR	V2
400	156	162	170
380	152	157	167
360	147	152	163
340	141	147	158
320	135	141	154
300	129	135	149
280	123	129	144
260	116	123	139
240	108	116	134
220	100	109	128
200	92	102	123

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	11	12						6	6						-2	-2					
60	9	10	13	15				5	5	7	8				-1	-1	-2	-2			
50	6	6	8	12	13	15	18	3	4	5	6	7	9	10	-1	-1	-1	-1	-2	-2	-2
40	3	3	6	8	10	13	15	2	2	3	5	6	7	9	0	0	-1	-1	-1	-2	-2
30	0	0	3	5	8	10	13	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	2	3	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-40	0	0	2	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1
-60	1	1	3	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

TO2 Takeoff Speeds - Dry Runway

20% Thrust Reduction

Flaps 20

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT	SLOPE (%)					WIND (KTS)							
(1000 KG)	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
400	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
380	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	2
360	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	2
340	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	2
320	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	2
300	-3	-1	0	2	3	-2	-1	0	0	1	1	2	2
280	-3	-1	0	2	3	-2	-1	0	0	1	1	2	3
260	-2	-1	0	2	3	-2	-1	0	0	1	2	2	3
240	-2	-1	0	2	3	-2	-1	0	0	1	2	2	3
220	-2	-1	0	2	3	-2	-1	0	0	1	2	2	3
200	-2	-1	0	2	3	-3	-2	-1	0	1	2	3	3

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	110	113	108	112	106	110	104	108						
50	113	116	111	115	107	110	104	108	102	107	100	104	97	101
40	119	122	118	121	113	116	108	112	104	108	100	104	97	101
30	122	126	122	125	117	121	113	117	108	112	103	107	98	103
20	123	126	122	126	119	123	116	120	112	116	108	112	102	106
-60	124	126	124	126	121	123	118	120	114	117	111	114	107	110

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT	Min VR (KIAS)						
(1000 KG)	100	105	110	115	120	125	130
280	143	143	143	144	144	144	145
260	137	137	137	137	138	139	145
240	131	132	131	132	134	139	144
220	126	126	126	128	133	138	144
200	120	120	122	127	132	137	143

TO2 Takeoff Speeds - Wet Runway

20%Thrust Reduction

Flaps 10

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 10		
	V1	VR	V2
440	166	185	193
420	161	180	189
400	155	175	185
380	149	170	181
360	143	165	177
340	137	159	172
320	130	153	167
300	124	147	162
280	117	140	157
260	109	133	151
240	102	126	145
220	94	119	139
200	86	111	133

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	12	13						6	6						-2	-2					
60	11	12	14	16				5	5	7	8				-1	-1	-2	-2			
50	7	7	9	12	15	17	20	3	4	5	6	7	9	10	-1	-1	-1	-1	-2	-2	-2
40	3	3	5	8	10	13	16	2	2	3	5	6	7	9	-0	-0	-1	-1	-1	-2	-2
30	0	0	3	5	7	10	13	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	2	3	5	8	11	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
0	0	0	2	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1
-20	1	1	3	4	6	8	10	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1
-40	2	2	4	5	7	9	11	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1
-60	2	2	4	5	7	9	11	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
440	-6	-3	0	4	8	-4	-3	-1	0	1	3	4	5
420	-6	-3	0	4	8	-5	-3	-1	0	1	3	4	5
400	-6	-3	0	4	7	-5	-3	-1	0	1	3	4	5
380	-6	-3	0	4	7	-5	-3	-1	0	1	3	4	5
360	-6	-3	0	4	7	-6	-4	-1	0	1	3	4	5
340	-6	-3	0	3	6	-6	-4	-2	0	1	3	4	5
320	-5	-2	0	3	6	-6	-4	-2	0	1	3	4	6
300	-5	-2	0	3	6	-6	-4	-2	0	2	3	4	6
280	-5	-2	0	3	5	-6	-4	-2	0	2	3	5	6
260	-4	-2	0	3	5	-6	-4	-2	0	2	3	5	6
240	-4	-1	0	3	5	-7	-4	-2	0	2	4	5	6
220	-3	-1	0	3	5	-7	-4	-1	0	2	4	5	7
200	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7

***V1 not to exceed VR**

TO2 Takeoff Speeds - Wet Runway

20%Thrust Reduction

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	110	113	108	112	106	110	104	108						
50	113	116	111	115	107	110	104	108	102	107	100	104	97	101
40	119	122	118	121	113	116	108	112	104	108	100	104	97	101
30	122	126	122	125	117	121	113	117	108	112	103	107	98	103
20	123	126	122	126	119	123	116	120	112	116	108	112	102	106
-60	124	126	124	126	121	123	118	120	114	117	111	114	107	110

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 KG)	Min VR (KIAS)						
	100	105	110	115	120	125	130
260	148	149	149	150	150	150	151
240	143	143	143	143	143	144	148
220	137	137	137	137	138	143	148
200	130	131	131	132	137	141	147

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 KG)	FLAPS 20		
	V1	VR	V2
400	143	162	170
380	138	157	167
360	133	152	163
340	127	147	158
320	121	141	154
300	115	135	149
280	108	129	144
260	101	123	139
240	94	116	134
220	86	109	128
200	79	103	123

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	12	13						6	6						-2	-2					
60	11	12	14	16				5	5	7	8				-1	-1	-2	-2			
50	7	7	9	12	15	17	20	3	4	5	6	7	9	10	-1	-1	-1	-1	-2	-2	-2
40	3	3	5	8	10	13	16	2	2	3	5	6	7	9	-0	-0	-1	-1	-1	-2	-2
30	0	0	3	5	7	10	13	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	2	3	5	8	11	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
0	0	0	2	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1
-20	1	1	3	4	6	8	10	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1
-40	2	2	4	5	7	9	11	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1
-60	2	2	4	5	7	9	11	0	0	1	2	3	4	5	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

TO2 Takeoff Speeds - Wet Runway

20%Thrust Reduction

Flaps 20

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT	SLOPE (%)					WIND (KTS)							
(1000 KG)	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
400	-6	-3	0	4	7	-5	-3	-1	0	1	3	4	5
380	-6	-3	0	4	7	-5	-3	-1	0	1	3	4	5
360	-6	-3	0	4	7	-6	-4	-1	0	1	3	4	5
340	-6	-3	0	3	6	-6	-4	-2	0	1	3	4	5
320	-5	-2	0	3	6	-6	-4	-2	0	1	3	4	6
300	-5	-2	0	3	6	-6	-4	-2	0	2	3	4	6
280	-5	-2	0	3	5	-6	-4	-2	0	2	3	5	6
260	-4	-2	0	3	5	-6	-4	-2	0	2	3	5	6
240	-4	-1	0	3	5	-7	-4	-2	0	2	4	5	6
220	-3	-1	0	3	5	-7	-4	-1	0	2	4	5	7
200	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	110	113	108	112	106	110	104	108						
50	113	116	111	115	107	110	104	108	102	107	100	104	97	101
40	119	122	118	121	113	116	108	112	104	108	100	104	97	101
30	122	126	122	125	117	121	113	117	108	112	103	107	98	103
20	123	126	122	126	119	123	116	120	112	116	108	112	102	106
-60	124	126	124	126	121	123	118	120	114	117	111	114	107	110

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT	Min VR (KIAS)						
(1000 KG)	100	105	110	115	120	125	130
280	143	143	143	144	144	144	145
260	137	137	137	137	138	139	145
240	131	132	131	132	134	139	144
220	126	126	126	128	133	138	144
200	120	120	122	127	132	137	143

TO2 Maximum Allowable Clearway
20% Thrust Reduction

FIELD LENGTH (M)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (M)
2000	250
2500	290
3000	320
3500	350
4000	380
4500	410
5000	430

TO2 Clearway and Stopway V1 Adjustments
20% Thrust Reduction

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

Use of clearway not allowed on wet runways.
V1 not to exceed VR.

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-8.9	-13.2	-17.5	-20.1	-28.0	-35.9	-45.2	-60.6	-76.0
440	-8.0	-12.3	-16.6	-18.2	-26.1	-34.0	-41.1	-56.5	-71.9
420	-7.1	-11.4	-15.7	-16.3	-24.2	-32.1	-37.0	-52.5	-67.9
400	-6.2	-10.5	-14.8	-14.4	-22.3	-30.2	-33.0	-48.4	-63.8
380	-5.3	-9.6	-13.9	-12.5	-20.4	-28.4	-29.1	-44.5	-59.9
360	-4.4	-8.8	-13.1	-10.8	-18.7	-26.6	-25.3	-40.7	-56.2
340	-3.7	-8.0	-12.3	-9.1	-17.1	-25.0	-21.8	-37.2	-52.6
320	-3.0	-7.3	-11.7	-7.6	-15.6	-23.5	-18.4	-33.8	-49.2
300	-2.4	-6.7	-11.1	-6.2	-14.2	-22.1	-15.1	-30.6	-46.0
280	-1.9	-6.2	-10.5	-4.9	-12.9	-20.8	-12.1	-27.5	-42.9
260	-1.5	-5.8	-10.1	-3.8	-11.7	-19.6	-9.2	-24.6	-40.0
240	-1.1	-5.4	-9.7	-2.7	-10.6	-18.6	-6.5	-21.9	-37.3
220	-0.7	-5.0	-9.3	-1.7	-9.7	-17.6	-3.9	-19.3	-34.7
200	-0.5	-4.8	-9.1	-0.9	-8.8	-16.7	-1.5	-16.9	-32.3

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1800				175.8			210.3		
2000	221.3			243.2			274.8		
2200	294.5			314.8			342.1	192.3	
2400	372.9	201.3		391.0	223.6		412.4	256.2	
2600	457.3	273.2		472.6	293.9		485.6	322.6	174.5
2800		349.9	181.6		368.7	204.3		392.0	237.7
3000		432.7	252.2		448.9	273.5		464.6	303.4
3200			327.5			346.9			371.9
3400			408.4			425.4			443.5
3600			495.2						

1. **Enter Table 1 with slush/standing water depth and TO2 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -140 m/+140 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-16	-13	-11	-10	-8	-5	0	0	0
440	-17	-15	-12	-12	-9	-7	0	0	0
420	-19	-16	-14	-14	-11	-9	-1	0	0
400	-20	-18	-15	-15	-13	-10	-3	-1	0
380	-21	-19	-16	-16	-14	-11	-5	-3	0
360	-22	-19	-17	-18	-15	-13	-8	-5	-3
340	-23	-20	-18	-19	-16	-14	-10	-7	-5
320	-23	-21	-18	-20	-17	-15	-11	-9	-6
300	-24	-21	-19	-21	-18	-16	-13	-11	-8
280	-24	-22	-19	-21	-19	-16	-15	-12	-10
260	-24	-22	-19	-22	-19	-17	-16	-14	-11
240	-24	-22	-19	-22	-20	-17	-17	-15	-12
220	-24	-21	-19	-22	-20	-17	-19	-16	-14
200	-23	-21	-18	-22	-20	-17	-20	-17	-15

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-12.6	-17.3	-22.1	-23.7	-31.8	-40.0	-49.5	-65.6	-81.7
440	-11.7	-16.5	-21.2	-21.8	-30.0	-38.2	-45.4	-61.5	-77.6
420	-10.8	-15.6	-20.3	-20.0	-28.2	-36.3	-41.4	-57.5	-73.6
400	-9.9	-14.7	-19.5	-18.2	-26.3	-34.5	-37.3	-53.4	-69.5
380	-9.1	-13.8	-18.6	-16.4	-24.6	-32.7	-33.4	-49.5	-65.6
360	-8.2	-13.0	-17.7	-14.7	-22.8	-31.0	-29.6	-45.7	-61.8
340	-7.3	-12.1	-16.8	-12.9	-21.1	-29.3	-25.8	-41.9	-58.0
320	-6.3	-11.1	-15.9	-11.2	-19.3	-27.5	-22.2	-38.3	-54.4
300	-5.3	-10.1	-14.8	-9.4	-17.6	-25.7	-18.6	-34.7	-50.8
280	-4.3	-9.0	-13.8	-7.6	-15.8	-23.9	-15.1	-31.2	-47.3
260	-3.2	-7.9	-12.7	-5.8	-14.0	-22.1	-11.7	-27.8	-43.9
240	-2.0	-6.7	-11.5	-3.9	-12.1	-20.2	-8.3	-24.4	-40.5
220	-0.7	-5.5	-10.2	-2.1	-10.2	-18.4	-5.0	-21.1	-37.2
200	0.0	-4.2	-9.0	-0.2	-8.3	-16.5	-1.8	-17.9	-34.0

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2200							202.4		
2400				178.4			298.3		
2600	215.9			309.9			393.9	189.8	
2800	372.3			430.6	160.3		489.8	285.7	
3000		192.0			293.2			381.3	177.1
3200		353.4			415.1			477.0	273.0
3400		487.8	167.3			276.2			368.6
3600			333.9			399.4			464.1
3800			470.4						

1. **Enter Table 1 with slush/standing water depth and TO2 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -165 m/+165 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3 mm (0.12 INCHES)			6 mm (0.25 INCHES)			13 mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-21	-16	-11	-15	-10	-5	0	0	0
440	-23	-18	-13	-17	-12	-7	-1	0	0
420	-25	-20	-15	-19	-14	-9	-4	0	0
400	-26	-21	-16	-21	-16	-11	-7	-2	0
380	-28	-23	-18	-23	-18	-13	-10	-5	0
360	-30	-25	-20	-24	-19	-14	-12	-7	-2
340	-31	-26	-21	-26	-21	-16	-15	-10	-5
320	-32	-27	-22	-28	-23	-18	-18	-13	-8
300	-33	-28	-23	-30	-25	-20	-21	-16	-11
280	-34	-29	-24	-31	-26	-21	-23	-18	-13
260	-35	-30	-25	-33	-28	-23	-26	-21	-16
240	-36	-31	-26	-34	-29	-24	-29	-24	-19
220	-37	-32	-27	-35	-30	-25	-31	-26	-21
200	-38	-33	-28	-37	-32	-27	-34	-29	-24

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff
20% Thrust Reduction
2 Engine Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-2.0	-5.2	-8.4	-7.1	-11.9	-16.7	-24.8	-37.0	-49.3
440	-1.9	-5.1	-8.2	-6.6	-11.3	-16.1	-22.7	-34.9	-47.2
420	-1.7	-4.9	-8.1	-6.0	-10.7	-15.5	-20.6	-32.8	-45.1
400	-1.6	-4.8	-7.9	-5.4	-10.2	-14.9	-18.5	-30.7	-43.0
380	-1.4	-4.6	-7.8	-4.9	-9.6	-14.4	-16.5	-28.7	-41.0
360	-1.3	-4.5	-7.7	-4.3	-9.1	-13.9	-14.5	-26.8	-39.0
340	-1.2	-4.4	-7.6	-3.9	-8.6	-13.4	-12.8	-25.0	-37.2
320	-1.1	-4.3	-7.5	-3.4	-8.2	-13.0	-11.1	-23.3	-35.6
300	-1.0	-4.2	-7.4	-3.0	-7.8	-12.6	-9.6	-21.8	-34.0
280	-1.0	-4.1	-7.3	-2.7	-7.4	-12.2	-8.1	-20.4	-32.6
260	-0.9	-4.1	-7.3	-2.4	-7.1	-11.9	-6.9	-19.1	-31.3
240	-0.9	-4.1	-7.3	-2.1	-6.8	-11.6	-5.7	-17.9	-30.2
220	-0.9	-4.1	-7.2	-1.8	-6.6	-11.3	-4.7	-16.9	-29.2
200	-0.9	-4.1	-7.3	-1.6	-6.4	-11.1	-3.8	-16.0	-28.2

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1600							167.7		
1800	191.6			203.3			229.5		
2000	263.5			272.9			292.5	173.5	
2200	336.9	198.4		343.7	209.9		356.8	235.4	
2400	411.7	270.4		416.0	279.5		422.6	298.6	179.4
2600	488.0	343.9	205.2	489.7	350.5	216.4	489.6	363.0	241.4
2800		418.9	277.4		423.0	286.2		428.9	304.6
3000		495.2	351.0		496.7	357.3		496.0	369.2
3200			426.1			430.0			435.3

1. **Enter Table 1 with dry snow depth and TO2 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -100 m/+95 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff
20% Thrust Reduction
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-8	-6	-3	-5	-3	0	0	0	0
440	-11	-8	-6	-8	-6	-3	0	0	0
420	-13	-11	-8	-11	-8	-6	-3	0	0
400	-15	-13	-10	-13	-10	-8	-5	-3	0
380	-18	-15	-13	-15	-13	-10	-8	-5	-3
360	-19	-17	-14	-17	-15	-12	-10	-7	-5
340	-21	-19	-16	-19	-16	-14	-12	-9	-7
320	-23	-20	-18	-20	-18	-15	-13	-11	-8
300	-24	-21	-19	-22	-19	-17	-15	-12	-10
280	-25	-22	-20	-23	-20	-18	-16	-14	-11
260	-26	-23	-21	-23	-21	-18	-17	-15	-12
240	-26	-24	-21	-24	-21	-19	-18	-15	-13
220	-26	-24	-21	-24	-22	-19	-18	-16	-13
200	-26	-24	-21	-24	-22	-19	-19	-16	-14

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-3.4	-5.9	-8.4	-9.5	-13.4	-17.2	-27.8	-39.4	-50.9
440	-3.6	-6.1	-8.6	-9.1	-13.0	-16.8	-25.9	-37.4	-49.0
420	-3.7	-6.2	-8.7	-8.7	-12.6	-16.5	-23.9	-35.5	-47.0
400	-3.9	-6.4	-8.9	-8.3	-12.2	-16.1	-22.0	-33.5	-45.1
380	-4.1	-6.6	-9.1	-8.0	-11.8	-15.7	-20.1	-31.7	-43.2
360	-4.2	-6.7	-9.2	-7.6	-11.4	-15.3	-18.2	-29.8	-41.4
340	-4.1	-6.6	-9.1	-7.0	-10.9	-14.8	-16.4	-27.9	-39.5
320	-3.9	-6.4	-8.9	-6.4	-10.3	-14.1	-14.5	-26.1	-37.6
300	-3.6	-6.0	-8.5	-5.7	-9.6	-13.4	-12.6	-24.2	-35.8
280	-3.1	-5.6	-8.0	-4.9	-8.7	-12.6	-10.8	-22.3	-33.9
260	-2.4	-4.9	-7.4	-3.9	-7.8	-11.6	-8.9	-20.4	-32.0
240	-1.6	-4.1	-6.6	-2.9	-6.7	-10.6	-7.0	-18.5	-30.1
220	-0.7	-3.2	-5.7	-1.7	-5.6	-9.5	-5.1	-16.6	-28.2
200	0.0	-2.1	-4.6	-0.5	-4.4	-8.2	-3.2	-14.7	-26.3

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.36 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2000							175.9		
2200				180.9			260.8		
2400	266.4			295.4			342.8	197.2	
2600	379.6	163.0		395.0	211.0		421.8	281.4	
2800	476.1	296.4		484.7	321.2		498.5	362.6	218.3
3000		404.7	199.0		417.9	239.8		441.0	301.8
3200		499.0	325.1			346.2			382.2
3400			428.9			440.3			460.0

1. **Enter Table 1 with dry snow depth and TO2 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -105 m/+100 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH								
	30 mm (1.18 INCHES)			60 mm (2.26 INCHES)			130 mm (5.12 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-12	-5	0	-9	-2	0	0	0	0
440	-15	-8	0	-12	-5	0	-3	0	0
420	-18	-11	-3	-15	-8	0	-6	0	0
400	-21	-13	-6	-18	-10	-3	-9	-2	0
380	-23	-16	-8	-21	-13	-6	-12	-4	0
360	-26	-18	-11	-23	-16	-8	-15	-7	0
340	-28	-21	-13	-25	-18	-10	-17	-10	-2
320	-30	-23	-15	-28	-20	-13	-20	-12	-5
300	-32	-25	-17	-30	-22	-15	-22	-15	-7
280	-34	-27	-19	-32	-24	-17	-24	-17	-9
260	-36	-29	-21	-34	-26	-19	-26	-19	-11
240	-38	-31	-23	-36	-28	-21	-28	-21	-13
220	-40	-32	-25	-37	-30	-22	-30	-22	-15
200	-41	-34	-26	-39	-31	-24	-32	-24	-17

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-3.5	-6.3	-9.0	-12.3	-16.3	-20.4	-36.1	-45.7	-55.2
440	-3.3	-6.0	-8.7	-11.4	-15.5	-19.6	-33.6	-43.2	-52.7
420	-3.1	-5.8	-8.5	-10.6	-14.7	-18.7	-31.1	-40.6	-50.2
400	-2.8	-5.6	-8.3	-9.7	-13.8	-17.9	-28.6	-38.1	-47.6
380	-2.6	-5.3	-8.1	-8.9	-13.0	-17.1	-26.2	-35.7	-45.3
360	-2.4	-5.1	-7.8	-8.1	-12.2	-16.3	-23.9	-33.4	-42.9
340	-2.2	-4.9	-7.6	-7.3	-11.4	-15.5	-21.5	-31.0	-40.5
320	-2.0	-4.7	-7.4	-6.5	-10.6	-14.7	-18.9	-28.4	-38.0
300	-1.7	-4.5	-7.2	-5.6	-9.7	-13.8	-16.2	-25.8	-35.3
280	-1.5	-4.2	-7.0	-4.7	-8.8	-12.9	-13.5	-23.0	-32.5
260	-1.3	-4.0	-6.7	-3.8	-7.8	-11.9	-10.6	-20.1	-29.6
240	-1.0	-3.8	-6.5	-2.7	-6.8	-10.9	-7.5	-17.1	-26.6
220	-0.8	-3.5	-6.2	-1.7	-5.8	-9.9	-4.4	-13.9	-23.5
200	-0.5	-3.3	-6.0	-0.6	-4.7	-8.8	-1.1	-10.7	-20.2

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1600							166.5		
1800	190.0			204.9			228.4		
2000	262.2			274.1			290.4	163.0	
2200	335.3	185.9		343.9	200.9		352.4	224.9	
2400	409.4	258.0		414.2	270.1		414.5	286.8	
2600	484.5	331.1	181.8	485.1	339.8	197.0	476.7	348.9	221.3
2800		405.1	253.8		410.2	266.1		410.9	283.2
3000		480.2	326.8		481.1	335.8		473.1	345.3
3200			400.8			406.1			407.4
3400			475.9			477.0			469.5

1. **Enter Table 1 with wet snow depth and TO2 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -95 m/+95 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-8	-5	-3	-4	-2	0	0	0	0
440	-10	-7	-5	-6	-4	-1	0	0	0
420	-12	-10	-7	-8	-6	-3	-1	0	0
400	-14	-12	-9	-10	-8	-5	-2	0	0
380	-16	-14	-11	-12	-10	-7	-4	-1	0
360	-18	-16	-13	-14	-12	-9	-5	-3	0
340	-20	-18	-15	-16	-13	-11	-7	-5	-2
320	-22	-19	-17	-18	-15	-13	-9	-6	-4
300	-23	-21	-18	-20	-17	-15	-11	-8	-6
280	-25	-22	-20	-21	-19	-16	-13	-11	-8
260	-26	-23	-21	-23	-20	-18	-16	-13	-11
240	-27	-24	-22	-24	-22	-19	-18	-16	-13
220	-27	-25	-22	-26	-23	-21	-21	-19	-16
200	-28	-25	-23	-27	-24	-22	-24	-22	-19

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-5.1	-8.3	-11.4	-15.2	-20.2	-25.2	-40.2	-50.0	-59.7
440	-5.2	-8.3	-11.5	-14.5	-19.5	-24.5	-37.7	-47.4	-57.2
420	-5.2	-8.4	-11.6	-13.8	-18.8	-23.8	-35.1	-44.9	-54.6
400	-5.3	-8.5	-11.7	-13.1	-18.1	-23.1	-32.6	-42.4	-52.1
380	-5.4	-8.6	-11.8	-12.4	-17.4	-22.4	-30.3	-40.0	-49.8
360	-5.4	-8.6	-11.8	-11.8	-16.8	-21.7	-28.0	-37.7	-47.5
340	-5.3	-8.5	-11.7	-10.9	-15.9	-20.9	-25.4	-35.2	-44.9
320	-5.0	-8.2	-11.3	-9.9	-14.9	-19.9	-22.7	-32.4	-42.2
300	-4.5	-7.7	-10.8	-8.7	-13.7	-18.7	-19.8	-29.5	-39.3
280	-3.8	-7.0	-10.2	-7.4	-12.3	-17.3	-16.6	-26.4	-36.1
260	-3.0	-6.2	-9.3	-5.8	-10.8	-15.8	-13.3	-23.0	-32.8
240	-2.0	-5.1	-8.3	-4.1	-9.1	-14.1	-9.7	-19.5	-29.2
220	-0.7	-3.9	-7.1	-2.2	-7.2	-12.1	-6.0	-15.7	-25.5
200	0.0	-2.5	-5.7	-0.1	-5.1	-10.1	-2.0	-11.8	-21.5

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2000							180.1		
2200				191.8			265.8		
2400	263.4			302.3			345.2	188.5	
2600	376.3			397.6	203.1		419.2	273.6	
2800	471.6	275.2		482.9	311.9		489.1	352.5	196.9
3000		385.9			406.0	214.2		426.0	281.3
3200		480.2	286.7		490.8	321.4		495.6	359.6
3400			395.5			414.4			432.7
3600			488.9			498.7			

1. **Enter Table 1 with wet snow depth and TO2 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -100 m/+100 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	WET SNOW DEPTH								
	5 mm (0.20 INCHES)			13 mm (0.50 INCHES)			30 mm (1.18 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-12	-7	-2	-8	-3	0	-1	0	0
440	-15	-10	-5	-11	-6	-1	-2	0	0
420	-17	-12	-7	-13	-8	-3	-4	0	0
400	-19	-14	-9	-15	-10	-5	-6	-1	0
380	-22	-17	-12	-17	-12	-7	-8	-3	0
360	-24	-19	-14	-20	-15	-10	-10	-5	0
340	-27	-22	-17	-22	-17	-12	-12	-7	-2
320	-29	-24	-19	-25	-20	-15	-15	-10	-5
300	-32	-27	-22	-28	-23	-18	-18	-13	-8
280	-34	-29	-24	-30	-25	-20	-22	-17	-12
260	-36	-31	-26	-33	-28	-23	-25	-20	-15
240	-38	-33	-28	-36	-31	-26	-30	-25	-20
220	-40	-35	-30	-39	-34	-29	-34	-29	-24
200	-42	-37	-32	-41	-36	-31	-39	-34	-29

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	0.0	-0.3	-2.6	0.0	-0.3	-2.6	-13.0	-15.3	-17.5
440	0.0	-0.5	-2.8	0.0	-0.5	-2.8	-12.3	-14.6	-16.9
420	0.0	-0.7	-3.0	0.0	-0.7	-2.9	-11.7	-14.0	-16.2
400	0.0	-0.9	-3.1	0.0	-0.9	-3.1	-11.0	-13.3	-15.6
380	0.0	-1.1	-3.3	0.0	-1.1	-3.3	-10.4	-12.7	-14.9
360	0.0	-1.2	-3.5	0.0	-1.2	-3.5	-9.7	-12.0	-14.2
340	0.0	-1.4	-3.7	0.0	-1.4	-3.7	-8.9	-11.2	-13.4
320	0.0	-1.6	-3.9	0.0	-1.6	-3.9	-8.0	-10.3	-12.6
300	0.0	-1.8	-4.0	0.0	-1.8	-4.0	-7.0	-9.3	-11.6
280	0.0	-1.9	-4.2	0.0	-2.0	-4.2	-6.0	-8.2	-10.5
260	0.0	-2.1	-4.4	0.0	-2.1	-4.4	-4.8	-7.1	-9.3
240	0.0	-2.3	-4.5	0.0	-2.3	-4.5	-3.5	-5.8	-8.1
220	-0.2	-2.4	-4.7	-0.2	-2.4	-4.7	-2.2	-4.5	-6.7
200	-0.3	-2.6	-4.9	-0.3	-2.6	-4.8	-0.8	-3.0	-5.3

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1600	195.9								
1800	283.1			198.7					
2000	365.9	177.1		271.6					
2200	445.3	265.2		346.9	183.7				
2400		348.9		425.6	256.2				
2600		428.7	247.1		330.7	168.6	170.9		
2800			331.6		408.8	240.8	205.3		
3000			412.1		489.1	314.8	241.3	163.8	
3200			490.9			392.3	278.7	197.9	
3400						472.1	318.4	233.6	
3600							360.3	270.7	190.6
3800							404.6	309.9	226.0
4000							452.5	351.4	262.8
4200								395.0	301.5
4400								442.2	342.5
4600								491.5	385.7
4800									432.0
5000									481.2

1. **Enter Table 1 with reported braking action and TO2 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -130 m/+130 m for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -130 m/+130 m for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -130 m/+130 m for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-10	-8	-5	-14	-11	-9	-43	-40	-38
440	-11	-9	-6	-16	-13	-11	-45	-42	-40
420	-12	-10	-7	-17	-15	-12	-46	-44	-41
400	-13	-10	-8	-19	-16	-14	-48	-45	-43
380	-14	-11	-9	-20	-18	-15	-49	-46	-44
360	-14	-12	-9	-21	-19	-16	-50	-48	-45
340	-14	-12	-9	-22	-20	-17	-51	-48	-46
320	-14	-12	-9	-23	-21	-18	-52	-49	-47
300	-14	-12	-9	-24	-21	-19	-52	-50	-47
280	-14	-12	-9	-25	-22	-20	-53	-50	-48
260	-14	-11	-9	-25	-22	-20	-53	-51	-48
240	-13	-11	-8	-25	-23	-20	-53	-51	-48
220	-13	-10	-8	-25	-23	-20	-53	-51	-48
200	-12	-10	-7	-25	-23	-20	-53	-50	-48

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 KG)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	0.0	-0.4	-2.7	0.0	-1.0	-3.3	-19.9	-22.2	-24.4
440	0.0	-0.6	-2.9	0.0	-1.6	-3.9	-18.8	-21.1	-23.4
420	0.0	-0.8	-3.0	0.0	-2.2	-4.5	-17.8	-20.0	-22.3
400	0.0	-0.9	-3.2	-0.6	-2.8	-5.1	-16.7	-19.0	-21.2
380	0.0	-1.1	-3.4	-1.2	-3.4	-5.7	-15.6	-17.9	-20.2
360	0.0	-1.3	-3.6	-1.6	-3.9	-6.2	-14.5	-16.8	-19.1
340	0.0	-1.5	-3.7	-1.9	-4.2	-6.4	-13.3	-15.6	-17.8
320	0.0	-1.6	-3.9	-2.0	-4.3	-6.5	-12.0	-14.2	-16.5
300	0.0	-1.8	-4.1	-1.9	-4.2	-6.5	-10.6	-12.8	-15.1
280	0.0	-2.0	-4.2	-1.7	-3.9	-6.2	-9.0	-11.3	-13.6
260	0.0	-2.1	-4.4	-1.2	-3.5	-5.8	-7.4	-9.7	-12.0
240	0.0	-2.3	-4.5	-0.6	-2.9	-5.2	-5.7	-8.0	-10.2
220	-0.2	-2.4	-4.7	0.0	-2.1	-4.4	-3.9	-6.2	-8.4
200	-0.3	-2.6	-4.8	0.0	-1.2	-3.5	-2.0	-4.3	-6.5

Table 2 of 3: V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (M)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
2000	196.7								
2200	356.5								
2400	456.6			281.7					
2600		330.7		395.0					
2800		438.0		489.2	254.3				
3000			302.4		373.1				
3200			418.3		470.0	224.9			
3400						350.3			
3600						450.7			
5400							195.8		
5600							265.4		
5800							333.7	181.2	
6000							401.8	250.8	

1. **Enter Table 1 with reported braking action and TO2 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -150 m/+145 m for every 10°C above/below 0°C.
Adjust "Medium" field length available by -150 m/+145 m for every 10°C above/below 0°C.
Adjust "Poor" field length available by -150 m/+145 m for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
460	-14	-9	-4	-19	-14	-9	-64	-59	-54
440	-15	-10	-5	-21	-16	-11	-67	-62	-57
420	-17	-12	-7	-23	-18	-13	-69	-64	-59
400	-17	-12	-7	-25	-20	-15	-71	-66	-61
380	-18	-13	-8	-27	-22	-17	-72	-67	-62
360	-19	-14	-9	-29	-24	-19	-74	-69	-64
340	-20	-15	-10	-31	-26	-21	-76	-71	-66
320	-20	-15	-10	-32	-27	-22	-77	-72	-67
300	-20	-15	-10	-34	-29	-24	-78	-73	-68
280	-21	-16	-11	-35	-30	-25	-80	-75	-70
260	-21	-16	-11	-37	-32	-27	-81	-76	-71
240	-21	-16	-11	-38	-33	-28	-81	-76	-71
220	-20	-15	-10	-39	-34	-29	-82	-77	-72
200	-20	-15	-10	-40	-35	-30	-83	-78	-73

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

TO2 Takeoff %N1

20% Thrust Reduction

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)												
	-2	-1	0	1	2	3	4	5	6	7	8	9	10
70	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	86.0
60	84.7	85.1	85.5	85.5	85.5	85.4	85.3	85.3	85.3	85.2	84.7	84.7	84.7
55	85.9	86.4	86.8	86.7	86.7	86.7	86.6	86.5	86.5	86.5	86.0	85.5	84.9
50	87.1	87.6	88.1	88.0	88.0	87.9	87.8	87.8	87.8	87.8	87.2	86.7	86.1
45	88.4	88.9	89.3	89.2	89.1	89.1	89.1	89.0	89.0	89.0	88.5	87.9	87.4
40	89.3	90.0	90.6	90.4	90.2	90.2	90.2	90.2	90.1	90.2	89.7	89.1	88.6
35	89.6	90.5	91.2	91.2	91.2	91.0	90.9	90.8	90.8	90.8	90.5	90.1	89.8
30	89.1	90.4	91.7	91.7	91.7	91.7	91.7	91.4	91.4	91.3	91.0	90.7	90.4
25	88.3	89.6	90.9	91.4	91.9	92.1	92.2	92.2	92.6	92.4	91.5	91.2	90.9
20	87.6	88.9	90.2	90.6	91.1	91.6	91.9	92.4	92.5	92.7	92.5	92.2	91.4
15	86.8	88.1	89.4	89.8	90.3	90.8	91.1	91.6	92.0	92.4	92.4	92.3	91.7
10	86.1	87.4	88.6	89.1	89.5	90.0	90.4	90.8	91.2	91.6	91.7	91.8	92.0
5	85.3	86.6	87.8	88.3	88.8	89.2	89.6	90.0	90.4	90.8	90.9	91.0	91.2
0	84.5	85.8	87.0	87.5	87.9	88.4	88.8	89.2	89.6	90.0	90.1	90.2	90.4
-10	83.0	84.2	85.4	85.9	86.3	86.8	87.1	87.6	88.0	88.4	88.5	88.6	88.8
-20	81.4	82.6	83.8	84.2	84.7	85.1	85.5	85.9	86.3	86.7	86.8	87.0	87.1
-30	79.8	81.0	82.1	82.5	83.0	83.5	83.9	84.3	84.6	85.0	85.2	85.3	85.5
-40	78.1	79.3	80.4	80.8	81.3	81.8	82.2	82.6	83.0	83.4	83.5	83.6	83.8
-50	76.4	77.6	78.7	79.1	79.6	80.1	80.5	80.8	81.2	81.6	81.7	81.9	82.0

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)			
	-2	0	9	10
PACKS OFF	0.5	0.6	0.6	0.7
ENGINE ANTI-ICE ON	0.0	0.0	0.0	-0.4
ENGINE AND WING ANTI-ICE ON	0.0	0.0	0.0	-0.4

Max Climb %N1

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

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KCAS OR MACH)									
	0	5	10	15	20	25	30	35	40	45
	340	340	340	340	340	340	0.81	0.84	0.84	0.84
60	91.0	91.6	92.9	94.1	96.1	97.6	99.8	101.2	101.5	100.7
50	92.8	93.2	93.8	93.1	94.7	96.2	98.3	99.7	100.0	99.2
40	94.2	95.0	95.4	94.8	95.0	94.9	96.7	98.2	98.4	97.7
30	92.7	95.5	97.0	96.4	96.6	96.5	95.2	96.6	96.8	96.1
20	91.2	93.9	96.6	97.9	98.2	98.0	96.9	95.5	95.2	94.5
15	90.4	93.1	95.8	97.3	99.0	98.9	97.8	96.5	95.9	95.2
10	89.6	92.3	95.0	96.5	98.7	99.7	98.7	97.6	97.0	96.3
5	88.8	91.5	94.1	95.6	97.9	99.6	99.7	98.6	98.0	97.3
0	88.0	90.7	93.3	94.8	97.0	98.7	100.8	99.6	99.0	98.3
-5	87.2	89.8	92.4	93.9	96.1	97.8	101.1	100.8	100.0	99.3
-10	86.4	89.0	91.5	93.0	95.2	96.8	100.2	101.4	100.9	100.3
-15	85.5	88.1	90.7	92.1	94.3	95.9	99.2	101.0	100.9	100.8
-20	84.7	87.3	89.8	91.2	93.4	95.0	98.3	100.0	99.9	99.9
-25	83.9	86.4	88.9	90.3	92.4	94.0	97.3	99.0	98.9	98.9
-30	83.0	85.5	88.0	89.4	91.5	93.1	96.3	98.0	97.9	97.9
-35	82.2	84.7	87.1	88.5	90.6	92.1	95.3	97.0	96.9	96.8
-40	81.3	83.8	86.2	87.5	89.6	91.2	94.3	96.0	95.9	95.8

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	45
ENGINE ANTI-ICE ON	-0.3	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.5	-0.5
ENGINE & WING ANTI-ICE ON	-0.7	-0.6	-0.6	-0.7	-0.8	-0.8	-0.9	-0.9	-0.9	-0.9

Go-around %N1

Based on engine bleed for packs on and anti-ice off

REPORTED OAT (°C)	TAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
		0	1	2	3	4	5	6	7	8	9	10
70	74	85.9	86.7	87.5	88.3	88.7	89.1	89.4	89.8	89.9	89.6	89.0
60	64	87.9	88.8	89.7	90.7	91.2	91.7	92.1	92.5	92.7	92.4	91.8
55	59	88.8	89.8	90.8	91.8	92.4	93.0	93.4	93.9	94.1	93.8	93.2
50	54	90.2	90.9	91.9	92.9	93.6	94.2	94.6	95.1	95.4	95.1	94.5
45	49	91.5	92.3	93.2	94.2	94.8	95.3	95.9	96.4	96.7	96.4	95.8
40	44	92.8	93.6	94.5	95.4	96.0	96.6	97.1	97.6	98.0	97.7	97.1
35	39	94.2	94.9	95.8	96.8	97.2	97.7	98.3	99.0	99.0	98.8	98.3
30	34	94.8	95.7	96.6	97.6	98.2	98.7	99.2	99.7	99.9	99.5	99.2
25	29	94.1	95.5	97.0	98.1	98.7	99.2	100.3	100.8	100.7	100.3	99.9
20	24	93.3	94.7	96.2	97.7	98.9	100.1	100.9	101.7	102.2	101.6	100.7
15	19	92.5	93.9	95.4	96.8	98.0	99.3	100.7	102.4	102.9	102.4	101.6
10	14	91.7	93.1	94.5	96.0	97.2	98.5	99.8	101.5	102.5	102.5	102.5
5	8	90.8	92.1	93.5	95.0	96.2	97.4	98.8	100.4	101.4	101.4	101.5
0	3	90.0	91.3	92.7	94.2	95.3	96.6	97.9	99.6	100.5	100.5	100.7
-10	-7	88.3	89.6	91.0	92.4	93.6	94.9	96.2	97.8	98.8	98.8	98.9
-20	-17	86.6	87.9	89.3	90.7	91.9	93.2	94.5	96.1	97.0	97.0	97.1
-30	-27	84.9	86.2	87.6	89.0	90.2	91.4	92.7	94.3	95.2	95.2	95.3
-40	-37	83.2	84.4	85.8	87.2	88.5	89.7	90.9	92.5	93.4	93.4	93.5
-50	-47	81.4	82.7	84.0	85.5	86.7	87.9	89.1	90.6	91.5	91.6	91.7

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	0	1	2	3	4	5	6	7	8	9	10
PACKS OFF	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
ENGINE ANTI-ICE ON	-0.3	-0.3	-0.3	-0.3	-0.3	-0.4	-0.5	-0.4	-0.4	-0.4	-0.4

Flight With Unreliable Airspeed / Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

Climb (310/.83)

Flaps Up, Max Climb Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		200	250	300	350	400	450
40000	PITCH ATT	**4.5**	**4.5**	**5.0**			
	V/S (FT/MIN)	2000	1200	600			
35000	PITCH ATT	**5.5**	**5.0**	**5.0**	**5.0**	**5.0**	
	V/S (FT/MIN)	3200	2300	1600	1000	400	
30000	PITCH ATT	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**5.0**
	V/S (FT/MIN)	2900	2200	1700	1300	900	600
20000	PITCH ATT	**8.0**	**7.0**	**6.5**	**6.5**	**6.5**	**6.5**
	V/S (FT/MIN)	4500	3500	2800	2200	1800	1400
10000	PITCH ATT	**11.5**	**10.0**	**9.5**	**9.0**	**8.5**	**8.5**
	V/S (FT/MIN)	6300	5000	4000	3300	2700	2300
SEA LEVEL	PITCH ATT	**16.0**	**13.5**	**12.0**	**11.0**	**10.5**	**10.5**
	V/S (FT/MIN)	7700	6100	5000	4100	3500	2900

Cruise (.83/310)

Flaps Up, %N1 for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		200	250	300	350	400	450
40000	PITCH ATT	**2.5**	**3.0**	**4.0**			
	%N1	81.7	85.2	90.3			
35000	PITCH ATT	**1.5**	**2.5**	**3.0**	**3.5**	**4.5**	
	%N1	79.3	81.3	84.0	87.6	92.7	
30000	PITCH ATT	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**
	%N1	78.5	79.5	81.3	83.8	86.8	90.2
25000	PITCH ATT	**1.5**	**2.0**	**3.0**	**3.5**	**4.0**	**4.5**
	%N1	74.5	75.5	77.1	79.6	82.4	85.4
20000	PITCH ATT	**1.5**	**2.0**	**3.0**	**3.5**	**4.0**	**5.0**
	%N1	70.7	71.7	73.0	75.2	77.9	80.7
15000	PITCH ATT	**1.5**	**2.0**	**3.0**	**3.5**	**4.0**	**4.5**
	%N1	67.1	68.0	69.2	71.3	73.7	76.4

Descent (.83/310)

Flaps Up, Idle Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		200	250	300	350	400	450
40000	PITCH ATT	**-1.0**	**0.5**	**1.0**	1.5	1.5	-1.0
	V/S (FT/MIN)	-2700	-2500	-2500	-2700	-2500	-5200
35000	PITCH ATT	**-2.5**	**-1.5**	**-0.5**	**0.5**	**1.0**	2.0
	V/S (FT/MIN)	-3600	-3100	-2900	-2900	-3000	-2200
30000	PITCH ATT	**-2.5**	**-1.0**	**0.0**	**0.5**	**1.0**	**1.5**
	V/S (FT/MIN)	-3000	-2500	-2200	-2100	-2100	-2100
20000	PITCH ATT	**-2.0**	**-1.0**	**0.0**	**1.0**	**1.5**	**2.0**
	V/S (FT/MIN)	-2800	-2300	-2000	-1900	-1900	-1900
10000	PITCH ATT	**-2.5**	**-1.0**	**0.0**	**0.5**	**1.5**	**2.0**
	V/S (FT/MIN)	-2600	-2100	-1900	-1800	-1700	-1700
SEA LEVEL	PITCH ATT	**-2.5**	**-1.0**	**0.0**	**1.0**	**1.5**	**2.0**
	V/S (FT/MIN)	-2300	-1900	-1700	-1600	-1500	-1500

Flight With Unreliable Airspeed / Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

Holding (Flaps Up Maneuvering Speed)

Flaps Up, %N1 for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)					
		200	250	300	350	400	450
10000	**PITCH ATT**	**5.5**	**6.0**	**6.5**	**7.0**	**7.0**	**7.0**
	%N1	51.3	55.9	60.1	64.1	68.1	71.5
	KIAS	205	217	231	243	254	268

Terminal Area (5000 FT)

%N1 for Level Flight

FLAP POSITION		WEIGHT (1000 KG)					
		200	250	300	350	400	450
FLAPS UP (GEAR UP)	**PITCH ATT**	**4.5**	**5.5**	**5.5**	**6.0**	**6.5**	**6.5**
	%N1	48.6	53.4	57.9	61.5	64.9	68.3
	KIAS	205	217	230	241	253	266
FLAPS 1 (GEAR UP)	**PITCH ATT**	**6.5**	**7.0**	**7.5**	**8.0**	**8.5**	**8.5**
	%N1	53.6	58.4	62.8	66.9	70.7	73.9
	KIAS	185	197	210	221	233	244
FLAPS 5 (GEAR UP)	**PITCH ATT**	**7.0**	**8.0**	**8.0**	**8.5**	**8.5**	**9.0**
	%N1	53.0	58.4	63.4	67.4	71.5	75.1
	KIAS	165	177	190	203	213	224
FLAPS 10 (GEAR UP)	**PITCH ATT**	**7.5**	**8.0**	**8.0**	**8.0**	**8.5**	**9.0**
	%N1	52.9	58.6	63.2	67.6	71.8	75.8
	KIAS	145	160	176	190	197	204
FLAPS 20 (GEAR DOWN)	**PITCH ATT**	**5.5**	**6.0**	**6.0**	**6.0**	**6.5**	**6.5**
	%N1	60.1	65.9	70.9	76.3	80.6	84.6
	KIAS	136	149	163	175	183	194

Final Approach (1500 FT)

Gear Down, %N1 for 3° Glideslope

FLAP POSITION (VREF+INCREMENT)		WEIGHT (1000 KG)					
		200	250	300	350	400	450
FLAPS 25 (VREF25+10)	**PITCH ATT**	**0.5**	**0.5**	**1.0**	**1.0**	**1.0**	**1.5**
	%N1	49.7	54.5	59.2	63.1	66.3	69.1
	KIAS	133	148	162	174	184	195
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**0.5**	**1.0**		
	%N1	52.5	57.8	62.5	66.6	*	*
	KIAS	130	145	158	170		

*** 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	450
10000	**PITCH ATT**	**20.5**	**16.5**	**13.5**	**11.0**	**10.5**	**9.0**
	V/S (FT/MIN)	4300	3300	2600	2000	1600	1200
	KIAS	136	149	164	176	185	196
5000	**PITCH ATT**	**23.5**	**18.5**	**15.0**	**13.0**	**11.5**	**10.5**
	V/S (FT/MIN)	4700	3700	3000	2400	1900	1500
	KIAS	136	149	163	175	183	194
SEA LEVEL	**PITCH ATT**	**24.0**	**19.0**	**15.5**	**13.5**	**12.0**	**11.0**
	V/S (FT/MIN)	4500	3500	2900	2400	1900	1500
	KIAS	136	149	163	174	183	193

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps Up, Gear Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
200	199	199	200	201	203	205	208	212
210	209	209	210	211	212	213	215	218
220	219	219	219	220	221	222	223	225
240	239	239	239	239	240	240	241	242
260	259	258	258	259	259	259	260	261
280	279	278	278	278	278	279	279	279
300	299	298	298	298	298	298	298	299
320	319	318	318	318	318	318	318	318
340	339	339	338	338	338	338	338	338
360	359	359	358	358	358	358	358	358

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
200	20	10	0	-30	-60	-100	-160	-230
210	30	20	10	-10	-40	-70	-110	-170
220	30	30	20	0	-20	-40	-80	-120
240	40	40	30	30	10	-10	-30	-60
260	40	50	50	40	30	20	0	-20
280	40	50	50	60	50	40	30	20
300	40	50	60	60	60	60	50	40
320	40	60	60	70	70	70	70	70
340	40	50	70	70	80	80	80	80
360	30	50	70	80	80	90	90	100

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 1, Gear Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
180	180	181	182	184	186	188	191	196
190	190	190	192	193	194	196	198	201
200	199	200	201	202	203	205	206	208
210	209	210	210	211	212	213	215	216
220	219	219	220	221	222	222	224	225
240	239	239	239	240	240	241	242	243
260	259	259	259	259	260	260	261	262
280	278	278	279	279	279	279	280	280
300	298	298	298	298	299	299	299	300

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
180	0	-20	-40	-70	-100	-150	-210	-270
190	10	-10	-30	-50	-80	-120	-160	-220
200	10	0	-20	-40	-60	-90	-130	-170
210	20	10	-10	-30	-50	-80	-110	-140
220	30	20	0	-20	-40	-60	-80	-120
240	30	30	20	10	-10	-30	-50	-80
260	40	40	30	20	10	0	-20	-40
280	50	50	50	40	30	20	0	-10
300	60	60	60	50	50	40	30	10

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 5, Gear Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
160	160	162	163	166	169	174	181	
164	164	165	167	169	172	175	181	
168	168	169	170	172	175	178	182	190
172	172	173	174	175	178	180	184	190
176	176	177	178	179	181	183	187	191
180	180	180	181	183	184	186	189	193
190	189	190	191	192	193	194	196	199
200	199	199	200	201	202	203	205	207
210	209	209	210	210	211	212	213	215
220	219	219	219	220	221	221	222	223
240	239	239	239	239	240	240	241	242
260	258	258	258	259	259	259	260	261
280	278	278	278	278	279	279	279	280

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
160	-10	-30	-50	-90	-140	-210	-310	
164	0	-20	-50	-80	-130	-180	-270	
168	0	-20	-40	-70	-110	-160	-230	-330
172	0	-10	-30	-60	-100	-150	-210	-290
176	10	-10	-30	-50	-90	-130	-190	-250
180	10	-10	-20	-50	-80	-120	-170	-230
190	20	0	-10	-30	-60	-90	-130	-180
200	20	10	0	-20	-40	-70	-100	-140
210	30	20	10	-10	-30	-50	-70	-100
220	30	30	20	0	-20	-30	-50	-80
240	40	40	30	20	10	-10	-20	-40
260	40	40	40	40	30	20	0	-20
280	50	50	50	50	50	40	30	10

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 10, Gear Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
140	140	142	145	149				
144	144	145	148	151	158			
148	148	149	151	154	158			
152	152	153	154	157	160	167		
156	156	156	158	160	163	167		
160	159	160	161	163	165	169	175	
164	163	164	165	166	168	171	176	184
168	167	168	169	170	171	174	178	183
172	171	172	172	173	175	177	180	184
176	175	175	176	177	178	180	182	186
180	179	179	180	181	182	183	185	188
190	189	189	189	190	191	192	193	195
200	198	199	199	199	200	201	202	203
210	208	208	209	209	210	210	211	212
220	218	218	218	219	219	220	220	221
240	238	238	238	238	238	239	239	240
260	258	258	258	258	258	258	258	259

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
140	-10	-30	-70	-130				
144	0	-20	-50	-100	-190			
148	0	-20	-40	-80	-150			
152	0	-10	-30	-70	-120	-210		
156	10	-10	-30	-60	-100	-170		
160	10	0	-20	-50	-90	-140	-230	
164	10	0	-10	-40	-70	-120	-190	-310
168	20	10	-10	-30	-60	-100	-160	-250
172	20	10	0	-20	-50	-90	-140	-210
176	20	10	0	-20	-40	-70	-120	-180
180	20	20	0	-10	-30	-60	-100	-150
190	30	20	10	0	-20	-40	-60	-100
200	40	30	20	10	0	-20	-40	-70
210	40	40	30	20	10	0	-20	-40
220	40	40	40	30	20	10	-10	-20
240	50	50	50	50	40	30	20	10
260	50	60	60	60	60	50	40	30

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 20, Gear Up and Gear Down

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
132	130	131	132	135	141			
136	134	134	136	138	142			
140	138	138	139	141	144	149		
144	142	142	143	144	146	150		
148	146	146	146	147	149	152	157	
152	150	150	150	151	152	154	158	165
156	154	154	154	154	155	157	160	164
160	158	157	158	158	159	160	162	166
164	162	161	161	162	162	164	165	168
168	165	165	165	166	166	167	168	170
172	169	169	169	169	170	171	172	173
176	173	173	173	173	174	174	175	176
180	177	177	177	177	177	178	179	180
190	187	187	187	187	187	187	188	188
200	197	197	197	197	197	197	197	197
210	207	207	207	207	207	207	207	207
220	218	217	217	217	217	217	216	217
240	238	237	237	237	236	236	236	236

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
132	30	20	0	-40	-120			
136	30	20	10	-20	-80			
140	30	30	10	-10	-50	-130		
144	40	30	20	0	-30	-90		
148	40	40	30	10	-10	-60	-130	
152	40	40	30	20	0	-40	-90	-190
156	40	40	40	30	10	-20	-60	-130
160	40	40	40	30	20	0	-40	-90
164	40	50	50	40	30	10	-20	-60
168	50	50	50	40	30	20	-10	-40
172	50	50	50	50	40	30	10	-20
176	50	50	50	50	50	40	20	-10
180	50	50	60	60	50	40	30	10
190	50	60	60	60	60	60	50	30
200	60	60	70	70	70	70	60	60
210	60	70	70	70	80	80	80	70
220	60	70	80	80	80	90	90	80
240	60	70	80	90	90	100	100	100

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 25, Gear Down

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
120	118	119	121					
124	122	122	124	127				
128	126	126	127	129				
132	129	130	130	132	135			
136	133	134	134	135	137			
140	137	137	138	138	140	143		
144	141	141	142	142	143	145	149	
148	145	145	145	146	146	148	151	
152	149	149	149	149	150	151	153	157
156	153	153	153	153	154	154	156	158
160	157	157	157	157	157	158	159	161
170	167	167	167	167	167	167	168	168
180	177	177	177	176	176	177	177	177
190	187	187	187	186	186	186	186	187
200	197	197	197	196	196	196	196	196
220	217	217	217	216	216	216	216	216

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
120	30	20	-10					
124	30	20	10	-40				
128	30	30	20	-10				
132	40	30	20	0	-40			
136	40	40	30	20	-20			
140	40	40	30	20	0	-40		
144	40	40	40	30	10	-20	-80	
148	50	50	40	40	30	0	-40	
152	50	50	50	40	30	20	-20	-70
156	50	50	50	50	40	30	0	-40
160	50	50	50	50	50	40	20	-10
170	50	60	60	60	60	50	40	30
180	60	60	70	70	70	60	60	50
190	60	70	70	80	80	80	70	70
200	60	70	80	80	90	90	90	80
220	60	70	80	90	100	100	100	110

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 30, Gear Down

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
120	118	118	121					
124	122	122	123	127				
128	125	126	127	129				
132	129	129	130	132	135			
136	133	133	134	135	137			
140	137	137	137	138	140	143		
144	141	141	141	142	143	145	150	
148	145	145	145	145	146	148	151	
152	149	149	149	149	150	151	153	157
156	153	153	153	153	153	154	156	158
160	157	157	157	157	157	158	159	161
170	168	167	167	167	167	167	167	168
180	178	177	177	176	176	176	177	177
190	188	187	187	186	186	186	186	186

Table 2 of 2: Pressure Altitude Adjustment

IFSD AIRSPEED (KIAS)	WEIGHT (1000 KG)							
	180	220	260	300	340	380	420	460
120	30	20	-10					
124	30	30	10	-40				
128	40	30	20	-10				
132	40	40	30	0	-50			
136	40	40	30	20	-20			
140	40	40	40	30	0	-50		
144	40	50	40	40	20	-20	-90	
148	40	50	50	40	30	0	-40	
152	40	50	50	50	40	20	-10	-80
156	40	50	50	50	50	30	0	-40
160	40	50	60	60	50	40	20	-10
170	40	50	60	60	60	60	50	30
180	40	50	60	70	70	70	70	60
190	40	50	60	70	80	80	80	80

Actual altitude = ISFD altitude + pressure altitude adjustment.

Performance Inflight — Chapter PI
All Engine — Section 11

Long Range Cruise Maximum Operating Altitude
Max Climb Thrust

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
460	29000	28700	32500	31300	29600
440	30000	29600	33700	32800	31000
420	31000	30700	34800	34100	32500
400	32100	31700	35800	35500	33900
380	33200	32800	36800	36600	35500
360	34300	34000	38000	37700	36700
340	35500	35200	39200	38800	37800
320	36800	36400	40400	40000	38900
300	38100	37800	41700	41200	40100
280	39600	39200	43100	42400	41300
260	41100	40800	43100	43100	42600
240	42800	42400	43100	43100	43100
220	43100	43100	43100	43100	43100
200	43100	43100	43100	43100	43100

***Based on 1.3g/39° bank maneuver capability.**
****300 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
460	%N1	87.8	89.1	90.7	93.3						
	MACH	.852	.860	.860	.859						
	KIAS	362	350	336	322						
	FF/ENG	3713	3620	3564	3559						
440	%N1	86.7	88.0	89.4	91.5	94.6					
	MACH	.845	.858	.860	.859	.854					
	KIAS	358	350	336	322	306					
	FF/ENG	3562	3483	3401	3358	3417					
420	%N1	85.6	86.9	88.1	89.9	92.4					
	MACH	.836	.852	.860	.860	.859					
	KIAS	354	347	336	322	308					
	FF/ENG	3410	3336	3254	3177	3203					
400	%N1	84.4	85.8	87.0	88.5	90.5	93.5				
	MACH	.827	.843	.858	.860	.859	.854				
	KIAS	350	343	335	322	308	293				
	FF/ENG	3261	3189	3122	3021	3011	3057				
380	%N1	83.2	84.5	85.8	87.2	88.8	91.2				
	MACH	.817	.834	.850	.859	.860	.859				
	KIAS	345	339	332	322	308	294				
	FF/ENG	3107	3041	2976	2880	2839	2853				
360	%N1	82.0	83.3	84.5	86.0	87.3	89.2	92.5			
	MACH	.805	.824	.840	.856	.860	.859	.856			
	KIAS	340	334	328	321	308	295	280			
	FF/ENG	2951	2895	2834	2751	2690	2671	2725			
340	%N1	80.7	82.0	83.3	84.8	86.1	87.6	90.2	94.2		
	MACH	.792	.812	.830	.846	.859	.860	.859	.849		
	KIAS	334	329	323	316	308	295	281	265		
	FF/ENG	2797	2751	2697	2614	2565	2518	2534	2606		
320	%N1	79.3	80.7	82.0	83.5	84.8	86.1	88.2	91.6		
	MACH	.776	.798	.818	.836	.852	.860	.859	.858		
	KIAS	327	323	318	312	305	295	281	268		
	FF/ENG	2643	2604	2560	2483	2440	2386	2370	2420		
300	%N1	77.9	79.3	80.6	82.2	83.5	84.8	86.5	89.3	93.0	
	MACH	.758	.782	.804	.823	.841	.857	.860	.859	.854	
	KIAS	318	316	312	307	301	294	281	269	255	
	FF/ENG	2532	2501	2416	2350	2309	2268	2231	2242	2301	
280	%N1	76.3	77.8	79.1	80.7	82.0	83.4	85.0	87.4	90.3	
	MACH	.737	.763	.787	.809	.828	.845	.859	.860	.859	
	KIAS	309	308	305	301	296	289	281	269	256	
	FF/ENG	2369	2348	2266	2209	2178	2138	2111	2092	2115	
240	%N1	72.5	74.2	75.8	77.5	78.9	80.3	82.0	84.1	86.2	88.7
	MACH	.686	.716	.744	.771	.795	.816	.835	.852	.860	.859
	KIAS	286	287	287	285	282	278	272	266	257	245
	FF/ENG	2033	2027	1958	1915	1899	1876	1858	1881	1862	1860
200	%N1	68.0	69.8	71.5	73.4	75.0	76.6	78.4	80.5	82.6	84.7
	MACH	.626	.654	.684	.715	.744	.772	.797	.818	.837	.853
	KIAS	260	261	262	263	263	261	258	254	249	243
	FF/ENG	1696	1691	1681	1649	1643	1632	1628	1626	1617	1613

Shaded area approximates optimum altitude.

Long Range Cruise Enroute Fuel and Time - Low Altitudes

Table 1 of 3: 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
681	636	595	559	528	500	479	459	441	424	409
1360	1270	1189	1119	1056	1000	959	920	885	852	822
2045	1909	1786	1680	1586	1500	1438	1381	1328	1279	1234
2735	2551	2386	2242	2115	2000	1918	1841	1770	1705	1645
3430	3197	2988	2806	2646	2500	2397	2301	2212	2130	2055
4131	3848	3593	3372	3177	3000	2876	2761	2653	2555	2464
4839	4502	4200	3939	3708	3500	3355	3219	3093	2978	2872
5553	5161	4810	4507	4241	4000	3833	3678	3533	3400	3279
6275	5826	5424	5078	4774	4500	4311	4134	3971	3821	3684
7004	6496	6041	5650	5309	5000	4788	4591	4409	4241	4088

Table 2 of 3: 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	14.7	1:24	13.3	1:20	12.3	1:16	11.4	1:14	10.7	1:12
1000	29.3	2:43	27.0	2:35	25.2	2:26	23.5	2:19	22.4	2:15
1500	43.7	4:04	40.4	3:51	37.8	3:37	35.4	3:26	33.7	3:19
2000	57.8	5:27	53.5	5:09	50.1	4:50	47.0	4:33	44.9	4:24
2500	71.5	6:51	66.5	6:28	62.4	6:04	58.6	5:42	56.1	5:30
3000	85.3	8:17	79.4	7:49	74.5	7:19	70.0	6:52	67.0	6:37
3500	98.9	9:45	92.0	9:11	86.3	8:36	81.2	8:04	77.6	7:44
4000	112.1	11:16	104.4	10:36	97.8	9:55	92.1	9:17	88.1	8:53
4500	125.1	12:48	116.5	12:02	109.2	11:15	102.8	10:31	98.3	10:03
5000	137.7	14:23	128.4	13:30	120.3	12:38	113.2	11:47	108.4	11:15

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	250	300	350	400	450
10	-1.1	-0.6	0.0	1.0	1.8
20	-2.2	-1.3	0.0	1.8	3.6
30	-3.4	-1.8	0.0	2.6	5.4
40	-4.5	-2.2	0.0	3.4	7.2
50	-5.8	-2.7	0.0	4.2	8.9
60	-7.0	-3.3	0.0	5.0	10.5
70	-8.3	-3.9	0.0	5.7	12.1
80	-9.7	-4.5	0.0	6.5	13.7
90	-11.1	-5.1	0.0	7.2	15.2
100	-12.5	-5.8	0.0	7.9	16.7
110	-14.0	-6.5	0.0	8.6	18.1
120	-15.6	-7.3	0.0	9.3	19.4
130	-17.2	-8.1	0.0	10.0	20.7
140	-18.8	-8.9	0.0	10.7	22.0

Long Range Cruise Enroute Fuel and Time - High Altitudes

Table 1 of 3: 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
3798	3608	3434	3276	3133	3000	2882	2772	2670	2575	2488
4434	4211	4007	3823	3655	3500	3363	3235	3116	3005	2904
5071	4816	4582	4370	4178	4000	3844	3697	3561	3436	3320
5711	5422	5157	4918	4701	4500	4324	4160	4007	3865	3735
6353	6031	5735	5468	5225	5000	4805	4623	4453	4295	4150
6998	6641	6312	6017	5748	5500	5285	5084	4897	4724	4565
7646	7253	6892	6567	6272	6000	5765	5546	5342	5153	4979
8297	7868	7473	7119	6797	6500	6246	6008	5786	5581	5393
8951	8484	8056	7671	7322	7000	6725	6469	6230	6009	5806
9609	9104	8640	8225	7848	7500	7205	6930	6673	6436	6219
10271	9726	9227	8779	8374	8000	7685	7390	7117	6864	6631

Table 2 of 3: Reference Fuel And Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		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)	FUEL (1000 KG)	TIME (HR:MIN)
3000	62.2	6:22	59.7	6:17	58.1	6:14	56.9	6:14	56.8	6:15
3500	72.0	7:26	69.1	7:20	67.3	7:16	65.9	7:15	65.6	7:16
4000	81.6	8:31	78.4	8:23	76.3	8:18	74.7	8:16	74.2	8:17
4500	91.1	9:37	87.5	9:27	85.2	9:21	83.3	9:18	82.7	9:18
5000	100.3	10:43	96.4	10:32	93.9	10:24	91.8	10:21	90.9	10:19
5500	109.3	11:50	105.1	11:37	102.4	11:28	100.1	11:23	99.0	11:21
6000	118.2	12:59	113.6	12:43	110.7	12:32	108.2	12:27	107.0	12:23
6500	126.9	14:08	122.0	13:50	118.9	13:38	116.2	13:30	114.8	13:26
7000	135.5	15:19	130.2	14:58	126.9	14:43	124.1	14:35	122.5	14:29
7500	144.1	16:31	138.3	16:07	134.9	15:50	131.9	15:40	130.2	15:32
8000	152.5	17:45	146.4	17:17	142.7	16:58	139.6	16:45	137.7	16:36

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	250	300	350	400	450
50	-8.9	-4.8	0.0	9.0	25.4
60	-10.4	-5.6	0.0	10.4	28.1
70	-11.9	-6.4	0.0	11.6	30.6
80	-13.5	-7.2	0.0	12.7	32.9
90	-15.1	-8.0	0.0	13.7	35.0
100	-16.7	-8.8	0.0	14.7	36.9
110	-18.4	-9.5	0.0	15.5	38.7
120	-20.0	-10.3	0.0	16.3	40.2
130	-21.7	-11.1	0.0	17.0	41.6
140	-23.4	-11.8	0.0	17.6	42.7
150	-25.2	-12.6	0.0	18.1	43.7
160	-27.0	-13.3	0.0	18.5	44.5

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 KG)							
	460	440	400	360	320	280	240	200
43						26	0	12
41					40	4	3	28
39				50	10	0	14	46
37				15	0	7	29	64
35			17	1	3	20	47	83
33	32	18	2	1	14	36	66	101
31	7	2	1	10	29	54	84	117
29	0	1	8	24	46	72	101	132
27	3	8	21	40	63	89	117	146
25	13	20	37	57	80	106	132	158
23	27	35	53	74	97	121	145	169

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 KIAS

PRESSURE ALT (1000 FT)	19	21	23	25	27	29	31	33	35	37	39	41
DISTANCE (NM)	71	78	86	93	101	108	116	124	131	137	143	149
TIME (MINUTES)	18	19	20	21	22	23	24	25	26	27	28	28

Holding

Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)									
		1500	5000	10000	15000	20000	25000	30000	35000	40000	43000
460	%N1	64.9	67.8	72.1	76.6	81.6	86.3	91.0			
	KIAS	267	269	271	277	318	323	316			
	FF/ENG	3300	3270	3260	3270	3440	3530	3580			
440	%N1	63.6	66.4	70.7	75.2	80.2	84.9	89.5			
	KIAS	261	263	265	269	311	315	316			
	FF/ENG	3150	3110	3100	3100	3260	3340	3400			
420	%N1	62.3	65.0	69.3	73.8	78.7	83.5	88.1			
	KIAS	257	257	259	262	303	307	312			
	FF/ENG	2990	2960	2950	2940	3080	3150	3210			
400	%N1	60.9	63.6	67.9	72.3	77.3	82.0	86.6	92.7		
	KIAS	252	252	254	255	296	299	304	283		
	FF/ENG	2850	2810	2790	2780	2910	2970	3020	3090		
380	%N1	59.5	62.1	66.4	70.8	75.8	80.5	85.1	90.4		
	KIAS	248	248	249	250	288	291	295	283		
	FF/ENG	2700	2660	2640	2620	2750	2790	2830	2870		
360	%N1	58.0	60.7	64.8	69.2	74.2	78.8	83.5	88.4		
	KIAS	243	243	244	246	280	283	287	283		
	FF/ENG	2560	2520	2560	2530	2640	2660	2650	2680		
340	%N1	56.6	59.2	63.3	67.6	72.6	77.2	81.9	86.8		
	KIAS	239	239	240	242	272	275	278	283		
	FF/ENG	2490	2450	2420	2390	2480	2500	2470	2530		
320	%N1	55.1	57.7	61.7	66.0	71.0	75.5	80.2	85.1	93.0	
	KIAS	235	235	235	237	263	266	269	273	252	
	FF/ENG	2370	2320	2290	2260	2330	2340	2300	2340	2490	
300	%N1	53.7	56.1	60.1	64.3	69.2	73.8	78.5	83.4	90.3	
	KIAS	230	230	230	231	254	257	260	264	252	
	FF/ENG	2240	2190	2160	2120	2180	2180	2140	2170	2280	
280	%N1	52.1	54.5	58.5	62.6	67.4	72.0	76.5	81.5	87.9	93.6
	KIAS	224	224	225	226	246	248	250	254	252	235
	FF/ENG	2120	2070	2030	1990	2040	2030	1970	2000	2100	2210
260	%N1	50.6	52.9	56.8	60.8	65.6	70.0	74.6	79.6	85.9	90.5
	KIAS	219	219	220	220	236	238	241	244	247	235
	FF/ENG	2000	1950	1910	1870	1890	1890	1870	1870	1980	2040
240	%N1	48.9	51.2	55.0	59.0	63.6	67.9	72.5	77.5	83.8	87.8
	KIAS	213	213	214	214	227	228	231	233	237	234
	FF/ENG	1890	1830	1780	1740	1750	1740	1720	1710	1810	1860
220	%N1	47.1	49.5	53.1	57.0	61.4	65.7	70.3	75.2	81.6	85.6
	KIAS	208	208	208	209	217	218	220	223	226	228
	FF/ENG	1770	1710	1670	1630	1620	1600	1580	1560	1640	1700
200	%N1	45.5	47.7	51.3	55.1	59.2	63.5	67.9	72.7	79.1	83.2
	KIAS	205	205	205	205	208	209	210	212	215	216
	FF/ENG	1670	1610	1560	1520	1490	1460	1450	1420	1480	1530

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
460	%N1	70.5	73.7	78.3	83.3	88.5
	KIAS	245	246	247	249	252
	FF/ENG	3990	3970	3980	4040	4110
440	%N1	69.2	72.3	76.9	81.9	87.0
	KIAS	241	241	243	245	247
	FF/ENG	3800	3790	3790	3850	3900
420	%N1	67.8	70.9	75.5	80.3	85.5
	KIAS	236	237	238	240	242
	FF/ENG	3620	3610	3610	3650	3690
400	%N1	66.4	69.4	74.1	78.8	83.9
	KIAS	232	232	234	235	237
	FF/ENG	3440	3430	3420	3450	3490
380	%N1	65.0	67.9	72.5	77.2	82.3
	KIAS	227	228	229	230	232
	FF/ENG	3270	3250	3240	3260	3300
360	%N1	63.5	66.4	70.9	75.6	80.6
	KIAS	223	223	224	225	227
	FF/ENG	3100	3080	3070	3080	3110
340	%N1	62.0	64.9	69.3	73.9	78.8
	KIAS	219	219	220	221	223
	FF/ENG	2930	2910	2900	2900	2930
320	%N1	60.5	63.3	67.6	72.2	76.9
	KIAS	214	215	215	216	218
	FF/ENG	2770	2740	2730	2720	2750
300	%N1	58.9	61.6	65.9	70.4	75.0
	KIAS	209	210	210	211	213
	FF/ENG	2610	2570	2620	2610	2620
280	%N1	57.2	59.9	64.1	68.5	73.1
	KIAS	204	204	205	206	207
	FF/ENG	2520	2480	2460	2440	2450
260	%N1	55.4	58.0	62.2	66.6	71.1
	KIAS	199	199	200	200	201
	FF/ENG	2370	2320	2300	2270	2280
240	%N1	53.6	56.2	60.3	64.5	69.0
	KIAS	193	193	194	194	195
	FF/ENG	2220	2170	2140	2110	2110
220	%N1	51.8	54.3	58.3	62.4	66.8
	KIAS	188	188	188	189	189
	FF/ENG	2080	2030	1990	1960	1940
200	%N1	50.1	52.5	56.4	60.4	64.7
	KIAS	185	185	185	185	185
	FF/ENG	1960	1900	1860	1820	1800

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

Performance Inflight — Chapter PI
Advisory Information — Section 12

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 30

REPORTED BRAKING ACTION	RUNWAY DESCRIPTION
Dry	Dry
Good	Wet (Smooth, Grooved or PFC), Frost 1/8" or less of: Water, Slush, Dry Snow or Wet Snow
Good to Medium	Compacted Snow at or below -15°C OAT
Medium	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 1/8" of: Dry Snow or Wet Snow Compacted Snow at OAT warmer than -15°C
Medium to Poor	Greater than 1/8" of: Water or Slush
Poor	Ice
Nil	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF30	TWO REV	NO REV

Dry Runway

MAX MANUAL	1535	25/-20	45	-70/235	0/-15	40/-40	70	50	95
AUTOBRAKE MAX	1795	20/-25	55	-85/275	0/0	50/-50	95	55	0
AUTOBRAKE 4	2235	30/-30	70	-110/365	0/0	65/-65	125	0	0
AUTOBRAKE 3	2535	35/-35	85	-125/425	0/0	75/-75	145	0	0
AUTOBRAKE 2	2855	40/-45	100	-145/490	10/-30	90/-85	145	15	15
AUTOBRAKE 1	3175	50/-50	125	-170/575	75/-90	125/-95	130	270	270

Good Reported Braking Action

MAX MANUAL	1985	35/-30	85	-110/400	45/-40	75/-65	100	155	345
AUTOBRAKE MAX	1995	35/-30	85	-105/400	50/-30	75/-65	105	150	330
AUTOBRAKE 4	2265	30/-30	75	-110/380	15/-5	65/-65	125	35	175
AUTOBRAKE 3	2550	35/-35	85	-130/435	10/-10	75/-75	145	0	25
AUTOBRAKE 2	2860	40/-45	100	-145/495	15/-35	90/-85	145	15	15
AUTOBRAKE 1	3175	50/-50	125	-170/575	80/-90	125/-95	130	270	270

Good to Medium Reported Braking Action

MAX MANUAL	2135	30/-30	85	-120/420	60/-50	80/-65	100	190	425
AUTOBRAKE MAX	2140	30/-30	90	-115/420	60/-45	80/-65	105	185	415
AUTOBRAKE 4	2285	30/-30	80	-115/400	25/-15	70/-65	125	75	315
AUTOBRAKE 3	2550	35/-35	85	-130/435	15/-10	75/-75	145	5	70
AUTOBRAKE 2	2860	40/-45	100	-145/495	15/-35	90/-85	145	15	15
AUTOBRAKE 1	3175	50/-50	125	-170/575	80/-90	125/-95	130	270	270

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 30

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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	2255	35/-30	90	-120/440	70/-60	85/-65	100	230	535
AUTOBRAKE MAX	2260	35/-35	90	-120/440	75/-55	85/-65	105	230	525
AUTOBRAKE 4	2340	35/-35	85	-125/435	50/-25	75/-70	125	175	485
AUTOBRAKE 3	2575	35/-35	90	-135/460	30/-15	75/-75	145	45	265
AUTOBRAKE 2	2860	40/-45	100	-150/495	25/-35	90/-85	145	25	85
AUTOBRAKE 1	3175	50/-50	125	-170/575	80/-90	125/-95	130	270	270

Medium to Poor Reported Braking Action

MAX MANUAL	2580	45/-40	120	-155/555	100/-85	115/-85	115	390	1000
AUTOBRAKE MAX	2590	45/-40	120	-155/555	110/-85	115/-85	115	380	1010
AUTOBRAKE 4	2590	45/-40	120	-155/555	110/-90	115/-85	115	380	1010
AUTOBRAKE 3	2660	40/-40	115	-140/510	75/-35	95/-75	130	310	940
AUTOBRAKE 2	2905	40/-40	105	-150/495	45/-45	95/-85	140	120	700
AUTOBRAKE 1	3200	50/-50	125	-170/580	90/-100	130/-95	125	280	490

Poor Reported Braking Action

MAX MANUAL	3220	50/-50	130	-200/755	250/-165	145/-95	115	755	2175
AUTOBRAKE MAX	3230	50/-50	135	-205/755	260/-170	145/-95	115	745	2180
AUTOBRAKE 4	3230	50/-50	135	-205/755	260/-170	145/-95	115	745	2180
AUTOBRAKE 3	3235	50/-50	135	-205/755	255/-150	145/-100	130	745	2180
AUTOBRAKE 2	3325	50/-50	130	-205/765	230/-150	135/-100	140	660	2095
AUTOBRAKE 1	3455	55/-55	150	-210/785	245/-175	150/-105	125	660	1975

Reference distance is for sea level, standard day, no wind or slope, VREF30 approach speed and 4 engines at maximum reverse thrust.

Max Manual assumes maximum achievable manual braking.
All reference distances and adjustments are increased by 15%.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

Max Manual and autobrake data valid for auto speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 45 m.
For autobrake and manual speedbrakes, increase reference landing distance by 40 m.

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 25

REPORTED BRAKING ACTION	RUNWAY DESCRIPTION
Dry	Dry
Good	Wet (Smooth, Grooved or PFC), Frost 1/8" or less of: Water, Slush, Dry Snow or Wet Snow
Good to Medium	Compacted Snow at or below -15°C OAT
Medium	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 1/8" of: Dry Snow or Wet Snow Compacted Snow at OAT warmer than -15°C
Medium to Poor	Greater than 1/8" of: Water or Slush
Poor	Ice
Nil	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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	1585	25/-20	45	-70/235	0/-20	45/-40	70	50	105
AUTOBRAKE MAX	1865	20/-25	55	-85/275	0/0	50/-50	95	60	0
AUTOBRAKE 4	2330	30/-35	70	-110/370	0/0	65/-65	125	0	0
AUTOBRAKE 3	2645	30/-40	85	-130/435	0/0	80/-80	145	0	0
AUTOBRAKE 2	2970	40/-45	100	-150/500	15/-40	100/-90	145	30	30
AUTOBRAKE 1	3280	50/-55	125	-175/585	80/-95	135/-100	130	320	325

Good Reported Braking Action

MAX MANUAL	2065	30/-30	85	-115/405	50/-40	80/-65	105	170	400
AUTOBRAKE MAX	2080	30/-30	85	-110/405	50/-35	80/-65	105	170	385
AUTOBRAKE 4	2360	30/-35	80	-115/385	15/-5	70/-70	125	40	215
AUTOBRAKE 3	2665	35/-40	85	-135/440	10/-10	80/-80	150	0	45
AUTOBRAKE 2	2975	40/-45	105	-150/505	25/-40	100/-90	145	30	30
AUTOBRAKE 1	3280	50/-55	130	-175/585	85/-95	135/-100	130	320	325

Good to Medium Reported Braking Action

MAX MANUAL	2210	30/-35	90	-120/425	60/-50	85/-65	105	205	485
AUTOBRAKE MAX	2220	30/-35	90	-120/425	65/-50	85/-70	105	205	470
AUTOBRAKE 4	2380	30/-35	80	-120/405	25/-15	70/-70	125	80	355
AUTOBRAKE 3	2665	35/-40	85	-135/440	15/-10	80/-80	150	5	90
AUTOBRAKE 2	2975	40/-45	105	-150/505	25/-40	100/-90	145	30	30
AUTOBRAKE 1	3280	50/-55	130	-175/585	85/-95	135/-100	130	320	325

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 25

BRAKING CONFIGURATION	REF DIST 310000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 310000 KG	ALT ADJ PER 1000 FT ABOVE SEA LEVEL	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	VREF ADJ PER 5 KTS ABOVE VREF25	REVERSE THRUST ADJ TWO REV	REVERSE THRUST ADJ NO REV
Medium Reported Braking Action									
MAX MANUAL	2330	35/-35	90	-125/445	75/-60	90/-70	105	250	600
AUTOBRAKE MAX	2340	35/-35	95	-125/445	75/-60	90/-70	105	250	590
AUTOBRAKE 4	2435	30/-35	85	-125/440	45/-25	80/-70	125	180	535
AUTOBRAKE 3	2685	35/-40	90	-135/465	25/-20	80/-80	150	40	300
AUTOBRAKE 2	2975	40/-45	105	-150/505	35/-40	100/-90	145	40	105
AUTOBRAKE 1	3280	50/-55	130	-175/585	85/-95	135/-100	130	320	325
Medium to Poor Reported Braking Action									
MAX MANUAL	2670	45/-45	120	-155/560	105/-85	120/-85	115	425	1165
AUTOBRAKE MAX	2685	45/-45	125	-155/560	110/-90	120/-85	120	430	1170
AUTOBRAKE 4	2685	45/-40	125	-155/560	110/-90	120/-85	115	430	1170
AUTOBRAKE 3	2770	40/-40	120	-140/510	70/-35	95/-80	135	340	1085
AUTOBRAKE 2	3020	40/-45	105	-150/505	50/-50	100/-90	140	145	840
AUTOBRAKE 1	3305	50/-55	130	-175/585	95/-105	135/-100	125	335	635
Poor Reported Braking Action									
MAX MANUAL	3295	50/-55	135	-200/755	250/-165	150/-100	115	800	2420
AUTOBRAKE MAX	3305	50/-55	135	-205/755	255/-170	150/-100	120	805	2430
AUTOBRAKE 4	3305	50/-55	135	-205/755	255/-170	150/-100	115	805	2430
AUTOBRAKE 3	3320	50/-50	135	-205/755	250/-150	150/-100	130	790	2420
AUTOBRAKE 2	3420	50/-55	135	-205/765	225/-150	145/-105	140	700	2325
AUTOBRAKE 1	3545	55/-60	150	-215/785	240/-175	155/-105	125	720	2210

Reference distance is for sea level, standard day, no wind or slope, VREF25 approach speed and 4 engines at maximum reverse thrust.

Max Manual assumes maximum achievable manual braking.
All reference distances and adjustments are increased by 15%.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

Max Manual and autobrake data valid for auto speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 50 m.
For autobrake and manual speedbrakes, increase reference landing distance by 40 m.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

AIR/GND SYSTEM - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1730	20/-25	55	-80/265	35/-30	50/-45	90	0	110
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	2325	40/-40	110	-135/485	95/-75	95/-80	130	0	415
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	2540	40/-40	110	-140/505	120/-95	100/-80	130	0	495
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	2705	40/-40	115	-150/530	145/-115	105/-85	130	0	605
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	3175	55/-55	160	-195/715	225/-165	150/-110	150	0	1175
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	4180	60/-65	185	-270/1015	530/-340	195/-130	150	0	2515
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

AIR/GND SYSTEM - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1665	20/-20	55	-80/260	35/-30	50/-45	85	0	100
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	2220	40/-35	105	-130/475	90/-70	90/-75	130	0	350
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	2430	40/-35	105	-140/495	115/-90	95/-80	130	0	425
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	2600	40/-40	110	-145/520	140/-110	100/-80	130	0	530
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	3035	55/-50	155	-190/705	215/-155	140/-105	145	0	985
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	4050	60/-60	180	-270/1010	530/-335	185/-125	145	0	2215
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ANTISKID / ANTISKID OFF - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	2325	30/-35	85	-125/435	95/-75	85/-65	105	275	740
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	2520	40/-40	110	-145/530	115/-90	105/-80	100	380	1100
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	2790	40/-45	120	-165/620	180/-130	120/-85	100	545	1670
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	2935	45/-45	125	-180/670	220/-150	130/-85	100	655	2120
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	3040	50/-50	140	-195/725	235/-160	145/-95	100	735	2480
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	3520	60/-60	160	-245/985	425/-255	175/-105	110	1280	6095
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ANTISKID / ANTISKID OFF - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	2255	30/-30	85	-125/435	95/-75	80/-65	90	250	660
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	2435	40/-35	105	-145/530	115/-90	100/-75	100	340	955
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	2710	40/-40	115	-165/615	180/-130	115/-80	100	500	1490
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	2860	45/-45	125	-180/670	225/-150	125/-85	100	605	1895
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	2960	50/-45	140	-195/725	240/-160	135/-90	110	675	2175
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	3455	60/-55	155	-250/1000	445/-260	165/-105	110	1215	6095
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
BLD DUCT LEAK L / BLD DUCT LEAK R - Flaps 25
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1415	25/-20	40	-65/210	20/-15	40/-35	65	30	60
AUTOBRAKE MAX	1625	20/-20	45	-75/240	0/0	45/-45	80	0	0
AUTOBRAKE 2	2600	35/-40	85	-130/435	5/-20	80/-80	135	5	5

Good Reported Braking Action

MAX MANUAL	1870	30/-30	75	-105/365	45/-40	70/-60	95	120	290
AUTOBRAKE MAX	1870	30/-30	80	-100/365	50/-35	70/-60	95	115	285
AUTOBRAKE 2	2605	35/-40	90	-130/445	20/-25	80/-80	135	5	5

Good to Medium Reported Braking Action

MAX MANUAL	2000	30/-30	80	-110/380	55/-50	75/-60	95	150	365
AUTOBRAKE MAX	2000	30/-30	80	-105/385	60/-45	75/-60	95	150	365
AUTOBRAKE 2	2605	35/-40	90	-130/445	20/-25	80/-80	135	5	5

Medium Reported Braking Action

MAX MANUAL	2100	30/-30	80	-110/400	65/-55	75/-60	95	185	475
AUTOBRAKE MAX	2100	30/-30	85	-110/400	70/-55	75/-60	95	185	470
AUTOBRAKE 3	2355	30/-35	80	-120/420	35/-25	75/-75	130	35	270

Medium to Poor Reported Braking Action

MAX MANUAL	2430	40/-40	105	-140/495	95/-80	105/-75	105	335	960
AUTOBRAKE MAX	2440	40/-40	110	-140/495	100/-85	105/-80	105	340	970
AUTOBRAKE 3	2510	35/-35	105	-125/450	70/-40	85/-70	115	270	900

Poor Reported Braking Action

MAX MANUAL	2970	45/-45	120	-180/665	195/-150	130/-90	105	660	2125
AUTOBRAKE MAX	2980	45/-45	120	-180/665	200/-155	130/-90	105	665	2135
AUTOBRAKE 3	2985	45/-45	120	-180/665	200/-140	130/-90	115	660	2130

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

BLD DUCT LEAK L / BLD DUCT LEAK R - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1365	25/-15	40	-65/210	20/-15	35/-35	60	25	55
AUTOBRAKE MAX	1560	20/-20	45	-70/235	0/0	40/-40	80	0	0
AUTOBRAKE 2	2495	35/-35	85	-130/430	0/-15	75/-75	135	0	0

Good Reported Braking Action

MAX MANUAL	1795	30/-25	75	-100/360	45/-40	65/-55	90	105	250
AUTOBRAKE MAX	1795	30/-25	75	-95/360	45/-30	65/-55	95	100	245
AUTOBRAKE 2	2500	35/-35	90	-130/430	10/-20	75/-75	135	0	0

Good to Medium Reported Braking Action

MAX MANUAL	1925	30/-30	75	-105/375	55/-45	70/-60	90	130	320
AUTOBRAKE MAX	1925	30/-30	80	-105/375	60/-40	70/-60	95	130	320
AUTOBRAKE 2	2500	35/-35	90	-130/430	10/-20	75/-75	135	0	0

Medium Reported Braking Action

MAX MANUAL	2030	30/-30	80	-110/395	65/-55	75/-60	90	170	420
AUTOBRAKE MAX	2030	30/-30	80	-110/395	70/-50	75/-60	95	170	420
AUTOBRAKE 3	2255	30/-30	80	-120/415	35/-25	70/-70	125	35	245

Medium to Poor Reported Braking Action

MAX MANUAL	2345	40/-35	105	-140/495	95/-75	100/-75	100	295	820
AUTOBRAKE MAX	2350	40/-35	105	-140/495	100/-80	100/-75	100	300	825
AUTOBRAKE 3	2405	35/-35	105	-125/455	70/-40	80/-70	110	240	770

Poor Reported Braking Action

MAX MANUAL	2900	45/-45	115	-180/665	200/-150	125/-85	100	615	1905
AUTOBRAKE MAX	2910	45/-45	115	-180/665	205/-155	125/-85	100	615	1915
AUTOBRAKE 3	2910	45/-45	115	-180/665	205/-140	125/-85	110	615	1915

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ENG 1, 2, 3, 4 SHUTDOWN - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1410	25/-20	40	-65/215	20/-15	40/-35	65	0	50
AUTOBRAKE MAX	1625	20/-20	45	-75/240	0/0	45/-45	80	0	0
AUTOBRAKE 2	2605	35/-40	85	-130/435	0/-5	80/-80	145	0	0

Good Reported Braking Action

MAX MANUAL	1920	30/-30	85	-110/400	55/-45	75/-65	105	0	210
AUTOBRAKE MAX	1925	30/-30	85	-105/400	55/-40	75/-65	105	0	200
AUTOBRAKE 2	2610	35/-40	85	-130/440	10/-5	80/-80	145	0	0

Good to Medium Reported Braking Action

MAX MANUAL	2075	30/-30	85	-115/415	70/-60	75/-65	105	0	250
AUTOBRAKE MAX	2075	30/-30	85	-110/415	70/-50	75/-65	105	0	245
AUTOBRAKE 2	2610	35/-40	85	-130/440	10/-5	80/-80	145	0	0

Medium Reported Braking Action

MAX MANUAL	2210	30/-30	85	-120/430	85/-70	80/-70	105	0	320
AUTOBRAKE MAX	2210	30/-35	90	-120/430	90/-65	80/-65	105	0	310
AUTOBRAKE 3	2360	30/-35	80	-125/420	45/-25	75/-70	130	0	220

Medium to Poor Reported Braking Action

MAX MANUAL	2645	45/-45	125	-165/595	140/-110	115/-90	125	0	660
AUTOBRAKE MAX	2655	45/-45	125	-165/595	145/-115	120/-95	125	0	665
AUTOBRAKE 3	2660	45/-45	125	-165/595	145/-105	120/-95	130	0	665

Poor Reported Braking Action

MAX MANUAL	3465	50/-55	140	-220/800	325/-230	145/-105	125	0	1415
AUTOBRAKE MAX	3475	50/-55	140	-220/805	330/-235	150/-110	125	0	1420
AUTOBRAKE 3	3480	50/-55	140	-220/805	330/-230	150/-110	130	0	1420

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ENG 1, 2, 3, 4 SHUTDOWN - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1365	25/-15	40	-65/210	20/-15	35/-35	65	0	45
AUTOBRAKE MAX	1560	20/-20	45	-70/235	0/0	40/-40	80	0	0
AUTOBRAKE 2	2495	35/-35	85	-130/430	0/-5	75/-75	140	0	0

Good Reported Braking Action

MAX MANUAL	1830	30/-30	80	-105/390	50/-45	70/-60	100	0	180
AUTOBRAKE MAX	1840	30/-30	80	-105/385	50/-35	70/-60	105	0	170
AUTOBRAKE 2	2495	35/-35	85	-130/430	5/-5	75/-75	140	0	0

Good to Medium Reported Braking Action

MAX MANUAL	1985	30/-30	80	-110/405	65/-55	70/-65	100	0	220
AUTOBRAKE MAX	1990	30/-30	85	-110/400	65/-50	70/-60	105	0	215
AUTOBRAKE 2	2495	35/-35	85	-130/430	5/-5	75/-75	140	0	0

Medium Reported Braking Action

MAX MANUAL	2125	30/-30	85	-115/420	85/-65	75/-65	100	0	280
AUTOBRAKE MAX	2130	30/-30	85	-115/420	85/-60	75/-65	105	0	275
AUTOBRAKE 3	2260	30/-30	80	-120/415	45/-25	70/-70	125	0	195

Medium to Poor Reported Braking Action

MAX MANUAL	2530	45/-40	120	-160/585	135/-105	110/-90	120	0	560
AUTOBRAKE MAX	2535	45/-45	120	-160/585	140/-110	110/-90	120	0	560
AUTOBRAKE 3	2540	45/-45	120	-160/585	135/-100	110/-90	125	0	565

Poor Reported Braking Action

MAX MANUAL	3350	50/-50	135	-215/795	320/-225	140/-105	120	0	1255
AUTOBRAKE MAX	3360	50/-50	135	-215/795	325/-230	140/-105	120	0	1255
AUTOBRAKE 3	3365	50/-50	135	-215/795	320/-225	140/-105	125	0	1260

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS CONTROL - Flaps 25
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1380	25/-20	40	-65/205	15/-15	40/-35	60	45	95
AUTOBRAKE MAX	1625	20/-20	45	-75/240	0/0	45/-45	80	0	0
AUTOBRAKE 2	2580	35/-40	90	-130/435	15/-35	85/-75	125	25	25

Good Reported Braking Action

MAX MANUAL	1795	30/-30	75	-100/350	40/-35	70/-55	90	145	365
AUTOBRAKE MAX	1805	30/-30	75	-95/350	45/-30	70/-60	90	140	350
AUTOBRAKE 2	2585	35/-40	90	-130/440	25/-35	85/-75	125	25	25

Good to Medium Reported Braking Action

MAX MANUAL	1925	30/-30	75	-105/370	55/-45	75/-60	90	175	440
AUTOBRAKE MAX	1930	30/-30	80	-105/370	55/-40	75/-60	90	170	430
AUTOBRAKE 2	2585	35/-40	90	-130/440	25/-35	85/-75	125	25	25

Medium Reported Braking Action

MAX MANUAL	2025	30/-30	80	-110/385	65/-55	75/-60	90	215	550
AUTOBRAKE MAX	2035	30/-30	80	-105/390	65/-50	75/-60	90	210	535
AUTOBRAKE 3	2335	30/-35	80	-120/405	25/-15	70/-70	130	35	290

Medium to Poor Reported Braking Action

MAX MANUAL	2325	40/-40	105	-135/485	90/-75	105/-75	100	370	1065
AUTOBRAKE MAX	2335	40/-40	105	-135/485	95/-75	105/-75	100	370	1075
AUTOBRAKE 3	2410	35/-35	100	-120/440	60/-30	80/-70	115	295	1000

Poor Reported Braking Action

MAX MANUAL	2865	45/-45	120	-175/655	190/-145	130/-85	100	695	2230
AUTOBRAKE MAX	2875	45/-45	120	-175/655	195/-145	130/-85	100	700	2240
AUTOBRAKE 3	2885	45/-45	120	-175/655	185/-130	130/-85	115	690	2230

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

FLAPS DRIVE - Flaps 25

VREF30+25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1670	25/-20	50	-70/225	20/-20	50/-45	65	65	140
AUTOBRAKE MAX	2020	20/-25	60	-80/265	5/-5	55/-55	90	0	0
AUTOBRAKE 2	3150	40/-45	115	-145/475	50/-70	115/-95	115	130	130

Good Reported Braking Action

MAX MANUAL	2225	35/-30	95	-110/390	55/-50	90/-70	95	225	575
AUTOBRAKE MAX	2260	35/-30	100	-110/390	55/-45	90/-75	95	220	570
AUTOBRAKE 2	3155	40/-45	115	-145/475	55/-70	115/-95	115	130	130

Good to Medium Reported Braking Action

MAX MANUAL	2355	35/-35	100	-115/405	65/-55	95/-75	95	255	650
AUTOBRAKE MAX	2385	35/-35	100	-115/405	70/-55	95/-75	95	255	655
AUTOBRAKE 2	3155	40/-45	115	-145/475	55/-70	115/-95	115	130	130

Medium Reported Braking Action

MAX MANUAL	2460	35/-35	100	-120/420	75/-65	100/-75	95	295	765
AUTOBRAKE MAX	2490	35/-35	105	-120/425	80/-65	100/-75	95	295	765
AUTOBRAKE 3	2915	35/-40	100	-130/445	30/-40	90/-85	125	50	400

Medium to Poor Reported Braking Action

MAX MANUAL	2810	45/-40	130	-145/520	110/-90	130/-90	105	500	1485
AUTOBRAKE MAX	2835	45/-45	130	-145/525	115/-95	130/-90	105	505	1500
AUTOBRAKE 3	2940	45/-40	125	-130/490	70/-45	110/-85	120	410	1410

Poor Reported Braking Action

MAX MANUAL	3360	50/-50	140	-190/690	210/-160	155/-100	105	835	2705
AUTOBRAKE MAX	3385	50/-50	140	-190/690	215/-165	160/-100	105	840	2720
AUTOBRAKE 3	3440	50/-50	140	-190/695	195/-145	150/-105	120	800	2685

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Flaps Up Landing - Flaps Up

VREF30+70

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	2220	40/-30	70	-80/255	25/-25	65/-60	70	95	215
AUTOBRAKE MAX	2840	30/-30	85	-95/310	5/-5	80/-80	105	10	25
AUTOBRAKE 2	4335	55/-60	170	-165/545	90/-95	180/-130	120	460	500

Good Reported Braking Action

MAX MANUAL	3015	40/-40	130	-130/440	70/-60	130/-100	95	340	885
AUTOBRAKE MAX	3060	40/-35	130	-125/440	60/-55	130/-100	100	345	895
AUTOBRAKE 2	4335	55/-60	170	-165/545	95/-95	180/-130	120	460	500

Good to Medium Reported Braking Action

MAX MANUAL	3145	40/-40	135	-135/460	80/-70	130/-100	95	370	960
AUTOBRAKE MAX	3185	40/-40	135	-135/455	75/-65	135/-100	100	375	970
AUTOBRAKE 2	4335	55/-60	170	-165/545	95/-95	180/-130	120	460	500

Medium Reported Braking Action

MAX MANUAL	3250	40/-40	135	-140/475	90/-75	135/-100	95	410	1070
AUTOBRAKE MAX	3290	40/-40	135	-140/475	85/-75	135/-100	100	415	1085
AUTOBRAKE 3	4090	45/-50	150	-155/510	70/-75	150/-125	120	180	365

Medium to Poor Reported Braking Action

MAX MANUAL	3815	55/-55	175	-170/585	140/-115	185/-125	105	760	2325
AUTOBRAKE MAX	3825	55/-55	175	-170/585	145/-120	185/-125	105	760	2320
AUTOBRAKE 3	4120	55/-50	175	-155/555	95/-85	165/-125	115	525	2080

Poor Reported Braking Action

MAX MANUAL	4395	60/-60	185	-205/750	240/-190	210/-135	105	1125	3675
AUTOBRAKE MAX	4405	60/-60	185	-205/750	245/-190	210/-135	105	1125	3670
AUTOBRAKE 3	4630	60/-65	190	-215/765	235/-190	215/-140	115	960	3495

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

FLARE ASSIST - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1380	25/-20	40	-65/205	15/-15	40/-35	60	45	95
AUTOBRAKE MAX	1625	20/-20	45	-75/240	0/0	45/-45	80	0	0
AUTOBRAKE 2	2580	35/-40	90	-130/435	15/-35	85/-75	125	25	25

Good Reported Braking Action

MAX MANUAL	1795	30/-30	75	-100/350	40/-35	70/-55	90	145	365
AUTOBRAKE MAX	1805	30/-30	75	-95/350	45/-30	70/-60	90	140	350
AUTOBRAKE 2	2585	35/-40	90	-130/440	25/-35	85/-75	125	25	25

Good to Medium Reported Braking Action

MAX MANUAL	1925	30/-30	75	-105/370	55/-45	75/-60	90	175	440
AUTOBRAKE MAX	1930	30/-30	80	-105/370	55/-40	75/-60	90	170	430
AUTOBRAKE 2	2585	35/-40	90	-130/440	25/-35	85/-75	125	25	25

Medium Reported Braking Action

MAX MANUAL	2025	30/-30	80	-110/385	65/-55	75/-60	90	215	550
AUTOBRAKE MAX	2035	30/-30	80	-105/390	65/-50	75/-60	90	210	535
AUTOBRAKE 3	2335	30/-35	80	-120/405	25/-15	70/-70	130	35	290

Medium to Poor Reported Braking Action

MAX MANUAL	2325	40/-40	105	-135/485	90/-75	105/-75	100	370	1065
AUTOBRAKE MAX	2335	40/-40	105	-135/485	95/-75	105/-75	100	370	1075
AUTOBRAKE 3	2410	35/-35	100	-120/440	60/-30	80/-70	115	295	1000

Poor Reported Braking Action

MAX MANUAL	2865	45/-45	120	-175/655	190/-145	130/-85	100	695	2230
AUTOBRAKE MAX	2875	45/-45	120	-175/655	195/-145	130/-85	100	700	2240
AUTOBRAKE 3	2885	45/-45	120	-175/655	185/-130	130/-85	115	690	2230

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (1 Body or 1 Wing Gear Up) - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1500	30/-25	45	-70/230	25/-20	45/-40	65	65	145
AUTOBRAKE MAX	1635	25/-20	50	-75/245	5/-5	45/-45	85	10	100
AUTOBRAKE 2	2585	35/-40	85	-130/435	10/-30	85/-75	130	20	20

Good Reported Braking Action

MAX MANUAL	1820	30/-30	75	-100/355	45/-40	70/-60	90	150	380
AUTOBRAKE MAX	1830	30/-30	75	-100/355	45/-35	70/-60	95	145	370
AUTOBRAKE 2	2595	35/-40	90	-130/440	20/-30	85/-80	130	20	20

Good to Medium Reported Braking Action

MAX MANUAL	1935	30/-30	80	-105/370	55/-45	75/-60	90	180	450
AUTOBRAKE MAX	1940	30/-30	80	-105/370	55/-45	75/-60	95	175	440
AUTOBRAKE 2	2595	35/-40	90	-130/440	20/-30	85/-80	130	20	20

Medium Reported Braking Action

MAX MANUAL	2035	30/-30	80	-110/390	65/-55	75/-60	90	220	560
AUTOBRAKE MAX	2045	30/-30	80	-110/390	65/-55	80/-60	95	215	550
AUTOBRAKE 3	2340	30/-35	80	-120/405	25/-15	70/-70	130	35	310

Medium to Poor Reported Braking Action

MAX MANUAL	2340	40/-40	105	-135/490	90/-75	105/-75	105	380	1100
AUTOBRAKE MAX	2350	40/-40	110	-135/490	100/-80	105/-75	105	380	1110
AUTOBRAKE 3	2420	35/-35	105	-120/445	65/-35	85/-70	115	310	1040

Poor Reported Braking Action

MAX MANUAL	2890	45/-45	120	-175/660	195/-145	135/-85	105	715	2310
AUTOBRAKE MAX	2900	45/-45	120	-180/660	200/-150	135/-85	105	720	2320
AUTOBRAKE 3	2910	45/-45	120	-180/660	190/-135	130/-90	115	710	2310

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (1 Body or 1 Wing Gear Up) - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1450	30/-20	45	-70/230	20/-20	40/-40	65	55	130
AUTOBRAKE MAX	1575	30/-20	45	-75/245	5/-5	40/-40	80	10	90
AUTOBRAKE 2	2485	35/-35	85	-130/425	5/-25	80/-75	130	10	10
Good Reported Braking Action									
MAX MANUAL	1755	30/-30	75	-100/350	40/-35	65/-55	90	135	330
AUTOBRAKE MAX	1760	30/-25	75	-95/350	45/-35	65/-55	90	130	320
AUTOBRAKE 2	2495	35/-35	90	-130/430	15/-25	80/-75	130	10	10
Good to Medium Reported Braking Action									
MAX MANUAL	1870	30/-30	75	-105/365	50/-45	70/-55	90	160	395
AUTOBRAKE MAX	1875	30/-30	75	-100/365	55/-40	70/-55	90	160	385
AUTOBRAKE 2	2495	35/-35	90	-130/430	15/-25	80/-75	130	10	10
Medium Reported Braking Action									
MAX MANUAL	1975	30/-30	80	-105/385	65/-55	75/-60	90	200	500
AUTOBRAKE MAX	1980	30/-30	80	-105/385	65/-50	75/-60	90	195	490
AUTOBRAKE 3	2240	30/-30	75	-115/400	25/-15	65/-65	125	40	280
Medium to Poor Reported Braking Action									
MAX MANUAL	2260	40/-35	105	-135/485	90/-75	100/-75	105	340	950
AUTOBRAKE MAX	2270	40/-35	105	-135/490	95/-75	100/-75	105	340	960
AUTOBRAKE 3	2325	40/-35	105	-120/450	70/-35	85/-65	110	285	905
Poor Reported Braking Action									
MAX MANUAL	2825	45/-45	115	-175/660	195/-145	125/-85	105	625	2075
AUTOBRAKE MAX	2835	45/-45	120	-180/660	200/-150	130/-85	105	625	2085
AUTOBRAKE 3	2835	45/-45	115	-180/660	200/-140	130/-85	110	625	2080

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (2 Body or 2 Wing Gear Up) - Flaps 25

VREF25

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1810	35/-35	60	-90/300	40/-35	60/-50	75	125	305
AUTOBRAKE MAX	1830	35/-30	60	-90/300	40/-35	60/-50	80	130	310
AUTOBRAKE 2	2595	35/-40	85	-130/435	5/-25	80/-80	135	10	10

Good Reported Braking Action

MAX MANUAL	1950	35/-35	80	-105/375	50/-45	75/-60	95	170	420
AUTOBRAKE MAX	1950	35/-35	80	-105/375	55/-45	75/-60	95	170	420
AUTOBRAKE 2	2610	35/-40	90	-135/450	25/-30	85/-80	135	10	10

Good to Medium Reported Braking Action

MAX MANUAL	1980	35/-30	80	-105/375	55/-45	75/-60	95	180	450
AUTOBRAKE MAX	1980	35/-30	80	-105/380	60/-50	75/-60	95	180	450
AUTOBRAKE 2	2610	35/-40	90	-135/450	25/-30	85/-80	135	10	10

Medium Reported Braking Action

MAX MANUAL	2085	30/-30	80	-110/395	65/-55	80/-60	95	220	560
AUTOBRAKE MAX	2085	30/-30	85	-110/395	70/-55	80/-60	95	220	560
AUTOBRAKE 3	2360	30/-35	80	-120/410	30/-20	70/-70	130	40	320

Medium to Poor Reported Braking Action

MAX MANUAL	2395	40/-40	110	-140/495	95/-75	105/-75	105	385	1125
AUTOBRAKE MAX	2410	40/-40	110	-140/495	100/-85	110/-80	105	390	1140
AUTOBRAKE 3	2470	40/-35	105	-125/455	70/-40	90/-70	115	325	1075

Poor Reported Braking Action

MAX MANUAL	2950	45/-45	120	-180/665	195/-150	135/-90	105	725	2365
AUTOBRAKE MAX	2965	45/-45	125	-180/665	205/-155	135/-90	105	730	2380
AUTOBRAKE 3	2970	45/-45	120	-180/665	200/-140	135/-90	115	725	2380

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (2 Body or 2 Wing Gear Up) - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1750	35/-30	60	-85/295	40/-35	55/-45	75	115	270
AUTOBRAKE MAX	1765	35/-30	60	-90/295	40/-35	55/-50	80	115	275
AUTOBRAKE 2	2495	35/-35	85	-130/430	0/-20	75/-75	135	0	0

Good Reported Braking Action

MAX MANUAL	1880	35/-30	75	-105/370	50/-40	70/-60	95	150	365
AUTOBRAKE MAX	1880	35/-30	80	-105/370	55/-45	70/-60	95	150	365
AUTOBRAKE 2	2505	35/-35	90	-130/440	15/-25	75/-75	135	5	5

Good to Medium Reported Braking Action

MAX MANUAL	1915	35/-30	75	-105/370	55/-45	70/-60	95	160	395
AUTOBRAKE MAX	1915	35/-30	80	-105/375	60/-45	70/-60	95	160	395
AUTOBRAKE 2	2505	35/-35	90	-130/440	15/-25	75/-75	135	5	5

Medium Reported Braking Action

MAX MANUAL	2020	30/-30	80	-110/390	65/-55	75/-60	90	200	500
AUTOBRAKE MAX	2020	30/-30	80	-110/390	70/-55	75/-60	95	200	500
AUTOBRAKE 3	2260	30/-30	80	-120/405	30/-20	70/-70	125	40	295

Medium to Poor Reported Braking Action

MAX MANUAL	2310	40/-40	105	-140/495	90/-75	100/-75	105	340	965
AUTOBRAKE MAX	2330	40/-40	110	-140/495	100/-80	105/-75	105	345	980
AUTOBRAKE 3	2375	40/-35	105	-125/460	75/-40	90/-70	110	300	935

Poor Reported Braking Action

MAX MANUAL	2880	45/-45	120	-180/665	200/-150	130/-85	105	675	2125
AUTOBRAKE MAX	2900	45/-45	120	-180/670	205/-155	130/-85	105	680	2140
AUTOBRAKE 3	2900	45/-45	120	-180/670	205/-145	130/-85	110	680	2140

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (Nose and Body Gear Up) - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1810	35/-35	60	-90/300	40/-35	60/-50	75	125	305
AUTOBRAKE MAX	1830	35/-30	60	-90/300	40/-35	60/-50	80	130	310
AUTOBRAKE 2	2595	35/-40	85	-130/435	5/-25	80/-80	135	10	10

Good Reported Braking Action

MAX MANUAL	1950	35/-35	80	-105/375	50/-45	75/-60	95	170	420
AUTOBRAKE MAX	1950	35/-35	80	-105/375	55/-45	75/-60	95	170	420
AUTOBRAKE 2	2610	35/-40	90	-135/450	25/-30	85/-80	135	10	10

Good to Medium Reported Braking Action

MAX MANUAL	1980	35/-30	80	-105/375	55/-45	75/-60	95	180	450
AUTOBRAKE MAX	1980	35/-30	80	-105/380	60/-50	75/-60	95	180	450
AUTOBRAKE 2	2610	35/-40	90	-135/450	25/-30	85/-80	135	10	10

Medium Reported Braking Action

MAX MANUAL	2085	30/-30	80	-110/395	65/-55	80/-60	95	220	560
AUTOBRAKE MAX	2085	30/-30	85	-110/395	70/-55	80/-60	95	220	560
AUTOBRAKE 3	2360	30/-35	80	-120/410	30/-20	70/-70	130	40	320

Medium to Poor Reported Braking Action

MAX MANUAL	2395	40/-40	110	-140/495	95/-75	105/-75	105	385	1125
AUTOBRAKE MAX	2410	40/-40	110	-140/495	100/-85	110/-80	105	390	1140
AUTOBRAKE 3	2470	40/-35	105	-125/455	70/-40	90/-70	115	325	1075

Poor Reported Braking Action

MAX MANUAL	2950	45/-45	120	-180/665	195/-150	135/-90	105	725	2365
AUTOBRAKE MAX	2965	45/-45	125	-180/665	205/-155	135/-90	105	730	2380
AUTOBRAKE 3	2970	45/-45	120	-180/665	200/-140	135/-90	115	725	2380

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (Nose and Body Gear Up) - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1750	35/-30	60	-85/295	40/-35	55/-45	75	115	270
AUTOBRAKE MAX	1765	35/-30	60	-90/295	40/-35	55/-50	80	115	275
AUTOBRAKE 2	2495	35/-35	85	-130/430	0/-20	75/-75	135	0	0

Good Reported Braking Action

MAX MANUAL	1880	35/-30	75	-105/370	50/-40	70/-60	95	150	365
AUTOBRAKE MAX	1880	35/-30	80	-105/370	55/-45	70/-60	95	150	365
AUTOBRAKE 2	2505	35/-35	90	-130/440	15/-25	75/-75	135	5	5

Good to Medium Reported Braking Action

MAX MANUAL	1915	35/-30	75	-105/370	55/-45	70/-60	95	160	395
AUTOBRAKE MAX	1915	35/-30	80	-105/375	60/-45	70/-60	95	160	395
AUTOBRAKE 2	2505	35/-35	90	-130/440	15/-25	75/-75	135	5	5

Medium Reported Braking Action

MAX MANUAL	2020	30/-30	80	-110/390	65/-55	75/-60	90	200	500
AUTOBRAKE MAX	2020	30/-30	80	-110/390	70/-55	75/-60	95	200	500
AUTOBRAKE 3	2260	30/-30	80	-120/405	30/-20	70/-70	125	40	295

Medium to Poor Reported Braking Action

MAX MANUAL	2310	40/-40	105	-140/495	90/-75	100/-75	105	340	965
AUTOBRAKE MAX	2330	40/-40	110	-140/495	100/-80	105/-75	105	345	980
AUTOBRAKE 3	2375	40/-35	105	-125/460	75/-40	90/-70	110	300	935

Poor Reported Braking Action

MAX MANUAL	2880	45/-45	120	-180/665	200/-150	130/-85	105	675	2125
AUTOBRAKE MAX	2900	45/-45	120	-180/670	205/-155	130/-85	105	680	2140
AUTOBRAKE 3	2900	45/-45	120	-180/670	205/-145	130/-85	110	680	2140

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRES SYS 1+4 - Flaps 25
VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	2150	25/-25	70	-90/300	50/-45	65/-60	105	0	150
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	2935	45/-45	140	-155/555	135/-110	125/-100	145	0	610
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	3160	45/-45	140	-165/575	165/-130	130/-105	145	0	700
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	3335	45/-45	145	-170/600	195/-150	135/-105	145	0	825
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	3870	65/-60	195	-215/785	285/-210	185/-135	155	0	1560
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	4915	70/-70	220	-295/1100	620/-400	230/-155	155	0	3060
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRES SYS 2+3 - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1845	25/-20	60	-75/250	35/-30	55/-50	95	0	115
AUTOBRAKE MAX	1920	20/-25	60	-80/260	20/-10	55/-55	95	0	90
AUTOBRAKE 2	3095	40/-40	105	-145/475	0/0	95/-95	160	0	0

Good Reported Braking Action

MAX MANUAL	2605	40/-40	125	-135/485	105/-85	110/-90	135	0	505
AUTOBRAKE MAX	2610	40/-40	125	-140/485	110/-90	110/-90	140	0	500
AUTOBRAKE 2	3135	40/-40	115	-150/490	35/-15	100/-100	160	0	240

Good to Medium Reported Braking Action

MAX MANUAL	2775	40/-40	125	-140/495	120/-95	115/-90	135	0	555
AUTOBRAKE MAX	2775	40/-40	130	-140/500	125/-105	115/-95	140	0	555
AUTOBRAKE 2	3135	40/-40	115	-150/490	35/-15	100/-100	160	0	240

Medium Reported Braking Action

MAX MANUAL	2925	40/-40	130	-145/515	140/-110	115/-95	135	0	645
AUTOBRAKE MAX	2925	40/-40	130	-145/515	150/-120	120/-95	140	0	645
AUTOBRAKE 3	2935	40/-40	130	-145/515	145/-75	115/-95	140	0	645

Medium to Poor Reported Braking Action

MAX MANUAL	3495	60/-55	180	-195/700	230/-170	165/-125	150	0	1340
AUTOBRAKE MAX	3510	60/-55	180	-195/700	235/-180	170/-125	150	0	1345
AUTOBRAKE 3	3510	60/-55	180	-195/700	235/-180	170/-125	150	0	1345

Poor Reported Braking Action

MAX MANUAL	4430	65/-65	195	-255/930	455/-320	205/-140	150	0	2395
AUTOBRAKE MAX	4445	65/-65	195	-255/930	465/-325	205/-140	150	0	2405
AUTOBRAKE 3	4445	65/-65	195	-255/930	465/-325	205/-140	150	0	2405

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1 / HYD PRESS SYS 2 / HYD PRESS SYS 3 - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1490	25/-20	45	-70/220	25/-20	40/-40	75	0	65
AUTOBRAKE MAX	1625	20/-20	45	-75/240	0/0	45/-45	80	0	20
AUTOBRAKE 2	2605	35/-40	85	-130/435	0/0	80/-80	150	0	0

Good Reported Braking Action

MAX MANUAL	2050	35/-35	95	-120/425	70/-55	80/-70	115	0	275
AUTOBRAKE MAX	2050	35/-35	95	-120/425	70/-60	85/-70	120	0	270
AUTOBRAKE 2	2620	35/-40	90	-135/445	15/-5	80/-80	150	0	35

Good to Medium Reported Braking Action

MAX MANUAL	2215	30/-35	95	-125/440	85/-70	85/-70	115	0	325
AUTOBRAKE MAX	2215	30/-35	95	-125/440	90/-70	85/-70	120	0	320
AUTOBRAKE 2	2620	35/-40	90	-135/445	15/-5	80/-80	150	0	35

Medium Reported Braking Action

MAX MANUAL	2360	35/-35	95	-130/455	100/-80	90/-75	115	0	400
AUTOBRAKE MAX	2360	35/-35	100	-130/460	105/-85	90/-75	120	0	400
AUTOBRAKE 3	2410	30/-35	95	-130/450	85/-40	85/-75	130	0	380

Medium to Poor Reported Braking Action

MAX MANUAL	2845	50/-50	140	-175/635	170/-130	130/-100	135	0	860
AUTOBRAKE MAX	2855	50/-50	140	-175/635	180/-135	130/-100	135	0	865
AUTOBRAKE 3	2855	50/-50	140	-175/635	180/-135	130/-100	135	0	865

Poor Reported Braking Action

MAX MANUAL	3745	55/-55	160	-235/865	390/-270	165/-115	135	0	1800
AUTOBRAKE MAX	3760	55/-55	160	-235/865	395/-275	165/-120	135	0	1805
AUTOBRAKE 3	3760	55/-55	160	-235/865	395/-275	165/-120	135	0	1805

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1 / HYD PRESS SYS 2 / HYD PRESS SYS 3 - Flaps 30 VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1435	25/-20	45	-65/220	20/-20	40/-40	70	0	55
AUTOBRAKE MAX	1560	20/-20	45	-70/235	0/0	40/-40	80	0	20
AUTOBRAKE 2	2495	35/-35	85	-130/430	0/0	75/-75	145	0	0

Good Reported Braking Action

MAX MANUAL	1955	35/-30	90	-115/415	65/-55	75/-65	115	0	230
AUTOBRAKE MAX	1955	35/-30	90	-115/415	65/-55	75/-65	115	0	225
AUTOBRAKE 2	2505	35/-35	90	-130/435	10/-5	75/-75	145	0	20

Good to Medium Reported Braking Action

MAX MANUAL	2120	35/-30	90	-120/430	80/-65	80/-70	115	0	280
AUTOBRAKE MAX	2120	35/-30	95	-120/430	85/-70	80/-70	115	0	275
AUTOBRAKE 2	2505	35/-35	90	-130/435	10/-5	75/-75	145	0	20

Medium Reported Braking Action

MAX MANUAL	2270	35/-30	95	-125/445	100/-80	85/-70	110	0	350
AUTOBRAKE MAX	2270	35/-30	95	-125/450	105/-80	85/-70	115	0	345
AUTOBRAKE 3	2310	35/-35	95	-125/440	85/-40	80/-70	125	0	340

Medium to Poor Reported Braking Action

MAX MANUAL	2715	50/-45	135	-170/625	160/-125	120/-95	135	0	720
AUTOBRAKE MAX	2725	50/-45	140	-170/625	170/-130	125/-95	135	0	725
AUTOBRAKE 3	2725	50/-45	140	-170/625	170/-130	125/-95	135	0	725

Poor Reported Braking Action

MAX MANUAL	3620	55/-55	155	-230/860	385/-265	155/-115	135	0	1580
AUTOBRAKE MAX	3630	55/-55	155	-235/860	390/-270	155/-115	135	0	1585
AUTOBRAKE 3	3630	55/-55	155	-235/860	390/-270	155/-115	135	0	1585

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS 4 - Flaps 25
VREF25

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1805	20/-25	60	-85/275	40/-35	55/-50	95	0	135
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	2425	40/-40	115	-140/505	105/-85	105/-85	140	0	490
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	2650	40/-40	115	-150/530	135/-105	105/-85	140	0	580
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	2825	40/-40	120	-155/555	165/-125	115/-90	140	0	705
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	3295	55/-55	170	-205/745	250/-180	160/-115	155	0	1345
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	4340	65/-70	195	-280/1060	585/-370	205/-135	155	0	2850
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 4 - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1740	20/-25	55	-85/275	40/-35	50/-45	95	0	120
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	2315	40/-35	110	-135/495	100/-80	95/-80	135	0	415
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	2540	40/-40	115	-145/520	130/-100	100/-80	135	0	495
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	2715	40/-40	120	-150/545	160/-120	105/-85	135	0	615
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	3155	55/-55	165	-200/735	240/-170	150/-110	155	0	1130
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	4205	65/-65	190	-280/1055	585/-365	195/-130	155	0	2505
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1 and HYD PRESS SYS 2/ HYD PRESS SYS 1 and HYD PRESS SYS 3 - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1810	25/-20	55	-75/250	35/-30	50/-50	85	0	0
AUTOBRAKE MAX	1915	25/-20	60	-80/260	30/-15	50/-55	95	0	0
AUTOBRAKE 2	3095	40/-40	105	-145/475	0/-5	95/-95	160	0	0

Good Reported Braking Action

MAX MANUAL	2800	45/-40	135	-160/580	135/-110	110/-105	155	0	0
AUTOBRAKE MAX	2805	45/-40	140	-160/585	145/-115	110/-110	155	0	0
AUTOBRAKE 2	3155	45/-40	135	-155/565	95/-35	105/-105	160	0	0

Good to Medium Reported Braking Action

MAX MANUAL	3015	40/-40	135	-165/590	160/-125	110/-105	155	0	0
AUTOBRAKE MAX	3015	40/-40	140	-165/590	170/-130	110/-110	155	0	0
AUTOBRAKE 2	3155	45/-40	135	-155/565	115/-35	105/-105	160	0	0

Medium Reported Braking Action

MAX MANUAL	3235	40/-40	140	-170/605	200/-150	110/-110	155	0	0
AUTOBRAKE MAX	3240	45/-40	140	-170/610	205/-155	110/-110	155	0	0
AUTOBRAKE 3	3280	45/-40	140	-170/605	195/-150	110/-110	160	0	0

Medium to Poor Reported Braking Action

MAX MANUAL	4325	65/-65	220	-270/1005	450/-295	170/-170	190	0	0
AUTOBRAKE MAX	4345	65/-65	225	-270/1005	460/-305	175/-175	190	0	0
AUTOBRAKE 3	4345	65/-65	225	-270/1005	460/-295	175/-175	195	0	0

Poor Reported Braking Action

MAX MANUAL	6160	65/-65	235	-370/1330	1125/-665	200/-200	190	0	0
AUTOBRAKE MAX	6180	70/-65	240	-370/1330	1135/-670	200/-200	190	0	0
AUTOBRAKE 3	6180	70/-65	240	-370/1330	1135/-660	200/-200	195	0	0

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 2 and HYD PRESS SYS 4/ HYD PRESS SYS 3 and HYD PRESS SYS 4 - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	2565	25/-30	90	-110/350	100/-80	75/-75	170	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	4050	60/-60	210	-235/845	395/-260	160/-160	260	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	4375	60/-55	215	-235/850	450/-300	160/-160	260	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	4705	60/-55	215	-245/865	535/-345	165/-165	260	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	6230	90/-90	345	-395/1465	1230/-635	255/-255	295	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	9040	90/-80	380	-545/1970	2895/-1345	295/-290	295	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Jammed Stab Landing - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1630	25/-20	50	-70/225	20/-20	45/-45	70	65	140
AUTOBRAKE MAX	1915	20/-20	55	-80/260	5/-5	50/-50	95	0	0
AUTOBRAKE 2	3025	40/-45	110	-140/465	30/-50	105/-90	130	70	70

Good Reported Braking Action

MAX MANUAL	2170	35/-30	95	-110/385	55/-50	90/-70	100	225	575
AUTOBRAKE MAX	2195	35/-30	95	-110/385	60/-50	90/-70	100	220	575
AUTOBRAKE 2	3050	40/-45	110	-145/470	40/-60	110/-90	125	75	95

Good to Medium Reported Braking Action

MAX MANUAL	2300	35/-30	95	-115/405	65/-55	90/-70	100	255	655
AUTOBRAKE MAX	2320	35/-35	100	-115/405	70/-60	95/-70	100	250	655
AUTOBRAKE 2	3050	40/-45	110	-145/470	40/-60	110/-90	125	75	95

Medium Reported Braking Action

MAX MANUAL	2405	35/-35	100	-120/420	80/-65	95/-75	100	295	775
AUTOBRAKE MAX	2425	35/-35	100	-120/420	80/-70	95/-75	100	295	775
AUTOBRAKE 3	2785	35/-35	95	-130/435	25/-25	85/-85	135	50	465

Medium to Poor Reported Braking Action

MAX MANUAL	2750	45/-40	130	-145/520	110/-90	130/-90	105	505	1525
AUTOBRAKE MAX	2770	45/-40	130	-145/520	115/-95	130/-90	110	510	1540
AUTOBRAKE 3	2840	45/-35	125	-130/495	85/-45	110/-85	120	440	1470

Poor Reported Braking Action

MAX MANUAL	3305	50/-50	140	-190/690	215/-165	155/-100	105	850	2800
AUTOBRAKE MAX	3325	50/-50	140	-190/690	220/-165	155/-100	110	855	2815
AUTOBRAKE 3	3355	50/-50	140	-190/695	205/-150	150/-100	120	830	2790

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

SPOILERS - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	1540	20/-20	50	-70/225	25/-25	45/-40	85	70	165
AUTOBRAKE MAX	1630	20/-20	50	-75/240	5/-5	45/-45	85	25	105
AUTOBRAKE 2	2605	35/-40	85	-130/435	0/-10	80/-80	145	0	0
Good Reported Braking Action									
MAX MANUAL	2015	30/-30	90	-110/385	60/-50	85/-65	115	235	645
AUTOBRAKE MAX	2015	35/-30	90	-110/385	65/-50	85/-65	115	235	635
AUTOBRAKE 2	2640	35/-40	90	-135/450	20/-20	80/-80	145	25	240
Good to Medium Reported Braking Action									
MAX MANUAL	2145	30/-35	90	-115/400	70/-60	90/-65	115	270	735
AUTOBRAKE MAX	2145	30/-35	90	-115/400	75/-65	90/-65	115	270	730
AUTOBRAKE 2	2640	35/-40	90	-135/450	20/-20	80/-80	145	25	250
Medium Reported Braking Action									
MAX MANUAL	2255	35/-35	95	-120/415	85/-70	90/-65	115	320	875
AUTOBRAKE MAX	2255	35/-35	95	-120/415	90/-70	95/-70	115	315	870
AUTOBRAKE 3	2385	30/-35	85	-125/430	55/-30	80/-75	135	185	740
Medium to Poor Reported Braking Action									
MAX MANUAL	2560	45/-45	125	-145/520	120/-95	125/-85	120	535	1755
AUTOBRAKE MAX	2575	45/-45	125	-145/520	125/-100	125/-85	120	540	1770
AUTOBRAKE 3	2575	45/-40	125	-135/520	125/-70	125/-85	120	535	1765
Poor Reported Braking Action									
MAX MANUAL	3130	50/-50	135	-190/690	225/-170	155/-95	120	915	3265
AUTOBRAKE MAX	3145	50/-50	140	-190/690	235/-175	155/-95	120	920	3280
AUTOBRAKE 3	3145	50/-50	140	-190/690	235/-175	155/-95	120	920	3280

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

SPOILERS - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1490	20/-20	50	-70/225	25/-20	45/-40	85	65	150
AUTOBRAKE MAX	1570	20/-20	50	-75/240	5/-5	45/-40	85	25	95
AUTOBRAKE 2	2495	35/-35	85	-130/430	0/-5	75/-75	145	0	0

Good Reported Braking Action

MAX MANUAL	1940	35/-30	85	-105/380	60/-50	80/-65	110	210	555
AUTOBRAKE MAX	1940	35/-30	90	-105/380	60/-50	80/-65	115	205	545
AUTOBRAKE 2	2525	35/-35	90	-130/440	20/-10	75/-75	145	20	190

Good to Medium Reported Braking Action

MAX MANUAL	2075	35/-30	90	-110/395	70/-60	85/-65	110	245	640
AUTOBRAKE MAX	2075	35/-30	90	-110/395	75/-60	85/-65	115	240	635
AUTOBRAKE 2	2525	35/-35	90	-130/440	20/-10	75/-75	145	20	200

Medium Reported Braking Action

MAX MANUAL	2185	35/-30	90	-115/410	85/-70	85/-65	110	290	775
AUTOBRAKE MAX	2185	35/-35	95	-115/415	90/-70	90/-65	115	285	770
AUTOBRAKE 3	2280	30/-30	85	-120/425	55/-25	75/-70	130	185	670

Medium to Poor Reported Braking Action

MAX MANUAL	2480	45/-40	120	-145/520	120/-95	120/-80	120	480	1500
AUTOBRAKE MAX	2490	45/-40	125	-145/520	125/-100	120/-80	120	485	1510
AUTOBRAKE 3	2490	45/-35	125	-135/520	125/-75	120/-80	120	485	1510

Poor Reported Braking Action

MAX MANUAL	3070	50/-50	135	-190/695	230/-175	150/-95	120	855	2915
AUTOBRAKE MAX	3075	50/-50	135	-190/695	235/-180	150/-95	120	860	2925
AUTOBRAKE 3	3075	50/-50	135	-190/695	235/-180	150/-95	120	860	2925

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

STAB TRIM UNSCHD - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	310000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 310000 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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	1630	25/-20	50	-70/225	20/-20	45/-45	70	65	140
AUTOBRAKE MAX	1915	20/-20	55	-80/260	5/-5	50/-50	95	0	0
AUTOBRAKE 2	3025	40/-45	110	-140/465	30/-50	105/-90	130	70	70

Good Reported Braking Action

MAX MANUAL	2170	35/-30	95	-110/385	55/-50	90/-70	100	225	575
AUTOBRAKE MAX	2195	35/-30	95	-110/385	60/-50	90/-70	100	220	575
AUTOBRAKE 2	3050	40/-45	110	-145/470	40/-60	110/-90	125	75	95

Good to Medium Reported Braking Action

MAX MANUAL	2300	35/-30	95	-115/405	65/-55	90/-70	100	255	655
AUTOBRAKE MAX	2320	35/-35	100	-115/405	70/-60	95/-70	100	250	655
AUTOBRAKE 2	3050	40/-45	110	-145/470	40/-60	110/-90	125	75	95

Medium Reported Braking Action

MAX MANUAL	2405	35/-35	100	-120/420	80/-65	95/-75	100	295	775
AUTOBRAKE MAX	2425	35/-35	100	-120/420	80/-70	95/-75	100	295	775
AUTOBRAKE 3	2785	35/-35	95	-130/435	25/-25	85/-85	135	50	465

Medium to Poor Reported Braking Action

MAX MANUAL	2750	45/-40	130	-145/520	110/-90	130/-90	105	505	1525
AUTOBRAKE MAX	2770	45/-40	130	-145/520	115/-95	130/-90	110	510	1540
AUTOBRAKE 3	2840	45/-35	125	-130/495	85/-45	110/-85	120	440	1470

Poor Reported Braking Action

MAX MANUAL	3305	50/-50	140	-190/690	215/-165	155/-100	105	850	2800
AUTOBRAKE MAX	3325	50/-50	140	-190/690	220/-165	155/-100	110	855	2815
AUTOBRAKE 3	3355	50/-50	140	-190/695	205/-150	150/-100	120	830	2790

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Two Engines Inop - Flaps 25
VREF25

BRAKING CONFIGURATION	REF DIST 310000 KG LANDING WEIGHT	WEIGHT ADJ PER 5000 KG ABV/BLW 310000 KG	ALT ADJ PER 1000 FT ABOVE SEA LEVEL	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABV VREF	REVERSE THRUST ADJ TWO REV	REVERSE THRUST ADJ NO REV
Dry Runway									
MAX MANUAL	1450	25/-20	40	-65/220	20/-20	40/-40	70	0	0
AUTOBRAKE MAX	1625	25/-20	45	-75/240	0/0	45/-45	80	0	0
AUTOBRAKE 2	2605	35/-40	85	-130/435	0/-10	80/-80	140	0	0
Good Reported Braking Action									
MAX MANUAL	2095	35/-35	95	-130/475	80/-65	80/-75	125	0	0
AUTOBRAKE MAX	2095	35/-35	95	-125/465	75/-55	75/-75	130	0	0
AUTOBRAKE 2	2605	35/-40	85	-130/440	5/-10	80/-80	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	2285	35/-35	95	-130/480	100/-80	80/-75	125	0	0
AUTOBRAKE MAX	2290	35/-35	95	-130/475	100/-70	75/-75	130	0	0
AUTOBRAKE 2	2605	35/-40	85	-130/440	5/-10	80/-80	140	0	0
Medium Reported Braking Action									
MAX MANUAL	2480	35/-35	95	-135/500	130/-100	80/-80	125	0	0
AUTOBRAKE MAX	2485	35/-35	95	-135/490	130/-90	80/-80	130	0	0
AUTOBRAKE 3	2540	35/-35	95	-135/500	125/-85	80/-80	130	0	0
Medium to Poor Reported Braking Action									
MAX MANUAL	3225	55/-55	155	-220/820	270/-190	130/-125	165	0	0
AUTOBRAKE MAX	3230	55/-55	155	-220/820	280/-195	130/-130	165	0	0
AUTOBRAKE 3	3245	55/-60	155	-220/825	270/-190	130/-130	175	0	0
Poor Reported Braking Action									
MAX MANUAL	4685	60/-65	160	-300/1075	725/-455	150/-150	165	0	0
AUTOBRAKE MAX	4695	60/-65	160	-300/1075	735/-460	150/-150	165	0	0
AUTOBRAKE 3	4710	60/-65	160	-300/1080	725/-455	150/-150	175	0	0

Table heading: LANDING DISTANCE AND ADJUSTMENTS (M)

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	LANDING CLIMB LIMIT WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	330.7					
52	338.6					
50	347.6	335.9				
48	355.8	344.6				
46	364.0	352.9	329.9			
44	372.3	361.2	337.0			
42	380.6	369.6	345.5	317.1		
40	389.2	377.9	353.1	324.3		
38	398.6	386.4	360.7	331.7	304.5	
36	407.5	394.9	368.4	338.4	310.4	
34	415.4	403.3	376.2	345.6	316.4	284.8
32	422.1	410.8	383.9	352.0	322.1	289.7
30	428.9	417.6	389.8	358.5	327.4	294.7
28	429.1	423.7	395.5	365.2	332.7	299.5
26	429.3	429.6	401.1	373.8	338.0	304.1
24	429.6	429.8	406.6	378.4	343.9	308.7
22	429.8	430.0	411.7	382.7	353.0	313.0
20	430.0	430.1	411.9	386.7	357.4	317.3
18	430.3	430.3	412.0	390.5	361.2	321.9
16	430.5	430.5	412.1	390.5	364.6	326.1
14	430.6	430.6	412.2	390.6	367.6	329.8
12	430.8	430.8	412.3	390.7	367.7	333.1
10	430.9	430.9	412.4	390.7	367.7	336.2
-40	431.7	431.7	415.2	391.9	368.6	337.3

With engine bleed for packs off, increase weight by 3700 kg.
With engine anti-ice on, decrease weight by 4500 kg.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10°C, decrease weight by 21900 kg.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Table 1 of 3: Reference Brake Energy (Millions of Foot Pounds)

		BRAKES-ON SPEED (KIAS)														
		100			120			140			160			180		
WEIGHT (1000 KG)	OAT (°C)	PRESSURE ALTITUDE (1000 FT)														
		0	5	10	0	5	10	0	5	10	0	5	10	0	5	10
450	0	33.9	38.5	43.8	45.9	52.5	60.2	59.3	68.3	78.9	73.8	85.5	99.6	89.0	103.9	122.0
	10	35.0	39.7	45.3	47.4	54.2	62.2	61.3	70.5	81.5	76.3	88.4	103.0	92.0	107.5	126.3
	15	35.5	40.3	46.0	48.2	55.1	63.2	62.3	71.7	82.9	77.5	89.9	104.7	93.5	109.3	128.4
	20	36.0	41.0	46.7	48.9	55.9	64.2	63.2	72.8	84.2	78.7	91.3	106.4	95.0	111.1	130.5
	30	37.0	42.1	48.0	50.3	57.5	66.0	65.1	74.9	86.7	81.1	94.1	109.7	97.9	114.5	134.7
	40	37.3	42.4	48.4	50.8	58.2	66.9	65.9	76.0	88.2	82.3	95.8	112.1	99.8	117.1	138.3
	50	37.2	42.4	48.5	50.9	58.5	67.4	66.4	76.9	89.4	83.4	97.4	114.5	101.6	119.8	142.3
400	0	30.9	35.0	39.8	41.7	47.6	54.4	53.8	61.7	71.1	66.8	77.2	89.5	80.5	93.6	109.4
	10	31.9	36.2	41.1	43.1	49.1	56.2	55.6	63.8	73.5	69.0	79.7	92.5	83.2	96.8	113.2
	15	32.4	36.7	41.8	43.8	49.9	57.1	56.4	64.8	74.7	70.1	81.0	94.1	84.6	98.4	115.1
	20	32.8	37.3	42.4	44.4	50.7	58.0	57.3	65.8	75.8	71.2	82.3	95.6	85.9	100.0	116.9
	30	33.8	38.3	43.6	45.7	52.1	59.7	59.0	67.7	78.1	73.3	84.8	98.5	88.5	103.1	120.6
	40	34.0	38.6	43.9	46.1	52.6	60.4	59.6	68.6	79.3	74.4	86.2	100.4	90.0	105.1	123.5
	50	33.9	38.5	44.0	46.1	52.8	60.7	60.0	69.2	80.2	75.1	87.4	102.2	91.4	107.2	126.6
350	0	27.9	31.5	35.8	37.5	42.7	48.7	48.2	55.1	63.3	59.7	68.8	79.5	71.9	83.3	96.9
	10	28.8	32.6	37.0	38.7	44.1	50.3	49.8	57.0	65.4	61.7	71.1	82.2	74.3	86.1	100.2
	15	29.2	33.1	37.5	39.3	44.8	51.1	50.5	57.9	66.5	62.7	72.2	83.5	75.5	87.5	101.8
	20	29.6	33.6	38.1	39.9	45.4	51.9	51.3	58.7	67.5	63.7	73.3	84.8	76.7	88.9	103.5
	30	30.4	34.5	39.2	41.0	46.7	53.4	52.8	60.4	69.5	65.5	75.5	87.4	79.0	91.6	106.7
	40	30.6	34.7	39.5	41.3	47.1	53.9	53.3	61.1	70.4	66.4	76.6	88.9	80.2	93.2	108.9
	50	30.5	34.6	39.4	41.3	47.2	54.1	53.5	61.5	71.0	66.9	77.4	90.2	81.2	94.7	111.2
300	0	24.9	28.1	31.9	33.2	37.8	43.0	42.5	48.5	55.5	52.6	60.3	69.4	63.2	72.9	84.4
	10	25.7	29.0	32.9	34.3	39.0	44.4	43.9	50.1	57.4	54.3	62.3	71.7	65.3	75.4	87.3
	15	26.0	29.5	33.4	34.9	39.6	45.1	44.6	50.9	58.3	55.1	63.3	72.8	66.4	76.6	88.7
	20	26.4	29.9	33.9	35.4	40.2	45.8	45.3	51.7	59.2	56.0	64.2	74.0	67.4	77.8	90.1
	30	27.2	30.7	34.8	36.4	41.3	47.1	46.5	53.1	60.9	57.6	66.1	76.2	69.4	80.1	92.9
	40	27.3	30.9	35.1	36.6	41.6	47.5	47.0	53.7	61.6	58.2	67.0	77.3	70.3	81.3	94.6
	50	27.2	30.8	35.0	36.5	41.6	47.6	47.0	53.9	62.0	58.5	67.5	78.2	71.0	82.3	96.1
250	0	21.9	24.7	28.0	29.0	32.9	37.3	36.8	41.9	47.8	45.2	51.6	59.2	54.1	62.1	71.5
	10	22.6	25.5	28.9	29.9	33.9	38.5	38.0	43.2	49.3	46.7	53.3	61.1	55.9	64.1	73.9
	15	22.9	25.9	29.3	30.4	34.4	39.1	38.6	43.9	50.1	47.4	54.2	62.1	56.8	65.2	75.1
	20	23.3	26.3	29.8	30.8	35.0	39.7	39.2	44.6	50.9	48.1	55.0	63.1	57.6	66.2	76.3
	30	23.9	27.0	30.6	31.7	35.9	40.8	40.3	45.8	52.3	49.5	56.6	64.9	59.3	68.1	78.6
	40	24.0	27.1	30.7	31.9	36.2	41.1	40.6	46.2	52.8	49.9	57.2	65.7	60.0	69.0	79.8
	50	23.9	27.0	30.6	31.8	36.1	41.1	40.5	46.3	53.0	50.1	57.5	66.2	60.3	69.6	80.7

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 and enter table at sea level, 15°C.

Event Adjusted Brake Energy (Millions of Foot Pounds)

Table 2(a) of 3: No Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)												
EVENT		10	20	30	40	50	60	70	80	90	100	110	120	130
RTO MAX MAN		10	20	30	40	50	60	70	80	90	100	110	120	130
LANDING	MAX MAN	7.4	15.2	23.5	32.2	41.2	50.5	60.0	69.7	79.6	89.5	99.5	109.5	119.4
	MAX AUTO	6.8	14.2	22.1	30.4	39.1	48.1	57.5	67.0	76.7	86.5	96.5	106.4	116.3
	AUTOBRAKE 4	6.7	13.8	21.2	29.1	37.2	45.7	54.4	63.4	72.6	82.0	91.5	101.2	111.0
	AUTOBRAKE 3	6.5	13.4	20.6	28.1	35.9	44.0	52.3	60.8	69.6	78.5	87.6	96.8	106.1
	AUTOBRAKE 2	6.3	12.9	19.8	26.9	34.3	41.9	49.7	57.8	66.0	74.3	82.8	91.4	100.1
	AUTOBRAKE 1	5.9	12.0	18.4	24.9	31.6	38.4	45.5	52.6	60.0	67.5	75.1	82.9	90.7

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Table 2(b) of 3: 4 Engine Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)												
EVENT		10	20	30	40	50	60	70	80	90	100	110	120	130
RTO MAX MAN		10	20	30	40	50	60	70	80	90	100	110	120	130
LANDING	MAX MAN	6.6	13.7	21.1	28.9	36.9	45.2	53.7	62.3	71.1	79.8	88.6	97.4	106.0
	MAX AUTO	5.0	10.6	16.8	23.6	30.8	38.5	46.6	55.0	63.6	72.4	81.3	90.4	99.4
	AUTOBRAKE 4	3.7	8.0	12.9	18.3	24.3	30.6	37.4	44.4	51.8	59.4	67.1	75.0	83.0
	AUTOBRAKE 3	2.7	6.1	10.1	14.6	19.7	25.1	31.0	37.2	43.7	50.4	57.3	64.3	71.4
	AUTOBRAKE 2	1.6	3.9	6.8	10.2	14.1	18.5	23.3	28.4	33.8	39.5	45.4	51.4	57.5
	AUTOBRAKE 1	1.0	2.4	4.1	6.2	8.6	11.3	14.3	17.5	21.0	24.7	28.7	32.8	37.1

Table 3 of 3: Cooling Time (Minutes)

	EVENT ADJUSTED BRAKE ENERGY (MILLIONS OF FOOT POUNDS)							
	BELOW 21	21	23	27	31	34	ABOVE 34 TO 48	48 & ABOVE
INFLIGHT GEAR DOWN	NO SPECIAL PROCEDURE REQUIRED	0.1	1.0	2.0	3.1	3.9	CAUTION	FUSE PLUG MELT ZONE
GROUND		1	9	20	31	39		
BRAKE TEMPERATURE INDICATION	UP TO 2.91	3.00	3.35	3.88	4.50	5.00	5.0 TO 7.0	7.0 & ABOVE

Observe maximum quick turnaround limit. Table shows energy per brake added by a single stop with all brakes operating. Energy is assumed to be equally distributed among the operating brakes. Total energy is the sum of residual energy plus energy added.

Add 1.0 million foot pounds for each taxi mile.

With one brake deactivated, increase brake energy by 7 percent.
With 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 4 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not approach gear or attempt 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 indication on Multifunction Display may be used 10 to 15 minutes after airplane has come to a complete stop, or in flight with gear retracted, to determine recommended cooling schedule.

1 ENGINE INOP

Max Continuous %N1

37000 FT to 27000 FT Pressure Altitudes

Based on engine bleed for packs on and anti-ice off

37000 FT PRESS ALT		TAT (°C)											
KCAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
200	0.63	93.8	94.9	95.9	96.9	97.9	98.9	98.3	96.9	95.9	94.8	93.7	93.3
240	0.74	93.7	94.7	95.8	96.8	97.8	98.8	99.8	100.3	99.0	97.9	96.9	95.7
280	0.86	93.6	94.6	95.6	96.6	97.7	98.7	99.6	100.6	100.9	100.3	99.2	98.2
35000 FT PRESS ALT		TAT (°C)											
KCAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
200	0.60	93.9	94.9	96.0	97.0	98.0	99.0	98.7	97.2	96.1	95.1	94.0	93.3
240	0.71	93.8	94.8	95.8	96.9	97.9	98.9	99.8	100.5	99.1	97.9	96.9	95.8
280	0.82	93.6	94.6	95.6	96.7	97.7	98.7	99.7	100.6	100.9	100.2	99.1	98.1
33000 FT PRESS ALT		TAT (°C)											
KCAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
200	0.58	95.1	96.1	97.2	98.2	99.2	100.1	98.8	97.5	96.4	95.3	94.2	94.4
240	0.68	94.9	96.0	97.0	98.0	99.0	100.0	100.6	100.0	98.7	97.6	96.5	95.4
280	0.79	94.4	95.4	96.4	97.4	98.4	99.4	100.4	101.0	100.6	99.4	98.3	97.3
31000 FT PRESS ALT		TAT (°C)											
KCAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
200	0.55	95.3	96.3	97.3	98.3	99.3	100.3	100.4	99.0	97.8	96.7	95.6	94.6
240	0.66	95.1	96.2	97.2	98.2	99.2	100.2	101.0	101.1	99.8	98.6	97.5	96.3
280	0.76	94.5	95.5	96.5	97.5	98.5	99.5	100.5	101.5	101.0	99.9	98.8	97.7
29000 FT PRESS ALT		TAT (°C)											
KCAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
200	0.53	96.0	97.1	98.1	99.1	100.1	100.5	99.6	98.3	97.2	96.1	95.0	95.0
240	0.63	95.8	96.8	97.8	98.8	99.8	100.8	100.8	99.8	98.6	97.6	96.5	95.5
280	0.73	94.8	95.9	96.9	97.8	98.8	99.8	100.8	100.9	99.9	98.8	97.8	96.8
27000 FT PRESS ALT		TAT (°C)											
KCAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
200	0.51	96.7	97.7	98.7	99.7	100.5	100.0	98.8	97.6	96.6	95.5	94.5	95.3
240	0.60	96.3	97.3	98.3	99.2	100.2	101.0	99.9	98.7	97.7	96.7	95.8	94.8
280	0.70	95.1	96.1	97.1	98.0	99.0	99.9	100.9	99.9	98.9	98.0	97.1	96.2
320	0.79	93.4	94.3	95.3	96.3	97.2	98.1	99.1	100.0	99.9	99.0	98.1	97.2

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	27	29	31	33	35	37
PACKS OFF	0.3	0.3	0.3	0.3	0.4	0.4
ENGINE ANTI-ICE ON	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
ENGINE & WING ANTI-ICE ON	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9

1 ENGINE INOP

Max Continuous %N1

25000 FT to 18000 FT Pressure Altitudes

Based on engine bleed for packs on and anti-ice off

25000 FT PRESS ALT		TAT (°C)											
KCAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
200	0.49	96.3	97.3	98.3	99.2	100.2	100.1	99.1	97.9	96.8	95.8	94.9	94.6
240	0.58	95.3	96.3	97.3	98.3	99.2	100.2	100.0	98.9	97.8	96.8	95.9	95.0
280	0.67	94.1	95.1	96.1	97.0	98.0	98.9	99.9	100.0	99.0	98.0	97.0	96.2
320	0.76	92.6	93.6	94.5	95.5	96.4	97.4	98.3	99.2	99.8	99.0	98.1	97.3
24000 FT PRESS ALT		TAT (°C)											
KCAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
200	0.48	96.7	97.7	98.7	99.6	100.2	99.2	98.1	97.0	95.9	95.0	94.2	95.0
240	0.57	95.8	96.8	97.7	98.7	99.6	100.1	99.1	98.0	97.0	96.1	95.2	94.3
280	0.66	94.7	95.6	96.6	97.6	98.5	99.4	100.0	99.0	98.0	97.1	96.3	95.4
320	0.75	93.3	94.2	95.2	96.1	97.0	97.9	98.8	99.8	99.1	98.2	97.3	96.5
22000 FT PRESS ALT		TAT (°C)											
KCAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
200	0.46	95.6	96.6	97.5	98.5	99.5	99.3	98.3	97.3	96.3	95.4	94.4	94.2
240	0.55	94.8	95.7	96.7	97.7	98.6	99.5	99.3	98.4	97.3	96.4	95.5	94.6
280	0.63	93.7	94.7	95.6	96.6	97.5	98.4	99.3	99.1	98.2	97.3	96.5	95.6
320	0.72	92.6	93.6	94.5	95.4	96.3	97.3	98.2	99.1	99.2	98.3	97.4	96.6
20000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.44	95.6	96.6	97.5	98.5	99.4	98.6	97.6	96.6	95.7	94.8	93.9	94.3
240	0.53	94.9	95.9	96.8	97.7	98.6	99.4	98.6	97.6	96.7	95.8	94.9	94.0
280	0.61	93.8	94.7	95.7	96.6	97.5	98.4	99.2	98.5	97.6	96.7	95.8	95.0
320	0.69	92.8	93.8	94.7	95.6	96.5	97.4	98.3	99.2	98.4	97.6	96.7	95.9
360	0.77	91.6	92.5	93.4	94.3	95.2	96.1	97.0	97.9	98.7	98.4	97.6	96.8
18000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.42	94.6	95.5	96.5	97.4	98.3	98.8	97.8	96.9	95.9	95.0	94.1	93.4
240	0.51	94.0	94.9	95.8	96.8	97.7	98.6	98.7	97.8	96.9	96.0	95.1	94.2
280	0.59	93.0	93.9	94.8	95.7	96.7	97.5	98.4	98.5	97.7	96.8	95.9	95.0
320	0.67	92.0	92.9	93.8	94.7	95.6	96.5	97.4	98.2	98.4	97.6	96.7	95.9
360	0.75	90.9	91.8	92.7	93.6	94.5	95.4	96.2	97.1	97.9	98.3	97.5	96.8

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	18	20	22	24	25
PACKS OFF	0.2	0.2	0.2	0.2	0.2
ENGINE ANTI-ICE ON	-0.4	-0.4	-0.4	-0.4	-0.4
ENGINE & WING ANTI-ICE ON	-0.8	-0.8	-0.8	-0.8	-0.9

1 ENGINE INOP

Max Continuous %N1

16000 FT to 5000 FT Pressure Altitudes

Based on engine bleed for packs on and anti-ice off

16000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.41	93.5	94.5	95.4	96.3	97.2	98.1	98.0	97.1	96.1	95.2	94.3	93.4
240	0.49	93.0	93.9	94.9	95.8	96.7	97.6	98.5	97.9	97.0	96.1	95.2	94.4
280	0.57	92.2	93.1	94.0	94.9	95.8	96.7	97.6	98.4	97.7	96.9	96.0	95.1
320	0.64	91.1	92.0	92.9	93.8	94.7	95.6	96.5	97.3	98.2	97.6	96.7	95.9
360	0.72	90.1	91.0	91.9	92.8	93.6	94.5	95.4	96.2	97.1	97.9	97.5	96.7
14000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.39	92.5	93.4	94.3	95.2	96.1	97.0	97.9	97.2	96.3	95.4	94.5	93.6
240	0.47	92.1	93.0	94.0	94.9	95.8	96.6	97.5	98.1	97.3	96.4	95.5	94.6
280	0.54	91.4	92.3	93.2	94.1	95.0	95.8	96.6	97.5	97.9	97.1	96.2	95.4
320	0.62	90.4	91.3	92.2	93.1	94.0	94.8	95.7	96.6	97.4	97.6	96.9	96.0
360	0.69	89.4	90.3	91.2	92.1	93.0	93.8	94.7	95.5	96.4	97.2	97.5	96.8
12000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.38	91.5	92.4	93.3	94.2	95.1	96.0	96.9	97.4	96.6	95.7	94.8	93.9
240	0.45	91.3	92.2	93.1	94.0	94.9	95.8	96.7	97.6	97.5	96.7	95.9	95.0
280	0.52	90.7	91.6	92.5	93.4	94.3	95.1	96.0	96.8	97.6	97.4	96.6	95.7
320	0.60	89.8	90.7	91.6	92.5	93.3	94.2	95.1	95.9	96.7	97.6	97.1	96.3
360	0.67	88.9	89.8	90.7	91.6	92.4	93.3	94.1	95.0	95.8	96.6	97.4	97.0
10000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.36	90.5	91.4	92.3	93.2	94.1	95.0	95.8	96.7	96.7	95.9	95.0	94.2
240	0.43	90.6	91.5	92.4	93.3	94.1	95.0	95.9	96.7	97.6	97.0	96.2	95.3
280	0.51	90.0	90.9	91.8	92.7	93.6	94.5	95.3	96.2	97.0	97.7	96.9	96.0
320	0.58	89.2	90.1	91.0	91.9	92.7	93.6	94.4	95.3	96.1	96.9	97.4	96.6
360	0.65	88.4	89.2	90.1	91.0	91.8	92.7	93.5	94.4	95.2	96.0	96.8	97.2
5000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.33	87.5	88.3	89.2	90.1	90.9	91.8	92.6	93.4	94.2	95.1	94.7	93.9
240	0.40	87.8	88.6	89.5	90.4	91.2	92.1	92.9	93.7	94.6	95.4	95.9	95.2
280	0.46	87.3	88.2	89.1	89.9	90.8	91.6	92.4	93.3	94.1	94.9	95.7	95.7
320	0.53	86.7	87.5	88.4	89.3	90.1	90.9	91.8	92.6	93.4	94.2	95.0	95.8
360	0.59	85.9	86.8	87.6	88.4	89.3	90.1	90.9	91.7	92.6	93.4	94.1	94.9

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	5	10	12	14	16
PACKS OFF	0.1	0.1	0.2	0.3	0.2
ENGINE ANTI-ICE ON	-0.3	-0.3	-0.3	-0.2	-0.3
ENGINE & WING ANTI-ICE ON	-0.6	-0.6	-0.6	-0.7	-0.7

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
460	450	323	25600	24200	22600
440	431	316	27000	25700	24200
420	412	311	28400	27100	25700
400	393	303	29900	28700	27300
380	374	297	31100	30300	28800
360	354	288	32400	31800	30500
340	335	284	33700	33200	32000
320	314	273	34900	34700	33600
300	294	264	36200	36100	35200
280	275	257	37500	37400	36500
260	255	247	39000	38800	37900
240	235	239	40500	40200	39300

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
460	23200	21100	19200
440	24900	22800	20600
420	26700	24600	22400
400	28400	26400	24300
380	30200	28300	26200
360	31700	30300	28000
340	33100	32000	29900
320	34500	33700	31800
300	35700	35400	33700
280	37100	36600	35500
260	38500	38000	36900
240	40000	39400	38300
220	41700	40900	39700
200	43100	42400	41300

Altitude reduced by 1000 ft for additional margin.
With engine anti-ice on, decrease altitude capability by 400 ft.
With engine and wing anti-ice on, decrease altitude capability by 1200 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
460	%N1	83.9	87.3	92.6							
	MACH	.655	.703	.784							
	KIAS	365	365	365							
	FF/ENG	4827	4896	4988							
440	%N1	83.1	86.4	91.6	95.9						
	MACH	.655	.703	.781	.831						
	KIAS	365	365	364	352						
	FF/ENG	4689	4755	4819	4830						
420	%N1	81.7	85.1	90.2	94.4	96.5					
	MACH	.643	.692	.768	.823	.838					
	KIAS	358	359	357	348	341					
	FF/ENG	4464	4527	4566	4593	4553					
400	%N1	80.2	83.5	88.8	93.0	94.9	96.9				
	MACH	.629	.677	.753	.812	.830	.843				
	KIAS	350	351	350	343	337	329				
	FF/ENG	4227	4275	4315	4359	4321	4300				
380	%N1	78.6	82.0	87.3	91.6	93.3	95.2	97.6			
	MACH	.614	.661	.738	.799	.820	.836	.846			
	KIAS	341	342	342	337	333	326	316			
	FF/ENG	3996	4025	4066	4120	4089	4072	4022			
360	%N1	76.9	80.4	85.6	90.0	91.7	93.5	95.6			
	MACH	.598	.645	.721	.785	.808	.827	.841			
	KIAS	332	333	334	331	327	322	314			
	FF/ENG	3770	3782	3821	3880	3859	3845	3793			
340	%N1	75.3	78.7	84.0	88.5	90.2	91.9	93.9	95.9		
	MACH	.582	.627	.703	.769	.793	.815	.833	.845		
	KIAS	323	324	325	323	321	317	311	302		
	FF/ENG	3555	3554	3587	3646	3635	3626	3583	3556		
320	%N1	73.6	77.1	82.3	86.9	88.6	90.3	92.2	94.1	96.4	
	MACH	.565	.610	.684	.750	.777	.801	.822	.838	.847	
	KIAS	314	315	316	315	314	311	306	300	290	
	FF/ENG	3346	3336	3361	3415	3410	3408	3369	3355	3338	
300	%N1	71.9	75.3	80.5	85.1	86.9	88.6	90.4	92.3	94.2	
	MACH	.549	.591	.664	.731	.758	.784	.808	.828	.842	
	KIAS	304	305	306	306	305	304	300	295	288	
	FF/ENG	3140	3121	3140	3185	3183	3189	3151	3148	3126	
280	%N1	70.0	73.5	78.6	83.3	85.1	86.8	88.6	90.4	92.3	94.7
	MACH	.532	.572	.643	.709	.736	.764	.790	.813	.832	.844
	KIAS	295	295	296	296	296	295	293	290	284	276
	FF/ENG	2936	2911	2921	2957	2956	2966	2936	2935	2925	2927
240	%N1	66.2	69.4	74.6	79.1	81.0	82.8	84.8	86.5	88.2	90.5
	MACH	.496	.532	.597	.661	.688	.716	.745	.772	.798	.821
	KIAS	275	274	274	275	275	275	275	274	271	267
	FF/ENG	2539	2504	2578	2586	2579	2518	2498	2508	2509	2523
200	%N1	62.0	65.0	69.9	74.4	76.2	78.0	80.0	81.9	83.7	85.9
	MACH	.460	.491	.548	.606	.632	.660	.688	.717	.746	.775
	KIAS	254	252	251	251	252	252	252	252	252	251
	FF/ENG	2256	2206	2169	2155	2146	2069	2050	2065	2077	2099

1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 1 of 3: 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
706	653	606	566	531	500	479	459	441	424	409
1414	1308	1214	1133	1063	1000	959	920	885	852	822
2129	1968	1825	1703	1596	1500	1438	1381	1328	1279	1235
2851	2633	2439	2273	2129	2000	1918	1842	1771	1706	1647
3579	3302	3056	2846	2664	2500	2398	2302	2214	2132	2058
4315	3976	3675	3420	3198	3000	2877	2762	2656	2558	2468
5059	4656	4299	3996	3734	3500	3356	3221	3097	2983	2878
5812	5342	4926	4574	4271	4000	3835	3681	3538	3406	3286
6573	6034	5557	5155	4809	4500	4313	4139	3978	3829	3693
7343	6732	6192	5738	5348	5000	4791	4597	4417	4251	4099

Table 2 of 3: 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	13.3	1:32	12.1	1:27	10.4	1:19	9.2	1:14	8.5	1:12
1000	26.4	3:00	24.4	2:51	21.4	2:32	19.2	2:20	18.0	2:15
1500	39.3	4:30	36.5	4:15	32.2	3:47	29.0	3:26	27.4	3:18
2000	51.9	6:03	48.3	5:42	42.7	5:02	38.6	4:34	36.4	4:23
2500	64.1	7:37	59.8	7:10	53.0	6:19	48.0	5:42	45.3	5:27
3000	76.1	9:13	71.3	8:41	63.3	7:38	57.2	6:52	54.0	6:33
3500	88.3	10:52	82.7	10:13	73.4	8:59	66.2	8:03	62.5	7:39
4000	100.2	12:33	93.9	11:48	83.4	10:21	74.9	9:15	70.8	8:47
4500	111.8	14:16	104.8	13:25	93.1	11:44	83.5	10:28	78.9	9:55
5000	123.2	16:02	115.5	15:04	102.6	13:10	91.8	11:43	86.8	11:04

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)					
	200	250	300	350	400	450
10	-1.3	-1.0	0.0	1.1	3.3	6.7
20	-2.6	-1.6	0.0	2.4	6.2	12.4
30	-3.8	-2.2	0.0	3.7	9.1	17.8
40	-5.1	-2.7	0.0	4.9	11.8	22.7
50	-6.5	-3.3	0.0	6.1	14.4	27.2
60	-7.9	-3.9	0.0	7.3	16.8	31.2
70	-9.3	-4.5	0.0	8.5	19.2	34.8
80	-10.8	-5.2	0.0	9.6	21.4	38.0
90	-12.3	-5.9	0.0	10.8	23.5	40.7
100	-13.8	-6.6	0.0	11.9	25.4	43.0
110	-15.4	-7.4	0.0	12.9	27.3	44.9
120	-17.0	-8.2	0.0	14.0	29.0	46.3
130	-18.7	-9.0	0.0	15.0	30.6	47.3

1 ENGINE INOP

MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)								
		1500	5000	10000	15000	20000	25000	30000	35000	40000
440	%N1	70.9	74.0	78.7	83.6	88.9	94.2			
	KIAS	261	263	265	269	311	315			
	FF/ENG	4070	4060	4080	4150	4390	4570			
420	%N1	69.3	72.5	77.1	82.0	87.4	92.5			
	KIAS	257	257	259	262	303	307			
	FF/ENG	3860	3850	3860	3920	4140	4300			
400	%N1	67.8	70.9	75.5	80.4	85.8	90.8	97.2		
	KIAS	252	253	254	256	296	299	304		
	FF/ENG	3650	3640	3650	3700	3900	4040	4250		
380	%N1	66.2	69.2	73.9	78.7	84.1	89.2	95.0		
	KIAS	248	248	249	251	288	291	295		
	FF/ENG	3450	3440	3440	3470	3660	3780	3940		
360	%N1	64.6	67.5	72.2	76.9	82.4	87.4	92.9		
	KIAS	244	244	244	246	280	283	287		
	FF/ENG	3250	3230	3240	3260	3430	3530	3650		
340	%N1	63.0	65.9	70.4	75.1	80.6	85.7	90.8		
	KIAS	240	240	241	242	272	275	278		
	FF/ENG	3070	3040	3050	3060	3220	3300	3390		
320	%N1	61.4	64.2	68.7	73.3	78.8	83.9	88.9	95.5	
	KIAS	235	235	236	237	263	266	269	273	
	FF/ENG	2890	2860	2860	2870	3010	3080	3150	3320	
300	%N1	59.8	62.5	66.9	71.5	76.8	81.9	87.0	92.9	
	KIAS	230	230	231	232	254	257	260	264	
	FF/ENG	2730	2690	2680	2680	2810	2860	2910	3030	
280	%N1	58.1	60.8	65.1	69.6	74.9	79.9	84.9	90.5	
	KIAS	225	225	225	226	246	248	250	254	
	FF/ENG	2560	2520	2610	2600	2700	2730	2690	2760	
260	%N1	56.3	59.0	63.2	67.6	72.8	77.7	82.8	88.1	
	KIAS	219	219	220	221	236	238	241	244	
	FF/ENG	2510	2460	2440	2420	2500	2520	2470	2520	
240	%N1	54.5	57.1	61.2	65.6	70.7	75.4	80.5	85.7	93.6
	KIAS	214	214	214	215	227	228	231	233	237
	FF/ENG	2360	2300	2280	2250	2310	2320	2250	2300	2490
220	%N1	52.6	55.1	59.2	63.5	68.3	73.0	78.0	83.3	90.6
	KIAS	209	209	209	209	217	218	220	223	226
	FF/ENG	2210	2150	2120	2090	2120	2120	2040	2070	2220
200	%N1	50.8	53.2	57.2	61.3	65.8	70.5	75.3	80.7	87.5
	KIAS	205	205	205	205	208	209	210	212	215
	FF/ENG	2070	2010	1970	1940	1940	1940	1930	1930	2040

This table includes 5% additional fuel for holding in a racetrack pattern.

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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
460	444	314	10600	9000	7100
440	425	307	12200	10700	8900
420	405	301	13900	12400	10700
400	386	294	15700	14200	12500
380	367	287	17600	16200	14500
360	348	280	19400	18100	16500
340	329	273	21200	19900	18400
320	310	265	23100	21700	20300
300	291	258	24900	23700	22200
280	272	249	26600	25700	24300
260	252	241	28300	27800	26500
240	233	231	29900	29700	28700
220	214	222	31600	31500	30500
200	194	212	33400	33400	32300

Altitude reduced by 2000 ft for additional margin.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Driftdown/LRC Cruise Range Capability

Table 1 of 2: Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
671	628	590	556	526	500	475	453	433	415	398
1337	1252	1178	1112	1053	1000	951	908	868	832	798
1999	1874	1764	1666	1578	1500	1428	1363	1304	1250	1200
2659	2494	2349	2220	2104	2000	1905	1819	1740	1668	1602
3319	3115	2934	2773	2629	2500	2382	2275	2177	2087	2005
3980	3736	3520	3327	3155	3000	2859	2730	2613	2506	2407
4644	4359	4107	3882	3681	3500	3335	3185	3049	2923	2808
5313	4986	4696	4438	4208	4000	3811	3640	3483	3339	3207
5989	5617	5289	4997	4735	4500	4286	4092	3915	3753	3603
6674	6255	5885	5557	5264	5000	4761	4544	4345	4164	3997

Table 2 of 2: 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	420	440	460	
500	7.1	7.7	8.2	8.7	9.4	10.0	10.7	11.2	11.8	12.3	13.0	13.6	14.3	15.1	1:17
1000	14.5	15.7	17.0	18.2	19.5	20.8	22.2	23.4	24.7	25.9	27.4	28.8	30.4	32.1	2:32
1500	21.7	23.6	25.5	27.4	29.3	31.2	33.3	35.1	37.1	39.0	41.2	43.5	45.9	48.3	3:45
2000	28.7	31.2	33.8	36.3	38.9	41.4	44.1	46.7	49.3	51.8	54.8	57.8	61.0	64.1	4:58
2500	35.5	38.6	41.8	44.9	48.2	51.3	54.7	57.9	61.1	64.2	68.0	71.7	75.6	79.5	6:10
3000	42.1	45.8	49.5	53.3	57.2	60.9	64.9	68.7	72.6	76.4	80.8	85.3	89.9	94.5	7:23
3500	48.4	52.7	57.1	61.4	65.9	70.2	74.9	79.3	83.8	88.2	93.3	98.4	103.8	109.1	8:38
4000	54.6	59.5	64.4	69.3	74.4	79.3	84.6	89.7	94.7	99.7	105.4	111.3	117.3	123.2	9:53
4500	60.7	66.1	71.5	77.0	82.7	88.1	94.0	99.7	105.3	110.9	117.2	123.8	130.4	137.0	11:12
5000	66.5	72.4	78.4	84.4	90.7	96.7	103.2	109.5	115.7	121.8	128.8	135.9	143.2	150.4	12:33

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
460	5000	2200	
440	6300	3600	
420	8700	6000	3500
400	10600	8700	6100
380	12500	10700	8700
360	14600	12800	10800
340	16800	15000	12800
320	18900	17200	15200
300	21100	19400	17700
280	23200	21600	19900
260	25400	24000	22200
240	27600	26300	24700
220	29600	29000	27300
200	31400	31100	29900

Altitude reduced by 2000 ft for additional margin.
With engine anti-ice on, decrease altitude capability by 200 ft.
With engine and wing anti-ice on, decrease altitude capability by 1100 ft.

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
420	%N1	94.3								
	MACH	.643								
	KIAS	358								
	FF/ENG	6903								
400	%N1	92.6								
	MACH	.629								
	KIAS	350								
	FF/ENG	6510								
380	%N1	90.9	94.6							
	MACH	.614	.661							
	KIAS	341	342							
	FF/ENG	6121	6215							
360	%N1	89.0	92.8							
	MACH	.598	.645							
	KIAS	332	333							
	FF/ENG	5740	5822							
340	%N1	87.1	91.0	93.8						
	MACH	.582	.627	.664						
	KIAS	323	324	325						
	FF/ENG	5378	5448	5501						
320	%N1	85.2	89.2	91.9	95.1					
	MACH	.565	.610	.646	.684					
	KIAS	314	315	315	316					
	FF/ENG	5030	5087	5131	5197					
300	%N1	83.2	87.1	90.0	92.9	96.5				
	MACH	.549	.591	.626	.664	.703				
	KIAS	304	305	305	306	306				
	FF/ENG	4691	4732	4767	4821	4945				
280	%N1	81.1	85.0	88.0	90.8	93.9	96.6			
	MACH	.532	.572	.606	.643	.682	.709			
	KIAS	295	295	295	296	296	296			
	FF/ENG	4357	4388	4411	4457	4551	4627			
260	%N1	78.9	82.7	85.7	88.6	91.6	93.8	96.6		
	MACH	.514	.552	.585	.621	.659	.686	.713		
	KIAS	285	284	285	285	286	286	286		
	FF/ENG	4025	4055	4066	4101	4182	4226	4294		
240	%N1	76.7	80.3	83.2	86.3	89.2	91.2	93.6	96.5	
	MACH	.496	.532	.563	.597	.635	.661	.688	.716	
	KIAS	275	274	274	274	275	275	275	275	
	FF/ENG	3699	3725	3732	3752	3824	3856	3886	3977	
220	%N1	74.3	77.8	80.6	83.6	86.7	88.6	90.7	93.2	96.3
	MACH	.478	.512	.541	.573	.609	.635	.661	.689	.718
	KIAS	265	263	262	262	263	263	264	264	264
	FF/ENG	3398	3399	3410	3417	3471	3501	3514	3568	3629
200	%N1	71.8	75.2	77.9	80.8	83.9	85.9	87.9	89.9	92.6
	MACH	.460	.491	.518	.548	.582	.606	.632	.660	.688
	KIAS	254	252	251	251	251	251	252	252	252
	FF/ENG	3109	3079	3094	3096	3130	3150	3161	3196	3220

Performance Inflight
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Alternate Mode EEC
Section 15

ALTERNATE MODE EEC

Limit Weight

PERFORMANCE LIMIT	ALTERNATE MODE EEC LIMIT WEIGHT (1000 KG)											
	PRIMARY MODE PERFORMANCE LIMIT WEIGHT (1000 KG)											
	240	260	280	300	320	340	360	380	400	420	440	460
FIELD	236.3	256.0	275.8	295.5	315.2	334.9	354.6	374.3	394.0	413.7	433.4	453.1
CLIMB	230.4	250.6	270.8	291.0	311.2	331.3	351.5	371.7	391.9	412.1	432.3	452.5
OBSTACLE	234.7	254.5	274.3	294.0	313.8	333.6	353.4	373.1	392.9	412.7	432.5	452.3
TIRE SPEED	239.1	258.9	278.7	298.5	318.4	338.2	358.0	377.8	397.6	417.4	437.3	457.1
BRAKE ENERGY	242.7	261.6	280.6	299.6	318.6	337.5	356.5	375.5	394.5	413.4	432.4	451.4
NET LEVEL OFF	240	260	280	300	320	340	360	380	400	420	440	460
LANDING CLIMB	240	260	280	300	320	340	360	380	400	420	440	460

ALTERNATE MODE EEC

Takeoff Speed Adjustments

TAKEOFF SPEEDS	TAKEOFF SPEED ADJUSTMENT (KTS)	
	DRY	WET
V1	0	0
VR	0	0
V2	0	0

ALTERNATE MODE EEC

Takeoff %N1

Based on engine bleed for packs on

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)												
	-2	-1	0	1	2	3	4	5	6	7	8	9	10
70	88.4	89.5	90.6	90.6	90.6	90.5	90.4	90.4	90.3	90.3	89.7	89.2	88.5
60	91.2	92.3	93.4	93.4	93.4	93.3	93.3	93.2	93.2	93.2	92.6	92.0	91.4
55	92.7	93.7	94.8	94.8	94.8	94.7	94.6	94.6	94.6	94.5	94.0	93.4	92.8
50	94.1	95.1	96.2	96.1	96.1	96.0	96.0	95.9	95.9	95.9	95.3	94.7	94.2
45	95.4	96.5	97.5	97.4	97.3	97.3	97.3	97.2	97.2	97.2	96.6	96.0	95.5
40	96.7	97.7	98.9	98.7	98.5	98.4	98.4	98.5	98.4	98.4	97.9	97.3	96.7
35	97.7	98.7	99.8	99.7	99.7	99.5	99.3	99.3	99.2	99.3	98.8	98.4	98.0
30	97.2	98.8	100.4	100.4	100.4	100.4	100.4	100.1	100.0	99.9	99.5	99.2	98.8
25	96.4	98.0	99.6	100.1	100.7	101.1	101.1	101.1	101.7	101.3	100.3	99.9	99.5
20	95.6	97.2	98.8	99.3	99.9	100.5	101.1	101.8	102.2	102.4	102.1	101.5	100.3
15	94.8	96.3	97.9	98.4	99.0	99.6	100.2	101.0	101.7	102.5	102.5	102.2	101.2
10	93.9	95.5	97.1	97.6	98.2	98.8	99.4	100.1	100.8	101.6	101.8	102.0	102.3
5	93.1	94.7	96.2	96.7	97.3	97.9	98.5	99.2	99.9	100.7	100.9	101.2	101.4
0	92.3	93.8	95.3	95.8	96.4	97.0	97.6	98.3	99.1	99.8	100.0	100.3	100.6
-10	90.6	92.1	93.6	94.1	94.6	95.2	95.9	96.6	97.3	98.0	98.3	98.5	98.8
-20	88.8	90.3	91.8	92.3	92.8	93.4	94.1	94.8	95.5	96.2	96.5	96.7	97.0
-30	87.0	88.5	89.9	90.4	91.0	91.6	92.3	93.0	93.7	94.4	94.7	94.9	95.2
-40	85.2	86.7	88.1	88.6	89.1	89.8	90.5	91.2	91.9	92.6	92.8	93.1	93.4
-50	83.4	84.8	86.2	86.7	87.3	87.9	88.6	89.3	90.0	90.7	91.0	91.2	91.5

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)				
	-2	0	8	9	10
PACKS OFF	0.6	0.6	0.6	0.7	0.7

ALTERNATE MODE EEC

Go-Around %N1

Based on engine bleed for packs off

AIRPORT OAT (°C)	TAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
		0	1	2	3	4	5	6	7	8	9	10
70	74	85.9	86.7	87.5	88.3	88.7	89.1	89.5	89.8	89.9	89.6	89.0
60	64	87.9	88.8	89.7	90.7	91.2	91.7	92.1	92.5	92.7	92.4	91.8
55	59	88.8	89.8	90.8	91.8	92.4	93.0	93.4	93.9	94.1	93.8	93.2
50	54	90.2	90.9	91.9	92.9	93.6	94.2	94.6	95.1	95.4	95.1	94.5
45	49	91.5	92.3	93.2	94.2	94.8	95.3	95.9	96.4	96.7	96.4	95.8
40	44	92.8	93.6	94.5	95.4	96.0	96.6	97.1	97.6	98.0	97.7	97.1
35	39	94.2	94.9	95.8	96.8	97.2	97.7	98.3	99.0	99.0	98.8	98.3
30	34	94.8	95.7	96.6	97.6	98.2	98.7	99.2	99.7	99.9	99.5	99.2
25	29	94.1	95.5	97.0	98.1	98.7	99.2	100.3	100.8	100.7	100.3	99.9
20	24	93.3	94.7	96.2	97.7	98.9	100.1	100.9	101.7	102.2	101.6	100.7
15	19	92.5	93.9	95.4	96.8	98.0	99.3	100.7	102.4	102.9	102.4	101.6
10	14	91.7	93.1	94.5	96.0	97.2	98.5	99.8	101.5	102.5	102.5	102.5
5	8	90.8	92.1	93.5	95.0	96.2	97.4	98.8	100.4	101.4	101.4	101.5
0	3	90.0	91.3	92.7	94.2	95.3	96.6	97.9	99.6	100.5	100.5	100.7
-10	-7	88.3	89.6	91.0	92.4	93.6	94.9	96.2	97.8	98.8	98.8	98.9
-20	-17	86.6	87.9	89.3	90.7	91.9	93.2	94.5	96.1	97.0	97.0	97.1
-30	-27	84.9	86.2	87.6	89.0	90.2	91.4	92.7	94.3	95.2	95.2	95.3
-40	-37	83.2	84.4	85.8	87.2	88.5	89.7	90.9	92.5	93.4	93.4	93.5
-50	-47	81.4	82.7	84.0	85.5	86.7	87.9	89.1	90.6	91.5	91.6	91.7

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)			
	0	8	9	10
PACKS OFF	0.6	0.6	0.7	0.7

GEAR DOWN

Max Climb %N1

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

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KCAS OR MACH)														
	0	5	10	12	14	16	18	20	22	24	26	28	30	32	34
	240	240	240	240	240	240	240	240	240	240	240	0.60	0.60	0.60	0.60
55	90.4	91.1	93.9	94.6	94.0	96.0	96.9	97.7	98.5	99.1	99.8	100.8	101.5	102.0	101.8
50	91.3	91.8	93.2	93.9	94.5	95.3	96.2	97.0	97.7	98.4	99.1	100.0	100.8	101.2	101.0
45	92.3	92.6	92.9	93.2	93.8	94.5	95.4	96.2	96.9	97.6	98.3	99.3	100.0	100.4	100.2
40	93.2	93.5	93.8	93.4	93.0	93.8	94.7	95.5	96.2	96.8	97.5	98.5	99.2	99.6	99.4
35	94.0	94.5	94.6	94.3	93.9	93.6	93.9	94.7	95.4	96.1	96.8	97.7	98.4	98.8	98.6
30	93.9	95.3	95.5	95.1	94.7	94.5	94.4	94.2	94.6	95.3	96.0	96.9	97.6	98.0	97.8
25	93.1	96.1	96.4	96.0	95.6	95.4	95.2	95.1	94.8	94.5	95.2	96.1	96.8	97.2	97.0
20	92.3	95.5	97.2	96.9	96.5	96.3	96.1	96.0	95.7	95.4	95.2	95.3	96.0	96.4	96.2
15	91.5	94.7	97.7	97.7	97.4	97.2	97.1	96.9	96.6	96.3	96.1	95.7	95.1	95.6	95.4
10	90.7	93.9	96.9	97.7	98.2	98.1	98.0	97.8	97.5	97.3	97.0	96.7	96.0	94.7	94.6
5	89.9	93.0	96.0	96.8	97.7	98.6	98.9	98.8	98.6	98.3	98.0	97.7	97.2	95.9	94.0
0	89.1	92.2	95.1	96.0	96.8	97.7	98.8	99.6	99.5	99.3	99.1	98.7	98.2	97.0	95.2
-5	88.3	91.4	94.3	95.1	95.9	96.8	97.8	98.8	99.7	100.3	100.2	99.9	99.4	98.1	96.3
-10	87.5	90.5	93.4	94.2	95.0	95.9	96.9	97.9	98.8	99.9	100.9	101.0	100.7	99.3	97.3
-15	86.6	89.6	92.5	93.3	94.1	95.0	96.0	97.0	97.9	98.9	99.9	101.2	101.0	100.8	98.5
-20	85.8	88.8	91.6	92.4	93.2	94.1	95.1	96.0	96.9	98.0	99.0	100.2	100.2	100.4	100.1

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)						
	0	5	10	15	20	25	30
ENGINE ANTI-ICE ON	-0.3	-0.3	-0.3	-0.3	-0.4	-0.5	-0.5
ENGINE & WING ANTI-ICE ON	-0.7	-0.6	-0.6	-0.7	-0.8	-0.9	-0.9

Long Range Cruise Altitude Capability

Max Climb Thrust, 300 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
460	18200	16700	14900
440	19300	17900	16100
420	20300	19000	17200
400	21500	20200	18500
380	23300	21900	20400
360	25100	23700	22200
340	26700	25500	24000
320	28300	27400	25900
300	29700	29200	27900
280	31100	31000	29600
260	32500	32400	31400
240	33900	33800	32800
220	35400	35300	34300
200	36700	36600	35600

GEAR DOWN

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)									
		10	14	20	21	23	25	27	29	31	33
460	%N1	84.3	88.6								
	MACH	.488	.525								
	KIAS	270	270								
	FF/ENG	4683	4757								
440	%N1	83.4	87.5								
	MACH	.488	.525								
	KIAS	270	270								
	FF/ENG	4544	4607								
420	%N1	82.5	86.6	93.1							
	MACH	.488	.525	.589							
	KIAS	270	270	270							
	FF/ENG	4417	4477	4601							
400	%N1	81.6	85.6	91.9	93.1						
	MACH	.488	.523	.586	.597						
	KIAS	270	269	269	269						
	FF/ENG	4290	4325	4432	4465						
380	%N1	80.0	83.8	90.1	91.2	93.6					
	MACH	.477	.511	.573	.584	.606					
	KIAS	264	262	262	262	262					
	FF/ENG	4051	4070	4158	4188	4248					
360	%N1	78.4	82.1	88.2	89.3	91.5	94.1				
	MACH	.466	.499	.559	.570	.592	.615				
	KIAS	258	256	256	256	255	255				
	FF/ENG	3821	3825	3889	3919	3969	4020				
340	%N1	76.7	80.3	86.3	87.4	89.6	91.9	94.8			
	MACH	.456	.487	.544	.555	.577	.600	.624			
	KIAS	252	250	249	249	249	248	248			
	FF/ENG	3603	3593	3630	3658	3707	3742	3805			
320	%N1	75.1	78.5	84.3	85.4	87.6	89.8	92.3			
	MACH	.445	.474	.529	.539	.561	.584	.607			
	KIAS	246	243	241	241	242	241	241			
	FF/ENG	3397	3369	3382	3404	3451	3482	3505			
300	%N1	73.4	76.6	82.3	83.3	85.5	87.6	89.9	92.5		
	MACH	.434	.462	.513	.523	.545	.567	.590	.613		
	KIAS	240	236	234	234	234	234	234	233		
	FF/ENG	3198	3151	3145	3161	3197	3227	3241	3277		
280	%N1	71.6	74.8	80.2	81.3	83.4	85.6	87.8	90.1	93.2	
	MACH	.423	.449	.498	.509	.530	.552	.575	.599	.625	
	KIAS	233	230	227	227	228	228	228	228	228	
	FF/ENG	3004	2942	2923	2943	2975	2997	3011	3036	3072	
240	%N1	67.8	70.9	76.2	77.2	79.4	81.5	83.6	85.7	88.1	90.8
	MACH	.398	.423	.473	.483	.503	.524	.546	.569	.594	.620
	KIAS	220	217	215	215	216	216	216	216	216	216
	FF/ENG	2612	2551	2598	2606	2628	2636	2641	2608	2603	2653
200	%N1	63.4	66.9	72.4	73.4	75.3	77.4	79.5	81.6	83.9	86.1
	MACH	.371	.401	.451	.460	.479	.499	.520	.543	.566	.591
	KIAS	205	205	205	205	205	205	205	205	205	205
	FF/ENG	2287	2269	2273	2273	2279	2288	2285	2244	2232	2258

GEAR DOWN

Long Range Cruise Enroute Fuel and Time

Table 1 of 3: 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
609	553	505	464	430	400	379	360	342	326	312
1226	1112	1012	930	861	800	758	719	684	652	624
1852	1677	1524	1399	1293	1200	1136	1078	1025	977	935
2485	2246	2038	1868	1726	1600	1514	1436	1364	1300	1243
3128	2823	2558	2341	2160	2000	1892	1793	1703	1623	1551
3780	3405	3080	2816	2594	2400	2269	2149	2040	1942	1856
4443	3995	3607	3292	3030	2800	2646	2505	2377	2262	2161
5118	4593	4139	3772	3467	3200	3022	2860	2712	2580	2464
5805	5199	4675	4254	3905	3600	3398	3214	3047	2898	2766
6494	5805	5211	4736	4343	4000	3774	3568	3381	3214	3067

Table 2 of 3: 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)
400	19.5	1:27	18.2	1:23	17.0	1:19	16.1	1:15	15.5	1:13
800	38.7	2:51	36.4	2:43	34.3	2:35	32.7	2:26	31.6	2:20
1200	57.3	4:18	54.0	4:05	51.0	3:53	48.8	3:39	47.2	3:30
1600	75.2	5:46	71.0	5:30	67.1	5:12	64.2	4:54	62.2	4:41
2000	92.6	7:17	87.4	6:56	82.7	6:33	79.2	6:10	76.7	5:53
2400	109.4	8:50	103.3	8:24	97.8	7:57	93.7	7:27	90.7	7:06
2800	125.6	10:26	118.7	9:54	112.6	9:21	107.8	8:46	104.3	8:21
3200	141.6	12:04	133.8	11:27	127.1	10:48	121.6	10:07	117.7	9:38
3600	157.1	13:45	148.5	13:02	141.1	12:16	135.1	11:29	130.7	10:55
4000	172.2	15:26	162.8	14:37	154.8	13:45	148.1	12:52	143.3	12:14

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	250	300	350	400	450
20	-3.1	-1.5	0.0	2.3	5.1
40	-6.4	-3.3	0.0	4.7	10.1
60	-9.5	-5.0	0.0	6.9	14.8
80	-12.3	-6.5	0.0	8.9	19.1
100	-14.9	-8.0	0.0	10.7	23.1
120	-17.3	-9.3	0.0	12.4	26.6
140	-19.4	-10.5	0.0	13.9	29.8
160	-21.3	-11.6	0.0	15.2	32.7
180	-23.0	-12.5	0.0	16.4	35.1

Descent at .66/250

PRESSURE ALT (1000 FT)	5	10	15	17	19	21	23	25	27	29	31	33	35	37
DISTANCE (NM)	12	23	35	40	45	49	54	59	64	69	73	77	82	86
TIME (MINUTES)	7	9	11	12	13	14	15	16	16	17	18	18	19	20

GEAR DOWN

Holding

Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)						
		1500	5000	10000	15000	20000	25000	30000
440	%N1	74.4	77.7	82.8	88.4			
	KIAS	261	263	265	269			
	FF/ENG	4560	4570	4670	4830			
420	%N1	73.0	76.3	81.2	86.6	93.1		
	KIAS	256	257	259	262	270		
	FF/ENG	4350	4340	4410	4530	4830		
400	%N1	71.6	74.8	79.6	84.9	91.1		
	KIAS	252	252	254	255	263		
	FF/ENG	4140	4140	4180	4270	4520		
380	%N1	70.1	73.4	78.1	83.3	89.1		
	KIAS	247	248	249	250	255		
	FF/ENG	3940	3940	3960	4040	4210		
360	%N1	68.7	71.9	76.6	81.7	87.4	93.7	
	KIAS	243	243	244	246	250	252	
	FF/ENG	3750	3750	3750	3830	3960	4150	
340	%N1	67.4	70.5	75.2	80.2	86.0	91.9	
	KIAS	239	239	240	242	246	248	
	FF/ENG	3570	3570	3570	3640	3770	3930	
320	%N1	66.0	69.0	73.7	78.5	83.9	89.4	
	KIAS	234	235	235	237	238	239	
	FF/ENG	3390	3380	3380	3430	3490	3610	
300	%N1	64.5	67.4	72.1	76.8	82.1	87.5	94.0
	KIAS	229	230	230	231	233	233	233
	FF/ENG	3210	3200	3190	3220	3280	3370	3480
280	%N1	62.9	65.8	70.4	75.1	80.2	85.6	91.5
	KIAS	224	224	225	226	227	228	228
	FF/ENG	3030	3010	3010	3020	3070	3150	3220
260	%N1	61.4	64.2	68.6	73.3	78.2	83.6	89.1
	KIAS	219	219	220	220	221	222	222
	FF/ENG	2860	2830	2830	2830	2870	2930	2970
240	%N1	59.6	62.4	66.8	71.4	76.2	81.5	86.8
	KIAS	213	213	214	214	215	216	216
	FF/ENG	2690	2650	2650	2640	2730	2770	2750
220	%N1	58.0	60.7	65.0	69.5	74.2	79.4	84.6
	KIAS	208	208	208	209	209	210	210
	FF/ENG	2530	2490	2540	2530	2540	2570	2540
200	%N1	56.6	59.2	63.4	67.8	72.4	77.4	82.7
	KIAS	205	205	205	205	205	205	205
	FF/ENG	2470	2430	2400	2380	2390	2400	2360

This table includes 5% additional fuel for holding in a racetrack pattern.

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Gear Down, One Engine Inop — Section 17

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

Based on engine bleed for 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
440	426	270	11900	10500	8800
420	409	269	13100	11800	10300
400	390	263	14800	13500	12000
380	370	257	16600	15300	13900
360	350	250	18400	17300	15800
340	331	246	20000	18900	17600
320	311	238	21900	20800	19500
300	292	232	23600	22500	21200
280	273	227	25200	24300	23100
260	253	221	26800	26100	24900
240	235	215	28300	27900	26800
220	215	209	29800	29800	28600
200	194	205	31000	31000	30100

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 packs on

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
460	10300	8700	6500
440	11300	9700	7800
420	12200	10700	9000
400	13200	11800	10000
380	15100	13600	12000
360	17000	15600	13900
340	18900	17600	16000
320	20800	19700	18200
300	22800	21700	20300
280	24600	23600	22300
260	26300	25500	24200
240	27800	27400	26200
220	29400	29300	28100
200	30800	30800	29800

Altitude reduced by 1000 ft for additional margin.
With engine anti-ice on, decrease altitude capability by 300 ft.
With engine and wing anti-ice on, decrease altitude capability by 900 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
400	%N1	90.8	95.1						
	MACH	.488	.523						
	KIAS	270	269						
	FF/ENG	5787	5886						
380	%N1	89.1	93.1						
	MACH	.477	.511						
	KIAS	264	262						
	FF/ENG	5450	5512						
360	%N1	87.3	91.2	94.6					
	MACH	.466	.499	.527					
	KIAS	258	256	256					
	FF/ENG	5126	5163	5237					
340	%N1	85.4	89.3	92.5					
	MACH	.456	.487	.513					
	KIAS	252	250	249					
	FF/ENG	4817	4833	4875					
320	%N1	83.5	87.4	90.4	93.9				
	MACH	.445	.474	.500	.529				
	KIAS	246	243	242	241				
	FF/ENG	4522	4518	4539	4617				
300	%N1	81.6	85.3	88.2	91.4	95.6			
	MACH	.434	.462	.486	.513	.545			
	KIAS	240	236	235	234	234			
	FF/ENG	4236	4214	4218	4263	4400			
280	%N1	79.6	83.2	86.0	89.2	92.9	96.1		
	MACH	.423	.449	.472	.498	.530	.552		
	KIAS	233	230	228	227	228	228		
	FF/ENG	3959	3923	3908	3940	4051	4146		
260	%N1	77.6	81.0	83.7	87.0	90.5	93.2	96.8	
	MACH	.411	.436	.457	.486	.517	.538	.561	
	KIAS	227	223	221	221	222	222	222	
	FF/ENG	3684	3644	3613	3661	3754	3810	3898	
240	%N1	75.5	78.7	81.5	84.8	88.2	90.5	93.5	
	MACH	.398	.423	.445	.473	.503	.524	.546	
	KIAS	220	217	215	215	216	216	216	
	FF/ENG	3412	3372	3353	3391	3470	3508	3559	
220	%N1	73.1	76.3	79.3	82.5	85.9	88.2	90.6	93.7
	MACH	.385	.409	.433	.461	.490	.510	.532	.554
	KIAS	212	209	209	209	210	210	210	210
	FF/ENG	3144	3100	3115	3141	3204	3233	3257	3336
200	%N1	70.7	74.5	77.4	80.5	83.9	86.1	88.3	90.9
	MACH	.371	.401	.425	.451	.479	.499	.520	.543
	KIAS	205	205	205	205	205	205	205	205
	FF/ENG	2883	2896	2916	2934	2983	3007	3022	3070

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 1 of 3: 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
313	282	256	234	216	200	189	179	170	161	154
629	567	513	469	432	400	378	357	339	323	308
948	853	771	705	649	600	567	536	508	483	461
1268	1140	1030	940	866	800	755	714	677	644	615
1592	1430	1290	1177	1083	1000	944	893	846	805	768
1917	1721	1551	1414	1300	1200	1132	1071	1015	965	921
2245	2013	1812	1651	1517	1400	1321	1249	1183	1125	1073
2576	2308	2076	1890	1735	1600	1509	1426	1351	1284	1225
2910	2604	2340	2128	1953	1800	1697	1603	1519	1443	1377
3247	2903	2606	2368	2172	2000	1886	1781	1687	1603	1528

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		25	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	8.8	0:48	8.1	0:46	7.4	0:44	6.9	0:43	6.7	0:41
400	17.8	1:32	16.6	1:28	15.5	1:24	14.8	1:20	14.4	1:17
600	26.7	2:16	25.0	2:11	23.5	2:05	22.5	1:58	22.0	1:53
800	35.3	3:02	33.3	2:54	31.3	2:46	30.0	2:36	29.4	2:30
1000	43.9	3:47	41.4	3:37	39.0	3:27	37.4	3:15	36.6	3:06
1200	52.2	4:34	49.3	4:22	46.5	4:09	44.7	3:54	43.7	3:44
1400	60.5	5:21	57.1	5:06	53.9	4:51	51.8	4:33	50.7	4:21
1600	68.5	6:08	64.8	5:51	61.2	5:33	58.8	5:13	57.5	4:59
1800	76.5	6:56	72.3	6:37	68.3	6:16	65.7	5:53	64.2	5:37
2000	84.2	7:45	79.7	7:23	75.4	7:00	72.5	6:34	70.8	6:15

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	200	250	300	350	400
10	-1.8	-0.9	0.0	1.9	3.9
20	-3.7	-1.9	0.0	3.8	8.3
30	-5.5	-2.9	0.0	5.6	12.3
40	-7.3	-3.9	0.0	7.2	16.0
50	-8.9	-4.9	0.0	8.6	19.3
60	-10.5	-5.8	0.0	9.8	22.3
70	-12.1	-6.7	0.0	10.9	25.0
80	-13.5	-7.6	0.0	11.8	27.4
90	-14.9	-8.5	0.0	12.6	29.4

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)					
		1500	5000	10000	15000	20000	25000
460	%N1	84.4	88.2	93.8			
	KIAS	267	269	270			
	FF/ENG	6370	6480	6670			
440	%N1	82.8	86.5	92.1			
	KIAS	261	263	265			
	FF/ENG	6030	6120	6310			
420	%N1	81.2	84.8	90.4			
	KIAS	256	257	259			
	FF/ENG	5720	5790	5950			
400	%N1	79.7	83.2	88.7	94.5		
	KIAS	252	252	254	255		
	FF/ENG	5430	5480	5620	5810		
380	%N1	78.2	81.6	87.0	92.6		
	KIAS	247	248	249	250		
	FF/ENG	5150	5190	5310	5480		
360	%N1	76.6	80.0	85.3	90.9		
	KIAS	243	243	244	246		
	FF/ENG	4880	4910	5010	5170		
340	%N1	75.1	78.5	83.6	89.3	96.1	
	KIAS	239	239	240	242	246	
	FF/ENG	4640	4660	4750	4890	5180	
320	%N1	73.6	76.9	81.9	87.5	93.4	
	KIAS	234	235	235	237	238	
	FF/ENG	4410	4410	4480	4600	4760	
300	%N1	71.9	75.2	80.1	85.5	91.2	
	KIAS	229	230	230	231	233	
	FF/ENG	4170	4160	4210	4310	4440	
280	%N1	70.2	73.4	78.2	83.6	89.2	96.1
	KIAS	224	224	225	226	227	228
	FF/ENG	3930	3920	3950	4030	4140	4350
260	%N1	68.4	71.6	76.4	81.5	87.0	93.2
	KIAS	219	219	220	220	221	222
	FF/ENG	3690	3680	3700	3770	3840	4000
240	%N1	66.5	69.6	74.4	79.4	84.8	90.5
	KIAS	213	213	214	214	215	216
	FF/ENG	3450	3440	3450	3500	3560	3680
220	%N1	64.7	67.7	72.4	77.2	82.5	88.2
	KIAS	208	208	208	209	209	210
	FF/ENG	3230	3220	3220	3250	3300	3390
200	%N1	63.2	66.1	70.7	75.4	80.5	86.1
	KIAS	205	205	205	205	205	205
	FF/ENG	3050	3030	3030	3050	3080	3160

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
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Performance Inflight — Chapter PI
Text — Section 18

Introduction

This chapter contains information to supplement performance data from the Flight Management Computer (FMC). In addition, sufficient inflight data is provided to complete a flight with the FMC inoperative. In the event of conflict between data presented in this chapter and that contained in the Airplane Flight Manual (AFM), the AFM takes precedence.

General

Minimum Takeoff Weight

Light weight takeoffs at the GENX-2B67 thrust rating may be limited by minimum takeoff weight in order to maintain airplane controllability. For weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

Takeoff Speeds

The speeds presented in the Takeoff Speeds table as well as FMC computed takeoff speeds can be used for all performance conditions except where adjustments must be made to V1 for clearway, stopway, brake deactivation, improved climb, contaminated runway situations, anti-skid inoperative, brake energy limits, or obstacle clearance with unbalanced V1. These speeds may be used for weights less than or equal to the performance limited weight.

The FMC will protect for minimum control speeds by increasing V1, VR and V2 as required. However, the FMC will not compute takeoff speeds for weights where the required speed increase exceeds the maximum certified speed increase. This typically occurs at full rated thrust and light weights. In this case, the message "V SPEEDS UNAVAILABLE" will appear on the FMC scratchpad and the takeoff speed entries will be blank. Takeoff is not permitted in this condition as certified limits have been exceeded.

The options are to select a smaller flap setting, select derate thrust and/or add weight (fuel). Selecting derate thrust is the preferred method as this will reduce minimum control speeds. Note that the assumed temperature method may not help this condition as minimum control speeds are determined at the actual temperature and, therefore, are not reduced.

Takeoff speeds are determined as follows:

(1) Determine V1, VR, and V2 from the Takeoff Speeds table (Table 1) with brake release weight.

(2) Adjust V1, VR and V2 for temperature and pressure altitude from the V1, VR, V2 Adjustments table (Table 2).

(3) Adjust V1 for slope and wind from the Slope and Wind V1 Adjustment table (Table 3).

(4) Determine V1(MCG) and Min VR from the V1(MCG) and Minimum VR table (Table 4).

(5) If V1 from Step 3 is less than V1(MCG), set V1=V1(MCG).

(6) If VR from Step 2 is less than Min VR, Set VR=Min VR.

(7) Using Min VR from Step (4), determine V2 from the V2 for Minimum VR table (Table 5).

(8) If V2 from Step 2 is less than V2 for Minimum VR, set V2=V2 for Minimum VR.

Note: Regulations prohibit scheduling takeoff with a V1 less than minimum V1 for control on the ground, V1(MCG), VR less than Minimum VR (Min VR), and V2 less than V2 for Minimum VR. It is necessary to compare the adjusted V1, VR and V2 to V1(MCG), Minimum VR and V2 for Minimum VR, respectively. No takeoff weight adjustment is necessary provided that the actual field length exceeds 1860 m for a dry runway, or 2680 m for a wet runway.

Clearway and Stopway V1 Adjustments

Takeoff speed corrections are to be applied to V1 when using takeoff weights based on the use of clearway and stopway.

Adjust V1 by the amount shown in the table. The adjusted V1 must not exceed VR. If V1 is greater than VR, VR may be increased to equal V1. Increase V2 by the same amount that VR is increased.

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 reference speeds for a given weight.

Flap Maneuver Speeds

This table provides the flap speed schedule for recommended maneuver speeds. During flap retraction, selection of the next flap position is initiated when reaching the maneuver speed for the next flap position. Maneuver capability of at least 30° of bank (15° angle of bank and 15° overshoot) to stick shaker is provided at the flap retraction speed. Full maneuvering capability or at least 40° of bank (25° of bank and 15° overshoot) is provided when the airplane has accelerated to the recommended maneuver speed for the selected flap position.

During flap extension, selection of flaps to the next flap position should be made when approaching (and before decelerating below) the maneuver speed for the existing flap position. The flap extension speed schedule provides full maneuver capability or at least 40° of bank (25° angle of bank and 15° overshoot) to stick shaker at all weights.

Slush/Standing Water Takeoff

Aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water or ice, and reductions in field/obstacle limited takeoff weight and revised takeoff speeds are necessary. The tables are intended for guidance in accordance with advisory material and assume an engine failure at the critical point during takeoff. Data are shown for 2 engine reverse thrust and for no reverse thrust.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore, this information is conservative when operating under typical cold weather conditions where patches of slush exist and some degree of sanding is common. Takeoffs in slush depths greater than 13mm (0.5 inches) are not recommended because of possible damage to the airplane as a result of slush impingement on the airplane structure. Use of assumed temperature for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Takeoff weight is determined as follows:

(1) Determine the dry field/obstacle limit weight for the takeoff flap setting.

(2) Enter the Weight Adjustment table (Table 1) with the dry field/obstacle limit weight to obtain the weight reduction for the slush/standing water depth and airport pressure altitude.

(3) Adjust field length available for temperature by the amount provided in the notes below the V1(MCG) Limit Weight table (Table 2).

(4) Enter the V1(MCG) Limit Weight table (Table 2) with the adjusted field length (determined from step 3) and pressure altitude to obtain the slush/ standing water limit weight with respect to minimum field length required for V1(MCG) speed.

The maximum allowable takeoff weight in slush/standing water is the lesser of the limit weights found in steps 2 and 4.

Takeoff speed determination:

(1) Determine takeoff speeds V1, VR and V2 for actual brake release weight using the Dry Runway Takeoff Speeds tables in this section.

(2) If V1(MCG) limited, set V1=V1(MCG). If not limited by V1(MCG), enter the V1 Adjustment table (Table 3) with actual brake release weight to determine the V1 reduction to apply to V1 speed determined in step (1). If the adjusted V1 is less than V1(MCG), set V1=V1(MCG).

Dry Snow Runway Takeoff/Wet Snow Runway Takeoff

In addition to slush/standing water, data are provided for dry snow and wet snow covered runways. Takeoff in dry snow and wet snow depths greater than 130 mm (5.1 inches) and 30 mm (1.18 inches), respectively, is not recommended. The tables provided are used in the same manner as the Slush/Standing Water Takeoff tables.

Slippery Runway Takeoff

Airplane braking action is reported as good, medium or poor, depending on existing runway conditions. If braking action is reported as good, conditions should not be expected to be as good as on clean, dry runways. The value “good” is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when stopping. The performance level of good is the same as used by the FAA and EASA to define wet runway rejected takeoff performance. A braking action of good to medium (interpolation between good and medium) is representative of a runway covered with compacted snow. Similarly, poor braking action is representative of a runway covered with ice. Performance is based on two symmetric reversers operating and a 15 ft screen height at the end of the runway. The tables provided are used in the same manner as the Slush/Standing Water tables. Data are shown for 2 engine reverse thrust and for no reverse thrust.

Antiskid Inoperative

When operating with antiskid inoperative, the field length/obstacle limited weight and the V1 speed must be reduced to account 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.

Takeoff with antiskid inoperative is allowed only on dry or wet skid resistant runways.

A simplified method which conservatively accounts for the effects of antiskid inoperative is to reduce the normal runway/obstacle limited weight by the amount shown in the table below. Then, reduce the V1 associated with the reduced weight by the amount shown. If takeoff weight is below the antiskid inoperative limited weight, it is only necessary to ensure that the V1 speed does not exceed the antiskid 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 V1(MCG) provided the accelerate stop distance available exceeds approximately 4300 m.

ANTISKID INOPERATIVE ADJUSTMENT		
FIELD LENGTH (M)	WEIGHT (1000 KG)	V1 (KTS)
4000	-20	-33
4500	-20	-30
5000	-20	-24

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Takeoff %N1

To find Takeoff %N1 based on engine bleed for packs on and anti-ice off, enter the Takeoff %N1 table with airport pressure altitude and airport OAT and read %N1. For Packs off and engine anti-ice on, apply the %N1 adjustments shown below the table.

Max Climb %N1

This table shows Max Climb %N1 for a 340/.84 climb speed schedule, normal engine bleed for packs on and anti-ice off. Enter the table with airport pressure altitude and TAT and read %N1. Adjustments are also shown for anti-ice operation.

Go-Around %N1

To find Max Go-Around %N1 based on normal engine bleed for packs on, enter the Go-around %N1 table with airport pressure altitude and reported OAT or TAT and read %N1. For packs off operation, apply the %N1 adjustments provided below the table. %N1 adjustments are shown for engine anti-ice operation.

Flight with Unreliable Airspeed / Turbulent Air Penetration

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 may also be unreliable.

ISFD Airspeed and Altitude Correction

In the event of loss of primary air data, Integrated Standby Flight Display (ISFD) airspeed and pressure altitude correction are provided. The first table provides the ISFD airspeed for a given gross weight and target airspeed. The second table provides a pressure altitude adjustment for a given gross weight and ISFD airspeed. The pressure altitude adjustment is added to the ISFD altitude to get the actual pressure altitude.

All Engines

Long Range Cruise Maximum Operating Altitude

The Long Range Cruise Maximum Operating Altitude tables provide both optimum altitude and climb thrust limited pressure altitude for a given weight at Long Range Cruise. Buffet limits corresponding to a maneuver margin of 1.3g (39° bank) are also shown. The maximum altitude shown in the table is limited by the maximum certified altitude of 43100 ft.

Long Range Cruise Control

This table provides target %N1, Long Range Cruise Mach number, KIAS and standard day fuel flow per engine for the airplane weight and pressure altitude. As indicated by the shaded area, at optimum altitude, .85 Mach approximates the Long Range Cruise Mach schedule.

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. Data are based on Long Range Cruise and .84/290/250 descent. Tables are presented for low altitudes for shorter trip distances and high altitudes for longer trip distances.

To determine remaining fuel and time required, first enter the Ground to Air Miles Conversion table (Table 1) to convert ground distance and enroute wind to an equivalent still-air distance. Next, enter the Reference Fuel and Time table (Table 2) with air distance from Table 1 and the desired altitude and read reference fuel and time required. Lastly, enter the Fuel Required Adjustment table (Table 3) 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 that may justify operations 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 at .84/290/250

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 are based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach and landing.

Holding

Target %N1, KIAS, and fuel flow per engine information are tabulated for holding with Flaps Up and Flaps 1 based on the FMC optimum holding speed schedule. This is the higher of maximum endurance speed and maneuvering speed for the selected flap setting. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read %N1, KIAS and fuel flow per engine.

Advisory Information

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distances on dry runways and slippery 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.

To use these tables, determine the reference landing distance for the selected braking configuration. Adjust this reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers to obtain actual landing distance.

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. If the surface is affected by water, snow, or ice, and braking action is reported as "good", conditions should not be expected to be as good as on clean, dry runways. The value "good" is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when landing. The performance level used to calculate "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate "poor" data reflects runways covered with wet ice.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" reported 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 appropriate to add the effects of slope and inoperative reversers when using the autobrake system.

Non-Normal Configuration Landing Distance

Advisory information is provided to support non-normal configurations that affect landing performance of the airplane. Landing distances and adjustments are provided for dry runways and runways with good, good to medium, medium, medium to poor, and poor reported braking action. The Non-Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

Enter the table with the applicable non-normal configuration and read normal approach speed. The reference landing distance is a distance from 50 ft above the threshold to stop, based on a reference landing weight and speed at sea level, zero wind, and zero runway slope. Subsequent columns provide corrections for off-reference landing weight, altitude, wind, runway slope, temperature, speed, and reverser conditions. Each correction is independently added to the reference landing distance. The reference landing distance is based on maximum manual braking and maximum available reverse thrust.

Landing Climb Limit Weight

Enter the Landing Climb Limit Weight table with airport OAT and pressure altitude and read landing climb limit weight. Apply the noted adjustments as required.

Recommended Brake Cooling Schedule

Advisory information is provided to assist in avoiding problems associated with hot brakes. Although for normal operations most landings are at weights below the AFM quick turnaround limit weight, brakes can still get hot enough that cooling is recommended. Use of the recommended cooling schedule can help avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Enter the Reference Brake Energy table (Table 1) with 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 Event Adjusted Brake Energy table (Table 2) for no reverse thrust or 4 engine reverse thrust with the reference brake energy per brake and the type of braking used during landing (Max Manual, Max Auto, or Autobrake). 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 (Table 3) 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 BTMS, the hottest brake indication 10 to 15 minutes after the airplane has come to a complete stop, or inflight with gear retracted, may be used to determine recommended cooling schedule by entering at the bottom of the chart. An EICAS advisory message, BRAKE TEMP, will appear when any brake registers 5 on the GEAR synoptic display and disappears as the hottest brake cools to an indication of 4. Note that even without an EICAS advisory message, brake cooling is recommended.

One Engine Inoperative

Max Continuous %N1

Power setting is based on one engine inoperative with packs on and anti-ice bleeds off. Enter the table with pressure altitude and KIAS or Mach to read %N1.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Driftdown Speed/Level Off Altitude

The Driftdown Speed/Level Off Altitude 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.

Level off altitude is dependent on air temperature (ISA deviation). Note that the maximum altitude shown has been reduced by 1000 ft to maintain consistency with the FMC.

Long Range Cruise Altitude Capability

The Long Range Cruise Altitude Capability 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 to maintain consistency with the FMC.

Long Range Cruise Control

The Long Range Cruise Control table provides target %N1, one engine inoperative Long Range Cruise Mach number, KIAS, and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect fuel burn per engine.

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 are 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 (Table 1) and read Fuel and Time (Table 2) 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 (Table 3) with fuel required for the reference weight and the actual weight at checkpoint.

Holding

One engine inoperative holding data are provided in the same format as the all engine holding data and are based on the same assumptions.

Two Engines Inoperative

Driftdown Speed/Level Off Altitude

The Driftdown Speed/Level Off Altitude table shows optimum driftdown speed as a function of cruise weight at the start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off.

Level off altitude is dependent on air temperature (ISA deviation). Note that the maximum altitude shown has been reduced by 2000 ft to maintain consistency with the FMC.

Driftdown/LRC Cruise Range Capability

This table shows range capability from the start of driftdown until the airplane levels off. As weight decreases due to fuel burn, the airplane accelerates to Long Range Cruise speed and maintains this speed at the level off altitude.

To determine fuel required, enter the Ground to Air Miles Conversion table (Table 1) with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Next, enter the Driftdown/ Cruise Fuel and Time table (Table 2) with air distance and weight at start of driftdown to determine fuel and time required.

Long Range Cruise Altitude Capability

The Long Range Cruise Altitude Capability 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 to be consistent with the FMC logic.

Long Range Cruise Control

The Long Range Cruise Control table provides target %N1, two engines inoperative Long Range Cruise Mach number, KIAS, and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect fuel burn for each engine.

Alternate Mode EEC

This section contains performance data for airplane operation with the Electronic Engine Control (EEC) in alternate mode (EEC ALTN lights illuminated). Data are based on engine bleed effects for normal air conditioning operations, i.e., three packs operating. Assumed temperature method is not allowed with EEC in alternate mode.

Limit Weight

A simplified method which conservatively accounts for the effects of EEC in alternate mode is to reduce the normal mode performance limited weights. The Limit Weight table provides takeoff field, climb, obstacle, tire speed, brake energy, net level off and landing climb weights. To determine limit weights for operations with the EEC in alternate mode, enter the table with the limit weights for normal mode EEC operation and read the associated limit weight for each performance condition. The most limiting of the takeoff weights must be used. Additionally, Landing Climb limit weight must be compared to the Landing Field Length limit weight and the more limiting of the two must be used as the landing limit weight. Analysis from the Airplane Flight Manual may yield less restrictive limit weights.

Takeoff Speed Adjustment

Takeoff speeds for the reduced weight should be increased by the amount shown in the Takeoff Speed Adjustments table.

Takeoff %N1/Go-around %N1

Takeoff and Go-around power setting are presented for normal air conditioning bleed. Takeoff or Go-around %N1 may be read directly from the tables for the desired pressure altitude and airport OAT, or TAT may be used for go-around.

Thrust protection is not provided for EEC in alternate mode and maximum rated thrust is reached at a thrust lever position less that full forward. As a result, thrust overboost can occur at full forward thrust lever positions.

Gear Down

This section contains performance for airplane operation with landing gear extended for all phases of flight. Data are based on engine bleeds for normal air conditioning.

Note: The FMC does not contain special provisions for operation with landing gear extended. As a result, the FMC 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 VNAV during descent under these circumstances is not recommended.

Tables for gear down performance in this section are identical in format and used in the same manner as tables for the gear up configuration previously described.

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747-8F GENX-2B67 LB FT FAA TO1-10% TO2-20%

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Performance Inflight — Chapter PI
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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
914	Freighter

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Performance Inflight — Chapter PI
General — Section 20

Minimum Takeoff Weight
Maximum Takeoff Thrust

Based on engine bleed for packs on and anti-ice off

Flaps 10

Weight Limit (1000 LB)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
45	407.7	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
40	430.9	414.6	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
35	453.5	436.3	419.9	403.4	402.0	402.0	402.0	402.0	402.0	402.0	402.0
30	470.1	453.0	436.3	420.0	404.3	402.0	402.0	402.0	402.0	402.0	402.0
25	470.7	459.4	448.6	434.8	418.5	402.3	402.0	402.0	402.0	402.0	402.0
20	471.1	459.8	449.0	437.9	426.8	416.5	402.0	402.0	402.0	402.0	402.0
15	471.5	460.2	449.3	438.1	427.0	416.6	405.9	402.0	402.0	402.0	402.0
10	471.7	460.4	449.5	438.3	427.1	416.6	405.9	402.0	402.0	402.0	402.0
0 & BELOW	472.0	460.5	449.5	438.3	427.3	416.6	405.9	402.0	402.0	402.0	402.0

Flaps 20

Weight Limit (1000 LB)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	432.4	415.8	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
45	457.8	440.1	423.1	407.2	402.0	402.0	402.0	402.0	402.0	402.0	402.0
40	483.7	465.4	447.2	429.9	413.7	402.0	402.0	402.0	402.0	402.0	402.0
35	509.0	489.7	471.3	452.8	434.1	417.2	402.0	402.0	402.0	402.0	402.0
30	527.6	508.3	489.6	471.4	453.8	435.8	418.4	402.3	402.0	402.0	402.0
25	528.2	515.5	503.4	488.0	469.7	451.6	438.6	420.6	402.0	402.0	402.0
20	528.7	516.0	503.9	491.4	478.9	467.4	451.0	435.0	415.9	402.0	402.0
15	529.2	516.4	504.2	491.6	479.2	467.5	455.5	444.1	426.0	406.8	402.0
10	529.3	516.6	504.4	491.8	479.3	467.5	455.5	444.1	427.8	411.9	402.0
0 & BELOW	529.6	516.8	504.5	491.8	479.5	467.5	455.4	444.0	427.7	412.0	402.0

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability. For weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

Takeoff Speeds - Dry Runway

Max Takeoff Thrust

Flaps 10

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 10		
	V1	VR	V2
1000	166	182	196
950	162	177	192
900	157	172	188
850	151	165	183
800	146	159	178
750	140	153	173
700	134	146	167
650	127	139	161
600	120	132	155
550	112	125	149
500	103	117	142
450	94	109	136

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	17	17						8	8						-2	-2					
60	12	12	15	17				6	6	8	9				-2	-2	-2	-2			
50	7	8	11	13	16	18	20	4	4	6	8	9	10	12	-1	-1	-2	-2	-2	-3	-3
40	3	4	7	9	12	15	18	2	2	4	5	7	8	10	-1	-1	-1	-1	-2	-2	-3
30	0	0	3	6	8	11	14	0	0	2	4	5	7	8	0	0	0	-1	-1	-2	-2
20	0	0	2	4	6	9	12	0	0	1	2	4	5	7	0	0	0	0	-1	-1	-2
10	0	0	2	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-40	0	0	2	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-60	1	1	2	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-6	-3	0	3	5	-4	-3	-1	0	1	2	3	3
950	-5	-2	0	3	5	-4	-3	-1	0	1	2	3	3
900	-5	-2	0	2	5	-4	-3	-1	0	1	2	3	3
850	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
800	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
750	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
700	-3	-2	0	2	3	-4	-2	-1	0	1	2	2	3
650	-3	-1	0	2	3	-3	-2	-1	0	1	2	2	3
600	-3	-1	0	2	3	-3	-2	-1	0	1	2	2	3
550	-3	-1	0	1	3	-3	-2	-1	0	1	2	2	3
500	-2	-1	0	1	3	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

Takeoff Speeds - Dry Runway

Max Takeoff Thrust

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	122	125	121	124										
50	126	129	124	127	119	122	116	120	114	118				
40	133	136	132	134	126	129	121	124	116	120	111	115	108	112
30	138	140	138	140	132	135	127	130	121	125	116	120	110	114
20	138	140	138	140	134	137	130	133	126	130	121	124	114	118
0	139	141	138	140	135	137	131	134	127	130	123	126	118	122
-60	140	140	139	140	135	137	131	133	128	130	123	126	119	122

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR							
	110	115	120	125	130	135	140	145
700	164	164	165	165	165	166	166	167
650	158	158	159	159	159	160	161	166
600	152	152	152	153	153	155	160	165
550	146	146	146	147	149	154	159	164
500	139	140	140	143	148	153	158	163
450	133	133	137	142	147	152	157	162

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 20		
	V1	VR	V2
1000	155	169	180
950	151	164	177
900	146	159	173
850	141	153	168
800	136	147	164
750	130	142	159
700	124	135	154
650	117	129	148
600	110	122	143
550	103	115	137
500	94	107	131
450	86	100	125

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Takeoff Speeds - Dry Runway
Max Takeoff Thrust
Flaps 20
Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	17	17						8	8						-2	-2					
60	12	12	15	17				6	6	8	9				-2	-2	-2	-2			
50	7	8	11	13	16	18	20	4	4	6	8	9	10	12	-1	-1	-2	-2	-2	-3	-3
40	3	4	7	9	12	15	18	2	2	4	5	7	8	10	-1	-1	-1	-1	-2	-2	-3
30	0	0	3	6	8	11	14	0	0	2	4	5	7	8	0	0	0	-1	-1	-2	-2
20	0	0	2	4	6	9	12	0	0	1	2	4	5	7	0	0	0	0	-1	-1	-2
10	0	0	2	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-40	0	0	2	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-60	1	1	2	4	6	8	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-6	-3	0	3	5	-4	-3	-1	0	1	2	3	3
950	-5	-2	0	3	5	-4	-3	-1	0	1	2	3	3
900	-5	-2	0	2	5	-4	-3	-1	0	1	2	3	3
850	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
800	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
750	-4	-2	0	2	4	-4	-2	-1	0	1	2	2	3
700	-3	-2	0	2	3	-4	-2	-1	0	1	2	2	3
650	-3	-1	0	2	3	-3	-2	-1	0	1	2	2	3
600	-3	-1	0	2	3	-3	-2	-1	0	1	2	2	3
550	-3	-1	0	1	3	-3	-2	-1	0	1	2	2	3
500	-2	-1	0	1	3	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), and Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	122	125	121	124										
50	126	129	124	127	119	122	116	120	114	118				
40	133	136	132	134	126	129	121	124	116	120	111	115	108	112
30	138	140	138	140	132	135	127	130	121	125	116	120	110	114
20	138	140	138	140	134	137	130	133	126	130	121	124	114	118
0	139	141	138	140	135	137	131	134	127	130	123	126	118	122
-60	140	140	139	140	135	137	131	133	128	130	123	126	119	122

Takeoff Speeds - Dry Runway
Max Takeoff Thrust
Flaps 20
Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)							
	110	115	120	125	130	135	140	145
800	161	162	162	163	163	164	164	164
750	157	157	157	158	158	158	159	162
700	151	151	151	152	152	153	156	161
650	145	146	146	146	147	151	155	160
600	140	140	141	141	145	150	155	160
550	134	135	136	139	144	149	154	159
500	126	129	133	138	143	149	154	159
450	122	127	133	138	143	148	153	158

DO NOT USE FOR FLIGHT

Takeoff Speeds - Wet Runway

Max Takeoff Thrust

Flaps 10

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 10		
	V1	VR	V2
1000	154	182	196
950	149	177	192
900	143	172	188
850	136	165	183
800	130	159	178
750	124	153	173
700	116	146	167
650	109	139	161
600	102	132	155
550	94	125	149
500	85	117	142
450	77	109	136

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	19	19						8	8						-2	-2					
60	14	15	17	19				6	7	8	9				-2	-2	-2	-2			
50	8	9	13	15	17	20	23	4	4	6	7	9	10	12	-1	-1	-2	-2	-2	-3	-3
40	2	4	7	10	13	15	19	2	2	4	5	7	8	10	-1	-1	-1	-1	-2	-2	-3
30	0	0	2	5	8	12	14	0	0	2	4	5	7	8	0	0	0	-1	-1	-2	-3
20	0	0	1	4	6	8	11	0	0	1	2	4	5	7	0	0	0	0	-1	-1	-2
10	1	1	2	4	5	8	10	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
0	1	1	3	4	6	8	10	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-20	2	2	3	5	7	9	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-40	3	3	4	6	8	10	12	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-60	4	4	5	7	9	11	13	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-6	-2	0	5	8	-5	-3	-1	0	2	4	5	6
950	-6	-2	0	5	8	-6	-3	-1	0	2	4	5	7
900	-6	-2	0	4	8	-6	-4	-1	0	2	4	5	7
850	-5	-2	0	4	7	-7	-4	-1	0	2	4	5	7
800	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
750	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
700	-4	-2	0	4	6	-7	-4	-1	0	2	4	6	7
650	-4	-1	0	4	6	-7	-4	-1	0	2	4	6	7
600	-4	-1	0	3	6	-7	-4	-1	0	2	4	6	7
550	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
500	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
450	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7

***V1 not to exceed VR**

Takeoff Speeds - Wet Runway
Max Takeoff Thrust
Flaps 10
Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	122	125	121	124										
50	126	129	124	127	119	122	116	120	114	118				
40	133	136	132	134	126	129	121	124	116	120	111	115	108	112
30	138	140	138	140	132	135	127	130	121	125	116	120	110	114
20	138	140	138	140	134	137	130	134	126	130	121	125	114	118
0	139	141	138	140	135	137	131	134	127	130	123	126	118	122
-60	140	140	139	140	135	137	131	134	128	130	123	126	119	122

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)							
	110	115	120	125	130	135	140	145
700	164	164	165	165	165	166	166	167
650	158	158	159	159	159	160	161	166
600	152	152	152	153	153	155	160	165
550	146	146	146	147	149	154	159	164
500	139	140	140	143	148	153	158	163
450	133	133	137	142	147	152	157	162

Flaps 20
Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 20		
	V1	VR	V2
1000	144	169	180
950	139	164	177
900	133	159	173
850	127	153	168
800	121	147	164
750	115	142	159
700	108	135	154
650	101	129	148
600	94	122	143
550	87	115	137
500	79	107	131
450	70	100	125

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Takeoff Speeds - Wet Runway

Max Takeoff Thrust

Flaps 20

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	18	18						8	8						-2	-2					
60	12	13	15	18				6	7	8	9				-2	-2	-2	-2			
50	7	8	11	13	16	18	21	4	4	6	7	8	11	13	-1	-1	-2	-2	-2	-3	-3
40	2	3	6	8	12	14	17	2	2	4	5	7	9	11	-1	-1	-1	-1	-2	-2	-3
30	0	0	2	5	8	10	14	0	0	2	4	5	7	8	0	0	0	-1	-1	-2	-2
20	0	0	1	4	6	8	11	0	0	1	2	4	5	7	0	0	0	0	-1	-1	-2
10	0	0	2	4	6	8	10	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
0	0	0	2	4	6	8	10	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-20	0	0	2	4	6	8	10	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-40	2	2	4	5	7	9	11	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1
-60	3	3	5	6	8	10	12	0	0	1	2	3	5	6	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-6	-2	0	5	8	-5	-3	-1	0	2	4	5	6
950	-6	-2	0	5	8	-6	-3	-1	0	2	4	5	7
900	-6	-2	0	4	8	-6	-4	-1	0	2	4	5	7
850	-5	-2	0	4	7	-7	-4	-1	0	2	4	5	7
800	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
750	-5	-2	0	4	7	-7	-4	-1	0	2	4	6	7
700	-4	-2	0	4	6	-7	-4	-1	0	2	4	6	7
650	-4	-1	0	4	6	-7	-4	-1	0	2	4	6	7
600	-4	-1	0	3	6	-7	-4	-1	0	2	4	6	7
550	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
500	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7
450	-3	-1	0	3	5	-7	-4	-1	0	2	4	6	7

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	122	125	121	124										
50	126	129	124	127	119	122	116	120	114	118				
40	133	136	132	134	126	129	121	124	116	120	111	115	108	112
30	138	140	138	140	132	135	127	130	121	125	116	120	110	114
20	138	140	138	140	134	137	130	134	126	130	121	125	114	118
0	139	141	138	140	135	137	131	134	127	130	123	126	118	122
-60	140	140	139	140	135	137	131	134	128	130	123	126	119	122

Takeoff Speeds - Wet Runway
Max Takeoff Thrust
Flaps 20
Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)							
	110	115	120	125	130	135	140	145
800	161	162	162	163	163	164	164	164
750	157	157	157	158	158	158	159	162
700	151	151	151	152	152	153	156	161
650	145	146	146	146	147	151	155	160
600	140	140	141	141	145	150	155	160
550	134	135	136	139	144	149	154	159
500	126	129	133	138	143	149	154	159
450	122	127	133	138	143	148	153	158

Maximum Allowable Clearway

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
6000	700
8000	900
10000	1050
12000	1150
14000	1250
16000	1400

Clearway and Stopway V1 Adjustments

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)									
	DRY RUNWAY					WET RUNWAY				
	100	120	140	160	180	100	120	140	160	180
1000	-4	-7	-7	-4	-4					
800	-3	-6	-6	-3	-3					
600	-2	-5	-5	-3	-3					
400	-1	-3	-3	-2	-2					
200	-1	-1	-1	-1	-1					
0	0	0	0	0	0	0	0	0	0	0
-200	1	1	1	1	1	2	2	2	2	2
-400	1	1	1	1	1	2	2	2	2	2
-600	1	1	1	1	1	2	2	2	2	2
-800	1	1	1	1	1	2	2	2	2	2
-1000	1	1	1	1	1	2	2	2	2	2

Use of clearway not allowed on wet runways.
V1 not to exceed VR.

VREF (KIAS)

WEIGHT (1000 LB)	FLAPS	
	30	25
1000	186	190
950	181	184
900	175	179
850	170	173
800	165	168
750	160	163
700	154	158
650	148	152
600	142	145
550	136	138
500	129	132
450	122	125

Flap Maneuver Speed

Sea Level Pressure Altitude

WEIGHT (1000 LB)	MANEUVER SPEED (KIAS)						
	FLAPS						
	UP	1	5	10	20	25	30
1000	264	243	223	203	193	190	186
950	258	238	218	200	188	184	181
900	254	233	213	196	183	179	175
850	249	228	208	193	178	173	170
800	243	223	203	190	174	168	165
750	239	219	199	186	172	163	160
700	234	214	193	180	166	158	154
650	228	208	188	173	160	152	148
600	222	202	182	166	153	145	142
550	216	196	175	158	147	138	136
500	209	189	169	151	140	132	129
450	205	185	164	144	134	125	122

10000 FT Pressure Altitude

WEIGHT (1000 LB)	MANEUVER SPEED (KIAS)						
	FLAPS						
	UP	1	5	10	20	25	30
1000	269	246	226	209	196	190	186
950	262	241	221	205	192	184	181
900	256	236	215	202	186	179	175
850	250	230	210	198	181	173	170
800	245	225	206	194	176	168	165
750	240	220	204	190	174	163	160
700	235	215	196	183	167	158	154
650	229	209	189	175	161	152	148
600	223	203	183	168	154	145	142
550	217	197	176	160	147	138	136
500	210	190	170	152	140	132	129
450	205	185	164	144	134	125	122

20000 FT Pressure Altitude and Above

WEIGHT (1000 LB)	MANEUVER SPEED (KIAS)						
	FLAPS						
	UP	1	5	10	20	25	30
1000	286	250	230	217	201	190	186
950	276	245	225	212	196	184	181
900	266	239	219	206	191	179	175
850	257	234	214	201	185	173	170
800	250	228	214	197	180	168	165
750	246	223	211	193	177	163	160
700	238	217	202	186	171	158	154
650	231	211	194	178	164	152	148
600	225	205	186	170	157	145	142
550	218	198	178	162	149	138	136
500	211	191	171	153	142	132	129
450	205	185	164	145	134	125	122

Flaps 25 maneuver speed based on VREF25.
Flaps 30 maneuver speed based on VREF30.

ADVISORY INFORMATION

Slush/Standing Water Takeoff

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-15.7	-25.2	-34.7	-37.0	-54.5	-72.0	-85.5	-119.5	-153.5
950	-13.5	-23.0	-32.5	-32.4	-49.9	-67.4	-75.5	-109.5	-143.5
900	-11.5	-21.0	-30.5	-28.0	-45.5	-63.0	-65.9	-99.9	-133.9
850	-9.6	-19.1	-28.6	-23.8	-41.3	-58.8	-56.8	-90.8	-124.8
800	-7.9	-17.4	-26.9	-20.0	-37.5	-55.0	-48.1	-82.1	-116.1
750	-6.4	-15.9	-25.4	-16.4	-33.9	-51.4	-39.8	-73.8	-107.8
700	-5.1	-14.6	-24.1	-13.1	-30.6	-48.1	-32.0	-66.0	-100.0
650	-3.9	-13.4	-22.9	-10.1	-27.6	-45.1	-24.6	-58.6	-92.6
600	-2.9	-12.4	-21.9	-7.3	-24.8	-42.3	-17.6	-51.6	-85.6
550	-2.0	-11.5	-21.0	-4.8	-22.3	-39.8	-11.1	-45.1	-79.1
500	-1.3	-10.8	-20.3	-2.6	-20.1	-37.6	-5.0	-39.0	-73.0
450	-0.8	-10.3	-19.8	-0.7	-18.2	-35.7	0.0	-33.3	-67.3

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
6200							361.4		
6600				355.2			432.6		
7000	379.4			430.0			504.3		
7400	456.9			505.9			577.0		
7800	536.0			583.3			650.5	379.2	
8200	617.0			662.5	373.9		724.8	450.4	
8600	700.0	398.7		743.4	448.8		800.1	522.4	
9000	785.2	476.5		826.2	525.1		876.4	595.3	
9400	872.7	556.1		911.2	602.9		953.7	669.0	397.0
9800	962.8	637.6		998.3	682.5	392.6	1032.0	743.6	468.4
10200	1054.9	721.1	418.0	1086.4	763.9	467.7		819.1	540.5
10600		806.9	496.2		847.3	544.4		895.6	613.6
11000		895.0	576.3		932.7	622.7		973.2	687.5
11400		985.7	658.3		1020.3	702.7		1051.4	762.4
11800		1078.1	742.3			784.6			838.2
12200			828.7			868.4			914.9
12600			917.4			954.4			992.7
13000			1008.8			1042.3			1071.0

1. **Enter Table 1 with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -460 ft/+460 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-20	-18	-15	-16	-13	-11	-6	-3	-1
950	-21	-19	-16	-17	-15	-12	-8	-5	-3
900	-22	-20	-17	-19	-16	-14	-10	-7	-5
850	-23	-21	-18	-20	-17	-15	-12	-9	-7
800	-24	-22	-19	-21	-18	-16	-14	-11	-9
750	-25	-22	-20	-22	-19	-17	-15	-13	-10
700	-25	-23	-20	-23	-20	-18	-17	-14	-12
650	-26	-23	-21	-23	-21	-18	-18	-16	-13
600	-26	-23	-21	-24	-21	-19	-19	-17	-14
550	-26	-23	-21	-24	-22	-19	-20	-18	-15
500	-26	-23	-21	-24	-22	-19	-21	-19	-16
450	-25	-23	-20	-24	-22	-19	-22	-20	-17

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-26.3	-36.8	-47.3	-47.8	-65.8	-83.8	-97.3	-132.8	-168.3
950	-24.1	-34.6	-45.1	-43.2	-61.2	-79.2	-87.2	-122.7	-158.2
900	-21.7	-32.2	-42.7	-38.6	-56.6	-74.6	-77.3	-112.8	-148.3
850	-19.3	-29.8	-40.3	-34.0	-52.0	-70.0	-67.6	-103.1	-138.6
800	-16.7	-27.2	-37.7	-29.4	-47.4	-65.4	-58.2	-93.7	-129.2
750	-14.0	-24.5	-35.0	-24.8	-42.8	-60.8	-48.9	-84.4	-119.9
700	-11.3	-21.8	-32.3	-20.1	-38.1	-56.1	-39.9	-75.4	-110.9
650	-8.4	-18.9	-29.4	-15.4	-33.4	-51.4	-31.2	-66.7	-102.2
600	-5.4	-15.9	-26.4	-10.7	-28.7	-46.7	-22.6	-58.1	-93.6
550	-2.3	-12.8	-23.3	-6.0	-24.0	-42.0	-14.3	-49.8	-85.3
500	0.0	-9.6	-20.1	-1.3	-19.3	-37.3	-6.2	-41.7	-77.2
450	0.0	-6.3	-16.8	0.0	-14.5	-32.5	0.0	-33.8	-69.3

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
8200							375.7		
8600							471.2		
9000							565.3		
9400				393.7			657.9		
9800				522.8			749.3	423.6	
10200	420.9			644.7			839.3	518.4	
10600	582.0			760.7			928.1	611.8	
11000	724.8			871.3	459.2		1015.9	703.8	375.7
11400	854.4			977.4	584.6			794.5	471.2
11800	974.0	504.2		1080.9	703.4			883.9	565.3
12200	1088.2	655.3			816.6	393.7		972.1	657.9
12600		791.0			924.9	522.8		1059.5	749.3
13000		915.3	420.9		1029.1	644.7			839.3
13400		1031.1	582.0			760.7			928.1
13800			724.8			871.3			1015.9
14200			854.4			977.4			
14600			974.0			1080.9			
15000			1088.2						

1. **Enter Table 1 with slush/standing water depth and dry field/obstacle limit weight to obtain slush/ standing water weight adjustment.**
2. **Adjust field length available by -540 ft/+540 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2)**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slush/Standing Water Takeoff

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-29	-24	-19	-24	-19	-14	-12	-7	-2
950	-30	-25	-20	-26	-21	-16	-14	-9	-4
900	-32	-27	-22	-27	-22	-17	-17	-12	-7
850	-33	-28	-23	-29	-24	-19	-19	-14	-9
800	-34	-29	-24	-30	-25	-20	-21	-16	-11
750	-35	-30	-25	-32	-27	-22	-24	-19	-14
700	-36	-31	-26	-33	-28	-23	-26	-21	-16
650	-37	-32	-27	-35	-30	-25	-28	-23	-18
600	-38	-33	-28	-36	-31	-26	-31	-26	-21
550	-39	-34	-29	-37	-32	-27	-33	-28	-23
500	-40	-35	-30	-38	-33	-28	-35	-30	-25
450	-40	-35	-30	-39	-34	-29	-37	-32	-27

1. **1. Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Dry Snow Takeoff
2 Engine Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 LB)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-4.2	-11.2	-18.2	-14.2	-24.7	-35.2	-48.0	-75.0	-102.0
950	-3.8	-10.8	-17.8	-12.8	-23.2	-33.8	-42.9	-69.9	-96.9
900	-3.5	-10.5	-17.5	-11.4	-21.9	-32.4	-38.0	-65.0	-92.0
850	-3.2	-10.2	-17.2	-10.2	-20.7	-31.2	-33.5	-60.5	-87.5
800	-3.0	-10.0	-17.0	-9.1	-19.6	-30.1	-29.2	-56.2	-83.2
750	-2.8	-9.8	-16.8	-8.1	-18.6	-29.1	-25.3	-52.3	-79.3
700	-2.6	-9.6	-16.6	-7.1	-17.6	-28.1	-21.7	-48.7	-75.7
650	-2.5	-9.5	-16.5	-6.3	-16.8	-27.3	-18.3	-45.3	-72.3
600	-2.4	-9.4	-16.4	-5.6	-16.1	-26.6	-15.3	-42.3	-69.3
550	-2.4	-9.4	-16.4	-4.9	-15.4	-25.9	-12.7	-39.7	-66.7
500	-2.4	-9.4	-16.4	-4.4	-14.9	-25.4	-10.3	-37.3	-64.3
450	-2.4	-9.4	-16.4	-3.9	-14.4	-24.9	-8.2	-35.2	-62.2

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
6200				353.6			420.5		
6600	412.2			438.4			497.0		
7000	500.8			524.1			574.6		
7400	590.7			611.0			653.4	411.1	
7800	681.9	401.2		699.1	427.7		733.4	487.4	
8200	774.5	489.7		788.5	513.3		814.6	564.9	
8600	868.4	579.4		879.3	600.0		897.2	643.5	401.6
9000	963.9	670.4	390.2	971.6	688.0	417.1	981.2	723.3	477.8
9400	1060.6	762.8	478.5	1064.8	777.3	502.5	1065.9	804.4	555.1
9800		856.6	568.1		867.9	589.1		886.8	633.6
10200		951.9	659.0		959.9	676.9		970.6	713.2
10600		1048.5	751.2		1053.1	766.0		1055.4	794.2
11000			844.8			856.5			876.4
11400			939.9			948.4			960.0
11800			1036.4			1041.5			1044.8

1. **Enter Table 1 with dry snow depth and dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -320 ft/+320 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Dry Snow Takeoff
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-14	-12	-9	-12	-10	-7	-6	-3	-1
950	-17	-14	-12	-15	-12	-10	-8	-6	-3
900	-19	-16	-14	-17	-14	-12	-11	-8	-6
850	-20	-18	-15	-19	-16	-14	-13	-10	-8
800	-22	-20	-17	-20	-18	-15	-15	-12	-10
750	-24	-21	-19	-22	-19	-17	-17	-14	-12
700	-25	-22	-20	-23	-21	-18	-18	-15	-13
650	-26	-23	-21	-24	-22	-19	-19	-17	-14
600	-26	-24	-21	-25	-22	-20	-20	-18	-15
550	-27	-24	-22	-25	-23	-20	-21	-18	-16
500	-27	-25	-22	-26	-23	-21	-21	-19	-16
450	-27	-25	-22	-26	-23	-21	-22	-19	-17

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Dry Snow Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-11.0	-16.5	-22.0	-22.4	-30.9	-39.4	-57.6	-83.1	-108.6
950	-11.3	-16.8	-22.3	-21.4	-29.9	-38.4	-52.7	-78.2	-103.7
900	-11.4	-16.9	-22.4	-20.2	-28.7	-37.2	-47.8	-73.3	-98.8
850	-11.0	-16.5	-22.0	-18.7	-27.2	-35.7	-42.9	-68.4	-93.9
800	-10.4	-15.9	-21.4	-17.0	-25.5	-34.0	-38.1	-63.6	-89.1
750	-9.4	-14.9	-20.4	-15.0	-23.5	-32.0	-33.2	-58.7	-84.2
700	-8.1	-13.6	-19.1	-12.8	-21.3	-29.8	-28.4	-53.9	-79.4
650	-6.4	-11.9	-17.4	-10.4	-18.9	-27.4	-23.5	-49.0	-74.5
600	-4.4	-9.9	-15.4	-7.8	-16.3	-24.8	-18.7	-44.2	-69.7
550	-2.1	-7.6	-13.1	-4.9	-13.4	-21.9	-13.8	-39.3	-64.8
500	0.0	-5.0	-10.5	-1.8	-10.3	-18.8	-9.0	-34.5	-60.0
450	0.0	-2.0	-7.5	0.0	-7.0	-15.5	-4.2	-29.7	-55.2

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
7400							354.4		
7800							456.3		
8200				372.5			557.2		
8600	424.3			517.2			657.1	367.2	
9000	587.5			651.5			755.9	469.0	
9400	732.4			777.1	391.0		853.7	569.8	
9800	864.1	446.0		895.6	534.5		950.5	669.5	379.9
10200	985.6	606.4		1008.0	667.6		1046.5	768.2	481.6
10600		749.5			792.3	409.5		865.8	582.3
11000		879.8	467.2		909.9	551.6		962.5	681.9
11400		1000.2	625.2		1021.8	683.6		1058.7	780.4
11800			766.4			807.3			878.0
12200			895.3			924.2			974.6
12600			1014.8			1035.7			1070.6

1. **Enter Table 1 with dry snow depth and dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -340 ft/+340 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Dry Snow Takeoff
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-21	-14	-6	-19	-11	-4	-11	-4	0
950	-24	-17	-9	-22	-14	-7	-14	-7	0
900	-27	-19	-12	-24	-17	-9	-17	-9	-2
850	-29	-21	-14	-27	-19	-12	-20	-12	-5
800	-31	-24	-16	-29	-22	-14	-22	-15	-7
750	-33	-26	-18	-31	-24	-16	-25	-17	-10
700	-35	-28	-20	-33	-26	-18	-27	-19	-12
650	-37	-30	-22	-35	-28	-20	-29	-22	-14
600	-39	-32	-24	-37	-29	-22	-31	-23	-16
550	-41	-33	-26	-39	-31	-24	-33	-25	-18
500	-42	-35	-27	-40	-33	-25	-34	-27	-19
450	-44	-36	-29	-42	-34	-27	-36	-28	-21

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Wet Snow Takeoff

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-7.7	-13.7	-19.7	-26.3	-35.3	-44.3	-77.0	-98.0	-119.0
950	-7.1	-13.1	-19.1	-24.2	-33.2	-42.2	-70.7	-91.7	-112.7
900	-6.5	-12.5	-18.5	-22.0	-31.0	-40.0	-64.1	-85.1	-106.1
850	-5.9	-11.9	-17.9	-19.8	-28.8	-37.8	-57.3	-78.3	-99.3
800	-5.3	-11.3	-17.3	-17.4	-26.4	-35.4	-50.4	-71.4	-92.4
750	-4.7	-10.7	-16.7	-15.1	-24.1	-33.1	-43.2	-64.2	-85.2
700	-4.1	-10.1	-16.1	-12.6	-21.6	-30.6	-35.9	-56.9	-77.9
650	-3.5	-9.5	-15.5	-10.1	-19.1	-28.1	-28.3	-49.3	-70.3
600	-2.8	-8.8	-14.8	-7.5	-16.5	-25.5	-20.6	-41.6	-62.6
550	-2.2	-8.2	-14.2	-4.8	-13.8	-22.8	-12.6	-33.6	-54.6
500	-1.5	-7.5	-13.5	-2.1	-11.1	-20.1	-4.5	-25.5	-46.5
450	-0.9	-6.9	-12.9	0.0	-8.3	-17.3	0.0	-17.2	-38.2

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
6200				363.2			424.1		
6600	414.7			447.5			499.9		
7000	503.2			532.6			576.2		
7400	592.9			618.5			652.9	395.8	
7800	683.8	381.7		705.3	415.8		730.2	471.4	
8200	776.0	469.9		793.1	500.6		808.0	547.5	
8600	869.4	559.2		881.8	586.2		886.2	624.1	367.5
9000	964.2	649.6		971.5	672.7	384.3	965.0	701.2	443.0
9400	1060.2	741.3	436.7	1062.0	760.1	468.7	1044.3	778.7	518.9
9800		834.2	525.5		848.4	554.0		856.8	595.3
10200		928.5	615.6		937.8	640.1		935.4	672.2
10600		1024.0	706.8		1028.0	727.2		1014.6	749.6
11000			799.2			815.2			827.5
11400			893.0			904.2			905.9
11800			988.2			994.1			984.8
12200			1084.0			1084.7			1064.0

1. **Enter Table 1 with wet snow depth and dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -310 ft/+310 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Wet Snow Takeoff
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-14	-11	-9	-10	-8	-5	-3	0	0
950	-16	-13	-11	-12	-10	-7	-5	-2	0
900	-18	-15	-13	-15	-12	-10	-6	-4	-1
850	-20	-17	-15	-17	-14	-12	-8	-6	-3
800	-22	-19	-17	-18	-16	-13	-10	-8	-5
750	-23	-21	-18	-20	-18	-15	-12	-10	-7
700	-24	-22	-19	-22	-19	-17	-14	-12	-9
650	-26	-23	-21	-23	-21	-18	-17	-14	-12
600	-26	-24	-21	-24	-22	-19	-19	-16	-14
550	-27	-25	-22	-26	-23	-21	-21	-18	-16
500	-28	-25	-23	-27	-24	-22	-23	-21	-18
450	-28	-26	-23	-27	-25	-22	-26	-23	-21

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Wet Snow Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-15.5	-22.5	-29.5	-36.3	-47.3	-58.3	-88.4	-109.9	-131.4
950	-15.6	-22.6	-29.6	-34.4	-45.4	-56.4	-82.0	-103.5	-125.0
900	-15.3	-22.3	-29.3	-32.2	-43.2	-54.2	-75.2	-96.7	-118.2
850	-14.6	-21.6	-28.6	-29.5	-40.5	-51.5	-67.9	-89.4	-110.9
800	-13.5	-20.5	-27.5	-26.6	-37.6	-48.6	-60.4	-81.9	-103.4
750	-12.0	-19.0	-26.0	-23.2	-34.2	-45.2	-52.4	-73.9	-95.4
700	-10.2	-17.2	-24.2	-19.5	-30.5	-41.5	-44.0	-65.5	-87.0
650	-7.9	-14.9	-21.9	-15.4	-26.4	-37.4	-35.3	-56.8	-78.3
600	-5.3	-12.3	-19.3	-11.0	-22.0	-33.0	-26.1	-47.6	-69.1
550	-2.3	-9.3	-16.3	-6.2	-17.2	-28.2	-16.6	-38.1	-59.6
500	0.0	-5.9	-12.9	-1.0	-12.0	-23.0	-6.7	-28.2	-49.7
450	0.0	-2.1	-9.1	0.0	-6.4	-17.4	0.0	-17.9	-39.4

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
7400							382.2		
7800							484.1		
8200				418.7			583.1		
8600	440.6			555.5			679.3	369.3	
9000	600.2			682.4			773.0	471.5	
9400	742.2			801.2	400.8		864.4	570.8	
9800	871.4	419.1		913.2	539.0		953.6	667.4	356.5
10200	990.8	581.4		1019.9	667.0		1041.2	761.5	458.8
10600		725.2			786.7	382.8		853.1	558.6
11000		855.9	397.1		899.6	522.3		942.6	655.5
11400		976.3	562.2		1006.6	651.4		1030.2	749.8
11800		1091.5	708.1			772.1			841.8
12200			840.2			885.8			931.5
12600			961.8			993.5			1019.4
13000			1077.2			1098.8			

1. **Enter Table 1 with wet snow depth and dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -330 ft/+330 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Wet Snow Takeoff
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-21	-16	-11	-16	-11	-6	-7	-2	0
950	-23	-18	-13	-19	-14	-9	-9	-4	0
900	-26	-21	-16	-22	-17	-12	-11	-6	-1
850	-28	-23	-18	-24	-19	-14	-14	-9	-4
800	-31	-26	-21	-27	-22	-17	-17	-12	-7
750	-33	-28	-23	-29	-24	-19	-20	-15	-10
700	-35	-30	-25	-32	-27	-22	-23	-18	-13
650	-37	-32	-27	-34	-29	-24	-26	-21	-16
600	-39	-34	-29	-37	-32	-27	-30	-25	-20
550	-41	-36	-31	-39	-34	-29	-34	-29	-24
500	-43	-38	-33	-41	-36	-31	-38	-33	-28
450	-45	-40	-35	-44	-39	-34	-42	-37	-32

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slippery Runway Takeoff
2 Engine Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 LB)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	0.0	-1.5	-6.5	0.0	-1.5	-6.5	-29.1	-34.1	-39.1
950	0.0	-1.9	-6.9	0.0	-1.9	-6.9	-27.4	-32.4	-37.4
900	0.0	-2.4	-7.4	0.0	-2.4	-7.4	-25.5	-30.5	-35.5
850	0.0	-2.8	-7.8	0.0	-2.9	-7.9	-23.5	-28.5	-33.5
800	0.0	-3.2	-8.2	0.0	-3.3	-8.3	-21.2	-26.2	-31.2
750	0.0	-3.7	-8.7	0.0	-3.7	-8.7	-18.6	-23.6	-28.6
700	0.0	-4.1	-9.1	0.0	-4.2	-9.2	-15.9	-20.9	-25.9
650	0.0	-4.5	-9.5	0.0	-4.6	-9.6	-13.0	-18.0	-23.0
600	0.0	-5.0	-10.0	0.0	-5.0	-10.0	-9.8	-14.8	-19.8
550	-0.4	-5.4	-10.4	-0.3	-5.3	-10.3	-6.5	-11.5	-16.5
500	-0.8	-5.8	-10.8	-0.7	-5.7	-10.7	-2.9	-7.9	-12.9
450	-1.2	-6.2	-11.2	-1.1	-6.1	-11.1	0.0	-4.2	-9.2

ADVISORY INFORMATION

Slippery Runway Takeoff

2 Engine Reverse Thrust

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
6200	455.5								
6600	566.2			389.6					
7000	673.5			480.4					
7400	777.7	384.6		572.5					
7800	879.1	497.4		666.0					
8200	977.8	606.8		761.0	423.5				
8600	1075.0	712.9		857.5	514.7				
9000		816.0	427.3	955.7	607.4				
9400		916.4	538.9	1055.1	701.4	367.0	351.4		
9800		1014.3	647.0		797.0	457.5	393.3		
10200			751.9		894.2	549.3	435.4		
10600			854.0		993.0	642.5	478.3		
11000			953.3		1092.6	737.1	522.0	367.1	
11400			1050.7			833.3	566.7	409.1	
11800						931.0	612.5	451.4	
12200						1030.2	659.2	494.6	
12600							707.3	538.7	382.8
13000							756.5	583.7	424.8
13400							807.1	629.9	467.5
13800							859.3	677.1	511.0
14200							913.0	725.6	555.5
14600							968.6	775.3	600.9
15000							1025.8	826.5	647.5
15400								879.2	695.1
15800								933.6	744.1
16200								989.9	794.4
16600								1047.2	846.1
17000									899.4
17400									954.5
17800									1011.5

1. **Enter Table 1 with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -430 ft/+430 ft for every 10°C above/below 0°C.
Adjust "Medium" field length available by -430 ft/+430 ft for every 10°C above/below 0°C.
Adjust "Poor" field length available by -430 ft/+430 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-11	-9	-6	-16	-13	-11	-50	-47	-45
950	-13	-10	-8	-18	-16	-13	-52	-49	-47
900	-14	-11	-9	-20	-18	-15	-54	-51	-49
850	-15	-12	-10	-22	-19	-17	-55	-53	-50
800	-15	-13	-10	-24	-21	-19	-57	-54	-52
750	-16	-13	-11	-25	-22	-20	-58	-56	-53
700	-16	-13	-11	-26	-24	-21	-59	-57	-54
650	-16	-13	-11	-27	-25	-22	-60	-57	-55
600	-16	-13	-11	-28	-25	-23	-61	-58	-56
550	-15	-13	-10	-28	-26	-23	-61	-58	-56
500	-14	-12	-9	-29	-26	-24	-61	-58	-56
450	-13	-11	-8	-29	-26	-24	-61	-58	-56

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

Slippery Runway Takeoff

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	0.0	-1.6	-6.6	-2.3	-7.3	-12.3	-43.9	-48.9	-53.9
950	0.0	-2.1	-7.1	-3.6	-8.6	-13.6	-41.1	-46.1	-51.1
900	0.0	-2.5	-7.5	-4.6	-9.6	-14.6	-38.2	-43.2	-48.2
850	0.0	-2.9	-7.9	-5.2	-10.2	-15.2	-35.0	-40.0	-45.0
800	0.0	-3.3	-8.3	-5.4	-10.4	-15.4	-31.5	-36.5	-41.5
750	0.0	-3.8	-8.8	-5.1	-10.1	-15.1	-27.9	-32.9	-37.9
700	0.0	-4.2	-9.2	-4.5	-9.5	-14.5	-24.1	-29.1	-34.1
650	0.0	-4.6	-9.6	-3.4	-8.4	-13.4	-20.0	-25.0	-30.0
600	0.0	-5.0	-10.0	-1.9	-6.9	-11.9	-15.7	-20.7	-25.7
550	-0.3	-5.3	-10.3	0.0	-5.0	-10.0	-11.1	-16.1	-21.1
500	-0.7	-5.7	-10.7	0.0	-2.7	-7.7	-6.4	-11.4	-16.4
450	-1.1	-6.1	-11.1	0.0	0.0	-5.0	-1.4	-6.4	-11.4

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
7800	386.1								
8200	636.9								
8600	802.5								
9000	935.5			515.8					
9400	1051.8	499.2		684.4					
9800		704.4		831.0					
10200		855.2		962.4	393.4				
10600		980.2		1085.3	582.3				
11000		1094.8	586.6		741.5				
11400			765.0		881.8				
11800			904.3		1008.6	468.7			
12200			1023.2			644.7			
12600						796.0			
13000						930.7			
13400						1054.7			
18200							389.4		
18600							501.5		
19000							613.6		
19400							725.7		
19800							837.8	431.4	

1. **Enter Table 1 with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -480 ft/+480 ft for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -480 ft/+480 ft for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -480 ft/+480 ft for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

Slippery Runway Takeoff
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-18	-13	-8	-23	-18	-13	-72	-67	-62
950	-19	-14	-9	-26	-21	-16	-75	-70	-65
900	-20	-15	-10	-28	-23	-18	-77	-72	-67
850	-21	-16	-11	-31	-26	-21	-80	-75	-70
800	-22	-17	-12	-33	-28	-23	-82	-77	-72
750	-23	-18	-13	-35	-30	-25	-84	-79	-74
700	-24	-19	-14	-37	-32	-27	-85	-80	-75
650	-24	-19	-14	-39	-34	-29	-87	-82	-77
600	-24	-19	-14	-41	-36	-31	-88	-83	-78
550	-24	-19	-14	-42	-37	-32	-89	-84	-79
500	-24	-19	-14	-44	-39	-34	-90	-85	-80
450	-24	-19	-14	-45	-40	-35	-91	-86	-81

1. **Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

Takeoff %N1

Max Takeoff Thrust

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)												
	-2	-1	0	1	2	3	4	5	6	7	8	9	10
70	89.7	90.1	90.6	90.6	90.6	90.5	90.4	90.4	90.3	90.3	89.7	89.2	88.5
60	92.5	93	93.4	93.4	93.4	93.3	93.3	93.2	93.2	93.2	92.6	92	91.4
55	93.9	94.4	94.8	94.8	94.8	94.7	94.6	94.6	94.6	94.5	94	93.4	92.8
50	95.2	95.7	96.2	96.1	96.1	96	96	95.9	95.9	95.9	95.3	94.7	94.2
45	96.5	97	97.5	97.4	97.3	97.3	97.3	97.2	97.2	97.2	96.6	96	95.5
40	97.5	98.2	98.9	98.7	98.5	98.4	98.4	98.5	98.4	98.4	97.9	97.3	96.7
35	97.8	98.9	99.8	99.7	99.7	99.5	99.3	99.3	99.2	99.3	98.8	98.4	98
30	97.2	98.8	100.4	100.4	100.4	100.4	100.4	100.1	100	99.9	99.5	99.2	98.8
25	96.4	98	99.6	100.1	100.7	101.1	101.1	101.1	101.7	101.3	100.3	99.9	99.5
20	95.6	97.2	98.8	99.3	99.9	100.5	101.1	101.8	102.2	102.4	102.1	101.5	100.3
15	94.8	96.3	97.9	98.4	99	99.6	100.2	101	101.7	102.5	102.5	102.2	101.2
10	93.9	95.5	97.1	97.6	98.2	98.8	99.4	100.1	100.8	101.6	101.8	102	102.3
5	93.1	94.7	96.2	96.7	97.3	97.9	98.5	99.2	99.9	100.7	100.9	101.2	101.4
0	92.3	93.8	95.3	95.8	96.4	97	97.6	98.3	99.1	99.8	100	100.3	100.6
-10	90.6	92.1	93.6	94.1	94.6	95.2	95.9	96.6	97.3	98	98.3	98.5	98.8
-20	88.8	90.3	91.8	92.3	92.8	93.4	94.1	94.8	95.5	96.3	96.5	96.7	97
-30	87.0	88.5	89.9	90.4	91	91.6	92.3	93	93.7	94.4	94.7	94.9	95.2
-40	85.2	86.7	88.1	88.6	89.1	89.8	90.5	91.2	91.9	92.6	92.8	93.1	93.4
-50	83.4	84.8	86.2	86.7	87.3	87.9	88.6	89.3	90	90.7	91	91.2	91.5

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)			
	-2	0	9	10
PACKS OFF	0.5	0.6	0.6	0.7
ENGINE ANTI-ICE ON	0.0	0.0	0.0	-0.4
ENGINE AND WING ANTI-ICE ON	0.0	0.0	0.0	-0.4

TO1 Minimum Takeoff Weight
10% Thrust Reduction
Based on engine bleed for packs on and anti-ice off
Flaps 10
Weight Limit (1000 LB)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
45	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
40	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
35	404.8	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
30	418.8	404.4	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
25	419.4	410.1	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
20	419.9	410.6	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
15	420.3	411.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
10	420.6	411.3	402.3	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
0 & BELOW	421.0	411.6	402.6	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0

Flaps 20
Weight Limit (1000 LB)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
45	413.6	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
40	436.9	419.6	402.8	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
35	454.4	438.3	421.8	405.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
30	470.2	454.0	437.7	421.3	406.5	402.0	402.0	402.0	402.0	402.0	402.0
25	470.8	460.4	450.4	437.0	421.5	405.7	402.0	402.0	402.0	402.0	402.0
20	471.3	460.9	450.8	440.2	428.5	417.9	405.0	402.0	402.0	402.0	402.0
15	471.8	461.4	451.2	440.6	428.9	418.2	408.0	402.0	402.0	402.0	402.0
10	472.1	461.7	451.6	440.9	429.2	418.4	408.2	402.0	402.0	402.0	402.0
0 & BELOW	472.6	462.1	452.0	441.2	429.7	418.9	408.7	402.0	402.0	402.0	402.0

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability. For weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

TO1 Takeoff Speeds - Dry Runway
10%Thrust Reduction
Flaps 10
Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 10		
	V1	VR	V2
1000	174	185	196
950	169	180	192
900	164	174	187
850	158	168	182
800	152	162	177
750	147	156	172
700	140	149	166
650	133	142	160
600	125	135	154
550	117	127	148
500	108	120	142
450	99	111	135

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	14	15						7	8						-2	-2					
60	10	11	13	15				5	6	7	8				-1	-2	-2	-2			
50	6	7	9	11	13	16	18	3	4	5	7	8	9	10	-1	-1	-1	-2	-2	-2	-3
40	2	3	6	8	10	13	15	1	2	4	5	6	8	9	0	0	-1	-1	-1	-2	-2
30	0	0	2	5	8	10	13	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	1	3	5	8	10	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
10	0	0	2	3	5	7	8	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
0	0	0	2	3	5	7	9	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-20	0	0	2	3	5	7	9	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-40	1	1	2	4	6	8	9	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-60	1	1	3	4	6	8	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-6	-3	0	3	5	-4	-3	-1	0	1	1	2	3
950	-5	-3	0	2	5	-4	-2	-1	0	1	1	2	3
900	-5	-2	0	2	4	-4	-2	-1	0	1	1	2	3
850	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
800	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
750	-4	-2	0	2	3	-3	-2	-1	0	1	1	2	3
700	-3	-2	0	2	3	-3	-2	-1	0	1	1	2	3
650	-3	-1	0	2	3	-3	-2	-1	0	1	1	2	3
600	-3	-1	0	2	3	-3	-2	-1	0	1	1	2	3
550	-3	-1	0	1	3	-3	-2	-1	0	1	1	2	3
500	-2	-1	0	1	3	-3	-2	-1	0	1	2	2	3
450	-2	-1	0	1	2	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

TO1 Takeoff Speeds - Dry Runway

10%Thrust Reduction

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	116	120	114	118	113	116	111	114						
50	119	123	118	121	113	117	111	114	108	113	106	110	102	107
40	126	129	125	128	119	123	115	118	110	114	106	110	102	107
30	130	133	130	133	125	128	120	124	115	118	110	114	104	109
20	130	133	130	133	127	130	123	127	120	123	115	119	108	113
-60	132	133	131	133	128	130	125	127	121	124	117	121	113	116

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)						
	105	110	115	120	125	130	135
650	159	159	159	159	154	151	155
600	152	152	152	153	150	150	154
550	145	145	146	146	146	149	153
500	138	138	139	140	142	147	152
450	131	132	132	136	141	146	151

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 20		
	V1	VR	V2
1000	163	172	181
950	158	167	177
900	153	161	172
850	147	156	168
800	142	150	163
750	136	144	158
700	129	137	153
650	123	131	148
600	116	124	142
550	108	117	137
500	99	110	131
450	91	102	124

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

TO1 Takeoff Speeds - Dry Runway

10%Thrust Reduction

Flaps 20

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	14	15						7	8						-2	-2					
60	10	11	13	15				5	6	7	8				-1	-2	-2	-2			
50	6	7	9	11	13	16	18	3	4	5	7	8	9	10	-1	-1	-1	-2	-2	-2	-3
40	2	3	6	8	10	13	15	1	2	4	5	6	8	9	0	0	-1	-1	-1	-2	-2
30	0	0	2	5	8	10	13	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	1	3	5	8	10	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
10	0	0	2	3	5	7	8	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
0	0	0	2	3	5	7	9	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-20	0	0	2	3	5	7	9	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-40	1	1	2	4	6	8	9	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-60	1	1	3	4	6	8	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-6	-3	0	3	5	-4	-3	-1	0	1	1	2	3
950	-5	-3	0	2	5	-4	-2	-1	0	1	1	2	3
900	-5	-2	0	2	4	-4	-2	-1	0	1	1	2	3
850	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
800	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
750	-4	-2	0	2	3	-3	-2	-1	0	1	1	2	3
700	-3	-2	0	2	3	-3	-2	-1	0	1	1	2	3
650	-3	-1	0	2	3	-3	-2	-1	0	1	1	2	3
600	-3	-1	0	2	3	-3	-2	-1	0	1	1	2	3
550	-3	-1	0	1	3	-3	-2	-1	0	1	1	2	3
500	-2	-1	0	1	3	-3	-2	-1	0	1	2	2	3
450	-2	-1	0	1	2	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	116	120	114	118	113	116	111	114						
50	119	123	118	121	113	117	111	114	108	113	106	110	102	107
40	126	129	125	128	119	123	115	118	110	114	106	110	102	107
30	130	133	130	133	125	128	120	124	115	118	110	114	104	109
20	130	133	130	133	127	130	123	127	120	123	115	119	108	113
-60	132	133	131	133	128	130	125	127	121	124	117	121	113	116

TO1 Takeoff Speeds - Dry Runway
10%Thrust Reduction
Flaps 20
Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)						
	105	110	115	120	125	130	135
750	152	152	152	152	153	153	153
700	151	151	151	152	152	152	153
650	145	146	146	146	146	146	150
600	139	140	140	141	141	144	150
550	133	134	134	135	139	144	149
500	127	128	129	133	138	143	148
450	121	122	127	132	137	143	148

TO1 Takeoff Speeds - Wet Runway
10%Thrust Reduction
Flaps 10
Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 10		
	V1	VR	V2
1000	162	185	196
950	157	180	192
900	150	174	187
850	144	168	182
800	137	162	177
750	130	156	172
700	123	149	166
650	115	142	160
600	108	135	154
550	100	127	148
500	91	120	142
450	83	111	135

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	16	17						7	8						-2	-2					
60	11	12	15	17				5	6	7	8				-1	-2	-2	-2			
50	6	7	10	13	15	17	21	3	4	5	7	8	9	11	-1	-1	-1	-2	-2	-2	-3
40	2	2	5	8	11	14	17	1	2	3	5	6	8	9	-0	-0	-1	-1	-1	-2	-2
30	0	0	2	5	8	11	14	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	1	3	5	8	12	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
10	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
0	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-20	1	1	2	4	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-40	2	2	4	5	6	8	11	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-60	3	3	4	5	6	8	11	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-7	-3	0	4	8	-5	-3	-1	0	1	3	4	5
950	-7	-3	0	4	8	-5	-3	-1	0	1	3	4	5
900	-6	-3	0	4	7	-6	-3	-1	0	2	3	4	6
850	-6	-3	0	4	7	-6	-4	-1	0	2	3	5	6
800	-6	-2	0	4	7	-6	-4	-1	0	2	3	5	6
750	-5	-2	0	4	6	-6	-4	-1	0	2	4	5	6
700	-5	-2	0	3	6	-7	-4	-2	0	2	4	5	6
650	-4	-2	0	3	6	-7	-4	-2	0	2	4	5	7
600	-4	-2	0	3	5	-7	-4	-2	0	2	4	5	7
550	-4	-1	0	3	5	-7	-4	-2	0	2	4	5	7
500	-3	-1	0	3	5	-7	-4	-2	0	2	4	5	7
450	-3	-1	0	3	4	-7	-4	-2	0	2	4	6	7

***V1 not to exceed VR**

TO1 Takeoff Speeds - Wet Runway

10%Thrust Reduction

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	116	120	114	118	113	116	111	114						
50	119	123	118	121	113	117	111	114	108	113	106	110	102	107
40	126	129	125	128	119	123	115	118	110	114	106	110	102	107
30	130	133	130	133	125	128	120	124	115	118	110	114	104	109
20	130	133	130	133	127	130	123	127	120	123	115	119	108	113
-60	132	133	131	133	128	130	125	127	121	124	117	121	113	116

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)						
	105	110	115	120	125	130	135
650	159	159	159	159	154	151	155
600	152	152	152	153	150	150	154
550	145	145	146	146	146	149	153
500	138	138	139	140	142	147	152
450	131	132	132	136	141	146	151

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 20		
	V1	VR	V2
1000	151	172	181
950	146	167	177
900	140	161	172
850	134	156	168
800	127	150	163
750	121	144	158
700	114	137	153
650	107	131	148
600	100	124	142
550	92	117	137
500	84	110	131
450	75	102	124

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

TO1 Takeoff Speeds - Wet Runway

10%Thrust Reduction

Flaps 20

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	16	17						7	8						-2	-2					
60	11	12	15	17				5	6	7	8				-1	-2	-2	-2			
50	6	7	10	13	15	17	21	3	4	5	7	8	9	11	-1	-1	-1	-2	-2	-2	-3
40	2	2	5	8	11	14	17	1	2	3	5	6	8	9	-0	-0	-1	-1	-1	-2	-2
30	0	0	2	5	8	11	14	0	0	2	3	5	6	8	0	0	0	-1	-1	-1	-2
20	0	0	1	3	5	8	12	0	0	1	2	3	5	7	0	0	0	0	-1	-1	-1
10	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
0	0	0	2	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-20	1	1	2	4	5	7	10	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-40	2	2	4	5	6	8	11	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1
-60	3	3	4	5	6	8	11	0	0	1	2	3	4	6	0	0	0	0	0	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-7	-3	0	4	8	-5	-3	-1	0	1	3	4	5
950	-7	-3	0	4	8	-5	-3	-1	0	1	3	4	5
900	-6	-3	0	4	7	-6	-3	-1	0	2	3	4	6
850	-6	-3	0	4	7	-6	-4	-1	0	2	3	5	6
800	-6	-2	0	4	7	-6	-4	-1	0	2	3	5	6
750	-5	-2	0	4	6	-6	-4	-1	0	2	4	5	6
700	-5	-2	0	3	6	-7	-4	-2	0	2	4	5	6
650	-4	-2	0	3	6	-7	-4	-2	0	2	4	5	7
600	-4	-2	0	3	5	-7	-4	-2	0	2	4	5	7
550	-4	-1	0	3	5	-7	-4	-2	0	2	4	5	7
500	-3	-1	0	3	5	-7	-4	-2	0	2	4	5	7
450	-3	-1	0	3	4	-7	-4	-2	0	2	4	6	7

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
60	116	120	114	118	113	116	111	114						
50	119	123	118	121	113	117	111	114	108	113	106	110	102	107
40	126	129	125	128	119	123	115	118	110	114	106	110	102	107
30	130	133	130	133	125	128	120	124	115	118	110	114	104	109
20	130	133	130	133	127	130	123	127	120	123	115	119	108	113
-60	132	133	131	133	128	130	125	127	121	124	117	121	113	116

TO1 Takeoff Speeds - Wet Runway

10%Thrust Reduction

Flaps 20

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)						
	105	110	115	120	125	130	135
750	152	152	152	152	153	153	153
700	151	151	151	152	152	152	153
650	145	146	146	146	146	146	150
600	139	140	140	141	141	144	150
550	133	134	134	135	139	144	149
500	127	128	129	133	138	143	148
450	121	122	127	132	137	143	148

TO1 Maximum Allowable Clearway
10% Thrust Reduction

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
6000	700
8000	900
10000	1050
12000	1150
14000	1250
16000	1350

TO1 Clearway and Stopway V1 Adjustments
10% Thrust Reduction

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)									
	DRY RUNWAY					WET RUNWAY				
	100	120	140	160	180	100	120	140	160	180
1000	-6	-6	-6	-6	-3					
800	-5	-5	-6	-5	-2					
600	-3	-4	-5	-3	-2					
400	-1	-3	-4	-2	-1					
200	0	-1	-1	-1	0					
0	0	0	0	0	0	0	0	0	0	0
-200	1	1	1	1	1	1	1	1	1	1
-400	1	1	1	1	1	1	1	1	1	1
-600	1	1	1	1	1	1	1	1	1	1
-800	1	1	1	1	1	1	1	1	1	1
-1000	1	1	1	1	1	1	1	1	1	1

Use of clearway not allowed on wet runways.
V1 not to exceed VR.

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-17.2	-26.7	-36.2	-39.8	-57.3	-74.8	-90.7	-124.7	-158.7
950	-15.0	-24.5	-34.0	-35.1	-52.6	-70.1	-80.6	-114.6	-148.6
900	-12.7	-22.2	-31.7	-30.4	-47.9	-65.4	-70.7	-104.7	-138.7
850	-10.7	-20.2	-29.7	-26.0	-43.5	-61.0	-61.2	-95.2	-129.2
800	-8.9	-18.4	-27.9	-21.9	-39.4	-56.9	-52.2	-86.2	-120.2
750	-7.2	-16.7	-26.2	-18.1	-35.6	-53.1	-43.6	-77.6	-111.6
700	-5.7	-15.2	-24.7	-14.6	-32.1	-49.6	-35.5	-69.5	-103.5
650	-4.4	-13.9	-23.4	-11.4	-28.9	-46.4	-27.9	-61.9	-95.9
600	-3.3	-12.8	-22.3	-8.5	-26.0	-43.5	-20.6	-54.6	-88.6
550	-2.3	-11.8	-21.3	-5.8	-23.3	-40.8	-13.9	-47.9	-81.9
500	-1.6	-11.1	-20.6	-3.5	-21.0	-38.5	-7.6	-41.6	-75.6
450	-1.0	-10.5	-20.0	-1.4	-18.9	-36.4	-1.7	-35.7	-69.7

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
5800							366.2		
6200				366.8			443.6		
6600	398.7			448.9			522.5		
7000	484.6			533.0			602.8		
7400	573.3			619.8			684.8	385.5	
7800	665.1			709.3	387.2		768.5	463.2	
8200	760.1	420.0		801.8	469.7		854.1	542.4	
8600	858.8	506.6		897.6	554.5		941.4	623.2	
9000	961.4	596.0		996.9	641.9		1030.7	705.6	404.8
9400	1067.5	688.5	356.4	1098.3	732.2	407.7		789.7	482.9
9800		784.4	441.4		825.4	490.7		875.7	562.5
10200		884.0	528.7		922.0	576.2		963.5	643.7
10600		987.7	618.9		1022.1	664.3		1053.5	726.5
11000		1093.9	712.2			755.2			811.1
11400			809.0			849.3			897.5
11800			909.5			946.8			985.8
12200			1014.1			1047.4			1075.6

1. **Enter Table 1 with slush/standing water depth and TO1 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -460 ft/+460 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-19	-16	-14	-14	-11	-9	-2	0	0
950	-20	-18	-15	-16	-13	-11	-4	-2	0
900	-22	-19	-17	-17	-15	-12	-7	-4	-2
850	-23	-20	-18	-19	-16	-14	-9	-6	-4
800	-24	-21	-19	-20	-17	-15	-11	-8	-6
750	-24	-22	-19	-21	-18	-16	-13	-10	-8
700	-25	-22	-20	-22	-19	-17	-15	-12	-10
650	-25	-23	-20	-23	-20	-18	-16	-14	-11
600	-26	-23	-21	-23	-21	-18	-18	-15	-13
550	-26	-23	-21	-24	-21	-19	-19	-17	-14
500	-25	-23	-20	-24	-21	-19	-20	-18	-15
450	-25	-23	-20	-24	-21	-19	-22	-19	-17

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-26.5	-37.0	-47.5	-49.0	-67.0	-85.0	-101.2	-136.7	-172.2
950	-24.3	-34.8	-45.3	-44.4	-62.4	-80.4	-91.1	-126.6	-162.1
900	-22.1	-32.6	-43.1	-39.9	-57.9	-75.9	-81.1	-116.6	-152.1
850	-19.9	-30.4	-40.9	-35.5	-53.5	-71.5	-71.5	-107.0	-142.5
800	-17.6	-28.1	-38.6	-31.1	-49.1	-67.1	-62.0	-97.5	-133.0
750	-15.1	-25.6	-36.1	-26.6	-44.6	-62.6	-52.8	-88.3	-123.8
700	-12.6	-23.1	-33.6	-22.1	-40.1	-58.1	-43.8	-79.3	-114.8
650	-9.8	-20.3	-30.8	-17.6	-35.6	-53.6	-34.9	-70.4	-105.9
600	-7.0	-17.5	-28.0	-13.0	-31.0	-49.0	-26.3	-61.8	-97.3
550	-4.0	-14.5	-25.0	-8.3	-26.3	-44.3	-18.0	-53.5	-89.0
500	-0.8	-11.3	-21.8	-3.6	-21.6	-39.6	-9.8	-45.3	-80.8
450	0.0	-8.1	-18.6	0.0	-16.9	-34.9	-1.8	-37.3	-72.8

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
7800							449.6		
8200							563.4		
8600				417.8			674.7		
9000				569.7			783.6	391.6	
9400	515.4			711.5			890.1	506.8	
9800	691.4			844.8			994.5	619.3	
10200	846.6			970.9	495.1		1097.7	729.4	
10600	986.9	416.6		1092.6	641.8			837.1	449.6
11000		606.5			779.1			942.6	563.4
11400		771.1			908.7	417.8		1046.1	674.7
11800		918.4			1031.8	569.7			783.6
12200		1053.8	515.4			711.5			890.1
12600			691.4			844.8			994.5
13000			846.6			970.9			1097.7
13400			986.9			1092.6			

1. **Enter Table 1 with slush/standing water depth and TO1 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -540 ft/+540 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2)**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Slush/Standing Water Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-26	-21	-16	-20	-15	-10	-6	-1	0
950	-28	-23	-18	-22	-17	-12	-9	-4	0
900	-29	-24	-19	-24	-19	-14	-12	-7	-2
850	-31	-26	-21	-26	-21	-16	-15	-10	-5
800	-32	-27	-22	-28	-23	-18	-17	-12	-7
750	-34	-29	-24	-30	-25	-20	-20	-15	-10
700	-35	-30	-25	-31	-26	-21	-23	-18	-13
650	-36	-31	-26	-33	-28	-23	-26	-21	-16
600	-37	-32	-27	-35	-30	-25	-28	-23	-18
550	-38	-33	-28	-36	-31	-26	-31	-26	-21
500	-39	-34	-29	-37	-32	-27	-33	-28	-23
450	-39	-34	-29	-39	-34	-29	-36	-31	-26

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff
10% Thrust Reduction
2 Engine Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 LB)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-4.2	-11.2	-18.2	-14.6	-25.1	-35.6	-50.1	-77.1	-104.1
950	-3.9	-10.9	-17.9	-13.2	-23.7	-34.2	-44.9	-71.9	-98.9
900	-3.5	-10.5	-17.5	-11.8	-22.3	-32.8	-39.8	-66.8	-93.8
850	-3.2	-10.2	-17.2	-10.5	-21.0	-31.5	-35.0	-62.0	-89.0
800	-2.9	-9.9	-16.9	-9.3	-19.8	-30.3	-30.5	-57.5	-84.5
750	-2.7	-9.7	-16.7	-8.2	-18.7	-29.2	-26.4	-53.4	-80.4
700	-2.5	-9.5	-16.5	-7.2	-17.7	-28.2	-22.6	-49.6	-76.6
650	-2.3	-9.3	-16.3	-6.3	-16.8	-27.3	-19.1	-46.1	-73.1
600	-2.2	-9.2	-16.2	-5.5	-16.0	-26.5	-15.9	-42.9	-69.9
550	-2.2	-9.2	-16.2	-4.9	-15.4	-25.9	-13.1	-40.1	-67.1
500	-2.2	-9.2	-16.2	-4.3	-14.8	-25.3	-10.6	-37.6	-64.6
450	-2.2	-9.2	-16.2	-3.8	-14.3	-24.8	-8.4	-35.4	-62.4

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
5800							414.1		
6200	409.0			435.3			494.2		
6600	501.8			525.0			575.5		
7000	595.7			615.8			657.8	404.2	
7400	691.0	397.5		707.9	424.2		741.3	484.2	
7800	787.6	490.1		801.2	513.7		826.1	565.2	
8200	885.6	583.9		895.9	604.4		912.3	647.4	394.2
8600	985.1	679.0	386.0	992.0	696.3	413.0	999.8	730.8	474.1
9000	1085.3	775.4	478.5	1088.6	789.5	502.4	1087.8	815.5	555.0
9400		873.3	572.1		884.0	593.0		901.4	637.1
9800		972.6	667.1		979.9	684.7		988.8	720.3
10200		1072.8	763.3		1076.5	777.8		1076.7	804.8
10600			861.0			872.1			890.6
11000			960.1			967.8			977.8
11400			1060.2			1064.6			1065.7

1. **Enter Table 1 with dry snow depth and TO1 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -320 ft/+320 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-12	-9	-7	-10	-7	-5	-2	0	0
950	-15	-12	-10	-12	-10	-7	-5	-3	0
900	-17	-15	-12	-15	-12	-10	-8	-5	-3
850	-19	-17	-14	-17	-14	-12	-10	-8	-5
800	-21	-19	-16	-19	-17	-14	-13	-10	-8
750	-23	-20	-18	-21	-18	-16	-15	-12	-10
700	-24	-22	-19	-22	-20	-17	-16	-14	-11
650	-26	-23	-21	-24	-21	-19	-18	-15	-13
600	-27	-24	-22	-25	-22	-20	-19	-16	-14
550	-27	-25	-22	-25	-23	-20	-20	-17	-15
500	-28	-25	-23	-26	-23	-21	-20	-18	-15
450	-28	-25	-23	-26	-23	-21	-21	-18	-16

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-9.1	-14.6	-20.1	-21.3	-29.8	-38.3	-58.2	-83.7	-109.2
950	-9.5	-15.0	-20.5	-20.3	-28.8	-37.3	-53.3	-78.8	-104.3
900	-9.9	-15.4	-20.9	-19.4	-27.9	-36.4	-48.6	-74.1	-99.6
850	-10.1	-15.6	-21.1	-18.3	-26.8	-35.3	-43.9	-69.4	-94.9
800	-9.9	-15.4	-20.9	-17.0	-25.5	-34.0	-39.3	-64.8	-90.3
750	-9.4	-14.9	-20.4	-15.3	-23.8	-32.3	-34.5	-60.0	-85.5
700	-8.4	-13.9	-19.4	-13.5	-22.0	-30.5	-29.8	-55.3	-80.8
650	-7.1	-12.6	-18.1	-11.3	-19.8	-28.3	-25.1	-50.6	-76.1
600	-5.4	-10.9	-16.4	-8.9	-17.4	-25.9	-20.3	-45.8	-71.3
550	-3.4	-8.9	-14.4	-6.3	-14.8	-23.3	-15.6	-41.1	-66.6
500	-0.9	-6.4	-11.9	-3.3	-11.8	-20.3	-10.8	-36.3	-61.8
450	0.0	-3.6	-9.1	-0.1	-8.6	-17.1	-6.0	-31.5	-57.0

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
7000							381.1		
7400							489.8		
7800				430.8			596.8		
8200	501.2			579.4			702.1	394.7	
8600	663.1			716.4			805.8	503.3	
9000	807.5			844.2	450.1		908.0	610.0	
9400	938.8	522.6		964.3	597.1		1008.6	715.1	408.4
9800	1061.3	682.0		1079.4	732.8			818.7	516.7
10200		824.5	364.3		859.6	469.2		920.6	623.3
10600		954.3	543.7		978.8	614.6		1021.2	728.2
11000		1076.5	700.7		1093.7	749.1			831.5
11400			841.4			874.8			933.3
11800			969.8			993.2			1033.7
12200			1091.5						

1. **Enter Table 1 with dry snow depth and TO1 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -340 ft/+340 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Dry Snow Takeoff
10% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-18	-10	-3	-15	-8	0	-6	0	0
950	-21	-13	-6	-18	-11	-3	-10	-2	0
900	-24	-16	-9	-21	-13	-6	-13	-5	0
850	-26	-19	-11	-24	-16	-9	-16	-8	-1
800	-29	-21	-14	-26	-19	-11	-19	-11	-4
750	-31	-24	-16	-29	-21	-14	-21	-14	-6
700	-34	-26	-19	-31	-24	-16	-24	-16	-9
650	-36	-28	-21	-33	-26	-18	-26	-19	-11
600	-38	-30	-23	-35	-28	-20	-29	-21	-14
550	-40	-32	-25	-37	-30	-22	-31	-23	-16
500	-42	-34	-27	-39	-32	-24	-33	-25	-18
450	-43	-36	-28	-41	-33	-26	-34	-27	-19

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff
10% Thrust Reduction
2 Engine Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 LB)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-7.6	-13.6	-19.6	-26.1	-35.1	-44.1	-76.7	-97.7	-118.7
950	-7.0	-13.0	-19.0	-24.0	-33.0	-42.0	-70.4	-91.4	-112.4
900	-6.4	-12.4	-18.4	-21.9	-30.9	-39.9	-64.4	-85.4	-106.4
850	-5.9	-11.9	-17.9	-19.9	-28.9	-37.9	-58.3	-79.3	-100.3
800	-5.3	-11.3	-17.3	-17.9	-26.9	-35.9	-52.0	-73.0	-94.0
750	-4.8	-10.8	-16.8	-15.7	-24.7	-33.7	-45.4	-66.4	-87.4
700	-4.2	-10.2	-16.2	-13.4	-22.4	-31.4	-38.5	-59.5	-80.5
650	-3.6	-9.6	-15.6	-11.0	-20.0	-29.0	-31.3	-52.3	-73.3
600	-3.0	-9.0	-15.0	-8.5	-17.5	-26.5	-23.9	-44.9	-65.9
550	-2.4	-8.4	-14.4	-6.0	-15.0	-24.0	-16.2	-37.2	-58.2
500	-1.8	-7.8	-13.8	-3.3	-12.3	-21.3	-8.3	-29.3	-50.3
450	-1.1	-7.1	-13.1	-0.5	-9.5	-18.5	-0.1	-21.1	-42.1

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
5800				352.3			414.3		
6200	408.1			441.2			494.2		
6600	501.1			530.5			574.3		
7000	595.0			620.5			654.7	384.5	
7400	690.0	373.3		711.2	407.8		735.4	464.2	
7800	786.0	466.0		802.6	496.9		816.4	544.2	
8200	883.2	559.6		894.9	586.6		897.7	624.5	354.6
8600	981.6	654.2		987.9	677.1	374.5	979.3	705.1	434.3
9000	1080.5	749.9	431.2	1081.1	768.3	463.4	1061.1	786.0	514.2
9400		846.7	524.4		860.2	552.9		867.2	594.4
9800		944.5	618.7		952.9	643.1		948.7	674.9
10200		1043.4	713.9		1046.3	734.0		1030.4	755.6
10600			810.2			825.6			836.7
11000			907.7			918.0			918.1
11400			1006.4			1011.3			999.8
11800									1081.6

1. **Enter Table 1 with wet snow depth and TO1 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -310 ft/+310 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff
10% Thrust Reduction
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-11	-9	-6	-8	-5	-3	-1	0	0
950	-14	-11	-9	-10	-8	-5	-2	0	0
900	-16	-14	-11	-12	-10	-7	-4	-2	0
850	-18	-16	-13	-14	-12	-9	-6	-3	-1
800	-20	-18	-15	-17	-14	-12	-8	-5	-3
750	-22	-20	-17	-18	-16	-13	-10	-7	-5
700	-24	-21	-19	-20	-18	-15	-12	-10	-7
650	-25	-23	-20	-22	-20	-17	-14	-12	-9
600	-27	-24	-22	-24	-21	-19	-17	-14	-12
550	-28	-25	-23	-25	-23	-20	-20	-17	-15
500	-28	-26	-23	-27	-24	-22	-22	-20	-17
450	-29	-26	-24	-28	-25	-23	-25	-23	-20

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-13.1	-20.1	-27.1	-34.2	-45.2	-56.2	-86.8	-108.3	-129.8
950	-13.3	-20.3	-27.3	-32.5	-43.5	-54.5	-80.5	-102.0	-123.5
900	-13.5	-20.5	-27.5	-30.8	-41.8	-52.8	-74.5	-96.0	-117.5
850	-13.5	-20.5	-27.5	-28.9	-39.9	-50.9	-68.3	-89.8	-111.3
800	-13.0	-20.0	-27.0	-26.7	-37.7	-48.7	-61.7	-83.2	-104.7
750	-12.1	-19.1	-26.1	-23.9	-34.9	-45.9	-54.5	-76.0	-97.5
700	-10.8	-17.8	-24.8	-20.8	-31.8	-42.8	-46.9	-68.4	-89.9
650	-8.9	-15.9	-22.9	-17.1	-28.1	-39.1	-38.7	-60.2	-81.7
600	-6.7	-13.7	-20.7	-13.1	-24.1	-35.1	-30.1	-51.6	-73.1
550	-4.0	-11.0	-18.0	-8.6	-19.6	-30.6	-21.0	-42.5	-64.0
500	-0.8	-7.8	-14.8	-3.7	-14.7	-25.7	-11.4	-32.9	-54.4
450	0.0	-4.2	-11.2	0.0	-9.3	-20.3	-1.4	-22.9	-44.4

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
7000							398.7		
7400							508.5		
7800				463.5			614.0		
8200	504.8			605.6			715.8	384.7	
8600	665.5			736.3			814.1	495.0	
9000	808.2			858.0	444.8		909.3	601.0	
9400	937.7	483.1		972.0	588.5		1001.6	703.3	370.7
9800	1058.0	646.5		1081.4	720.5			802.0	481.4
10200		791.2			843.2	425.9		897.6	588.0
10600		922.1	461.0		958.1	571.2		990.1	690.7
11000		1043.2	627.3		1067.7	704.6		1080.9	789.9
11400			774.0			828.4			885.9
11800			906.3			944.1			978.7
12200			1028.2			1054.0			1069.5

1. **Enter Table 1 with wet snow depth and TO1 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -330 ft/+330 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Wet Snow Takeoff
10% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-17	-12	-7	-13	-8	-3	-4	0	0
950	-20	-15	-10	-15	-10	-5	-6	-1	0
900	-22	-17	-12	-18	-13	-8	-8	-3	0
850	-25	-20	-15	-21	-16	-11	-11	-6	-1
800	-28	-23	-18	-24	-19	-14	-13	-8	-3
750	-30	-25	-20	-26	-21	-16	-16	-11	-6
700	-33	-28	-23	-29	-24	-19	-19	-14	-9
650	-35	-30	-25	-32	-27	-22	-23	-18	-13
600	-38	-33	-28	-35	-30	-25	-27	-22	-17
550	-40	-35	-30	-38	-33	-28	-31	-26	-21
500	-42	-37	-32	-40	-35	-30	-36	-31	-26
450	-44	-39	-34	-43	-38	-33	-41	-36	-31

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	0.0	-1.2	-6.2	0.0	-1.1	-6.1	-28.3	-33.3	-38.3
950	0.0	-1.6	-6.6	0.0	-1.6	-6.6	-26.7	-31.7	-36.7
900	0.0	-2.1	-7.1	0.0	-2.1	-7.1	-25.1	-30.1	-35.1
850	0.0	-2.5	-7.5	0.0	-2.6	-7.6	-23.3	-28.3	-33.3
800	0.0	-3.0	-8.0	0.0	-3.0	-8.0	-21.3	-26.3	-31.3
750	0.0	-3.4	-8.4	0.0	-3.5	-8.5	-19.1	-24.1	-29.1
700	0.0	-3.8	-8.8	0.0	-3.9	-8.9	-16.7	-21.7	-26.7
650	0.0	-4.2	-9.2	0.0	-4.3	-9.3	-14.0	-19.0	-24.0
600	0.0	-4.7	-9.7	0.0	-4.7	-9.7	-11.0	-16.0	-21.0
550	-0.1	-5.1	-10.1	-0.1	-5.1	-10.1	-7.8	-12.8	-17.8
500	-0.5	-5.5	-10.5	-0.5	-5.5	-10.5	-4.4	-9.4	-14.4
450	-0.9	-5.9	-10.9	-0.8	-5.8	-10.8	-0.7	-5.7	-10.7

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

2 Engine Reverse Thrust

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
5400	357.9								
5800	474.4								
6200	587.8			407.5					
6600	697.7			501.4					
7000	804.3	401.5		596.7					
7400	908.0	517.3		693.5					
7800	1009.9	629.4		792.7	442.6				
8200		738.0		893.8	536.9				
8600		843.6	445.4	996.7	632.8				
9000		946.4	559.8		730.4	384.2	370.5		
9400		1047.9	670.5		830.4	477.8	414.1		
9800			777.9		932.2	572.7	458.8		
10200			882.4		1035.7	669.1	504.4		
10600			984.6			767.7	551.1	386.8	
11000			1085.8			868.4	598.8	430.8	
11400						970.8	647.9	475.8	
11800						1074.5	698.6	521.8	359.5
12200							750.8	568.8	403.2
12600							804.5	617.0	447.5
13000							859.9	666.8	492.9
13400							917.5	718.0	539.3
13800							977.4	770.8	586.8
14200							1039.0	825.1	635.4
14600								881.2	685.8
15000								939.7	737.6
15400								1000.5	791.0
15800									845.9
16200									902.8
16600									962.2
17000									1023.6

1. Enter Table 1 with reported braking action and TO1 dry field/obstacle limit weight to obtain slippery runway weight adjustment.
2. Adjust "Good" field length available by -430 ft/+430 ft for every 10°C above/below 0°C.
Adjust "Medium" field length available by -430 ft/+430 ft for every 10°C above/below 0°C.
Adjust "Poor" field length available by -430 ft/+430 ft for every 10°C above/below 0°C.
3. Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).
4. Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
10% Thrust Reduction
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-11	-9	-6	-16	-13	-11	-47	-45	-42
950	-13	-10	-8	-18	-15	-13	-49	-47	-44
900	-14	-11	-9	-20	-17	-15	-51	-49	-46
850	-14	-12	-9	-21	-19	-16	-53	-50	-48
800	-15	-12	-10	-23	-20	-18	-54	-52	-49
750	-15	-13	-10	-24	-21	-19	-55	-53	-50
700	-16	-13	-11	-25	-23	-20	-56	-54	-51
650	-15	-13	-10	-26	-23	-21	-57	-54	-52
600	-15	-13	-10	-27	-24	-22	-57	-55	-52
550	-15	-12	-10	-27	-25	-22	-58	-55	-53
500	-14	-12	-9	-27	-25	-22	-58	-55	-53
450	-13	-11	-8	-27	-25	-22	-57	-55	-52

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff

10% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO1 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	0.0	-1.3	-6.3	0.0	-4.8	-9.8	-43.0	-48.0	-53.0
950	0.0	-1.8	-6.8	-1.3	-6.3	-11.3	-40.3	-45.3	-50.3
900	0.0	-2.2	-7.2	-2.8	-7.8	-12.8	-37.7	-42.7	-47.7
850	0.0	-2.7	-7.7	-3.9	-8.9	-13.9	-34.9	-39.9	-44.9
800	0.0	-3.1	-8.1	-4.6	-9.6	-14.6	-31.9	-36.9	-41.9
750	0.0	-3.5	-8.5	-4.8	-9.8	-14.8	-28.6	-33.6	-38.6
700	0.0	-3.9	-8.9	-4.6	-9.6	-14.6	-25.0	-30.0	-35.0
650	0.0	-4.3	-9.3	-3.9	-8.9	-13.9	-21.2	-26.2	-31.2
600	0.0	-4.7	-9.7	-2.7	-7.7	-12.7	-17.1	-22.1	-27.1
550	-0.1	-5.1	-10.1	-1.1	-6.1	-11.1	-12.8	-17.8	-22.8
500	-0.5	-5.5	-10.5	0.0	-4.1	-9.1	-8.2	-13.2	-18.2
450	-0.9	-5.9	-10.9	0.0	-1.6	-6.6	-3.3	-8.3	-13.3

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
7400	585.2								
7800	768.6								
8200	911.0			479.0					
8600	1031.5	417.7		656.3					
9000		661.2		808.4					
9400		825.4		943.4					
9800		958.1		1067.3	549.4				
10200		1075.2	526.8		715.7				
10600			727.9		860.9				
11000			878.0		990.3	428.4			
11400			1002.2			614.9			
11800						772.2			
12200						911.2			
12600						1036.4			
17800							380.2		
18200							481.7		
18600							583.2		
19000							683.8		
19400							784.1	418.2	
19800							884.4	519.7	

1. **Enter Table 1 with reported braking action and TO1 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -480 ft/+480 ft for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -480 ft/+480 ft for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -480 ft/+480 ft for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO1 Slippery Runway Takeoff
10% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-16	-11	-6	-22	-17	-12	-70	-65	-60
950	-18	-13	-8	-25	-20	-15	-73	-68	-63
900	-19	-14	-9	-27	-22	-17	-75	-70	-65
850	-20	-15	-10	-29	-24	-19	-77	-72	-67
800	-21	-16	-11	-31	-26	-21	-79	-74	-69
750	-22	-17	-12	-33	-28	-23	-81	-76	-71
700	-22	-17	-12	-35	-30	-25	-83	-78	-73
650	-23	-18	-13	-37	-32	-27	-84	-79	-74
600	-23	-18	-13	-39	-34	-29	-86	-81	-76
550	-23	-18	-13	-41	-36	-31	-87	-82	-77
500	-23	-18	-13	-42	-37	-32	-88	-83	-78
450	-22	-17	-12	-43	-38	-33	-89	-84	-79

1. **Obtain V1, VR and V2 for the actual weight using the TO1 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

TO1 Takeoff %N1

10% Thrust Reduction

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)												
	-2	-1	0	1	2	3	4	5	6	7	8	9	10
70	86.0	86.5	86.9	86.9	86.8	86.8	86.7	86.6	86.6	86.6	86.1	85.9	86.0
60	88.7	89.1	89.6	89.6	89.5	89.5	89.4	89.3	89.3	89.3	88.8	88.2	87.6
55	90.0	90.5	90.9	90.9	90.9	90.8	90.7	90.7	90.7	90.6	90.1	89.5	89.0
50	91.3	91.8	92.2	92.1	92.1	92.1	92.0	92.0	92.0	91.9	91.4	90.8	90.3
45	92.6	93.1	93.5	93.4	93.4	93.3	93.3	93.2	93.2	93.2	92.7	92.1	91.5
40	93.5	94.3	94.9	94.7	94.5	94.5	94.5	94.5	94.4	94.4	93.9	93.4	92.8
35	93.9	94.8	95.6	95.5	95.5	95.3	95.2	95.1	95.1	95.1	94.8	94.4	94.0
30	93.3	94.7	96.1	96.0	96.0	96.0	96.0	95.8	95.7	95.6	95.3	95.0	94.7
25	92.5	93.9	95.3	95.7	96.2	96.5	96.6	96.6	97.0	96.7	95.9	95.5	95.2
20	91.7	93.1	94.5	94.9	95.4	95.9	96.3	96.8	97.0	97.1	97.0	96.6	95.7
15	90.9	92.3	93.6	94.1	94.6	95.1	95.5	96.0	96.4	96.9	96.9	96.7	96.1
10	90.1	91.5	92.8	93.3	93.8	94.3	94.7	95.1	95.6	96.0	96.2	96.3	96.5
5	89.3	90.7	92.0	92.5	93.0	93.4	93.8	94.3	94.7	95.2	95.3	95.5	95.6
0	88.5	89.9	91.2	91.6	92.1	92.6	93.0	93.4	93.9	94.3	94.5	94.6	94.8
-10	86.9	88.2	89.5	89.9	90.4	90.9	91.3	91.8	92.2	92.6	92.8	92.9	93.1
-20	85.2	86.5	87.8	88.2	88.7	89.2	89.6	90.0	90.5	90.9	91.1	91.2	91.4
-30	83.5	84.8	86.0	86.4	86.9	87.4	87.9	88.3	88.7	89.2	89.3	89.5	89.6
-40	81.8	83.0	84.2	84.7	85.1	85.7	86.1	86.5	87.0	87.4	87.6	87.7	87.9
-50	80.0	81.2	82.4	82.9	83.4	83.9	84.3	84.7	85.2	85.6	85.7	85.9	86.1

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)			
	-2	0	9	10
PACKS OFF	0.5	0.6	0.6	0.7
ENGINE ANTI-ICE ON	0.0	0.0	0.0	-0.4
ENGINE AND WING ANTI-ICE ON	0.0	0.0	0.0	-0.4

TO2 Minimum Takeoff Weight

20% Thrust Reduction

Based on engine bleed for packs on and anti-ice off

Flaps 10

Weight Limit (1000 LB)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
45	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
40	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
35	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
30	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
25	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
20	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
15	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
10	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
0 & BELOW	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0

Flaps 20

Weight Limit (1000 LB)

OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	S.L & BELOW	1	2	3	4	5	6	7	8	9	10
50	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
45	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
40	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
35	406.3	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
30	419.7	404.4	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
25	420.3	409.8	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
20	420.7	410.3	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
15	421.2	410.7	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
10	421.5	411.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0
0 & BELOW	422.1	411.5	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0	402.0

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability.

TO2 Takeoff Speeds - Dry Runway

20% Thrust Reduction

Flaps 10

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 10		
	V1	VR	V2
950	175	183	191
900	169	177	186
850	163	171	182
800	158	165	177
750	152	158	171
700	145	151	166
650	137	144	160
600	130	137	154
550	122	129	148
500	113	121	141
450	103	113	134

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	10	12						5	6						-2	-2					
60	9	10	12	15				4	5	7	8				-1	-1	-2	-2			
50	5	6	8	11	13	15	18	3	4	5	6	7	9	10	-1	-1	-1	-2	-2	-2	-2
40	1	2	5	8	10	12	15	1	1	3	4	6	7	8	-0	-1	-1	-1	-1	-2	-2
30	0	0	3	5	8	10	13	0	0	1	3	4	6	7	0	0	-0	-1	-1	-1	-2
20	0	0	2	3	5	7	11	0	0	1	2	3	4	6	0	0	-0	-0	-1	-1	-1
10	0	0	2	3	5	7	8	0	0	1	2	3	4	5	0	0	-0	-0	-1	-1	-1
-40	0	0	2	3	5	7	9	0	0	1	2	3	4	5	0	0	-0	-0	-1	-1	-1
-60	1	1	2	3	5	7	9	0	0	1	2	3	4	5	0	0	-0	-0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-5	-3	0	3	5	-4	-2	-1	0	1	2	2	3
950	-5	-2	0	2	5	-3	-2	-1	0	1	2	2	3
900	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
850	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	2
800	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	2
750	-3	-1	0	2	3	-2	-2	-1	0	1	1	2	2
700	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	2
650	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	2
600	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	3
550	-2	-1	0	2	3	-2	-1	-1	0	1	2	2	3
500	-2	-1	0	2	3	-3	-2	-1	0	1	2	2	3
450	-2	-1	0	2	3	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

TO2 Takeoff Speeds - Dry Runway

20% Thrust Reduction

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
70	110	113	108	111										
60	110	113	108	111	106	110	104	108						
50	113	116	111	114	107	110	104	108	102	106	100	104	97	101
40	119	122	118	121	113	116	108	112	104	108	100	104	97	101
30	122	125	122	125	117	121	113	116	108	112	103	107	98	102
20	123	125	122	125	119	123	116	119	112	116	108	112	102	106
-60	124	126	124	125	121	123	118	120	114	117	111	114	107	110

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)						
	100	105	110	115	120	125	130
550	145	145	145	146	146	146	149
500	138	138	139	139	139	143	148
450	131	132	132	133	137	142	147

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 20		
	V1	VR	V2
850	152	158	167
800	147	152	163
750	141	146	158
700	134	140	152
650	127	133	147
600	120	126	142
550	112	119	136
500	103	112	130
450	94	104	124

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	10	12						5	6						-2	-2					
60	9	10	12	15				4	5	7	8				-1	-1	-2	-2			
50	5	6	8	11	13	15	18	3	4	5	6	7	9	10	-1	-1	-1	-2	-2	-2	-2
40	1	2	5	8	10	12	15	1	1	3	4	6	7	8	-0	-1	-1	-1	-1	-2	-2
30	0	0	3	5	8	10	13	0	0	1	3	4	6	7	0	0	-0	-1	-1	-1	-2
20	0	0	2	3	5	7	11	0	0	1	2	3	4	6	0	0	-0	-0	-1	-1	-1
10	0	0	2	3	5	7	8	0	0	1	2	3	4	5	0	0	-0	-0	-1	-1	-1
-40	0	0	2	3	5	7	9	0	0	1	2	3	4	5	0	0	-0	-0	-1	-1	-1
-60	1	1	2	3	5	7	9	0	0	1	2	3	4	5	0	0	-0	-0	-1	-1	-1

***V1 not to exceed VR**

TO2 Takeoff Speeds - Dry Runway

20% Thrust Reduction

Flaps 20

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-5	-3	0	3	5	-4	-2	-1	0	1	2	2	3
950	-5	-2	0	2	5	-3	-2	-1	0	1	2	2	3
900	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	3
850	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	2
800	-4	-2	0	2	4	-3	-2	-1	0	1	1	2	2
750	-3	-1	0	2	3	-2	-2	-1	0	1	1	2	2
700	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	2
650	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	2
600	-3	-1	0	2	3	-2	-1	-1	0	1	1	2	3
550	-2	-1	0	2	3	-2	-1	-1	0	1	2	2	3
500	-2	-1	0	2	3	-3	-2	-1	0	1	2	2	3
450	-2	-1	0	2	3	-3	-2	-1	0	1	2	2	3

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
70	110	113	108	111										
60	110	113	108	111	106	110	104	108						
50	113	116	111	114	107	110	104	108	102	106	100	104	97	101
40	119	122	118	121	113	116	108	112	104	108	100	104	97	101
30	122	125	122	125	117	121	113	116	108	112	103	107	98	102
20	123	125	122	125	119	123	116	119	112	116	108	112	102	106
-60	124	126	124	125	121	123	118	120	114	117	111	114	107	110

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)						
	100	105	110	115	120	125	130
650	145	145	146	146	146	147	148
600	139	139	140	140	141	141	145
550	133	134	134	134	135	139	144
500	127	128	128	129	133	138	143
450	121	121	123	127	132	137	142

TO2 Takeoff Speeds - Wet Runway

20%Thrust Reduction

Flaps 10

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 10		
	V1	VR	V2
950	164	183	191
900	157	177	186
850	150	171	182
800	143	165	177
750	137	158	171
700	129	151	166
650	121	144	160
600	113	137	154
550	105	129	148
500	97	121	141
450	88	113	134

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	11	12						5	6						-2	-2					
60	10	11	13	15				4	5	7	8				-1	-1	-2	-2			
50	6	7	9	11	14	16	19	3	4	5	6	7	9	10	-1	-1	-1	-2	-2	-2	-2
40	1	2	5	7	10	12	16	1	1	3	4	6	7	8	0	-1	-1	-1	-1	-2	-2
30	0	0	2	4	7	10	13	0	0	1	3	4	6	7	0	0	0	-1	-1	-1	-2
20	0	0	1	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	-1	-1	-1
10	0	0	2	3	5	7	8	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1
0	0	0	2	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1
-20	1	1	2	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1
-40	2	2	3	4	6	8	10	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1
-60	3	3	4	5	7	9	11	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-6	-3	0	5	8	-4	-3	-1	0	1	3	4	5
950	-6	-3	0	4	8	-4	-3	-1	0	1	3	4	5
900	-6	-3	0	4	7	-5	-3	-1	0	1	3	4	5
850	-6	-3	0	4	7	-5	-3	-1	0	1	3	4	5
800	-6	-3	0	4	7	-6	-3	-1	0	1	3	4	5
750	-6	-2	0	3	6	-6	-4	-2	0	1	3	4	5
700	-5	-2	0	3	6	-6	-4	-2	0	1	3	4	6
650	-5	-2	0	3	6	-6	-4	-2	0	2	3	4	6
600	-4	-2	0	3	5	-6	-4	-2	0	2	3	5	6
550	-4	-2	0	3	5	-7	-4	-2	0	2	4	5	6
500	-3	-1	0	3	5	-7	-4	-2	0	2	4	5	7
450	-3	-1	0	3	5	-7	-4	-2	0	2	4	5	7

***V1 not to exceed VR**

TO2 Takeoff Speeds - Wet Runway

20%Thrust Reduction

Flaps 10

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
70	110	113	108	111										
60	110	113	108	111	106	110	104	108						
50	113	116	111	114	107	110	104	108	102	106	100	104	97	101
40	119	122	118	121	113	116	108	112	104	108	100	104	97	101
30	122	125	122	125	117	121	113	116	108	112	103	107	98	102
20	123	125	122	125	119	123	116	119	112	116	108	112	102	106
-60	124	126	124	125	121	123	118	120	114	117	111	114	107	110

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)						
	100	105	110	115	120	125	130
550	145	145	145	146	146	146	149
500	138	138	139	139	139	143	148
450	131	132	132	133	137	142	147

Flaps 20

Table 1 of 5: V1, VR, V2 (KIAS)

WEIGHT (1000 LB)	FLAPS 20		
	V1	VR	V2
850	139	158	167
800	133	152	163
750	127	146	158
700	120	140	152
650	112	133	147
600	105	126	142
550	97	119	136
500	89	112	130
450	80	104	124

Check V1(MCG), Minimum VR, V2 for Minimum VR and Minimum Takeoff Weight.

Table 2 of 5: V1, VR, V2 Adjustments (KIAS)*

TEMP (°C)	V1							VR							V2						
	PRESS ALT (1000 FT)							PRESS ALT (1000 FT)							PRESS ALT (1000 FT)						
	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10	-2	0	2	4	6	8	10
70	11	12						5	6						-2	-2					
60	10	11	13	15				4	5	7	8				-1	-1	-2	-2			
50	6	7	9	11	14	16	19	3	4	5	6	7	9	10	-1	-1	-1	-2	-2	-2	-2
40	1	2	5	7	10	12	16	1	1	3	4	6	7	8	0	-1	-1	-1	-1	-2	-2
30	0	0	2	4	7	10	13	0	0	1	3	4	6	7	0	0	0	-1	-1	-1	-2
20	0	0	1	3	5	7	10	0	0	1	2	3	4	6	0	0	0	0	-1	-1	-1
10	0	0	2	3	5	7	8	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1
0	0	0	2	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1
-20	1	1	2	3	5	7	9	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1
-40	2	2	3	4	6	8	10	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1
-60	3	3	4	5	7	9	11	0	0	1	2	3	4	5	0	0	0	0	-1	-1	-1

***V1 not to exceed VR**

TO2 Takeoff Speeds - Wet Runway
20%Thrust Reduction
Flaps 20
Table 3 of 5: Slope and Wind V1 Adjustments (KIAS)*

WEIGHT (1000 LB)	SLOPE (%)					WIND (KTS)							
	-2	-1	0	1	2	-15	-10	-5	0	10	20	30	40
1000	-6	-3	0	5	8	-4	-3	-1	0	1	3	4	5
950	-6	-3	0	4	8	-4	-3	-1	0	1	3	4	5
900	-6	-3	0	4	7	-5	-3	-1	0	1	3	4	5
850	-6	-3	0	4	7	-5	-3	-1	0	1	3	4	5
800	-6	-3	0	4	7	-6	-3	-1	0	1	3	4	5
750	-6	-2	0	3	6	-6	-4	-2	0	1	3	4	5
700	-5	-2	0	3	6	-6	-4	-2	0	1	3	4	6
650	-5	-2	0	3	6	-6	-4	-2	0	2	3	4	6
600	-4	-2	0	3	5	-6	-4	-2	0	2	3	5	6
550	-4	-2	0	3	5	-7	-4	-2	0	2	4	5	6
500	-3	-1	0	3	5	-7	-4	-2	0	2	4	5	7
450	-3	-1	0	3	5	-7	-4	-2	0	2	4	5	7

***V1 not to exceed VR**

Table 4 of 5: V1(MCG), Minimum VR (KIAS)

TEMP (°C)	PRESSURE ALTITUDE (FT)													
	-2000		0		2000		4000		6000		8000		10000	
	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR	V1 (MCG)	Min VR
70	110	113	108	111										
60	110	113	108	111	106	110	104	108						
50	113	116	111	114	107	110	104	108	102	106	100	104	97	101
40	119	122	118	121	113	116	108	112	104	108	100	104	97	101
30	122	125	122	125	117	121	113	116	108	112	103	107	98	102
20	123	125	122	125	119	123	116	119	112	116	108	112	102	106
-60	124	126	124	125	121	123	118	120	114	117	111	114	107	110

Table 5 of 5: V2 for Minimum VR (KIAS)

WEIGHT (1000 LB)	Min VR (KIAS)						
	100	105	110	115	120	125	130
650	145	145	146	146	146	147	148
600	139	139	140	140	141	141	145
550	133	134	134	134	135	139	144
500	127	128	128	129	133	138	143
450	121	121	123	127	132	137	142

TO2 Maximum Allowable Clearway
20% Thrust Reduction

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
6000	750
8000	950
10000	1100
12000	1200
14000	1300
16000	1400

TO2 Clearway and Stopway V1 Adjustments

20% Thrust Reduction

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)									
	DRY RUNWAY					WET RUNWAY				
	100	120	140	160	180	100	120	140	160	180
1000	-3	-3	-3	-3	-3					
800	-3	-3	-3	-3	-3					
600	-3	-3	-3	-3	-3					
400	-1	-1	-1	-1	-1					
200	0	0	0	0	0					
0	0	0	0	0	0	0	0	0	0	0
-200	1	1	1	1	1	1	1	1	1	1
-400	1	1	1	1	1	1	1	1	1	1
-600	1	1	1	1	1	1	1	1	1	1
-800	1	1	1	1	1	1	1	1	1	1
-1000	1	1	1	1	1	1	1	1	1	1

Use of clearway not allowed on wet runways.
V1 not to exceed VR.

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-18.9	-28.4	-37.9	-42.9	-60.4	-77.9	-96.7	-130.7	-164.7
950	-16.6	-26.1	-35.6	-38.2	-55.7	-73.2	-86.5	-120.5	-154.5
900	-14.4	-23.9	-33.4	-33.4	-50.9	-68.4	-76.4	-110.4	-144.4
850	-12.1	-21.6	-31.1	-28.7	-46.2	-63.7	-66.5	-100.5	-134.5
800	-10.1	-19.6	-29.1	-24.2	-41.7	-59.2	-57.0	-91.0	-125.0
750	-8.2	-17.7	-27.2	-20.2	-37.7	-55.2	-48.1	-82.1	-116.1
700	-6.5	-16.0	-25.5	-16.4	-33.9	-51.4	-39.6	-73.6	-107.6
650	-5.1	-14.6	-24.1	-13.0	-30.5	-48.0	-31.6	-65.6	-99.6
600	-3.8	-13.3	-22.8	-9.8	-27.3	-44.8	-24.0	-58.0	-92.0
550	-2.7	-12.2	-21.7	-7.0	-24.5	-42.0	-17.0	-51.0	-85.0
500	-1.8	-11.3	-20.8	-4.5	-22.0	-39.5	-10.4	-44.4	-78.4
450	-1.1	-10.6	-20.1	-2.2	-19.7	-37.2	-4.3	-38.3	-72.3

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
5400							357.4		
5800				364.2			441.1		
6200	403.3			453.3			526.7		
6600	497.1			545.2			614.4		
7000	594.5			640.5			704.2	378.2	
7400	696.0			739.4	386.4		796.5	462.4	
7800	801.9	426.4		842.4	476.0		891.2	548.4	
8200	912.8	521.1		949.9	568.7		988.7	636.7	
8600	1028.9	619.5		1061.5	664.9		1088.2	727.1	399.1
9000		722.1	357.2		764.9	408.5		820.0	483.7
9400		829.2	449.7		868.9	498.8		915.4	570.3
9800		941.4	545.3		977.6	592.4		1013.5	659.0
10200		1058.4	644.8		1089.7	689.5			750.1
10600			748.4			790.5			843.6
11000			856.7			895.6			939.7
11400			970.3			1005.5			1038.4
11800			1088.0						

1. **Enter Table 1 with slush/standing water depth and TO2 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -460 ft/+460 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
20% Thrust Reduction
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-16	-14	-11	-11	-8	-6	0	0	0
950	-18	-16	-13	-13	-10	-8	0	0	0
900	-20	-17	-15	-14	-12	-9	-2	0	0
850	-21	-18	-16	-16	-14	-11	-5	-2	0
800	-22	-19	-17	-18	-15	-13	-7	-5	-2
750	-23	-20	-18	-19	-16	-14	-10	-7	-5
700	-23	-21	-18	-20	-17	-15	-12	-9	-7
650	-24	-21	-19	-21	-18	-16	-14	-11	-9
600	-24	-22	-19	-21	-19	-16	-15	-13	-10
550	-24	-22	-19	-22	-19	-17	-17	-14	-12
500	-24	-21	-19	-22	-20	-17	-18	-16	-13
450	-24	-21	-19	-22	-20	-17	-19	-17	-14

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 LB)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-27.1	-37.6	-48.1	-50.9	-68.9	-86.9	-106.3	-141.8	-177.3
950	-24.9	-35.4	-45.9	-46.3	-64.3	-82.3	-96.1	-131.6	-167.1
900	-22.7	-33.2	-43.7	-41.7	-59.7	-77.7	-85.9	-121.4	-156.9
850	-20.5	-31.0	-41.5	-37.2	-55.2	-73.2	-76.0	-111.5	-147.0
800	-18.4	-28.9	-39.4	-32.9	-50.9	-68.9	-66.4	-101.9	-137.4
750	-16.1	-26.6	-37.1	-28.5	-46.5	-64.5	-57.0	-92.5	-128.0
700	-13.7	-24.2	-34.7	-24.2	-42.2	-60.2	-47.9	-83.4	-118.9
650	-11.2	-21.7	-32.2	-19.7	-37.7	-55.7	-39.0	-74.5	-110.0
600	-8.4	-18.9	-29.4	-15.1	-33.1	-51.1	-30.3	-65.8	-101.3
550	-5.6	-16.1	-26.6	-10.6	-28.6	-46.6	-21.9	-57.4	-92.9
500	-2.5	-13.0	-23.5	-5.9	-23.9	-41.9	-13.4	-48.9	-84.4
450	0.0	-9.8	-20.3	-1.2	-19.2	-37.2	-5.4	-40.9	-76.4

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
7000							376.2		
7400							505.3		
7800				359.4			634.0		
8200				540.9			762.4		
8600	516.5			712.3			890.7	440.6	
9000	729.9			875.4			1019.2	569.5	
9400	919.2			1032.6	451.2			698.2	
9800	1094.8	396.2			627.8			826.6	376.2
10200		627.3			795.0			955.1	505.3
10600		827.2			954.7	359.4		1084.2	634.0
11000		1007.3				540.9			762.4
11400			516.5			712.3			890.7
11800			729.9			875.4			1019.2
12200			919.2			1032.6			
12600			1094.8						

1. **Enter Table 1 with slush/standing water depth and TO2 dry field/obstacle limit weight to obtain slush/standing water weight adjustment.**
2. **Adjust field length available by -540 ft/+540 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slush/standing water limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slush/Standing Water Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-22	-17	-12	-15	-10	-5	0	0	0
950	-24	-19	-14	-18	-13	-8	-2	0	0
900	-26	-21	-16	-20	-15	-10	-6	-1	0
850	-28	-23	-18	-22	-17	-12	-9	-4	0
800	-29	-24	-19	-24	-19	-14	-12	-7	-2
750	-31	-26	-21	-26	-21	-16	-15	-10	-5
700	-32	-27	-22	-28	-23	-18	-18	-13	-8
650	-34	-29	-24	-30	-25	-20	-21	-16	-11
600	-35	-30	-25	-32	-27	-22	-25	-20	-15
550	-36	-31	-26	-33	-28	-23	-28	-23	-18
500	-37	-32	-27	-35	-30	-25	-30	-25	-20
450	-38	-33	-28	-36	-31	-26	-33	-28	-23

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-4.4	-11.4	-18.4	-15.3	-25.8	-36.3	-53.2	-80.2	-107.2
950	-4.0	-11.0	-18.0	-13.9	-24.4	-34.9	-47.9	-74.9	-101.9
900	-3.6	-10.6	-17.6	-12.5	-23.0	-33.5	-42.7	-69.7	-96.7
850	-3.3	-10.3	-17.3	-11.0	-21.5	-32.0	-37.5	-64.5	-91.5
800	-2.9	-9.9	-16.9	-9.7	-20.2	-30.7	-32.6	-59.6	-86.6
750	-2.6	-9.6	-16.6	-8.5	-19.0	-29.5	-28.1	-55.1	-82.1
700	-2.4	-9.4	-16.4	-7.5	-18.0	-28.5	-24.0	-51.0	-78.0
650	-2.2	-9.2	-16.2	-6.5	-17.0	-27.5	-20.2	-47.2	-74.2
600	-2.1	-9.1	-16.1	-5.6	-16.1	-26.6	-16.8	-43.8	-70.8
550	-2.0	-9.0	-16.0	-4.8	-15.3	-25.8	-13.7	-40.7	-67.7
500	-2.0	-9.0	-16.0	-4.2	-14.7	-25.2	-11.0	-38.0	-65.0
450	-2.0	-9.0	-16.0	-3.7	-14.2	-24.7	-8.7	-35.7	-62.7

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
5400							400.8		
5800	397.2			423.9			483.9		
6200	493.2			516.7			568.0		
6600	590.3			610.6			653.1	390.5	
7000	688.6	385.2		705.6	412.4		739.2	473.5	
7400	788.1	481.1		801.7	505.0		826.6	557.4	
7800	888.9	578.1		899.1	598.8		915.2	642.3	380.2
8200	991.0	676.2	373.2	997.7	693.6	400.8	1005.1	728.4	463.0
8600	1093.7	775.6	469.1	1096.8	789.6	493.4		815.6	546.8
9000		876.2	565.9		886.8	587.0		904.0	631.7
9400		978.2	663.9		985.3	681.7		993.8	717.6
9800		1080.9	763.1		1084.4	777.6		1084.0	804.6
10200			863.6			874.6			892.9
10600			965.4			973.0			982.5
11000			1068.1			1072.1			1072.5

1. **Enter Table 1 with dry snow depth and TO2 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -320 ft/+320 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-9	-6	-4	-6	-4	-1	0	0	0
950	-12	-9	-7	-9	-7	-4	-2	0	0
900	-15	-12	-10	-12	-10	-7	-4	-2	0
850	-17	-14	-12	-15	-12	-10	-7	-5	-2
800	-19	-17	-14	-17	-14	-12	-10	-7	-5
750	-21	-19	-16	-19	-16	-14	-12	-9	-7
700	-23	-20	-18	-20	-18	-15	-14	-11	-9
650	-24	-22	-19	-22	-19	-17	-15	-13	-10
600	-25	-23	-20	-23	-20	-18	-17	-14	-12
550	-26	-23	-21	-24	-21	-19	-18	-15	-13
500	-26	-24	-21	-24	-22	-19	-18	-16	-13
450	-26	-24	-21	-24	-22	-19	-19	-16	-14

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 LB)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-7.6	-13.1	-18.6	-20.7	-29.2	-37.7	-59.9	-85.4	-110.9
950	-8.0	-13.5	-19.0	-19.7	-28.2	-36.7	-55.0	-80.5	-106.0
900	-8.4	-13.9	-19.4	-18.8	-27.3	-35.8	-50.2	-75.7	-101.2
850	-8.9	-14.4	-19.9	-17.8	-26.3	-34.8	-45.4	-70.9	-96.4
800	-9.2	-14.7	-20.2	-16.8	-25.3	-33.8	-40.8	-66.3	-91.8
750	-9.1	-14.6	-20.1	-15.5	-24.0	-32.5	-36.1	-61.6	-87.1
700	-8.5	-14.0	-19.5	-14.0	-22.5	-31.0	-31.5	-57.0	-82.5
650	-7.6	-13.1	-18.6	-12.1	-20.6	-29.1	-26.8	-52.3	-77.8
600	-6.2	-11.7	-17.2	-9.9	-18.4	-26.9	-22.1	-47.6	-73.1
550	-4.5	-10.0	-15.5	-7.5	-16.0	-24.5	-17.3	-42.8	-68.3
500	-2.3	-7.8	-13.3	-4.7	-13.2	-21.7	-12.6	-38.1	-63.6
450	0.0	-5.2	-10.7	-1.7	-10.2	-18.7	-7.8	-33.3	-58.8

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
6600							398.9		
7000							513.7		
7400	369.0			473.0			625.9		
7800	555.6			624.6			735.6	413.3	
8200	717.1			763.6			843.0	527.8	
8600	860.9	393.6		892.7	492.7		948.1	639.8	
9000	991.4	577.1		1013.5	642.7		1051.4	749.2	427.7
9400		736.0			780.3			856.3	541.9
9800		877.9	418.1		908.2	512.2		961.1	653.5
10200		1007.1	598.1		1028.2	660.5		1064.2	762.7
10600			754.7			796.9			869.5
11000			894.7			923.6			974.1
11400			1022.7			1043.0			1077.0

1. **Enter Table 1 with dry snow depth and TO2 dry field/obstacle limit weight to obtain dry snow weight adjustment.**
2. **Adjust field length available by -340 ft/+340 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable dry snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Dry Snow Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	DRY SNOW DEPTH								
	1.18 INCHES (30 mm)			2.36 INCHES (60 mm)			5.12 INCHES (130 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-13	-6	0	-10	-3	0	-1	0	0
950	-17	-9	-2	-14	-6	0	-4	0	0
900	-20	-12	-5	-17	-9	-2	-8	0	0
850	-23	-15	-8	-20	-12	-5	-11	-4	0
800	-25	-18	-10	-23	-15	-8	-14	-7	0
750	-28	-21	-13	-25	-18	-10	-17	-10	-2
700	-31	-23	-16	-28	-20	-13	-20	-13	-5
650	-33	-26	-18	-30	-23	-15	-23	-15	-8
600	-35	-28	-20	-33	-25	-18	-25	-18	-10
550	-37	-30	-22	-35	-27	-20	-27	-20	-12
500	-39	-32	-24	-37	-29	-22	-29	-22	-14
450	-41	-33	-26	-38	-31	-23	-31	-24	-16

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-7.6	-13.6	-19.6	-26.4	-35.4	-44.4	-77.9	-98.9	-119.9
950	-7.0	-13.0	-19.0	-24.3	-33.3	-42.3	-71.6	-92.6	-113.6
900	-6.5	-12.5	-18.5	-22.2	-31.2	-40.2	-65.3	-86.3	-107.3
850	-5.9	-11.9	-17.9	-20.1	-29.1	-38.1	-59.2	-80.2	-101.2
800	-5.4	-11.4	-17.4	-18.2	-27.2	-36.2	-53.4	-74.4	-95.4
750	-4.8	-10.8	-16.8	-16.2	-25.2	-34.2	-47.4	-68.4	-89.4
700	-4.3	-10.3	-16.3	-14.1	-23.1	-32.1	-41.0	-62.0	-83.0
650	-3.7	-9.7	-15.7	-11.9	-20.9	-29.9	-34.2	-55.2	-76.2
600	-3.2	-9.2	-15.2	-9.6	-18.6	-27.6	-27.1	-48.1	-69.1
550	-2.6	-8.6	-14.6	-7.1	-16.1	-25.1	-19.7	-40.7	-61.7
500	-1.9	-7.9	-13.9	-4.5	-13.5	-22.5	-12.0	-33.0	-54.0
450	-1.3	-7.3	-13.3	-1.8	-10.8	-19.8	-4.0	-25.0	-46.0

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
5400							398.4		
5800	393.6			427.3			481.7		
6200	490.1			520.0			564.9		
6600	587.3			613.1			648.2	367.3	
7000	685.4	357.3		706.8	392.5		731.5	450.4	
7400	784.2	453.8		800.9	485.1		814.9	533.6	
7800	884.0	550.8		895.6	578.1		898.4	616.9	
8200	984.7	648.5		990.9	671.6	357.7	982.0	700.2	419.2
8600	1085.8	747.1	417.6	1086.2	765.6	450.4	1065.5	783.6	502.4
9000		846.6	514.4		860.1	543.2		867.1	585.7
9400		946.9	611.8		955.1	636.6		950.6	669.0
9800		1047.9	710.0		1050.5	730.3		1034.2	752.4
10200			809.1			824.6			835.8
10600			909.1			919.4			919.2
11000			1009.9			1014.8			1002.9

1. **Enter Table 1 with wet snow depth and TO2 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -310 ft/+310 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff
20% Thrust Reduction
2 Engine Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-8	-6	-3	-5	-2	0	0	0	0
950	-11	-8	-6	-7	-5	-2	0	0	0
900	-13	-11	-8	-9	-7	-4	-2	0	0
850	-16	-13	-11	-12	-9	-7	-3	-1	0
800	-18	-15	-13	-14	-11	-9	-5	-3	0
750	-20	-18	-15	-16	-13	-11	-7	-5	-2
700	-22	-19	-17	-18	-16	-13	-9	-7	-4
650	-24	-21	-19	-20	-18	-15	-12	-9	-7
600	-25	-23	-20	-22	-19	-17	-14	-12	-9
550	-26	-24	-21	-24	-21	-19	-17	-15	-12
500	-27	-25	-22	-25	-23	-20	-20	-18	-15
450	-28	-25	-23	-27	-24	-22	-24	-21	-19

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-11.3	-18.3	-25.3	-33.1	-44.1	-55.1	-86.8	-108.3	-129.8
950	-11.5	-18.5	-25.5	-31.3	-42.3	-53.3	-80.5	-102.0	-123.5
900	-11.7	-18.7	-25.7	-29.6	-40.6	-51.6	-74.2	-95.7	-117.2
850	-11.9	-18.9	-25.9	-27.8	-38.8	-49.8	-68.2	-89.7	-111.2
800	-12.0	-19.0	-26.0	-26.2	-37.2	-48.2	-62.4	-83.9	-105.4
750	-11.7	-18.7	-25.7	-24.1	-35.1	-46.1	-56.1	-77.6	-99.1
700	-10.9	-17.9	-24.9	-21.6	-32.6	-43.6	-49.3	-70.8	-92.3
650	-9.6	-16.6	-23.6	-18.5	-29.5	-40.5	-41.8	-63.3	-84.8
600	-7.8	-14.8	-21.8	-14.9	-25.9	-36.9	-33.8	-55.3	-76.8
550	-5.4	-12.4	-19.4	-10.8	-21.8	-32.8	-25.1	-46.6	-68.1
500	-2.6	-9.6	-16.6	-6.2	-17.2	-28.2	-16.0	-37.5	-59.0
450	0.0	-6.2	-13.2	-1.1	-12.1	-23.1	-6.2	-27.7	-49.2

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
6600							408.6		
7000							525.0		
7400	361.2			494.7			635.9		
7800	548.9			640.8			741.9	393.5	
8200	710.4			774.1			843.4	510.7	
8600	853.4			897.4	475.3		940.8	622.2	
9000	982.6	527.0		1012.4	623.2		1034.8	728.8	378.5
9400		691.4			758.0			830.9	496.3
9800		836.4			882.5	455.6		928.9	608.5
10200		967.1	504.6		998.4	605.4		1023.4	715.7
10600		1089.5	672.0			741.8			818.4
11000			819.2			867.5			916.9
11400			951.5			984.4			1011.7
11800			1074.5			1096.4			

1. **Enter Table 1 with wet snow depth and TO2 dry field/obstacle limit weight to obtain wet snow weight adjustment.**
2. **Adjust field length available by -330 ft/+330 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable wet snow limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Wet Snow Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	WET SNOW DEPTH								
	0.20 INCHES (5 mm)			0.50 INCHES (13 mm)			1.18 INCHES (30 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-13	-8	-3	-9	-4	0	-1	0	0
950	-16	-11	-6	-11	-6	-1	-3	0	0
900	-18	-13	-8	-14	-9	-4	-5	0	0
850	-21	-16	-11	-17	-12	-7	-7	-2	0
800	-24	-19	-14	-20	-15	-10	-9	-4	0
750	-27	-22	-17	-22	-17	-12	-12	-7	-2
700	-29	-24	-19	-25	-20	-15	-15	-10	-5
650	-32	-27	-22	-28	-23	-18	-19	-14	-9
600	-35	-30	-25	-32	-27	-22	-23	-18	-13
550	-37	-32	-27	-35	-30	-25	-28	-23	-18
500	-40	-35	-30	-38	-33	-28	-33	-28	-23
450	-42	-37	-32	-41	-36	-31	-38	-33	-28

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
20% Thrust Reduction
2 Engine Reverse Thrust
Table 1 of 3: Weight Adjustment (1000 LB)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	0.0	-0.9	-5.9	0.0	-0.8	-5.8	-28.2	-33.2	-38.2
950	0.0	-1.3	-6.3	0.0	-1.3	-6.3	-26.6	-31.6	-36.6
900	0.0	-1.8	-6.8	0.0	-1.7	-6.7	-24.9	-29.9	-34.9
850	0.0	-2.2	-7.2	0.0	-2.2	-7.2	-23.3	-28.3	-33.3
800	0.0	-2.7	-7.7	0.0	-2.7	-7.7	-21.6	-26.6	-31.6
750	0.0	-3.1	-8.1	0.0	-3.2	-8.2	-19.7	-24.7	-29.7
700	0.0	-3.5	-8.5	0.0	-3.6	-8.6	-17.4	-22.4	-27.4
650	0.0	-4.0	-9.0	0.0	-4.0	-9.0	-14.9	-19.9	-24.9
600	0.0	-4.4	-9.4	0.0	-4.4	-9.4	-12.2	-17.2	-22.2
550	0.0	-4.8	-9.8	0.0	-4.8	-9.8	-9.2	-14.2	-19.2
500	-0.2	-5.2	-10.2	-0.2	-5.2	-10.2	-5.9	-10.9	-15.9
450	-0.7	-5.7	-10.7	-0.6	-5.6	-10.6	-2.3	-7.3	-12.3

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
5000	357.2								
5400	477.0								
5800	594.0			412.7					
6200	707.2			509.8					
6600	817.1	401.8		608.3					
7000	923.8	521.3		708.5	352.6				
7400	1029.8	636.9		812.5	448.9				
7800		748.8		918.4	546.5				
8200		857.4	447.1	1026.0	645.7				
8600		963.8	565.1		747.2	388.7	384.7		
9000		1069.5	679.3		852.0	485.4	430.7		
9400			789.9		958.6	583.5	478.2		
9800			897.4		1066.8	683.3	526.7	356.2	
10200			1003.5			786.3	576.5	401.8	
10600						891.7	627.5	448.4	
11000						999.1	680.9	496.2	
11400							736.0	545.3	373.3
11800							792.8	595.5	419.0
12200							851.5	647.3	466.2
12600							912.8	701.4	514.5
13000							977.2	757.1	563.9
13400							1043.4	814.6	614.7
13800								874.0	667.4
14200								936.7	722.1
14600								1002.0	778.4
15000									836.6
15400									897.0
15800									960.9
16200									1026.9

1. **Enter Table 1 with reported braking action and TO2 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -430 ft/+430 ft for every 10°C above/below 0°C.
   Adjust "Medium" field length available by -430 ft/+430 ft for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -430 ft/+430 ft for every 10°C above/below 0°C.**
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

2 Engine Reverse Thrust

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-11	-8	-6	-14	-12	-9	-43	-41	-38
950	-12	-9	-7	-16	-14	-11	-45	-43	-40
900	-13	-10	-8	-18	-16	-13	-47	-45	-42
850	-13	-11	-8	-20	-17	-15	-49	-46	-44
800	-14	-11	-9	-21	-19	-16	-50	-47	-45
750	-14	-12	-9	-22	-20	-17	-51	-48	-46
700	-14	-12	-9	-23	-21	-18	-52	-49	-47
650	-14	-12	-9	-24	-22	-19	-52	-50	-47
600	-14	-12	-9	-25	-22	-20	-53	-50	-48
550	-14	-11	-9	-25	-23	-20	-53	-51	-48
500	-13	-11	-8	-25	-23	-20	-53	-51	-48
450	-12	-10	-7	-25	-23	-20	-53	-50	-48

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff

20% Thrust Reduction

No Reverse Thrust

Table 1 of 3: Weight Adjustment (1000 LB)

TO2 DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	0.0	-1.0	-6.0	0.0	-2.6	-7.6	-43.1	-48.1	-53.1
950	0.0	-1.5	-6.5	0.0	-4.2	-9.2	-40.4	-45.4	-50.4
900	0.0	-1.9	-6.9	-0.7	-5.7	-10.7	-37.8	-42.8	-47.8
850	0.0	-2.4	-7.4	-2.2	-7.2	-12.2	-35.1	-40.1	-45.1
800	0.0	-2.8	-7.8	-3.4	-8.4	-13.4	-32.4	-37.4	-42.4
750	0.0	-3.2	-8.2	-4.2	-9.2	-14.2	-29.3	-34.3	-39.3
700	0.0	-3.6	-8.6	-4.4	-9.4	-14.4	-26.0	-31.0	-36.0
650	0.0	-4.0	-9.0	-4.1	-9.1	-14.1	-22.4	-27.4	-32.4
600	0.0	-4.4	-9.4	-3.4	-8.4	-13.4	-18.6	-23.6	-28.6
550	0.0	-4.8	-9.8	-2.1	-7.1	-12.1	-14.4	-19.4	-24.4
500	-0.2	-5.2	-10.2	-0.3	-5.3	-10.3	-10.0	-15.0	-20.0
450	-0.6	-5.6	-10.6	0.0	-3.1	-8.1	-5.3	-10.3	-15.3

Table 2 of 3: V1(MCG) Limit Weight (1000 LB)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
6600	464.7								
7000	693.6								
7400	854.3			392.0					
7800	984.7			589.0					
8200		565.2		751.7					
8600		758.6		894.7					
9000		906.2		1021.2	471.6				
9400		1028.9	378.3		652.8				
9800			645.9		807.2				
10200			817.6		943.4				
10600			954.5		1067.3	544.1			
11000			1073.2			713.1			
11400						860.5			
11800						990.4			
17400							357.8		
17800							451.2		
18200							544.7		
18600							637.6		
19000							729.1	392.8	
19400							820.7	486.3	
19800							912.2	579.7	

1. **Enter Table 1 with reported braking action and TO2 dry field/obstacle limit weight to obtain slippery runway weight adjustment.**
2. **Adjust "Good" field length available by -480 ft/+480 ft for every 10°C above/below 0°C.**
   Adjust "Medium" field length available by -480 ft/+480 ft for every 10°C above/below 0°C.
   Adjust "Poor" field length available by -480 ft/+480 ft for every 10°C above/below 0°C.
3. **Find V1(MCG) limit weight for adjusted field length and pressure altitude (Table 2).**
4. **Max allowable slippery runway limited weight is lesser of weights from Table 1 and Table 2.**

ADVISORY INFORMATION

TO2 Slippery Runway Takeoff
20% Thrust Reduction
No Reverse Thrust
Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 LB)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	5000	10000	S.L.	5000	10000	S.L.	5000	10000
1000	-15	-10	-5	-20	-15	-10	-65	-60	-55
950	-16	-11	-6	-22	-17	-12	-68	-63	-58
900	-17	-12	-7	-25	-20	-15	-70	-65	-60
850	-18	-13	-8	-27	-22	-17	-72	-67	-62
800	-19	-14	-9	-29	-24	-19	-74	-69	-64
750	-20	-15	-10	-31	-26	-21	-76	-71	-66
700	-20	-15	-10	-33	-28	-23	-77	-72	-67
650	-20	-15	-10	-34	-29	-24	-79	-74	-69
600	-21	-16	-11	-36	-31	-26	-80	-75	-70
550	-21	-16	-11	-37	-32	-27	-81	-76	-71
500	-21	-16	-11	-39	-34	-29	-82	-77	-72
450	-20	-15	-10	-40	-35	-30	-83	-78	-73

1. **Obtain V1, VR and V2 for the actual weight using the TO2 Dry Runway Takeoff Speeds table.**
2. **If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter Table 3 with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG). V1 not to exceed VR.**

TO2 Takeoff %N1

20% Thrust Reduction

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)												
	-2	-1	0	1	2	3	4	5	6	7	8	9	10
70	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	85.9	86.0
60	84.7	85.1	85.5	85.5	85.5	85.4	85.3	85.3	85.3	85.2	84.7	84.7	84.7
55	85.9	86.4	86.8	86.7	86.7	86.7	86.6	86.5	86.5	86.5	86.0	85.5	84.9
50	87.1	87.6	88.1	88.0	88.0	87.9	87.8	87.8	87.8	87.8	87.2	86.7	86.1
45	88.4	88.9	89.3	89.2	89.1	89.1	89.1	89.0	89.0	89.0	88.5	87.9	87.4
40	89.3	90.0	90.6	90.4	90.2	90.2	90.2	90.2	90.1	90.2	89.7	89.1	88.6
35	89.6	90.5	91.2	91.2	91.2	91.0	90.9	90.8	90.8	90.8	90.5	90.1	89.8
30	89.1	90.4	91.7	91.7	91.7	91.7	91.7	91.4	91.4	91.3	91.0	90.7	90.4
25	88.3	89.6	90.9	91.4	91.9	92.1	92.2	92.2	92.6	92.4	91.5	91.2	90.9
20	87.6	88.9	90.2	90.6	91.1	91.6	91.9	92.4	92.5	92.7	92.5	92.2	91.4
15	86.8	88.1	89.4	89.8	90.3	90.8	91.1	91.6	92.0	92.4	92.4	92.3	91.7
10	86.1	87.4	88.6	89.1	89.5	90.0	90.4	90.8	91.2	91.6	91.7	91.8	92.0
5	85.3	86.6	87.8	88.3	88.8	89.2	89.6	90.0	90.4	90.8	90.9	91.0	91.2
0	84.5	85.8	87.0	87.5	87.9	88.4	88.8	89.2	89.6	90.0	90.1	90.2	90.4
-10	83.0	84.2	85.4	85.9	86.3	86.8	87.1	87.6	88.0	88.4	88.5	88.6	88.8
-20	81.4	82.6	83.8	84.2	84.7	85.1	85.5	85.9	86.3	86.7	86.8	87.0	87.1
-30	79.8	81.0	82.1	82.5	83.0	83.5	83.9	84.3	84.6	85.0	85.2	85.3	85.5
-40	78.1	79.3	80.4	80.8	81.3	81.8	82.2	82.6	83.0	83.4	83.5	83.6	83.8
-50	76.4	77.6	78.7	79.1	79.6	80.1	80.5	80.8	81.2	81.6	81.7	81.9	82.0

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)			
	-2	0	9	10
PACKS OFF	0.5	0.6	0.6	0.7
ENGINE ANTI-ICE ON	0.0	0.0	0.0	-0.4
ENGINE AND WING ANTI-ICE ON	0.0	0.0	0.0	-0.4

Max Climb %N1

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

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KCAS OR MACH)									
	0	5	10	15	20	25	30	35	40	45
	340	340	340	340	340	340	0.81	0.84	0.84	0.84
60	91.0	91.6	92.9	94.1	96.1	97.6	99.8	101.2	101.5	100.7
50	92.8	93.2	93.8	93.1	94.7	96.2	98.3	99.7	100.0	99.2
40	94.2	95.0	95.4	94.8	95.0	94.9	96.7	98.2	98.4	97.7
30	92.7	95.5	97.0	96.4	96.6	96.5	95.2	96.6	96.8	96.1
20	91.2	93.9	96.6	97.9	98.2	98.0	96.9	95.5	95.2	94.5
15	90.4	93.1	95.8	97.3	99.0	98.9	97.8	96.5	95.9	95.2
10	89.6	92.3	95.0	96.5	98.7	99.7	98.7	97.6	97.0	96.3
5	88.8	91.5	94.1	95.6	97.9	99.6	99.7	98.6	98.0	97.3
0	88.0	90.7	93.3	94.8	97.0	98.7	100.8	99.6	99.0	98.3
-5	87.2	89.8	92.4	93.9	96.1	97.8	101.1	100.8	100.0	99.3
-10	86.4	89.0	91.5	93.0	95.2	96.8	100.2	101.4	100.9	100.3
-15	85.5	88.1	90.7	92.1	94.3	95.9	99.2	101.0	100.9	100.8
-20	84.7	87.3	89.8	91.2	93.4	95.0	98.3	100.0	99.9	99.9
-25	83.9	86.4	88.9	90.3	92.4	94.0	97.3	99.0	98.9	98.9
-30	83.0	85.5	88.0	89.4	91.5	93.1	96.3	98.0	97.9	97.9
-35	82.2	84.7	87.1	88.5	90.6	92.1	95.3	97.0	96.9	96.8
-40	81.3	83.8	86.2	87.5	89.6	91.2	94.3	96.0	95.9	95.8

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	45
ENGINE ANTI-ICE ON	-0.3	-0.2	-0.3	-0.3	-0.4	-0.4	-0.5	-0.5	-0.5	-0.5
ENGINE & WING ANTI-ICE ON	-0.7	-0.6	-0.6	-0.7	-0.8	-0.8	-0.9	-0.9	-0.9	-0.9

Go-around %N1

Based on engine bleed for packs on and anti-ice off

REPORTED OAT (°C)	TAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
		0	1	2	3	4	5	6	7	8	9	10
70	74	85.9	86.7	87.5	88.3	88.7	89.1	89.4	89.8	89.9	89.6	89.0
60	64	87.9	88.8	89.7	90.7	91.2	91.7	92.1	92.5	92.7	92.4	91.8
55	59	88.8	89.8	90.8	91.8	92.4	93.0	93.4	93.9	94.1	93.8	93.2
50	54	90.2	90.9	91.9	92.9	93.6	94.2	94.6	95.1	95.4	95.1	94.5
45	49	91.5	92.3	93.2	94.2	94.8	95.3	95.9	96.4	96.7	96.4	95.8
40	44	92.8	93.6	94.5	95.4	96.0	96.6	97.1	97.6	98.0	97.7	97.1
35	39	94.2	94.9	95.8	96.8	97.2	97.7	98.3	99.0	99.0	98.8	98.3
30	34	94.8	95.7	96.6	97.6	98.2	98.7	99.2	99.7	99.9	99.5	99.2
25	29	94.1	95.5	97.0	98.1	98.7	99.2	100.3	100.8	100.7	100.3	99.9
20	24	93.3	94.7	96.2	97.7	98.9	100.1	100.9	101.7	102.2	101.6	100.7
15	19	92.5	93.9	95.4	96.8	98.0	99.3	100.7	102.4	102.9	102.4	101.6
10	14	91.7	93.1	94.5	96.0	97.2	98.5	99.8	101.5	102.5	102.5	102.5
5	8	90.8	92.1	93.5	95.0	96.2	97.4	98.8	100.4	101.4	101.4	101.5
0	3	90.0	91.3	92.7	94.2	95.3	96.6	97.9	99.6	100.5	100.5	100.7
-10	-7	88.3	89.6	91.0	92.4	93.6	94.9	96.2	97.8	98.8	98.8	98.9
-20	-17	86.6	87.9	89.3	90.7	91.9	93.2	94.5	96.1	97.0	97.0	97.1
-30	-27	84.9	86.2	87.6	89.0	90.2	91.4	92.7	94.3	95.2	95.2	95.3
-40	-37	83.2	84.4	85.8	87.2	88.5	89.7	90.9	92.5	93.4	93.4	93.5
-50	-47	81.4	82.7	84.0	85.5	86.7	87.9	89.1	90.6	91.5	91.6	91.7

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)										
	0	1	2	3	4	5	6	7	8	9	10
PACKS OFF	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.7	0.7
ENGINE ANTI-ICE ON	-0.3	-0.3	-0.3	-0.3	-0.3	-0.4	-0.5	-0.4	-0.4	-0.4	-0.4

Flight With Unreliable Airspeed / Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

Climb (310/.83)

Flaps Up, Max Climb Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)					
		500	600	700	800	900	1000
40000	**PITCH ATT**	**4.5**	**5.0**				
	V/S (FT/MIN)	1600	1000				
35000	**PITCH ATT**	**5.0**	**5.0**	**5.0**	**5.0**	**5.0**	
	V/S (FT/MIN)	2700	2000	1400	900	400	
30000	**PITCH ATT**	**4.5**	**4.5**	**4.5**	**4.5**	**4.5**	**5.0**
	V/S (FT/MIN)	2500	2000	1500	1200	800	500
20000	**PITCH ATT**	**7.5**	**7.0**	**6.5**	**6.5**	**6.5**	**6.5**
	V/S (FT/MIN)	3900	3200	2600	2100	1700	1400
10000	**PITCH ATT**	**10.5**	**9.5**	**9.0**	**8.5**	**8.5**	**8.5**
	V/S (FT/MIN)	5600	4500	3800	3200	2700	2200
SEA LEVEL	**PITCH ATT**	**14.5**	**12.5**	**11.5**	**11.0**	**10.5**	**10.5**
	V/S (FT/MIN)	6700	5500	4600	3900	3400	2900

Cruise (.83/310)

Flaps Up, %N1 for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)					
		500	600	700	800	900	1000
40000	**PITCH ATT**	**3.0**	**3.5**	**4.5**			
	%N1	83.4	87.1	92.4			
35000	**PITCH ATT**	**2.0**	**2.5**	**3.0**	**4.0**	**4.5**	
	%N1	80.2	82.4	85.1	88.6	93.5	
30000	**PITCH ATT**	**1.5**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**
	%N1	79.1	80.3	82.2	84.5	87.1	90.4
25000	**PITCH ATT**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**5.0**
	%N1	75.0	76.2	78.0	80.3	82.7	85.8
20000	**PITCH ATT**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**5.0**
	%N1	71.1	72.1	73.8	75.9	78.2	81.0
15000	**PITCH ATT**	**2.0**	**2.5**	**3.0**	**3.5**	**4.0**	**5.0**
	%N1	67.4	68.3	69.9	71.9	74.0	76.6

Descent (.83/310)

Flaps Up, Idle Thrust

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)					
		500	600	700	800	900	1000
40000	**PITCH ATT**	**0.0**	**0.5**	**1.5**	2.0	0.5	-2.0
	V/S (FT/MIN)	-2600	-2500	-2600	-2800	-3100	-5900
35000	**PITCH ATT**	**-2.0**	**-1.0**	**0.0**	**0.5**	**1.0**	2.0
	V/S (FT/MIN)	-3300	-3000	-2900	-2900	-3000	-2300
30000	**PITCH ATT**	**-1.5**	**-0.5**	**0.0**	**0.5**	**1.5**	**2.0**
	V/S (FT/MIN)	-2700	-2400	-2200	-2100	-2000	-2100
20000	**PITCH ATT**	**-1.5**	**-0.5**	**0.5**	**1.0**	**1.5**	**2.5**
	V/S (FT/MIN)	-2500	-2200	-2000	-1900	-1900	-1900
10000	**PITCH ATT**	**-1.5**	**-0.5**	**0.0**	**1.0**	**1.5**	**2.0**
	V/S (FT/MIN)	-2300	-2000	-1800	-1700	-1700	-1700
SEA LEVEL	**PITCH ATT**	**-1.5**	**-0.5**	**0.0**	**1.0**	**1.5**	**2.5**
	V/S (FT/MIN)	-2000	-1800	-1600	-1500	-1500	-1500

Flight With Unreliable Airspeed / Turbulent Air Penetration

Altitude and/or vertical speed indications may also be unreliable.

Holding (Flaps Up Maneuvering Speed)

Flaps Up, %N1 for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)					
		450	550	650	750	850	950
10000	**PITCH ATT**	**5.5**	**6.0**	**6.5**	**6.5**	**7.0**	**7.0**
	%N1	51.8	56.0	59.9	63.4	66.9	70.3
	KIAS	205	217	229	241	250	262

Terminal Area (5000 FT)

%N1 for Level Flight

FLAP POSITION		WEIGHT (1000 LB)					
		500	600	700	800	900	1000
FLAPS UP (GEAR UP)	**PITCH ATT**	**5.0**	**5.5**	**6.0**	**6.0**	**6.5**	**6.5**
	%N1	51.2	55.4	59.3	62.4	65.5	68.6
	KIAS	210	223	235	244	255	267
FLAPS 1 (GEAR UP)	**PITCH ATT**	**7.0**	**7.5**	**7.5**	**8.0**	**8.5**	**8.5**
	%N1	56.1	60.4	64.3	67.9	71.3	74.2
	KIAS	190	203	214	224	235	244
FLAPS 5 (GEAR UP)	**PITCH ATT**	**7.5**	**8.0**	**8.0**	**8.5**	**9.0**	**9.0**
	%N1	55.9	60.7	64.9	68.5	72.2	75.4
	KIAS	170	183	195	204	215	224
FLAPS 10 (GEAR UP)	**PITCH ATT**	**8.0**	**8.0**	**8.0**	**8.0**	**8.5**	**9.0**
	%N1	56.1	60.8	64.8	68.7	72.5	76.0
	KIAS	152	167	181	192	198	205
FLAPS 20 (GEAR DOWN)	**PITCH ATT**	**6.0**	**6.0**	**5.5**	**6.0**	**6.5**	**6.5**
	%N1	63.4	68.4	72.7	77.4	81.3	84.9
	KIAS	142	155	168	176	185	195

Final Approach (1500 FT)

Gear Down, %N1 for 3° Glideslope

FLAP POSITION (VREF+INCREMENT)		WEIGHT (1000 LB)					
		500	600	700	800	900	1000
FLAPS 25 (VREF25+10)	**PITCH ATT**	**1.0**	**1.0**	**1.0**	**1.0**	**1.5**	**1.5**
	%N1	52.5	56.6	60.6	64.0	66.9	69.9
	KIAS	141	154	166	177	186	196
FLAPS 30 (VREF30+10)	**PITCH ATT**	**0.5**	**0.5**	**0.5**	**1.0**	*	*
	%N1	55.4	59.9	64.0	67.6		
	KIAS	138	151	162	173		

*** Exceeds flap placard speed.**

Go-Around (1500 FT)

Flaps 20, Gear Up, Go-Around Thrust, Maneuver Speed

PRESSURE ALTITUDE (FT)		WEIGHT (1000 LB)					
		500	600	700	800	900	1000
10000	**PITCH ATT**	**18.5**	**15.0**	**12.5**	**11.0**	**10.0**	**9.0**
	VS (FT/MIN)	3700	3000	2400	1900	1500	1200
	KIAS	142	156	168	177	187	197
5000	**PITCH ATT**	**21.0**	**17.0**	**14.5**	**13.0**	**11.5**	**10.5**
	VS (FT/MIN)	4100	3400	2800	2300	1800	1500
	KIAS	142	155	168	176	185	195
SEA LEVEL	**PITCH ATT**	**21.0**	**17.5**	**14.5**	**13.0**	**12.0**	**11.0**
	VS (FT/MIN)	3900	3200	2700	2200	1800	1500
	KIAS	142	155	167	175	184	194

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps Up, Gear Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
200	199	200	201	202	204	207	211
210	209	209	210	211	212	214	217
220	219	219	219	220	221	223	225
240	239	239	239	239	240	241	242
260	259	258	258	259	259	260	261
280	279	278	278	278	279	279	279
300	299	298	298	298	298	298	299
320	319	318	318	318	318	318	318
340	339	339	338	338	338	338	338
360	359	359	358	358	358	358	358

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
200	20	10	-10	-40	-80	-140	-220
210	30	20	0	-20	-50	-100	-160
220	30	30	10	-10	-30	-70	-120
240	40	40	30	20	0	-30	-60
260	40	50	50	40	30	10	-20
280	40	50	50	50	50	40	20
300	40	50	60	60	60	60	50
320	40	60	60	70	70	70	70
340	40	60	70	70	80	80	80
360	30	60	70	80	90	90	100

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 1, Gear Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
180	180	181	183	185	187	190	195
190	190	191	192	193	195	198	201
200	199	200	201	202	204	206	208
210	209	210	211	212	213	214	216
220	219	219	220	221	222	223	225
240	239	239	239	240	241	242	243
260	259	259	259	259	260	261	261
280	278	278	279	279	279	280	280
300	298	298	298	298	299	299	300

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
180	0	-20	-50	-80	-130	-190	-260
190	10	-10	-40	-70	-100	-150	-210
200	10	0	-30	-50	-80	-120	-170
210	20	10	-10	-40	-60	-100	-140
220	30	10	0	-20	-50	-80	-110
240	30	30	20	0	-20	-50	-70
260	40	40	30	20	0	-20	-40
280	50	50	50	40	30	10	-10
300	60	60	60	50	40	30	20

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 5, Gear Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
160	161	162	164	167	171	179	
164	164	165	167	170	174	179	
168	168	169	171	173	176	181	188
172	172	173	174	176	179	183	189
176	176	177	178	180	182	186	190
180	180	181	182	183	185	188	192
190	189	190	191	192	194	196	199
200	199	200	200	201	203	204	206
210	209	209	210	211	212	213	214
220	219	219	219	220	221	222	223
240	239	239	239	239	240	241	242
260	258	258	259	259	259	260	260
280	278	278	278	278	279	279	279

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
160	-10	-30	-60	-110	-180	-280	
164	0	-30	-60	-100	-160	-240	
168	0	-20	-50	-90	-140	-210	-310
172	0	-20	-40	-80	-120	-190	-270
176	10	-10	-40	-70	-110	-170	-240
180	10	-10	-30	-60	-100	-150	-220
190	20	0	-20	-40	-70	-110	-170
200	20	10	-10	-30	-50	-90	-130
210	30	20	0	-20	-40	-70	-100
220	30	20	10	0	-20	-50	-80
240	40	40	30	20	0	-20	-40
260	40	50	40	30	20	10	-10
280	50	50	50	50	40	30	20

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 10, Gear Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
140	140	142	146	152			
144	144	146	149	153			
148	148	149	152	155	163		
152	152	153	155	158	163		
156	156	157	158	161	165	173	
160	159	160	162	164	167	173	
164	163	164	165	167	170	174	182
168	167	168	169	170	173	176	182
172	171	172	173	174	176	179	183
176	175	175	176	177	179	182	185
180	179	179	180	181	182	185	188
190	189	189	190	190	191	193	195
200	198	199	199	200	201	202	203
210	208	208	209	209	210	211	212
220	218	218	218	219	219	220	221
240	238	238	238	238	239	239	240
260	258	258	258	258	258	258	259

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
140	-10	-30	-80	-170			
144	0	-30	-70	-130			
148	0	-20	-50	-110	-210		
152	0	-10	-40	-90	-170		
156	10	-10	-30	-80	-140	-250	
160	10	0	-30	-60	-120	-200	
164	10	0	-20	-50	-100	-170	-280
168	20	0	-20	-40	-80	-140	-230
172	20	10	-10	-30	-70	-120	-190
176	20	10	0	-30	-60	-100	-160
180	20	10	0	-20	-50	-90	-140
190	30	20	10	-10	-30	-60	-100
200	40	30	20	10	-10	-30	-60
210	40	40	30	20	0	-20	-40
220	40	40	40	30	10	0	-20
240	50	50	50	50	40	20	10
260	50	60	60	60	60	50	30

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 20, Gear Up and Gear Down

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
132	130	131	133	137			
136	134	135	136	139	146		
140	138	138	139	142	146		
144	142	142	143	145	148	155	
148	146	146	147	148	150	155	
152	150	150	150	151	153	157	163
156	154	154	154	155	156	159	163
160	158	157	158	158	160	162	165
164	162	161	161	162	163	165	167
168	165	165	165	166	167	168	170
172	169	169	169	170	170	171	173
176	173	173	173	173	174	175	176
180	177	177	177	177	178	178	179
190	187	187	187	187	187	187	188
200	197	197	197	197	197	197	197
210	207	207	207	207	207	207	207
220	218	217	217	217	217	216	217
240	238	237	237	237	236	236	236

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
132	30	10	-10	-70			
136	30	20	0	-40	-130		
140	30	30	10	-30	-90		
144	40	30	20	-10	-60	-150	
148	40	40	20	0	-40	-110	
152	40	40	30	10	-20	-70	-170
156	40	40	40	20	-10	-50	-120
160	40	40	40	30	10	-30	-80
164	40	50	40	30	20	-10	-60
168	50	50	50	40	30	0	-30
172	50	50	50	50	30	10	-20
176	50	50	50	50	40	20	0
180	50	50	60	50	50	30	10
190	50	60	60	60	60	50	40
200	60	60	70	70	70	70	60
210	60	70	70	70	80	80	70
220	60	70	80	80	80	90	80
240	60	80	90	90	100	100	100

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15000 ft pressure altitude

Flaps 25, Gear Down

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
120	118	119	122				
124	122	122	124				
128	126	126	127	131			
132	129	130	131	133			
136	133	134	134	136	139		
140	137	137	138	139	141		
144	141	141	142	142	144	148	
148	145	145	145	146	147	150	
152	149	149	149	150	150	152	156
156	153	153	153	153	154	155	158
160	157	157	157	157	158	159	160
170	167	167	167	167	167	167	168
180	177	177	177	176	177	177	177
190	187	187	186	186	186	186	187
200	197	197	196	196	196	196	196
220	217	217	217	216	216	216	216

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
120	30	20	-20				
124	30	20	0				
128	30	30	10	-40			
132	40	30	20	-10			
136	40	40	30	0	-50		
140	40	40	30	20	-20		
144	40	40	40	30	0	-50	
148	50	50	40	30	10	-30	
152	50	50	50	40	30	-10	-60
156	50	50	50	40	30	10	-30
160	50	50	50	50	40	30	-10
170	50	60	60	60	50	50	30
180	60	60	70	70	70	60	50
190	60	70	70	80	80	80	70
200	60	70	80	80	90	90	80
220	60	80	80	90	100	100	110

Actual altitude = ISFD altitude + pressure altitude adjustment.

ISFD Airspeed and Altitude Correction
Applicable to low speed operations below 15000 ft pressure altitude
Flaps 30, Gear Down
Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
120	118	119	122				
124	122	122	124				
128	125	126	127	131			
132	129	129	130	133			
136	133	133	134	136	140		
140	137	137	137	139	141		
144	141	141	141	142	144	148	
148	145	145	145	146	147	150	
152	149	149	149	149	150	152	156
156	153	153	153	153	154	155	158
160	157	157	157	157	157	158	160
170	168	167	167	167	167	167	168
180	178	177	177	176	176	176	177
190	188	187	187	186	186	186	186

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	WEIGHT (1000 LB)						
	400	500	600	700	800	900	1000
120	30	20	-20				
124	30	30	0				
128	40	30	10	-40			
132	40	40	20	-10			
136	40	40	30	10	-50		
140	40	40	40	20	-20		
144	40	50	40	30	0	-60	
148	40	50	50	40	20	-30	
152	40	50	50	50	30	0	-70
156	40	50	50	50	40	10	-30
160	40	50	60	50	50	30	-10
170	40	60	60	60	60	50	40
180	40	60	70	70	70	70	60
190	40	60	70	80	80	80	80

Actual altitude = ISFD altitude + pressure altitude adjustment.

Performance Inflight — Chapter PI
All Engine — Section 21

Long Range Cruise Maximum Operating Altitude
Max Climb Thrust
ISA + 10°C and Below

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
1000	28900	2	32200	30300
950	30100	0	33300	31400
900	31200	-3	34400	32600
850	32500	-6	35600	33800
800	33800	-9	36900	35100
750	35100	-12	38200	36400
700	36600	-14	39700	37900
650	38100	-14	41200	39400
600	39800	-14	42900	41100
550	41600	-14	43100	42900
500	43100	-14	43100	43100
450	43100	-14	43100	43100

***Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.**

ISA + 15°C

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
1000	28900	8	31900*	30300
950	30100	5	33300	31400
900	31200	3	34400	32600
850	32500	0	35600	33800
800	33800	-3	36900	35100
750	35100	-6	38200	36400
700	36600	-8	39700	37900
650	38100	-8	41200	39400
600	39800	-8	42900	41100
550	41600	-8	43100	42900
500	43100	-8	43100	43100
450	43100	-8	43100	43100

***Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb**

ISA + 20°C

WEIGHT (1000 LB)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
1000	28900	14	30400*	30300
950	30100	11	32000*	31400
900	31200	9	33600*	32600
850	32500	6	35200*	33800
800	33800	3	36600*	35100
750	35100	0	37900*	36400
700	36600	-2	39200*	37900
650	38100	-2	40600*	39400
600	39800	-2	42100*	41100
550	41600	-2	43100	42900
500	43100	-2	43100	43100
450	43100	-2	43100	43100

***Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.**

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)									
		25	27	29	31	33	35	37	39	41	43
1000	%N1	87.3	88.5	90.0	92.3						
	MACH	.846	.849	.848	.846						
	KIAS	359	346	331	316						
	FF/ENG	7982	7729	7599	7525						
950	%N1	86.1	87.3	88.5	90.4	93.1					
	MACH	.839	.848	.849	.848	.844					
	KIAS	356	345	331	317	302					
	FF/ENG	7622	7413	7219	7069	7138					
900	%N1	84.7	86.1	87.3	88.8	90.9	93.9				
	MACH	.826	.844	.848	.849	.846	.843				
	KIAS	349	344	331	317	303	288				
	FF/ENG	7213	7083	6895	6674	6658	6778				
850	%N1	83.1	84.7	86.0	87.4	89.0	91.4				
	MACH	.806	.834	.847	.849	.848	.845				
	KIAS	340	339	331	317	304	289				
	FF/ENG	6756	6719	6588	6324	6239	6259				
800	%N1	81.6	83.2	84.6	86.0	87.3	89.1	92.3			
	MACH	.787	.816	.840	.848	.849	.847	.843			
	KIAS	332	331	328	317	304	290	275			
	FF/ENG	6331	6289	6253	6022	5869	5820	5922			
750	%N1	80.0	81.5	83.1	84.7	85.9	87.3	89.8	93.8		
	MACH	.768	.794	.824	.844	.848	.849	.846	.842		
	KIAS	323	321	321	316	304	290	276	263		
	FF/ENG	5932	5868	5874	5723	5568	5452	5466	5642		
700	%N1	78.4	79.9	81.4	83.2	84.5	85.7	87.7	90.9		
	MACH	.749	.774	.800	.831	.846	.849	.848	.845		
	KIAS	315	312	311	310	303	290	277	264		
	FF/ENG	5636	5585	5455	5390	5294	5139	5088	5157		
650	%N1	76.7	78.2	79.7	81.4	83.0	84.3	85.9	88.5	91.9	
	MACH	.730	.753	.779	.806	.836	.847	.849	.848	.844	
	KIAS	306	303	301	300	299	290	277	265	251	
	FF/ENG	5230	5202	5064	4976	4980	4869	4761	4754	4841	
600	%N1	74.9	76.3	77.8	79.6	81.1	82.7	84.3	86.4	89.1	92.6
	MACH	.708	.732	.755	.782	.811	.839	.848	.849	.847	.843
	KIAS	296	294	292	290	289	287	277	265	252	240
	FF/ENG	4862	4829	4673	4586	4584	4570	4489	4417	4424	4533
550	%N1	72.9	74.4	75.8	77.6	79.1	80.7	82.6	84.7	86.8	89.5
	MACH	.684	.709	.733	.757	.783	.813	.840	.848	.849	.847
	KIAS	285	284	282	280	278	277	274	265	253	241
	FF/ENG	4498	4458	4307	4204	4193	4189	4201	4219	4159	4175
500	%N1	70.7	72.3	73.8	75.5	77.0	78.5	80.5	82.8	84.9	87.0
	MACH	.659	.682	.707	.731	.756	.783	.813	.840	.848	.849
	KIAS	274	273	272	270	267	266	264	262	253	241
	FF/ENG	4135	4079	4050	3940	3907	3888	3913	3935	3884	3833
450	%N1	68.3	70.0	71.4	73.2	74.7	76.3	78.2	80.5	82.9	84.9
	MACH	.629	.654	.677	.703	.728	.753	.780	.810	.839	.848
	KIAS	261	261	259	258	257	254	253	251	250	241
	FF/ENG	3742	3716	3684	3585	3552	3518	3531	3564	3599	3564

Shaded area approximates optimum altitude.

Long Range Cruise Enroute Fuel and Time - Low Altitudes

Table 1 of 3: 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
692	643	600	562	530	500	477	457	438	420	405
1385	1288	1201	1126	1060	1000	957	916	879	844	813
2083	1936	1804	1690	1590	1500	1435	1375	1319	1267	1220
2789	2589	2411	2257	2122	2000	1913	1832	1757	1689	1626
3501	3247	3020	2825	2654	2500	2391	2289	2195	2109	2031
4221	3911	3633	3395	3187	3000	2868	2746	2633	2529	2435
4949	4580	4250	3968	3722	3500	3345	3202	3069	2948	2837
5686	5255	4870	4542	4257	4000	3822	3657	3504	3365	3238
6433	5937	5495	5119	4793	4500	4298	4111	3939	3781	3638
7190	6626	6125	5699	5331	5000	4774	4565	4373	4197	4037

Table 2 of 3: Reference Fuel And Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		25	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
500	30.5	1:27	27.7	1:23	25.5	1:19	23.6	1:16	22.4	1:15
1000	61.0	2:50	56.2	2:42	52.5	2:33	49.0	2:27	46.7	2:22
1500	91.2	4:16	84.7	4:02	79.1	3:49	74.0	3:38	70.4	3:31
2000	121.1	5:43	112.6	5:23	105.1	5:06	98.4	4:50	93.6	4:40
2500	150.5	7:12	139.9	6:47	130.6	6:24	122.4	6:04	116.4	5:51
3000	179.2	8:44	166.7	8:13	155.5	7:44	145.9	7:19	138.7	7:02
3500	207.3	10:19	192.9	9:40	180.0	9:05	168.9	8:35	160.7	8:15
4000	234.9	11:56	218.5	11:10	203.9	10:29	191.3	9:53	182.2	9:29
4500	261.8	13:35	243.7	12:42	227.3	11:54	213.4	11:12	203.3	10:44
5000	288.2	15:18	268.3	14:17	250.3	13:21	234.9	12:32	224.0	12:00

Table 3 of 3: Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB)					
	500	600	700	800	900	1000
20	-1.7	-0.6	0.0	2.0	3.3	4.5
40	-4.1	-1.6	0.0	2.9	6.1	9.6
60	-6.5	-2.7	0.0	4.2	9.2	14.7
80	-9.0	-3.8	0.0	5.8	12.3	19.7
100	-11.5	-5.0	0.0	7.3	15.4	24.6
120	-14.1	-6.2	0.0	8.9	18.6	29.4
140	-16.7	-7.5	0.0	10.5	21.7	34.2
160	-19.3	-8.7	0.0	12.1	24.8	38.9
180	-22.1	-10.1	0.0	13.7	28.0	43.5
200	-24.8	-11.4	0.0	15.3	31.1	48.1
220	-27.6	-12.8	0.0	16.8	34.2	52.6
240	-30.5	-14.2	0.0	18.4	37.3	57.0
260	-33.4	-15.7	0.0	20.0	40.5	61.3
280	-36.4	-17.2	0.0	21.6	43.6	65.6
300	-39.4	-18.7	0.0	23.2	46.7	69.8

Long Range Cruise Enroute Fuel and Time - High Altitudes

Table 1 of 3: 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
3854	3649	3462	3293	3141	3000	2881	2770	2666	2571	2483
4503	4262	4041	3843	3665	3500	3362	3232	3112	3000	2898
5153	4876	4622	4395	4189	4000	3842	3694	3556	3429	3312
5807	5492	5204	4947	4714	4500	4322	4156	4001	3858	3726
6463	6111	5788	5500	5240	5000	4802	4617	4445	4286	4140
7123	6732	6373	6054	5765	5500	5282	5078	4888	4713	4552
7786	7355	6960	6609	6292	6000	5761	5538	5330	5139	4963
8452	7980	7548	7164	6818	6500	6240	5998	5773	5565	5374
9123	8608	8139	7721	7345	7000	6719	6457	6214	5989	5783
9797	9240	8732	8280	7873	7500	7198	6916	6655	6413	6191
10475	9874	9326	8839	8402	8000	7677	7375	7094	6836	6598

Table 2 of 3: Reference Fuel And Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		37	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
3000	127.9	6:42	122.7	6:32	119.4	6:22	116.2	6:19	114.1	6:19
3500	148.1	7:51	142.1	7:38	138.3	7:27	134.7	7:21	132.2	7:21
4000	167.9	9:00	161.1	8:46	156.9	8:33	152.8	8:25	149.9	8:23
4500	187.3	10:10	179.7	9:54	175.0	9:39	170.5	9:29	167.2	9:25
5000	206.6	11:22	197.9	11:03	192.9	10:46	188.0	10:35	184.5	10:28
5500	225.7	12:34	216.2	12:13	210.7	11:55	205.4	11:41	201.5	11:32
6000	244.5	13:48	234.2	13:24	228.2	13:04	222.5	12:48	218.2	12:36
6500	262.9	15:03	251.8	14:37	245.4	14:14	239.2	13:56	234.5	13:42
7000	280.9	16:19	269.0	15:50	262.2	15:24	255.5	15:04	250.5	14:48
7500	298.6	17:36	286.0	17:04	278.6	16:36	271.6	16:14	266.3	15:56
8000	315.9	18:55	302.6	18:20	294.8	17:49	287.3	17:25	281.6	17:04

Table 3 of 3: Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB)					
	500	600	700	800	900	1000
100	-14.9	-9.1	0.0	13.9	33.1	60.8
120	-17.9	-10.2	0.0	15.8	37.5	68.2
140	-20.9	-11.3	0.0	17.6	41.8	75.2
160	-24.0	-12.6	0.0	19.3	45.8	81.7
180	-27.2	-14.0	0.0	21.1	49.6	87.8
200	-30.5	-15.4	0.0	22.7	53.2	93.5
220	-33.8	-17.0	0.0	24.3	56.5	98.7
240	-37.2	-18.6	0.0	25.9	59.7	103.6
260	-40.7	-20.3	0.0	27.4	62.6	108.0
280	-44.3	-22.1	0.0	28.8	65.3	111.9
300	-47.9	-24.0	0.0	30.2	67.7	115.5
320	-51.7	-26.0	0.0	31.6	70.0	118.6

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 LB)											
	1000	950	900	850	800	750	700	650	600	550	500	450
43								41	14	2	1	10
41							32	11	1	1	9	24
39					48	23	7	0	1	9	22	41
37				33	14	4	0	2	10	23	39	58
35		39	20	8	1	0	4	12	24	39	57	76
33	23	10	3	0	1	6	15	26	40	56	74	93
31	4	0	0	3	10	18	29	43	57	74	91	109
29	0	2	7	13	22	33	46	59	74	90	107	123
27	5	11	18	27	38	49	62	76	91	106	121	137
25	16	23	32	43	54	66	79	92	106	120	134	148
23	29	38	48	59	70	82	94	107	120	133	146	159

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 KIAS

PRESSURE ALT (1000 FT)	19	21	23	25	27	29	31	33	35	37	39	41
DISTANCE (NM)	72	79	87	94	102	110	118	126	133	139	145	151
TIME (MINUTES)	17	18	19	20	22	22	24	25	26	26	27	28

Holding

Flaps Up

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)									
		1500	5000	10000	15000	20000	25000	30000	35000	40000	43000
1000	%N1	64.8	67.6	71.9	76.3	81.1	85.8	90.4			
	KIAS	265	267	269	274	316	320	316			
	FF/ENG	7200	7130	7090	7060	7420	7580	7710			
950	%N1	63.3	66.0	70.3	74.7	79.5	84.2	88.8			
	KIAS	259	260	262	265	308	312	316			
	FF/ENG	6820	6740	6690	6650	6980	7120	7290			
900	%N1	61.8	64.4	68.7	73.1	77.8	82.6	87.1	93.5		
	KIAS	254	254	256	257	299	303	307	283		
	FF/ENG	6450	6350	6300	6260	6540	6670	6780	6950		
850	%N1	60.3	62.8	66.9	71.3	76.2	80.9	85.4	90.8		
	KIAS	249	249	250	252	290	294	298	283		
	FF/ENG	6080	5970	5910	5870	6100	6230	6310	6390		
800	%N1	58.6	61.2	65.2	69.5	74.4	79.0	83.7	88.6		
	KIAS	244	244	245	246	281	284	288	283		
	FF/ENG	5730	5610	5680	5620	5820	5900	5860	5930		
750	%N1	57.0	59.5	63.4	67.6	72.6	77.2	81.8	86.7		
	KIAS	239	239	240	242	272	275	278	283		
	FF/ENG	5410	5420	5330	5260	5440	5480	5430	5550		
700	%N1	55.4	57.8	61.7	65.8	70.7	75.3	80.0	84.8	92.4	
	KIAS	234	234	235	236	262	265	268	272	252	
	FF/ENG	5240	5100	5000	4910	5060	5060	5010	5080	5370	
650	%N1	53.7	56.1	59.9	63.9	68.7	73.3	77.9	82.8	89.4	
	KIAS	228	228	229	230	252	255	257	261	252	
	FF/ENG	4930	4790	4670	4580	4680	4680	4610	4660	4880	
600	%N1	52.0	54.3	58.0	61.9	66.7	71.2	75.8	80.7	87.1	92.1
	KIAS	222	222	223	224	242	244	247	250	252	235
	FF/ENG	4620	4490	4360	4260	4320	4320	4210	4240	4490	4720
550	%N1	50.1	52.4	56.0	59.9	64.5	68.8	73.5	78.5	84.7	88.9
	KIAS	216	216	217	217	231	233	235	238	242	235
	FF/ENG	4310	4190	4060	3940	3960	3950	3940	3930	4140	4260
500	%N1	48.1	50.4	53.9	57.7	62.1	66.4	71.1	75.9	82.3	86.3
	KIAS	210	210	210	211	220	222	224	226	230	232
	FF/ENG	4010	3880	3760	3640	3620	3590	3580	3540	3710	3870
450	%N1	46.1	48.3	51.8	55.5	59.5	63.8	68.4	73.2	79.6	83.6
	KIAS	205	205	205	205	209	210	212	214	217	219
	FF/ENG	3720	3590	3480	3360	3290	3240	3230	3180	3310	3430

This table includes 5% additional fuel for holding in a racetrack pattern.

Holding
Flaps 1

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
1000	%N1	70.0	73.3	77.9	82.9	88.0
	KIAS	243	244	246	248	250
	FF/ENG	8630	8590	8620	8740	8870
950	%N1	68.5	71.7	76.3	81.2	86.3
	KIAS	239	239	241	243	245
	FF/ENG	8170	8150	8130	8240	8350
900	%N1	67.0	70.0	74.7	79.4	84.6
	KIAS	234	234	236	237	239
	FF/ENG	7720	7700	7660	7760	7840
850	%N1	65.4	68.4	73.0	77.6	82.7
	KIAS	229	229	230	232	234
	FF/ENG	7280	7250	7220	7290	7360
800	%N1	63.8	66.6	71.2	75.8	80.8
	KIAS	223	224	225	226	228
	FF/ENG	6850	6800	6780	6810	6880
750	%N1	62.1	64.9	69.3	74.0	78.8
	KIAS	219	219	220	221	223
	FF/ENG	6440	6380	6360	6350	6430
700	%N1	60.3	63.1	67.4	72.0	76.7
	KIAS	214	214	215	216	217
	FF/ENG	6040	5960	5930	5910	5990
650	%N1	58.5	61.2	65.4	69.9	74.5
	KIAS	208	208	209	210	211
	FF/ENG	5640	5550	5650	5620	5640
600	%N1	56.5	59.1	63.3	67.8	72.3
	KIAS	202	202	203	204	205
	FF/ENG	5400	5290	5240	5200	5200
550	%N1	54.5	57.1	61.2	65.5	70.0
	KIAS	196	196	197	197	198
	FF/ENG	5030	4910	4840	4790	4780
500	%N1	52.4	54.9	58.9	63.1	67.5
	KIAS	189	190	190	191	191
	FF/ENG	4670	4540	4460	4400	4380
450	%N1	50.4	52.8	56.7	60.8	65.0
	KIAS	185	185	185	185	185
	FF/ENG	4350	4220	4110	4030	3980

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 30

REPORTED BRAKING ACTION	RUNWAY DESCRIPTION
Dry	Dry
Good	Wet (Smooth, Grooved or PFC), Frost 1/8" or less of: Water, Slush, Dry Snow or Wet Snow
Good to Medium	Compacted Snow at or below -15°C OAT
Medium	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 1/8" of: Dry Snow or Wet Snow Compacted Snow at OAT warmer than -15°C
Medium to Poor	Greater than 1/8" of: Water or Slush
Poor	Ice
Nil	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF30	TWO REV	NO REV
Dry Runway									
MAX MANUAL	5020	80/-60	150	-230/770	0/-60	140/-130	230	160	310
AUTOBRAKE MAX	5870	70/-70	170	-270/890	0/0	160/-160	300	190	0
AUTOBRAKE 4	7310	90/-90	240	-360/1190	0/0	210/-210	400	0	0
AUTOBRAKE 3	8280	100/-110	280	-420/1390	0/0	240/-250	470	0	0
AUTOBRAKE 2	9330	120/-130	320	-480/1610	20/-110	300/-280	480	50	50
AUTOBRAKE 1	10370	140/-150	410	-560/1890	250/-290	420/-310	430	880	890
Good Reported Braking Action									
MAX MANUAL	6480	100/-90	280	-370/1310	150/-130	250/-210	340	510	1130
AUTOBRAKE MAX	6520	100/-90	280	-350/1310	160/-110	250/-210	350	500	1090
AUTOBRAKE 4	7400	90/-90	250	-370/1240	40/-20	220/-210	410	110	580
AUTOBRAKE 3	8330	100/-110	280	-430/1420	30/-30	250/-250	470	0	90
AUTOBRAKE 2	9330	120/-130	330	-480/1620	60/-110	300/-280	480	50	50
AUTOBRAKE 1	10370	140/-150	410	-560/1890	260/-290	420/-310	430	880	890
Good to Medium Reported Braking Action									
MAX MANUAL	6970	100/-90	280	-390/1370	190/-160	260/-210	340	620	1390
AUTOBRAKE MAX	6990	100/-90	290	-380/1380	200/-150	260/-210	350	610	1350
AUTOBRAKE 4	7470	90/-90	260	-380/1310	90/-50	220/-220	410	250	1030
AUTOBRAKE 3	8330	100/-110	280	-430/1420	50/-30	250/-250	470	20	220
AUTOBRAKE 2	9330	120/-130	330	-480/1620	60/-110	300/-280	480	50	50
AUTOBRAKE 1	10370	140/-150	410	-560/1890	260/-290	420/-310	430	880	890

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 30

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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	7360	100/-100	290	-400/1440	230/-200	270/-220	330	760	1750
AUTOBRAKE MAX	7380	100/-100	300	-400/1440	240/-180	270/-220	350	750	1720
AUTOBRAKE 4	7650	100/-100	280	-410/1420	160/-90	250/-220	410	570	1600
AUTOBRAKE 3	8410	100/-110	290	-440/1510	90/-60	250/-250	470	140	880
AUTOBRAKE 2	9340	120/-130	330	-480/1630	80/-110	300/-280	480	80	270
AUTOBRAKE 1	10370	140/-150	410	-560/1890	260/-290	420/-310	430	880	890
Medium to Poor Reported Braking Action									
MAX MANUAL	8430	130/-120	390	-510/1820	340/-270	370/-270	380	1280	3290
AUTOBRAKE MAX	8450	130/-120	390	-510/1830	350/-290	380/-280	380	1250	3310
AUTOBRAKE 4	8450	130/-120	390	-510/1830	350/-290	380/-280	380	1250	3310
AUTOBRAKE 3	8680	130/-110	380	-450/1680	240/-120	300/-250	430	1030	3080
AUTOBRAKE 2	9490	120/-130	340	-490/1630	150/-150	310/-280	460	390	2300
AUTOBRAKE 1	10440	140/-150	410	-560/1900	290/-330	420/-310	410	920	1610
Poor Reported Braking Action									
MAX MANUAL	10510	150/-150	430	-660/2480	830/-550	470/-320	380	2480	7140
AUTOBRAKE MAX	10540	150/-150	440	-660/2480	850/-560	470/-320	380	2450	7160
AUTOBRAKE 4	10540	150/-150	440	-660/2480	850/-560	470/-320	380	2450	7160
AUTOBRAKE 3	10550	150/-150	440	-670/2480	840/-500	470/-320	430	2440	7150
AUTOBRAKE 2	10860	150/-150	420	-680/2510	750/-480	450/-330	460	2170	6870
AUTOBRAKE 1	11280	160/-170	490	-700/2570	800/-570	490/-340	410	2160	6480

Reference distance is for sea level, standard day, no wind or slope, VREF30 approach speed and 4 engines at maximum reverse thrust.

Max Manual assumes maximum achievable manual braking.
All reference distances and adjustments are increased by 15%.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

Max Manual and autobrake data valid for auto speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 150 ft.
For autobrake and manual speedbrakes, increase reference landing distance by 120 ft.

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 25

REPORTED BRAKING ACTION	RUNWAY DESCRIPTION
Dry	Dry
Good	Wet (Smooth, Grooved or PFC), Frost 1/8" or less of: Water, Slush, Dry Snow or Wet Snow
Good to Medium	Compacted Snow at or below -15°C OAT
Medium	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 1/8" of: Dry Snow or Wet Snow Compacted Snow at OAT warmer than -15°C
Medium to Poor	Greater than 1/8" of: Water or Slush
Poor	Ice
Nil	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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	5190	80/-60	150	-240/780	0/-60	140/-130	230	160	340
AUTOBRAKE MAX	6100	60/-70	180	-280/910	0/0	160/-170	310	190	0
AUTOBRAKE 4	7610	80/-100	240	-370/1220	0/0	220/-220	410	0	0
AUTOBRAKE 3	8640	100/-110	280	-430/1420	0/0	250/-260	480	0	0
AUTOBRAKE 2	9690	110/-140	330	-490/1640	50/-120	320/-290	480	100	100
AUTOBRAKE 1	10700	140/-160	420	-570/1920	270/-310	440/-320	430	1060	1070

Good Reported Braking Action

MAX MANUAL	6740	100/-100	280	-370/1330	160/-140	260/-220	340	550	1320
AUTOBRAKE MAX	6780	100/-90	290	-360/1330	160/-120	270/-220	350	560	1260
AUTOBRAKE 4	7720	90/-100	260	-380/1260	50/-20	230/-220	420	130	700
AUTOBRAKE 3	8710	100/-110	290	-440/1450	30/-30	260/-260	480	0	150
AUTOBRAKE 2	9710	120/-140	340	-490/1650	90/-130	320/-290	480	100	100
AUTOBRAKE 1	10700	140/-160	420	-570/1920	280/-310	440/-320	430	1060	1070

Good to Medium Reported Braking Action

MAX MANUAL	7220	90/-100	290	-390/1390	200/-170	270/-220	340	670	1590
AUTOBRAKE MAX	7250	90/-100	290	-390/1400	210/-160	280/-220	350	680	1550
AUTOBRAKE 4	7780	90/-100	260	-390/1330	90/-50	240/-230	420	260	1170
AUTOBRAKE 3	8710	100/-110	290	-440/1450	50/-30	260/-260	480	20	300
AUTOBRAKE 2	9710	120/-140	340	-490/1650	90/-130	320/-290	480	100	100
AUTOBRAKE 1	10700	140/-160	420	-570/1920	280/-310	440/-320	430	1060	1070

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 25

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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	7610	100/-100	300	-410/1460	240/-200	290/-230	340	810	1970
AUTOBRAKE MAX	7640	100/-100	300	-410/1460	250/-190	290/-230	350	820	1930
AUTOBRAKE 4	7950	90/-100	280	-410/1440	150/-80	260/-230	420	590	1760
AUTOBRAKE 3	8780	100/-120	290	-450/1530	90/-60	260/-260	480	140	980
AUTOBRAKE 2	9710	120/-140	340	-490/1660	110/-130	320/-290	480	130	340
AUTOBRAKE 1	10700	140/-160	420	-570/1920	280/-310	440/-320	430	1060	1070

Medium to Poor Reported Braking Action

MAX MANUAL	8720	130/-130	400	-510/1830	340/-280	390/-280	380	1390	3820
AUTOBRAKE MAX	8760	130/-130	400	-510/1830	360/-290	400/-290	390	1400	3840
AUTOBRAKE 4	8760	130/-130	400	-510/1830	360/-290	400/-290	380	1400	3840
AUTOBRAKE 3	9050	120/-120	390	-450/1670	220/-120	310/-260	430	1110	3550
AUTOBRAKE 2	9860	120/-130	350	-500/1660	170/-170	330/-290	460	470	2760
AUTOBRAKE 1	10780	140/-160	420	-570/1920	320/-350	450/-320	410	1100	2080

Poor Reported Braking Action

MAX MANUAL	10760	150/-160	440	-660/2470	810/-540	490/-320	380	2630	7950
AUTOBRAKE MAX	10790	150/-160	450	-670/2470	830/-550	500/-330	390	2640	7980
AUTOBRAKE 4	10790	150/-160	450	-670/2470	830/-560	500/-330	380	2640	7980
AUTOBRAKE 3	10830	150/-150	440	-670/2480	810/-490	480/-330	430	2600	7940
AUTOBRAKE 2	11160	150/-160	440	-680/2510	740/-490	470/-340	460	2300	7630
AUTOBRAKE 1	11580	160/-170	500	-700/2580	790/-580	520/-350	410	2360	7250

Reference distance is for sea level, standard day, no wind or slope, VREF25 approach speed and 4 engines at maximum reverse thrust.

Max Manual assumes maximum achievable manual braking.
All reference distances and adjustments are increased by 15%.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

Max Manual and autobrake data valid for auto speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 160 ft.
For autobrake and manual speedbrakes, increase reference landing distance by 130 ft.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
AIR/GND SYSTEM - Flaps 25
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5650	60/-70	180	-260/870	120/-100	170/-150	290	0	360
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	7590	110/-110	350	-440/1590	310/-250	320/-260	430	0	1360
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	8290	110/-120	360	-460/1660	390/-310	330/-270	430	0	1620
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	8840	110/-120	370	-490/1740	480/-370	350/-280	430	0	1990
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	10360	160/-160	520	-640/2350	730/-540	490/-360	490	0	3850
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	13660	190/-190	610	-890/3320	1740/-1120	640/-430	490	0	8250
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

AIR/GND SYSTEM - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5440	60/-60	180	-260/850	110/-100	160/-150	280	0	320
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	7240	110/-110	340	-430/1560	290/-230	300/-250	420	0	1150
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	7940	110/-110	350	-450/1630	370/-300	310/-260	420	0	1390
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	8490	120/-110	360	-470/1710	460/-360	320/-260	420	0	1730
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	9900	160/-150	510	-630/2310	700/-510	460/-350	480	0	3240
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	13230	190/-180	590	-880/3310	1730/-1110	600/-420	480	0	7270
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ANTISKID / ANTISKID OFF - Flaps 25

VREF25

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	7600	90/-100	280	-410/1430	310/-250	280/-210	350	910	2430
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								
Good Reported Braking Action									
MAX MANUAL	8220	120/-120	360	-480/1740	380/-300	350/-250	320	1250	3610
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								
Good to Medium Reported Braking Action									
MAX MANUAL	9110	130/-130	390	-550/2030	590/-420	390/-270	340	1780	5480
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								
Medium Reported Braking Action									
MAX MANUAL	9580	130/-140	420	-590/2200	720/-490	420/-280	340	2140	6950
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								
Medium to Poor Reported Braking Action									
MAX MANUAL	9930	150/-150	470	-630/2380	770/-520	470/-310	330	2410	8130
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								
Poor Reported Braking Action									
MAX MANUAL	11490	170/-170	520	-810/3240	1400/-840	570/-350	360	4200	20000
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ANTISKID / ANTISKID OFF - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	7370	90/-90	270	-410/1430	310/-250	270/-210	290	820	2160
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	7950	120/-110	350	-470/1730	380/-300	330/-250	330	1120	3130
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	8850	130/-120	380	-540/2030	590/-420	380/-260	330	1640	4890
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	9340	130/-130	410	-590/2200	740/-490	400/-280	330	1980	6220
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	9660	150/-140	460	-630/2390	780/-520	450/-300	350	2210	7140
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	11280	170/-170	510	-810/3270	1450/-860	550/-340	350	3990	20000
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
BLD DUCT LEAK L / BLD DUCT LEAK R - Flaps 25
VREF25

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4620	70/-50	130	-210/690	60/-50	120/-120	210	90	200
AUTOBRAKE MAX	5310	60/-60	150	-240/790	0/0	140/-140	270	0	0
AUTOBRAKE 2	8500	100/-120	280	-430/1430	10/-70	260/-260	440	20	20

Good Reported Braking Action

MAX MANUAL	6100	80/-80	250	-340/1200	150/-130	230/-200	310	390	960
AUTOBRAKE MAX	6110	90/-80	260	-330/1200	160/-110	230/-200	310	380	940
AUTOBRAKE 2	8510	100/-120	300	-430/1460	60/-80	270/-260	440	20	20

Good to Medium Reported Braking Action

MAX MANUAL	6520	80/-90	260	-350/1250	180/-160	240/-200	310	490	1200
AUTOBRAKE MAX	6520	80/-90	260	-350/1260	200/-150	240/-200	310	490	1200
AUTOBRAKE 2	8510	100/-120	300	-430/1460	60/-80	270/-260	440	20	20

Medium Reported Braking Action

MAX MANUAL	6860	90/-90	270	-370/1310	220/-180	250/-200	300	610	1550
AUTOBRAKE MAX	6860	90/-90	270	-360/1310	230/-180	250/-210	310	610	1550
AUTOBRAKE 3	7700	90/-100	270	-400/1380	110/-90	240/-240	420	120	880

Medium to Poor Reported Braking Action

MAX MANUAL	7930	110/-110	350	-460/1630	320/-260	340/-250	340	1100	3150
AUTOBRAKE MAX	7960	110/-120	360	-460/1630	330/-270	340/-250	340	1110	3180
AUTOBRAKE 3	8190	110/-100	340	-410/1480	220/-140	280/-230	370	880	2950

Poor Reported Braking Action

MAX MANUAL	9700	130/-140	390	-590/2180	640/-490	430/-290	340	2170	6970
AUTOBRAKE MAX	9740	130/-140	390	-590/2190	660/-500	430/-290	340	2180	7000
AUTOBRAKE 3	9750	130/-130	390	-590/2190	650/-450	430/-290	370	2170	6990

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

BLD DUCT LEAK L / BLD DUCT LEAK R - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4460	70/-50	130	-210/680	60/-50	120/-120	200	80	180
AUTOBRAKE MAX	5110	60/-60	150	-240/780	0/0	140/-140	260	0	0
AUTOBRAKE 2	8150	100/-110	280	-420/1410	0/-50	250/-250	450	0	0

Good Reported Braking Action

MAX MANUAL	5860	90/-80	250	-330/1180	140/-120	220/-190	300	340	810
AUTOBRAKE MAX	5860	90/-80	250	-320/1180	150/-100	220/-190	310	330	800
AUTOBRAKE 2	8160	100/-110	290	-420/1420	40/-60	250/-250	450	0	0

Good to Medium Reported Braking Action

MAX MANUAL	6280	90/-80	250	-350/1230	180/-150	230/-190	300	430	1050
AUTOBRAKE MAX	6280	90/-80	260	-340/1240	190/-140	230/-190	310	430	1040
AUTOBRAKE 2	8160	100/-110	290	-420/1420	40/-60	250/-250	450	0	0

Medium Reported Braking Action

MAX MANUAL	6630	90/-80	260	-360/1290	210/-180	240/-190	300	550	1380
AUTOBRAKE MAX	6630	90/-80	270	-350/1290	230/-160	240/-190	310	550	1370
AUTOBRAKE 3	7360	90/-90	260	-390/1350	110/-70	230/-230	410	120	800

Medium to Poor Reported Braking Action

MAX MANUAL	7650	110/-110	340	-450/1620	310/-250	320/-250	340	970	2700
AUTOBRAKE MAX	7680	120/-110	350	-450/1620	330/-270	330/-250	340	980	2710
AUTOBRAKE 3	7870	110/-100	340	-420/1490	240/-130	270/-230	360	790	2530

Poor Reported Braking Action

MAX MANUAL	9470	130/-130	380	-590/2190	650/-490	410/-280	340	2010	6260
AUTOBRAKE MAX	9490	130/-130	380	-590/2190	670/-510	410/-280	340	2020	6270
AUTOBRAKE 3	9490	140/-130	380	-590/2190	660/-470	410/-280	360	2020	6280

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ENG 1, 2, 3, 4 SHUTDOWN - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4610	80/-50	140	-210/700	60/-60	130/-120	210	0	170
AUTOBRAKE MAX	5310	60/-60	150	-240/790	0/0	140/-140	270	0	0
AUTOBRAKE 2	8520	100/-110	280	-430/1430	0/-20	260/-260	480	0	0

Good Reported Braking Action

MAX MANUAL	6260	90/-90	270	-360/1310	180/-150	240/-210	340	0	680
AUTOBRAKE MAX	6280	90/-90	270	-350/1310	190/-130	240/-210	350	0	660
AUTOBRAKE 2	8520	100/-110	290	-430/1440	30/-20	260/-260	480	0	0

Good to Medium Reported Braking Action

MAX MANUAL	6770	90/-90	280	-380/1360	230/-190	250/-220	340	0	830
AUTOBRAKE MAX	6770	90/-90	280	-370/1350	240/-170	250/-210	350	0	810
AUTOBRAKE 2	8520	100/-110	290	-430/1440	30/-20	260/-260	480	0	0

Medium Reported Braking Action

MAX MANUAL	7220	90/-100	280	-390/1410	280/-230	260/-220	340	0	1040
AUTOBRAKE MAX	7220	90/-100	290	-390/1410	290/-210	260/-220	350	0	1020
AUTOBRAKE 3	7710	90/-100	270	-400/1380	150/-80	240/-230	420	0	730

Medium to Poor Reported Braking Action

MAX MANUAL	8630	130/-130	410	-540/1950	460/-360	380/-300	400	0	2160
AUTOBRAKE MAX	8660	130/-130	410	-540/1950	480/-380	390/-310	400	0	2180
AUTOBRAKE 3	8680	130/-130	410	-540/1950	480/-350	390/-310	420	0	2180

Poor Reported Braking Action

MAX MANUAL	11310	150/-160	450	-710/2630	1070/-760	480/-350	400	0	4650
AUTOBRAKE MAX	11340	150/-160	460	-720/2630	1090/-780	490/-350	400	0	4660
AUTOBRAKE 3	11360	150/-160	460	-720/2640	1080/-750	490/-350	420	0	4660

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

ENG 1, 2, 3, 4 SHUTDOWN - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4460	80/-50	130	-210/690	60/-60	120/-120	210	0	150
AUTOBRAKE MAX	5110	60/-60	150	-240/780	0/0	140/-140	260	0	0
AUTOBRAKE 2	8150	100/-110	280	-420/1410	0/-20	250/-250	460	0	0

Good Reported Braking Action

MAX MANUAL	5980	90/-90	260	-350/1280	170/-140	230/-200	330	0	580
AUTOBRAKE MAX	6000	90/-80	270	-340/1270	170/-120	230/-200	340	0	560
AUTOBRAKE 2	8150	100/-110	280	-420/1410	20/-20	250/-250	460	0	0

Good to Medium Reported Braking Action

MAX MANUAL	6490	90/-90	270	-370/1320	220/-180	240/-210	330	0	720
AUTOBRAKE MAX	6500	90/-90	270	-360/1310	220/-160	230/-200	340	0	700
AUTOBRAKE 2	8150	100/-110	280	-420/1410	20/-20	250/-250	460	0	0

Medium Reported Braking Action

MAX MANUAL	6940	90/-90	280	-380/1380	270/-220	250/-210	330	0	920
AUTOBRAKE MAX	6950	90/-90	280	-380/1370	270/-200	240/-210	340	0	900
AUTOBRAKE 3	7390	90/-100	260	-400/1360	160/-80	230/-220	410	0	640

Medium to Poor Reported Braking Action

MAX MANUAL	8250	130/-130	390	-530/1920	440/-340	360/-290	400	0	1830
AUTOBRAKE MAX	8270	130/-130	400	-530/1920	460/-360	360/-290	400	0	1840
AUTOBRAKE 3	8290	130/-130	400	-530/1920	450/-330	360/-290	420	0	1850

Poor Reported Braking Action

MAX MANUAL	10940	150/-150	440	-710/2610	1050/-740	460/-340	400	0	4110
AUTOBRAKE MAX	10960	150/-150	440	-710/2610	1070/-760	460/-340	400	0	4120
AUTOBRAKE 3	10980	160/-150	440	-710/2620	1050/-740	460/-340	420	0	4130

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

FLAPS CONTROL - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (FT)							
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4510	70/-50	130	-210/680	60/-50	130/-120	200	140	310
AUTOBRAKE MAX	5310	60/-60	150	-240/790	0/0	140/-140	270	0	0
AUTOBRAKE 2	8430	100/-120	290	-430/1420	40/-110	280/-250	410	90	90

Good Reported Braking Action

MAX MANUAL	5860	80/-80	250	-320/1160	140/-120	230/-190	300	480	1200
AUTOBRAKE MAX	5900	80/-80	250	-310/1160	140/-100	230/-190	300	460	1150
AUTOBRAKE 2	8440	100/-120	290	-430/1440	80/-110	280/-250	420	90	90

Good to Medium Reported Braking Action

MAX MANUAL	6280	80/-90	250	-340/1210	170/-150	240/-190	300	580	1440
AUTOBRAKE MAX	6310	80/-90	260	-340/1210	180/-140	240/-190	300	570	1410
AUTOBRAKE 2	8440	100/-120	290	-430/1440	80/-110	280/-250	420	90	90

Medium Reported Braking Action

MAX MANUAL	6620	90/-90	260	-350/1270	210/-170	250/-200	290	710	1800
AUTOBRAKE MAX	6640	90/-90	260	-350/1270	220/-170	250/-200	300	690	1760
AUTOBRAKE 3	7630	90/-100	260	-390/1330	80/-50	230/-230	420	120	950

Medium to Poor Reported Braking Action

MAX MANUAL	7580	110/-110	350	-440/1590	300/-240	340/-250	330	1210	3500
AUTOBRAKE MAX	7620	110/-110	350	-440/1600	310/-250	340/-250	340	1220	3530
AUTOBRAKE 3	7870	110/-100	340	-390/1450	190/-110	270/-230	380	970	3280

Poor Reported Braking Action

MAX MANUAL	9360	130/-140	390	-580/2150	620/-470	430/-280	330	2290	7320
AUTOBRAKE MAX	9390	130/-140	390	-580/2150	640/-480	430/-280	340	2290	7340
AUTOBRAKE 3	9420	130/-130	390	-580/2150	620/-430	420/-290	380	2260	7310

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

FLAPS DRIVE - Flaps 25

VREF30+25

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5460	80/-60	170	-220/730	70/-60	160/-140	220	210	460
AUTOBRAKE MAX	6610	60/-70	200	-270/870	10/-20	180/-180	300	0	0
AUTOBRAKE 2	10290	120/-130	380	-470/1550	160/-230	380/-310	380	430	430

Good Reported Braking Action

MAX MANUAL	7270	100/-90	320	-360/1270	180/-160	300/-240	320	730	1880
AUTOBRAKE MAX	7380	100/-90	320	-360/1270	190/-150	300/-240	320	720	1880
AUTOBRAKE 2	10310	120/-130	380	-470/1560	170/-230	380/-310	370	430	430

Good to Medium Reported Braking Action

MAX MANUAL	7690	100/-100	320	-380/1330	220/-180	310/-240	320	830	2140
AUTOBRAKE MAX	7790	100/-100	330	-380/1330	230/-180	310/-240	320	830	2140
AUTOBRAKE 2	10310	120/-130	380	-470/1560	170/-230	380/-310	370	430	430

Medium Reported Braking Action

MAX MANUAL	8030	100/-100	330	-400/1380	250/-210	320/-240	320	960	2500
AUTOBRAKE MAX	8130	100/-100	340	-400/1390	260/-210	320/-250	320	960	2510
AUTOBRAKE 3	9530	100/-110	330	-430/1450	100/-130	300/-290	410	160	1310

Medium to Poor Reported Braking Action

MAX MANUAL	9170	130/-130	430	-480/1710	360/-290	430/-300	340	1640	4860
AUTOBRAKE MAX	9260	130/-130	430	-480/1720	370/-310	430/-300	340	1650	4920
AUTOBRAKE 3	9610	130/-110	420	-430/1610	230/-140	350/-280	400	1340	4620

Poor Reported Braking Action

MAX MANUAL	10970	150/-150	460	-620/2260	690/-530	510/-330	340	2750	8870
AUTOBRAKE MAX	11050	150/-150	470	-620/2270	700/-540	520/-340	340	2760	8930
AUTOBRAKE 3	11230	150/-150	460	-620/2290	640/-480	500/-340	400	2620	8810

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Flaps Up Landing - Flaps Up

VREF30+70

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	7250	120/-80	230	-260/840	90/-80	220/-190	230	310	710
AUTOBRAKE MAX	9290	90/-80	280	-320/1020	10/-10	260/-260	340	30	90
AUTOBRAKE 2	14160	160/-170	550	-550/1780	300/-310	590/-430	390	1510	1640

Good Reported Braking Action

MAX MANUAL	9850	120/-120	430	-420/1450	220/-200	420/-330	310	1120	2910
AUTOBRAKE MAX	10000	120/-110	430	-410/1440	200/-170	430/-330	330	1130	2930
AUTOBRAKE 2	14160	160/-170	550	-550/1780	310/-310	590/-430	390	1510	1640

Good to Medium Reported Braking Action

MAX MANUAL	10280	120/-120	440	-440/1500	260/-230	430/-330	310	1220	3160
AUTOBRAKE MAX	10410	120/-120	440	-440/1500	250/-210	440/-330	330	1240	3190
AUTOBRAKE 2	14160	160/-170	550	-550/1780	310/-310	590/-430	390	1510	1640

Medium Reported Braking Action

MAX MANUAL	10620	120/-120	450	-450/1560	290/-250	450/-340	310	1350	3520
AUTOBRAKE MAX	10750	120/-120	450	-450/1550	280/-240	450/-340	330	1370	3550
AUTOBRAKE 3	13370	130/-150	490	-500/1670	220/-250	490/-400	390	600	1200

Medium to Poor Reported Braking Action

MAX MANUAL	12460	160/-160	580	-550/1920	450/-380	600/-400	340	2490	7620
AUTOBRAKE MAX	12490	160/-160	580	-550/1920	470/-390	600/-410	340	2490	7610
AUTOBRAKE 3	13460	160/-160	580	-510/1830	310/-280	550/-410	380	1730	6820

Poor Reported Braking Action

MAX MANUAL	14350	180/-180	610	-680/2450	790/-620	690/-440	340	3690	12060
AUTOBRAKE MAX	14390	180/-180	610	-680/2460	810/-630	700/-440	340	3690	12050
AUTOBRAKE 3	15130	180/-190	620	-700/2510	780/-630	700/-470	380	3150	11470

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

FLARE ASSIST - Flaps 25

VREF25

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4510	70/-50	130	-210/680	60/-50	130/-120	200	140	310
AUTOBRAKE MAX	5310	60/-60	150	-240/790	0/0	140/-140	270	0	0
AUTOBRAKE 2	8430	100/-120	290	-430/1420	40/-110	280/-250	410	90	90

Good Reported Braking Action

MAX MANUAL	5860	80/-80	250	-320/1160	140/-120	230/-190	300	480	1200
AUTOBRAKE MAX	5900	80/-80	250	-310/1160	140/-100	230/-190	300	460	1150
AUTOBRAKE 2	8440	100/-120	290	-430/1440	80/-110	280/-250	420	90	90

Good to Medium Reported Braking Action

MAX MANUAL	6280	80/-90	250	-340/1210	170/-150	240/-190	300	580	1440
AUTOBRAKE MAX	6310	80/-90	260	-340/1210	180/-140	240/-190	300	570	1410
AUTOBRAKE 2	8440	100/-120	290	-430/1440	80/-110	280/-250	420	90	90

Medium Reported Braking Action

MAX MANUAL	6620	90/-90	260	-350/1270	210/-170	250/-200	290	710	1800
AUTOBRAKE MAX	6640	90/-90	260	-350/1270	220/-170	250/-200	300	690	1760
AUTOBRAKE 3	7630	90/-100	260	-390/1330	80/-50	230/-230	420	120	950

Medium to Poor Reported Braking Action

MAX MANUAL	7580	110/-110	350	-440/1590	300/-240	340/-250	330	1210	3500
AUTOBRAKE MAX	7620	110/-110	350	-440/1600	310/-250	340/-250	340	1220	3530
AUTOBRAKE 3	7870	110/-100	340	-390/1450	190/-110	270/-230	380	970	3280

Poor Reported Braking Action

MAX MANUAL	9360	130/-140	390	-580/2150	620/-470	430/-280	330	2290	7320
AUTOBRAKE MAX	9390	130/-140	390	-580/2150	640/-480	430/-280	340	2290	7340
AUTOBRAKE 3	9420	130/-130	390	-580/2150	620/-430	420/-290	380	2260	7310

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (1 Body or 1 Wing Gear Up) - Flaps 25

VREF25

BRAKING CONFIGURATION	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4890	90/-70	150	-230/760	80/-70	140/-130	210	210	480
AUTOBRAKE MAX	5340	80/-70	160	-250/810	20/-10	140/-140	270	40	320
AUTOBRAKE 2	8450	100/-120	290	-430/1430	30/-90	280/-250	420	70	70

Good Reported Braking Action

MAX MANUAL	5950	90/-90	250	-330/1170	140/-120	230/-190	300	500	1240
AUTOBRAKE MAX	5970	90/-90	250	-320/1170	150/-120	230/-190	310	480	1210
AUTOBRAKE 2	8470	100/-120	290	-430/1450	70/-100	280/-260	420	70	70

Good to Medium Reported Braking Action

MAX MANUAL	6320	80/-90	250	-340/1220	170/-150	240/-190	300	590	1480
AUTOBRAKE MAX	6340	80/-90	260	-340/1220	180/-150	240/-200	310	580	1450
AUTOBRAKE 2	8470	100/-120	290	-430/1450	70/-100	280/-260	420	70	70

Medium Reported Braking Action

MAX MANUAL	6650	90/-90	260	-360/1280	210/-180	250/-200	300	720	1840
AUTOBRAKE MAX	6680	90/-90	270	-360/1280	220/-170	260/-200	310	710	1810
AUTOBRAKE 3	7650	90/-100	260	-390/1330	80/-50	230/-230	420	120	1010

Medium to Poor Reported Braking Action

MAX MANUAL	7640	110/-110	350	-450/1600	300/-250	350/-250	340	1240	3610
AUTOBRAKE MAX	7680	120/-120	350	-450/1610	320/-260	350/-250	340	1250	3650
AUTOBRAKE 3	7910	110/-100	340	-400/1460	210/-110	280/-230	370	1020	3410

Poor Reported Braking Action

MAX MANUAL	9440	130/-140	390	-580/2160	630/-480	430/-280	340	2350	7570
AUTOBRAKE MAX	9470	130/-140	400	-580/2160	650/-490	440/-290	340	2360	7610
AUTOBRAKE 3	9500	130/-140	390	-580/2160	630/-440	430/-290	370	2330	7580

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (1 Body or 1 Wing Gear Up) - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4720	90/-70	150	-230/750	70/-70	140/-120	210	190	420
AUTOBRAKE MAX	5140	80/-60	160	-240/800	20/-10	140/-140	270	40	290
AUTOBRAKE 2	8120	100/-110	280	-420/1400	10/-80	250/-240	420	30	30

Good Reported Braking Action

MAX MANUAL	5730	90/-80	240	-320/1150	140/-120	220/-180	300	440	1080
AUTOBRAKE MAX	5750	90/-80	250	-320/1160	150/-110	220/-180	300	430	1040
AUTOBRAKE 2	8140	100/-110	290	-420/1420	50/-90	260/-250	430	30	30

Good to Medium Reported Braking Action

MAX MANUAL	6100	90/-80	250	-340/1200	170/-150	230/-190	300	530	1300
AUTOBRAKE MAX	6120	90/-80	250	-330/1210	180/-140	230/-190	300	520	1270
AUTOBRAKE 2	8140	100/-110	290	-420/1420	50/-90	260/-250	430	30	30

Medium Reported Braking Action

MAX MANUAL	6450	90/-80	260	-350/1260	210/-170	240/-190	300	650	1640
AUTOBRAKE MAX	6460	90/-90	260	-350/1260	220/-170	240/-190	300	640	1610
AUTOBRAKE 3	7320	90/-90	250	-380/1310	80/-50	220/-220	410	130	920

Medium to Poor Reported Braking Action

MAX MANUAL	7380	120/-110	340	-440/1600	300/-240	330/-240	340	1110	3120
AUTOBRAKE MAX	7410	120/-110	350	-440/1600	310/-250	330/-240	340	1120	3140
AUTOBRAKE 3	7590	110/-100	340	-400/1480	230/-110	270/-220	370	940	2960

Poor Reported Braking Action

MAX MANUAL	9230	140/-130	380	-580/2160	640/-480	420/-280	340	2050	6810
AUTOBRAKE MAX	9260	140/-130	390	-580/2170	660/-490	420/-280	340	2060	6840
AUTOBRAKE 3	9260	140/-130	390	-580/2170	660/-450	420/-280	370	2050	6830

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (2 Body or 2 Wing Gear Up) - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5910	110/-100	190	-290/980	130/-120	190/-160	250	420	1000
AUTOBRAKE MAX	5970	110/-90	200	-290/980	130/-110	190/-160	270	420	1020
AUTOBRAKE 2	8480	100/-120	280	-430/1430	20/-80	270/-260	430	30	30

Good Reported Braking Action

MAX MANUAL	6360	110/-100	260	-350/1230	170/-140	240/-200	310	550	1370
AUTOBRAKE MAX	6360	110/-100	260	-350/1230	190/-150	250/-200	320	550	1370
AUTOBRAKE 2	8530	100/-120	300	-430/1470	80/-100	280/-260	440	40	40

Good to Medium Reported Braking Action

MAX MANUAL	6470	100/-90	260	-350/1240	180/-150	240/-200	310	590	1470
AUTOBRAKE MAX	6470	100/-90	260	-350/1240	200/-160	250/-200	320	590	1470
AUTOBRAKE 2	8530	100/-120	300	-430/1470	80/-100	280/-260	440	40	40

Medium Reported Braking Action

MAX MANUAL	6810	90/-90	270	-360/1290	210/-180	260/-200	310	720	1840
AUTOBRAKE MAX	6810	90/-90	270	-360/1300	230/-190	260/-200	320	720	1840
AUTOBRAKE 3	7710	90/-100	260	-400/1350	100/-70	230/-230	430	130	1050

Medium to Poor Reported Braking Action

MAX MANUAL	7810	120/-120	350	-450/1630	310/-250	350/-250	350	1260	3680
AUTOBRAKE MAX	7870	120/-120	360	-460/1630	330/-270	360/-260	350	1270	3740
AUTOBRAKE 3	8080	110/-100	350	-400/1500	230/-130	290/-230	380	1070	3530

Poor Reported Braking Action

MAX MANUAL	9630	140/-140	400	-590/2180	640/-490	440/-290	350	2380	7760
AUTOBRAKE MAX	9680	140/-140	400	-590/2190	670/-510	450/-290	350	2400	7820
AUTOBRAKE 3	9700	140/-140	400	-590/2190	650/-460	440/-290	380	2380	7800

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (2 Body or 2 Wing Gear Up) - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5700	110/-90	190	-290/960	130/-110	180/-150	240	370	880
AUTOBRAKE MAX	5760	110/-90	190	-290/970	130/-110	180/-160	260	380	900
AUTOBRAKE 2	8150	100/-110	280	-420/1410	0/-60	250/-250	440	10	10

Good Reported Braking Action

MAX MANUAL	6130	110/-90	250	-340/1210	160/-140	230/-190	300	490	1200
AUTOBRAKE MAX	6130	110/-90	260	-340/1220	180/-140	230/-190	310	490	1200
AUTOBRAKE 2	8190	100/-110	290	-430/1440	60/-80	250/-250	440	10	10

Good to Medium Reported Braking Action

MAX MANUAL	6250	110/-80	250	-340/1220	170/-150	230/-190	300	530	1300
AUTOBRAKE MAX	6250	110/-80	260	-340/1230	190/-150	240/-190	310	530	1300
AUTOBRAKE 2	8190	100/-110	290	-430/1440	60/-80	250/-250	440	10	10

Medium Reported Braking Action

MAX MANUAL	6600	90/-90	260	-360/1280	210/-170	240/-190	300	650	1640
AUTOBRAKE MAX	6600	90/-90	270	-360/1280	230/-180	250/-200	310	650	1640
AUTOBRAKE 3	7380	90/-90	260	-390/1330	100/-70	220/-220	420	130	970

Medium to Poor Reported Braking Action

MAX MANUAL	7550	120/-110	350	-450/1620	300/-250	330/-240	350	1120	3170
AUTOBRAKE MAX	7600	120/-110	360	-450/1630	330/-270	340/-250	350	1140	3220
AUTOBRAKE 3	7760	120/-100	350	-400/1510	250/-130	290/-230	370	980	3060

Poor Reported Braking Action

MAX MANUAL	9410	140/-130	390	-590/2190	650/-490	420/-280	350	2210	6980
AUTOBRAKE MAX	9460	140/-140	390	-590/2190	680/-510	430/-280	350	2230	7020
AUTOBRAKE 3	9460	140/-130	390	-590/2190	680/-480	430/-290	370	2230	7020

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (Nose and Body Gear Up) - Flaps 25

VREF25

BRAKING CONFIGURATION	REF DIST 680000 LB LANDING WEIGHT	WEIGHT ADJ PER 10000 LB ABV/BLW 680000 LB	ALT ADJ PER 1000 FT ABOVE SEA LEVEL	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABV VREF	REVERSE THRUST ADJ TWO REV	REVERSE THRUST ADJ NO REV
Dry Runway									
MAX MANUAL	5910	110/-100	190	-290/980	130/-120	190/-160	250	420	1000
AUTOBRAKE MAX	5970	110/-90	200	-290/980	130/-110	190/-160	270	420	1020
AUTOBRAKE 2	8480	100/-120	280	-430/1430	20/-80	270/-260	430	30	30
Good Reported Braking Action									
MAX MANUAL	6360	110/-100	260	-350/1230	170/-140	240/-200	310	550	1370
AUTOBRAKE MAX	6360	110/-100	260	-350/1230	190/-150	250/-200	320	550	1370
AUTOBRAKE 2	8530	100/-120	300	-430/1470	80/-100	280/-260	440	40	40
Good to Medium Reported Braking Action									
MAX MANUAL	6470	100/-90	260	-350/1240	180/-150	240/-200	310	590	1470
AUTOBRAKE MAX	6470	100/-90	260	-350/1240	200/-160	250/-200	320	590	1470
AUTOBRAKE 2	8530	100/-120	300	-430/1470	80/-100	280/-260	440	40	40
Medium Reported Braking Action									
MAX MANUAL	6810	90/-90	270	-360/1290	210/-180	260/-200	310	720	1840
AUTOBRAKE MAX	6810	90/-90	270	-360/1300	230/-190	260/-200	320	720	1840
AUTOBRAKE 3	7710	90/-100	260	-400/1350	100/-70	230/-230	430	130	1050
Medium to Poor Reported Braking Action									
MAX MANUAL	7810	120/-120	350	-450/1630	310/-250	350/-250	350	1260	3680
AUTOBRAKE MAX	7870	120/-120	360	-460/1630	330/-270	360/-260	350	1270	3740
AUTOBRAKE 3	8080	110/-100	350	-400/1500	230/-130	290/-230	380	1070	3530
Poor Reported Braking Action									
MAX MANUAL	9630	140/-140	400	-590/2180	640/-490	440/-290	350	2380	7760
AUTOBRAKE MAX	9680	140/-140	400	-590/2190	670/-510	450/-290	350	2400	7820
AUTOBRAKE 3	9700	140/-140	400	-590/2190	650/-460	440/-290	380	2380	7800

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

GEAR DISAGREE (Nose and Body Gear Up) - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5700	110/-90	190	-290/960	130/-110	180/-150	240	370	880
AUTOBRAKE MAX	5760	110/-90	190	-290/970	130/-110	180/-160	260	380	900
AUTOBRAKE 2	8150	100/-110	280	-420/1410	0/-60	250/-250	440	10	10

Good Reported Braking Action

MAX MANUAL	6130	110/-90	250	-340/1210	160/-140	230/-190	300	490	1200
AUTOBRAKE MAX	6130	110/-90	260	-340/1220	180/-140	230/-190	310	490	1200
AUTOBRAKE 2	8190	100/-110	290	-430/1440	60/-80	250/-250	440	10	10

Good to Medium Reported Braking Action

MAX MANUAL	6250	110/-80	250	-340/1220	170/-150	230/-190	300	530	1300
AUTOBRAKE MAX	6250	110/-80	260	-340/1230	190/-150	240/-190	310	530	1300
AUTOBRAKE 2	8190	100/-110	290	-430/1440	60/-80	250/-250	440	10	10

Medium Reported Braking Action

MAX MANUAL	6600	90/-90	260	-360/1280	210/-170	240/-190	300	650	1640
AUTOBRAKE MAX	6600	90/-90	270	-360/1280	230/-180	250/-200	310	650	1640
AUTOBRAKE 3	7380	90/-90	260	-390/1330	100/-70	220/-220	420	130	970

Medium to Poor Reported Braking Action

MAX MANUAL	7550	120/-110	350	-450/1620	300/-250	330/-240	350	1120	3170
AUTOBRAKE MAX	7600	120/-110	360	-450/1630	330/-270	340/-250	350	1140	3220
AUTOBRAKE 3	7760	120/-100	350	-400/1510	250/-130	290/-230	370	980	3060

Poor Reported Braking Action

MAX MANUAL	9410	140/-130	390	-590/2190	650/-490	420/-280	350	2210	6980
AUTOBRAKE MAX	9460	140/-140	390	-590/2190	680/-510	430/-280	350	2230	7020
AUTOBRAKE 3	9460	140/-130	390	-590/2190	680/-480	430/-290	370	2230	7020

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRES SYS 1+4 - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	7030	70/-70	230	-300/980	170/-150	210/-190	350	0	500
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	9590	140/-130	460	-510/1810	440/-350	410/-330	480	0	2000
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	10320	140/-130	470	-540/1890	540/-420	420/-340	480	0	2290
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	10890	140/-140	480	-560/1970	630/-480	440/-350	480	0	2700
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	12640	190/-180	640	-710/2580	940/-680	600/-440	510	0	5120
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	16050	210/-210	720	-970/3610	2040/-1310	750/-500	510	0	10030
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 3	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRES SYS 2+3 - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	6040	70/-60	200	-250/820	120/-100	180/-170	310	0	380
AUTOBRAKE MAX	6280	70/-70	200	-260/850	60/-30	180/-170	320	0	300
AUTOBRAKE 2	10110	110/-120	350	-470/1550	0/0	310/-310	530	0	0

Good Reported Braking Action

MAX MANUAL	8510	120/-110	410	-450/1590	340/-280	360/-300	450	0	1650
AUTOBRAKE MAX	8520	120/-110	410	-450/1590	360/-290	370/-300	460	0	1650
AUTOBRAKE 2	10240	120/-120	380	-490/1620	120/-40	330/-320	530	0	790

Good to Medium Reported Braking Action

MAX MANUAL	9060	120/-120	410	-460/1630	390/-320	370/-300	450	0	1820
AUTOBRAKE MAX	9060	120/-120	420	-470/1640	420/-340	370/-300	460	0	1820
AUTOBRAKE 2	10240	120/-120	380	-490/1620	120/-40	330/-320	530	0	790

Medium Reported Braking Action

MAX MANUAL	9560	120/-120	420	-480/1690	460/-370	380/-310	450	0	2110
AUTOBRAKE MAX	9560	120/-120	430	-480/1690	480/-390	390/-310	460	0	2110
AUTOBRAKE 3	9580	120/-120	430	-480/1680	480/-240	380/-300	460	0	2120

Medium to Poor Reported Braking Action

MAX MANUAL	11410	170/-160	580	-640/2300	750/-560	550/-400	490	0	4390
AUTOBRAKE MAX	11460	170/-160	590	-640/2300	780/-590	550/-410	490	0	4420
AUTOBRAKE 3	11460	170/-160	590	-640/2300	780/-590	550/-410	490	0	4420

Poor Reported Braking Action

MAX MANUAL	14470	190/-190	640	-840/3050	1500/-1050	670/-460	490	0	7860
AUTOBRAKE MAX	14520	190/-190	640	-840/3050	1530/-1070	670/-460	490	0	7890
AUTOBRAKE 3	14520	190/-190	640	-840/3050	1530/-1070	670/-460	490	0	7890

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1 / HYD PRESS SYS 2 / HYD PRESS SYS 3 - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4860	70/-60	150	-220/730	80/-70	140/-130	240	0	210
AUTOBRAKE MAX	5310	60/-60	150	-240/790	0/0	140/-140	270	0	60
AUTOBRAKE 2	8520	100/-110	280	-430/1430	0/0	260/-260	490	0	0

Good Reported Braking Action

MAX MANUAL	6700	100/-100	300	-390/1400	220/-190	270/-230	380	0	900
AUTOBRAKE MAX	6700	100/-100	310	-390/1400	240/-190	270/-230	390	0	890
AUTOBRAKE 2	8560	100/-120	290	-440/1460	40/-20	260/-260	490	0	120

Good to Medium Reported Braking Action

MAX MANUAL	7230	100/-100	310	-400/1440	270/-230	280/-230	380	0	1060
AUTOBRAKE MAX	7230	100/-100	320	-400/1440	290/-230	280/-240	390	0	1050
AUTOBRAKE 2	8560	100/-120	290	-440/1460	40/-20	260/-260	490	0	120

Medium Reported Braking Action

MAX MANUAL	7710	100/-100	320	-420/1500	340/-270	290/-240	380	0	1310
AUTOBRAKE MAX	7710	100/-100	320	-420/1500	350/-280	290/-240	390	0	1310
AUTOBRAKE 3	7870	100/-100	310	-420/1470	280/-130	280/-250	420	0	1250

Medium to Poor Reported Braking Action

MAX MANUAL	9280	140/-140	460	-570/2090	560/-420	430/-330	450	0	2820
AUTOBRAKE MAX	9320	140/-140	470	-580/2090	580/-450	430/-330	450	0	2840
AUTOBRAKE 3	9320	140/-140	470	-580/2090	580/-440	430/-330	450	0	2840

Poor Reported Braking Action

MAX MANUAL	12230	160/-170	520	-770/2840	1280/-890	540/-380	450	0	5900
AUTOBRAKE MAX	12270	160/-170	530	-770/2850	1300/-910	550/-390	450	0	5930
AUTOBRAKE 3	12270	160/-170	530	-770/2850	1300/-910	550/-390	450	0	5930

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1 / HYD PRESS SYS 2 / HYD PRESS SYS 3 - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	4690	70/-50	150	-220/720	70/-70	130/-120	240	0	190
AUTOBRAKE MAX	5110	60/-60	150	-240/780	10/0	140/-140	260	0	60
AUTOBRAKE 2	8150	100/-110	280	-420/1410	0/0	250/-250	480	0	0

Good Reported Braking Action

MAX MANUAL	6390	100/-90	290	-380/1360	210/-170	250/-220	370	0	760
AUTOBRAKE MAX	6390	100/-90	300	-380/1360	220/-180	250/-220	380	0	750
AUTOBRAKE 2	8180	100/-110	290	-430/1430	40/-10	250/-250	480	0	60

Good to Medium Reported Braking Action

MAX MANUAL	6930	100/-90	300	-390/1410	260/-210	260/-220	370	0	910
AUTOBRAKE MAX	6930	100/-90	310	-390/1410	280/-220	260/-230	380	0	900
AUTOBRAKE 2	8180	100/-110	290	-430/1430	40/-10	250/-250	480	0	60

Medium Reported Braking Action

MAX MANUAL	7410	100/-100	310	-410/1470	320/-260	270/-230	370	0	1150
AUTOBRAKE MAX	7410	100/-100	310	-410/1470	340/-270	270/-230	380	0	1140
AUTOBRAKE 3	7540	100/-100	310	-410/1450	290/-130	260/-230	410	0	1110

Medium to Poor Reported Braking Action

MAX MANUAL	8860	140/-130	450	-560/2050	530/-400	400/-320	440	0	2360
AUTOBRAKE MAX	8890	140/-130	450	-560/2050	550/-420	400/-320	440	0	2380
AUTOBRAKE 3	8890	140/-130	450	-560/2060	550/-420	400/-320	440	0	2380

Poor Reported Braking Action

MAX MANUAL	11820	160/-160	500	-760/2820	1260/-870	510/-370	440	0	5190
AUTOBRAKE MAX	11860	160/-160	510	-760/2820	1280/-890	520/-370	440	0	5200
AUTOBRAKE 3	11860	160/-160	510	-760/2820	1280/-880	520/-370	440	0	5200

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 4 - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5900	60/-70	190	-280/910	140/-120	180/-160	310	0	440
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	7920	120/-120	370	-460/1660	350/-280	340/-280	450	0	1610
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	8650	120/-120	380	-490/1740	440/-350	350/-280	450	0	1900
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	9220	120/-130	400	-510/1820	540/-410	370/-290	450	0	2310
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	10760	170/-170	550	-670/2440	810/-590	520/-380	510	0	4410
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	14170	190/-200	650	-920/3470	1930/-1220	670/-450	510	0	9350
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 4 - Flaps 30

VREF30

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5690	60/-70	190	-270/900	130/-110	170/-160	310	0	390
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	7550	120/-110	360	-450/1630	330/-260	320/-260	440	0	1360
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	8290	120/-110	370	-470/1700	430/-330	330/-270	440	0	1630
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	8870	120/-120	390	-500/1790	520/-400	350/-280	440	0	2020
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	10290	170/-160	530	-650/2410	780/-560	490/-360	500	0	3700
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	13730	190/-190	620	-920/3460	1920/-1200	640/-430	500	0	8220
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 1 and HYD PRESS SYS 2/ HYD PRESS SYS 1 and HYD PRESS SYS 3 - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5920	80/-60	190	-250/820	110/-100	160/-160	280	0	0
AUTOBRAKE MAX	6270	80/-60	190	-260/850	100/-40	170/-170	310	0	0
AUTOBRAKE 2	10110	110/-120	350	-470/1550	0/-20	310/-310	530	0	0

Good Reported Braking Action

MAX MANUAL	9150	130/-120	450	-530/1910	450/-350	350/-350	510	0	0
AUTOBRAKE MAX	9160	130/-120	450	-530/1920	480/-370	360/-350	510	0	0
AUTOBRAKE 2	10310	130/-130	440	-510/1860	310/-120	350/-350	520	0	0

Good to Medium Reported Braking Action

MAX MANUAL	9840	120/-120	450	-540/1940	530/-410	360/-350	510	0	0
AUTOBRAKE MAX	9850	130/-120	460	-540/1940	560/-430	360/-360	510	0	0
AUTOBRAKE 2	10310	130/-130	440	-510/1860	380/-120	350/-350	520	0	0

Medium Reported Braking Action

MAX MANUAL	10580	130/-120	460	-560/1990	650/-490	360/-360	510	0	0
AUTOBRAKE MAX	10580	130/-120	470	-560/2000	680/-510	370/-360	510	0	0
AUTOBRAKE 3	10720	130/-120	460	-560/1990	640/-490	370/-360	520	0	0

Medium to Poor Reported Braking Action

MAX MANUAL	14130	190/-190	720	-890/3290	1470/-970	570/-560	620	0	0
AUTOBRAKE MAX	14190	200/-190	730	-890/3300	1510/-1000	570/-570	620	0	0
AUTOBRAKE 3	14190	200/-190	730	-890/3300	1510/-970	570/-570	640	0	0

Poor Reported Braking Action

MAX MANUAL	20140	200/-200	770	-1210/4360	3690/-2170	650/-650	620	0	0
AUTOBRAKE MAX	20200	200/-200	780	-1210/4370	3730/-2210	650/-660	620	0	0
AUTOBRAKE 3	20200	200/-200	780	-1210/4370	3730/-2170	650/-660	640	0	0

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

HYD PRESS SYS 2 and HYD PRESS SYS 4/ HYD PRESS SYS 3 and HYD PRESS SYS 4 - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	8400	80/-80	290	-360/1150	330/-270	240/-250	550	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good Reported Braking Action

MAX MANUAL	13230	180/-170	690	-770/2770	1300/-860	530/-520	860	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Good to Medium Reported Braking Action

MAX MANUAL	14300	180/-170	700	-780/2790	1480/-980	530/-530	860	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium Reported Braking Action

MAX MANUAL	15370	180/-170	710	-800/2840	1760/-1140	540/-530	860	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Medium to Poor Reported Braking Action

MAX MANUAL	20350	270/-270	1120	-1290/4800	4030/-2080	840/-830	970	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Poor Reported Braking Action

MAX MANUAL	29570	270/-240	1250	-1790/6460	9500/-4410	970/-950	960	0	0
AUTOBRAKE MAX	AUTOBRAKES INOPERATIVE								
AUTOBRAKE 2	AUTOBRAKES INOPERATIVE								

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Jammed Stab Landing - Flaps 25

VREF30+20

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV
Dry Runway									
MAX MANUAL	5330	80/-60	170	-220/730	70/-70	150/-140	230	210	470
AUTOBRAKE MAX	6260	60/-70	190	-260/850	10/-10	170/-170	310	0	10
AUTOBRAKE 2	9880	120/-130	360	-460/1530	100/-170	350/-300	430	230	230
Good Reported Braking Action									
MAX MANUAL	7080	100/-90	310	-360/1270	180/-160	290/-230	320	730	1890
AUTOBRAKE MAX	7170	100/-90	320	-360/1270	190/-160	300/-230	330	720	1880
AUTOBRAKE 2	9970	120/-130	370	-470/1550	130/-200	360/-300	410	250	320
Good to Medium Reported Braking Action									
MAX MANUAL	7510	100/-100	320	-380/1320	220/-190	300/-230	320	830	2150
AUTOBRAKE MAX	7580	100/-100	320	-380/1330	230/-200	310/-240	330	830	2160
AUTOBRAKE 2	9970	120/-130	370	-470/1550	130/-200	360/-300	410	250	320
Medium Reported Braking Action									
MAX MANUAL	7850	100/-100	330	-390/1380	250/-210	320/-240	320	970	2540
AUTOBRAKE MAX	7920	100/-100	330	-400/1380	270/-220	320/-240	330	960	2540
AUTOBRAKE 3	9100	100/-110	310	-420/1430	80/-90	270/-270	440	160	1520
Medium to Poor Reported Braking Action									
MAX MANUAL	8970	130/-130	420	-480/1710	360/-300	420/-290	350	1660	5000
AUTOBRAKE MAX	9040	130/-130	430	-480/1710	380/-310	430/-290	360	1670	5060
AUTOBRAKE 3	9270	130/-110	420	-430/1620	270/-140	360/-280	400	1440	4830
Poor Reported Braking Action									
MAX MANUAL	10790	150/-150	460	-620/2260	700/-530	510/-330	350	2790	9190
AUTOBRAKE MAX	10860	150/-150	460	-620/2270	720/-550	520/-330	360	2810	9240
AUTOBRAKE 3	10950	150/-150	450	-620/2280	670/-490	490/-340	400	2720	9150

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

SPOILERS - Flaps 25

VREF25

	LANDING DISTANCE AND ADJUSTMENTS (FT)								
	REF DIST	WEIGHT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	680000 LB LANDING WEIGHT	PER 10000 LB ABV/BLW 680000 LB	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 ABV VREF	TWO REV	NO REV

Dry Runway

MAX MANUAL	5040	60/-60	160	-230/740	80/-70	150/-130	270	230	540
AUTOBRAKE MAX	5340	60/-70	160	-240/790	20/-10	150/-140	280	90	340
AUTOBRAKE 2	8520	100/-120	280	-430/1430	0/-40	260/-260	470	0	0

Good Reported Braking Action

MAX MANUAL	6570	100/-100	290	-360/1260	200/-170	280/-210	370	780	2110
AUTOBRAKE MAX	6570	100/-100	300	-350/1260	210/-170	280/-220	380	770	2090
AUTOBRAKE 2	8630	100/-120	300	-440/1480	70/-70	260/-270	480	80	780

Good to Medium Reported Braking Action

MAX MANUAL	7010	100/-100	300	-370/1310	240/-200	290/-220	370	890	2400
AUTOBRAKE MAX	7010	100/-100	300	-370/1310	250/-210	290/-220	380	890	2390
AUTOBRAKE 2	8630	100/-120	300	-440/1480	70/-70	260/-270	480	80	820

Medium Reported Braking Action

MAX MANUAL	7370	100/-100	310	-390/1360	280/-230	300/-220	370	1050	2870
AUTOBRAKE MAX	7370	100/-100	310	-390/1370	290/-240	300/-220	380	1040	2860
AUTOBRAKE 3	7790	90/-100	280	-410/1410	180/-100	260/-240	440	610	2430

Medium to Poor Reported Braking Action

MAX MANUAL	8360	130/-130	400	-480/1710	390/-310	410/-270	400	1750	5750
AUTOBRAKE MAX	8400	130/-130	410	-480/1710	410/-330	410/-280	400	1770	5800
AUTOBRAKE 3	8410	130/-110	410	-440/1710	410/-220	410/-270	400	1760	5790

Poor Reported Braking Action

MAX MANUAL	10220	150/-150	450	-620/2270	740/-560	500/-310	400	3010	10720
AUTOBRAKE MAX	10260	150/-150	450	-620/2270	760/-580	510/-310	400	3020	10770
AUTOBRAKE 3	10260	150/-150	450	-620/2270	760/-580	510/-310	400	3020	10770

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILERS - Flaps 30
VREF30

BRAKING CONFIGURATION	REF DIST 680000 LB LANDING WEIGHT	WEIGHT ADJ PER 10000 LB ABV/BLW 680000 LB	ALT ADJ PER 1000 FT ABOVE SEA LEVEL	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABV VREF	REVERSE THRUST ADJ TWO REV	REVERSE THRUST ADJ NO REV
Dry Runway									
MAX MANUAL	4880	60/-60	160	-220/730	80/-70	140/-130	270	210	480
AUTOBRAKE MAX	5140	60/-60	160	-240/780	20/-10	140/-140	280	90	320
AUTOBRAKE 2	8150	100/-110	280	-420/1410	0/-20	250/-250	480	0	0
Good Reported Braking Action									
MAX MANUAL	6330	100/-90	290	-350/1240	190/-160	260/-210	370	690	1820
AUTOBRAKE MAX	6330	100/-90	290	-350/1250	200/-170	260/-210	370	680	1790
AUTOBRAKE 2	8250	100/-110	300	-430/1440	60/-40	250/-250	480	70	630
Good to Medium Reported Braking Action									
MAX MANUAL	6780	100/-90	290	-370/1290	230/-190	270/-210	370	800	2100
AUTOBRAKE MAX	6780	100/-90	300	-370/1300	250/-200	270/-210	370	790	2080
AUTOBRAKE 2	8250	100/-110	300	-430/1440	60/-40	250/-250	480	70	660
Medium Reported Braking Action									
MAX MANUAL	7140	100/-100	300	-380/1350	270/-230	290/-210	370	950	2540
AUTOBRAKE MAX	7140	100/-100	310	-380/1350	290/-230	290/-220	370	940	2520
AUTOBRAKE 3	7450	100/-100	280	-390/1390	180/-90	250/-230	430	610	2190
Medium to Poor Reported Braking Action									
MAX MANUAL	8100	130/-120	400	-470/1710	390/-310	390/-270	400	1580	4930
AUTOBRAKE MAX	8130	130/-120	400	-480/1710	410/-320	390/-270	400	1590	4960
AUTOBRAKE 3	8130	130/-110	400	-450/1710	410/-240	390/-270	400	1590	4960
Poor Reported Braking Action									
MAX MANUAL	10010	150/-150	440	-620/2280	760/-570	480/-300	400	2810	9570
AUTOBRAKE MAX	10040	150/-150	440	-620/2280	780/-590	490/-310	400	2820	9600
AUTOBRAKE 3	10040	150/-150	440	-620/2280	780/-590	490/-310	400	2820	9600

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

STAB TRIM UNSCHD - Flaps 25

VREF30+20

BRAKING CONFIGURATION	REF DIST: 680000 LB LANDING WEIGHT	WEIGHT ADJ: PER 10000 LB ABV/BLW 680000 LB	ALT ADJ: PER 1000 FT ABOVE SEA LEVEL	WIND ADJ: PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ: PER 1% DOWN/ UP HILL	TEMP ADJ: PER 10°C ABV/ BLW ISA	APP SPD ADJ: PER 5 KTS ABV VREF	REVERSE THRUST ADJ: TWO REV	REVERSE THRUST ADJ: NO REV
Dry Runway									
MAX MANUAL	5330	80/-60	170	-220/730	70/-70	150/-140	230	210	470
AUTOBRAKE MAX	6260	60/-70	190	-260/850	10/-10	170/-170	310	0	10
AUTOBRAKE 2	9880	120/-130	360	-460/1530	100/-170	350/-300	430	230	230
Good Reported Braking Action									
MAX MANUAL	7080	100/-90	310	-360/1270	180/-160	290/-230	320	730	1890
AUTOBRAKE MAX	7170	100/-90	320	-360/1270	190/-160	300/-230	330	720	1880
AUTOBRAKE 2	9970	120/-130	370	-470/1550	130/-200	360/-300	410	250	320
Good to Medium Reported Braking Action									
MAX MANUAL	7510	100/-100	320	-380/1320	220/-190	300/-230	320	830	2150
AUTOBRAKE MAX	7580	100/-100	320	-380/1330	230/-200	310/-240	330	830	2160
AUTOBRAKE 2	9970	120/-130	370	-470/1550	130/-200	360/-300	410	250	320
Medium Reported Braking Action									
MAX MANUAL	7850	100/-100	330	-390/1380	250/-210	320/-240	320	970	2540
AUTOBRAKE MAX	7920	100/-100	330	-400/1380	270/-220	320/-240	330	960	2540
AUTOBRAKE 3	9100	100/-110	310	-420/1430	80/-90	270/-270	440	160	1520
Medium to Poor Reported Braking Action									
MAX MANUAL	8970	130/-130	420	-480/1710	360/-300	420/-290	350	1660	5000
AUTOBRAKE MAX	9040	130/-130	430	-480/1710	380/-310	430/-290	360	1670	5060
AUTOBRAKE 3	9270	130/-110	420	-430/1620	270/-140	360/-280	400	1440	4830
Poor Reported Braking Action									
MAX MANUAL	10790	150/-150	460	-620/2260	700/-530	510/-330	350	2790	9190
AUTOBRAKE MAX	10860	150/-150	460	-620/2270	720/-550	520/-330	360	2810	9240
AUTOBRAKE 3	10950	150/-150	450	-620/2280	670/-490	490/-340	400	2720	9150

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance

Two Engines Inop - Flaps 25

VREF25

BRAKING CONFIGURATION	REF DIST 680000 LB LANDING WEIGHT	WEIGHT ADJ PER 10000 LB ABV/BLW 680000 LB	ALT ADJ PER 1000 FT ABOVE SEA LEVEL	WIND ADJ PER 10 KTS HEAD/ TAIL WIND	SLOPE ADJ PER 1% DOWN/ UP HILL	TEMP ADJ PER 10°C ABV/ BLW ISA	APP SPD ADJ PER 5 KTS ABV VREF	REVERSE THRUST ADJ TWO REV	REVERSE THRUST ADJ NO REV
Dry Runway									
MAX MANUAL	4740	80/-60	140	-220/720	70/-70	130/-130	220	0	0
AUTOBRAKE MAX	5310	70/-60	150	-240/790	0/0	140/-140	270	0	0
AUTOBRAKE 2	8520	100/-110	280	-430/1430	0/-30	260/-260	470	0	0
Good Reported Braking Action									
MAX MANUAL	6830	100/-100	310	-420/1550	260/-210	260/-250	400	0	0
AUTOBRAKE MAX	6850	100/-100	310	-410/1530	250/-180	250/-250	420	0	0
AUTOBRAKE 2	8520	100/-110	290	-430/1440	20/-30	260/-260	470	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	7470	100/-100	310	-430/1580	330/-260	260/-250	400	0	0
AUTOBRAKE MAX	7470	100/-100	310	-420/1560	330/-240	250/-250	420	0	0
AUTOBRAKE 2	8520	100/-110	290	-430/1440	20/-30	260/-260	470	0	0
Medium Reported Braking Action									
MAX MANUAL	8110	100/-110	320	-450/1630	420/-330	260/-260	400	0	0
AUTOBRAKE MAX	8110	100/-110	320	-440/1610	420/-300	260/-250	420	0	0
AUTOBRAKE 3	8290	100/-110	320	-450/1640	420/-280	270/-260	420	0	0
Medium to Poor Reported Braking Action									
MAX MANUAL	10520	160/-170	500	-720/2690	880/-620	420/-420	540	0	0
AUTOBRAKE MAX	10550	160/-170	510	-720/2700	910/-640	430/-420	540	0	0
AUTOBRAKE 3	10600	160/-170	510	-730/2700	890/-620	430/-420	570	0	0
Poor Reported Braking Action									
MAX MANUAL	15310	180/-190	520	-980/3530	2380/-1490	490/-490	540	0	0
AUTOBRAKE MAX	15340	180/-190	530	-980/3530	2410/-1510	490/-500	540	0	0
AUTOBRAKE 3	15380	180/-190	530	-980/3540	2370/-1490	490/-500	570	0	0

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
Actual (unfactored) distances are shown.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.

ADVISORY INFORMATION

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on engine bleed for packs on and anti-ice off

AIRPORT OAT (°C)	LANDING CLIMB LIMIT WEIGHT (1000 LB)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	0	2000	4000	6000	8000	10000
54	729.1					
52	746.6					
50	766.5	740.7				
48	784.4	759.8				
46	802.6	778.0	727.3			
44	820.8	796.3	743.0			
42	839.2	814.9	761.7	699.1		
40	858.2	833.2	778.5	715.0		
38	878.7	851.9	795.2	731.2	671.4	
36	898.4	870.6	812.3	746.1	684.3	
34	915.9	889.2	829.4	762.0	697.6	627.9
32	930.6	905.6	846.4	776.2	710.2	638.8
30	945.5	920.6	859.3	790.5	721.8	649.8
28	946.1	934.1	871.9	805.1	733.5	660.3
26	946.6	947.1	884.4	824.2	745.1	670.5
24	947.1	947.5	896.5	834.3	758.2	680.5
22	947.6	947.9	907.6	843.8	778.2	690.1
20	948.1	948.3	908.0	852.7	788.0	699.6
18	948.6	948.7	908.3	860.9	796.5	709.7
16	949.1	949.1	908.6	861.1	803.8	718.9
14	949.5	949.4	908.8	861.2	810.5	727.1
12	949.7	949.8	909.0	861.3	810.7	734.5
10	950.0	950.1	909.2	861.4	810.8	741.3
-40	951.8	951.8	915.3	864.1	812.7	743.7

With engine bleed for packs off, increase weight by 8200 lb.
With engine anti-ice on, decrease weight by 9900 lb.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10°C, decrease weight by 48300 lb.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Table 1 of 3: Reference Brake Energy (Millions of Foot Pounds)

		BRAKES-ON SPEED (KIAS)														
		100			120			140			160			180		
WEIGHT (1000 LB)	OAT (°C)	PRESSURE ALTITUDE (1000 FT)														
		0	5	10	0	5	10	0	5	10	0	5	10	0	5	10
	0	34.1	38.7	44.1	46.2	52.8	60.6	59.7	68.7	79.4	74.3	86.1	100.3	89.6	104.7	122.9
	10	35.2	40.0	45.6	47.7	54.6	62.6	61.7	71.0	82.1	76.8	89.0	103.8	92.6	108.3	127.2
	15	35.7	40.6	46.3	48.5	55.4	63.6	62.7	72.2	83.4	78.0	90.5	105.5	94.2	110.1	129.3
1000	20	36.3	41.2	47.0	49.2	56.3	64.6	63.6	73.3	84.8	79.3	91.9	107.2	95.7	111.8	131.5
	30	37.3	42.4	48.3	50.6	57.9	66.5	65.5	75.5	87.3	81.6	94.7	110.5	98.6	115.4	135.7
	40	37.5	42.7	48.7	51.1	58.6	67.3	66.3	76.6	88.8	82.9	96.5	112.9	100.5	118.0	139.4
	50	37.5	42.7	48.8	51.3	58.9	67.9	66.8	77.4	90.1	84.0	98.1	115.4	102.3	120.7	143.5
	0	31.4	35.6	40.5	42.4	48.4	55.4	54.7	62.8	72.4	68.0	78.5	91.2	81.9	95.3	111.5
	10	32.4	36.7	41.8	43.8	50.0	57.2	56.5	64.9	74.8	70.2	81.2	94.3	84.7	98.6	115.3
	15	32.9	37.3	42.5	44.5	50.8	58.1	57.4	65.9	76.0	71.3	82.5	95.8	86.0	100.2	117.2
900	20	33.4	37.9	43.1	45.2	51.5	59.0	58.3	67.0	77.2	72.5	83.8	97.4	87.4	101.8	119.2
	30	34.3	38.9	44.3	46.4	53.0	60.7	60.0	68.9	79.5	74.6	86.3	100.3	90.1	104.9	123.0
	40	34.5	39.2	44.7	46.8	53.5	61.4	60.7	69.8	80.7	75.7	87.8	102.3	91.6	107.1	125.9
	50	34.4	39.2	44.7	46.9	53.8	61.8	61.0	70.5	81.7	76.5	89.0	104.2	93.1	109.3	129.2
	0	28.6	32.4	36.8	38.6	43.9	50.2	49.6	56.8	65.3	61.6	70.9	82.0	74.1	85.9	100.1
	10	29.6	33.5	38.0	39.8	45.4	51.8	51.3	58.7	67.5	63.6	73.3	84.8	76.6	88.8	103.5
	15	30.0	34.0	38.6	40.5	46.1	52.7	52.1	59.6	68.6	64.6	74.5	86.2	77.9	90.3	105.2
800	20	30.5	34.5	39.2	41.1	46.8	53.5	52.9	60.6	69.6	65.6	75.6	87.6	79.1	91.7	106.9
	30	31.3	35.5	40.3	42.2	48.1	55.0	54.4	62.3	71.7	67.5	77.9	90.2	81.4	94.5	110.3
	40	31.5	35.7	40.6	42.6	48.6	55.6	54.9	63.1	72.7	68.4	79.1	91.8	82.7	96.3	112.7
	50	31.4	35.6	40.6	42.6	48.7	55.8	55.2	63.5	73.4	69.0	80.0	93.2	83.8	97.9	115.1
	0	25.9	29.3	33.2	34.7	39.5	45.0	44.5	50.8	58.3	55.1	63.3	73.0	66.3	76.5	88.8
	10	26.7	30.3	34.3	35.9	40.8	46.5	46.0	52.5	60.2	57.0	65.4	75.4	68.5	79.1	91.8
	15	27.1	30.7	34.8	36.4	41.4	47.2	46.7	53.3	61.2	57.9	66.5	76.6	69.6	80.4	93.3
700	20	27.6	31.2	35.4	37.0	42.0	47.9	47.4	54.2	62.1	58.7	67.5	77.8	70.7	81.7	94.8
	30	28.3	32.0	36.3	38.0	43.2	49.3	48.7	55.7	63.9	60.4	69.5	80.2	72.8	84.1	97.7
	40	28.4	32.2	36.6	38.3	43.6	49.7	49.2	56.3	64.7	61.1	70.4	81.4	73.8	85.5	99.6
	50	28.3	32.1	36.5	38.2	43.6	49.9	49.3	56.6	65.2	61.5	71.0	82.4	74.5	86.6	101.3
	0	23.2	26.2	29.7	30.9	35.0	39.8	39.3	44.8	51.2	48.5	55.4	63.7	58.2	66.9	77.2
	10	23.9	27.1	30.6	31.9	36.2	41.1	40.6	46.3	52.9	50.0	57.3	65.8	60.1	69.1	79.8
	15	24.3	27.5	31.1	32.4	36.7	41.8	41.2	47.0	53.7	50.8	58.2	66.8	61.0	70.2	81.1
600	20	24.7	27.9	31.6	32.9	37.3	42.4	41.9	47.7	54.5	51.6	59.1	67.9	62.0	71.3	82.4
	30	25.3	28.6	32.4	33.8	38.3	43.6	43.0	49.1	56.1	53.1	60.8	69.9	63.8	73.4	84.9
	40	25.5	28.8	32.6	34.0	38.6	44.0	43.4	49.5	56.7	53.6	61.5	70.8	64.6	74.5	86.3
	50	25.3	28.7	32.5	33.9	38.6	44.0	43.4	49.6	57.0	53.8	61.9	71.5	65.0	75.2	87.5
	0	20.6	23.2	26.2	27.0	30.6	34.7	34.1	38.7	44.1	41.7	47.5	54.4	49.8	57.0	65.5
	10	21.2	24.0	27.1	27.9	31.6	35.9	35.2	40.0	45.6	43.1	49.1	56.2	51.4	58.9	67.7
	15	21.6	24.3	27.5	28.3	32.1	36.4	35.7	40.6	46.3	43.7	49.9	57.1	52.2	59.8	68.8
500	20	21.9	24.7	27.9	28.8	32.6	37.0	36.3	41.2	47.0	44.4	50.6	58.0	53.0	60.7	69.8
	30	22.5	25.4	28.7	29.5	33.5	38.0	37.3	42.4	48.3	45.6	52.1	59.6	54.5	62.5	71.9
	40	22.6	25.5	28.8	29.7	33.7	38.3	37.5	42.7	48.8	46.0	52.6	60.3	55.1	63.2	72.9
	50	22.4	25.3	28.7	29.6	33.6	38.2	37.5	42.7	48.9	46.1	52.8	60.7	55.3	63.7	73.6

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 and enter table at sea level, 15°C.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Event Adjusted Brake Energy (Millions of Foot Pounds)

Table 2(a) of 3: No Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)												
EVENT		10	20	30	40	50	60	70	80	90	100	110	120	130
RTO MAX MAN		10	20	30	40	50	60	70	80	90	100	110	120	130
LANDING	MAX MAN	7.4	15.2	23.5	32.2	41.2	50.5	60.0	69.7	79.6	89.5	99.5	109.5	119.4
	MAX AUTO	6.8	14.2	22.1	30.4	39.1	48.1	57.5	67.0	76.7	86.5	96.5	106.4	116.3
	AUTOBRAKE 4	6.7	13.8	21.2	29.1	37.2	45.7	54.4	63.4	72.6	82.0	91.5	101.2	111.0
	AUTOBRAKE 3	6.5	13.4	20.6	28.1	35.9	44.0	52.3	60.8	69.6	78.5	87.6	96.8	106.1
	AUTOBRAKE 2	6.3	12.9	19.8	26.9	34.3	41.9	49.7	57.8	66.0	74.3	82.8	91.4	100.1
	AUTOBRAKE 1	5.9	12.0	18.4	24.9	31.6	38.4	45.5	52.6	60.0	67.5	75.1	82.9	90.7

Table 2(b) of 3: 4 Engine Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)												
EVENT		10	20	30	40	50	60	70	80	90	100	110	120	130
RTO MAX MAN		10	20	30	40	50	60	70	80	90	100	110	120	130
LANDING	MAX MAN	6.6	13.7	21.1	28.9	36.9	45.2	53.7	62.3	71.1	79.8	88.6	97.4	106.0
	MAX AUTO	5.0	10.6	16.8	23.6	30.8	38.5	46.6	55.0	63.6	72.4	81.3	90.4	99.4
	AUTOBRAKE 4	3.7	8.0	12.9	18.3	24.3	30.6	37.4	44.4	51.8	59.4	67.1	75.0	83.0
	AUTOBRAKE 3	2.7	6.1	10.1	14.6	19.7	25.1	31.0	37.2	43.7	50.4	57.3	64.3	71.4
	AUTOBRAKE 2	1.6	3.9	6.8	10.2	14.1	18.5	23.3	28.4	33.8	39.5	45.4	51.4	57.5
	AUTOBRAKE 1	1.0	2.4	4.1	6.2	8.6	11.3	14.3	17.5	21.0	24.7	28.7	32.8	37.1

Table 3 of 3: Cooling Time (Minutes)

	EVENT ADJUSTED BRAKE ENERGY (MILLIONS OF FOOT POUNDS)							
	BELOW 21	21	23	27	31	34	ABOVE 34 TO 48	48 & ABOVE
INFLIGHT GEAR DOWN	NO SPECIAL PROCEDURE REQUIRED	0.1	1.0	2.0	3.1	3.9	CAUTION	FUSE PLUG MELT ZONE
GROUND		1	9	20	31	39		
BRAKE TEMPERATURE INDICATION	UP TO 2.91	3.00	3.35	3.88	4.50	5.00	5.0 TO 7.0	7.0 & ABOVE

Observe maximum quick turnaround limit. Table shows energy per brake added by a single stop with all brakes operating. Energy is assumed to be equally distributed among the operating brakes. Total energy is the sum of residual energy plus energy added.

Add 1.0 million foot pounds for each taxi mile.

With one brake deactivated, increase brake energy by 7 percent.
With 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 4 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not approach gear or attempt 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 indication on Multifunction Display may be used 10 to 15 minutes after airplane has come to a complete stop, or in flight with gear retracted, to determine recommended cooling schedule.

Performance Inflight — Chapter PI
Engine Inoperative — Section 23

1 ENGINE INOP

Max Continuous %N1
37000 FT to 27000 FT Pressure Altitudes
Based on engine bleed for packs on and anti-ice off

37000 FT PRESS ALT		TAT (°C)											
KCAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
200	0.63	93.8	94.9	95.9	96.9	97.9	98.9	98.3	96.9	95.9	94.8	93.7	93.3
240	0.74	93.7	94.7	95.8	96.8	97.8	98.8	99.8	100.3	99.0	97.9	96.9	95.7
280	0.86	93.6	94.6	95.6	96.6	97.7	98.7	99.6	100.6	100.9	100.3	99.2	98.2
35000 FT PRESS ALT		TAT (°C)											
KCAS	M	-50	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5
200	0.60	93.9	94.9	96.0	97.0	98.0	99.0	98.7	97.2	96.1	95.1	94.0	93.3
240	0.71	93.8	94.8	95.8	96.9	97.9	98.9	99.8	100.5	99.1	97.9	96.9	95.8
280	0.82	93.6	94.6	95.6	96.7	97.7	98.7	99.7	100.6	100.9	100.2	99.1	98.1
33000 FT PRESS ALT		TAT (°C)											
KCAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
200	0.58	95.1	96.1	97.2	98.2	99.2	100.1	98.8	97.5	96.4	95.3	94.2	94.4
240	0.68	94.9	96.0	97.0	98.0	99.0	100.0	100.6	100.0	98.7	97.6	96.5	95.4
280	0.79	94.4	95.4	96.4	97.4	98.4	99.4	100.4	101.0	100.6	99.4	98.3	97.3
31000 FT PRESS ALT		TAT (°C)											
KCAS	M	-45	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10
200	0.55	95.3	96.3	97.3	98.3	99.3	100.3	100.4	99.0	97.8	96.7	95.6	94.6
240	0.66	95.1	96.2	97.2	98.2	99.2	100.2	101.0	101.1	99.8	98.6	97.5	96.3
280	0.76	94.5	95.5	96.5	97.5	98.5	99.5	100.5	101.5	101.0	99.9	98.8	97.7
29000 FT PRESS ALT		TAT (°C)											
KCAS	M	-40	-35	-30	-25	-20	-15	-10	-5	0	5	10	15
200	0.53	96.0	97.1	98.1	99.1	100.1	100.5	99.6	98.3	97.2	96.1	95.0	95.0
240	0.63	95.8	96.8	97.8	98.8	99.8	100.8	100.8	99.8	98.6	97.6	96.5	95.5
280	0.73	94.8	95.9	96.9	97.8	98.8	99.8	100.8	100.9	99.9	98.8	97.8	96.8
27000 FT PRESS ALT		TAT (°C)											
KCAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
200	0.51	96.7	97.7	98.7	99.7	100.5	100.0	98.8	97.6	96.6	95.5	94.5	95.3
240	0.60	96.3	97.3	98.3	99.2	100.2	101.0	99.9	98.7	97.7	96.7	95.8	94.8
280	0.70	95.1	96.1	97.1	98.0	99.0	99.9	100.9	99.9	98.9	98.0	97.1	96.2
320	0.79	93.4	94.3	95.3	96.3	97.2	98.1	99.1	100.0	99.9	99.0	98.1	97.2

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	27	29	31	33	35	37
PACKS OFF	0.3	0.3	0.3	0.3	0.4	0.4
ENGINE ANTI-ICE ON	-0.4	-0.4	-0.4	-0.4	-0.4	-0.4
ENGINE & WING ANTI-ICE ON	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9

1 ENGINE INOP

Max Continuous %N1

25000 FT to 18000 FT Pressure Altitudes

Based on engine bleed for packs on and anti-ice off

25000 FT PRESS ALT		TAT (°C)											
KCAS	M	-35	-30	-25	-20	-15	-10	-5	0	5	10	15	20
200	0.49	96.3	97.3	98.3	99.2	100.2	100.1	99.1	97.9	96.8	95.8	94.9	94.6
240	0.58	95.3	96.3	97.3	98.3	99.2	100.2	100.0	98.9	97.8	96.8	95.9	95.0
280	0.67	94.1	95.1	96.1	97.0	98.0	98.9	99.9	100.0	99.0	98.0	97.0	96.2
320	0.76	92.6	93.6	94.5	95.5	96.4	97.4	98.3	99.2	99.8	99.0	98.1	97.3
24000 FT PRESS ALT		TAT (°C)											
KCAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
200	0.48	96.7	97.7	98.7	99.6	100.2	99.2	98.1	97.0	95.9	95.0	94.2	95.0
240	0.57	95.8	96.8	97.7	98.7	99.6	100.1	99.1	98.0	97.0	96.1	95.2	94.3
280	0.66	94.7	95.6	96.6	97.6	98.5	99.4	100.0	99.0	98.0	97.1	96.3	95.4
320	0.75	93.3	94.2	95.2	96.1	97.0	97.9	98.8	99.8	99.1	98.2	97.3	96.5
22000 FT PRESS ALT		TAT (°C)											
KCAS	M	-30	-25	-20	-15	-10	-5	0	5	10	15	20	25
200	0.46	95.6	96.6	97.5	98.5	99.5	99.3	98.3	97.3	96.3	95.4	94.4	94.2
240	0.55	94.8	95.7	96.7	97.7	98.6	99.5	99.3	98.4	97.3	96.4	95.5	94.6
280	0.63	93.7	94.7	95.6	96.6	97.5	98.4	99.3	99.1	98.2	97.3	96.5	95.6
320	0.72	92.6	93.6	94.5	95.4	96.3	97.3	98.2	99.1	99.2	98.3	97.4	96.6
20000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.44	95.6	96.6	97.5	98.5	99.4	98.6	97.6	96.6	95.7	94.8	93.9	94.3
240	0.53	94.9	95.9	96.8	97.7	98.6	99.4	98.6	97.6	96.7	95.8	94.9	94.0
280	0.61	93.8	94.7	95.7	96.6	97.5	98.4	99.2	98.5	97.6	96.7	95.8	95.0
320	0.69	92.8	93.8	94.7	95.6	96.5	97.4	98.3	99.2	98.4	97.6	96.7	95.9
360	0.77	91.6	92.5	93.4	94.3	95.2	96.1	97.0	97.9	98.7	98.4	97.6	96.8
18000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.42	94.6	95.5	96.5	97.4	98.3	98.8	97.8	96.9	95.9	95.0	94.1	93.4
240	0.51	94.0	94.9	95.8	96.8	97.7	98.6	98.7	97.8	96.9	96.0	95.1	94.2
280	0.59	93.0	93.9	94.8	95.7	96.7	97.5	98.4	98.5	97.7	96.8	95.9	95.0
320	0.67	92.0	92.9	93.8	94.7	95.6	96.5	97.4	98.2	98.4	97.6	96.7	95.9
360	0.75	90.9	91.8	92.7	93.6	94.5	95.4	96.2	97.1	97.9	98.3	97.5	96.8

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	18	20	22	24	25
PACKS OFF	0.2	0.2	0.2	0.2	0.2
ENGINE ANTI-ICE ON	-0.4	-0.4	-0.4	-0.4	-0.4
ENGINE & WING ANTI-ICE ON	-0.8	-0.8	-0.8	-0.8	-0.9

1 ENGINE INOP

Max Continuous %N1

16000 FT to 5000 FT Pressure Altitudes

Based on engine bleed for packs on and anti-ice off

16000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.41	93.5	94.5	95.4	96.3	97.2	98.1	98.0	97.1	96.1	95.2	94.3	93.4
240	0.49	93.0	93.9	94.9	95.8	96.7	97.6	98.5	97.9	97.0	96.1	95.2	94.4
280	0.57	92.2	93.1	94.0	94.9	95.8	96.7	97.6	98.4	97.7	96.9	96.0	95.1
320	0.64	91.1	92.0	92.9	93.8	94.7	95.6	96.5	97.3	98.2	97.6	96.7	95.9
360	0.72	90.1	91.0	91.9	92.8	93.6	94.5	95.4	96.2	97.1	97.9	97.5	96.7
14000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.39	92.5	93.4	94.3	95.2	96.1	97.0	97.9	97.2	96.3	95.4	94.5	93.6
240	0.47	92.1	93.0	94.0	94.9	95.8	96.6	97.5	98.1	97.3	96.4	95.5	94.6
280	0.54	91.4	92.3	93.2	94.1	95.0	95.8	96.6	97.5	97.9	97.1	96.2	95.4
320	0.62	90.4	91.3	92.2	93.1	94.0	94.8	95.7	96.6	97.4	97.6	96.9	96.0
360	0.69	89.4	90.3	91.2	92.1	93.0	93.8	94.7	95.5	96.4	97.2	97.5	96.8
12000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.38	91.5	92.4	93.3	94.2	95.1	96.0	96.9	97.4	96.6	95.7	94.8	93.9
240	0.45	91.3	92.2	93.1	94.0	94.9	95.8	96.7	97.6	97.5	96.7	95.9	95.0
280	0.52	90.7	91.6	92.5	93.4	94.3	95.1	96.0	96.8	97.6	97.4	96.6	95.7
320	0.60	89.8	90.7	91.6	92.5	93.3	94.2	95.1	95.9	96.7	97.6	97.1	96.3
360	0.67	88.9	89.8	90.7	91.6	92.4	93.3	94.1	95.0	95.8	96.6	97.4	97.0
10000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.36	90.5	91.4	92.3	93.2	94.1	95.0	95.8	96.7	96.7	95.9	95.0	94.2
240	0.43	90.6	91.5	92.4	93.3	94.1	95.0	95.9	96.7	97.6	97.0	96.2	95.3
280	0.51	90.0	90.9	91.8	92.7	93.6	94.5	95.3	96.2	97.0	97.7	96.9	96.0
320	0.58	89.2	90.1	91.0	91.9	92.7	93.6	94.4	95.3	96.1	96.9	97.4	96.6
360	0.65	88.4	89.2	90.1	91.0	91.8	92.7	93.5	94.4	95.2	96.0	96.8	97.2
5000 FT PRESS ALT		TAT (°C)											
KCAS	M	-25	-20	-15	-10	-5	0	5	10	15	20	25	30
200	0.33	87.5	88.3	89.2	90.1	90.9	91.8	92.6	93.4	94.2	95.1	94.7	93.9
240	0.40	87.8	88.6	89.5	90.4	91.2	92.1	92.9	93.7	94.6	95.4	95.9	95.2
280	0.46	87.3	88.2	89.1	89.9	90.8	91.6	92.4	93.3	94.1	94.9	95.7	95.7
320	0.53	86.7	87.5	88.4	89.3	90.1	90.9	91.8	92.6	93.4	94.2	95.0	95.8
360	0.59	85.9	86.8	87.6	88.4	89.3	90.1	90.9	91.7	92.6	93.4	94.1	94.9

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)				
	5	10	12	14	16
PACKS OFF	0.1	0.1	0.2	0.3	0.2
ENGINE ANTI-ICE ON	-0.3	-0.3	-0.3	-0.2	-0.3
ENGINE & WING ANTI-ICE ON	-0.6	-0.6	-0.6	-0.7	-0.7

1 ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

WEIGHT (1000 LB)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
1000	981	321	26100	24700	23200
950	932	314	27800	26500	24900
900	886	307	29300	28100	26700
850	838	299	30900	30000	28500
800	787	289	32300	31700	30400
750	740	283	33800	33300	32100
700	690	272	35200	35000	33900
650	640	262	36600	36500	35600
600	589	252	38200	38000	37100
550	541	244	39800	39500	38700

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 LB)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
1000	24000	22000	19800
950	25900	24000	21900
900	27900	25900	24000
850	30000	28000	26000
800	31600	30200	28000
750	33200	32200	30100
700	34700	34000	32300
650	36100	35800	34400
600	37700	37200	36100
550	39300	38800	37700
500	41100	40400	39300
450	43100	42200	41100

Altitude reduced by 1000 ft for additional margin.
With engine anti-ice on, decrease altitude capability by 400 ft.
With engine and wing anti-ice on, decrease altitude capability by 1200 ft.

1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)									
		10	14	20	25	27	29	31	33	35	37
1000	%N1	83.7	87.2	92.1	96.7						
	MACH	.655	.703	.777	.833						
	KIAS	365	365	362	353						
	FF/ENG	10538	10706	10768	10878						
950	%N1	82.2	85.5	90.6	95.0	97.2					
	MACH	.644	.689	.761	.823	.837					
	KIAS	359	357	354	348	341					
	FF/ENG	10001	10095	10125	10264	10199					
900	%N1	80.5	83.8	89.0	93.3	95.3					
	MACH	.629	.673	.745	.809	.830					
	KIAS	350	349	346	342	337					
	FF/ENG	9426	9491	9504	9658	9614					
850	%N1	78.8	82.1	87.3	91.7	93.5	95.4	98.1			
	MACH	.613	.657	.728	.793	.817	.835	.841			
	KIAS	341	340	337	335	332	325	314			
	FF/ENG	8845	8895	8902	9047	9016	9006	8904			
800	%N1	77.0	80.3	85.5	89.9	91.6	93.5	95.7			
	MACH	.596	.640	.710	.775	.801	.824	.838			
	KIAS	331	331	329	326	324	321	313			
	FF/ENG	8283	8302	8314	8433	8417	8424	8325			
750	%N1	75.1	78.5	83.7	88.1	89.9	91.6	93.7	95.8		
	MACH	.579	.622	.692	.754	.782	.808	.829	.840		
	KIAS	322	321	320	317	316	314	309	300		
	FF/ENG	7761	7732	7757	7840	7842	7852	7792	7740		
700	%N1	73.2	76.7	81.8	86.3	88.0	89.7	91.7	93.7	95.9	
	MACH	.561	.603	.672	.734	.760	.788	.814	.833	.841	
	KIAS	312	311	310	307	306	306	303	298	288	
	FF/ENG	7254	7198	7227	7278	7269	7296	7237	7240	7190	
650	%N1	71.3	74.7	79.8	84.3	86.1	87.8	89.6	91.5	93.5	96.5
	MACH	.543	.583	.651	.712	.738	.765	.793	.819	.836	.842
	KIAS	301	301	300	298	297	296	295	292	286	275
	FF/ENG	6750	6683	6705	6733	6711	6732	6677	6702	6685	6704
600	%N1	69.2	72.5	77.6	82.2	84.0	85.7	87.5	89.3	91.3	93.7
	MACH	.524	.562	.628	.689	.714	.740	.768	.797	.822	.838
	KIAS	290	289	289	287	287	285	285	283	280	273
	FF/ENG	6249	6177	6162	6194	6172	6181	6127	6151	6166	6190
550	%N1	67.1	70.3	75.4	79.8	81.7	83.4	85.4	87.1	88.9	91.3
	MACH	.504	.540	.604	.664	.689	.715	.742	.770	.799	.824
	KIAS	279	278	277	276	276	275	274	273	272	268
	FF/ENG	5758	5678	5633	5833	5797	5646	5584	5609	5624	5678
500	%N1	64.7	67.9	72.9	77.3	79.1	80.9	82.9	84.7	86.4	88.7
	MACH	.483	.518	.579	.637	.662	.687	.714	.741	.770	.799
	KIAS	267	266	265	265	264	263	263	262	261	259
	FF/ENG	5485	5392	5319	5304	5275	5106	5053	5064	5088	5138
450	%N1	62.3	65.4	70.2	74.7	76.4	78.2	80.2	82.0	83.8	86.0
	MACH	.461	.494	.552	.608	.632	.657	.683	.710	.738	.767
	KIAS	255	254	252	252	252	251	251	250	249	248
	FF/ENG	5009	4910	4822	4767	4762	4574	4517	4534	4545	4596

1 ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 1 of 3: 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
700	649	604	565	531	500	479	459	441	424	409
1401	1299	1208	1130	1062	1000	959	921	886	853	823
2109	1954	1816	1697	1594	1500	1439	1382	1329	1280	1236
2823	2613	2426	2266	2126	2000	1919	1843	1773	1708	1649
3543	3276	3039	2836	2659	2500	2398	2304	2216	2135	2061
4270	3945	3655	3408	3193	3000	2878	2764	2658	2560	2471
5005	4619	4275	3982	3728	3500	3357	3223	3099	2985	2881
5748	5298	4898	4558	4264	4000	3836	3682	3540	3410	3290
6499	5983	5525	5137	4801	4500	4314	4141	3980	3833	3698
7259	6674	6155	5717	5339	5000	4793	4599	4420	4255	4104

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		22		29		33	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
500	29.7	1:29	27.1	1:25	23.5	1:18	20.6	1:13	19.1	1:11
1000	59.4	2:55	55.0	2:46	48.5	2:30	43.4	2:18	40.9	2:13
1500	88.5	4:23	82.2	4:09	73.0	3:44	65.8	3:25	62.1	3:16
2000	116.8	5:53	108.8	5:34	96.9	4:58	87.6	4:32	82.8	4:20
2500	144.6	7:25	134.9	7:00	120.3	6:14	109.0	5:40	103.0	5:24
3000	171.7	8:59	160.4	8:28	143.1	7:31	129.9	6:49	122.7	6:29
3500	198.2	10:35	185.4	9:58	165.8	8:50	150.3	8:00	142.0	7:35
4000	224.9	12:13	210.7	11:30	188.3	10:10	170.3	9:11	160.9	8:42
4500	251.2	13:54	235.4	13:03	210.2	11:32	189.8	10:23	179.4	9:50
5000	277.0	15:37	259.6	14:40	231.8	12:55	208.8	11:37	197.5	10:59

Table 3 of 3: Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB)					
	500	600	700	800	900	1000
20	-2.5	-1.8	0.0	2.2	6.6	6.6
40	-4.6	-3.1	0.0	4.6	12.3	16.6
60	-6.7	-4.3	0.0	6.9	17.7	26.1
80	-8.9	-5.5	0.0	9.2	22.9	35.0
100	-11.1	-6.7	0.0	11.4	27.8	43.4
120	-13.4	-7.8	0.0	13.5	32.4	51.3
140	-15.7	-9.0	0.0	15.6	36.7	58.6
160	-18.1	-10.1	0.0	17.7	40.8	65.4
180	-20.5	-11.2	0.0	19.6	44.6	71.7
200	-23.0	-12.3	0.0	21.5	48.1	77.4
220	-25.5	-13.4	0.0	23.4	51.3	82.6
240	-28.1	-14.5	0.0	25.1	54.3	87.3
260	-30.8	-15.5	0.0	26.9	57.0	91.4
280	-33.5	-16.5	0.0	28.5	59.4	95.0

1 ENGINE INOP

MAX CONTINUOUS THRUST

Holding

Flaps Up

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)								
		1500	5000	10000	15000	20000	25000	30000	35000	40000
1000	%N1	72.2	75.3	79.9	84.8	89.9	95.3			
	KIAS	265	267	269	274	316	320			
	FF/ENG	9370	9310	9400	9510	10020	10450			
950	%N1	70.6	73.7	78.2	83.1	88.2	93.3			
	KIAS	259	260	262	265	308	312			
	FF/ENG	8840	8800	8820	8930	9380	9740			
900	%N1	68.8	71.8	76.4	81.3	86.5	91.4			
	KIAS	254	255	256	258	299	303			
	FF/ENG	8320	8280	8250	8380	8770	9080			
850	%N1	67.1	70.0	74.5	79.3	84.6	89.6	95.4		
	KIAS	249	249	250	252	290	294	298		
	FF/ENG	7800	7760	7710	7820	8180	8450	8790		
800	%N1	65.3	68.1	72.6	77.2	82.6	87.7	93.0		
	KIAS	244	244	245	247	281	284	288		
	FF/ENG	7310	7250	7210	7260	7600	7830	8070		
750	%N1	63.5	66.2	70.6	75.2	80.6	85.7	90.7		
	KIAS	240	240	241	242	272	275	278		
	FF/ENG	6850	6770	6730	6730	7070	7240	7420		
700	%N1	61.7	64.4	68.6	73.2	78.5	83.6	88.6	94.9	
	KIAS	234	234	235	236	262	265	268	272	
	FF/ENG	6420	6320	6270	6250	6560	6680	6830	7140	
650	%N1	59.9	62.4	66.6	71.1	76.3	81.4	86.4	92.2	
	KIAS	229	229	229	230	252	255	257	261	
	FF/ENG	5990	5880	5830	5790	6040	6150	6260	6450	
600	%N1	57.9	60.4	64.5	68.9	74.0	79.1	84.1	89.5	
	KIAS	223	223	223	224	242	244	247	250	
	FF/ENG	5580	5690	5620	5560	5720	5800	5710	5820	
550	%N1	55.8	58.4	62.3	66.6	71.6	76.5	81.6	86.8	94.9
	KIAS	216	217	217	218	231	233	235	238	242
	FF/ENG	5420	5290	5200	5130	5250	5290	5160	5250	5710
500	%N1	53.6	56.1	60.1	64.2	69.0	73.8	78.9	84.1	91.5
	KIAS	210	210	210	211	220	222	224	226	230
	FF/ENG	5030	4890	4790	4710	4780	4780	4620	4700	5020
450	%N1	51.4	53.8	57.7	61.8	66.2	70.9	75.8	81.2	88.1
	KIAS	205	205	205	205	209	210	212	214	217
	FF/ENG	4650	4510	4410	4320	4300	4310	4310	4310	4550

This table includes 5% additional fuel for holding in a racetrack pattern.

Performance Inflight — Chapter PI
Two Engines Inoperative — Section 24

2 ENGINES INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

WEIGHT (1000 LB)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
1000	967	312	11100	9600	7800
950	917	304	12900	11500	9800
900	869	297	14900	13400	11800
850	822	289	17100	15600	13900
800	774	281	19200	17800	16200
750	726	273	21200	19900	18400
700	679	265	23300	22000	20600
650	631	256	25400	24300	22800
600	583	246	27300	26500	25200
550	535	236	29200	28900	27600
500	486	225	31000	30900	29900
450	438	214	33100	33000	32000

Altitude reduced by 2000 ft for additional margin.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Driftdown/LRC Cruise Range Capability

Table 1 of 2: 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
670	627	590	556	526	500	475	453	433	415	398
1337	1252	1178	1112	1053	1000	952	908	868	832	798
2000	1875	1764	1666	1579	1500	1428	1363	1304	1249	1199
2662	2497	2351	2221	2104	2000	1905	1818	1740	1667	1601
3324	3119	2937	2775	2630	2500	2381	2274	2176	2085	2003
3988	3742	3524	3330	3156	3000	2858	2729	2611	2503	2404
4656	4367	4112	3885	3682	3500	3334	3183	3046	2920	2803
5327	4996	4703	4442	4209	4000	3810	3637	3479	3335	3201
6006	5629	5296	5001	4737	4500	4285	4089	3911	3748	3597
6692	6267	5894	5562	5266	5000	4759	4540	4341	4158	3990

Table 2 of 2: Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 LB)											TIME (HR:MIN)
	WEIGHT AT START OF DRIFTDOWN (1000 LB)											
	450	500	550	600	650	700	750	800	850	900	950	***	
500	15.3	16.7	18.3	19.9	21.2	22.8	24.3	25.9	27.2	28.8	30.2	32.0	1:16
1000	31.5	34.6	37.9	41.2	44.1	47.5	50.8	53.9	57.1	60.8	64.3	68.1	2:31
1500	47.3	52.0	57.0	62.0	66.4	71.5	76.3	81.1	85.9	91.6	97.1	102.9	3:45
2000	62.6	68.9	75.4	82.2	88.2	94.9	101.4	107.7	114.2	121.7	129.2	136.8	4:59
2500	77.5	85.3	93.3	101.8	109.2	117.6	125.7	133.6	141.7	151.0	160.3	169.8	6:12
3000	91.9	101.2	110.7	120.8	129.7	139.7	149.3	158.8	168.4	179.5	190.6	201.8	7:26
3500	105.9	116.6	127.6	139.2	149.6	161.1	172.4	183.3	194.5	207.2	220.0	232.9	8:41
4000	119.5	131.7	143.9	157.1	168.9	182.0	194.8	207.1	219.8	234.2	248.7	263.2	9:57
4500	132.8	146.3	159.9	174.6	187.7	202.4	216.6	230.4	244.5	260.5	276.6	292.7	11:16
5000	145.7	160.5	175.4	191.6	206.1	222.2	237.8	253.0	268.5	286.1	303.8	321.4	12:37

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 LB)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
1000	5300	2700	
950	8000	5000	2400
900	10200	8200	5300
850	12400	10500	8500
800	14800	12900	10800
750	17200	15400	13200
700	19600	17900	15900
650	22000	20300	18600
600	24500	22900	21200
550	27000	25600	23900
500	29200	28400	26800
450	31300	30900	29700

Altitude reduced by 2000 ft for additional margin.
With engine anti-ice on, decrease altitude capability by 200 ft.
With engine and wing anti-ice on, decrease altitude capability by 1100 ft.

2 ENGINES INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT) 10	14	17	20	23	25	27	29	31
950	%N1	94.9								
	MACH	.644								
	KIAS	359								
	FF/ENG	15277								
900	%N1	93.0								
	MACH	.629								
	KIAS	350								
	FF/ENG	14333								
850	%N1	91.1	94.7							
	MACH	.613	.657							
	KIAS	341	340							
	FF/ENG	13395	13543							
800	%N1	89.0	92.7							
	MACH	.596	.640							
	KIAS	331	331							
	FF/ENG	12471	12600							
750	%N1	86.9	90.7							
	MACH	.579	.622							
	KIAS	322	321							
	FF/ENG	11593	11703							
700	%N1	84.7	88.7	94.4						
	MACH	.561	.603	.672						
	KIAS	312	311	310						
	FF/ENG	10749	10836	11003						
650	%N1	82.5	86.4	92.1						
	MACH	.543	.583	.651						
	KIAS	301	301	300						
	FF/ENG	9925	9986	10111						
600	%N1	80.1	83.9	89.7	95.1					
	MACH	.524	.562	.628	.689					
	KIAS	290	289	289	287					
	FF/ENG	9114	9160	9250	9522					
550	%N1	77.7	81.3	87.2	92.1	94.7	97.6			
	MACH	.504	.540	.604	.664	.689	.715			
	KIAS	279	278	277	276	276	275			
	FF/ENG	8291	8354	8403	8616	8676	8849			
500	%N1	75.0	78.5	84.3	89.3	91.3	93.8	97.0		
	MACH	.483	.518	.579	.637	.662	.687	.714		
	KIAS	267	266	265	265	264	263	263		
	FF/ENG	7528	7555	7583	7758	7771	7870	7973		
450	%N1	72.1	75.6	81.2	86.3	88.2	90.2	92.9		
	MACH	.461	.494	.552	.608	.632	.657	.683		
	KIAS	255	254	252	252	252	251	251		
	FF/ENG	6810	6755	6798	6917	6924	6974	6996		

ALTERNATE MODE EEC

Limit Weight

PERFORMANCE LIMIT	ALTERNATE MODE EEC LIMIT WEIGHT (1000 LB)											
	PRIMARY MODE PERFORMANCE LIMIT WEIGHT (1000 LB)											
	450	500	550	600	650	700	750	800	850	900	950	1000
FIELD	443.0	492.2	541.5	590.9	640.2	689.5	738.7	788.0	837.2	886.5	935.7	985.0
CLIMB	428.0	478.5	529.0	579.5	630.0	680.5	730.8	781.3	831.8	882.3	932.8	983.3
OBSTACLE	439.1	488.6	538.1	587.6	636.9	686.3	735.8	785.3	834.6	884.1	933.6	983.1
TIRE SPEED	448.8	498.3	547.8	597.3	646.8	696.5	746.0	795.5	845.0	894.5	944.1	993.7
BRAKE ENERGY	460.3	507.5	554.8	602.1	649.6	697.1	744.4	791.9	839.4	886.8	934.2	981.7
NET LEVEL OFF	450	500	550	600	650	700	750	800	850	900	950	1000
LANDING CLIMB	450	500	550	600	650	700	750	800	850	900	950	1000

ALTERNATE MODE EEC

Takeoff Speed Adjustments

TAKEOFF SPEEDS	TAKEOFF SPEED ADJUSTMENT (KTS)	
	DRY	WET
V1	0	0
VR	0	0
V2	0	0

ALTERNATE MODE EEC

Takeoff %N1

Based on engine bleed for packs on

AIRPORT OAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)												
	-2	-1	0	1	2	3	4	5	6	7	8	9	10
70	88.4	89.5	90.6	90.6	90.6	90.5	90.4	90.4	90.3	90.3	89.7	89.2	88.5
60	91.2	92.3	93.4	93.4	93.4	93.3	93.3	93.2	93.2	93.2	92.6	92.0	91.4
55	92.7	93.7	94.8	94.8	94.8	94.7	94.6	94.6	94.6	94.5	94.0	93.4	92.8
50	94.1	95.1	96.2	96.1	96.1	96.0	96.0	95.9	95.9	95.9	95.3	94.7	94.2
45	95.4	96.5	97.5	97.4	97.3	97.3	97.3	97.2	97.2	97.2	96.6	96.0	95.5
40	96.7	97.7	98.9	98.7	98.5	98.4	98.4	98.5	98.4	98.4	97.9	97.3	96.7
35	97.7	98.7	99.8	99.7	99.7	99.5	99.3	99.3	99.2	99.3	98.8	98.4	98.0
30	97.2	98.8	100.4	100.4	100.4	100.4	100.4	100.1	100.0	99.9	99.5	99.2	98.8
25	96.4	98.0	99.6	100.1	100.7	101.1	101.1	101.1	101.7	101.3	100.3	99.9	99.5
20	95.6	97.2	98.8	99.3	99.9	100.5	101.1	101.8	102.2	102.4	102.1	101.5	100.3
15	94.8	96.3	97.9	98.4	99.0	99.6	100.2	101.0	101.7	102.5	102.5	102.2	101.2
10	93.9	95.5	97.1	97.6	98.2	98.8	99.4	100.1	100.8	101.6	101.8	102.0	102.3
5	93.1	94.7	96.2	96.7	97.3	97.9	98.5	99.2	99.9	100.7	100.9	101.2	101.4
0	92.3	93.8	95.3	95.8	96.4	97.0	97.6	98.3	99.1	99.8	100.0	100.3	100.6
-10	90.6	92.1	93.6	94.1	94.6	95.2	95.9	96.6	97.3	98.0	98.3	98.5	98.8
-20	88.8	90.3	91.8	92.3	92.8	93.4	94.1	94.8	95.5	96.2	96.5	96.7	97.0
-30	87.0	88.5	89.9	90.4	91.0	91.6	92.3	93.0	93.7	94.4	94.7	94.9	95.2
-40	85.2	86.7	88.1	88.6	89.1	89.8	90.5	91.2	91.9	92.6	92.8	93.1	93.4
-50	83.4	84.8	86.2	86.7	87.3	87.9	88.6	89.3	90.0	90.7	91.0	91.2	91.5

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)				
	-2	0	8	9	10
PACKS OFF	0.6	0.6	0.6	0.7	0.7

ALTERNATE MODE EEC

Go-Around %N1

Based on engine bleed for packs off

AIRPORT OAT (°C)	TAT (°C)	AIRPORT PRESSURE ALTITUDE (1000 FT)										
		0	1	2	3	4	5	6	7	8	9	10
70	74	85.9	86.7	87.5	88.3	88.7	89.1	89.5	89.8	89.9	89.6	89.0
60	64	87.9	88.8	89.7	90.7	91.2	91.7	92.1	92.5	92.7	92.4	91.8
55	59	88.8	89.8	90.8	91.8	92.4	93.0	93.4	93.9	94.1	93.8	93.2
50	54	90.2	90.9	91.9	92.9	93.6	94.2	94.6	95.1	95.4	95.1	94.5
45	49	91.5	92.3	93.2	94.2	94.8	95.3	95.9	96.4	96.7	96.4	95.8
40	44	92.8	93.6	94.5	95.4	96.0	96.6	97.1	97.6	98.0	97.7	97.1
35	39	94.2	94.9	95.8	96.8	97.2	97.7	98.3	99.0	99.0	98.8	98.3
30	34	94.8	95.7	96.6	97.6	98.2	98.7	99.2	99.7	99.9	99.5	99.2
25	29	94.1	95.5	97.0	98.1	98.7	99.2	100.3	100.8	100.7	100.3	99.9
20	24	93.3	94.7	96.2	97.7	98.9	100.1	100.9	101.7	102.2	101.6	100.7
15	19	92.5	93.9	95.4	96.8	98.0	99.3	100.7	102.4	102.9	102.4	101.6
10	14	91.7	93.1	94.5	96.0	97.2	98.5	99.8	101.5	102.5	102.5	102.5
5	8	90.8	92.1	93.5	95.0	96.2	97.4	98.8	100.4	101.4	101.4	101.5
0	3	90.0	91.3	92.7	94.2	95.3	96.6	97.9	99.6	100.5	100.5	100.7
-10	-7	88.3	89.6	91.0	92.4	93.6	94.9	96.2	97.8	98.8	98.8	98.9
-20	-17	86.6	87.9	89.3	90.7	91.9	93.2	94.5	96.1	97.0	97.0	97.1
-30	-27	84.9	86.2	87.6	89.0	90.2	91.4	92.7	94.3	95.2	95.2	95.3
-40	-37	83.2	84.4	85.8	87.2	88.5	89.7	90.9	92.5	93.4	93.4	93.5
-50	-47	81.4	82.7	84.0	85.5	86.7	87.9	89.1	90.6	91.5	91.6	91.7

%N1 Adjustment for Engine Bleed

ENGINE BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)			
	0	8	9	10
PACKS OFF	0.6	0.6	0.7	0.7

Performance Inflight — Chapter PI
Gear Down — Section 26

GEAR DOWN

Max Climb %N1
Based on engine bleed for packs on, engine and wing anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT) / SPEED (KCAS OR MACH)														
	0	5	10	12	14	16	18	20	22	24	26	28	30	32	34
	240	240	240	240	240	240	240	240	240	240	240	0.60	0.60	0.60	0.60
55	90.4	91.1	93.9	94.6	94.0	96.0	96.9	97.7	98.5	99.1	99.8	100.8	101.5	102.0	101.8
50	91.3	91.8	93.2	93.9	94.5	95.3	96.2	97.0	97.7	98.4	99.1	100.0	100.8	101.2	101.0
45	92.3	92.6	92.9	93.2	93.8	94.5	95.4	96.2	96.9	97.6	98.3	99.3	100.0	100.4	100.2
40	93.2	93.5	93.8	93.4	93.0	93.8	94.7	95.5	96.2	96.8	97.5	98.5	99.2	99.6	99.4
35	94.0	94.5	94.6	94.3	93.9	93.6	93.9	94.7	95.4	96.1	96.8	97.7	98.4	98.8	98.6
30	93.9	95.3	95.5	95.1	94.7	94.5	94.4	94.2	94.6	95.3	96.0	96.9	97.6	98.0	97.8
25	93.1	96.1	96.4	96.0	95.6	95.4	95.2	95.1	94.8	94.5	95.2	96.1	96.8	97.2	97.0
20	92.3	95.5	97.2	96.9	96.5	96.3	96.1	96.0	95.7	95.4	95.2	95.3	96.0	96.4	96.2
15	91.5	94.7	97.7	97.7	97.4	97.2	97.1	96.9	96.6	96.3	96.1	95.7	95.1	95.6	95.4
10	90.7	93.9	96.9	97.7	98.2	98.1	98.0	97.8	97.5	97.3	97.0	96.7	96.0	94.7	94.6
5	89.9	93.0	96.0	96.8	97.7	98.6	98.9	98.8	98.6	98.3	98.0	97.7	97.2	95.9	94.0
0	89.1	92.2	95.1	96.0	96.8	97.7	98.8	99.6	99.5	99.3	99.1	98.7	98.2	97.0	95.2
-5	88.3	91.4	94.3	95.1	95.9	96.8	97.8	98.8	99.7	100.3	100.2	99.9	99.4	98.1	96.3
-10	87.5	90.5	93.4	94.2	95.0	95.9	96.9	97.9	98.8	99.9	100.9	101.0	100.7	99.3	97.3
-15	86.6	89.6	92.5	93.3	94.1	95.0	96.0	97.0	97.9	98.9	99.9	101.2	101.0	100.8	98.5
-20	85.8	88.8	91.6	92.4	93.2	94.1	95.1	96.0	96.9	98.0	99.0	100.2	100.2	100.4	100.1

%N1 Adjustments for Engine Bleed

ENGINE BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)						
	0	5	10	15	20	25	30
ENGINE ANTI-ICE ON	-0.3	-0.3	-0.3	-0.3	-0.4	-0.5	-0.5
ENGINE & WING ANTI-ICE ON	-0.7	-0.6	-0.6	-0.7	-0.8	-0.9	-0.9

Long Range Cruise Altitude Capability
Max Climb Thrust, 300 ft/min residual rate of climb

WEIGHT (1000 LB)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
1000	18400	17000	15200
950	19700	18300	16500
900	20900	19600	17800
850	22800	21400	19800
800	24800	23400	21900
750	26700	25500	23900
700	28500	27600	26100
650	30100	29600	28300
600	31600	31500	30300
550	33200	33100	32100
500	34800	34700	33700
450	36500	36400	35400

GEAR DOWN

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)									
		10	14	20	21	23	25	27	29	31	33
1000	%N1	84.1	88.3								
	MACH	.488	.525								
	KIAS	270	270								
	FF/ENG	10220	10378								
950	%N1	83.0	87.2	93.8							
	MACH	.488	.525	.589							
	KIAS	270	270	270							
	FF/ENG	9865	10004	10294							
900	%N1	82.0	86.1	92.5	93.8						
	MACH	.488	.525	.589	.600						
	KIAS	270	270	270	270						
	FF/ENG	9552	9677	9931	10016						
850	%N1	80.5	84.4	90.7	91.8	94.3					
	MACH	.480	.514	.577	.588	.610					
	KIAS	266	264	264	264	264					
	FF/ENG	9064	9102	9311	9376	9514					
800	%N1	78.6	82.3	88.5	89.6	91.9	94.5				
	MACH	.468	.501	.561	.572	.594	.617				
	KIAS	259	257	257	257	256	256				
	FF/ENG	8481	8482	8636	8700	8810	8926				
750	%N1	76.8	80.3	86.4	87.5	89.6	92.0	94.9			
	MACH	.456	.487	.544	.555	.577	.600	.624			
	KIAS	252	250	249	249	249	248	248			
	FF/ENG	7915	7906	7985	8047	8153	8228	8365			
700	%N1	74.9	78.2	84.1	85.2	87.4	89.6	92.0	94.9		
	MACH	.443	.473	.527	.537	.559	.582	.605	.628		
	KIAS	245	242	240	240	241	241	240	239		
	FF/ENG	7393	7351	7364	7413	7514	7581	7626	7773		
650	%N1	73.0	76.2	81.7	82.8	85.0	87.1	89.4	91.9		
	MACH	.431	.458	.509	.519	.540	.562	.586	.610		
	KIAS	238	235	232	232	232	232	232	232		
	FF/ENG	6904	6798	6774	6808	6883	6947	6978	7083		
600	%N1	70.9	74.0	79.4	80.5	82.7	84.9	87.1	89.3	92.2	
	MACH	.418	.444	.493	.504	.525	.547	.569	.593	.619	
	KIAS	231	227	225	225	225	225	225	225	225	
	FF/ENG	6426	6276	6253	6289	6361	6406	6437	6506	6564	
550	%N1	68.7	71.8	77.1	78.2	80.4	82.6	84.7	86.8	89.4	92.2
	MACH	.404	.429	.479	.489	.510	.531	.553	.577	.601	.627
	KIAS	223	220	218	218	219	219	219	219	219	219
	FF/ENG	5940	5791	5790	5809	5862	5895	5918	5975	5977	6106
500	%N1	66.4	69.5	74.8	75.8	78.0	80.1	82.2	84.4	86.7	89.2
	MACH	.390	.414	.465	.474	.494	.515	.536	.559	.583	.609
	KIAS	215	212	211	211	212	212	212	212	212	212
	FF/ENG	5457	5440	5432	5453	5485	5503	5510	5461	5444	5526
450	%N1	63.9	67.2	72.6	73.5	75.5	77.6	79.7	81.8	84.2	86.4
	MACH	.374	.401	.451	.460	.479	.499	.520	.543	.566	.591
	KIAS	206	205	205	205	205	205	205	205	205	205
	FF/ENG	5108	5013	4992	4999	5034	5049	5045	4984	4960	5021

GEAR DOWN

Long Range Cruise Enroute Fuel and Time

Table 1 of 3: 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
622	562	510	467	432	400	378	358	340	324	309
1253	1130	1023	936	864	800	756	716	679	647	618
1892	1704	1540	1408	1297	1200	1134	1073	1018	969	926
2542	2284	2062	1881	1732	1600	1511	1430	1356	1290	1232
3202	2873	2588	2358	2167	2000	1888	1786	1693	1610	1536
3873	3467	3117	2836	2604	2400	2264	2140	2028	1928	1840
4557	4071	3652	3317	3041	2800	2640	2495	2363	2245	2142
5247	4679	4190	3800	3480	3200	3016	2849	2697	2562	2443
5937	5286	4727	4282	3918	3600	3391	3201	3030	2877	2743
6628	5894	5265	4765	4356	4000	3767	3554	3363	3192	3043

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		25	
	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)	FUEL (1000 LB)	TIME (HR:MIN)
400	40.4	1:29	37.7	1:26	35.1	1:22	33.1	1:18	31.7	1:15
800	80.2	2:57	75.3	2:49	70.7	2:41	67.2	2:32	64.7	2:26
1200	118.8	4:27	111.5	4:15	105.3	4:02	100.2	3:48	96.6	3:38
1600	156.2	5:59	146.6	5:42	138.6	5:25	132.1	5:05	127.5	4:51
2000	192.2	7:34	180.6	7:12	171.1	6:49	163.0	6:24	157.4	6:06
2400	227.4	9:11	214.1	8:44	202.9	8:16	193.5	7:44	186.8	7:23
2800	261.9	10:51	246.6	10:18	233.7	9:44	223.0	9:06	215.3	8:40
3200	295.4	12:32	278.2	11:54	263.7	11:13	251.6	10:29	243.0	9:59
3600	328.1	14:14	309.1	13:29	293.0	12:42	279.4	11:53	269.8	11:19
4000	360.2	15:55	339.3	15:04	321.6	14:12	306.5	13:17	296.1	12:39

Table 3 of 3: Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB)					
	500	600	700	800	900	1000
40	-5.4	-3.0	0.0	4.0	8.8	14.2
80	-11.4	-6.2	0.0	8.1	17.5	28.2
120	-16.8	-9.2	0.0	11.9	25.7	41.3
160	-21.8	-11.9	0.0	15.6	33.4	53.5
200	-26.3	-14.4	0.0	18.9	40.5	64.8
240	-30.3	-16.7	0.0	22.1	47.1	75.1
280	-33.8	-18.8	0.0	25.0	53.1	84.5
320	-36.8	-20.6	0.0	27.7	58.5	92.9
360	-39.4	-22.2	0.0	30.2	63.4	100.4

Descent at .66/250

PRESSURE ALT (1000 FT)	5	10	15	17	19	21	23	25	27	29	31	33	35	37
DISTANCE (NM)	12	23	35	40	45	49	54	59	64	69	73	77	82	86
TIME (MINUTES)	6	8	10	11	12	13	14	15	16	16	17	18	18	19

GEAR DOWN

Holding

Flaps Up

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)						
		1500	5000	10000	15000	20000	25000	30000
1000	%N1	75.6	79.0	84.0	89.4			
	KIAS	265	267	269	270			
	FF/ENG	10400	10500	10700	10950			
950	%N1	74.0	77.2	82.2	87.7	93.8		
	KIAS	259	260	262	265	270		
	FF/ENG	9850	9850	10040	10340	10810		
900	%N1	72.4	75.6	80.4	85.7	92.0		
	KIAS	254	254	256	257	266		
	FF/ENG	9370	9300	9430	9630	10230		
850	%N1	70.8	74.0	78.7	83.9	89.7		
	KIAS	249	249	250	252	257		
	FF/ENG	8880	8810	8880	9040	9430		
800	%N1	69.2	72.3	76.9	82.0	87.6	93.9	
	KIAS	243	244	245	246	250	252	
	FF/ENG	8380	8340	8330	8490	8760	9170	
750	%N1	67.7	70.7	75.3	80.3	86.1	91.9	
	KIAS	239	239	240	242	246	248	
	FF/ENG	7940	7900	7850	8000	8280	8640	
700	%N1	66.1	69.0	73.6	78.3	83.7	89.2	
	KIAS	234	234	235	236	238	238	
	FF/ENG	7490	7440	7380	7480	7610	7860	
650	%N1	64.5	67.2	71.7	76.4	81.6	87.1	93.4
	KIAS	228	228	229	230	231	232	232
	FF/ENG	7040	6970	6920	6960	7080	7280	7520
600	%N1	62.7	65.4	69.8	74.4	79.4	84.9	90.6
	KIAS	222	222	223	224	225	225	225
	FF/ENG	6590	6510	6460	6460	6570	6730	6880
550	%N1	60.8	63.5	67.8	72.4	77.1	82.6	88.0
	KIAS	216	216	217	217	218	219	219
	FF/ENG	6150	6060	6010	5990	6080	6190	6300
500	%N1	58.8	61.5	65.7	70.2	74.8	80.1	85.5
	KIAS	209	210	210	211	211	212	212
	FF/ENG	5710	5620	5710	5670	5700	5780	5760
450	%N1	57.0	59.6	63.7	68.1	72.6	77.6	83.0
	KIAS	205	205	205	205	205	205	205
	FF/ENG	5490	5380	5320	5260	5240	5300	5250

This table includes 5% additional fuel for holding in a racetrack pattern.

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Gear Down, One Engine Inop — Section 27

GEAR DOWN
1 ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude

Based on engine bleed for packs on

WEIGHT (1000 LB)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
1000	970	270	11200	9700	7900
950	923	270	12300	10900	9300
900	877	265	14000	12800	11300
850	828	259	16000	14800	13300
800	780	251	18100	16900	15500
750	731	246	19900	18900	17600
700	681	237	22100	21000	19700
650	633	231	24000	22900	21700
600	586	224	25700	24900	23700
550	537	218	27500	27000	25900
500	489	211	29200	29100	28000
450	438	205	30800	30800	29900

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 packs on

WEIGHT (1000 LB)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
1000	10500	8900	6700
950	11600	10100	8300
900	12700	11200	9500
850	14500	13100	11400
800	16600	15300	13600
750	18800	17600	16000
700	21000	19900	18400
650	23300	22200	20800
600	25200	24300	23000
550	27100	26400	25200
500	28800	28600	27400
450	30600	30600	29600

Altitude reduced by 1000 ft for additional margin.
With engine anti-ice on, decrease altitude capability by 300 ft.
With engine and wing anti-ice on, decrease altitude capability by 900 ft.

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 LB)		PRESSURE ALTITUDE (1000 FT)							
		10	14	17	20	23	25	27	29
900	%N1	91.3							
	MACH	.488							
	KIAS	270							
	FF/ENG	12907							
850	%N1	89.6	93.8						
	MACH	.480	.514						
	KIAS	266	264						
	FF/ENG	12202	12364						
800	%N1	87.6	91.6	95.1					
	MACH	.468	.501	.529					
	KIAS	259	257	257					
	FF/ENG	11383	11473	11654					
750	%N1	85.5	89.4	92.5					
	MACH	.456	.487	.514					
	KIAS	252	250	249					
	FF/ENG	10607	10646	10741					
700	%N1	83.3	87.2	90.2	93.7				
	MACH	.443	.473	.498	.527				
	KIAS	245	242	241	240				
	FF/ENG	9870	9858	9902	10064				
650	%N1	81.1	84.8	87.7	90.9	95.0			
	MACH	.431	.458	.482	.509	.540			
	KIAS	238	235	233	232	232			
	FF/ENG	9163	9102	9101	9188	9458			
600	%N1	78.9	82.4	85.2	88.4	92.0	95.1		
	MACH	.418	.444	.466	.493	.525	.547		
	KIAS	231	227	225	225	225	225		
	FF/ENG	8485	8385	8336	8425	8653	8830		
550	%N1	76.5	79.8	82.6	85.9	89.4	91.9	95.2	
	MACH	.404	.429	.451	.479	.510	.531	.553	
	KIAS	223	220	218	218	219	219	219	
	FF/ENG	7798	7699	7633	7732	7922	8023	8179	
500	%N1	74.0	77.2	80.1	83.3	86.7	89.0	91.7	95.0
	MACH	.390	.414	.437	.465	.494	.515	.536	.559
	KIAS	215	212	211	211	212	212	212	212
	FF/ENG	7112	7028	7014	7075	7228	7299	7371	7569
450	%N1	71.3	74.8	77.6	80.7	84.1	86.4	88.6	91.3
	MACH	.374	.401	.425	.451	.479	.499	.520	.543
	KIAS	206	205	205	205	205	205	205	205
	FF/ENG	6463	6416	6460	6488	6596	6650	6689	6802

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 1 of 3: Ground to Air Miles Conversion

AIR DISTANCE (NM) HEADWIND COMPONENT (KTS) 100	80	60	40	20	GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS) 20	40	60	80	100
310	280	254	233	216	200	188	178	168	160	153
622	562	510	467	432	400	377	357	338	321	307
936	845	766	702	648	600	566	534	506	481	459
1253	1130	1023	936	864	800	754	712	675	641	612
1571	1416	1282	1172	1081	1000	943	890	843	801	764
1892	1704	1540	1408	1297	1200	1131	1068	1011	961	916
2215	1993	1800	1644	1514	1400	1319	1245	1179	1119	1067
2541	2284	2061	1881	1732	1600	1507	1422	1346	1278	1218
2870	2577	2324	2119	1949	1800	1695	1599	1513	1436	1369
3201	2872	2588	2358	2167	2000	1882	1775	1679	1594	1519

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT) 10 FUEL (1000 LB)	10 TIME (HR:MIN)	14 FUEL (1000 LB)	14 TIME (HR:MIN)	18 FUEL (1000 LB)	18 TIME (HR:MIN)	22 FUEL (1000 LB)	22 TIME (HR:MIN)
200	19.9	0:46	18.3	0:44	16.8	0:43	15.8	0:41
400	40.4	1:29	37.7	1:25	35.4	1:22	33.8	1:18
600	60.5	2:13	56.9	2:07	53.6	2:01	51.4	1:55
800	80.3	2:57	75.6	2:49	71.4	2:41	68.7	2:32
1000	99.7	3:42	94.1	3:32	88.9	3:21	85.6	3:10
1200	118.8	4:27	112.2	4:15	106.1	4:02	102.3	3:48
1400	137.6	5:13	130.0	4:58	123.0	4:43	118.6	4:27
1600	156.0	5:59	147.5	5:43	139.6	5:25	134.6	5:06
1800	174.0	6:46	164.6	6:27	155.9	6:07	150.4	5:45
2000	191.8	7:34	181.5	7:12	171.9	6:50	165.8	6:24

Table 3 of 3: Fuel Required Adjustment (1000 LB)

REFERENCE FUEL REQUIRED (1000 LB)	WEIGHT AT CHECK POINT (1000 LB) 500	600	700	800	900
20	-3.1	-1.5	0.0	2.6	3.4
40	-6.7	-3.3	0.0	5.3	7.9
60	-10.2	-5.0	0.0	7.9	13.0
80	-13.6	-6.7	0.0	10.3	18.1
100	-17.0	-8.5	0.0	12.5	23.0
120	-20.2	-10.2	0.0	14.7	27.9
140	-23.4	-12.0	0.0	16.7	32.7
160	-26.4	-13.7	0.0	18.5	37.4
180	-29.4	-15.5	0.0	20.3	42.0
200	-32.3	-17.2	0.0	21.9	46.4

GEAR DOWN
1 ENGINE INOP
MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 LB)		PRESSURE ALTITUDE (FT)					
		1500	5000	10000	15000	20000	25000
1000	%N1	84.2	87.9	93.5			
	KIAS	265	267	269			
	FF/ENG	13880	14090	14530			
950	%N1	82.4	85.9	91.5			
	KIAS	259	260	262			
	FF/ENG	13060	13200	13580			
900	%N1	80.7	84.1	89.5	95.5		
	KIAS	254	254	256	257		
	FF/ENG	12340	12420	12700	13160		
850	%N1	78.9	82.3	87.7	93.3		
	KIAS	249	249	250	252		
	FF/ENG	11630	11690	11920	12280		
800	%N1	77.2	80.5	85.7	91.2		
	KIAS	243	244	245	246		
	FF/ENG	10920	10990	11160	11480		
750	%N1	75.5	78.8	83.8	89.3	96.2	
	KIAS	239	239	240	242	246	
	FF/ENG	10310	10360	10490	10780	11410	
700	%N1	73.8	76.9	81.8	87.3	93.2	
	KIAS	234	234	235	236	238	
	FF/ENG	9730	9710	9820	10030	10390	
650	%N1	71.9	75.0	79.7	85.1	90.8	
	KIAS	228	228	229	230	231	
	FF/ENG	9140	9070	9150	9320	9600	
600	%N1	69.8	73.0	77.6	82.8	88.4	95.1
	KIAS	222	222	223	224	225	225
	FF/ENG	8540	8480	8510	8640	8850	9270
550	%N1	67.8	70.8	75.5	80.4	85.9	91.9
	KIAS	216	216	217	217	218	219
	FF/ENG	7930	7900	7870	7980	8120	8420
500	%N1	65.6	68.6	73.2	78.0	83.3	89.0
	KIAS	209	210	210	211	211	212
	FF/ENG	7320	7290	7250	7340	7430	7660
450	%N1	63.6	66.5	71.0	75.7	80.7	86.4
	KIAS	205	205	205	205	205	205
	FF/ENG	6810	6760	6720	6760	6810	6980

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

Performance Inflight — Chapter PI
Text — Section 28

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 Airplane Flight Manual (AFM), the AFM takes precedence.

General

Minimum Takeoff Weight

Light weight takeoffs at the GENX-2B67 thrust rating may be limited by minimum takeoff weight in order to maintain airplane controllability. For weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

Takeoff Speeds

The speeds presented in the Takeoff Speeds table as well as FMC computed takeoff speeds can be used for all performance conditions except where adjustments must be made to V1 for clearway, stopway, brake deactivation, improved climb, contaminated runway situations, anti-skid inoperative, brake energy limits, or obstacle clearance with unbalanced V1. These speeds may be used for weights less than or equal to the performance limited weight.

The FMC will protect for minimum control speeds by increasing V1, VR and V2 as required. However, the FMC will not compute takeoff speeds for weights where the required speed increase exceeds the maximum certified speed increase. This typically occurs at full rated thrust and light weights. In this case, the message "V SPEEDS UNAVAILABLE" will appear on the FMC scratchpad and the takeoff speed entries will be blank. Takeoff is not permitted in this condition as certified limits have been exceeded.

The options are to select a smaller flap setting, select derate thrust and/or add weight (fuel). Selecting derate thrust is the preferred method as this will reduce minimum control speeds. Note that the assumed temperature method may not help this condition as minimum control speeds are determined at the actual temperature and, therefore, are not reduced.

Takeoff speeds are determined as follows:

(1) Determine V1, VR, and V2 from the Takeoff Speeds table (Table 1) with brake release weight.

(2) Adjust V1, VR and V2 for temperature and pressure altitude from the V1, VR, V2 Adjustments table (Table 2).

(3) Adjust V1 for slope and wind from the Slope and Wind V1 Adjustment table (Table 3).

(4) Determine V1(MCG) and Min VR from the V1(MCG) and Minimum VR table (Table 4).

(5) If V1 from Step 3 is less than V1(MCG), set V1=V1(MCG).

(6) If VR from Step 2 is less than Min VR, Set VR=Min VR.

(7) Using Min VR from Step (4), determine V2 from the V2 for Minimum VR table (Table 5).

(8) If V2 from Step 2 is less than V2 for Minimum VR, set V2=V2 for Minimum VR.

Note: Regulations prohibit scheduling takeoff with a V1 less than minimum V1 for control on the ground, V1(MCG), VR less than Minimum VR (Min VR), and V2 less than V2 for Minimum VR. It is necessary to compare the adjusted V1, VR and V2 to V1(MCG), Minimum VR and V2 for Minimum VR, respectively. No takeoff weight adjustment is necessary provided that the actual field length exceeds 6100 ft for a dry runway, or 8800 ft for a wet runway.

Clearway and Stopway V1 Adjustments

Takeoff speed corrections are to be applied to V1 when using takeoff weights based on the use of clearway and stopway.

Adjust V1 by the amount shown in the table. The adjusted V1 must not exceed VR. If V1 is greater than VR, VR may be increased to equal V1. Increase V2 by the same amount that VR is increased.

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 reference speeds for a given weight.

Flap Maneuver Speeds

This table provides the flap speed schedule for recommended maneuver speeds. During flap retraction, selection of the next flap position is initiated when reaching the maneuver speed for the next flap position. Maneuver capability of at least 30° of bank (15° angle of bank and 15° overshoot) to stick shaker is provided at the flap retraction speed. Full maneuvering capability or at least 40° of bank (25° of bank and 15° overshoot) is provided when the airplane has accelerated to the recommended maneuver speed for the selected flap position.

During flap extension, selection of flaps to the next flap position should be made when approaching (and before decelerating below) the maneuver speed for the existing flap position. The flap extension speed schedule provides full maneuver capability or at least 40° of bank (25° angle of bank and 15° overshoot) to stick shaker at all weights.

Slush/Standing Water Takeoff

Aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water or ice, and reductions in field/obstacle limited takeoff weight and revised takeoff speeds are necessary. The tables are intended for guidance in accordance with advisory material and assume an engine failure at the critical point during takeoff. Data are shown for 2 engine reverse thrust and for no reverse thrust.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore, this information is conservative when operating under typical cold weather conditions where patches of slush exist and some degree of sanding is common. Takeoffs in slush depths greater than 0.5 inches (13 mm) are not recommended because of possible damage to the airplane as a result of slush impingement on the airplane structure. Use of assumed temperature for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

(1) Determine the dry field/obstacle limit weight for the takeoff flap setting.

(2) Enter the Weight Adjustment table (Table 1) with the dry field/obstacle limit weight to obtain the weight reduction for the slush/standing water depth and airport pressure altitude.

(3) Adjust field length available for temperature by the amount provided in the notes below the V1(MCG) Limit Weight table (Table 2).

(4) Enter the V1(MCG) Limit Weight table (Table 2) with the adjusted field length (determined from step 3) and pressure altitude to obtain the slush/standing water limit weight with respect to minimum field length required for V1(MCG) speed.

The maximum allowable takeoff weight in slush/standing water is the lesser of the limit weights found in steps 2 and 4.

Takeoff speed determination:

(1) Determine takeoff speeds V1, VR and V2 for actual brake release weight using the Dry Runway Takeoff Speeds tables in this section.

(2) If V1(MCG) limited, set V1=V1(MCG). If not limited by V1(MCG), enter the V1 Adjustment table (Table 3) with actual brake release weight to determine the V1 reduction to apply to V1 speed determined in step (1). If the adjusted V1 is less than V1(MCG), set V1=V1(MCG).

Dry Snow Runway Takeoff/Wet Snow Runway Takeoff

In addition to slush/standing water, data are provided for dry snow and wet snow covered runways. Takeoff in dry snow and wet snow depths greater than 5.1 inches (130 mm) and 1.18 inches (30 mm), respectively, is not recommended. The tables provided are used in the same manner as the Slush/Standing Water Takeoff tables.

Slippery Runway Takeoff

Airplane braking action is reported as good, medium or poor, depending on existing runway conditions. If braking action is reported as good, conditions should not be expected to be as good as on clean, dry runways. The value “good” is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when stopping. The performance level of good is the same as used by the FAA and EASA to define wet runway rejected takeoff performance. A braking action of good to medium (interpolation between good and medium) is representative of a runway covered with compacted snow. Similarly, poor braking action is representative of a runway covered with ice. Performance is based on two symmetric reversers operating and a 15 ft screen height at the end of the runway. The tables provided are used in the same manner as the Slush/Standing Water tables. Data are shown for 2 engine reverse thrust and for no reverse thrust.

Antiskid Inoperative

When operating with antiskid inoperative, the field length/obstacle limited weight and the V1 speed must be reduced to account 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.

Takeoff with antiskid inoperative is allowed only on dry or wet skid resistant runways.

A simplified method which conservatively accounts for the effects of antiskid inoperative is to reduce the normal runway/obstacle limited weight by the amount shown in the table below. Then, reduce the V1 associated with the reduced weight by the amount shown. If takeoff weight is below the antiskid inoperative limited weight, it is only necessary to ensure that the V1 speed does not exceed the antiskid 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 V1(MCG) provided the accelerate stop distance available exceeds approximately 13900 ft.

ANTISKID INOPERATIVE ADJUSTMENT		
FIELD LENGTH (FT)	WEIGHT (1000 LB)	V1 (KTS)
13000	-45	-34
14000	-45	-32
15000	-44	-29
16000	-43	-26

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Takeoff %N1

To find Takeoff %N1 based on engine bleed for packs on and anti-ice off, enter the Takeoff %N1 table with airport pressure altitude and airport OAT and read %N1. For Packs off and engine anti-ice on, apply the %N1 adjustments shown below the table.

Max Climb %N1

This table shows Max Climb %N1 for a 340/.84 climb speed schedule, normal engine bleed for packs on and anti-ice off. Enter the table with airport pressure altitude and TAT and read %N1. Adjustments are also shown for anti-ice operation.

Go-Around %N1

To find Max Go-Around %N1 based on normal engine bleed for packs on, enter the Go-around %N1 table with airport pressure altitude and reported OAT or TAT and read %N1. For packs off operation, apply the %N1 adjustments provided below the table. %N1 adjustments are shown for engine anti-ice operation.

Flight with Unreliable Airspeed / Turbulent Air Penetration

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 may also be unreliable.

ISFD Airspeed and Altitude Correction

In the event of loss of primary air data, Integrated Standby Flight Display (ISFD) airspeed and pressure altitude correction are provided. The first table provides the ISFD airspeed for a given gross weight and target airspeed. The second table provides a pressure altitude adjustment for a given gross weight and ISFD airspeed. The pressure altitude adjustment is added to the ISFD altitude to get the actual pressure altitude.

All Engines

Long Range Cruise Maximum Operating Altitude

These tables provide maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. This table considers both thrust and buffet limits, providing the more limiting of the two. Data that are thrust limited are denoted by an asterisk and represents only a thrust limited condition in level flight with 300 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude. The maximum altitude shown in the table is limited by the maximum certified altitude of 43100 ft.

Long Range Cruise Control

This table provides target %N1, Long Range Cruise Mach number, KIAS and standard day fuel flow per engine for the airplane weight and pressure altitude. As indicated by the shaded area, at optimum altitude, .85 Mach approximates the Long Range Cruise Mach schedule.

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. Data are based on Long Range Cruise and .84/290/250 descent. Tables are presented for low altitudes for shorter trip distances and high altitudes for longer trip distances.

To determine remaining fuel and time required, first enter the Ground to Air Miles Conversion table (Table 1) to convert ground distance and enroute wind to an equivalent still-air distance. Next, enter the Reference Fuel and Time table (Table 2) with air distance from Table 1 and the desired altitude and read reference fuel and time required. Lastly, enter the Fuel Required Adjustment table (Table 3) 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 that may justify operations 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 at .84/290/250

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 are based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach and landing.

Holding

Target %N1, KIAS, and fuel flow per engine information are tabulated for holding with Flaps Up and Flaps 1 based on the FMC optimum holding speed schedule. This is the higher of maximum endurance speed and maneuvering speed for the selected flap setting. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read %N1, KIAS and fuel flow per engine.

Advisory Information

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distances on dry runways and slippery 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.

To use these tables, determine the reference landing distance for the selected braking configuration. Adjust this reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers to obtain actual landing distance.

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. If the surface is affected by water, snow, or ice, and braking action is reported as "good", conditions should not be expected to be as good as on clean, dry runways. The value "good" is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when landing. The performance level used to calculate "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate "poor" data reflects runways covered with wet ice.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" reported 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 appropriate to add the effects of slope and inoperative reversers when using the autobrake system.

Non-Normal Configuration Landing Distance

Advisory information is provided to support non-normal configurations that affect landing performance of the airplane. Landing distances and adjustments are provided for dry runways and runways with good, good to medium, medium, medium to poor, and poor reported braking action. The Non-Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

Enter the table with the applicable non-normal configuration and read normal approach speed. The reference landing distance is a distance from 50 ft above the threshold to stop, based on a reference landing weight and speed at sea level, zero wind, and zero runway slope. Subsequent columns provide corrections for off-reference landing weight, altitude, wind, runway slope, temperature, speed, and reverser conditions. Each correction is independently added to the reference landing distance. The reference landing distance is based on maximum manual braking and maximum available reverse thrust.

Landing Climb Limit Weight

Enter the Landing Climb Limit Weight table with airport OAT and pressure altitude and read landing climb limit weight. Apply the noted adjustments as required.

Recommended Brake Cooling Schedule

Advisory information is provided to assist in avoiding problems associated with hot brakes. Although for normal operations most landings are at weights below the AFM quick turnaround limit weight, brakes can still get hot enough that cooling is recommended. Use of the recommended cooling schedule can help avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Enter the Reference Brake Energy table (Table 1) with 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 Event Adjusted Brake Energy table (Table 2) for no reverse thrust or 4 engine reverse thrust with the reference brake energy per brake and the type of braking used during landing (Max Manual, Max Auto, or Autobrake). 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 (Table 3) 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 BTMS, the hottest brake indication 10 to 15 minutes after the airplane has come to a complete stop, or inflight with gear retracted, may be used to determine recommended cooling schedule by entering at the bottom of the chart. An EICAS advisory message, BRAKE TEMP, will appear when any brake registers 5 on the GEAR synoptic display and disappears as the hottest brake cools to an indication of 4. Note that even without an EICAS advisory message, brake cooling is recommended.

One Engine Inoperative

Max Continuous %N1

Power setting is based on one engine inoperative with packs on and anti-ice bleeds off. Enter the table with pressure altitude and KIAS or Mach to read %N1.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Driftdown Speed/Level Off Altitude

The Driftdown Speed/Level Off Altitude 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.

Level off altitude is dependent on air temperature (ISA deviation). Note that the maximum altitude shown has been reduced by 1000 ft to maintain consistency with the FMC.

Long Range Cruise Altitude Capability

The Long Range Cruise Altitude Capability 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 to maintain consistency with the FMC.

Long Range Cruise Control

The Long Range Cruise Control table provides target %N1, one engine inoperative Long Range Cruise Mach number, KIAS, and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect fuel burn per engine.

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 are 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 (Table 1) and read Fuel and Time (Table 2) 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 (Table 3) with fuel required for the reference weight and the actual weight at checkpoint.

Holding

One engine inoperative holding data are provided in the same format as the all engine holding data and are based on the same assumptions.

Two Engines Inoperative

Driftdown Speed/Level Off Altitude

The Driftdown Speed/Level Off Altitude table shows optimum driftdown speed as a function of cruise weight at the start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off.

Level off altitude is dependent on air temperature (ISA deviation). Note that the maximum altitude shown has been reduced by 2000 ft to maintain consistency with the FMC.

Driftdown/LRC Cruise Range Capability

This table shows range capability from the start of driftdown until the airplane levels off. As weight decreases due to fuel burn, the airplane accelerates to Long Range Cruise speed and maintains this speed at the level off altitude.

To determine fuel required, enter the Ground to Air Miles Conversion table (Table 1) with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Next, enter the Driftdown/Cruise Fuel and Time table (Table 2) with air distance and weight at start of driftdown to determine fuel and time required.

Long Range Cruise Altitude Capability

The Long Range Cruise Altitude Capability 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 to be consistent with the FMC logic.

Long Range Cruise Control

The Long Range Cruise Control table provides target %N1, two engines inoperative Long Range Cruise Mach number, KIAS, and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect fuel burn for each engine.

Alternate Mode EEC

This section contains performance data for airplane operation with the Electronic Engine Control (EEC) in alternate mode (EEC ALTN lights illuminated). Data are based on engine bleed effects for normal air conditioning operations, i.e., three packs operating. Assumed temperature method is not allowed with EEC in alternate mode.

Limit Weight

A simplified method which conservatively accounts for the effects of EEC in alternate mode is to reduce the normal mode performance limited weights. The Limit Weight table provides takeoff field, climb, obstacle, tire speed, brake energy, net level off and landing climb weights. To determine limit weights for operations with the EEC in alternate mode, enter the table with the limit weights for normal mode EEC operation and read the associated limit weight for each performance condition. The most limiting of the takeoff weights must be used. Additionally, Landing Climb limit weight must be compared to the Landing Field Length limit weight and the more limiting of the two must be used as the landing limit weight. Analysis from the Airplane Flight Manual may yield less restrictive limit weights.

Takeoff Speed Adjustment

Takeoff speeds for the reduced weight should be increased by the amount shown in the Takeoff Speed Adjustments table.

Takeoff %N1/Go-around %N1

Takeoff and Go-around power setting are presented for normal air conditioning bleed. Takeoff or Go-around %N1 may be read directly from the tables for the desired pressure altitude and airport OAT, or TAT may be used for go-around.

Thrust protection is not provided for EEC in alternate mode and maximum rated thrust is reached at a thrust lever position less that full forward. As a result, thrust overboost can occur at full forward thrust lever positions.

Gear Down

This section contains performance for airplane operation with landing gear extended for all phases of flight. Data are based on engine bleeds for normal air conditioning.

Note: The FMC does not contain special provisions for operation with landing gear extended. As a result, the FMC 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 VNAV during descent under these circumstances is not recommended.

Tables for gear down performance in this section are identical in format and used in the same manner as tables for the gear up configuration previously described.

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Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Dimensions — Section 10

Principal Dimensions

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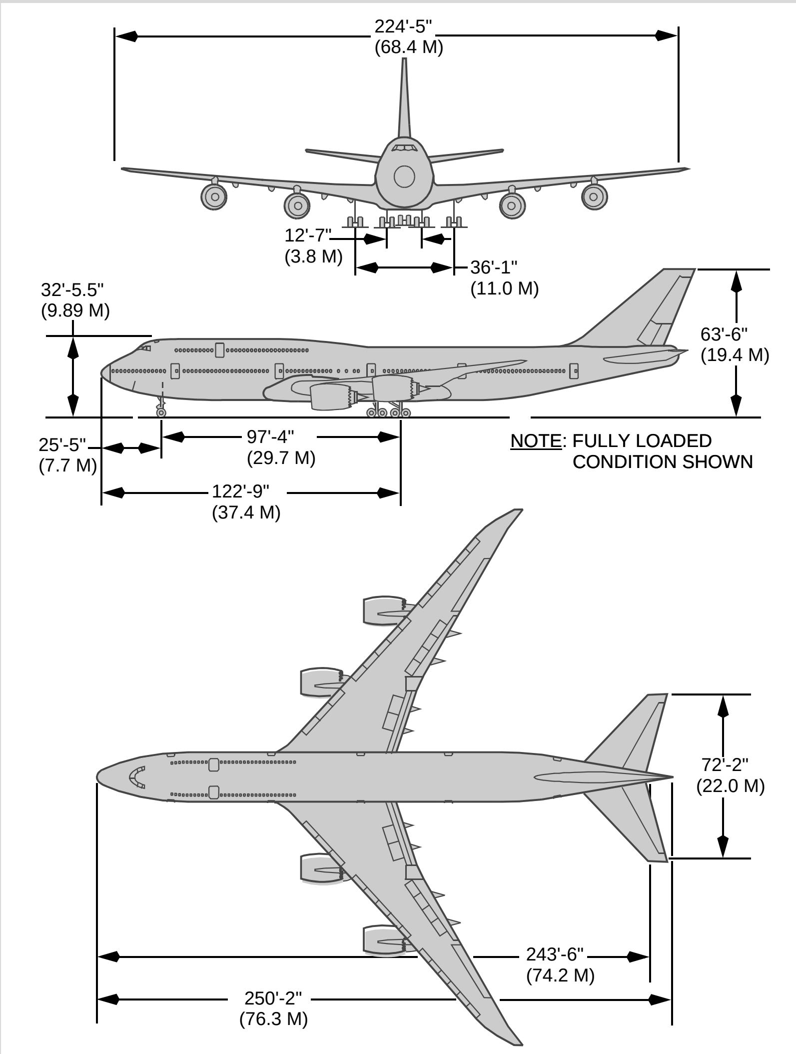

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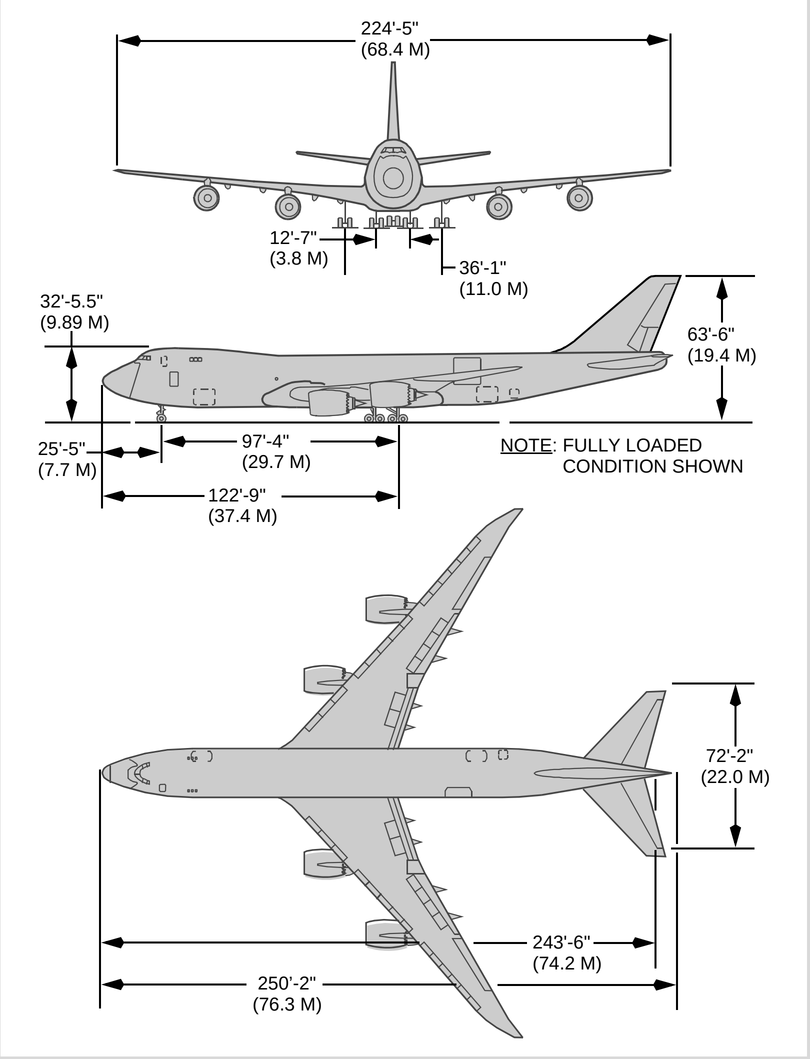
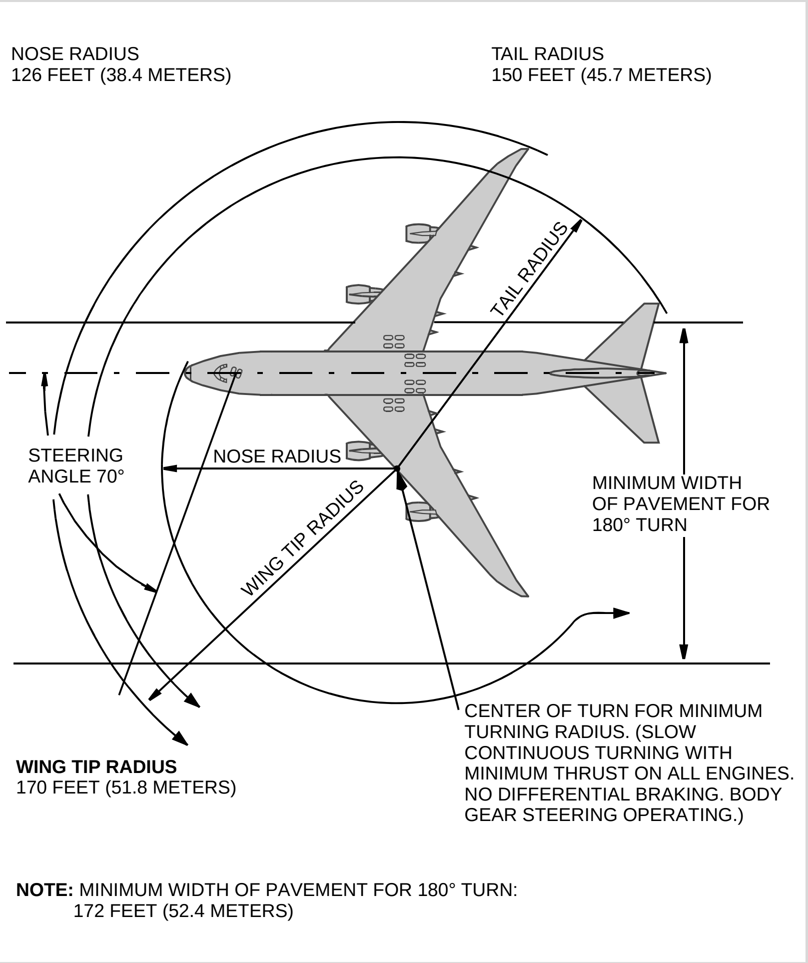

224'-5"
(68.4 M)
12'-7"
(3.8 M)
36'-1"
(11.0 M)
32'-5.5"
(9.89 M)
63'-6"
(19.4 M)
25'-5"
(7.7 M)
97'-4"
(29.7 M)
122'-9"
(37.4 M)
NOTE: FULLY LOADED CONDITION SHOWN
72'-2"
(22.0 M)
243'-6"
(74.2 M)
250'-2"
(76.3 M)

Turning Radius

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



CAUTION: Do not attempt to make a turn away from an obstacle within (15 feet/4.6m) of the wing tip or within (59 feet/18.0m) of the nose.

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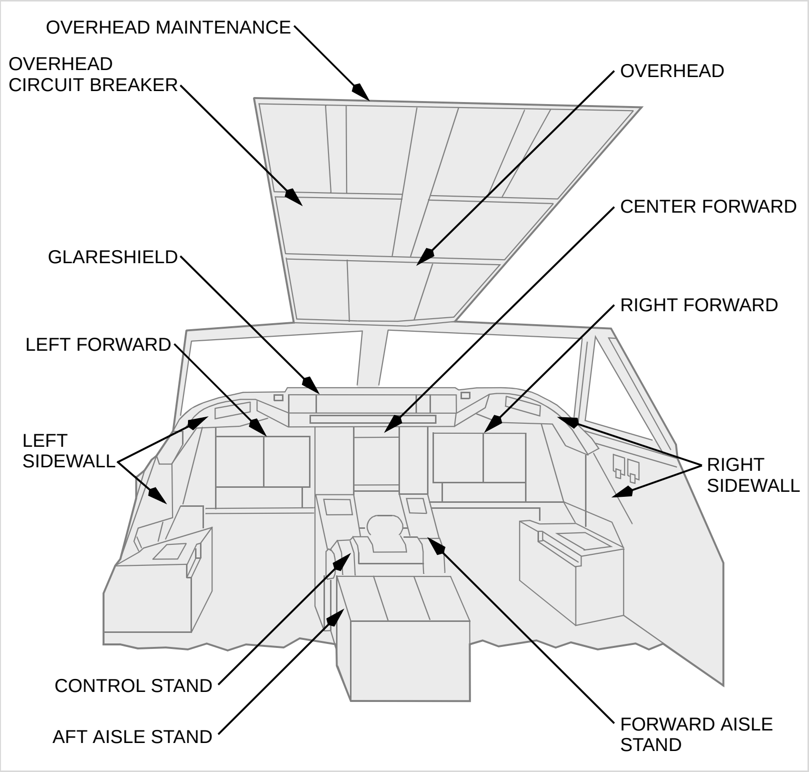
Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Inst. Panels — Section 20

Flight Deck Panels



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

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

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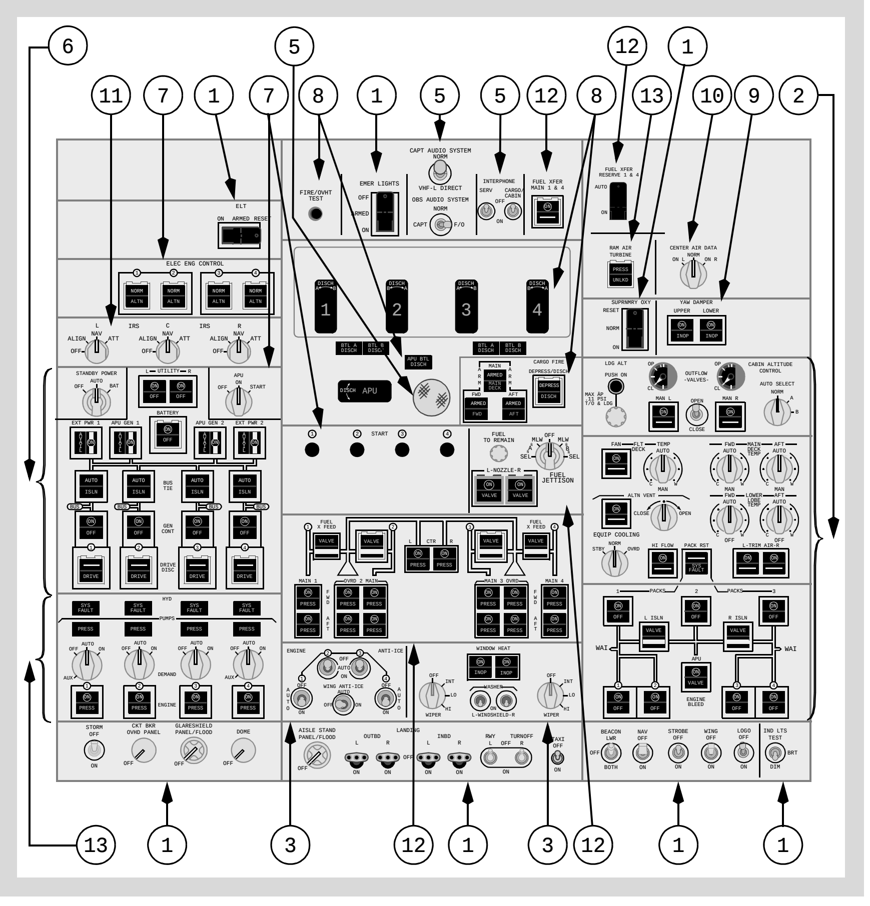
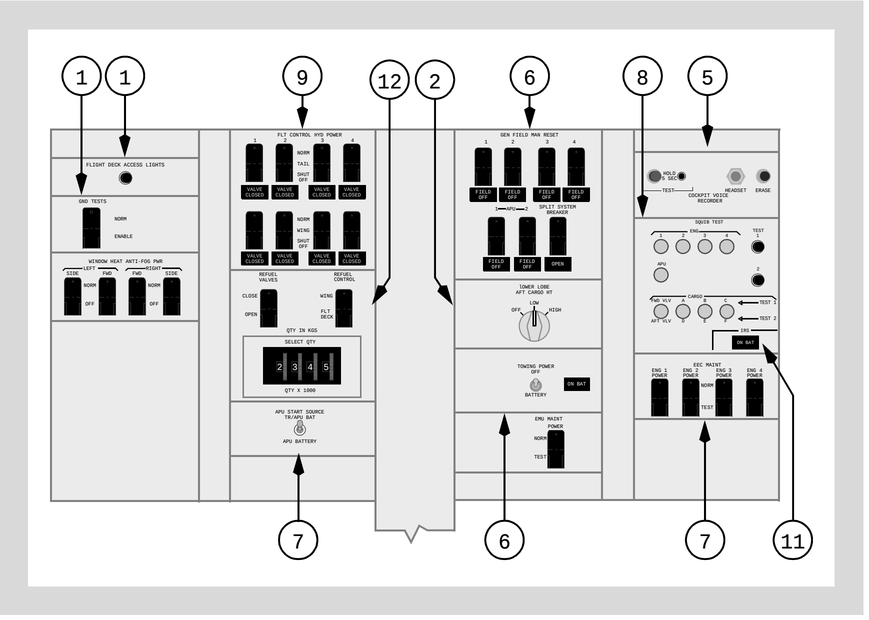
Overhead Panels

Overhead Panel

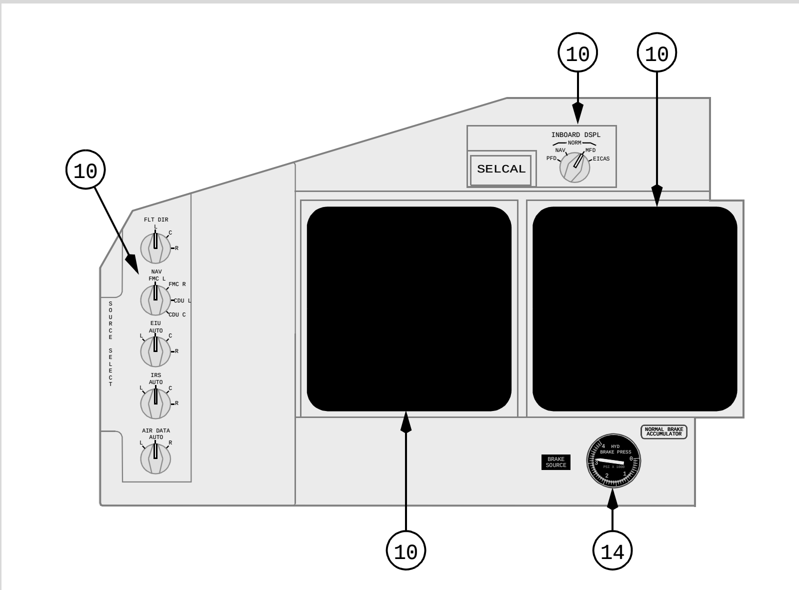


Overhead Maintenance Panel

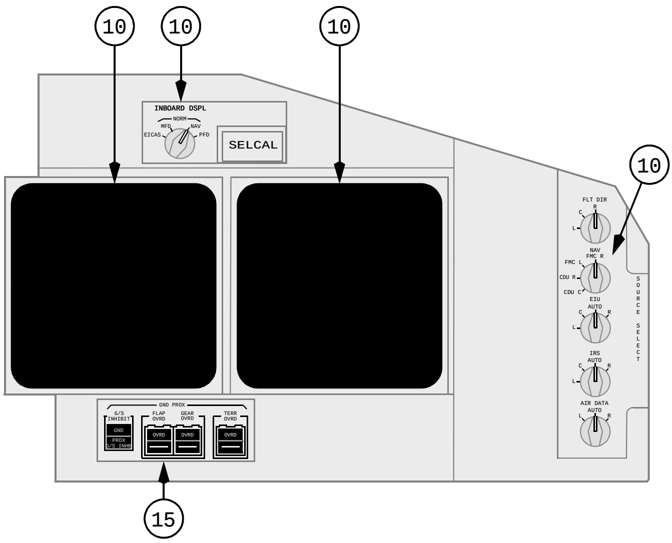


Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Inst. Panels, Forward — Section 22

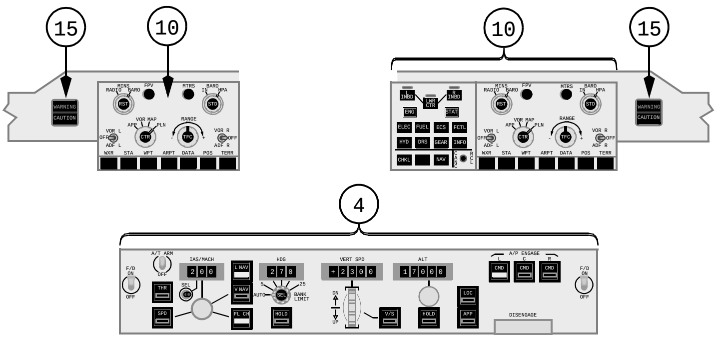
Left Forward Panel



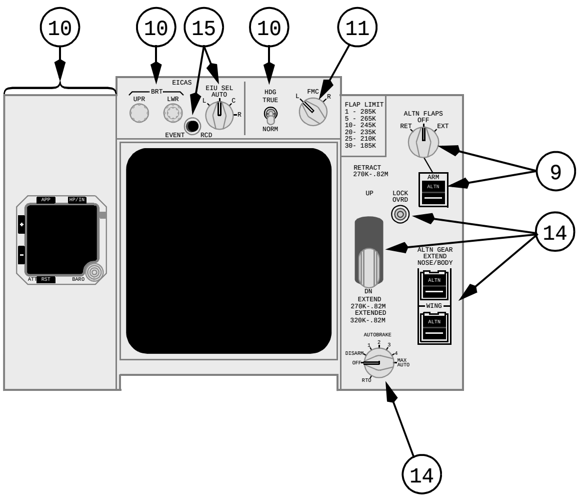
Right Forward Panel



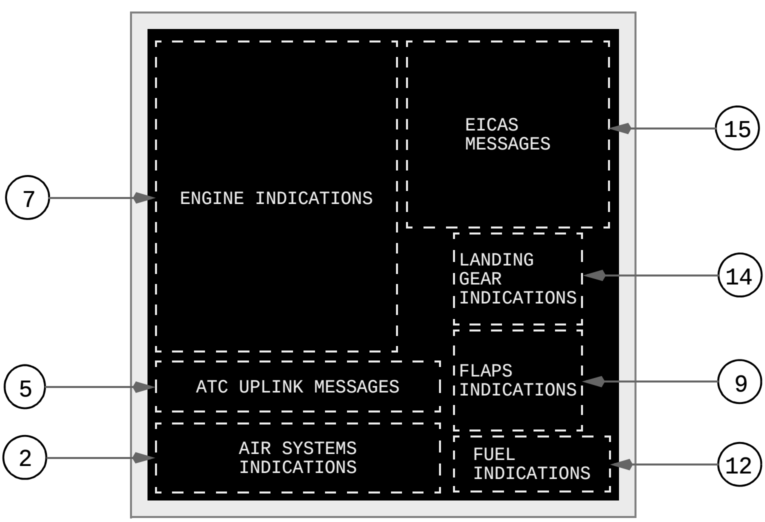
Glareshield Panel



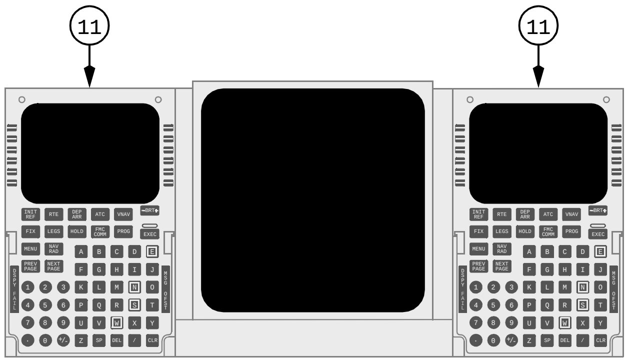
Center Instrument Panel



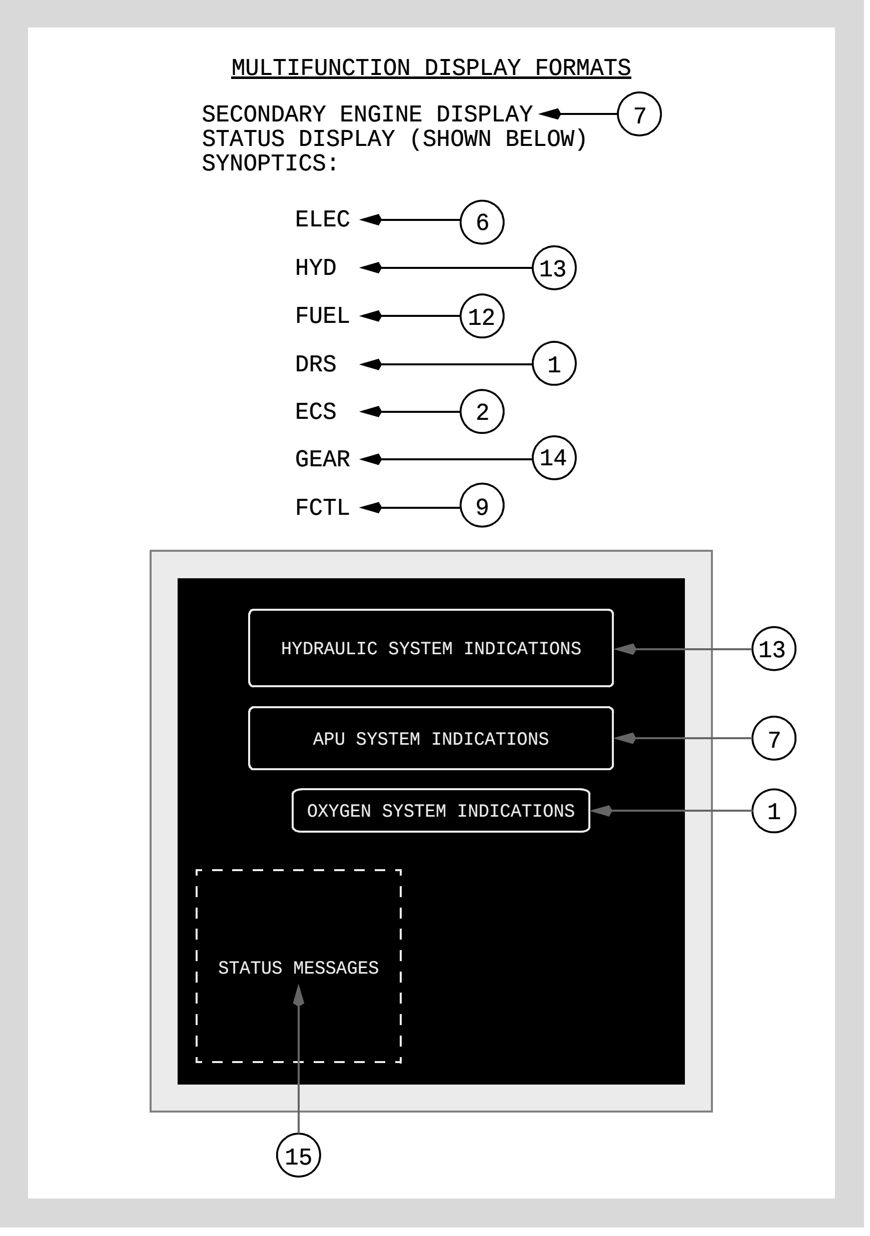
EICAS Display



Forward Aisle Stand



Multifunction Display (MFD)



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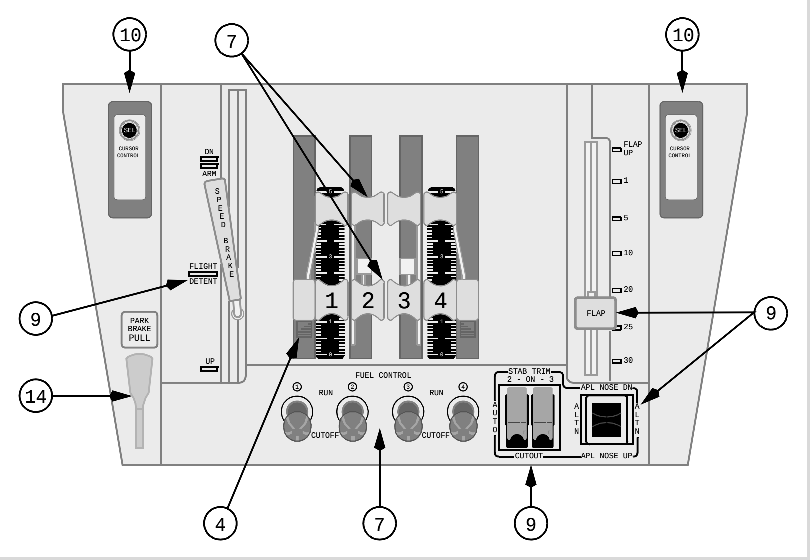
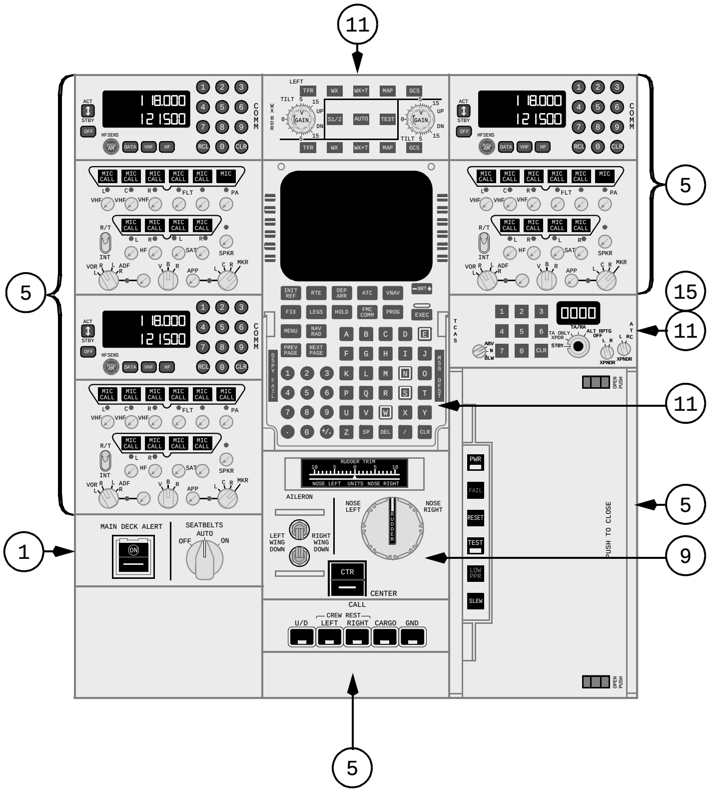
Inst. Panels, Aft and Side — Section 23

Control Stand

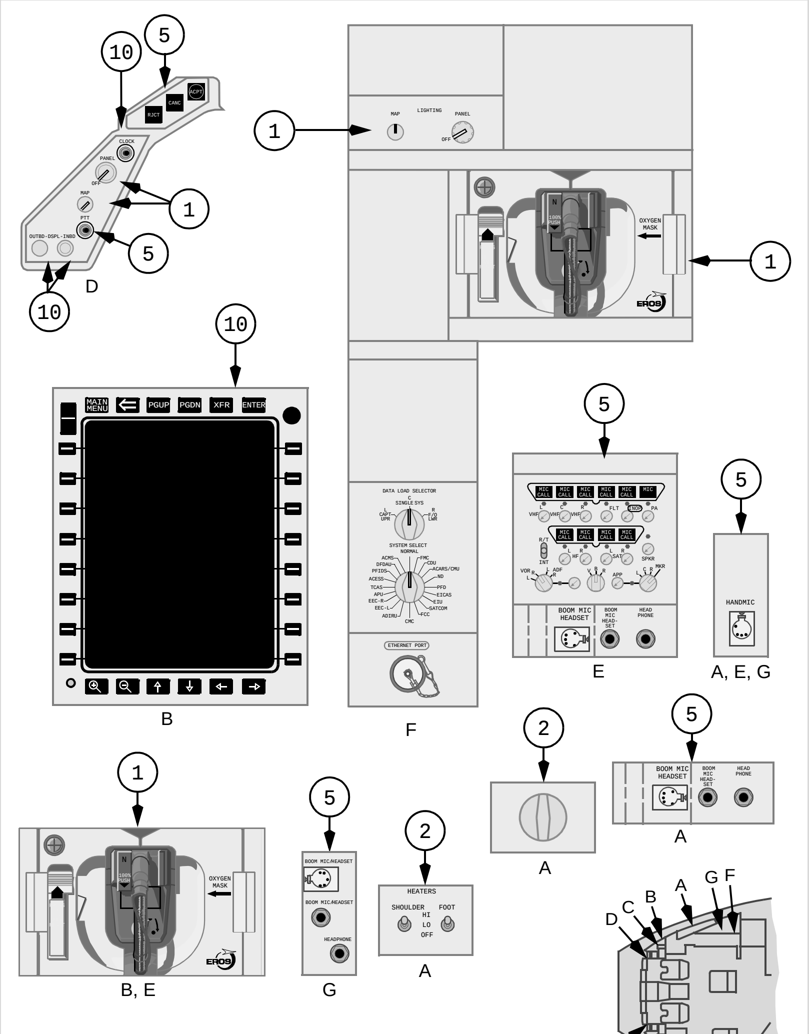


Aft Aisle Stand, Sidewall Panels

Aft Aisle Stand Panels



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



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

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

Controls and Indicators — Section 30

Push-Button Switches

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

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

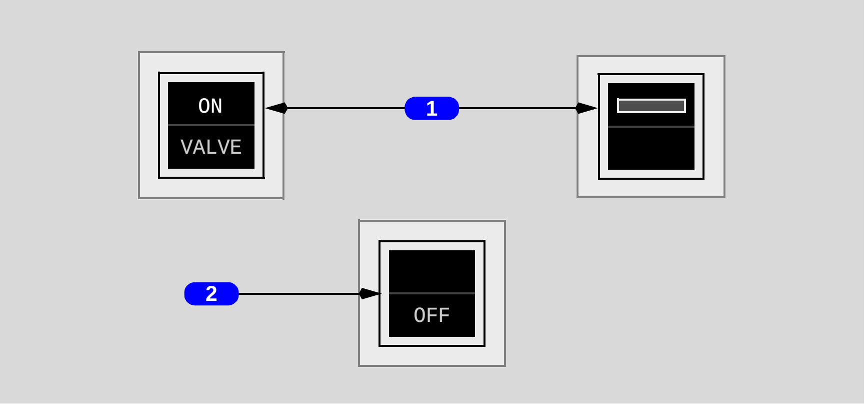
Alternate Action Switches

Alternate action switches have two positions: on and off.

When pushed in and flush with the panel, the switch is on. 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.

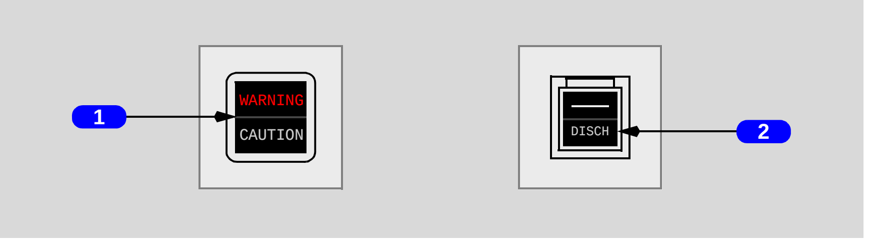
2 **Switch is OFF**

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

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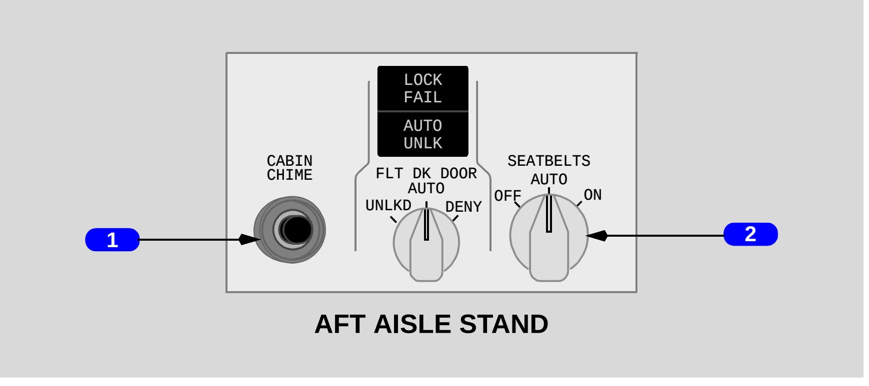

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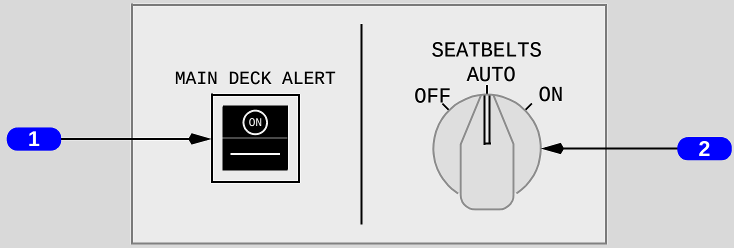

AFT AISLE STAND

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1 CABIN CHIME Switch

Push - sounds cabin chime

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1 MAIN DECK ALERT Switch

See Main Deck Alert System, this section

2 SEAT BELTS Selector

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

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

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

914

ON -

- FASTEN SEAT BELTS and RETURN TO SEAT signs illuminate
- main deck ceiling lights flash for several seconds

806

Note: Anytime passenger oxygen deploys, FASTEN SEAT BELTS signs illuminate and RETURN TO SEAT signs extinguish, regardless of selector position.

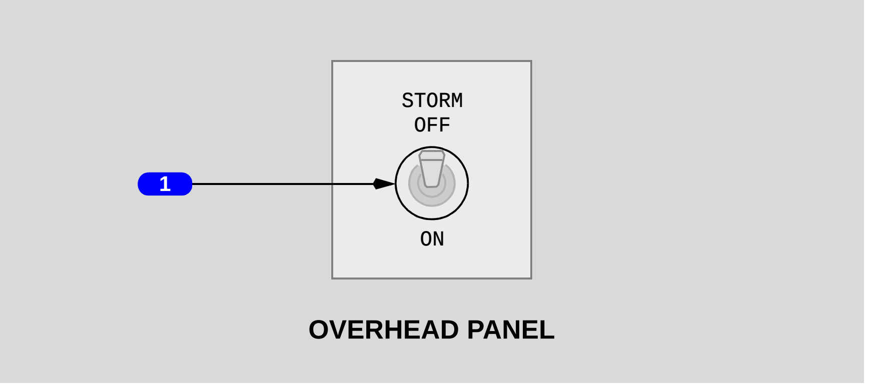
914

Note: Anytime supernumerary oxygen deploys, FASTEN SEAT BELTS signs illuminate and RETURN TO SEAT signs extinguish, regardless of selector position.

Lighting

Flight Deck Lighting

Storm Lights Switch

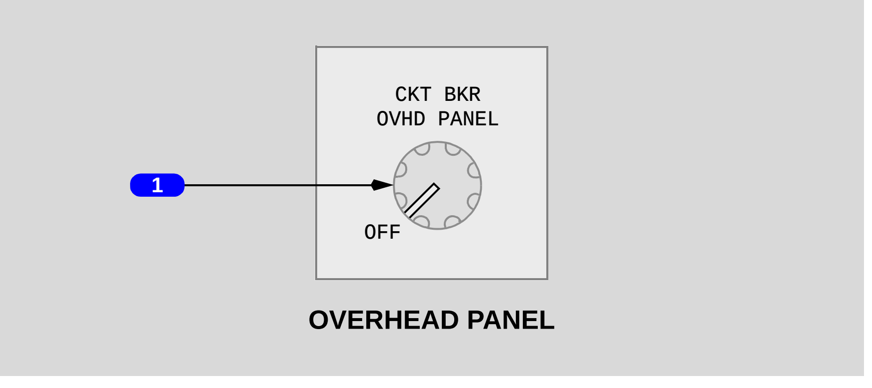


1 STORM Lights Switch

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

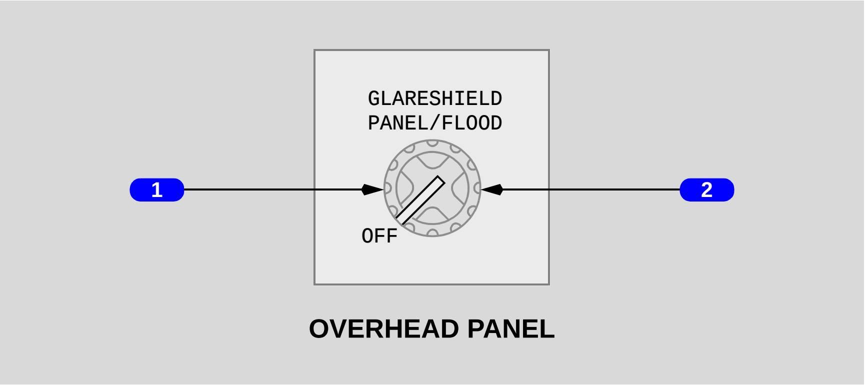
Circuit Breaker/Overhead Panel Lights Control



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

Rotate - controls circuit breaker panel and overhead panel brightness.

Glareshield Panel/Flood Lights Control



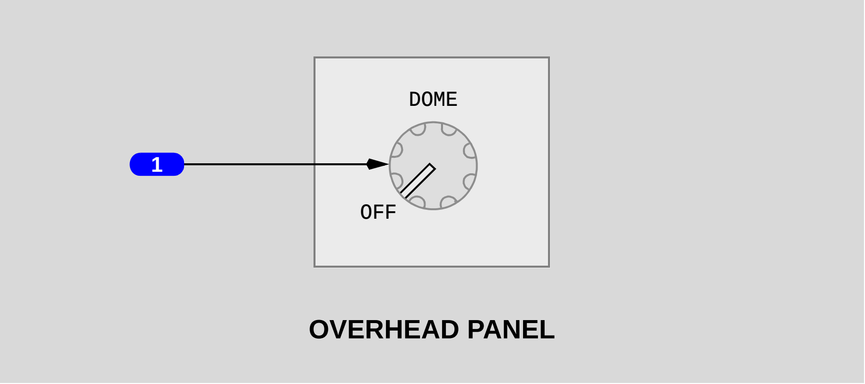
1 GLARESHIELD PANEL/FLOOD Lights Control (inner)

Rotate - controls left and right glareshield flood lights.

2 GLARESHIELD PANEL/FLOOD Lights Control (outer)

Rotate - controls glareshield panel and standby magnetic compass lights.

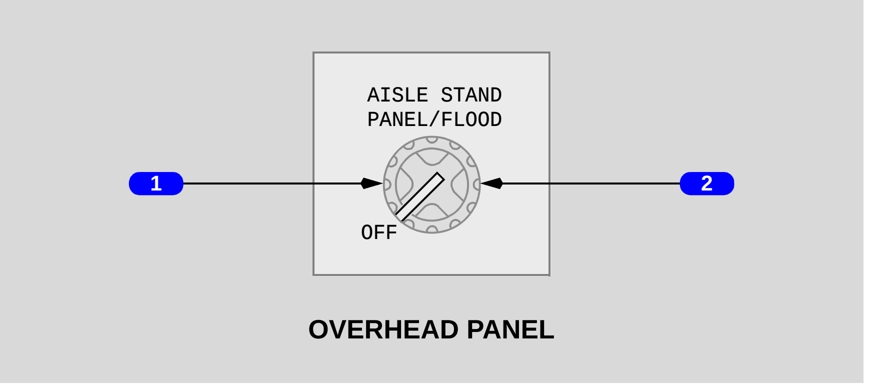
Dome Lights Control



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)

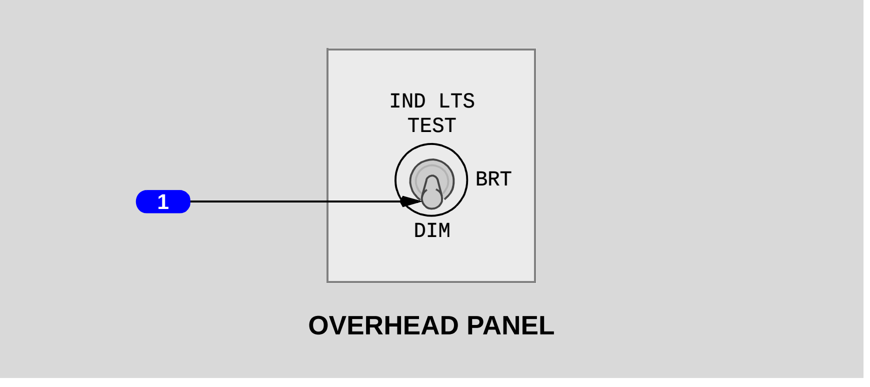
Rotate - controls aisle stand flood lights brightness.

2 AISLE STAND PANEL/FLOOD Lights Control (outer)

Rotate -

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

Indicator Lights Switch



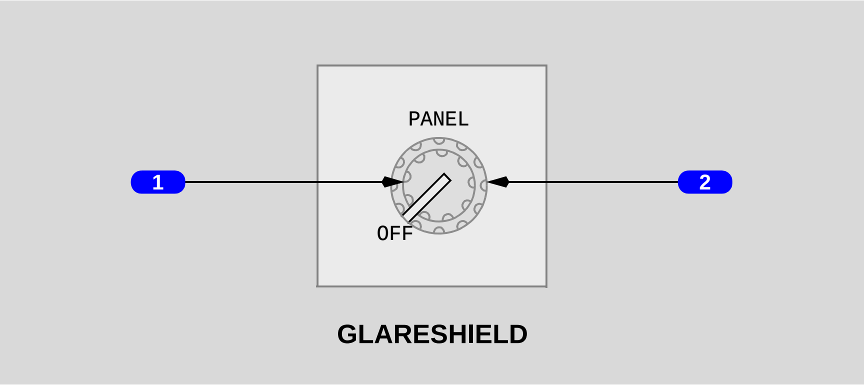
1 Indicator Lights (IND LTS) Switch

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)

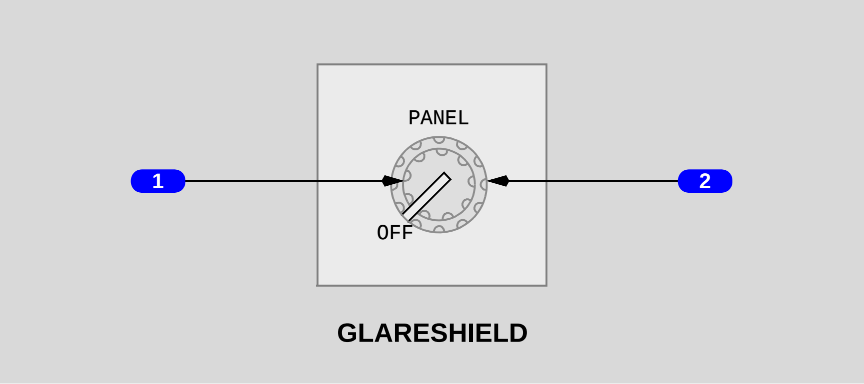
Rotate -

- 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)

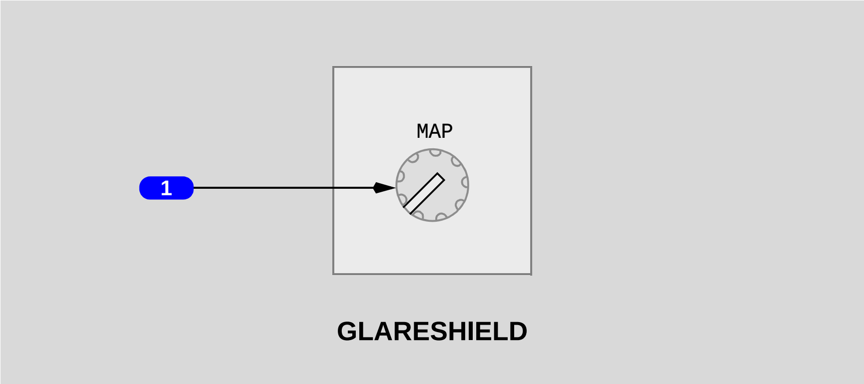
Rotate -

- 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.

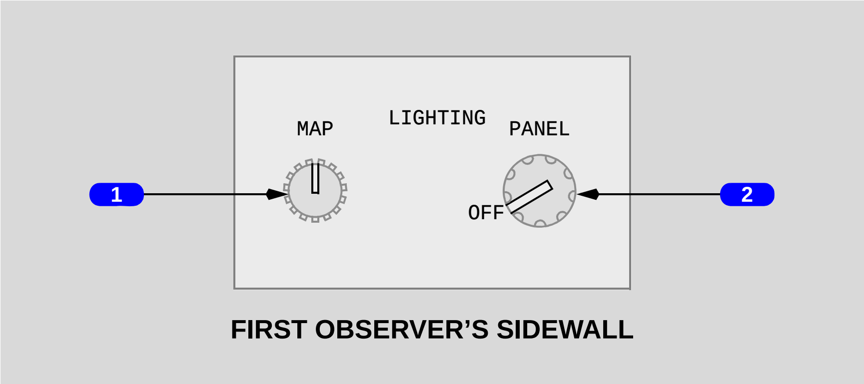
Captain’s and First Officer’s Map Light Controls



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



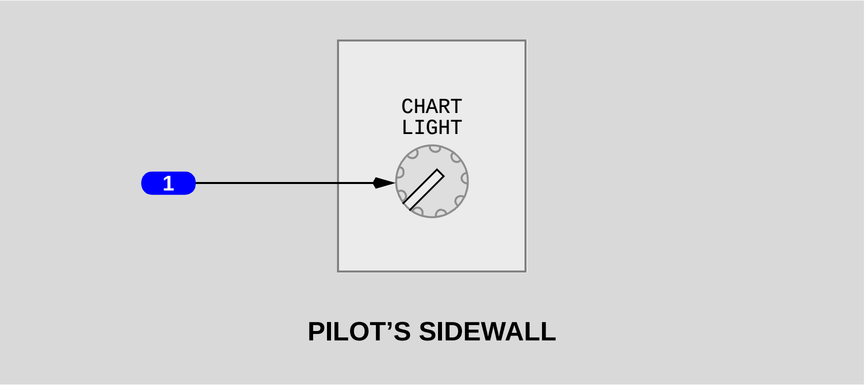
1 First Observer’s MAP Light Switch

Pull/Rotate - controls first observer’s map light brightness.

2 First Observer’s PANEL Light Switch

Rotate - controls first observer’s panel light brightness.

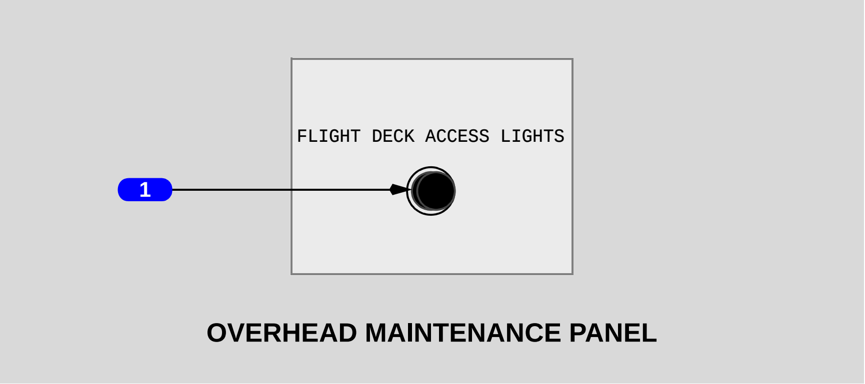
Captain’s and First Officer’s Chart Light Controls



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
806



1 FLIGHT DECK ACCESS LIGHTS Switch

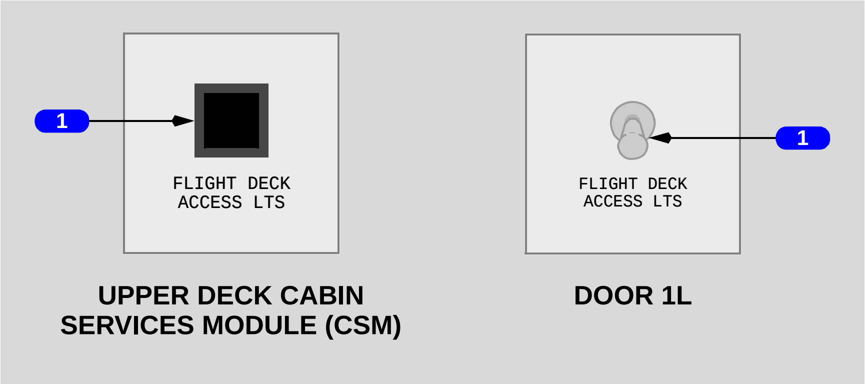
Additional Access Lights switches are located at Door 1 left attendant panel, and Main Equipment Center lower hatch.

Push (any switch) - when the airplane is powered by the ground handling bus, illuminates path between the flight deck and door 1L

Second push (any switch) - extinguishes lighting.

Flight Deck Access Lights Switches

914



1 FLIGHT DECK ACCESS Lights (LTS) Switch

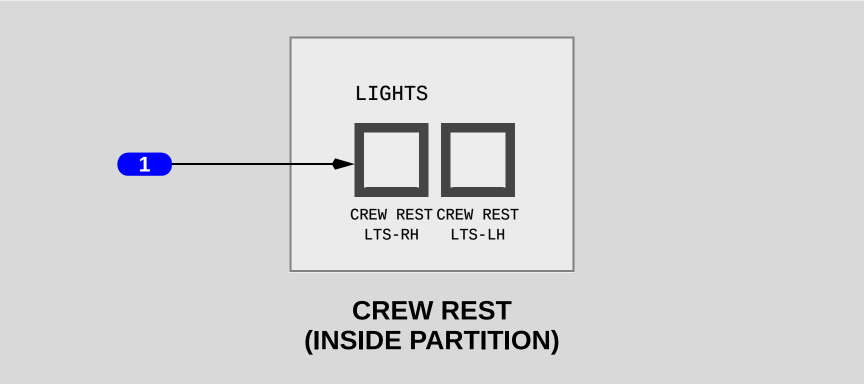
Additional Access Lights switches are located on the overhead maintenance panel, at the upper deck door, and at the Main Equipment Center lower hatch.

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

- Main Equipment Center lights
- left sidewall light forward of Door 1L
- threshold light at Door 1L
- upper deck lights above crew access ladder
- upper deck dome lights

Second push or move up/down (any switch) - extinguishes exit or entry path lighting.

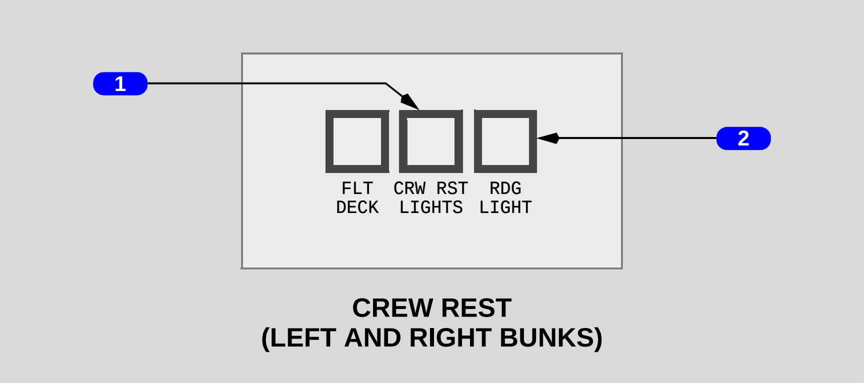
Crew Rest Lights Switches
914



1 CREW REST LIGHTS Switches

Illuminated (white) - crew rest lights on respective side (left or right) extinguished.

Push - activates respective side (left or right) crew rest lights.



1 CREW REST (CRW RST) LIGHTS Switch

Illuminated (white) - crew rest lights extinguished.

Push - activates crew rest bunk area lights.

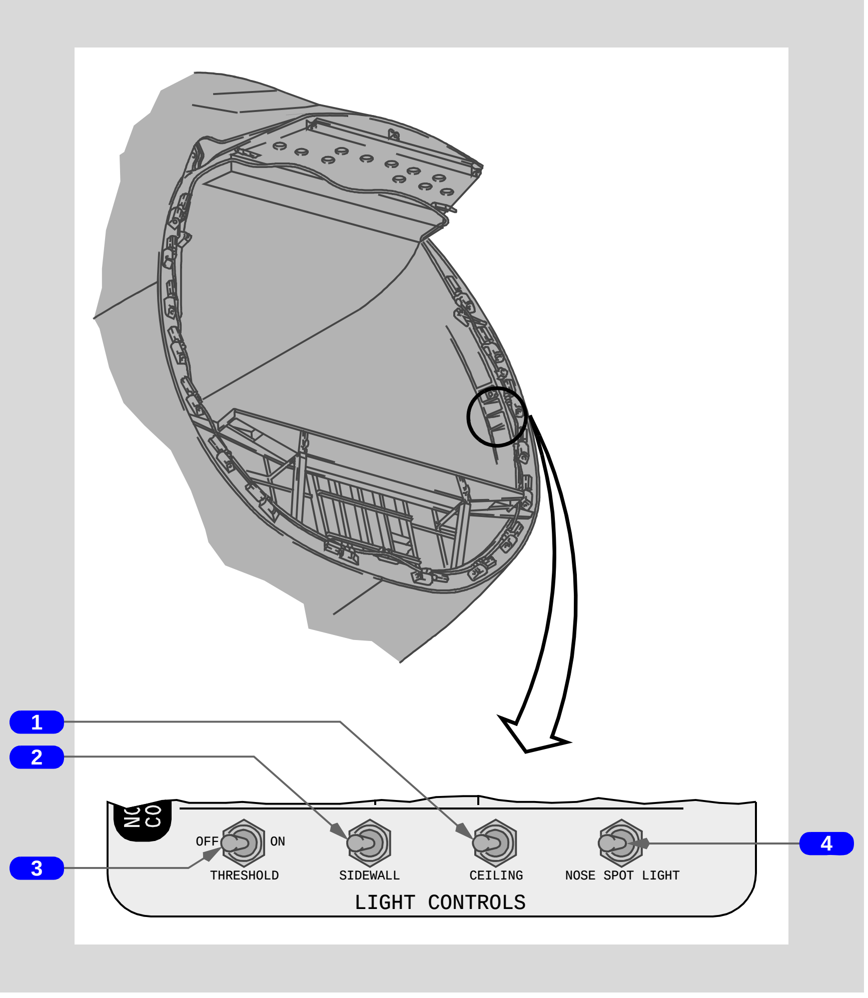
2 Crew Rest Reading (RDG) LIGHT Switch

Illuminated (white) - crew reading lights extinguished.

Push - activates crew rest bunk area reading lights.

Nose Light Controls

914



1 CEILING Light Switch

ON - illuminates ceiling lights in main deck cargo area.

2 SIDEWALL Light Switch

ON - illuminates sidewall lights in main deck cargo area.

3 **THRESHOLD Light Switch**

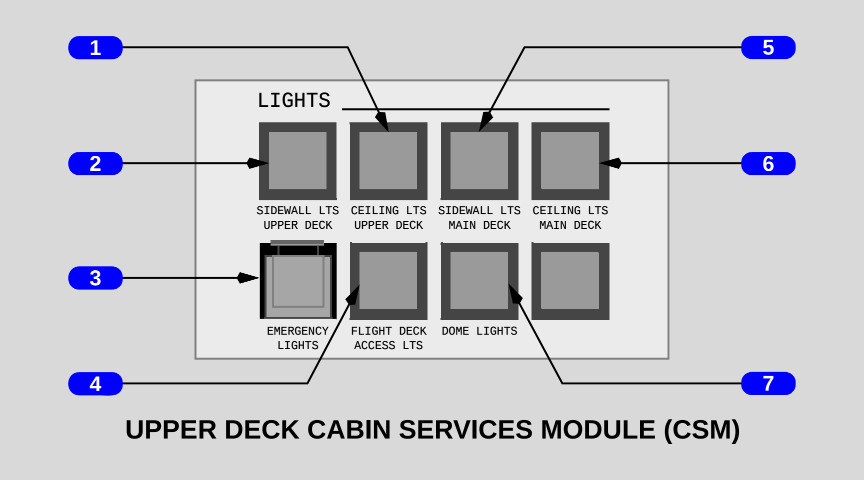
ON - illuminates two cargo loading ramp lights on nose cargo door.

4 **NOSE SPOT LIGHT Switch**

ON - illuminates nose cargo door spot light.

Cabin Light Controls

914



1 **CEILING Lights (LTS) UPPER DECK Switch**

Illuminated (white) - confirms switch selection.

Push - activates upper deck ceiling lights.

2 **SIDEWALL Lights (LTS) UPPER DECK Switch**

Illuminated (white) - confirms switch selection.

Push - activates upper deck sidewall lights.

3 **EMERGENCY LIGHTS Switch**

See Emergency Lighting Controls, this section.

4 **FLIGHT DECK ACCESS Lights (LTS) Switch**

See Flight Deck Access Lights, this section.

5 **SIDEWALL Lights (LTS) MAIN DECK Switch**

Illuminated (white) - confirms switch selection.

Push - activates main deck sidewall lights.

6 **CEILING Lights (LTS) MAIN DECK Switch**

Illuminated (white) - confirms switch selection.

Push - activates main deck ceiling lights.

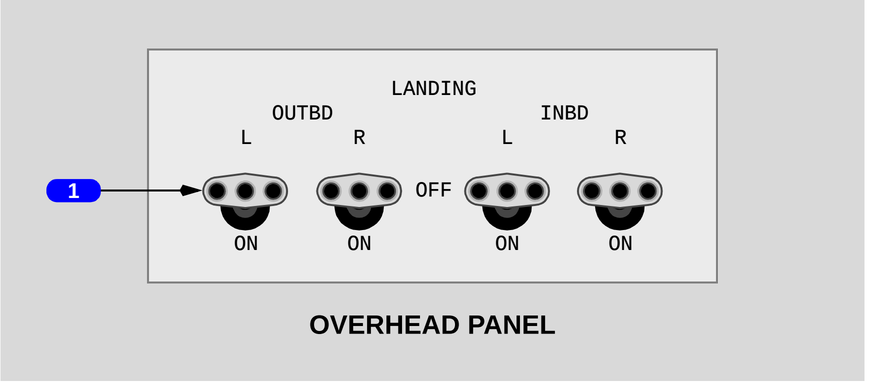
7 **DOME LIGHTS Switch**

Illuminated (white) - confirms switch selection.

Push - activates dome light at upper deck door and ceiling dome light.

Exterior Lighting

Landing Light Switches

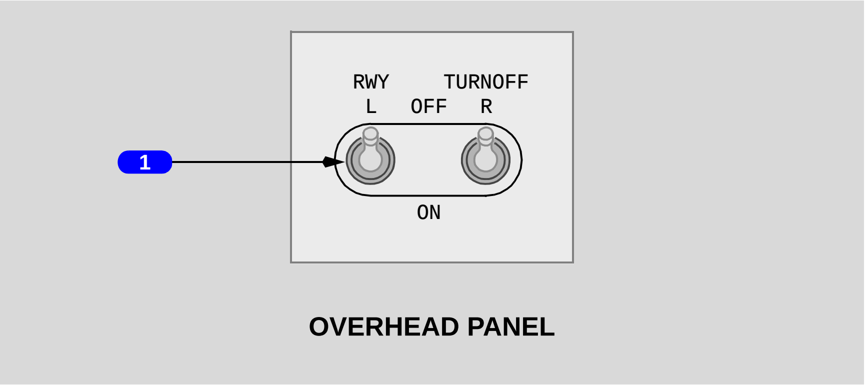


1 **Outboard (OUTBD) and Inboard (INBD) LANDING Light Switches**

ON (L or R)-

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

Runway Turnoff Light Switches

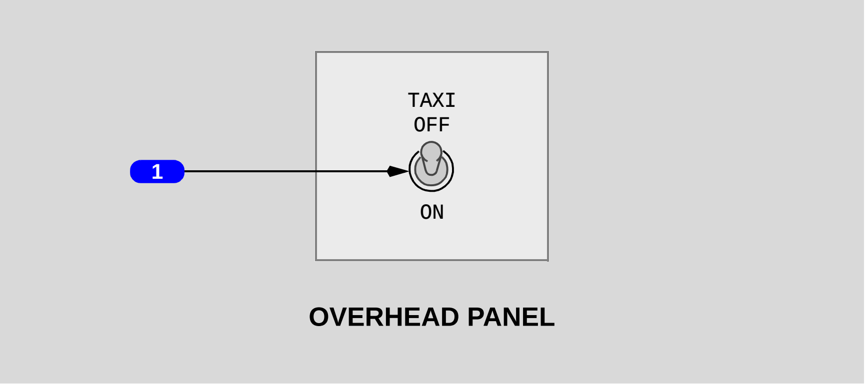


1 Runway (RWY) TURNOFF Light Switches

ON (L or R) -

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

Taxi Lights Switch



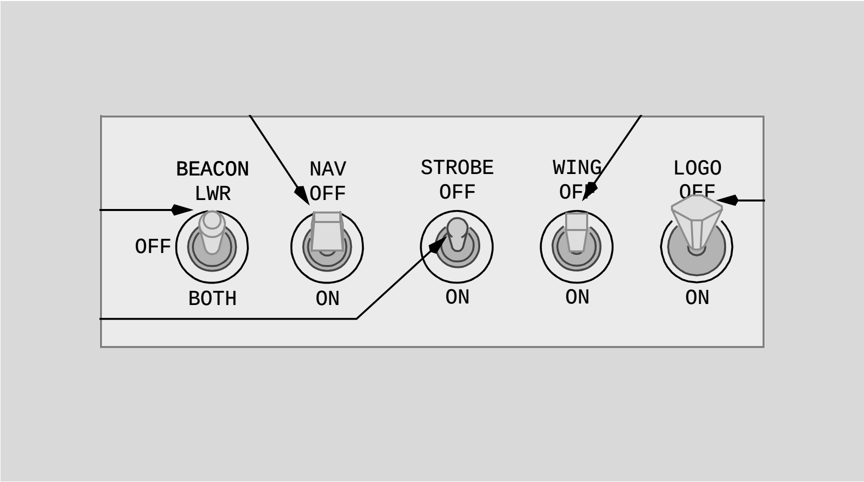
1 TAXI Lights Switch

ON -

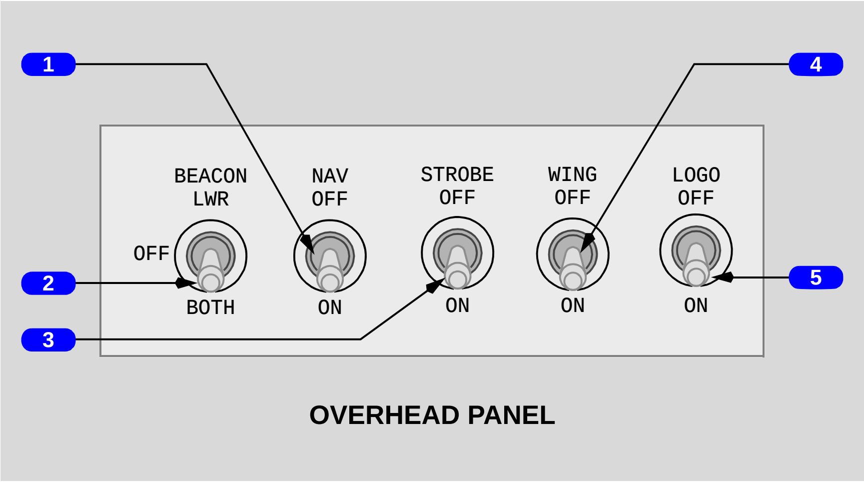
- illuminates two taxi lights on nose landing gear
- lights extinguish when air/ground sensing system in air mode

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

914



806



1 Navigation (NAV) Lights Switch

ON - illuminates red, green, and white navigation lights, and white wingtip marker 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.

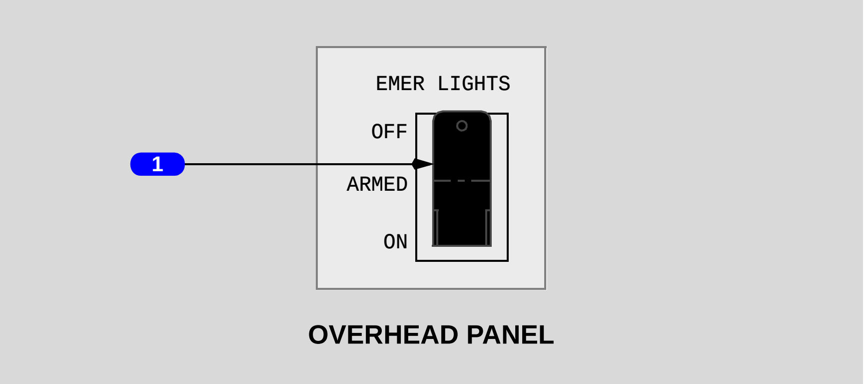
4 WING Lights Switch

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

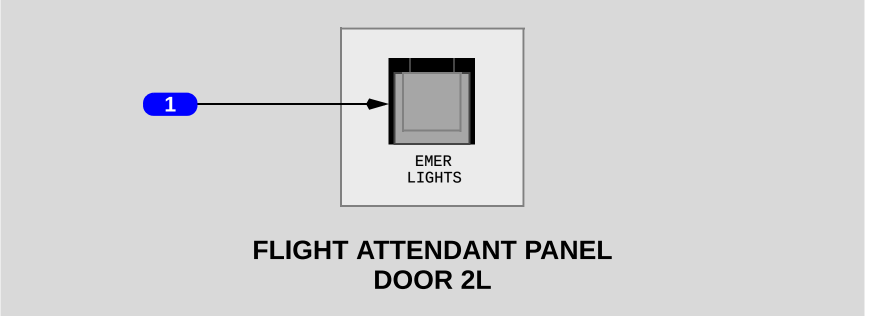
OFF - prevents emergency lights system operation if airplane electrical power fails or is turned off.

ARMED (guard closed) - all emergency lights illuminate if airplane electrical power fails or is turned off.

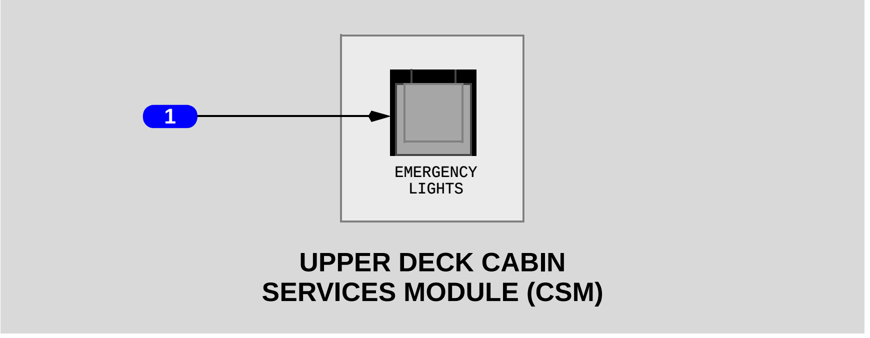
ON - all emergency lights illuminate.

Cabin Emergency Lights Switch

806



914



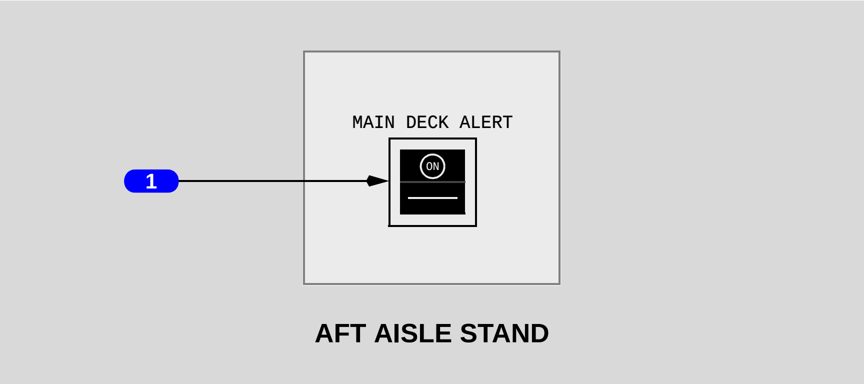
1 Cabin Emergency (EMER) LIGHTS Switch

Push -

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

Main Deck Alert System

914



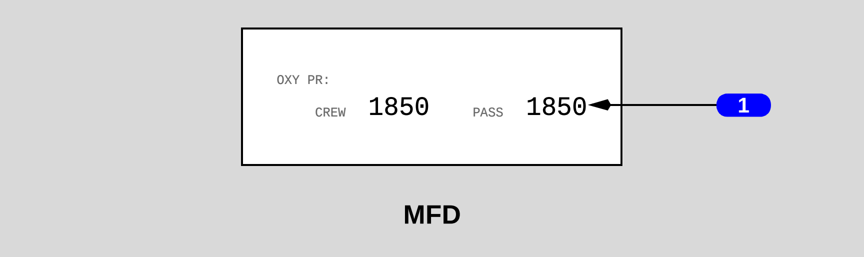
1 MAIN DECK ALERT Switch

Push -

- flashes ceiling lights and sounds aural in main deck for several seconds
- ON light illuminates to indicate system activation
- ON light extinguishes after several seconds to indicate system deactivation

Oxygen Systems

Oxygen Indications



1 Oxygen Pressure (OXY PR) Display

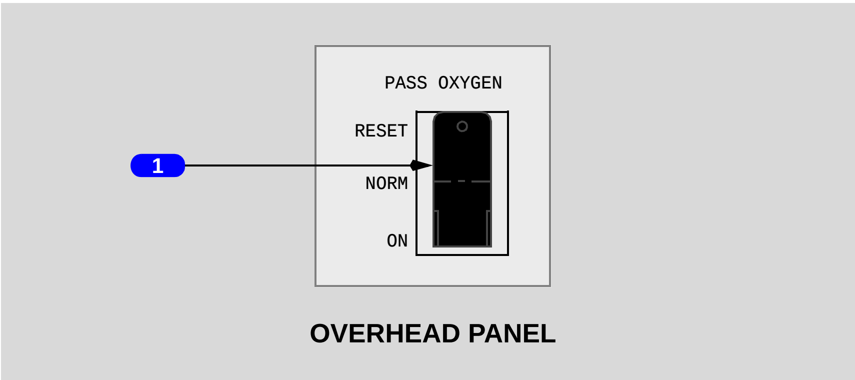
806
Displays crew and passenger oxygen cylinder pressure (PSI).

914
Displays crew and supernumerary oxygen cylinder pressure (PSI).

Note: Access is through display select panel STAT switch.

Passenger Oxygen Switch

806



1 PASSENGER (PASS) OXYGEN Switch

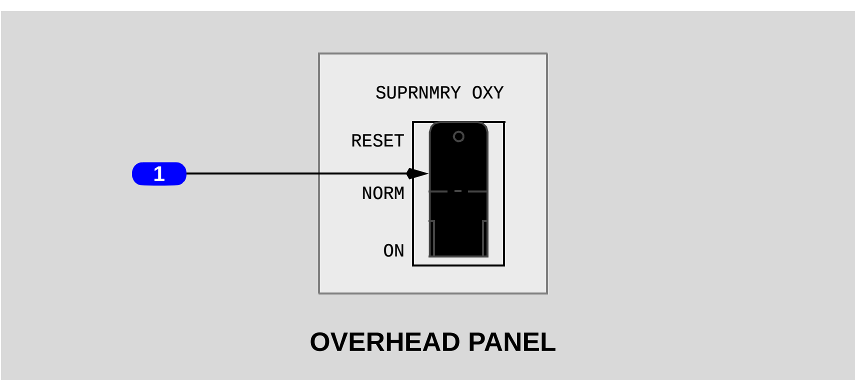
RESET (spring-loaded toggle) - flow control units closed electrically when cabin altitude below 12,000 feet.

NORM (guard closed) - system activates if cabin altitude reaches approximately 14,000 feet.

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

Supernumerary Oxygen Switch

914



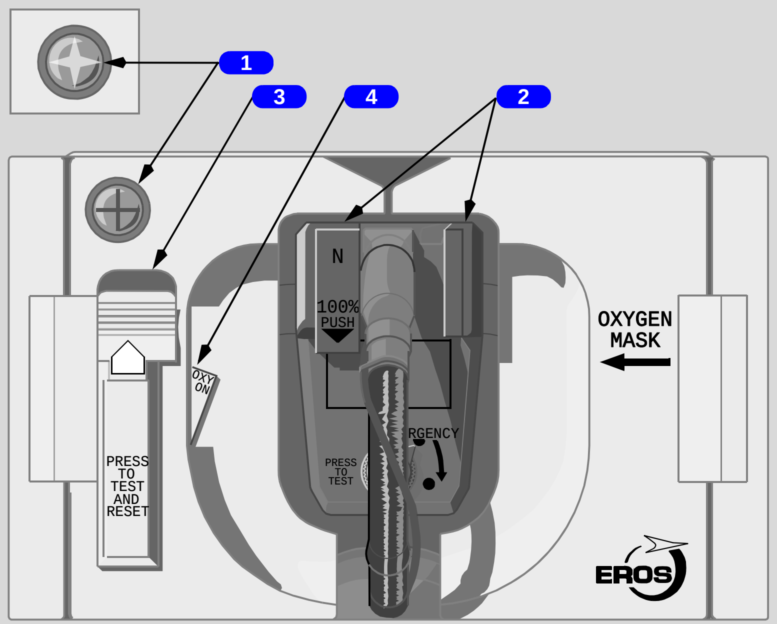
1 Supernumerary Oxygen (SUPRNMRY OXY) Switch

RESET (spring-loaded toggle) - flow control unit 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 toggle) - cabin oxygen masks drop.

Oxygen Mask Panel



CREW MEMBER STATION

1 Oxygen Flow Indicator

Shows a yellow cross when oxygen flowing.

2 Oxygen Mask Release Levers

Squeeze and pull -

- unlocks oxygen panel doors
- releases mask
- oxygen turns on when oxygen panel doors open
- flow indicator shows a yellow cross momentarily as harness inflates
- when 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

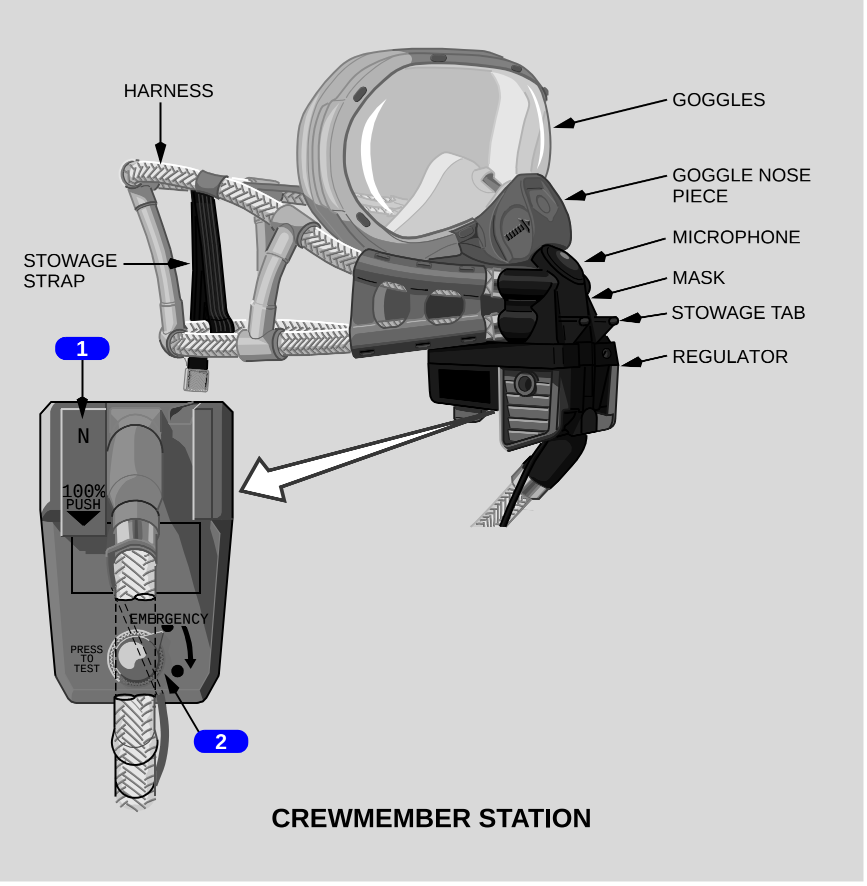
Push -

- 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



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

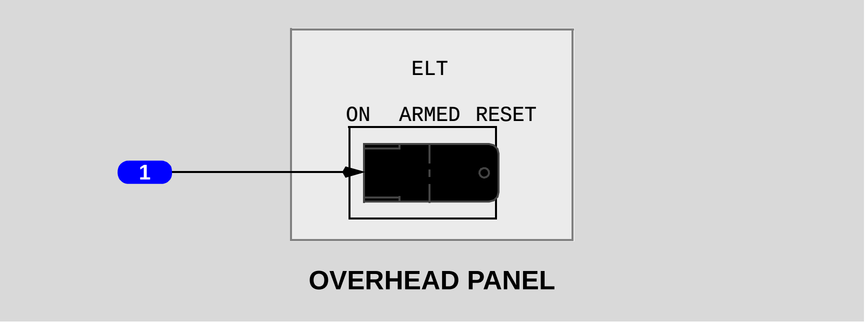
Rotate (in the direction of the arrow) - supplies 100% oxygen under positive pressure at all cabin altitudes (protects against smoke and harmful vapors).Use to purge contaminants from mask and to remove condensation or fogging from interior of mask lens.

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

CAUTION: CAUTION: Use of the EMER mode depletes oxygen supply at a higher rate than 100% or NORM mode. Use EMER mode only as conditions require.

Note: Communications in EMER mode may be difficult. Switch to 100% or NORM mode if conditions allow.

Emergency Locator Transmitter



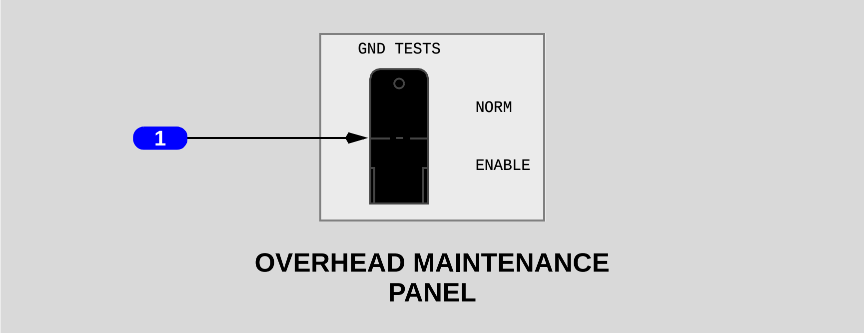
1 Emergency Locator Transmitter (ELT) Switch

ON - transmits emergency locator signal.

ARMED (guard closed) - transmits emergency locator signal if activated by high deceleration forces.

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

Ground Tests Switch



1 Ground (GND) TESTS Switch

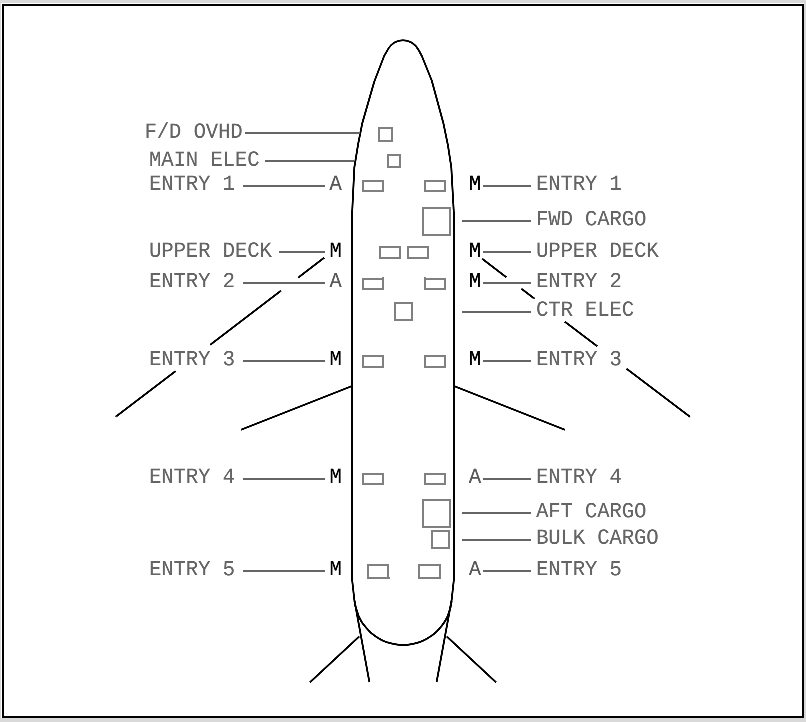
ENABLE - allows Central Maintenance Computer to initiate ground tests of airplane systems.

NORM (Normal - guard closed) - systems configured for flight.

Doors

Doors Synoptic Display

806



MFD

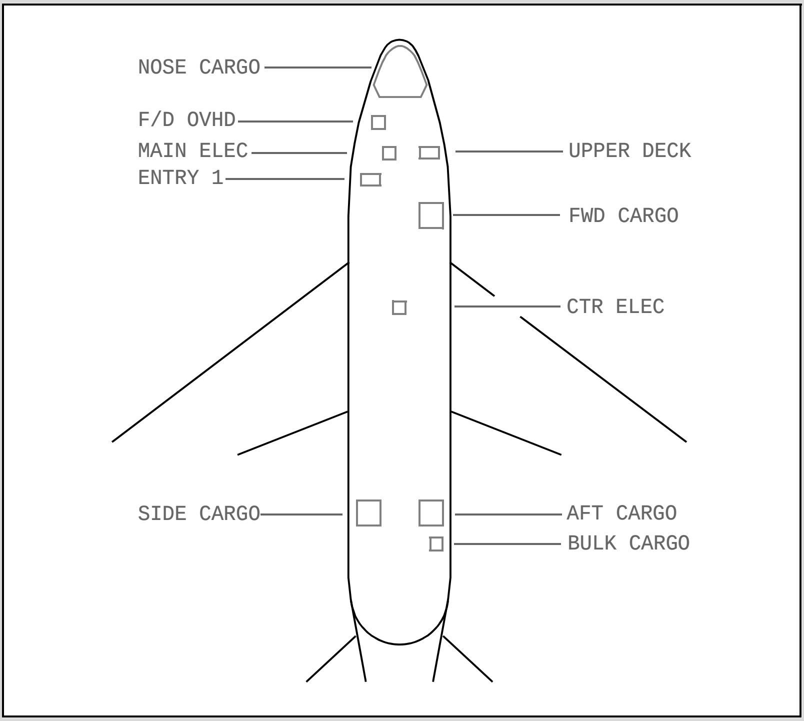
(AMBER) - DOOR OPEN
(BLANK) - DOOR CLOSED

CYAN NOMENCLATURE
DISPLAYED CONTINUOUSLY

M (WHITE) - DOOR MODE SELECT
LEVER IN MANUAL POSITION

A (GREEN) - DOOR MODE SELECT
LEVER IN AUTOMATIC POSITION

914



MFD

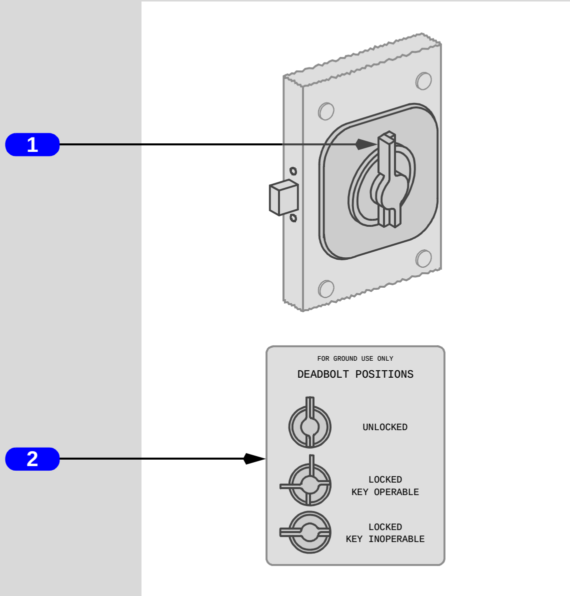
(AMBER) - DOOR OPEN
(BLANK) - DOOR CLOSED

CYAN NOMENCLATURE DISPLAYED CONTINUOUSLY

Flight Deck Door

806

Deadbolt

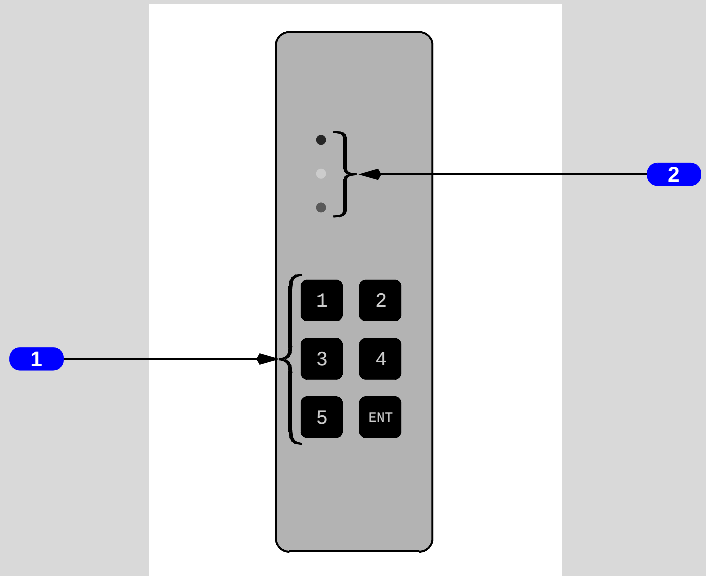


FLIGHT DECK DOOR
(FLIGHT DECK SIDE)

1 **Deadbolt Levers**

2 **DEADBOLT POSITION Placard**

Flight Deck Emergency Access Panel



PASSENGER SIDE DOOR POST

1 Keypad

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

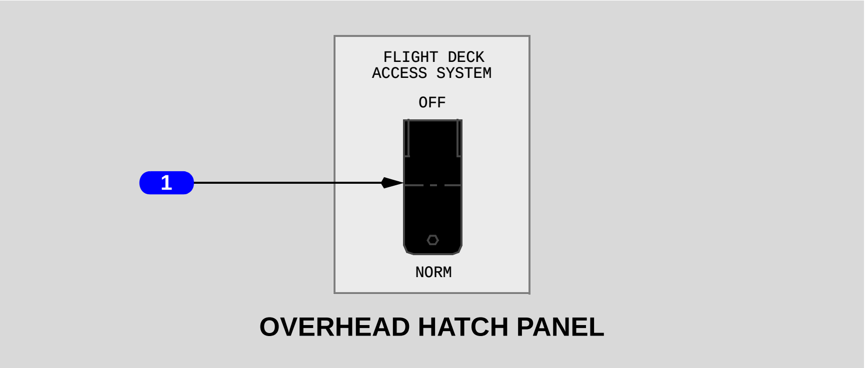
2 Access Lights

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

Illuminated (amber) - correct emergency access code entered.

Illuminated (green) - door unlocked.

Flight Deck Access System Switch

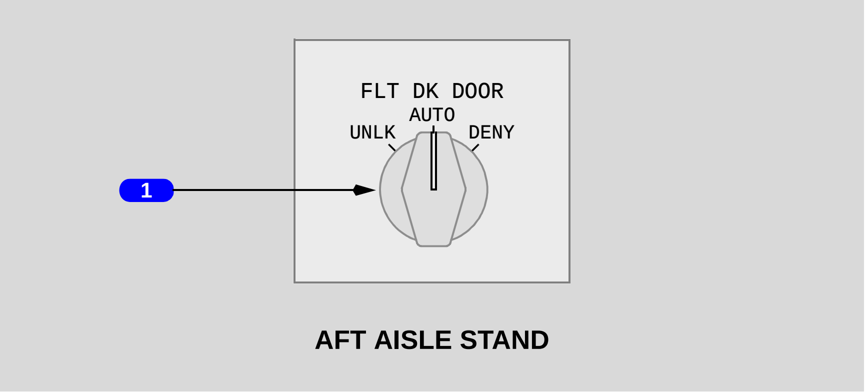


1 Flight Deck Access System Switch

OFF - removes electrical power from door lock.

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

Flight Deck Door Lock Panel



1 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.

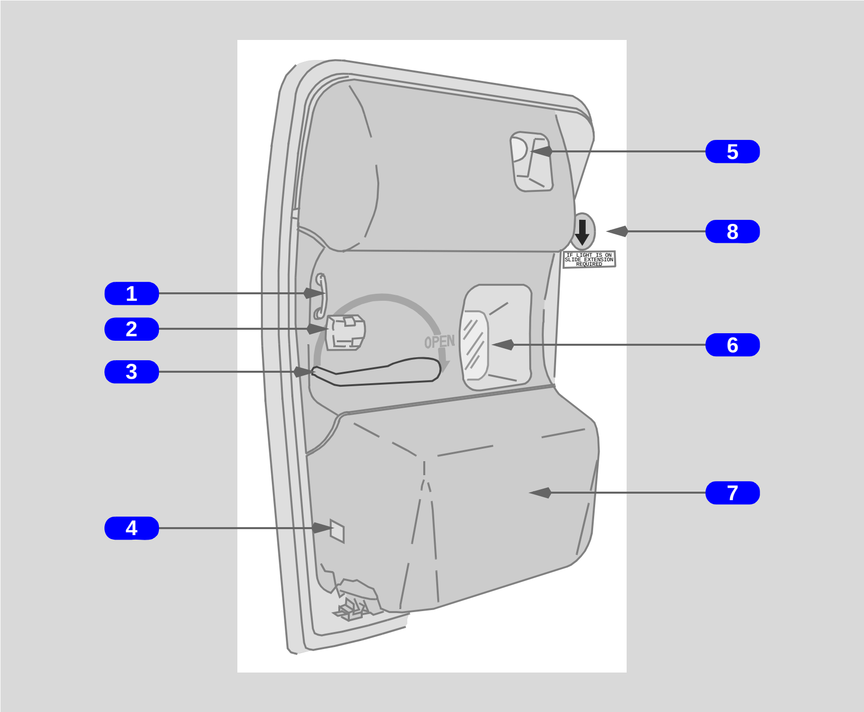
UNLKD - door unlocked while selector in UNLKD.

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

806



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.

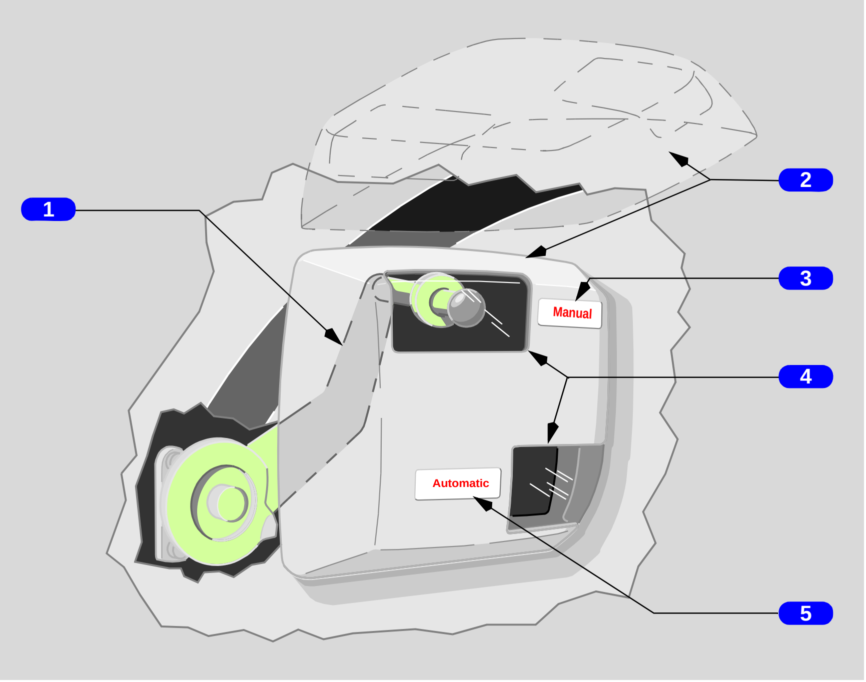
8 **Slide Extension Light (Door 1)**

Illuminated (red) - slide extension required

Door Mode Select Panel

When door is opened from outside, door mode select lever moves to MANUAL.

A lockout pin with warning flag may be installed when the mode select lever is in the MANUAL position. The lockout pin prevents handle movement from MANUAL.



1 Door Mode Select Lever

Used to select the required mode for flight, AUTOMATIC, or arrival, MANUAL.

2 Access Cover

Open -

- allows access to the door mode select lever

Closed -

- allows verification of the door mode select lever position

3 MANUAL

The door is disarmed if the mode select lever knob is visible in the viewport.

Moving the mode select lever to the MANUAL position disables automatic slide/raft deployment

Note: Automatic deployment of the slide/raft is disabled when the exterior door operating handle is moved to the open position.

4 Plastic Viewport Cover

MANUAL -

- knob visible in viewport indicates door is in the disarmed mode

AUTOMATIC -

- knob visible in viewport indicates door is in the armed mode

5 AUTOMATIC

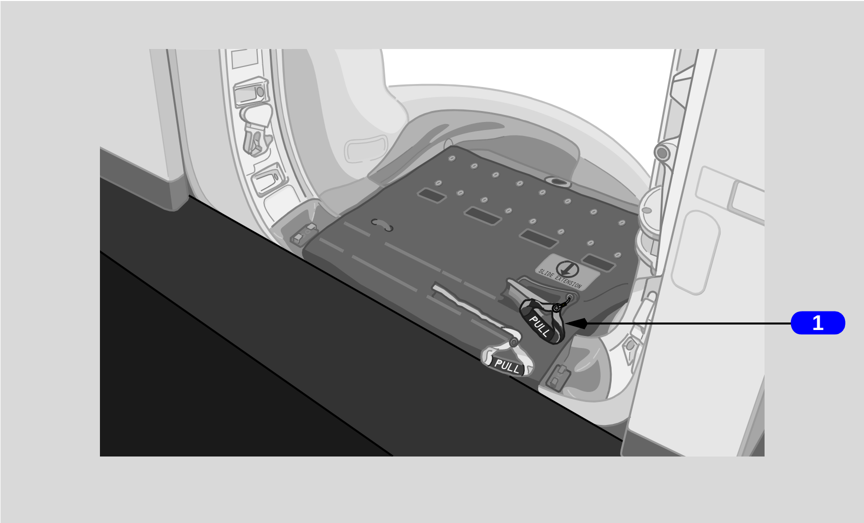
The door is armed if the mode select lever knob is visible in the viewport.

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

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

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

Escape Slide/Raft, Door 1



1 Slide Extension Handle

Pull - manually inflates slide extension

Note: Slide extension should automatically inflate if the airplane is tipped tail down.

Main Deck Entry Door

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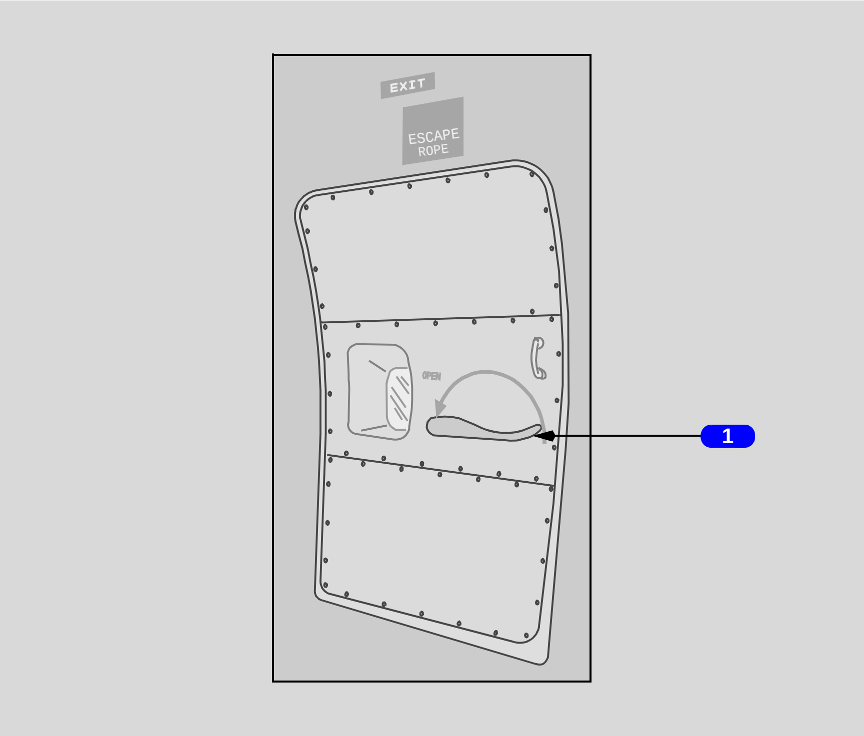


1 Door Operating Handle

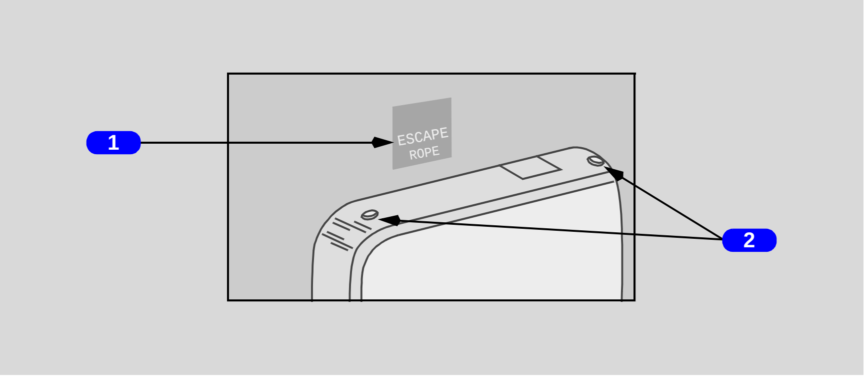
OPEN -

- unlatches door when handle rotated
- door moves inward, then outward

Close - latches door in closed position when handle rotated.

Note: The Main Deck Entry Door is manually operated and has no power assist.

Main Deck Entry Door Threshold Lights and Escape Rope

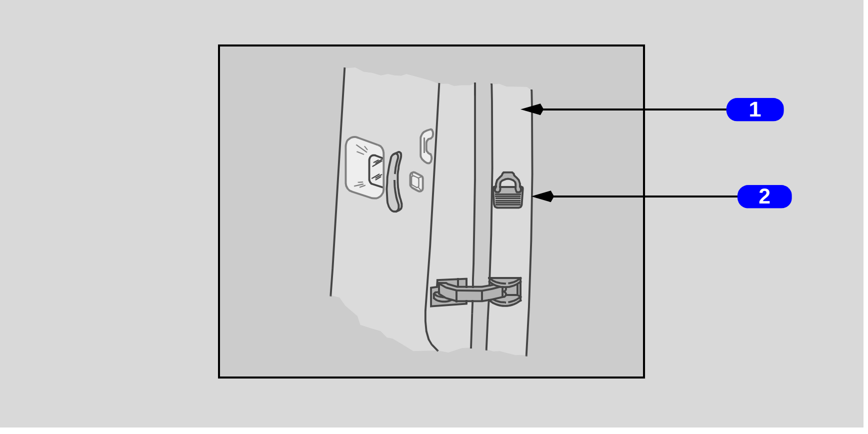


1 Escape Rope

Stowed.

2 Threshold Lights

Main Deck Entry Door Hold Open Release Lever



1 Body Frame

2 Door Hold Open Release Lever

Disengages when lifted up to allow door to close.

Upper Deck Emergency Door

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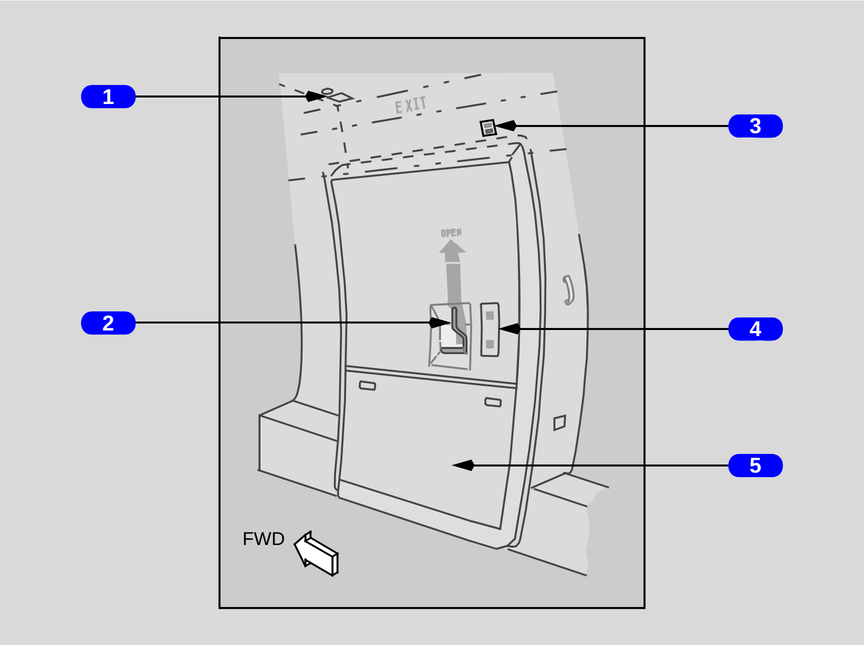


1 Door Operating Gas Bottle Pressure Gage

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 Door Ground Mode/Battery OK Panel, this section.

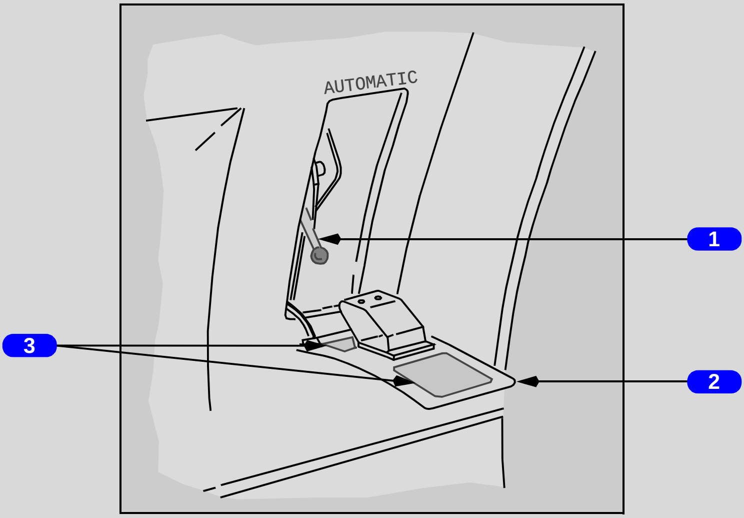
4 Door Mode Select Lever

See Upper Deck Door Mode Select Panel, this section.

5 **Escape Slide Pack**

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

Upper Deck Emergency Door Mode Select Panel



UPPER DECK
EMERGENCY DOOR

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.

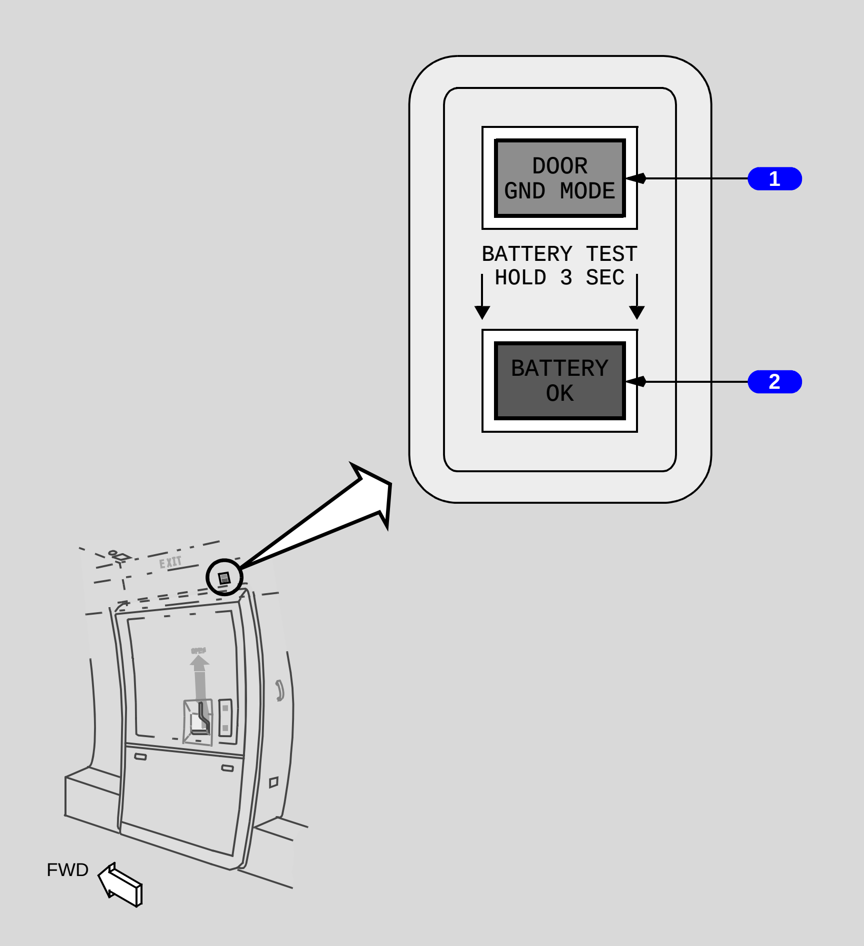
Cover will not close unless door mode select lever fully in MANUAL or AUTOMATIC position.

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.

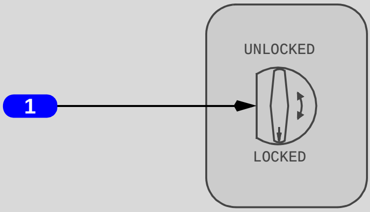
2 BATTERY OK Test Switch/Light

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



INTERIOR VIEW

1 Overhead Escape Hatch Handle

Rotate handle to unlock hatch.

Pull hatch inward.

Upper Deck Door

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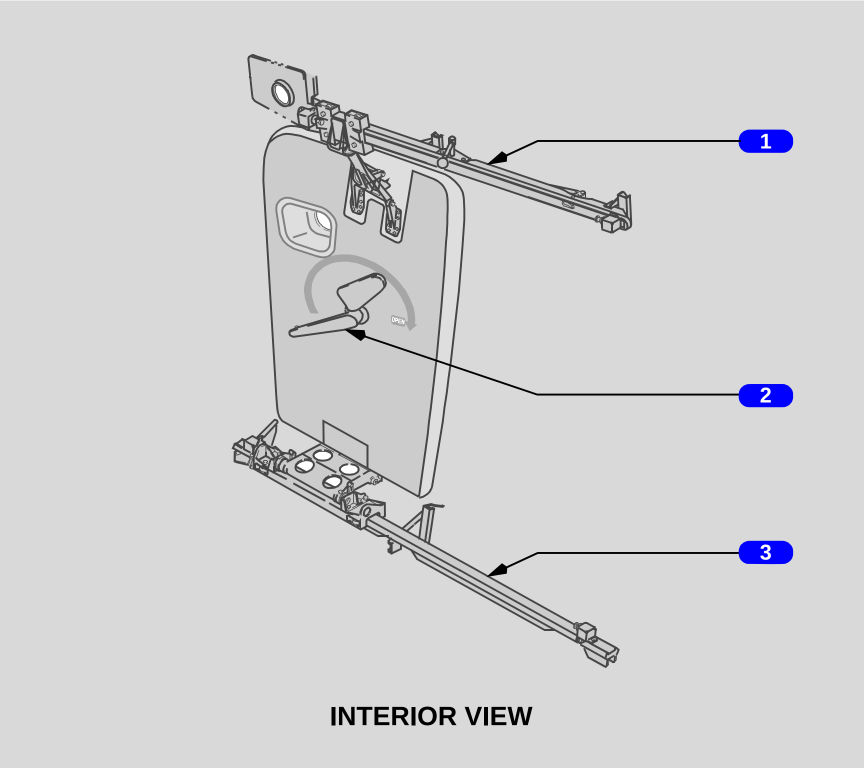

1 Door Latch Manual Handle

Push - releases door from aft stowed position.

2 Door Handle

Pull and rotate clockwise - unlocks latches and continues door movement inboard on upper and lower hinges.

3 Door Tracks

Upper and lower tracks.

Escape Slide, Upper Deck Door

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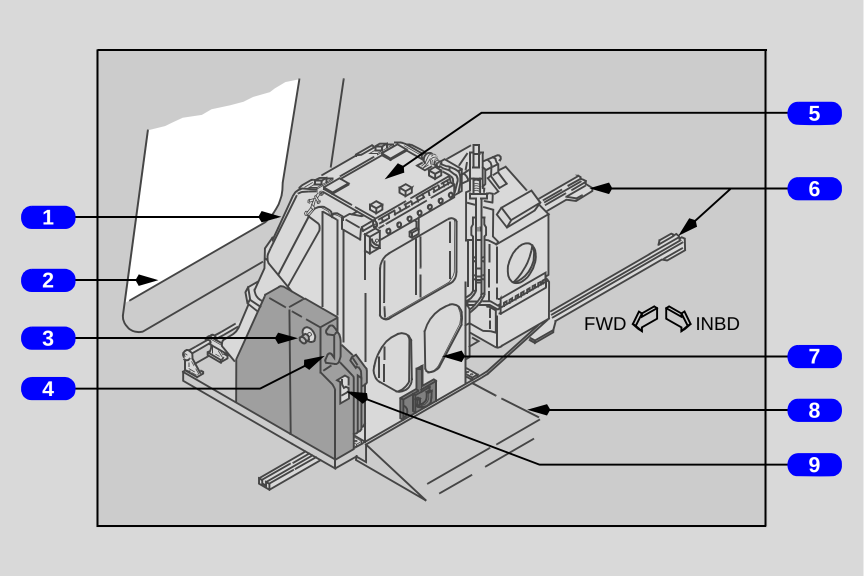
Escape Slide Deployment Position



1 **Escape Slide Pack**

2 **Entry Doorway**

3 **Platform Lock Control**

4 **Assist Handle**

5 **Chute Extension Panel**

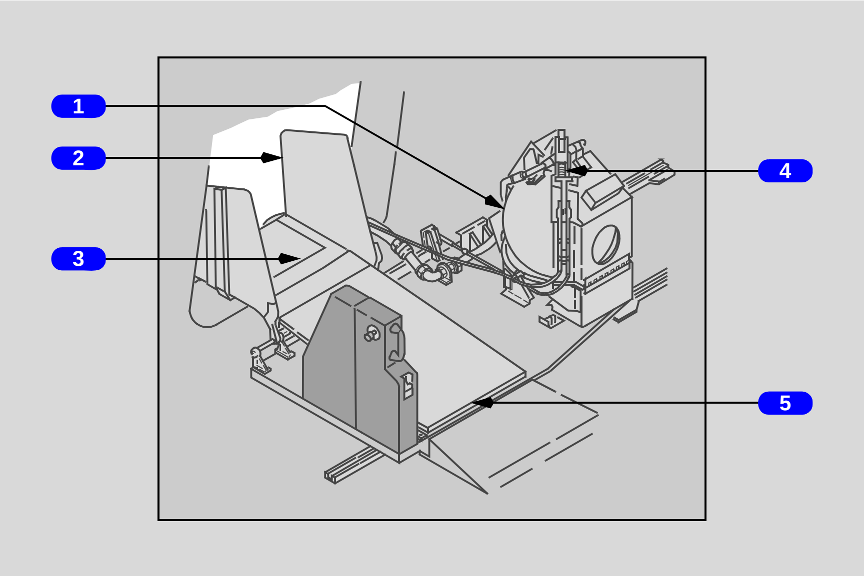
6 **Floor Tracks**

7 **Packboard**

8 **Floor Ramp**

9 **Packboard Manual Release Handle**

Escape Slide Deployed



1 **Stored Gas Bottle**

2 **Chute**

3 **Escape Slide Girt**

4 **Manual Inflation Handle**

CAUTION: DO NOT PULL MANUAL INFLATION HANDLE UNLESS PACKBOARD IS OUT THROUGH DOORWAY.

5 **Ramp Plate**

Side Cargo Door

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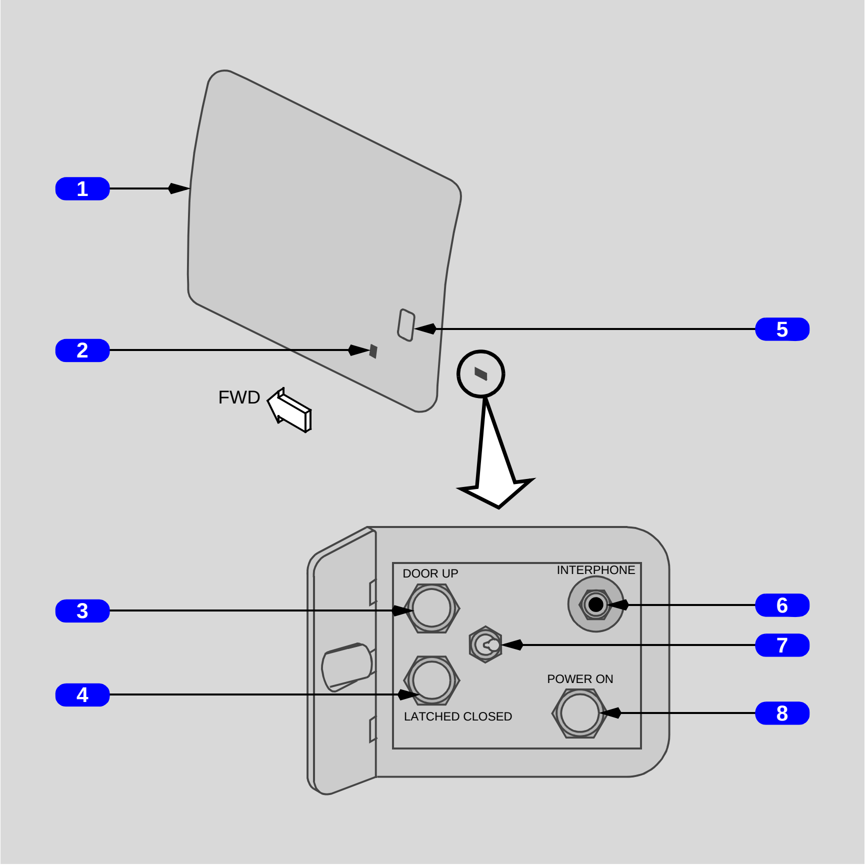
Side Cargo Door Exterior Controls



1 Side Cargo Door

2 Exterior Latch Lock Handle

Upper handle area release -

Press - releases exterior and interior Latch Lock handles.

Latch Lock handle -

Pull down - powers Door Control switch.

3 DOOR UP Light

Illuminated (green) - side cargo door in full open position.

4 **LATCHED CLOSED Light**

Illuminated (green) - Latch Lock handles are released with door in closed position and latches engaged.

5 **Window**

6 **INTERPHONE Jack**

7 **Door Control Switch**

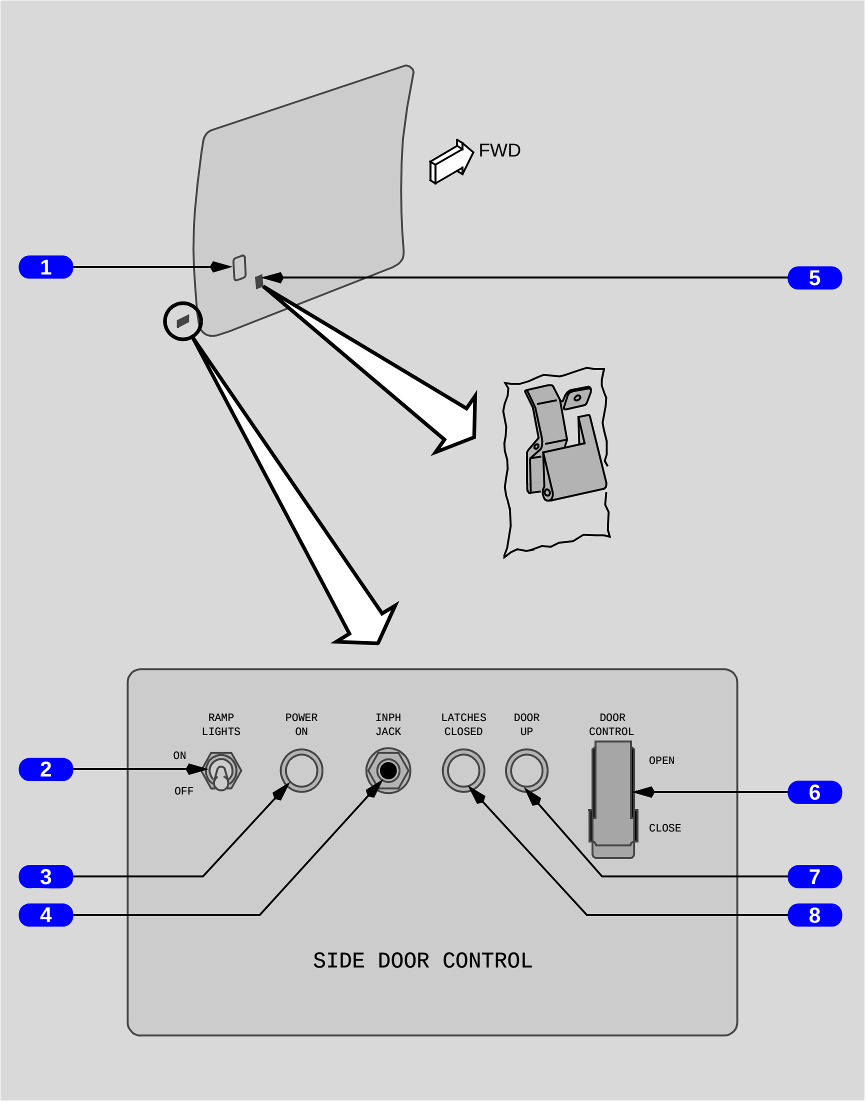
Electrically powered when POWER ON light illuminated and Latch Lock handle in extended position.

Hold - switch in either DOOR UP or LATCHED CLOSED position operates door.

8 **POWER ON Light**

Illuminated (green) - electrical power available to operate door.

Side Cargo Door Interior Controls



1 Side Cargo Door Window

2 RAMP LIGHTS Switch

ON - illuminates lights in upper part of door to light loading area.

OFF - lights extinguished.

3 POWER ON Light

Illuminated (green) - electrical power available to open door.

4 Interphone (INPH) JACK

5 Latch Lock Handle

6 DOOR CONTROL Switch

Electrically powered when POWER ON light illuminated and Latch Lock handle in extended position.

Hold - switch in either OPEN or CLOSED position operates door.

7 DOOR UP Light

Illuminated (green) - side cargo door in full open position.

8 LATCHED CLOSED Light

Illuminated (green) - Latch Lock handles released with door in closed position and latches engaged.

Nose Cargo Door

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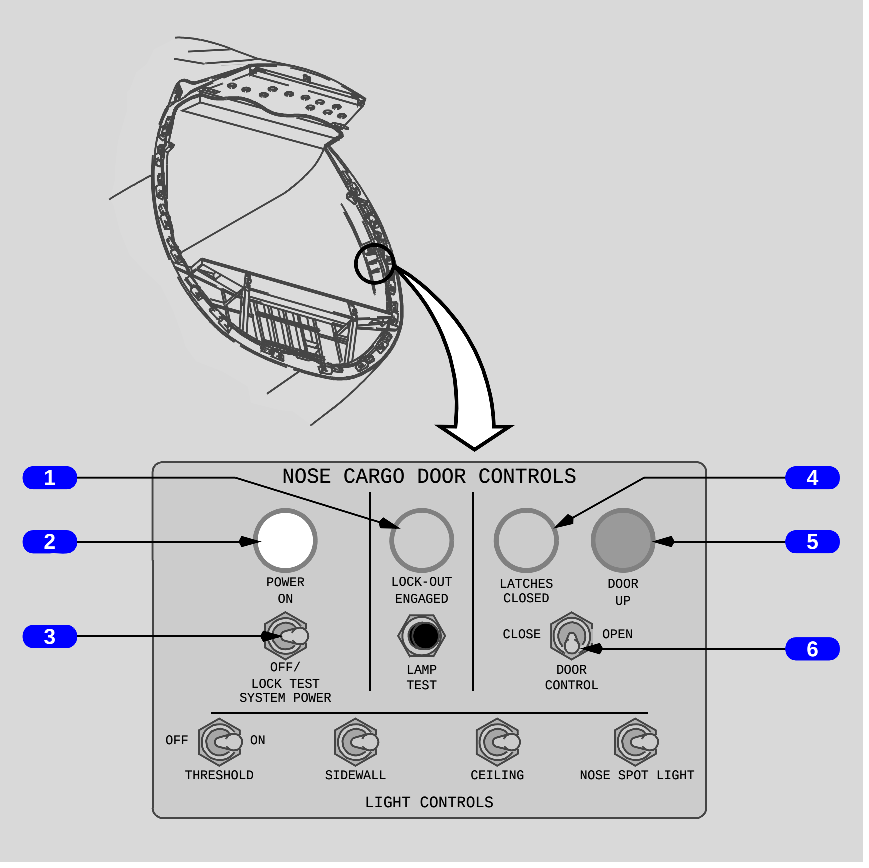
Nose Cargo Door Control Panel



1 NOSE CARGO DOOR LOCK-OUT ENGAGED Light

Illuminated (green) - Door Control switch in OFF position and main deck cargo handling bus has AC power.

2 NOSE CARGO DOOR POWER ON Light

Illuminated (white) - main deck cargo handling bus powered and System Power switch in ON position.

3 NOSE CARGO DOOR SYSTEM POWER Switch

ON -

- nose cargo door control system powered
- lamp test and door control available
- POWER ON light illuminates
- momentary position, nose cargo door operation stops when released

OFF/LOCK TEST -

- lock out engaged
- Lock-Out Engage light illuminates

4 NOSE CARGO DOOR LATCHES CLOSED Light

Illuminated (green) - all latch pins fully latched.

5 NOSE CARGO DOOR UP Light

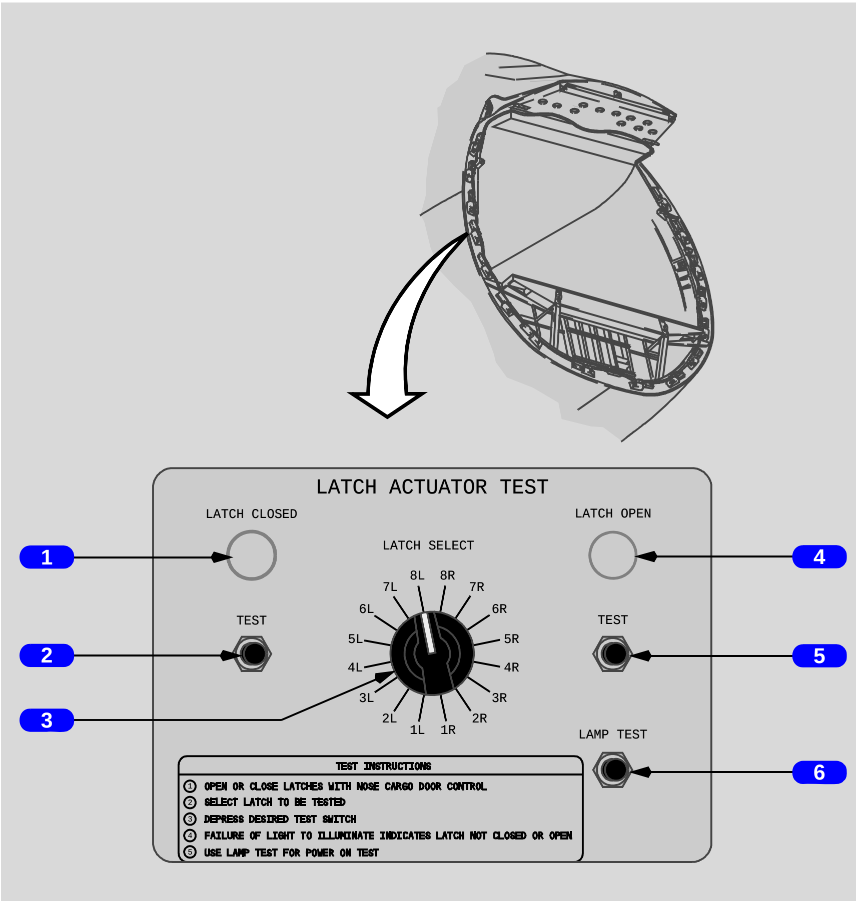
Illuminated (blue) - nose cargo door in full up position.

6 NOSE CARGO DOOR CONTROL Switch

CLOSE - powers door actuation system closed when System Power switch ON.

OPEN - powers door actuation system open when System Power switch ON.

Nose Cargo Door Latch Actuator Test Panel



1 LATCH CLOSED Light

Illuminated (green) - selected latch closed.

2 LATCH CLOSED TEST Switch

Push - illuminates LATCH CLOSED light when selected latch closed.

3 LATCH ACTUATOR TEST Selector (LATCH SELECT)

XL, XR - selects latch for test by Latch Closed and Latch Open Test switches.

4 LATCH OPEN Light

Illuminated (green) - selected latch open.

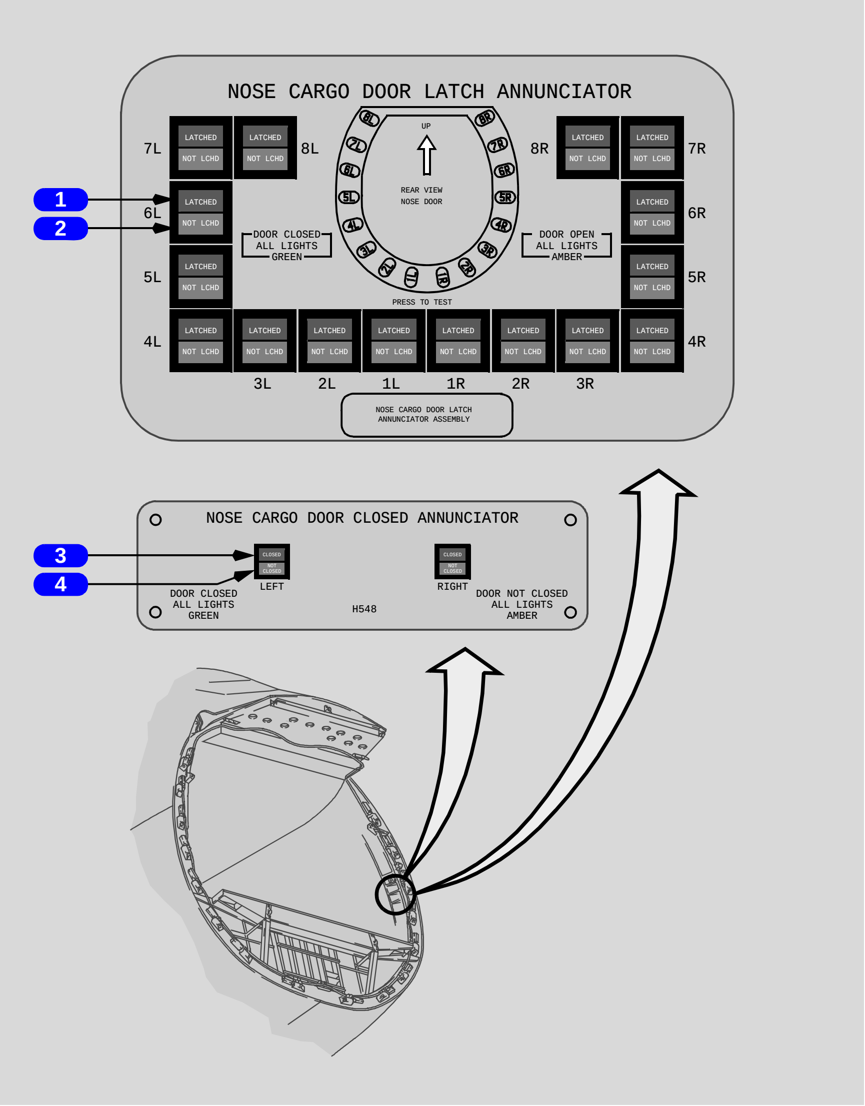
5 **LATCH OPEN TEST Switch**

Push - illuminates LATCH OPEN light when selected latch open.

6 **LAMP TEST Switch**

Push - illuminates LATCH CLOSED and LATCH OPEN lights when test power available.

Nose Cargo Door Latch Annunciator and Door Closed Annunciator Panels



1 NOSE CARGO DOOR LATCHED ANNUNCIATOR Lights

Provides indication with control system unpowered.

Illuminated (green) - respective latch closed and latched.

2 NOSE CARGO DOOR NOT Latched (LCHD) ANNUNCIATOR Lights

Provides indication with control system unpowered.

Illuminated (amber) - respective latch not latched.

3 NOSE CARGO DOOR CLOSED ANNUNCIATOR Lights

Provides indication with control system unpowered.

Illuminated (green) - door closed.

Push - light test.

4 NOSE CARGO DOOR NOT CLOSED ANNUNCIATOR Lights

Provides indication with control system unpowered.

Illuminated (amber) - door not closed.

Push - light test.

Upper Deck Crew Access Ladder

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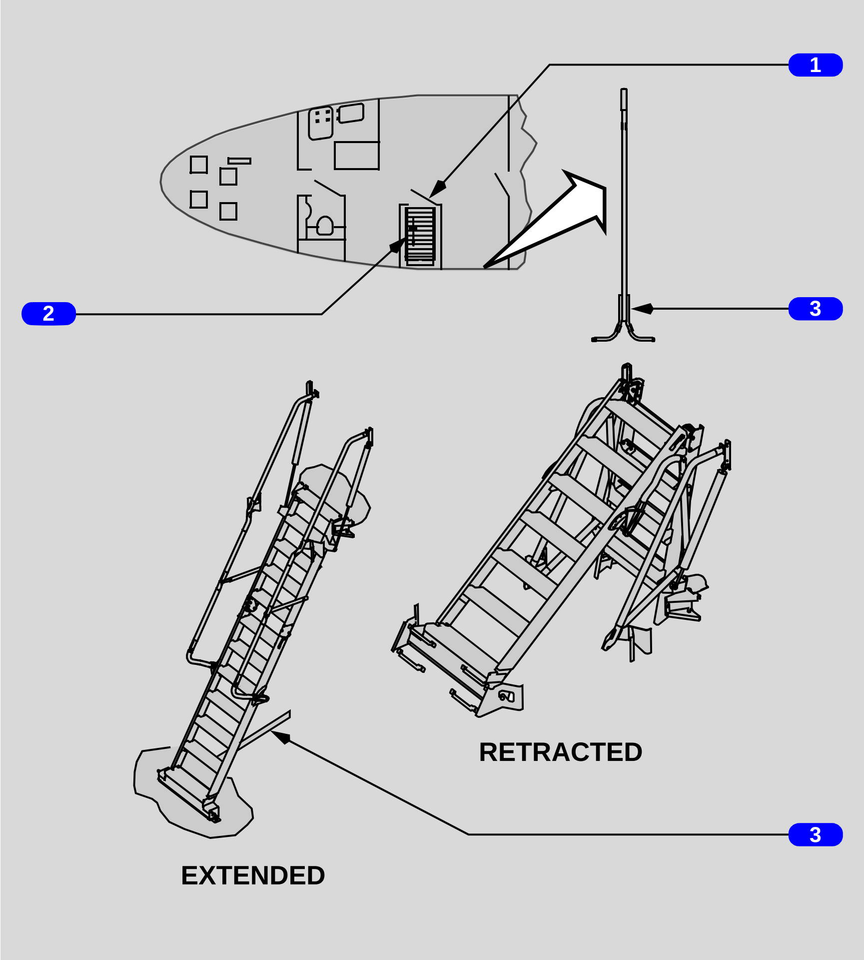
The upper deck crew access ladder is retracted to the ceiling during cargo loading/unloading and extended at all other times. The Ladder Enclosure must be closed during taxi, takeoff, flight, and landing

CAUTION: Always use the handrail when climbing or descending the ladder.

Note: The user should face the ladder when climbing or descending.



1 **Ladder Enclosure**

2 **Crew Access Ladder**

3 **Stow Assist Tool**

Stow assist tool is mounted on the side panel adjacent to Door 1L.

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

Introduction

This chapter describes miscellaneous airplane systems, including:

- lighting systems
- oxygen systems
- emergency equipment
- doors
- flight deck seats

Lighting Systems

Lighting systems described in this chapter include:

- exterior lighting
- flight deck lighting
- passenger signs

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- nose/main deck lighting
- emergency lighting

Exterior Lighting

Exterior lighting consists of these lights:

- landing
- runway turnoff
- taxi
- strobe
- beacon
- navigation (position)
- marker
- 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.

Taxi Lights

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

Strobe Lights

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

Beacon Lights

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

Navigation Lights

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

Marker Lights

Aft facing marker lights are installed on the underside of each wingtip and illuminate the wingtip area during ground operations.

Logo Lights

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

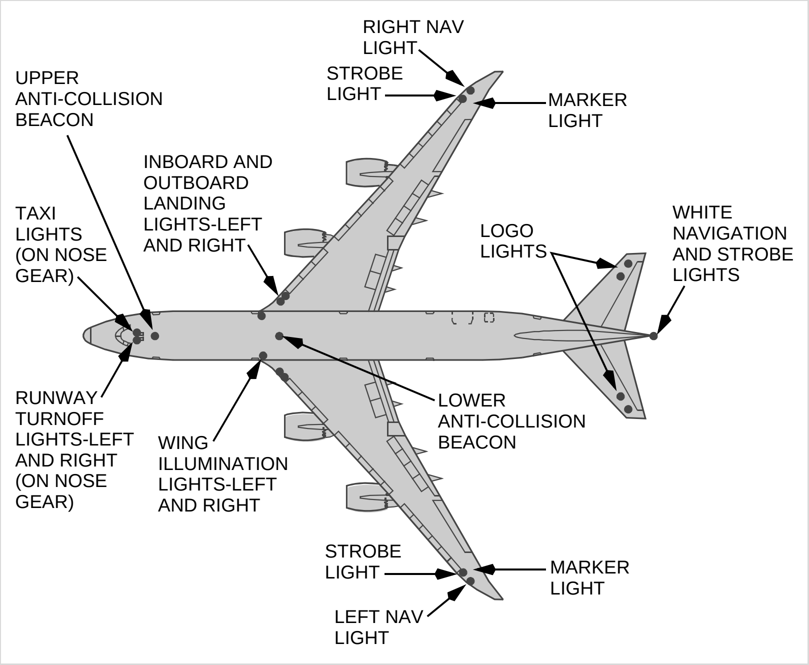
Wing Lights

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 FASTEN SEAT BELTS signs are controlled by a selector on the aisle stand and illuminate when the following conditions are satisfied:

FASTEN SEAT BELTS signs (AUTO selected):

- landing gear not up and locked or
- flap lever not up, or

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- passenger oxygen on, or
- airplane altitude below 10,300 feet, or
- cabin altitude above 10,000 feet

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

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

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

When the FASTEN SEAT BELTS signs illuminate or extinguish, a low tone sounds over the PA system.

Nose/Main Deck Lighting

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Threshold Lights

Two cargo loading ramp lights are mounted on the inside of the nose cargo door. The nose cargo door must be in the full open position for the lights to illuminate. When the nose cargo door is in the full open position, the lights are exposed and illuminate the loading ramp below the raised nose.

Sidewall Lights

The sidewall lights are spaced along both sides of the main deck cargo compartment. These lights illuminate the sidewall and adjacent floor. The forward left sidewall light also functions as a flight deck access light.

Ceiling Lights

The ceiling lights are spaced along the centerline of the ceiling from the crew ladder to the aft end of the main deck cargo compartment. The ceiling light adjacent to the crew ladder opening also functions as a flight deck access light. The seven forward ceiling lights also function as threshold lights.

Nose Spot Light

The nose spot light is located in the lower left side of the nose cargo door. When the nose cargo door is closed, the light illuminates the forward portion of the main deck. The nose spot light is used with the mirror to verify the end locks raised when cargo is loaded in the forward location.

Emergency Lighting

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Interior emergency lighting consists of door, aisle, cross-aisle, escape path, and exit lights, and luminescent exit signs. Additional battery powered exit identifier lights are located at each cabin exit.

A photoluminescent floor path marking system is installed along the cabin aisle. After being charged by cabin lighting, the photoluminescent material glows for exit path guidance. Battery operated lights and markers are installed on galleys, lavatories, and partitions on the cross aisles. Escape path lighting illuminates emergency evacuation routes for visual guidance when all sources of lighting more than four feet above the aisle floor are obscured by smoke.

See QRH Operational Information for detailed information on lighting system charging requirements.

Exterior emergency lighting illuminates the escape slides and areas at the base of the slides.

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.

Emergency Lighting

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Interior emergency lighting consists of door, aisle, exit lights, and luminescent exit signs. Additional battery-powered exit identifier lights are located at each cabin exit.

Exterior emergency lighting consists of an escape slide light and a light below the crew service door to illuminate the inertia reel landing zone.

Emergency lighting is controlled by the Emergency Lights switch on the overhead panel. The switch can be used to manually activate or arm the system for automatic operation. Automatic operation occurs if DC power fails or is turned off when the system is armed. The emergency lighting system can also be activated by the Emergency Lights switch on the upper deck cabin services module regardless of the flight deck switch position.

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

Exterior Emergency Lighting Locations

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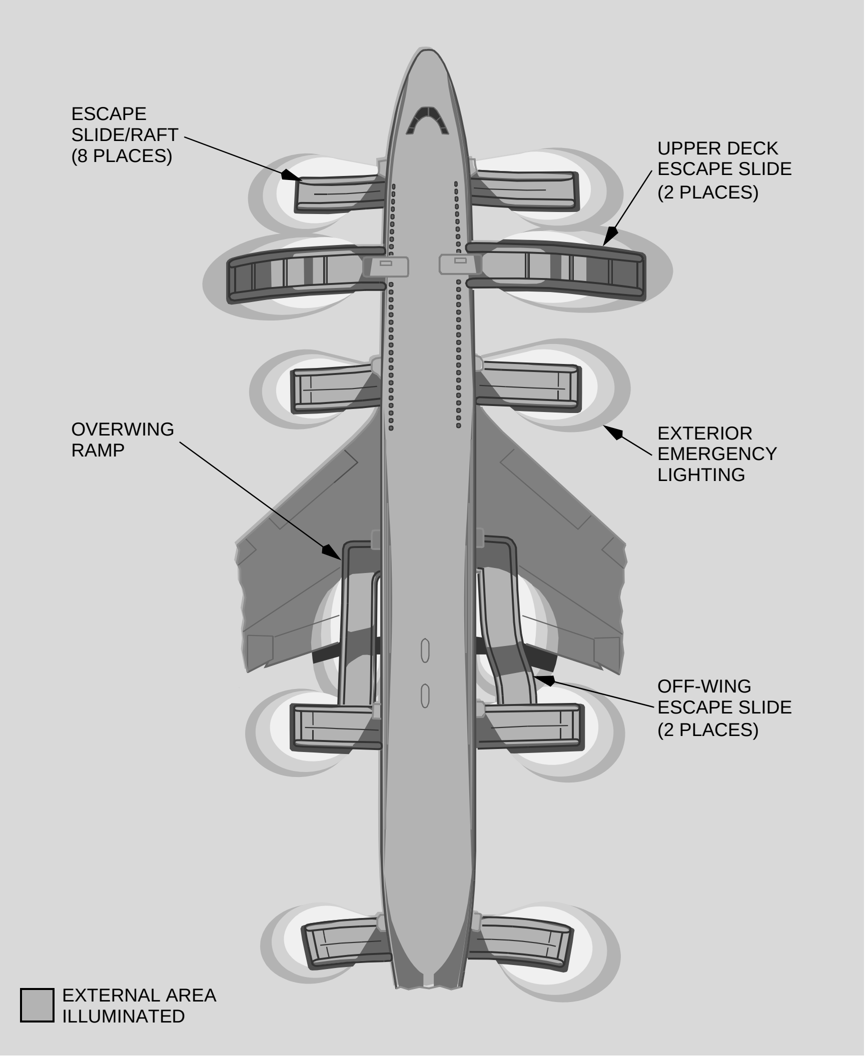

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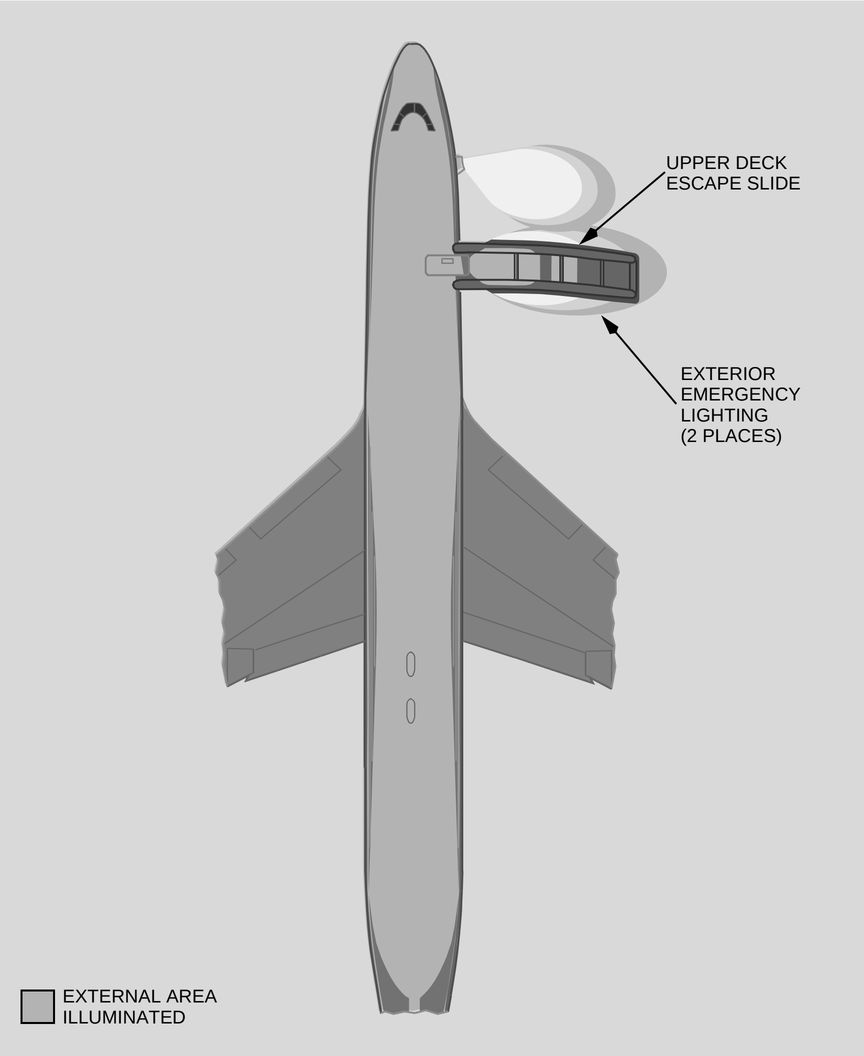
UPPER DECK
ESCAPE SLIDE
EXTERIOR
EMERGENCY
LIGHTING
(2 PLACES)
EXTERNAL AREA
ILLUMINATED

Oxygen Systems

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

914
Two independent oxygen systems are provided, one for the flight crew and one for the supernumeraries. Portable oxygen cylinders are located in the cabin for emergency use.

Oxygen pressure displays on the EICAS STATUS page.

Flight Crew Oxygen System

The flight crew oxygen system uses quick-donning diluter-demand masks located at each crew station. Oxygen flow is controlled by an automatic pressure breathing regulator mounted on each mask. After donning the mask, the goggles can be removed by pulling the goggle nose piece away from the face. To replace the goggles, push the goggles into place until they click.

During the preflight check of the crew oxygen mask, a pressure decrease may indicate the crew oxygen cylinder shutoff valve is closed, and oxygen is unavailable.

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

When the left-hand door to the mask stowage box is opened, the mask microphone activates in the removed mask.

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

Flight Crew Oxygen Mask Usage

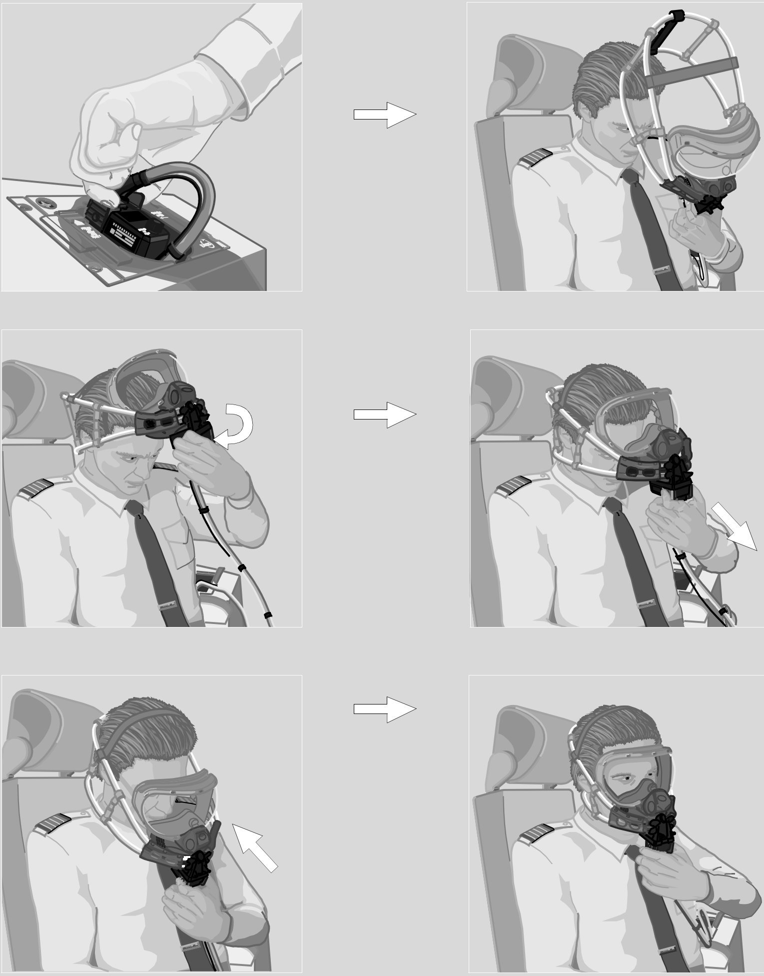
Donning Instructions

To don the oxygen mask accomplish the following:

- Grasp and squeeze the regulator’s red inflation levers to remove the mask from the stowage box.

Note: Headset should be removed towards the back of the head prior to donning the oxygen mask.

- Pull the mask out and away from the box, ensuring ample hose extension.
- Face inboard (to minimize interference with flight deck obstructions), and place the inflated harness behind the head, with the lower harness tube near the neck. Tilting of head may be required.
- With the harness tight to the back of the head, bring the mask down and away from the face from the forehead to chin.
- Release inflation levers and guide the mask towards the face to secure mask.
- Adjust as necessary for a comfortable, snug fit.



MASK DONNING

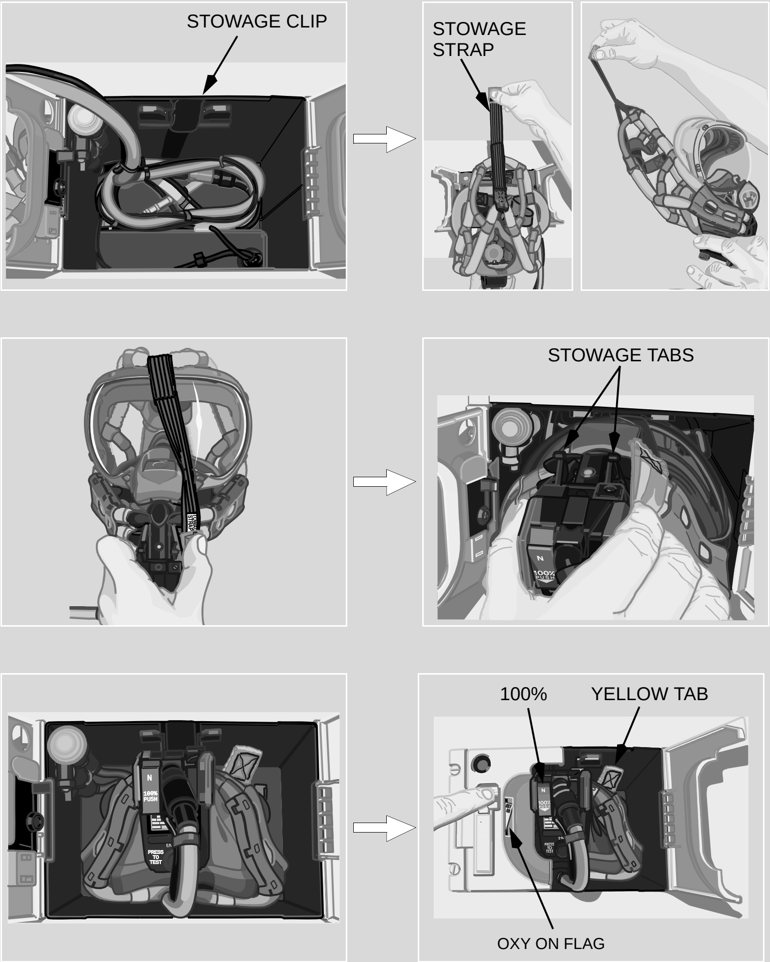
Stowing Instructions

To stow the oxygen mask accomplish the following:

- Ensure the smoke goggles are securely attached to the mask facepiece.
- Ensure the harness is completely deflated.
- Coil the supply hose into the bottom of the stowage box, making the largest diameter possible.
- Hold the mask by the regulator, with the front of the mask toward you.

WARNING: Do not squeeze the red inflation levers during stowing. Doing this will inflate the harness and prevent the correct stowing of the mask.

- Pull the yellow tab attached to the harness away from the mask
- While keeping the strap tight, pull the yellow tab up and around the top of the goggles towards the left or right inflation levers. Make sure the upper harness tube stays inside the sides of the goggles.
- While maintaining the position of the yellow tab near the red inflation lever, rotate the mask so it is vertical above the box.
- Position the supply hose down the center of the mask.
- Insert the mask-regulator into the stowage box while still holding the yellow tab.
- Once the mask nosepiece is below the stowage clip, gently release the yellow tab and guide the mask the rest of the way into the box.
- Press down until the mask-regulator is fully seated against the stop/clip in the stowage box.
- Set the "N/100%" regulator control to "100%".
- Ensure the "EMERGENCY" oxygen control knob is off.
- Close the left-hand door. The "OXY ON" flag will slide into view at the center of the door.
- Press, then release the "TEST AND RESET" control lever on the left-hand door. Ensure the "OXY ON" flag disappears when the control lever is released.
- Close the right-hand door, ensuring not to pinch the hose.



MASK STOWING

Passenger Oxygen System

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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 oxygen boxes. The masks automatically drop from the oxygen boxes 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 or streamer is pulled down.

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

Passenger oxygen pressure displays on the EICAS STATUS page.

Supernumerary Oxygen System

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

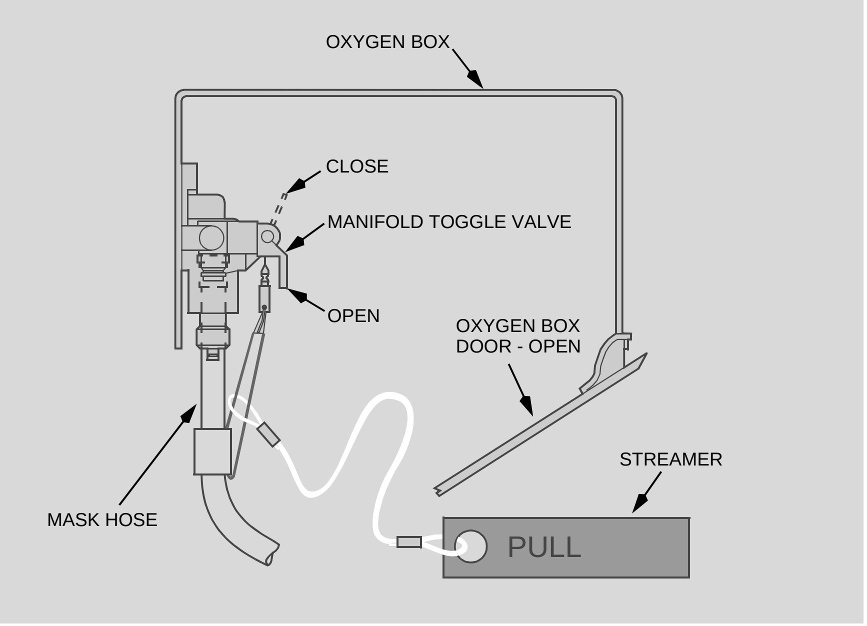
Oxygen flow to a mask begins when the mask or streamer is pulled down.

When an oxygen mask is no longer in use, placing the manifold toggle valve in the oxygen box to the CLOSE position will conserve oxygen and increase flow to the masks still in use.

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

Supernumerary oxygen pressure displays on the EICAS STATUS page.

Oxygen Box



Portable Oxygen Bottles

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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.

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

Emergency Equipment Overview

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

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- main deck alert system
- emergency locator transmitters (ELTs)
- fire extinguishers
- smoke barrier
- emergency equipment locations

Main Deck Alert System

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The main deck alert system consists of both visual and aural alerts in the main cargo deck to alert supernumerary personnel to return to their seats and/or don portable oxygen in the event of fire, smoke, cabin depressurization, or turbulence. The visual alert consists of flashing ceiling lights and the aural alert consists of pulsing horns. Alerts last several seconds.

Main deck ceiling lights flash and horns sound on the main deck when:
- cabin altitude reaches 10,000 ft.
- smoke is detected in the main deck
- supernumerary oxygen switch is selected ON
- MAIN DECK ALERT switch is selected ON

The main deck ceiling lights also flash when the FASTEN SEAT BELTS signs are selected ON.

Emergency Locator Transmitter (ELT) Passenger Cabin

806

On the passenger airplane, emergency locator transmitters (ELTs) are installed:
- 1 ELT - in the overhead stowage bin forward of door 2L
- 1 ELT - in the last overhead stowage bin forward of door 5L

Freighter Supernumerary Area

914

On the freighter, emergency locator transmitters (ELTs) are installed:

- 1 ELT - on the upper deck closet exterior wall across from the upper deck crew service door

Fuselage Mounted Emergency Locator Transmitter

A fixed emergency locator transmitter is installed forward of Door 5. The ELT activates by high deceleration forces or when the ELT switch is ON. The ELT can be deactivated by moving the ELT switch to RESET momentarily, then ARMED.

914
A fixed emergency locator transmitter is installed on the main deck aft overhead. The ELT activates by high deceleration forces or when the ELT switch is ON. The ELT can be deactivated by moving the ELT switch to RESET momentarily, then ARMED.

Portable Emergency Equipment
Fire Extinguishers

806
Halon and water fire extinguishers are located throughout the passenger cabin and on the flight deck.

914
Halon and water fire extinguishers are located on the flight deck, in the supernumerary area, and on the main deck cargo area.

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.

Water Fire Extinguishers

914

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.

Note: The directions for use of the fire extinguisher are printed on the extinguisher.

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

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

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

Portable Oxygen Bottles

806

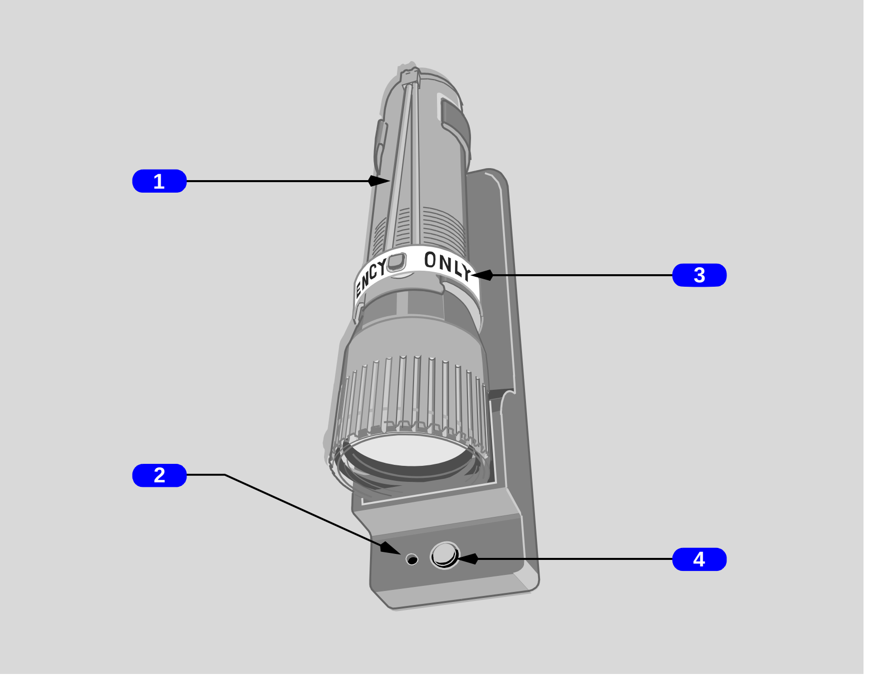
Portable oxygen bottles are stowed in various locations in the cabin. The bottles are fitted with a disposable mask and safety strap and are used for first aid purposes or as walk–around units. All bottles are identical in size and capacity.

914

There are portable and walk-around oxygen bottles stowed in the supernumerary area. The portable bottles are fitted with disposable mask and safety straps and are used for first aid purpose. The walk-around bottles are fitted with full face mask and larger capacity bottle.

Flashlights

Flashlights are stowed throughout the airplane. These high intensity flashlights illuminate automatically when they are removed from the stowage bracket. The light can be extinguished only by placing the flashlight back into the stowage bracket. The batteries cannot be recharged.



1 **Elastic Wrist Strap**

2 **Condition Light**

Illuminated (green) – One flash during test indicates a normal battery charge.

Illuminated (red) – One flash during test indicates the battery should be replaced. Flashes every ten seconds when the battery has reached its end of life.

3 **Tamper Seal**

4 **Push-to-Test Switch**

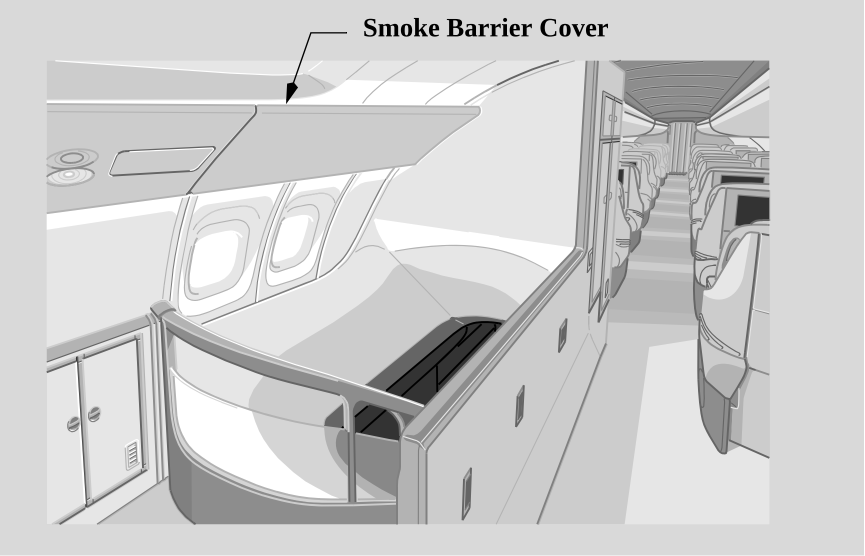
Push – produces one green or red flash on the condition light.

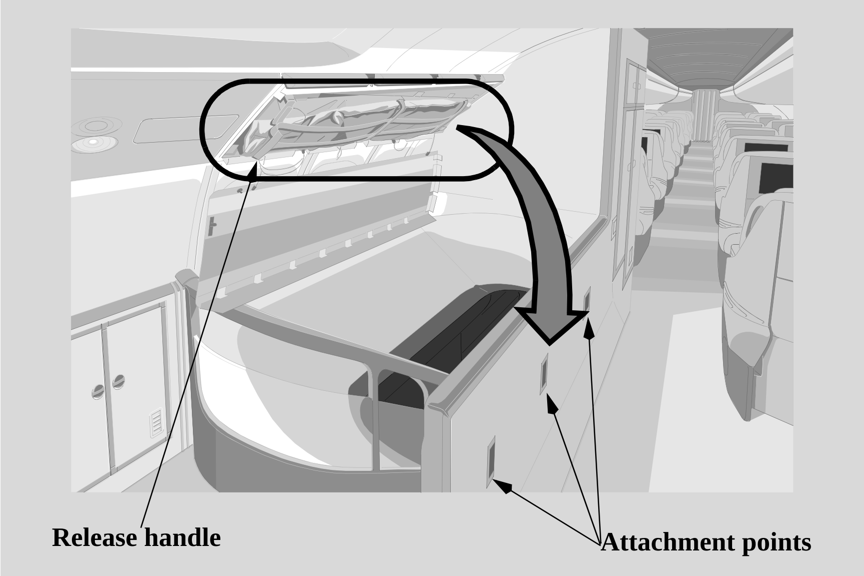
Smoke Barrier

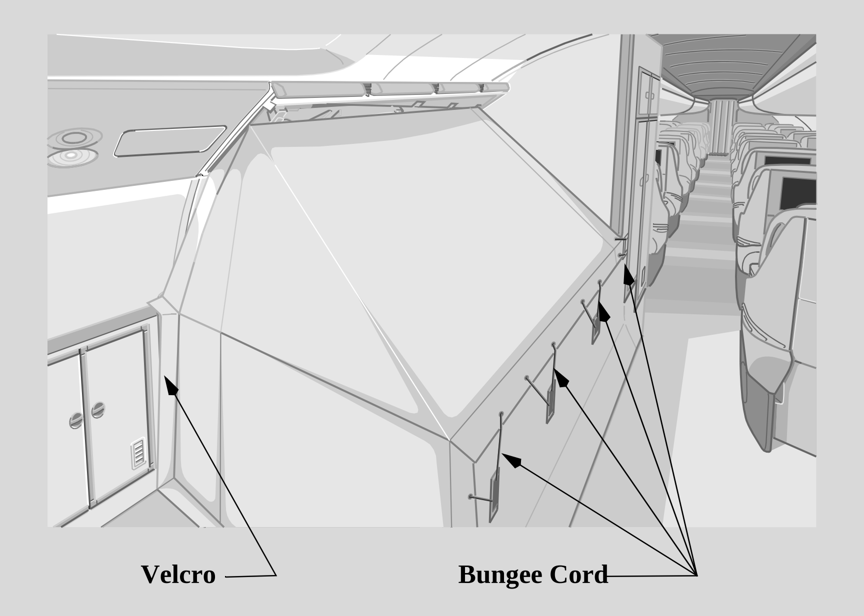
806

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.

Removing the smoke barrier cover, and pulling the release handle allows the smoke barrier to fall free.




Release handle
Attachment points



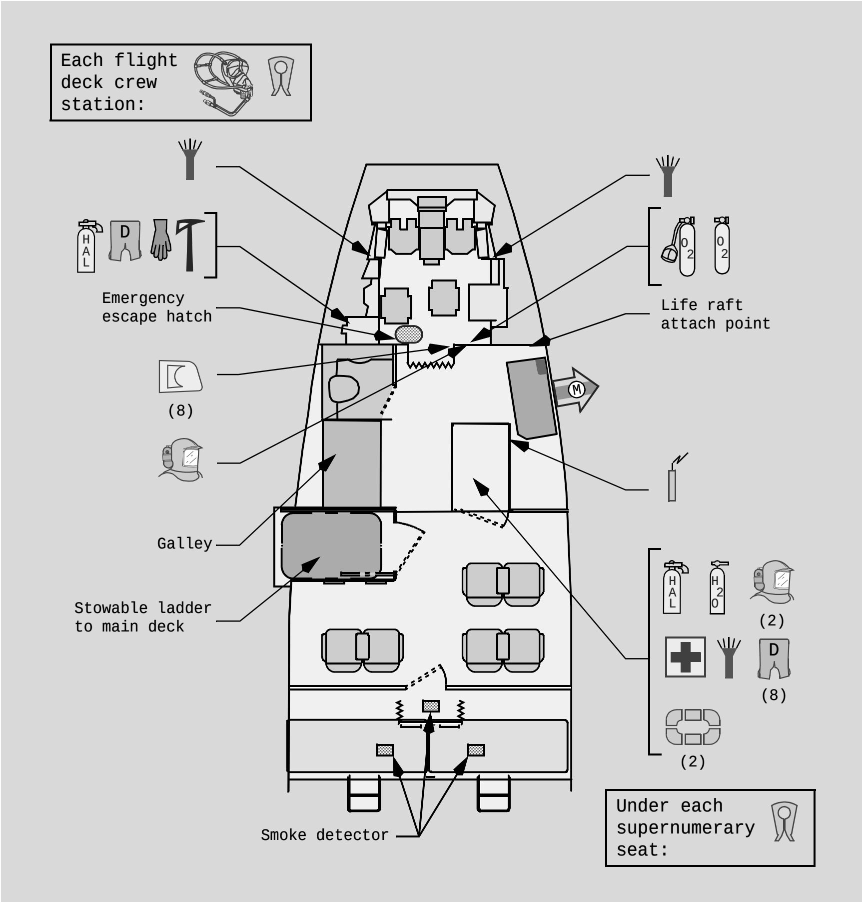
WARNING: The smoke barrier is for ground use only.

Note: The smoke barrier is used on the ground to prevent smoke from rising up the stairway into the upper deck area. Evacuation of the airplane should be considered prior to deploying the smoke barrier. In flight, normal airplane ventilation minimizes smoke migration into the upper deck area.

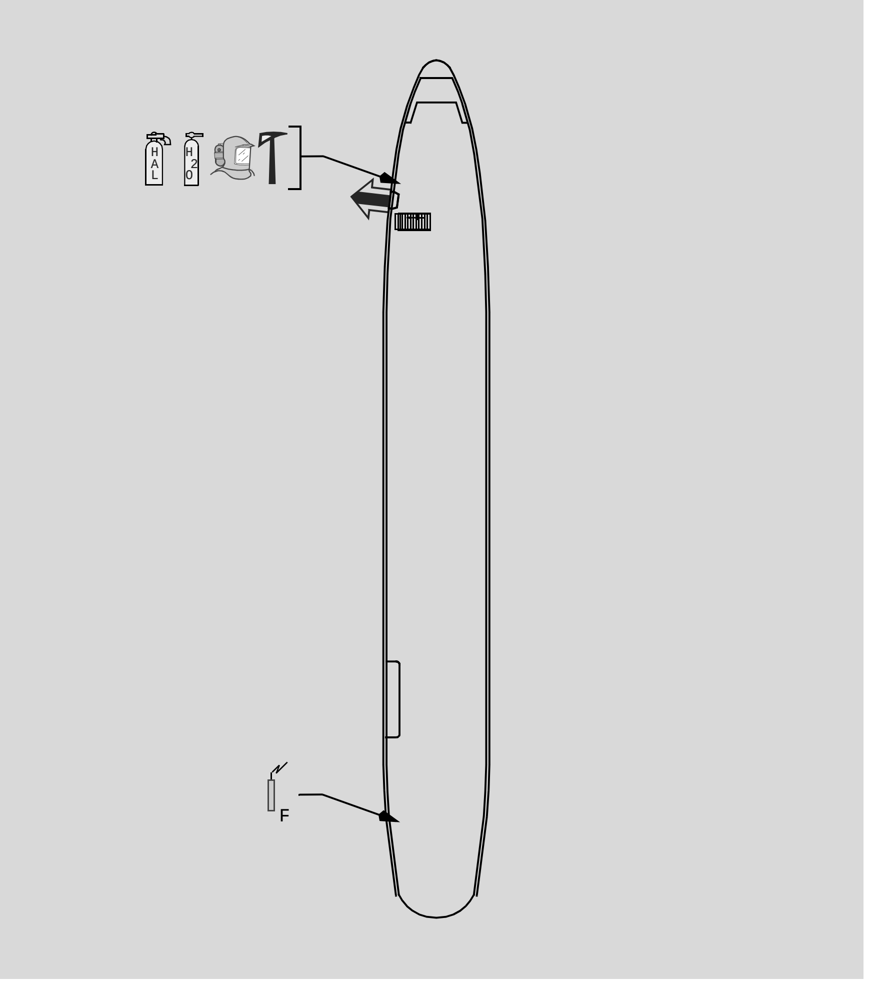
Emergency Equipment Symbols

NOTE: Some symbols do not apply to all configurations.

Emergency Equipment Location
747-8 Freighter
Flight Deck/Supernumerary Area

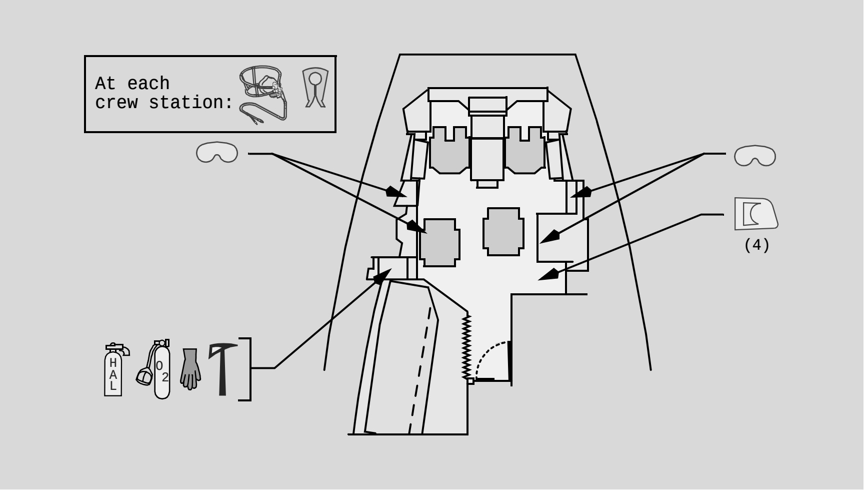


Main Deck

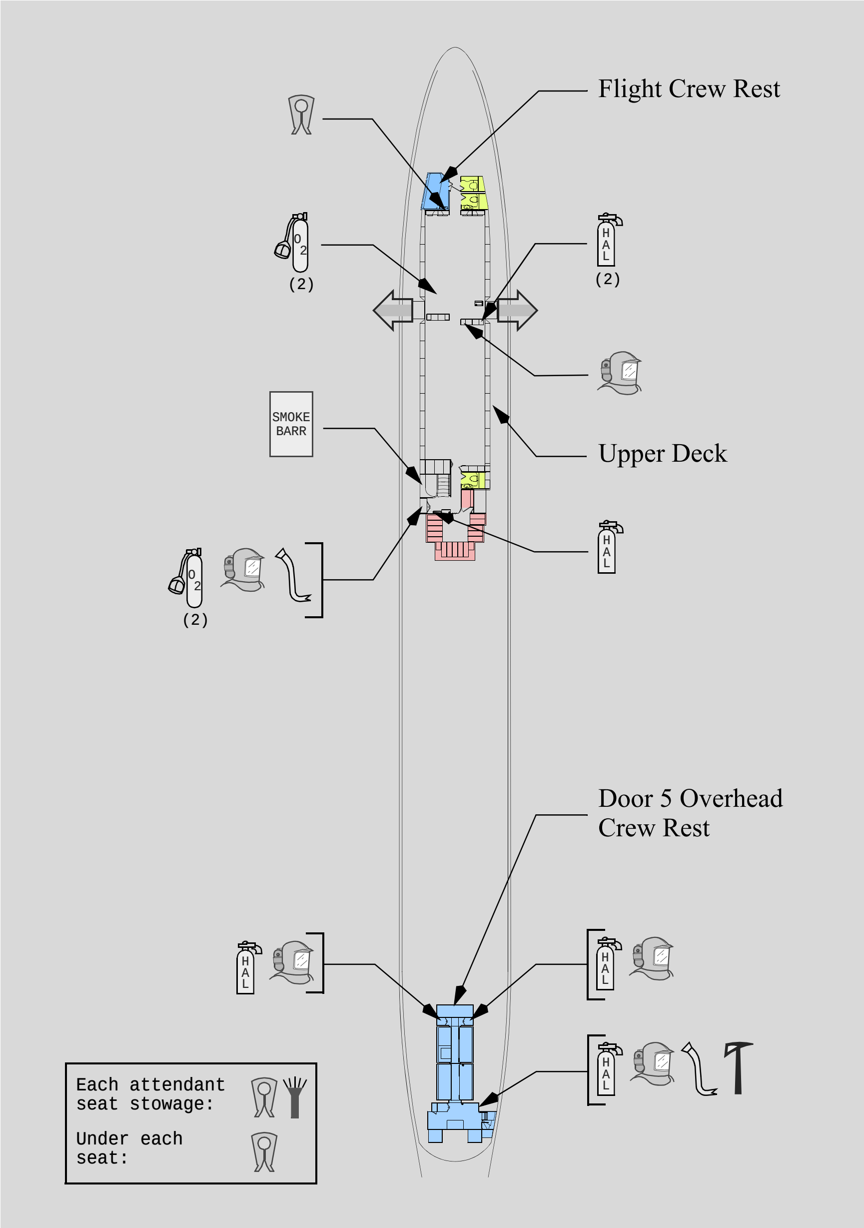


Emergency Equipment Location
747-8I Intercontinental
806

Flight Deck

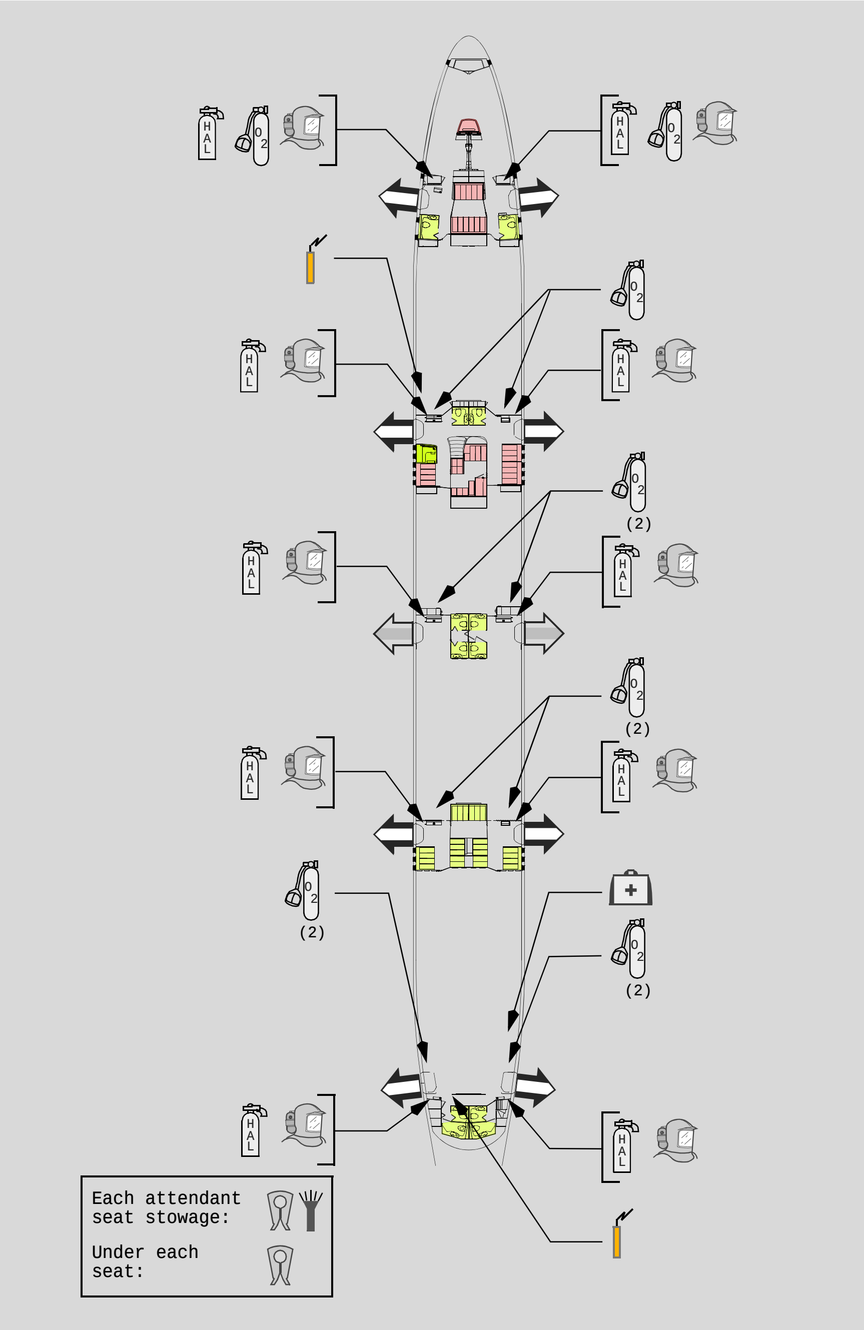


Upper Deck/Door 5 Overhead Crew Rest



Note: Door 5 overhead crew rest installed.

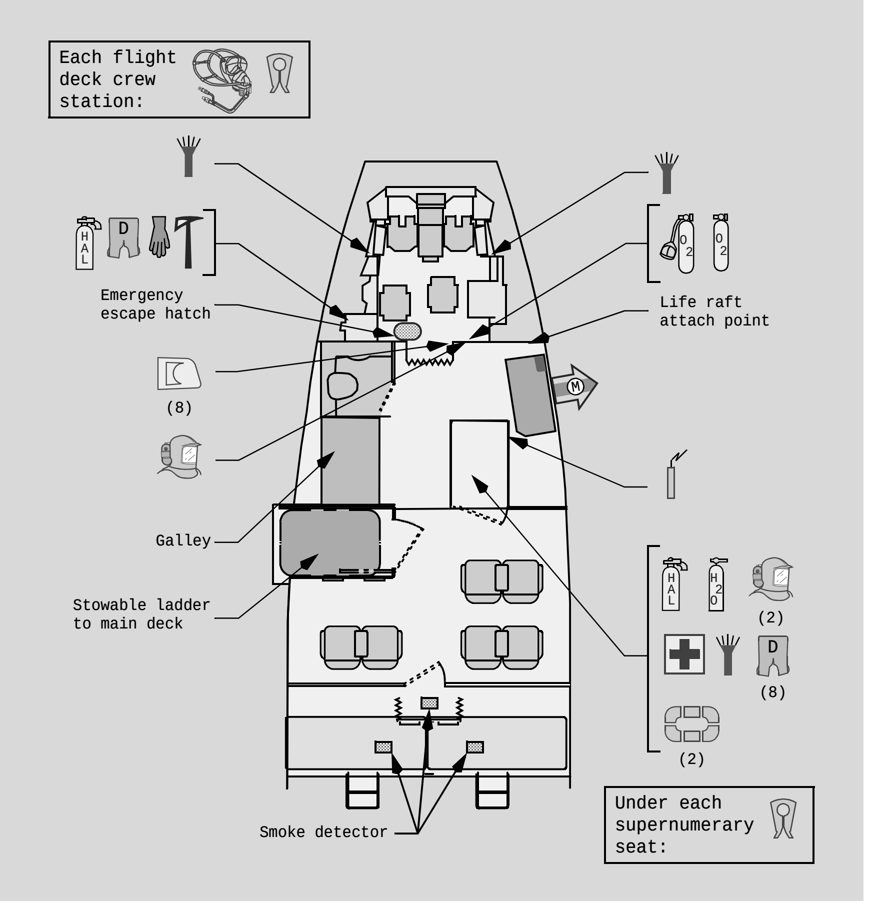
Main Deck



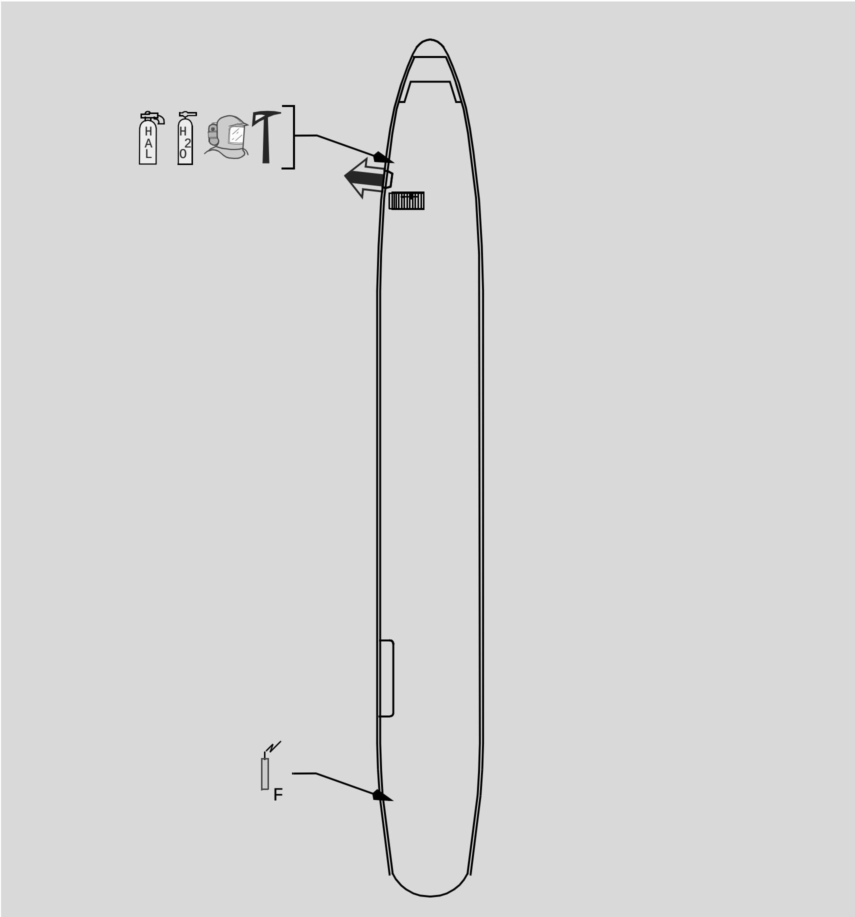
747-8 Freighter

911

Flight Deck/Supernumerary Area



Main Deck



Intentionally
Blank

Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Systems Description — Section 50

Doors

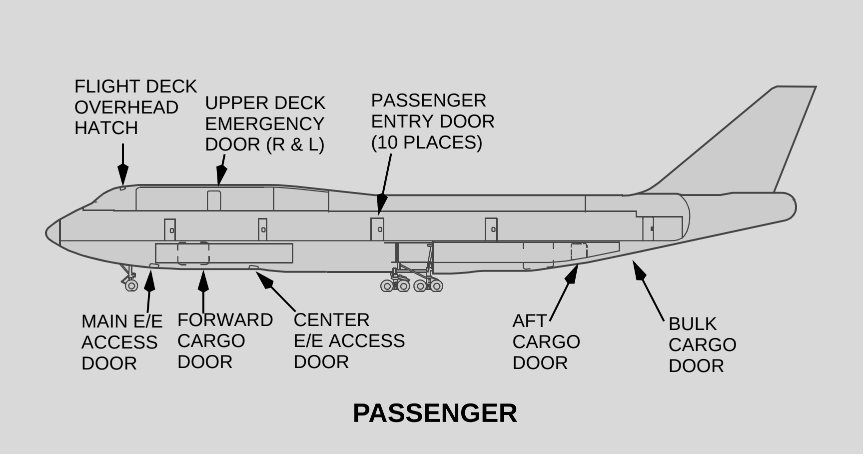
806
The airplane has ten main deck passenger entry doors, one flight deck door (the flight deck/passenger cabin entry), two upper deck emergency doors, and three cargo doors. It also has two electrical and electronic (E/E) equipment access doors and one flight deck overhead hatch.

914
The airplane has one main deck entry door, one upper deck door, and five cargo doors. It also has two electrical and electronic (E/E) equipment access doors and one flight deck overhead hatch.

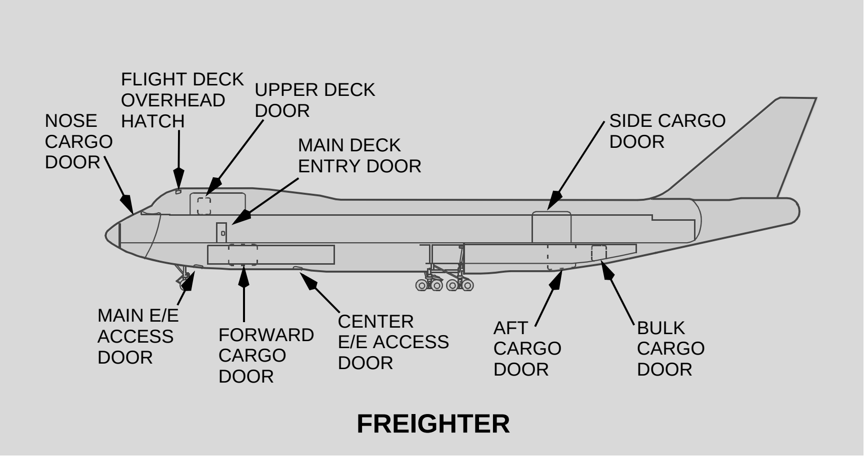
CAUTION: Do not operate the entry or cargo doors with winds at the door of more than 40 knots. Do not keep doors open when wind gusts are more than 65 knots. Strong winds can cause damage to the structure of the airplane.

Door Locations

806



914



Flight Deck Door

806

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 flight crew 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 flight crew take no action, the door unlocks after expiration of the time delay. Before the door unlocks, the chime sounds continuously and the AUTO UNLK light flashes.

By pressing "1" then "ENT" keys on the emergency access panel, the flight deck chime will sound (if programmed).

The door latch system incorporates a pressure rate-sensor that unlocks the door in the event of flight deck depressurization.

Passenger Entry Doors

806

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

806

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.

If the airplane is tipped tail down, the door 1 slide/rafts are usable after the slide extensions are inflated. When a tail down condition is sensed, a light next to the door illuminates and the extension inflates automatically. A slide extension handle becomes accessible as the slide inflates to manually deploy the extension.

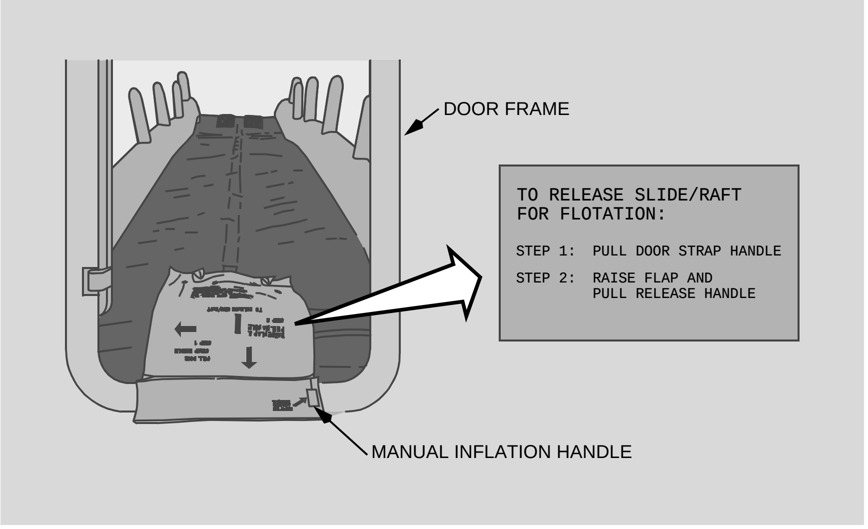
When the door is to be opened from the interior and slide deployment is not desired, the door mode select lever must be in MANUAL position.

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.

Slide/Raft Deployed

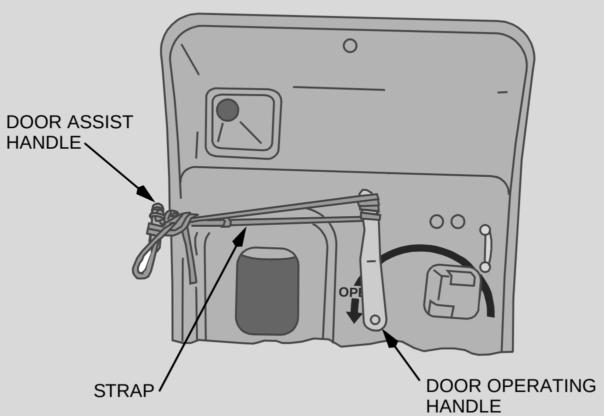


Securing Main Deck Doors 1, 2, 4, or 5 In The Open Position

To accomplish some non-normal procedures, 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

806

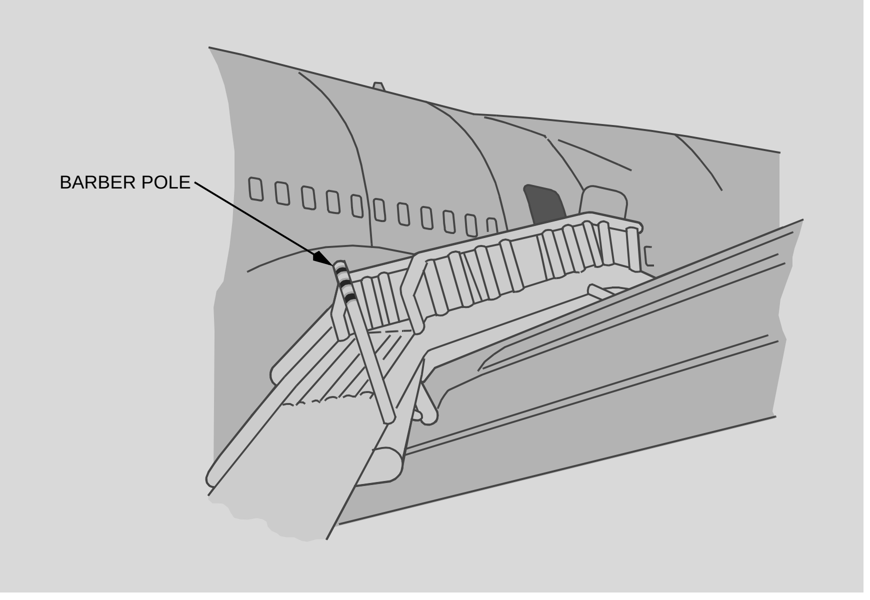
When the door mode select lever is in AUTOMATIC position and the door operating handle is rotated 180 degrees, the door begins to open and the power assist opening system activates.

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 deployment indicator is visible to the flight attendant at door 3 when the overwing 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



Main Deck Door

914

The main deck entry door can be opened from either outside or inside the airplane. An escape rope is stowed above the door. Threshold lights illuminate with the emergency lights activated.

Upper Deck Emergency Doors

806

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

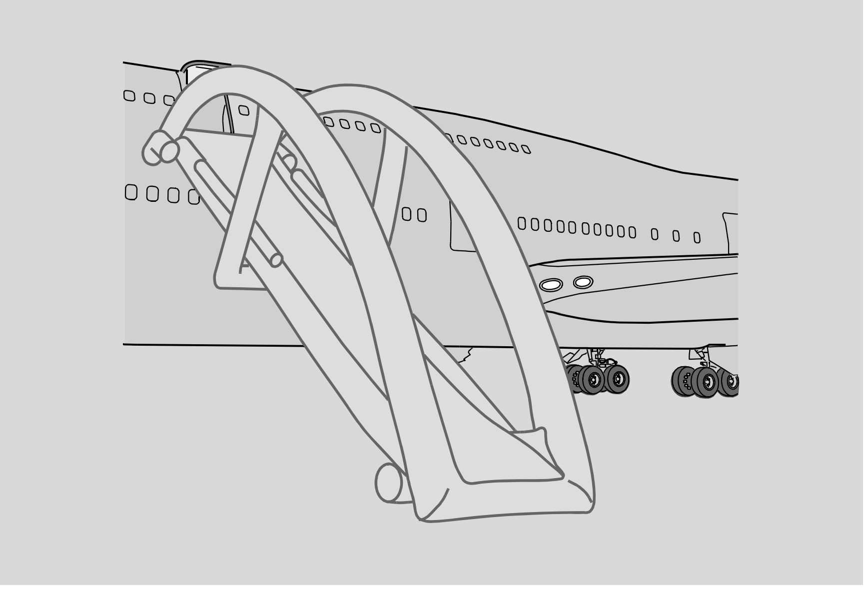
With the door mode select lever in AUTOMATIC position, lifting the door operating handle actuates the emergency power system for the door, moving the door up and out to full-open position. The escape slide deploys and inflates as the door opens.

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.

Upper Deck Slide Deployed



Upper Deck Door

914

The upper deck door is used for emergency evacuation.

Outside the airplane, pushing the tabs releases the handles. Rotating the handles unlatches and opens the door. The exterior handles must be stowed prior to moving the door aft on the tracks.

Inside the airplane, pulling the handle and rotating towards OPEN opens the door.

The upper deck door can be closed from either inside or outside of the airplane.

Pushing the Door Latch Manual handle releases the door from the aft stowed position and allows the door to slide forward on the tracks.

Rotating either the interior or exterior handle closes and latches the door.

Escape Slide

914

The escape slide for the upper deck door is mounted on tracks parallel to the door and the right bulkhead. Placing the Platform Lock Control lever to Unlocked and using the assist handle moves the escape slide on the tracks. The escape slide can be locked in multiple positions, including:

- forward (in front of the door)
- aft (clear of the door)

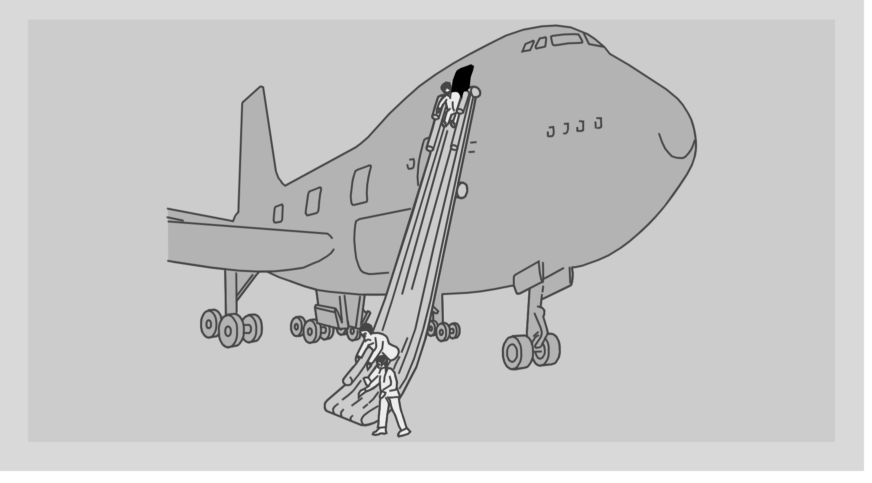
To use the upper deck door as an emergency exit, the slide must be in the forward position and the crew service door must be open. Pulling the Packboard Manual Release handle and rotating the escape slide through the open doorway deploys the slide.

WARNING: USE CAUTION WHEN PUSHING THE SLIDE OUT OF THE DOOR TO AVOID FALLING OUT OF THE OPEN DOOR.

The slide inflates automatically. If automatic inflation does not occur, pulling down on the Manual Inflation handle inflates the slide.

CAUTION: The escape slide is unusable if the airplane tips tail down on the ground.

Upper Deck Door Slide Deployed

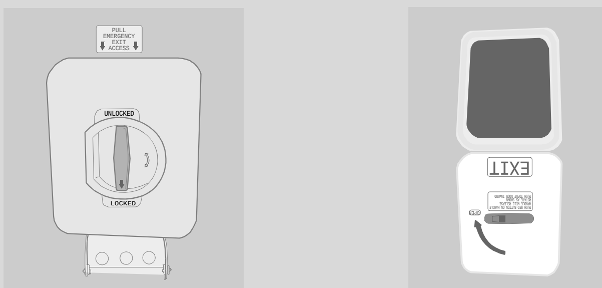


Flight Deck Overhead Hatch

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° 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.

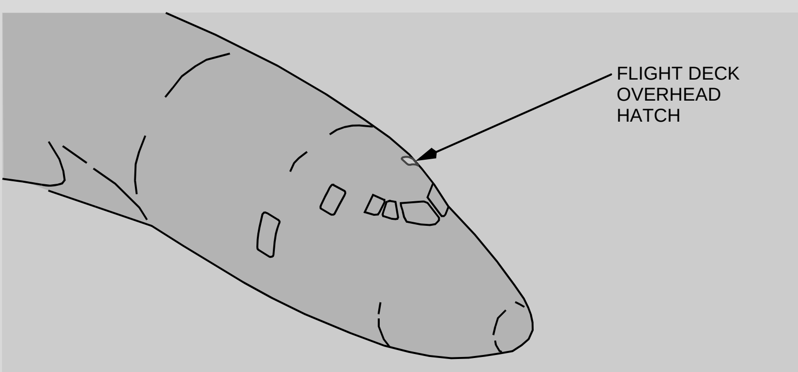


CLOSED

OPEN

FLIGHT DECK OVERHEAD HATCH

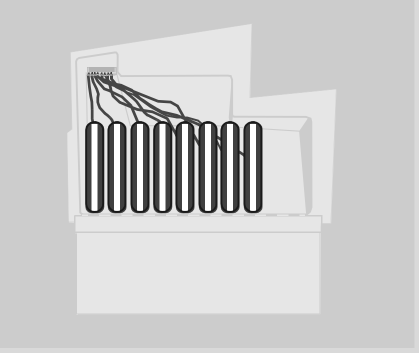
Flight Deck Overhead Hatch Location



Emergency Escape Devices

914
Eight emergency escape devices are stowed adjacent to the flight deck overhead hatch.

914



EMERGENCY ESCAPE DEVICES

806
Four emergency escape devices are stowed adjacent to the flight deck overhead hatch.

806

EMERGENCY ESCAPE DEVICES

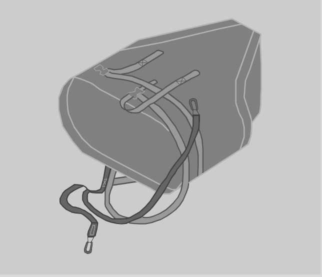
The emergency escape device is used by removing it from the holder and exiting the airplane through the flight deck overhead hatch or upper deck door while holding the device handle. The emergency descent device can also be used for evacuation over the slide if the airplane tips tail down. Inertial reels 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.

Emergency Escape Harnesses

914
There is one escape harness for each emergency escape device stowed in the upper deck cabin. The harness is used by donning the garment, attaching the hook to the fastening ring on an escape device handle, and departing through the flight deck overhead hatch or upper deck door.

806
There is one escape harness for each emergency escape device stowed in the flight deck. The harness is used by donning the garment, attaching the hook to the fastening ring on an escape device handle, and departing through the flight deck overhead hatch.



EMERGENCY ESCAPE HARNESS

Flight Deck Overhead Hatch Emergency Evacuation

Cargo Doors

806
There are three lower cargo doors: one forward, one aft, and one bulk.

914

There are three lower cargo doors: one forward, one aft, and one bulk. There is also one side cargo door and one nose cargo door.

Lower Cargo Doors

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

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

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

Side Cargo Door

914

The left side cargo door can be operated from inside or outside the airplane. Electric power to operate the door is supplied by the airplane ground handling bus.

The door is operated by checking the POWER ON light is illuminated and extending the interior or exterior latch lock handle. The LATCHES CLOSED light illuminates when handles are released. The interior or exterior DOOR CONTROL switch opens or closes the door. The LATCHES CLOSED light extinguishes as the door opens. The DOOR UP light illuminates when the door is fully open.

Nose Cargo Door

914

The nose cargo door receives electrical power from the airplane ground handling bus. It is controlled from the nose cargo door and light control panel. A mechanical system operates the door when electrical power is not available.

With the System Power switch in ON position, the POWER ON and LATCHES CLOSED lights illuminate.

With the System Power switch held in ON position and the Door Control switch held in OPEN position, the door actuation system opens the nose cargo door.

With the System Power switch held in ON position and the Door Control switch held in CLOSE position, the door actuation system closes the nose cargo door.

The nose cargo door can be stopped and held in position at any point by releasing the System Power switch or the Door Control switch.

When the System Power switch is placed in OFF/LOCK-TEST position, the nose cargo door control system is unpowered, lock-out is engaged, LOCK-OUT ENGAGED light illuminates, and LATCHES CLOSED lights extinguish.

When the System Power switch is released, the LOCK-OUT ENGAGED light extinguishes. This verifies power is removed and electrical lock-out is engaged. A doors EICAS alert message displays if power is not removed from the control system.

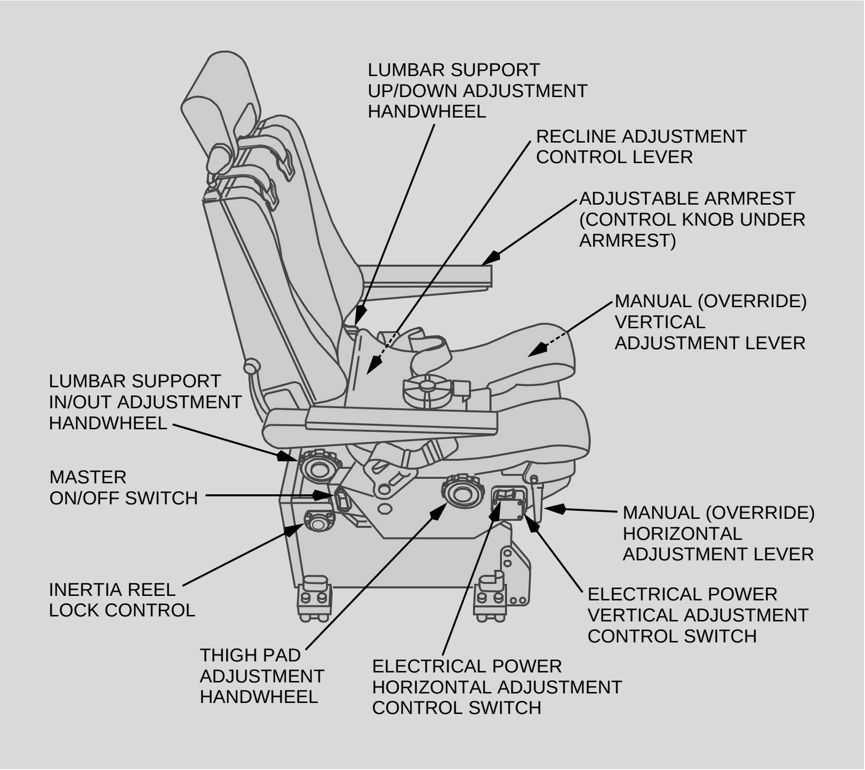
CLOSED and NOT CLOSED lights on the nose cargo door closed annunciator panel and LATCHED and NOT LCHD lights on the nose cargo door latch annunciator panel provide indication of closed and latched conditions when the control system is unpowered.

Flight Deck Seats

The flight deck has three seat types:

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

Pilot Seats



The pilot seats:

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

The seats also have:

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

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

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

Lumbar and thigh pad support can be adjusted using the adjustment hand wheels. Armrest pitch can be adjusted using the control knob under the armrest. The armrests can be stowed vertically for easier seat access.

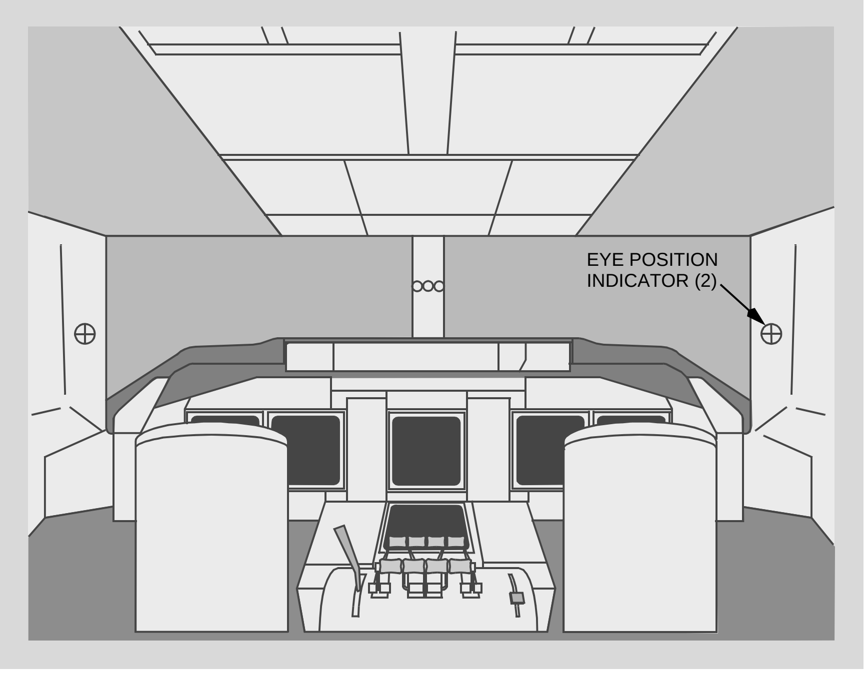
806
Adjusting the seat obtains the optimum eye position as shown on the following illustration. The vertical line on the eye position indicator just passes out of peripheral vision (looking straight ahead) when the seat is properly adjusted.

914
Adjusting the seat obtains the optimum eye position as shown on the following illustration. The eye position indicator balls will be level with the eye when the seat is properly adjusted. The center ball will be masked by the nearer ball 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

806



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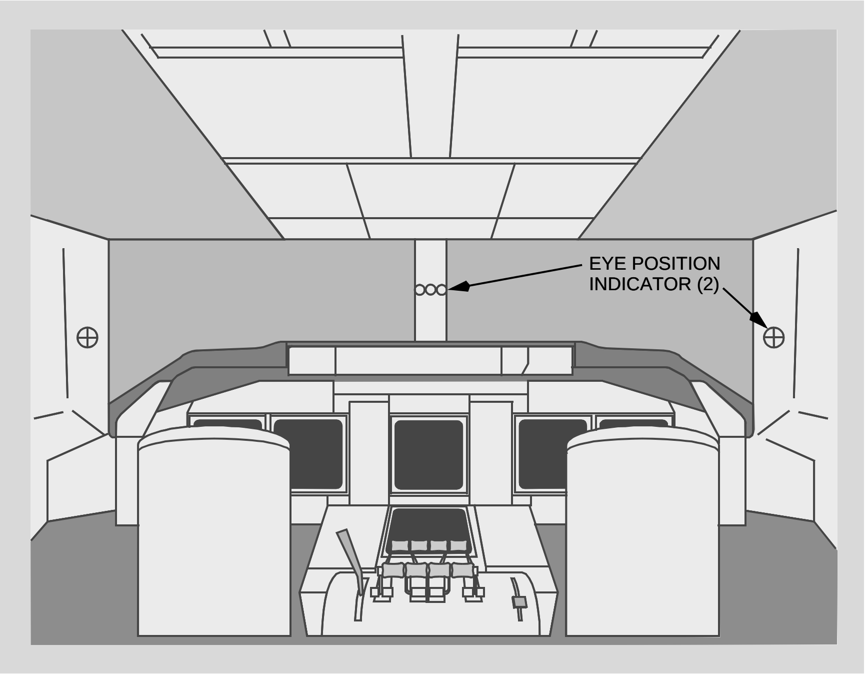


Observer Seats

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

806

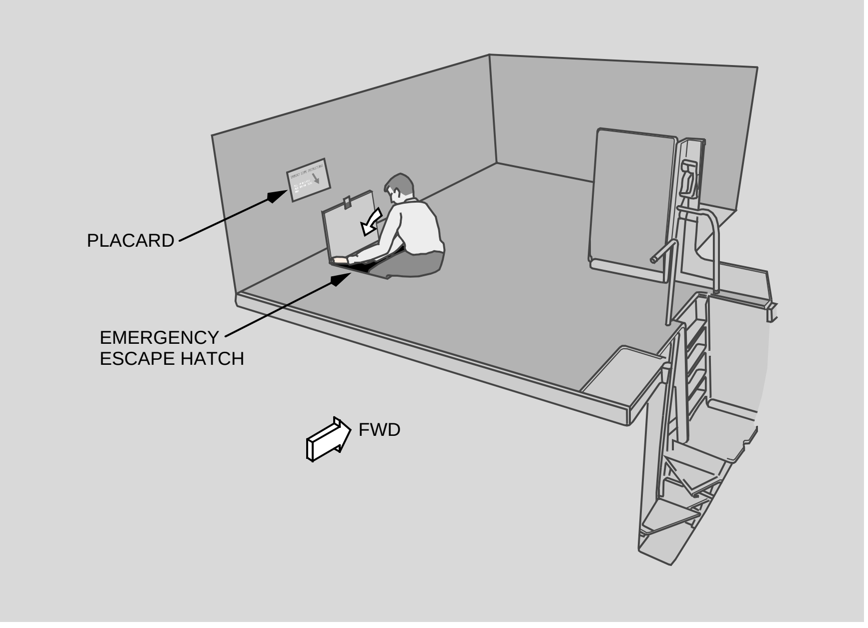
The door 5 overhead crew rest area is entered through a locked door on the right side of the airplane aft of door 5R. An emergency escape hatch is located on the floor on the left side of the crew rest area. To use the emergency escape hatch follow the placarded instructions. In some cases, a bunk must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



EICAS Alert Messages

Message	Level	Aural	Message Logic
CREW OXY LOW	Advisory		Crew oxygen pressure low.
DOOR AFT CARGO	Caution	Beeper	Aft cargo door is not closed and secure.
DOOR BULK CARGO	Advisory		Bulk cargo door is not closed and secure.
DOOR ELEC CTR	Advisory		Electrical equipment door is not closed and secure.
DOOR ELEC MAIN	Advisory		Electrical equipment door is not closed and secure.

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DOOR ENTRY L 1, L 2, L 3, L 4, L 5, R 1, R 2, R 3, R 4, R 5	Advisory		Main deck entry door is not closed and secure.

914

DOOR ENTRY L 1	Advisory		Main deck entry door is not closed and secure.

914

DOOR F/D OVHD	Advisory		Flight deck overhead door is not closed and secure.

DOOR FWD CARGO	Caution	Beeper	Forward cargo door is not closed and secure.

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DOOR L, R UPPER DK	Advisory		Upper deck door is not closed and secure.

Message	Level	Aural	Message Logic
914			
DOOR NOSE CARGO	Caution	Beeper	Nose cargo door is not closed, latched and locked condition sensed.
914			
DOOR R UPPER DK	Advisory		Upper deck door is not closed and secure.
914			
DOOR SIDE CARGO	Caution	Beeper	Side cargo door not closed, latched and locked condition sensed.
806			
DOOR U/D FLT LK	Caution	Beeper	Upper deck door automatic lock failed to lock after takeoff.
DOORS ELEC	Advisory		Both electrical equipment doors are not closed and secure.
806			
DOORS ENTRY L, R	Advisory		Two or more main deck entry doors on the same side are not closed and secure.
806			
DOORS UPR DECK	Advisory		Both upper deck doors are not closed and secure.
ELT ON	Advisory		The emergency locator transmitter is on.

Message	Level	Aural	Message Logic
EMER LIGHTS	Advisory		One of these occurs: • The emergency lights switch is ARMED and emergency lights are on • The emergency lights switch is not armed

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PASS OXYGEN ON	Advisory		Passenger oxygen system is on.

914

SUPRNRY OXY LO	Advisory		Supernumerary oxygen pressure low.

914

SUPRNMRY OXY ON	Advisory		Supernumerary oxygen system activated.

EICAS Memo Messages

Message	Level	Aural	Message Logic

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DOORS AUTO	Memo		Indicates position of mode select levers for main deck and upper deck doors when on the ground.
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.

SEATBELTS OFF	Memo		SEATBELTS selector in OFF position in flight.

Message	Level	Aural	Message Logic
SEATBELTS ON	Memo		FASTEN BELTS signs manually selected ON.

Air Systems Chapter 2
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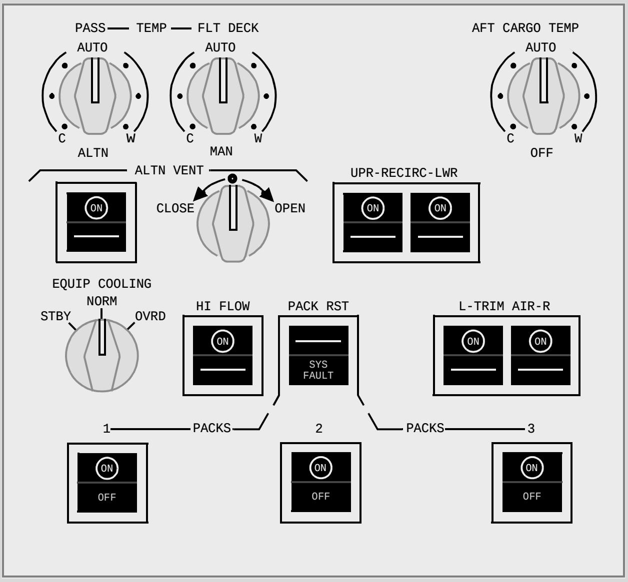
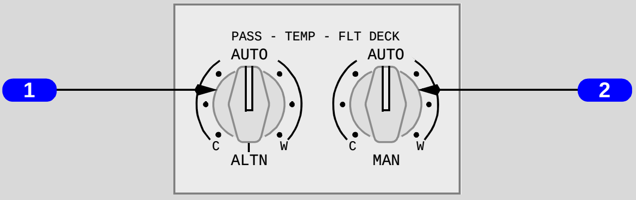
ECS Control



OVERHEAD PANEL

Passenger and Flight Deck Temperature Selectors



ECS PANEL

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 to 85°F (18°C to 29°C)
- in backup mode, range C to W sets average cabin temperature from 65°F to 85°F (18°C to 29°C) and cabin temperature panel control of zone temperatures is inhibited

ALTN -

- zone trim air valves remain in last position and left and right master trim air valves remain open
- zone temperature controller bypassed
- pack output temperature regulated to provide average cabin temperature of 75°F (24°C)
- cabin temperature panel control of zone temperatures inhibited

2 Flight (FLT) DECK Temperature (TEMP) Selector

AUTO -

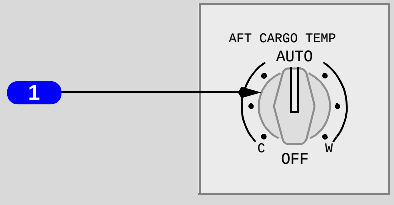
- provides automatic control of flight deck temperature
- range C to W sets flight deck temperature from 65°F to 85°F (18°C to 29°C)

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.

Aft Cargo Temperature Selector



ECS PANEL

1 AFT CARGO Temperature (TEMP) Selector

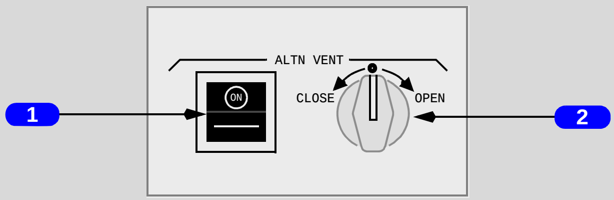
AUTO -

- range C to W sets temperature of aft cargo conditioned air from 40°F to 80°F (4°C to 27°C)
- lower aft cargo heat overheat shutoff valve is closed and aft cargo heat is inhibited and will not be supplied regardless of the position of the Lower Lobe Aft Cargo Heat selector

OFF -

- aft cargo conditioned air is shut off
- aft cargo heat will be supplied when the Lower Lobe Aft Cargo Heat selector is in LOW or HIGH

Alternate Ventilation Controls



ECS PANEL

1 Alternate (ALTN) Ventilation (VENT) Switch

ON -

- with airplane depressurized, opens alternate ventilation valve
- outside air is supplied to flight deck
- when switch is pushed ON, valve moves to open position
- 20 seconds after switch is pushed ON, valve can be repositioned with the Alternate Ventilation selector

Off - alternate ventilation valve closed.

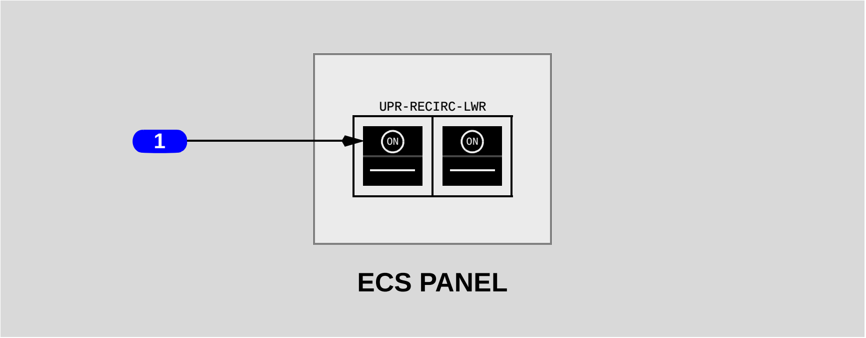
2 Alternate (ALTN) Ventilation (VENT) Selector

Spring loaded to 12 o’clock position.

When Alternate Ventilation switch ON:

- CLOSE - moves the alternate ventilation valve toward closed.
- OPEN - moves the alternate ventilation valve toward open.

Recirculation Fans Switch

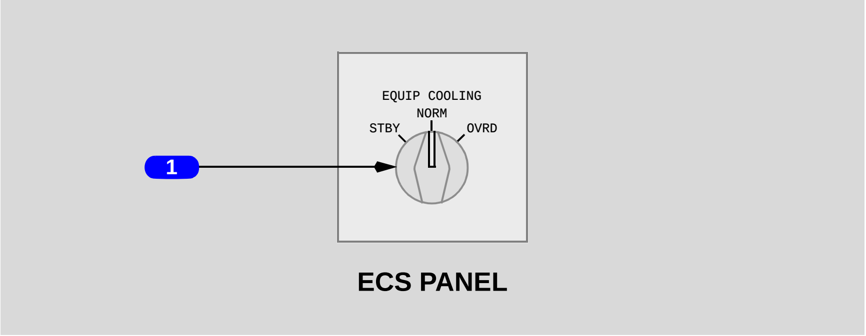


1 Recirculation (RECIRC) Fans Switch

ON - recirculation fans controlled automatically.

Off - recirculation fans off.

Equipment Cooling Selector



1 Equipment (EQUIP) COOLING Selector

STBY -

- ground exhaust valve closed
- automatic control bypassed to configure system for flight; inboard exhaust valve open
- with a single internal fault, equipment inboard exhaust valve closes and cooling system reconfigures to allow internal closed loop recirculation of cooling air

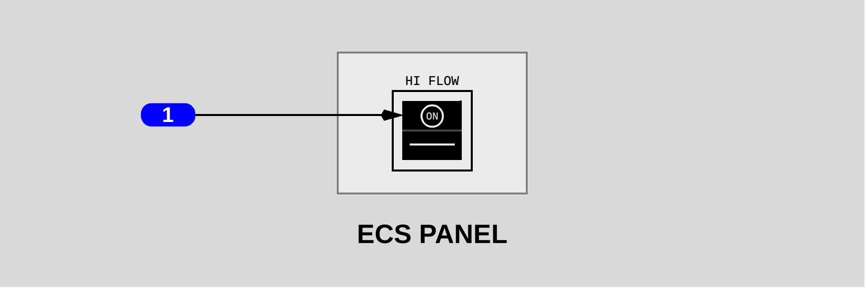
NORM -

- ground operation based on ambient temperature; 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 -

- inboard exhaust valve closed
- ground exhaust valve closed
- cooling fans are not powered
- equipment supply valves closed; cooling air supplied through flight panels
- smoke/override valve open; differential pressure exhausts cooling air overboard
- NGS is shutdown

Pack High Flow Switch

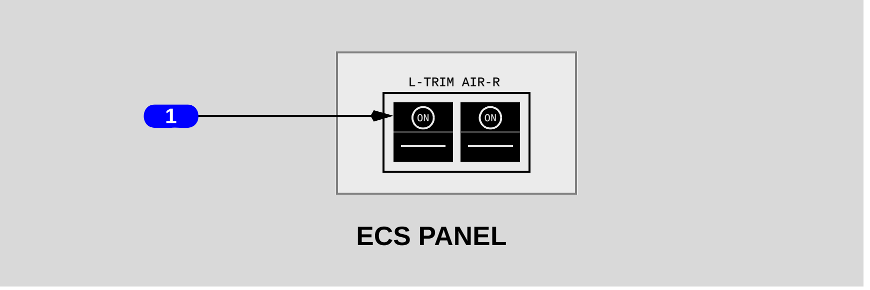


1 Pack High (HI) FLOW Switch

ON - all operating packs configured to high flow.

Off - pack air flow controlled automatically.

Trim Air Switches



1 TRIM AIR Switch

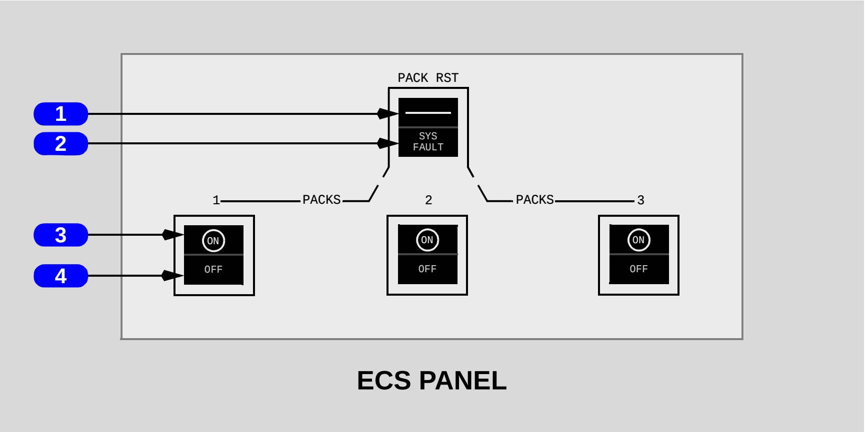
Both ON -

- left and right master trim air valves open and zone trim air valves operate automatically
- trim air isolation valve closed
- left trim air system supplies trim air to the flight deck and main deck A, C, and E temperature zones
- right trim air system supplies trim air to the upper deck, aft cargo compartment, and main deck B and D temperature zones
- if one master trim air valve fails closed, trim air isolation valve opens and trim air to all temperature zones supplied by the operating trim air system.
- if one master trim air valve closes due to overheat, the trim air isolation valve remains closed
- if left trim air fails and trim air isolation valve fails closed, all packs operate in backup mode. Pack output temperatures are regulated to provide average passenger cabin temperature from 65°F to 85°F (18°C to 29°C) as selected by Passenger Temperature selector in AUTO

Both off -

- left and right master trim air valves closed
- pack output temperature in backup mode regulated to provide average passenger cabin temperature from 65°F to 85°F (18°C to 29°C) as selected by Passenger Temperature selector in AUTO
- cabin temperature panel control of temperatures inhibited

Pack Control



1 PACK Reset (RST) Switch

Push -

- resets pack fault protection system
- resets zone trim air fault protection system
- restarts pack after automatic shutdown if fault no longer exists
- reopens master trim air valves if duct overheat no longer exists

2 Pack System (SYS) FAULT Light

Illuminated (amber) -

- pack overheat or other pack system fault has occurred
- temperature zone duct overheat has occurred
- master trim air valves failed closed

3 PACKS Switch

ON -

- pack valve open
- pack commanded on

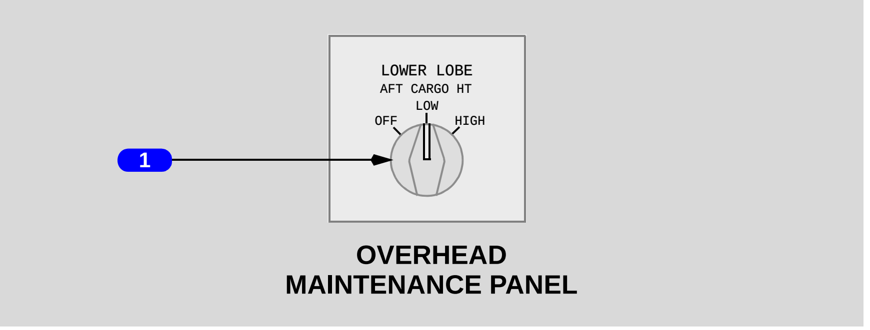
Off -

- pack valve closed
- extinguishes Pack System Fault light for the pack
- resets pack fault protection system

4 Pack OFF Light

Illuminated (amber) - pack valve closed.

Lower Lobe Aft Cargo Heat Selector



1 LOWER LOBE AFT CARGO Heat (HT) Selector

OFF - lower lobe aft cargo heat is off.

LOW -

- with Aft Cargo Temperature selector in AUTO:
  - lower lobe aft cargo overheat shutoff valve is closed
  - lower lobe aft cargo heat is inhibited, regardless of the position of the Lower Lobe Aft Cargo Heat selector
- with Aft Cargo Temperature selector in OFF:
  - lower lobe aft cargo overheat shutoff valve opens to supply aft lower lobe cargo heat
  - lower lobe aft cargo heat temperature control valve closes and opens to maintain at least 40°F (4°C)
  - lower lobe aft cargo overheat shutoff valve closes and opens for overheat protection

HIGH -

- with Aft Cargo Temperature selector in AUTO:
  - lower lobe aft cargo overheat shutoff valve is closed
  - lower lobe aft cargo heat is inhibited, regardless of the position of the Lower Lobe Aft Cargo Heat selector
- with Aft Cargo Temperature selector in OFF:
  - lower lobe aft cargo overheat shutoff valve opens to supply aft lower lobe cargo heat
  - lower lobe aft cargo heat temperature control valve closes and opens to maintain at least 50°F (10°C)
  - lower lobe aft cargo overheat shutoff valve closes and opens for overheat protection

Air Conditioning

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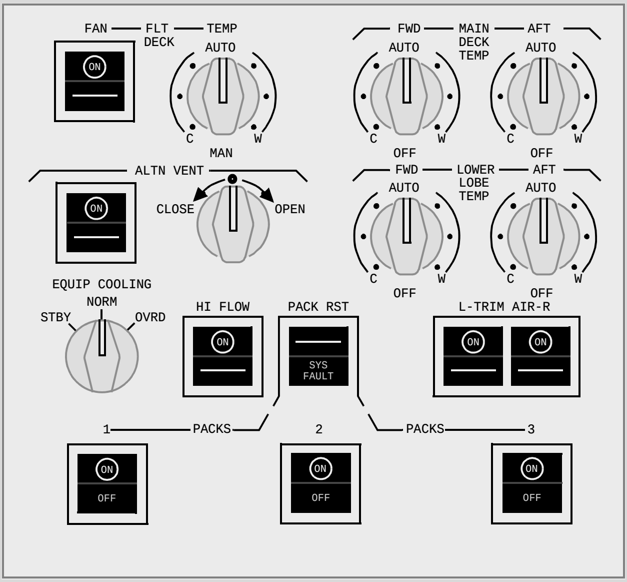
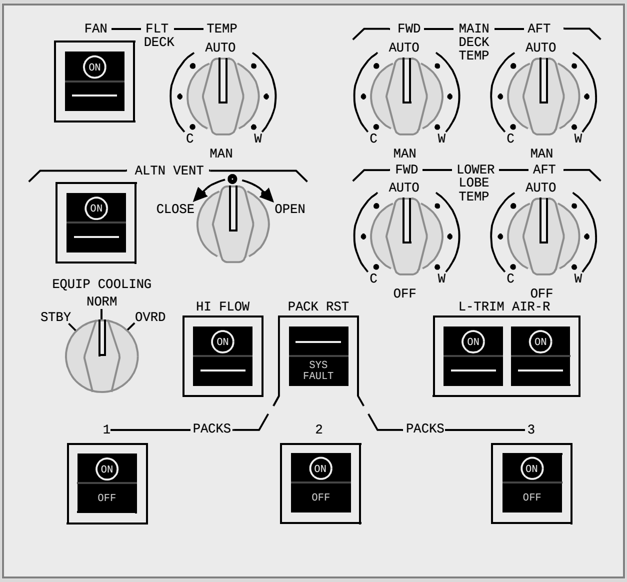
ECS Control

(914 ; SB installs Main Deck Temperature OFF selectors)



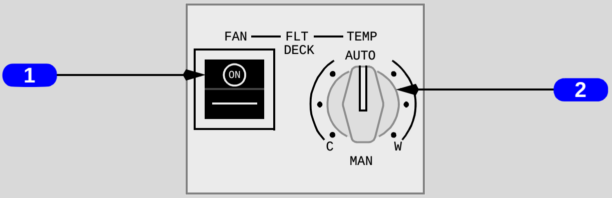
OVERHEAD PANEL

(914 ; before SB, Main Deck Temperature MAN selectors are installed)



OVERHEAD PANEL

Flight Deck Fan Switch and Flight Deck Temperature Selector



ECS PANEL

1 Flight (FLT) DECK FAN Switch

ON -

- with all packs off, recirculated cabin air supplied to flight deck
- with at least one pack operating, fan increases flow of conditioned air supplied to flight deck
- fan disabled in flight

2 Flight (FLT) DECK Temperature (TEMP) Selector

AUTO -

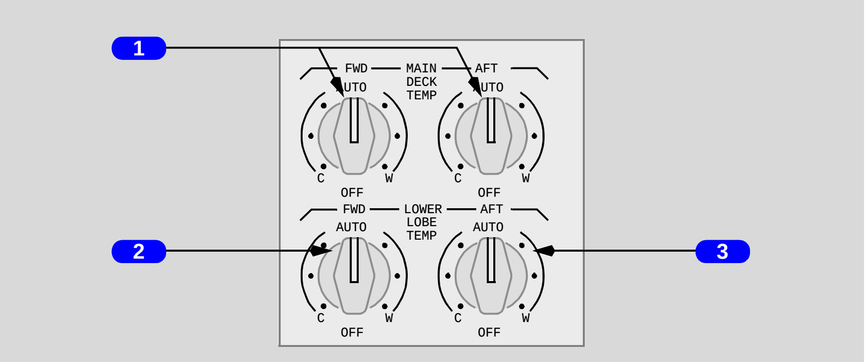
- provides automatic control of flight deck temperature
- range C to W sets temperature from 65°F to 85°F (18°C to 29°C). Mid position, 12 o'clock, sets approximately 75°F (24°C)
- if left trim air fails and trim air isolation valve fails closed, all packs operate in backup mode. All pack output temperatures are regulated to provide average flight deck temperature from 65°F to 85°F (18°C to 29°C) as set by Flight Deck Temperature selector in AUTO

MAN (spring loaded to 6 o'clock position) – flight deck trim air valve controlled manually:

- C (cool) - valve moves toward closed to supply cooler air
- W (warm) - valve moves toward open to supply warmer air

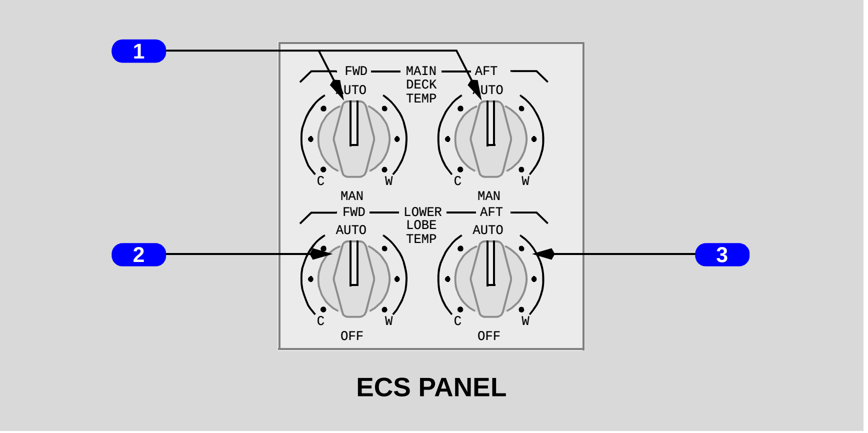
Main Deck and Lower Lobe Temperature Selectors

(914 ; SB installs Main Deck Temperature OFF selectors)



ECS PANEL

(914 ; before SB, Main Deck Temperature MAN selectors are installed)



(914 ; SB installs Main Deck Temperature OFF selectors)

1 MAIN DECK Temperature (TEMP) Selector

AUTO -

- C to W sets temperature from 40°F to 85°F (4°C to 29°C)
- in backup mode, flight deck control of main deck temperature is inhibited

OFF -

- flight deck control of main deck temperature zone is inhibited
- main deck temperature zone conditioned airflow is reduced
- main deck temperature zone target is 68°F (20°C)

(914 ; before SB, Main Deck Temperature MAN selectors are installed)

1 MAIN DECK Temperature (TEMP) Selector

AUTO -

- when both Forward and Aft Lower Lobe Temperature selectors are not in OFF, C to W sets temperature from 40°F to 85°F (4°C to 29°C)
- when both Forward and Aft Lower Lobe Temperature selectors are in OFF, full control of cargo zone temperatures may not be available and conditioned air flow is reduced
- in backup mode, full control of cargo zone temperatures may not be available.

MAN (spring loaded to 6 o’clock position) – main deck trim air valve controlled manually:

- C (cool) - valve moves toward closed to supply cooler air
- W (warm) - valve moves toward open to supply warmer air
- when both Forward and Aft Lower Lobe Temperature selectors are in OFF, full control of cargo zone temperatures may not be available

2 Forward (FWD) LOWER LOBE Temperature (TEMP) Selector

AUTO -

- C to W sets temperature of forward lower lobe conditioned air from 40°F to 85°F (4°C to 29°C)
- in backup mode, full control of cargo zone temperatures may not be available.

OFF -

- flight deck control of forward lower lobe zone target temperature is inhibited
- forward lower lobe conditioned airflow is shut off

(914 ; SB installs Main Deck Temperature OFF selectors)

- forward lower lobe temperature zone target is 68°F (20°C)

3 AFT LOWER LOBE Temperature (TEMP) Selector

AUTO -

- C to W sets temperature of aft lower lobe conditioned air from 40°F to 85°F (4°C to 29°C)
- lower lobe aft cargo heat overheat shutoff valve is closed and aft cargo heat is inhibited and will not be supplied regardless of the position of the Lower Lobe Aft Cargo Heat selector
- in backup mode, full control of cargo zone temperatures may not be available

OFF -

- flight deck control of aft lower lobe zone target temperature is inhibited
- lower lobe aft cargo heat will be supplied when the Lower Lobe Aft Cargo Heat selector is in LOW or HIGH
- aft lower lobe conditioned airflow is shutoff

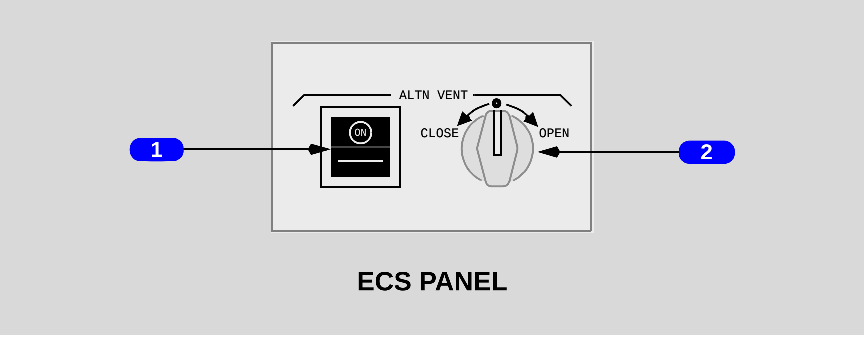
(914 ; SB installs Main Deck Temperature OFF selectors)

- aft lower lobe temperature zone target is 68°F (20°C)

(914 ; SB installs Main Deck Temperature OFF selectors)

Note: In cruise flight at or above FL 250 with all packs operating, the Pack High Flow switch off, both Forward and Aft Main Deck Temperature selectors, Forward Lower Lobe, and both Forward and Aft Lower Lobe Temperature selectors in OFF, cargo zone target temperatures are 68°F (20°C), full control of cargo zone temperatures may not be available. Economy flow rate and trim air flow may be inadequate to achieve the cargo zone target temperatures for carriage of temperature sensitive cargo.

Alternate Ventilation Controls



1 Alternate (ALTN) Ventilation (VENT) Switch

ON -

- with airplane depressurized, opens alternate ventilation valve
- outside air is supplied to flight deck
- when switch is pushed ON, valve moves to open position
- 20 seconds after switch is pushed ON, valve can be repositioned with the Alternate Ventilation selector

Off - alternate ventilation valve closed.

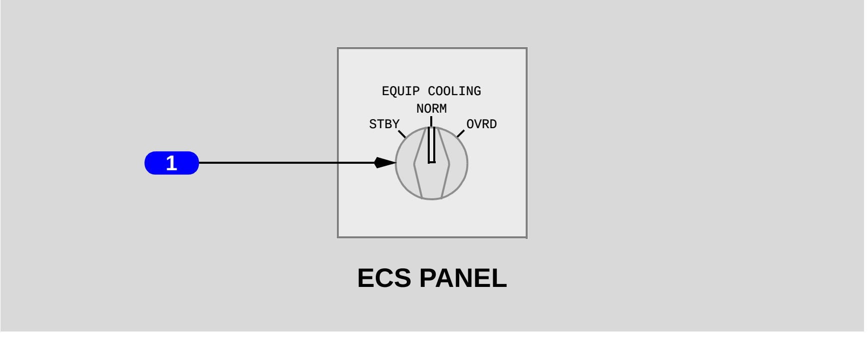
2 Alternate (ALTN) Ventilation (VENT) Selector

Spring loaded to 12 o’clock position.

When Alternate Ventilation switch ON:

- CLOSE - moves the alternate ventilation valve toward closed
- OPEN - moves the alternate ventilation valve toward open

Equipment Cooling Selector



1 Equipment (EQUIP) COOLING Selector

STBY -

- ground exhaust valve closed
- automatic control bypassed to configure system for flight; inboard exhaust valve open
- with a single internal fault, equipment inboard exhaust valve closes and cooling system reconfigures to allow internal closed loop recirculation of cooling air

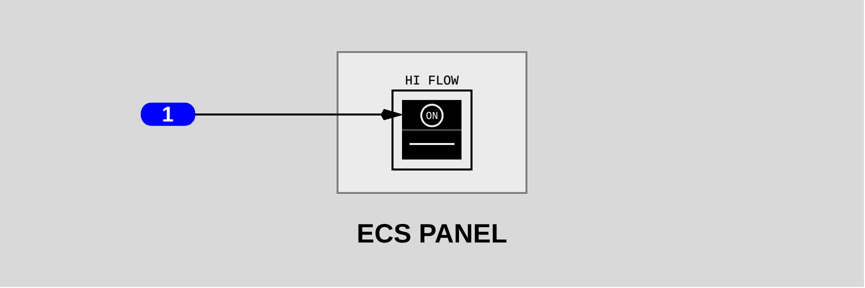
NORM -

- ground operation based on ambient temperature and temperature set by the Forward Lower Lobe Temperature selector; equipment cooling air exhausted overboard, or exhausted into forward cargo compartment
- with two or more engines running and Forward Lower Lobe Temperature selector set above 50°F (10°C), cooling air exhausted into forward cargo compartment and ground exhaust valve closed
- with two or more engines running and forward lower lobe temperature selected below 50°F (10°C), inboard exhaust valve closed and equipment cooling air recirculated in a closed loop mode
- with a single internal fault, equipment inboard exhaust valve closes and cooling system reconfigures to allow internal closed loop recirculation of cooling air

OVRD -

- inboard exhaust valve closed
- ground exhaust valve closed
- equipment supply valves closed; cooling air supplied through flight panels
- smoke/override valve open; differential pressure exhausts cooling air overboard
- NGS is shutdown

Pack High Flow Switch

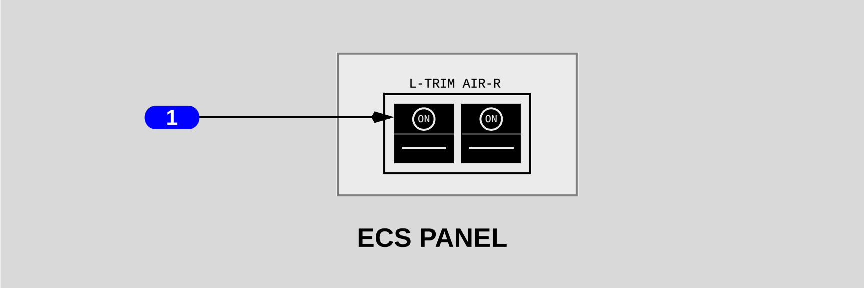


1 Pack High (HI) FLOW Switch

ON - all operating packs configured to high flow.

Off - pack air flow controlled automatically.

Trim Air Switches



1 TRIM AIR Switch

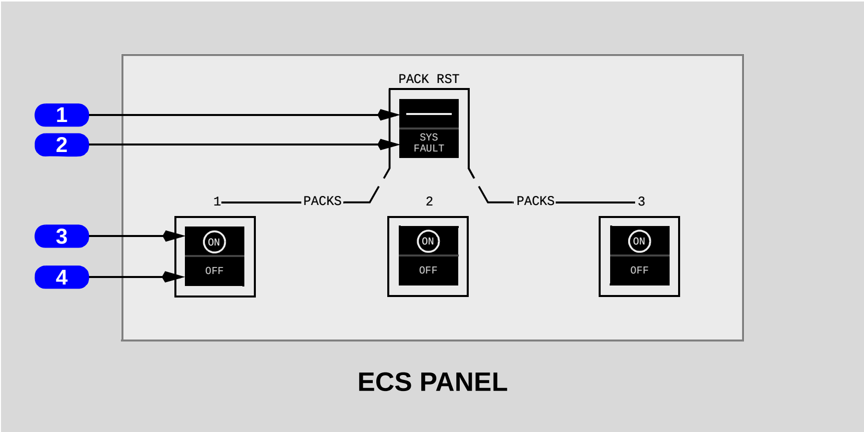
Both ON -

- left and right master trim air valves open and zone trim air valves operate automatically
- trim air isolation valve closed
- left trim air system supplies trim air to flight deck, upper deck, crew rest, and aft main deck zones
- right trim air system supplies trim air to forward main deck, forward lower lobe, and aft lower lobe zones
- if one master trim air valve fails closed, trim air isolation valve opens and trim air to all temperature zones supplied by the operating trim air system.
- if one master trim air valve closes due to overheat, the trim air isolation valve remains closed
- if left trim air fails and trim air isolation valve fails closed, all packs operate in backup mode. Pack output temperatures are regulated to provide average flight deck temperature from 65°F to 85°F (18°C to 29°C) as set by Flight Deck Temperature selector in AUTO

Both off -

- left and right master trim air valves closed
- all packs operate in backup mode. Pack output temperatures are regulated to provide average flight deck temperature from 65°F to 85°F (18°C to 29°C) as set by Flight Deck Temperature selector in AUTO

Pack Control



1 PACK Reset (RST) Switch

Push -

- resets pack fault protection system
- resets zone trim air fault protection system
- restarts pack after automatic shutdown if fault no longer exists
- reopens master trim air valves if duct overheat no longer exists

2 Pack System (SYS) FAULT Light

Illuminated (amber) -

- pack overheat or other pack system fault has occurred
- temperature zone duct overheat has occurred
- master trim air valves failed closed

3 PACKS Switch

ON -

- pack valve open
- pack commanded on

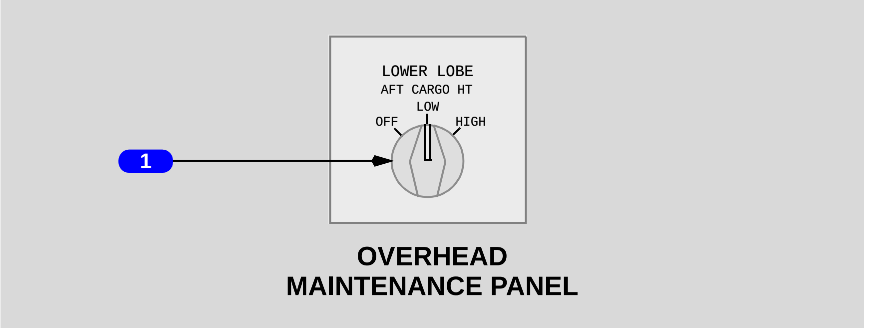
Off -

- pack valve closed
- extinguishes Pack System Fault light for the pack
- resets pack fault protection system

4 Pack OFF Light

Illuminated (amber) - pack valve closed.

Lower Lobe Aft Cargo Heat Selector



1 LOWER LOBE AFT CARGO Heat (HT) Selector

OFF - lower lobe aft cargo heat is off.

LOW -

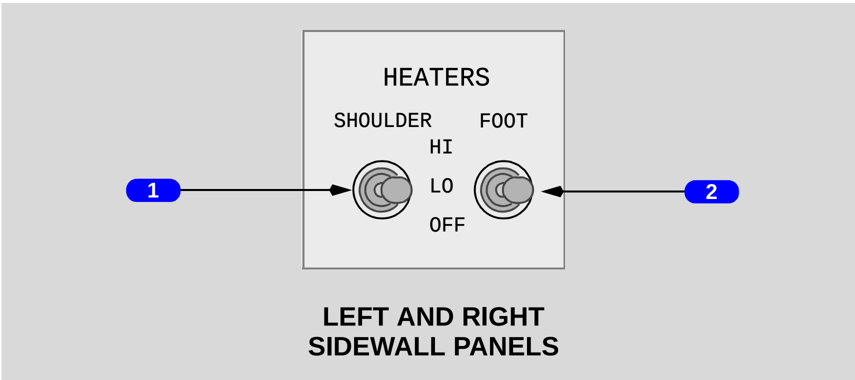
- with Aft Lower Lobe Temperature selector in AUTO:
  - lower lobe aft cargo overheat shutoff valve is closed
  - lower lobe aft cargo heat is inhibited, regardless of the position of the Lower Lobe Aft Cargo Heat selector
- with Aft Lower Lobe Temperature selector in OFF:
  - lower lobe aft cargo overheat shutoff valve opens to supply aft lower lobe cargo heat
  - lower lobe aft cargo heat temperature control valve closes and opens to maintain at least 40°F (4°C)
  - lower lobe aft cargo overheat shutoff valve closes and opens for overheat protection

HIGH -

- with Aft Lower Lobe Temperature selector in AUTO:
  - lower lobe aft cargo overheat shutoff valve is closed
  - lower lobe aft cargo heat is inhibited, regardless of the position of the Lower Lobe Aft Cargo Heat selector
- with Aft Lower Lobe Temperature selector in OFF:
  - lower lobe aft cargo overheat shutoff valve opens to supply aft lower lobe cargo heat
  - lower lobe aft cargo heat temperature control valve closes and opens to maintain at least 50°F (10°C)
  - lower lobe aft cargo overheat shutoff valve closes and opens for overheat protection

Pilot Auxiliary Heat

Electric shoulder heater and foot heater operate only in flight.



1 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.

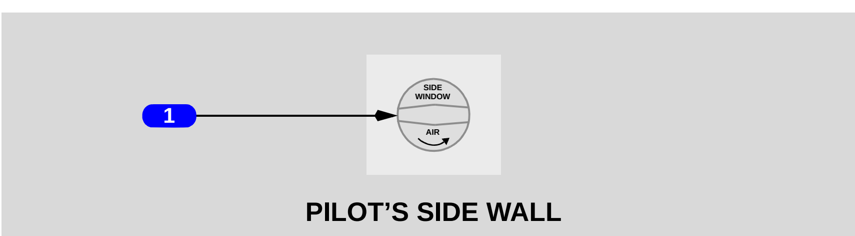
2 FOOT Heater Switch

Control temperature is the same in HI and LO. Heater is inhibited when temperature of foot heater plate is above 65°F (18°C).

HI - under-floor electric heater operates at high heating rate.

LO - under-floor electric heater operates at low heating rate.

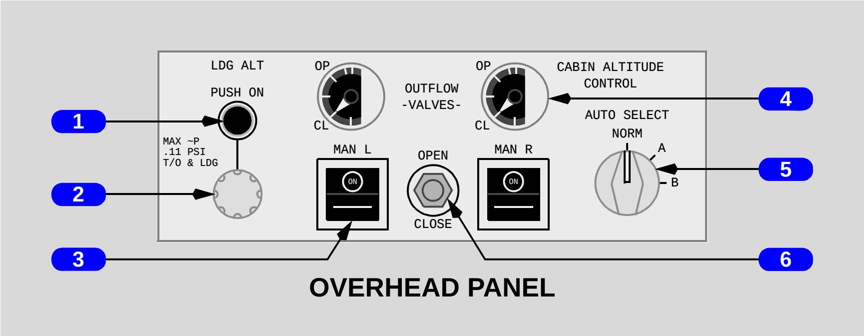
OFF - under-floor electric heater off.



1 Shoulder Air Selector

Rotate - Sets air flow to side window shoulder air outlet.

Pressurization System
Cabin Altitude Control



1 Landing Altitude (LDG ALT) Switch

Push - alternately changes landing altitude control between Automatic and Manual.

Manual -

- landing altitude set by rotating Landing Altitude selector
- landing altitude followed by MAN displayed on primary EICAS
- the EICAS advisory message LANDING ALT 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) Switch

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.

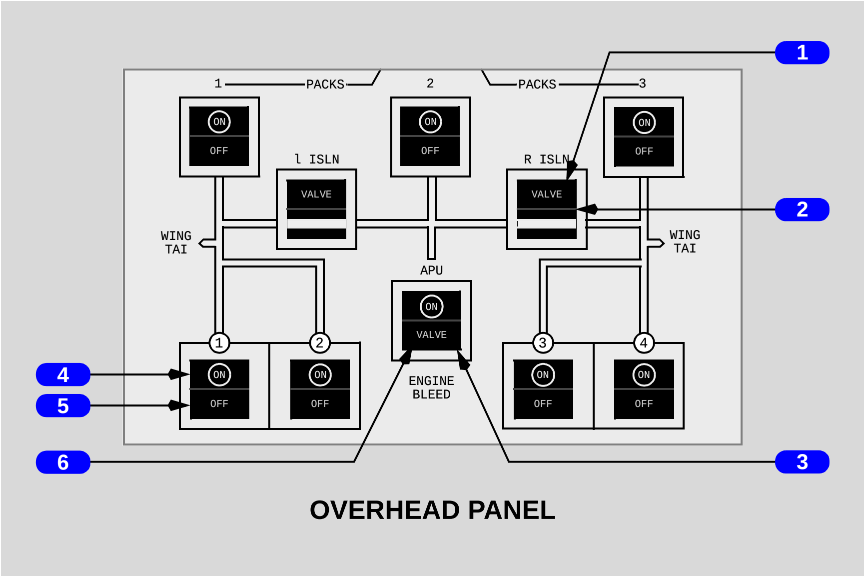
B - selects cabin altitude controller B as primary controller; selects A if B fails.

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 Light

Illuminated (amber) - isolation valve position disagrees with switch position.

2 Isolation (ISLN) Valve Switch

ON (bar in view) - valve is commanded open.

Off - valve is commanded closed.

3 APU Bleed Air Switch

ON - valve commanded open when EICAS memo message APU RUNNING is displayed.

Off - valve is commanded closed.

4 ENGINE BLEED Air Switch

ON - engine bleed air valve and HP bleed valve open by system logic when bleed air pressure is available.

Off - engine bleed air valve and HP bleed valve are commanded closed.

5 ENGINE BLEED Air OFF Light

Illuminated (amber) - engine bleed air valve is closed.

6 APU Bleed Air VALVE Light

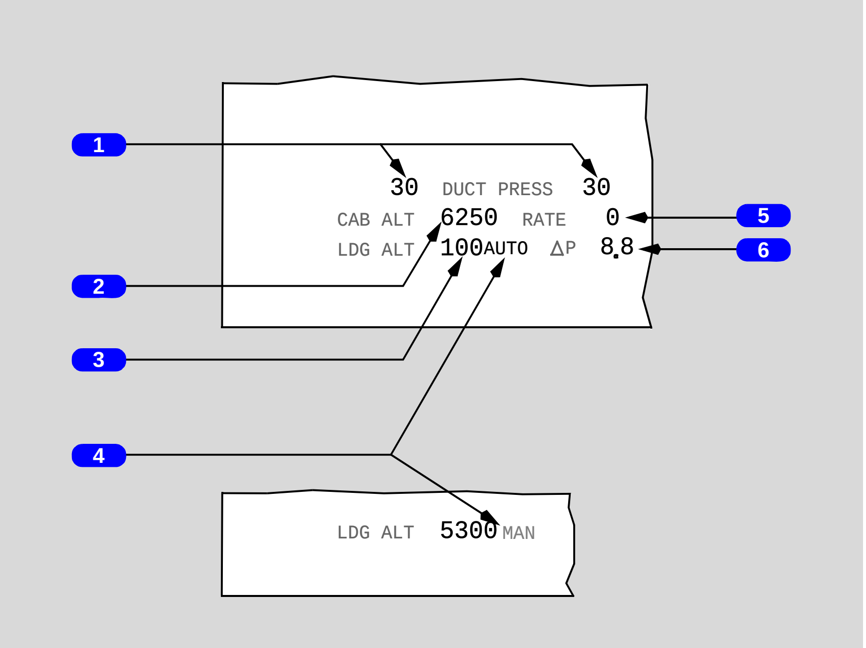
Illuminated (amber) - APU bleed air isolation valve position disagrees with switch position.

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 is displayed
- cabin altitude is in amber above normal range or in red excessive range
- cabin differential pressure is in amber above normal range or in red excessive range
- duct pressure is in the amber range
- ECS or ENG switch is pushed on the display select panel



PRIMARY EICAS DISPLAY

1 Bleed Air Duct Pressure

White - 12 psi and above.

Amber - 11 psi and below.

2 Cabin Altitude

White - normal range.

Amber - above normal range.

Red - excessive cabin altitude.

3 Landing Altitude

- inhibited if both cabin altitude controllers A and B fail
- inhibited if both outflow valves are in MAN

4 Landing Altitude Selection

AUTO (white) - altitude set automatically from FMC - Refer to Chapter 11, Flight Management Navigation, Arrivals Page - IFR Approaches.

MAN (amber) - altitude set by the 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. It does not display actual air flow, therefore the display may not represent actual system operation.

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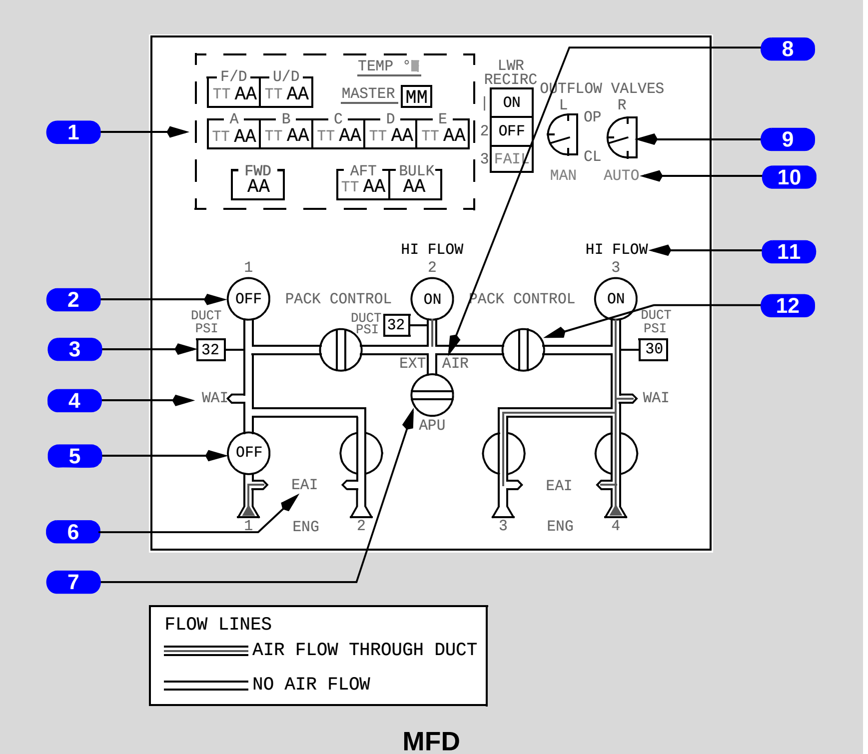

MFD

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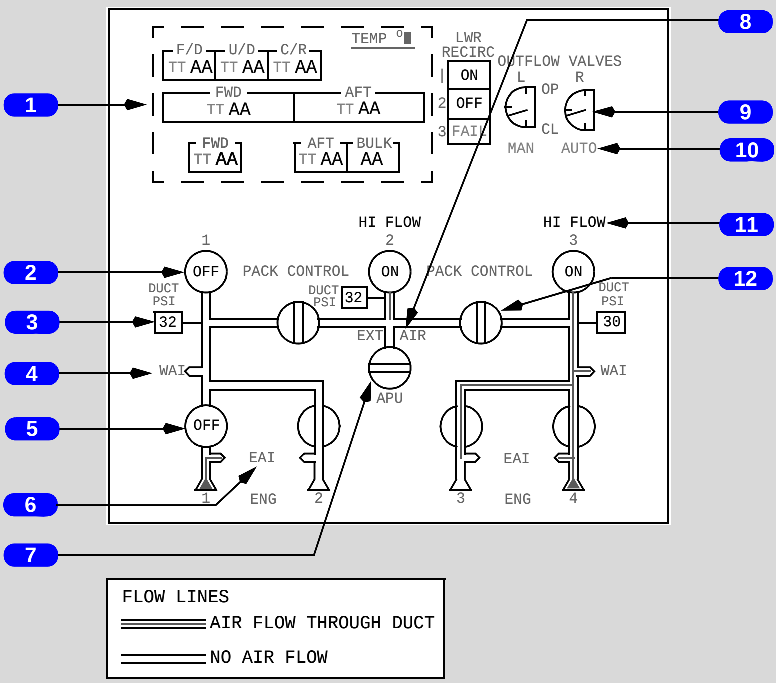

MFD

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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.

FWD, BULK - (AA) actual temperature of cargo compartment.

AFT -

- (TT) target temperature on left; displayed when:
  - at least one is pack operating, and
  - temperature control not in backup made
- (AA) actual temperature on right

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1 Zone Temperature

F/D, U/D, C/R, FWD lower lobe, AFT lower lobe -

- (TT) target temperature on left; displayed when:
  - at least one pack operating, and
  - temperature selector is in AUTO, and
  - temperature control is not in backup mode
- (AA) actual temperature on right

(914 ; SB installs Main Deck Temperature OFF selectors)
FWD main deck, AFT main deck (when both Forward and Aft Main Deck Temperatures and both Forward and Aft Lower Lobe Temperature selectors are not in OFF) -

- (TT) target temperature on left; displayed when:
  - at least one pack operating, and
  - temperature selector is in AUTO
- (AA) actual temperature on right

(914 ; SB installs Main Deck Temperature OFF selectors)
FWD main deck, AFT main deck (when both Forward and Aft Main Deck Temperatures and both Forward and Aft Lower Lobe Temperature selectors are in OFF) -

- (AA) actual temperature

BULK cargo - (AA) actual temperature

2 Pack Control

ON - pack valve is open.

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 **Engine Anti-Icing**

Engine anti-icing is valve is open.

7 **APU Bleed Air Isolation Valve**

Position of the isolation valve.

8 **External Air Indication**

- 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**

AUTO - Outflow Valve Manual Switch is ON.

MAN - closed.

10 **Outflow Valves Manual Switch Position**

MAN - switch is ON.

AUTO - switch is off.

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11 **Economy, High Flow**

(914 ; SB installs Main Deck Temperature OFF selectors)
ECONOMY - displayed in cruise flight at or above FL250 when:

- all packs are operating, and
- the Pack High Flow switch is off, and
- both Forward and Aft Main Deck Temperature selectors are in OFF, and both Forward and Aft Lower Lobe Temperature selectors are in OFF

HI FLOW - pack is in high flow

Blank - pack is in normal flow or pack is off.

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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.

Air Systems Chapter 2
Air Conditioning System Description Section 20

Introduction

The air conditioning system supplies conditioned bleed air and recirculated air at controlled temperature throughout the airplane. Pack control, temperature control, air recirculation, fault detection, and overheat protection are all automatic. Backup system control modes operate in the event of system failures.

The system supplies conditioned air to the flight deck shoulder heaters and ventilation for:

- crew rest

  806
- galleys

  806
- lavatories

  914
- lavatory

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.

Each pack is controlled by an Integrated Air System Controller (IASC). Each IASC controls the respective pack and some bleed air functions.

Pack Normal Operation

When a Pack switch is pushed ON the respective pack valve opens, which allows bleed air to flow into the pack.

During engine start, all packs may be off or one pack may be on.

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Each pack valve has three flow rates; economy, normal, and high. During cruise, economy flow and normal flow reduce bleed air demand on the engine to reduce fuel consumption. Fuel consumption is reduced approximately 0.6% for each pack in economy flow and approximately 0.3% for each pack in normal flow.

Pack Economy Flow Configuration
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(914 ; SB installs Main Deck Temperature OFF selectors)
In cruise flight at or above FL250, the configuration for economy flow is:

- all packs operating, and
- the Pack High Flow switch off, and
- both Forward and Aft Main Deck Temperature selectors in OFF, and both Forward and Aft Lower Lobe Temperature selectors in OFF

(914 ; SB installs Main Deck Temperature OFF selectors)
Note: In cruise flight at or above FL 250 with all packs operating, the Pack High Flow switch off, both Forward and Aft Main Deck Temperature selectors, Forward Lower Lobe, and both Forward and Aft Lower Lobe Temperature selectors in OFF, cargo zone target temperatures are 68°F (20°C), full control of cargo zone temperatures may not be available.Economy flow rate and trim air flow may be inadequate to achieve the cargo zone target temperatures required for carriage of temperature sensitive cargo.

Pack High Flow Switch

In cruise, pushing the Pack High Flow switch ON configures all packs to high flow.

Pack Normal Operation With Nitrogen Generation System (NGS)

The NGS converts bleed air to nitrogen-enriched air to reduce flammability of center wing tank fuel. To reduce bleed air demand the NGS is shut down:

- during engine out operation, or
- if the Equipment Cooling selector is in OVRD, or
- if the right bleed air duct is isolated, or
- if a Cargo Fire Arm switch is ARMED

After landing:

- with pack 3 opearing and TAT at or above 60°F (16°C), the NGS continues to operate for approximately seven minutes then shuts down, or
- with TAT below 60°F (16°C), the NGS shuts down immediately

Pack Non-Normal Operation

Pack Automatic Shutdown

If an overheat, pack operation fault, or controller fault is detected, the respective pack valve closes resulting in a pack shutdown and the EICAS advisory message PACK is displayed. If a cabin pressure relief valve is open, pack 2 shuts down.

An attempt to restore pack operation may be made by pushing the Pack Reset switch.

If the pack can not be reset, pushing the respective Packs switch to OFF extinguishes the Pack System Fault light for use by the operating packs.

Pack Standby Cooling Mode

If certain pack internal faults occur:

- the pack continues to operate,
- the pack is controlled in standby cooling mode,
- the EICAS advisory message PACK MODE is displayed

When operating in standby cooling mode, pack cooling capacity may be less than normal. Warmer flight deck and cabin temperatures may occur at lower altitudes.

If one pack is operating in standby cooling mode and any other pack is operating normally, the pack operating in standby cooling mode shuts down at lower altitudes and higher outside air temperatures. The pack restarts automatically when altitude and outside air temperature are suitable for standby mode operation.

All Packs Shut Down

If all packs are shut down the EICAS caution message PACKS 1+2+3 is displayed. The alternate ventilation system can provide outside air to the flight deck when the airplane is depressurized.

Conditioned Air Distribution

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Recirculation fans assist the packs to maintain a constant ventilation rate throughout the passenger cabin. The fans draw cabin air through filters, then reintroduce the air into the conditioned air distribution system. If a fan overheat is detected, electrical power is removed from the respective fan.

Pack flow is configured by:

- phase of flight,
- aft cargo conditioned air selection,
- Pack High Flow switch position, and
- the number of operating air conditioning packs
- the number of operating recirculation fans

Conditioned Air Distribution Non-Normal Operation

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.

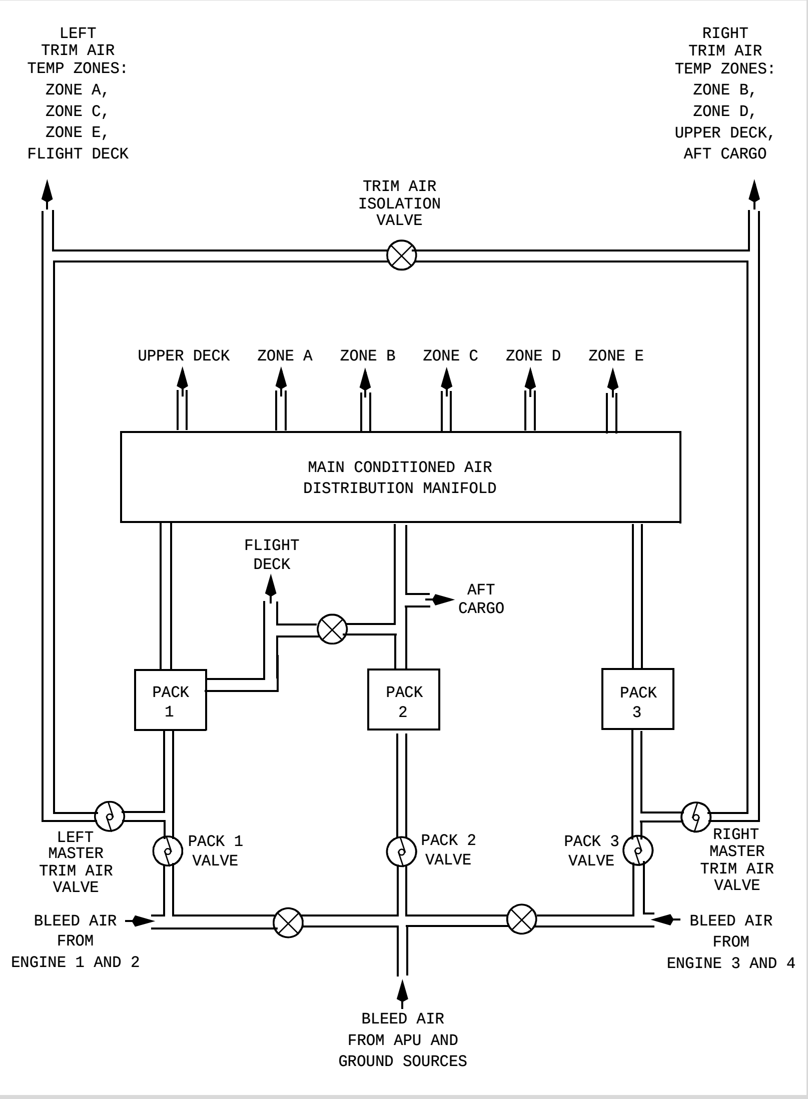
Alternate Ventilation System

If all packs are inoperative and the airplane is depressurized, the alternate ventilation system can provide outside air to the flight deck. Pushing the Alternate Ventilation switch ON opens the alternate ventilation valve to draw outside air through the flight deck conditioned air distribution ducts to the flight deck. Twenty seconds after the Alternate Ventilation is pushed ON, valve position can be controlled by the Alternate Ventilation selector.

Door Five Crew Rest Smoke Detection Mode

If smoke is detected in the crew rest area, the crew rest air supply valves close and remain closed until reset. Pushing the Crew Rest Reset switch on the Upper Deck Cabin Services Module (CSM) resets the valves if smoke is no longer detected.

Air Distribution Diagram



Temperature Control

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Conditioned air temperature control is provided for the temperature zones:

- flight deck
- upper deck
- crew rest
- five main deck cabin zones A through E
- aft cargo conditioned air

Zone temperatures are controlled by the IASCs

Hot bleed air is provided to the left and right trim air systems. Trim air is added through trim air valves into the conditioned air distribution duct for each temperature zone. The IASCs control zone temperatures by modulating the respective zone trim air valves.

The left trim air system normally provides trim air to the temperature zones.

- flight deck
- main deck A, C, and E

The right trim air system normally provides trim air to the temperature zones:

- upper deck
- main deck B and D
- aft cargo compartment

A trim air isolation valve allows either the left or right trim air to be supplied to all temperature zones. The trim air isolation valve is normally closed.

Passenger Zone Target Temperatures

The passenger cabin master temperatures are set to 75°F (24°C) when electrical power is initially applied to the airplane.

The Passenger Temperature selector sets the master passenger cabin temperature to between 65°F (18°C) and 85°F (29°C).

Automatic Passenger Comfort Compensation Of Zone Target Temperatures

For passenger comfort, the IASC slowly increases the target temperature for each passenger cabin temperature zone during the early part of flight. The temperature increase compensates for presumed decreases in passenger activity and humidity. During descent, the target temperatures decrease slowly until the comfort temperature corrections that were added are all removed.

Manual Modifications To Zone Target Temperatures

The target temperatures of each passenger zone may also be modified plus or minus 10°F (6°C) within the range of 65°F (18°C) to 85°F (29°C) from the comfort compensated master temperature. This is accomplished with the cabin temperature panels located at the purser station, the door four flight attendant station, and the aft upper deck flight attendant station.

The cabin temperature panel accepts temperature modifications after reaching cruise flight until start of descent.

Temperature Control Non-Normal Operation

If a system fault or overheat occurs in a temperature zone, the respective 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 Pack Reset switch.

Temperature Control With Loss of Left Trim Air System

If the left master trim air valve is failed closed, the trim air isolation valve opens and trim air is supplied to the flight deck and main deck A, C, and E temperature zones through the right master trim air valve.

If the left master trim air valve is closed due to an overheat or the Left Trim Air switch is off, the isolation valve remains closed.

Trim air is not available to the flight deck and main deck A, C, and E temperature zones if:

- the EICAS advisory message TEMP ZONE L is displayed due to a zone duct overheat, or
- the EICAS advisory message TRIM AIR L OFF is displayed, or
- the Left Trim Air switch is off

Temperature Control With Loss of Right Trim Air System

If the right master trim air valve is failed closed, the trim air isolation valve opens and trim air is supplied to the upper deck, aft cargo compartment, and main deck B and D temperature zones through the left master trim air valve.

If the right master trim air valve is closed due to an overheat or the Right Trim Air switch is off, the isolation valve remains closed.

Trim air is not available to the upper deck, aft cargo compartment, and main deck B and D temperature zones if:

- the EICAS advisory message TEMP ZONE R is displayed due to a zone duct overheat, or
- the EICAS advisory message TRIM AIR R OFF is displayed, or
- the Right Master Trim Air switch is off

If right trim air is not available, all packs operate in backup mode.

Cargo Heat

When the equipment cooling system inboard exhaust valve is open, the heated air exhausted from the electrical and electronic (E & E) compartment heats the forward cargo compartment.

Lower lobe aft cargo heat is provided by bleed air from the center section of the bleed air duct. To provide aft cargo heat, the Aft Cargo Temperature selector must be in OFF.

Conditioned Air Distribution

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Recirculation fans assist the packs to maintain a constant ventilation rate to the main deck and lower lobe cargo zones. The fans draw cabin air through filters, then reintroduce the air into the conditioned air distribution system. If a fan overheat is detected, electrical power is removed.

Pack flow is configured by:

- phase of fight,
- forward and aft main deck conditioned air selection,
- forward and aft lower lobe condition air selection,
- Pack High Flow switch position,
- the mode and number of operating air conditioning packs, and
- the number of operating recirculation fans

Forward Lower Lobe Conditioned Air Distribution

Forward lower lobe conditioned air is supplied from pack three.

With the Forward Lower Lobe Temperature selector in OFF, conditioned air flow from pack three to the forward lower lobe compartment is shutoff, and pack three air is distributed to the other temperature zones.

Aft Lower Lobe Conditioned Air Distribution

Aft lower lobe conditioned air is supplied from pack two.

With the Aft Lower Lobe Temperature selector in OFF conditioned air flow to the aft lower lobe compartment is shutoff, and pack two air is distributed to the other temperature zones.

Aft cargo heat is disabled when the Aft Lower Lobe Temperature selector is in AUTO.

Flight Deck Ventilation

Flight deck air is normally supplied from pack one and pack three. If pack one and pack three are commanded off or fail, the flight deck will be supplied a mix of fresh air from pack two and recirculated air.

With the Lower Lobe Temperature selector in AUTO, the cargo exhaust system discharges the forward lower lobe conditioned air overboard to prevent offensive odors from migrating from the lower lobe compartment into the other temperature zones and to ensure favorable air flow distribution throughout the compartment. The forward lower lobe exhaust system discharges the air overboard through the overboard valve on the fuselage side skin.

Flight Deck Fan

On the ground, the flight deck fan increases flow of conditioned air to the flight deck when at least one pack is operating and supplies recirculated air to the flight deck when all packs are off.

Conditioned Air Distribution Non-Normal Operation

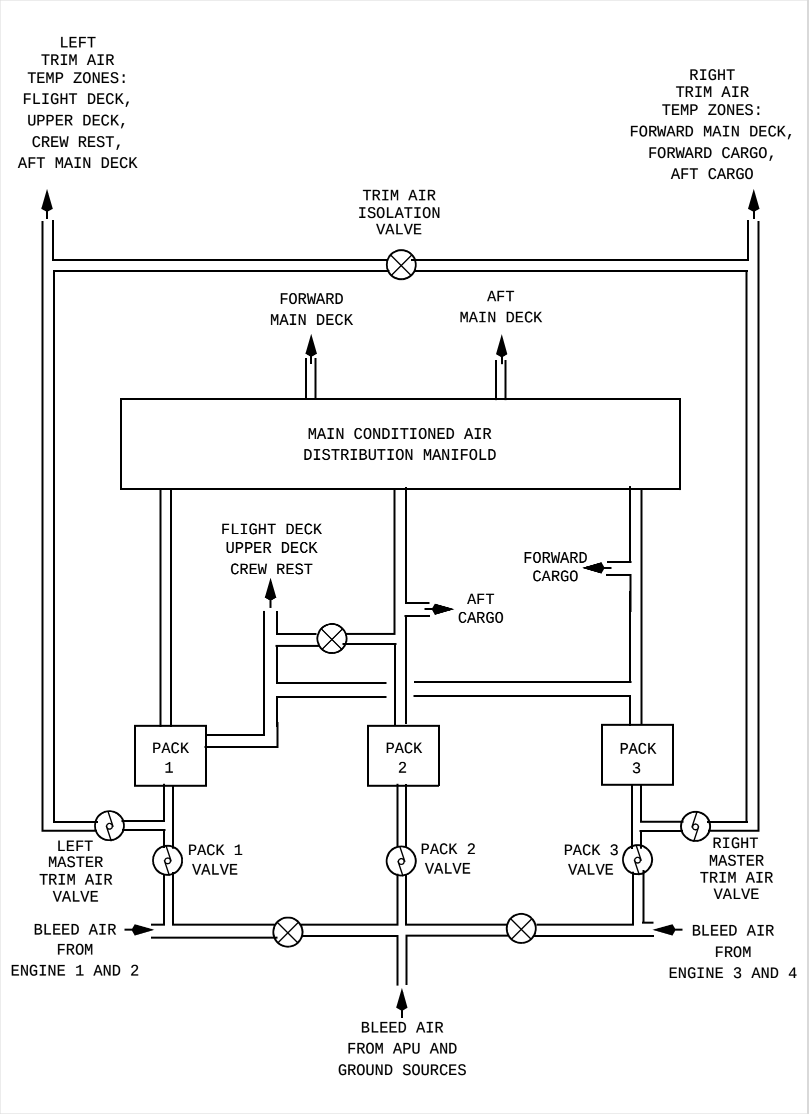
Cargo Fire Arm

When a Cargo Fire Arm switch is pushed, pack operation and air distribution is configured to starve the affected zone of fresh air, minimize air movement, purge smoke from the flight deck and upper deck, and increase the supply of fresh air to the flight deck.

Alternate Ventilation System

If all packs are inoperative and the airplane is depressurized, the alternate ventilation system can provide outside air to the flight deck. Pushing the Alternate Ventilation switch ON opens the alternate ventilation valve to draw outside air through the flight deck conditioned air distribution ducts to the flight deck. Twenty seconds after the Alternate Ventilation is pushed ON, valve position can be controlled by the Alternate Ventilation selector.

Air Distribution Diagram



Temperature Control

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Conditioned air temperature control is provided for the temperature zones:

- flight deck
- upper deck
- crew rest
- forward main deck
- aft main deck
- forward lower lobe cargo
- aft lower lobe cargo

Pack output temperature is normally controlled by the IASCs to ensure the minimum temperatures for the flight deck, forward cargo air conditioning, and aft cargo air conditioning zones can be maintained, and to ensure that the packs are protected from freezing.

Bleed air is provided to left and right trim air systems. Trim air is added through trim air valves into the conditioned air distribution duct for each temperature zone. The IASCs control zone temperatures by modulating the respective zone trim air valves.

The left trim air system normally provides trim air to the temperature zones:

- flight deck
- upper deck
- crew rest
- aft main deck

The right trim air system provides trim air to the temperature zones:

- forward main deck
- forward lower lobe cargo
- aft lower lobe cargo

A trim air isolation valve allows either the left or right trim air to be supplied to all temperature zones. The trim air isolation valve is normally closed.

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.

Lower lobe 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 lower lobe aft cargo heat 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 the lower lobe aft cargo overheat shutoff valve at higher temperatures.

To provide aft lower lobe cargo heat, the Aft Lower Lobe Temperature selector must be in OFF. When the Aft Lower Lobe Temperature selector is in AUTO, the lower lobe aft cargo heat overheat shutoff valve is closed and aft lower lobe cargo heat is inhibited and will not be provided regardless of the position of the Lower Lobe Temperature Aft Cargo Heat selector.

Temperature Control Normal Operation

Zone Target Temperatures

The upper deck and crew rest zone target temperatures are set to 75°F (24°C) when electrical power is initially applied to the airplane.

(914 ; SB installs Main Deck Temperature OFF selectors)
When a main deck or lower lobe temperature selector is in OFF, the ISAC attempts to modulate pack condition air and trim air to achieve a target zone temperature of 68°F (20°C) in the respective temperature zone. During cruise, the cargo zone target temperatures might not be achieved.

Manual Modifications To Zone Target Temperatures

The target temperatures of the upper deck and crew rest zones may be modified plus or minus 10°F (6°C) within the range of 65°F to 85°F (18°C to 29°C) from the master temperature. This is accomplished with the cabin temperature panel located on the upper deck. The cabin temperature panel accepts temperature modifications whenever the IASCs are powered.

Temperature Control Non-Normal Operation

If a system fault or overheat occurs in a temperature zone, the respective 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 Pack Reset switch.

Temperature Control With Loss of Left Trim Air System

If the left master trim air valve is failed closed, the trim air isolation valve opens and trim air is supplied to the flight deck, upper deck, crew rest, and aft main deck zones through the right master trim air valve.

If the left master trim air valve is closed due to an overheat or the Left Trim Air switch is off, the isolation valve remains closed.

Trim air is not available to the flight deck, upper deck, crew rest, and aft main deck zones if:

- the EICAS advisory message TEMP ZONE L is displayed due to a zone duct overheat, or
- the EICAS advisory message TRIM AIR L OFF is displayed, or
- the Left Trim Air switch is off

If trim air is not available to the flight deck, upper deck, and aft main deck zones, backup modes control temperature for those zones. Pack output temperature of two packs is regulated to achieve the average temperature of the flight deck and upper deck zones set by the Flight Deck Temperature selector.

Temperature Control With Loss of Right Trim Air System

If the right master trim air valve is failed closed, the trim air isolation valve opens and trim air is supplied to the forward main deck, forward lower lobe cargo, and aft lower lobe cargo zones through the left master trim air valve.

If the right master trim air valve is closed due to an overheat or the Right Trim Air switch is off, the isolation valve remains closed.

Trim air is not available to the forward main deck, forward lower lobe cargo, and aft lower lobe cargo zones if:

- the EICAS advisory message TEMP ZONE R is displayed due to a zone duct overheat, or
- the EICAS advisory message TRIM AIR R OFF is displayed, or
- the Right Master Trim Air switch is off

If right trim air is not available, all packs operate in backup mode.

In backup mode with right trim air not available, the forward main deck cargo, forward lower lobe cargo, and aft lower lobe cargo zone temperatures are regulated to maintain the lowest temperature set by the respective temperature selectors. For all other temperature zones, temperature control may be normal or may be affected by the Flight Deck Temperature selector in AUTO. For conditioned air distributed to all other zones, the pack output temperatures will not be lower than the pack output temperature necessary to maintain the temperature set by the Flight Deck Temperature selector in AUTO.

Gasper System

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The gasper system supplies recirculated air drawn from the upper passenger cabin area. Gasper air is distributed to the passenger service unit air gasper outlets above each passenger seat.

Pilot Auxiliary Heat

Flight crew shoulder heat is provided by electric elements in the side window and pilot shoulder air diffusers. The foot heat is provided by electric heating elements under the pilot foot area. Shoulder heat and foot heat are available in flight.

Lavatory and Galley Ventilation

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Two ventilation fans, a primary and a backup, draw air from the galleys and lavatories. If the primary fan fails, the backup fan operates automatically.

Conditioned air is provided to the galleys from the air distribution system.

Equipment Cooling

The equipment cooling system provides cooling air for flight deck equipment and the electrical and electronic (E & E) compartment equipment racks. The system uses internal fans and valves to direct cool cabin air from inside the lower fuselage into the equipment racks. The warm exhaust air is ducted into the forward cargo compartment, recirculated in a closed loop mode through the E & E compartment cooling racks, or ducted overboard.

On the ground, when the Equipment cooling selector in NORM and:

- the engines not operating:
  - with 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
- one or more engines on each wing are operating, the ground exhaust valve is closed to pressurize the airplane for flight

If the Equipment Cooling selector is in STBY the overboard exhaust valve is closed manually to pressurize the airplane for flight.

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In flight with two or three packs operating, conditioned air is directed into the flight deck electrical equipment.

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In flight, when the Forward Lower Lobe Temperature selector is:

- in OFF or set above 50°F (10°C), the inboard exhaust valve is open and the warmed equipment cooling exhaust air discharges into the forward cargo compartment
- set below 50°F (10°C), the inboard exhaust valve is closed and the recirculated in a closed loop mode

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 both internal fans are inoperative or if smoke is detected. 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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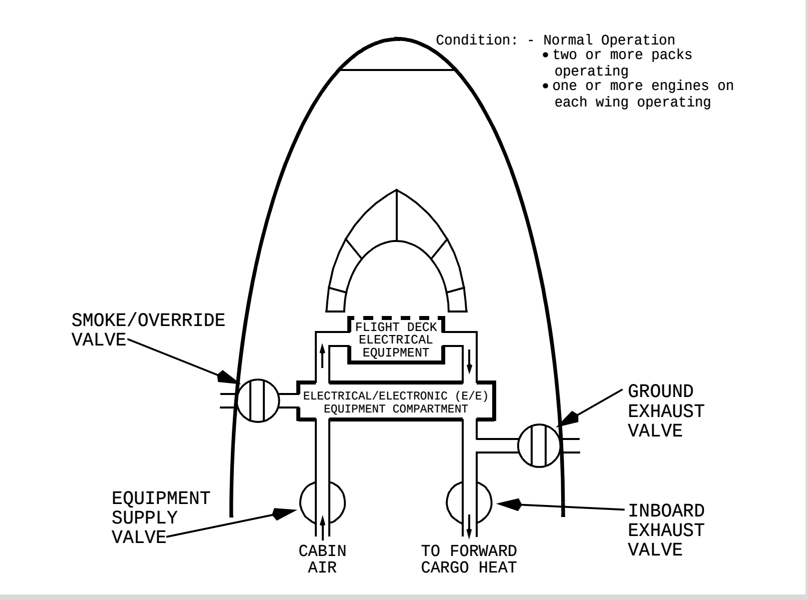

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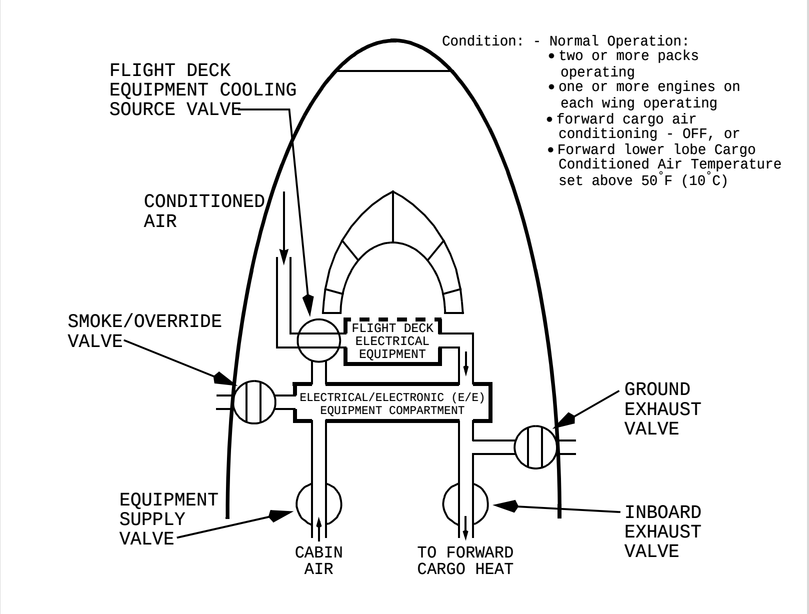
Condition: - Normal Operation:
• two or more packs operating
• one or more engines on each wing operating
• forward cargo air conditioning - OFF, or
• Forward lower lobe Cargo Conditioned Air Temperature set above 50˚F (10˚C)
FLIGHT DECK EQUIPMENT COOLING SOURCE VALVE
CONDITIONED AIR
SMOKE/OVERRIDE VALVE
FLIGHT DECK ELECTRICAL EQUIPMENT
ELECTRICAL/ELECTRONIC (E/E) EQUIPMENT COMPARTMENT
GROUND EXHAUST VALVE
EQUIPMENT SUPPLY VALVE
CABIN AIR
TO FORWARD CARGO HEAT
INBOARD EXHAUST VALVE

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 Normal 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 2,000 feet below sea level to 14,000 feet above sea level. The left altimeter setting provides landing altitude barometric pressure correction.

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

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 Relief

Two mechanical positive pressure relief valves prevent over pressurization of the airplane. One or both valves open if cabin pressure becomes excessive, and close when cabin pressure is no longer excessive. Pack two shuts down to assist in relieving excess cabin pressure. Pack two resets when both cabin pressure relief valves close.

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Negative pressure relief valves in the forward and aft cargo doors open when the airplane cabin pressure is slightly less than outside air pressure. The valves also open to relieve any existing differential pressure when a cargo door is unlatched.

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Negative pressure relief valves in the side cargo door and the forward and aft cargo doors open when the airplane cabin pressure is slightly less than outside air pressure. The valves also open to relieve any existing differential pressure when a cargo door is unlatched.

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Air Systems Chapter 2
Bleed Air System Description Section 40

Introduction

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

Bleed air is used for:

- air conditioning
- pressurization
- wing and engine nacelle inlet anti-icing
- engine start
- leading edge flaps
- TAT probe aspiration
- aft cargo heat
- hydraulic reservoir pressurization
- air driven hydraulic demand pumps (ADP)
- NGS

Engine Bleed Air Supply

Engine bleed air is supplied from either the high pressure stage (HP) or the intermediate pressure stage (IP) engine sections. Intermediate stage air is used during high power setting operations. High stage air is used during descent and other low power setting operations.

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

- when a ground cart is supplying air.
- during engine start
- if a bleed air over temperature occurs
- if a bleed air over pressure occurs
- if a bleed source loss occurs
- if a bleed air duct leak occurs
- when an engine fire switch is pulled

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 air 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 because of 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.

Nitrogen Generation System (NGS)

The NGS converts bleed air to nitrogen-enriched air to reduce flammability of center wing tank fuel. To reduce bleed air demand the NGS is shut down:

- during engine out operation, or
- if the Equipment Cooling selector is in OVRD, or
- if the right bleed air duct is isolated, or
- if a Cargo Fire Arm switch is ARMED

After landing:

- with TAT at or above 60°F (16°C), the NGS continues to operate for approximately seven minutes then shuts down, or
- with TAT below 60°F (16°C), the NGS shuts down immediately

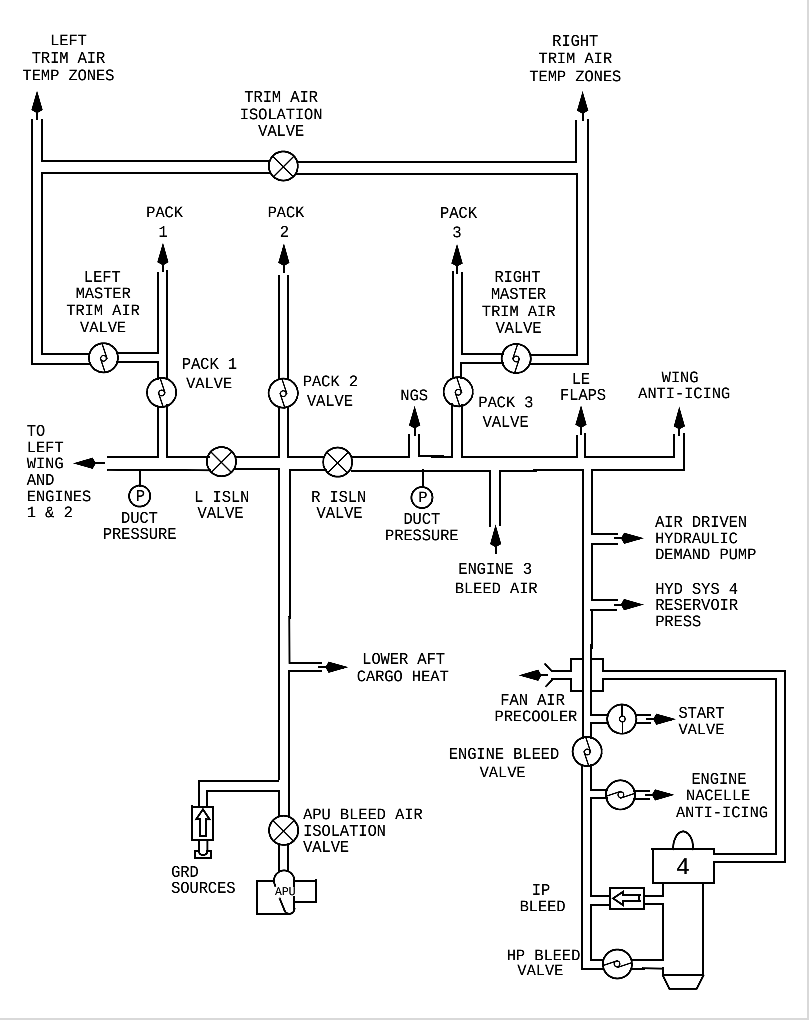
Bleed Air System Non-normal Operation

If engine bleed air temperature from an engine is too low to provide sufficient wing anti-icing, the EICAS advisory message BLD LOW TEMP is displayed. The respective Engine Bleed Air switch is pushed off to assure that the temperature of the air supplied from the other engines that are running is adequate for wing anti-icing.

If a bleed duct leak is detected, the EICAS advisory message BLD DUCT LEAK is displayed. Closing the respective isolation and engine bleed air valves prevents further air loss.

If the left or right duct section is isolated, the respective leading edge flaps operate electrically in secondary mode. The respective hydraulic demand pump one or four is selected OFF to avoid the EICAS alert message HYD PRESS DEMAND from being displayed during approach. A maximum of one air conditioning pack on assures sufficient thrust is available from the two engines which supply air to the unaffected duct sections.

Bleed Air System Diagram



EICAS Alert Messages

Message	Level	Aural	Message Logic
ALTN VENT ON	Advisory		Alternate ventilation valve is not closed.
BLD 1, 2, 3, 4 LOW TEMP	Advisory		Engine bleed air temperature is too low to provide sufficient wing anti-icing.
BLD DUCT LEAK L, C, R	Caution	Beeper	Bleed air leak or overheat along the left, center, or right duct section.
BLEED 1, 2, 3, 4	Advisory		Engine bleed air valve or HP bleed valve is not in the commanded position, or an engine bleed air overtemperature or overpressure, or a bleed air temperature or pressure sensor is failed, or an airflow fault in the engine anti-icing system has occurred.
BLEED 1, 2, 3, 4 OFF	Advisory		Engine Bleed Air switch is OFF, and the engine is operating, and the engine bleed air valve is closed.
BLEED HP ENG 1, 2, 3, 4	Advisory		Engine HP bleed air valve is closed when commanded open, and engine anti-icing is commanded on. At low N1 settings, engine bleed air may be insufficient for engine anti-icing.
BLEED ISLN APU	Advisory		APU bleed isolation valve is not in the commanded position.
BLEED ISLN L, R	Advisory		Bleed isolation valve is not in the commanded position.
CABIN ALT AUTO	Caution	Beeper	Both cabin altitude controllers have failed or both Outflow Valve Manual switches are ON.
CABIN ALTITUDE	Warning	Siren	Cabin altitude is excessive.

Message	Level	Aural	Message Logic

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CABIN TEMP	Advisory		Flight deck or cabin temperature zone is excessively hot or excessively cold.

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CABIN TEMP	Advisory		Flight deck zone is excessively hot or excessively cold.

E/E CLNG CARD	Advisory		Fault in equipment cooling system has occured and the system not fully functional. Message is inhibited in flight.
EQUIP COOLING	Caution	Beeper	With Equipment Cooling selector in NORM or STBY, airflow is inadequate, or an overheat has occured, or smoke is detected; or with selector in OVRD differential pressure for reverse flow cooling is inadequate; or the ground exhaust valve is not in the commanded position
LANDING ALT	Advisory		Disagreement between controller landing altitude and FMC landing altitude, or the landing altitude is in MAN.
OUTFLOW VLV L, R	Advisory		Automatic control of the outflow valve is inoperative, or the Outflow Valve Manual switch is ON.
PACK 1, 2, 3	Advisory		Pack controller fault, or a pack operation fault, or a pack overheat, or pack 2 is shut down with either cabin pressure relief valve open.
PACK 1+2+3	Caution	Beeper	All packs are shut down.
PACK MODE 1, 2, 3	Advisory		Pack is in standby cooling mode.

Message	Level	Aural	Message Logic
PRESS RELIEF	Advisory		Either pressure relief valve is open with all packs operating.
TEMP CARGO HEAT	Advisory		Overheat detected in the aft cargo compartment when the aft cargo heat system is operating.
TEMP ZONE L, R	Advisory		Zone duct overheat, or the trim air valve is failed closed, or the left trimair valve and the right trim air valve are failed closed.
TRIM AIR L OFF	Advisory		Left master trim air valve is closed and pack 1 is operating. Some zones may still receive trim air for temperature control. Some zone temperatures are controlled by pack outlet temperature only and may not achieve the target temperature.
TRIM AIR R OFF	Advisory		Right master trim air valve is closed and pack 3 is operating. Some zones may still receive trim air for temperature control. Some zone temperatures are controlled by pack outlet temperature only and may not achieve the target temperature.

EICAS Memo Messages

Message	Level	Aural	Message Logic
PACK 1, 2, 3 OFF	Memo		Pack switch is off.
PACKS 1 + 2, 1 + 3, 2 + 3 OFF	Memo		Pack switches are off.
PACKS HIGH FLOW	Memo		High flow switch is ON. Pack flow setting is not controlled automatically.
PACKS OFF	Memo		All Pack switches are off.

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Anti-Ice, Rain — Chapter 3

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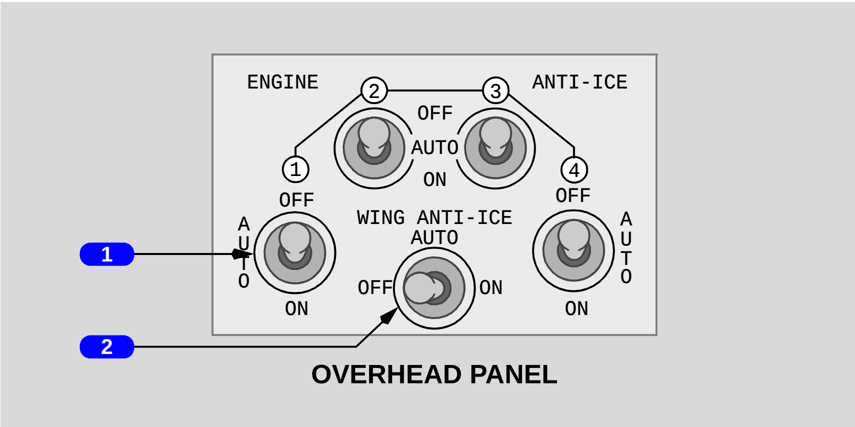
Engine and Wing Anti-Icing

Anti-Ice Panel



1 ENGINE ANTI-ICE Switches

OFF - the engine anti-icing valves are commanded closed.

AUTO -

- in flight, engine anti-icing operates when the icing conditions detection system detects engine icing conditions. The engine anti-icing valve is opened by engine bleed air pressure
- on the ground, the system is off and the valve is closed

ON - the engine anti-icing valve opens when engine bleed air pressure is available.

2 WING ANTI-ICE Switch

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

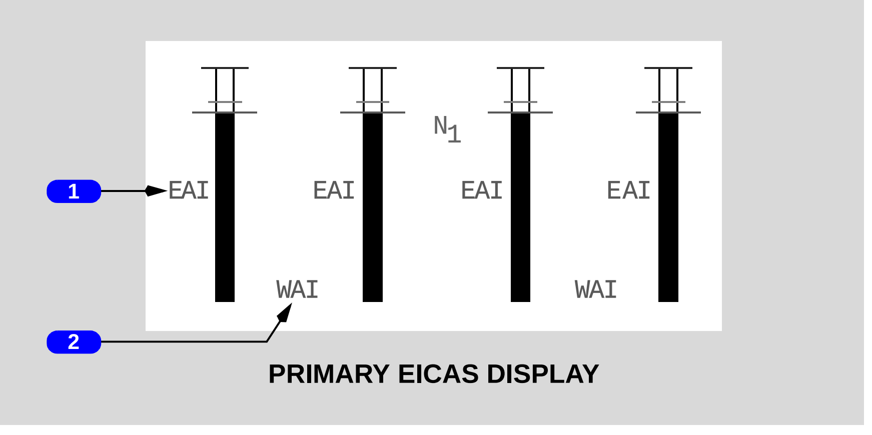
AUTO -

- in flight with the leading edge flaps retracted, the wing anti-icing valves open when the icing conditions detection system detects wing icing conditions. The valves close when the leading edge flaps are extended.
- when wing icing conditions are detected, the flaps down maneuver margin is reduced. The flaps down maneuver margin remains reduced until the airplane is on the ground, regardless of:
  - whether wing icing conditions are no longer detected, or
  - the position of the flaps, or
  - the position of the Wing Anti-Ice switch
- on the ground, the wing anti-icing valves are closed

ON -

- in flight with the leading edge flaps retracted, the wing anti-icing valves open to supply bleed air to the left and right wing leading edges. The valves close when the leading edge flaps are extended.
- the flaps down maneuver margin is reduced. The flaps down maneuver margin remains reduced until the airplane is on the ground, regardless of:
  - whether wing icing conditions are no longer detected, or
  - the position of the flaps, or
  - the position of the Wing Anti-Ice switch
- on the ground, the wing anti-icing valves are closed

Anti-Icing Indications on EICAS Display



1 Engine Anti-icing Indication

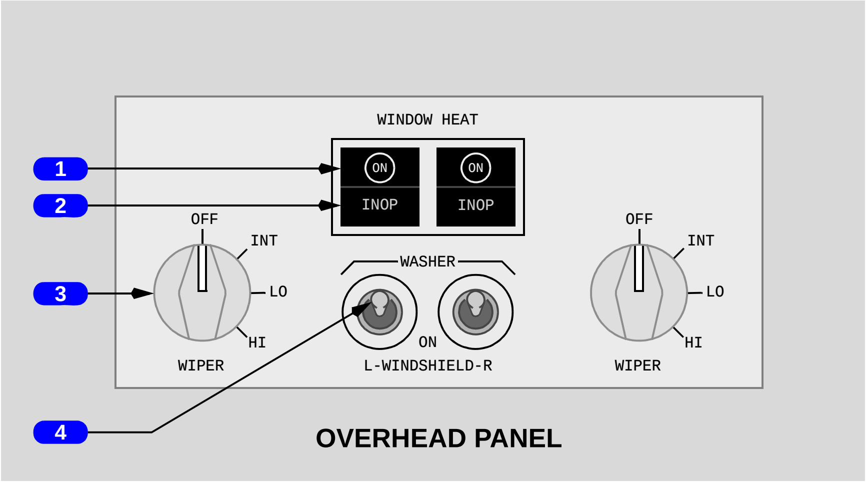
Displayed (green) - the engine anti-icing valve is open.

2 **Wing Anti-Icing Indication**

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

Windshield Heat and Washers

Windshield Heat and Washers Panel



1 **WINDOW HEAT Switches**

ON - controlled heat is applied to the windshield.

2 **WINDOW HEAT Inoperative (INOP) Lights**

Illuminated (amber) -

- a windshield overheat or controller fault has been detected
- power is removed from the windshield

3 **Windshield WIPER Selectors**

OFF -the wipers are off and are sequenced to the stowed position.

INT - the wipers operate intermittently at low speed.

LO - the wipers operate at low speed.

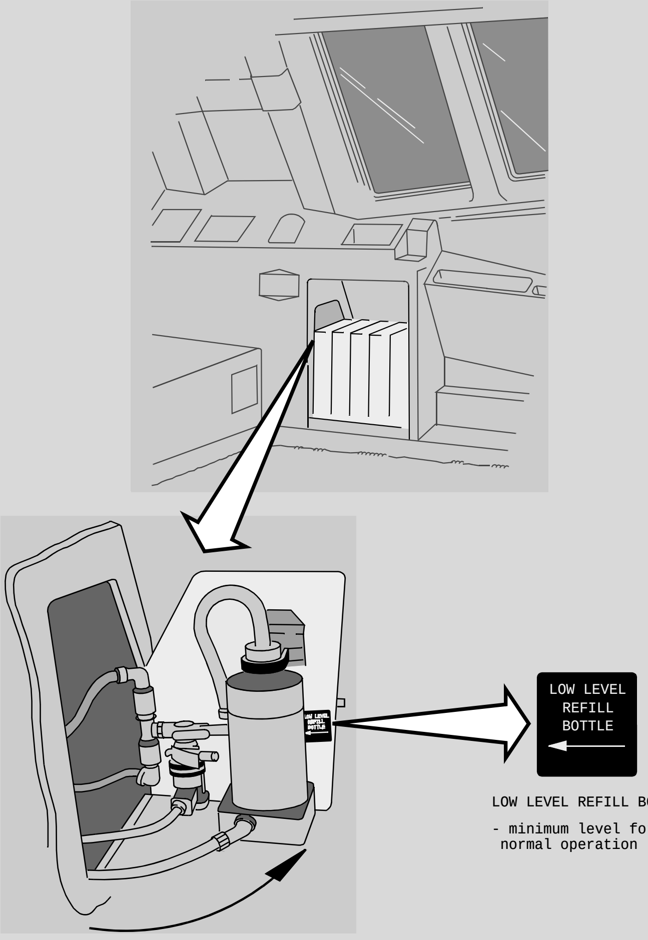
HI - the wipers operate at high speed.

4 **WINDSHIELD L, R WASHER Switches**

Spring loaded to neutral.

ON - applies washer fluid.

Windshield Washer Fluid



LOW LEVEL REFILL BOTTLE

- minimum level for normal operation

**LEFT HAND SIDE PANEL
IN BOOK STOWAGE**

Anti-Ice, Rain — Chapter 3
System Description — Section 20

Introduction

The anti-icing and rain systems include:

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

Anti-Icing Systems

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

Icing Conditions Detection

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

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

When the Wing Anti-Ice switch is in AUTO, system logic includes identification of wing icing conditions for a range of altitudes and air temperatures in which wing icing can occur and wing anti-icing will operate, even though visible moisture is absent.

Engine Anti-Icing

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

In flight, when an Engine Anti-Ice switch is in AUTO and engine icing conditions are detected, the respective engine anti-icing valve is commanded open.

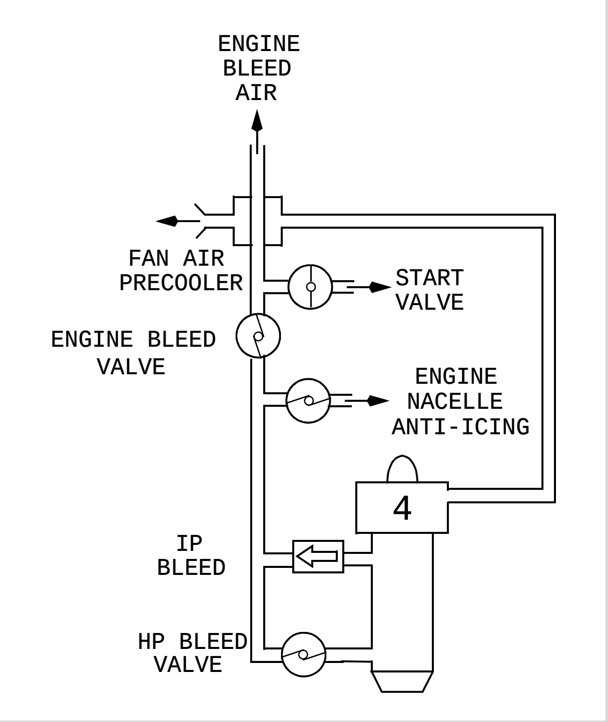
When an engine anti-icing valve is open on the ground, the respective engine booster anti-ice valve is opened.

When an Engine Anti-Ice switch is ON, the respective engine anti-icing valve is commanded open.

When engine anti-icing is commanded on with the engine bleed valve closed, the HP bleed valve remains closed and bleed air is supplied by IP bleed only.

If the EICAS advisory message BLEED HP ENG is displayed, engine bleed air at low thrust settings may be insufficient for engine anti-icing.

Engine Anti-Icing System Diagram



Wing Anti-Icing

In flight, when the wing Anti-Ice switch is in AUTO, the leading edge flaps are retracted, and wing icing conditions are detected, the wing anti-icing valves are commanded open.

In flight, when the wing Anti-Ice switch is ON and the leading edge flaps are retracted, the wing anti-icing valves are commanded open.

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

If the EICAS advisory message BLD LOW TEMP is displayed, engine bleed air is too low for sufficient wing anti-icing.

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 in intermittent, low, and high. 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 gauge and a refill reference mark.

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.

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Anti-Ice, Rain — Chapter 3
EICAS Messages — Section 30

EICAS Alert Messages

Message	Level	Aural	Message Logic
ANTI-ICE	Advisory		Any Engine Anti-Ice switch, or the Wing Anti-Ice switch is ON, and TAT is more than 12°C, and icing conditions do not exist.
EAI VALVE 1, 2, 3, 4	Advisory		Engine anti-icing valve is not in the commanded position.
HEAT L, R TAT	Advisory		TAT probe heat is failed, or the ground/air logic has failed to remove power and the TAT probe is heated on the ground.
HEAT P/S CAPT, F/O, L, R AUX	Advisory		Pitot static probe heat is failed.
HEAT WINDOW L, R	Advisory		Forward window heat is inoperative.
ICE DETECTORS	Advisory		Icing conditions detection system is failed.
ICING	Advisory		Any Engine Anti-Ice switch or the Wing Anti-Ice switch is OFF, and icing conditions exist.
WAI INHIBITED	Advisory		Wing anti-icing is commanded on, when on the ground or when flaps are extended in flight.
WAI SWITCH OFF	Advisory		Wing Anti-Ice switch is OFF.
WAI VALVE LEFT, RIGHT	Caution	Beeper	Wing anti-icing valve is not in the commanded position.

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Automatic Flight — Chapter 4
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Deferred Systems Content

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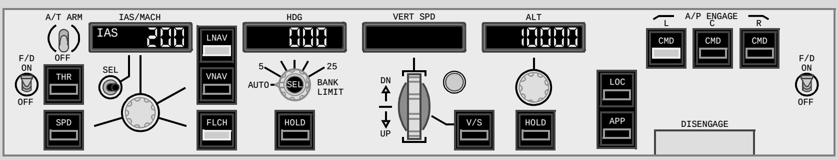
This section contains deferred systems description content.

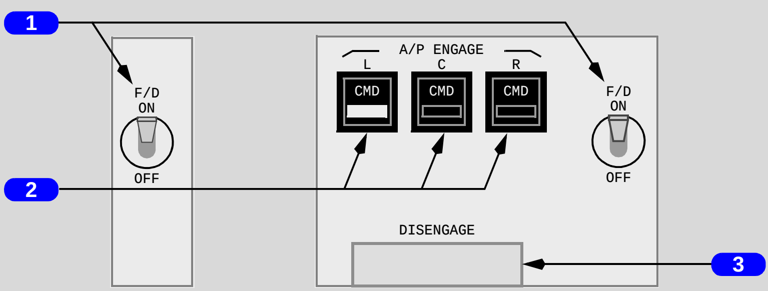
Deferred systems content is indicated by strike-through text. For example, ~~Quiet Climb set to OFF~~

Mode Control Panel (MCP)



GLARESHIELD PANEL

Autopilot Flight Director System (AFDS) Controls



MODE CONTROL PANEL (MCP)

1 Flight Director (F/D) Switches

The left flight director switch activates flight director steering indications on the left primary flight display (PFD). The right flight director switch activates flight director steering indications on the right PFD.

ON -

- on the ground with both flight director switches OFF, the first flight director switch positioned ON arms the flight director in the takeoff go-around (TO/GA) roll and pitch modes. Positioning the second switch ON displays the flight director steering indications on the second PFD
- in flight with the autopilot disengaged and both flight director switches OFF, the first flight director switch positioned ON activates the flight director in:
  - vertical speed (V/S) as the pitch mode, and
  - heading hold (HDG HOLD) as the roll mode; or, if bank angle is greater than five degrees, attitude hold (ATT)

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- in flight with the autopilot engaged and both flight director switches OFF, the first flight director switch positioned ON activates the flight director in the selected autopilot mode(s)

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- in flight with the autopilot engaged and both flight director switches OFF, the first flight director switch positioned ON activates the flight director in the selected autopilot mode(s). Command bars do not display when autopilot and flight director are using the same flight control computer

OFF -

- flight director steering indications do not display, unless
- a TO/GA switch is pushed when airspeed is greater than 80 knots and flaps are out of up

2 Autopilot (A/P) ENGAGE Switches

Push (either switch engages the autopilot) -

- when either flight director switch is ON, the autopilot engages in the selected flight director mode(s)
- when both flight director switches are OFF, the autopilot 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

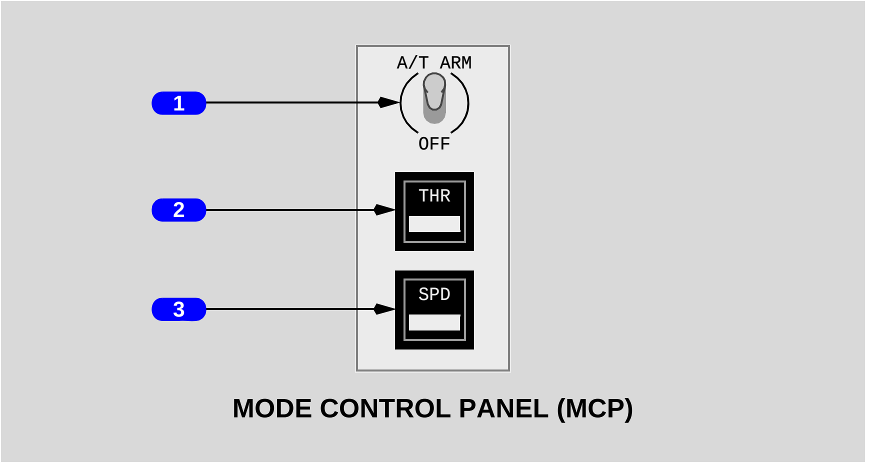
Push down -

- disengages all three A/Ps
- prevents autopilot engagement
- exposes amber stripe

Lift up -

- enables autopilot 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 OFF and back to ARM activates the A/T

OFF -

- disconnects autothrottle
- disables autothrottle 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

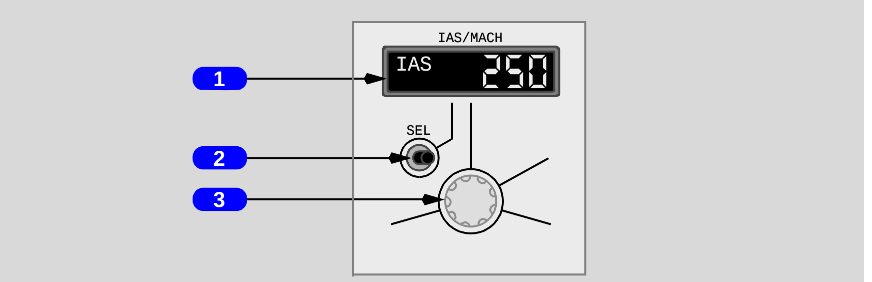
3 Speed (SPD) Switch

Operative from 400 feet after takeoff until landing.

Push (light illuminates) -

- selects A/T SPD mode
- displays SPD on both PFDs
- autothrottle controls thrust to maintain IAS or Mach displayed in IAS/MACH window subject to minimum and maximum speed limits
- inactive in VNAV XXX, FLCH SPD, or TO/GA pitch modes

Autopilot Flight Director IAS/Mach Controls



MODE CONTROL PANEL (MCP)

1 IAS/MACH Window

IAS/Mach window and PFD speeds set to 200 knots when power first applied.

Displays selected speed when speed intervention is active. IAS/MACH selector may be used to set command speed.

IAS/MACH window open if pitch mode is FLCH SPD, V/S , TO/GA, ALT, or G/S.

When FMC target speed is active, window is closed.

Display range:

- 100 - 399 KIAS
- .400 - .950 Mach, three digit Mach displayed

Displays selected speed on PFD.

In climb, changes from IAS to Mach at approximately .840 Mach.

In descent, changes from Mach to IAS at approximately 310 knots.

2 IAS/MACH Select (SEL) Switch

Push -

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

3 IAS/MACH Selector

Push - with VNAV active, alternately opens or closes the IAS/MACH window.

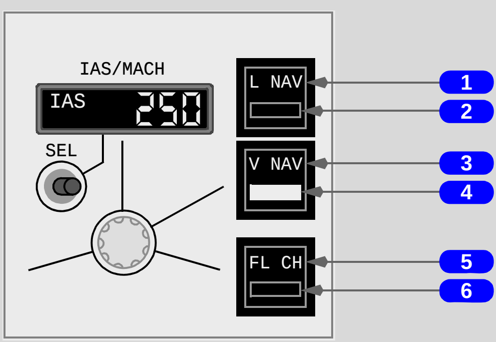
When the window is closed, FMC computed target speed is active and displays on both PFDs.

When the window is open, FMC speed-intervention is active and the IAS/MACH selector may be used to set the desired speed.

Rotate -

- sets speed in IAS/MACH window and command speed on both PFDs. When VNAV active and in descent phase, setting a speed changes the FMC target speed. The reset speed is retained as the FMC target speed when closing the window.
- inoperative when IAS/MACH window closed

Autopilot Flight Director Roll and Pitch Controls



MODE CONTROL PANEL (MCP)

1 Lateral Navigation (L NAV) 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 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 annunciation
- selection of LNAV with the airplane not on a heading to intercept the active leg, displays NOT ON INTERCEPT HEADING in the CDU scratchpad
- LNAV maintains current heading when:
  - passing last active route waypoint
  - passing last waypoint prior to a route discontinuity
  - passing 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 no end-of-descent point in descent) displays PERF/VNAV UNAVAILABLE in CDU scratchpad
- VNAV SPD, VNAV PTH, or VNAV ALT pitch mode displays in green (active) on PFD pitch flight mode annunciation
- in VNAV SPD pitch mode, AFDS commands pitch to hold target airspeed. The autothrottle 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; autothrottle operates in speed (SPD) mode
- in VNAV ALT pitch mode, AFDS commands pitch to maintain MCP selected altitude; A/T operates in SPD mode
- VNAV pitch guidance available with one or two engines inoperative

Note: In VNAV, if a conflict exists between the VNAV profile and the MCP altitude, the airplane levels and the pitch flight mode annunciation becomes VNAV ALT. Resetting the MCP altitude window and pushing the Altitude selector continues the climb or descent. If below the VNAV path, resetting the MCP altitude window and intercepting the VNAV path will also continue the descent.

VNAV deactivated:

- by selecting TO/GA, FLCH SPD, V/S, ALT, or G/S pitch mode
- 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 (FL CH) Switch

Push -

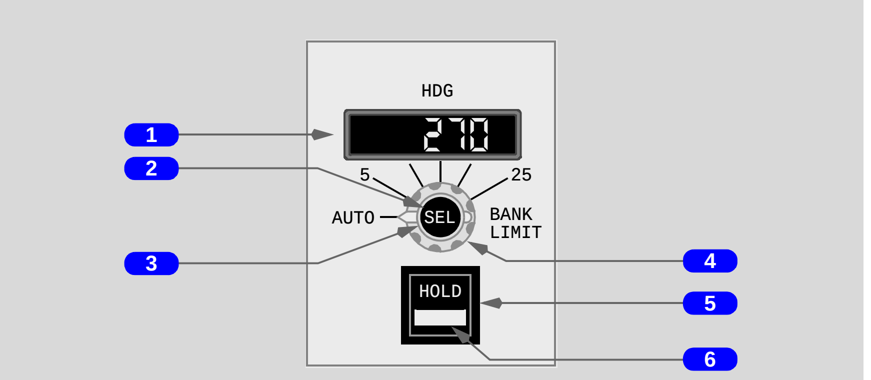
- selects FLCH SPD pitch mode
- FLCH SPD pitch mode displays in green (active) on PFD flight mode annunciation
- when IAS/MACH window closed, IAS/MACH window opens to FMC target speed, if valid. If not valid, IAS/MACH window opens to current speed
- when IAS/MACH window open, it displays command speed
- when changing from TO/GA to FLCH, IAS/MACH window displays highest value of current airspeed or selected speed

- AFDS pitch holds MCP selected speed. When MCP selected altitude captured, pitch flight mode annunciation changes to ALT
- A/T operates in THR, followed by HOLD mode in descent. When MCP selected altitude captured, A/T mode changes to SPD
- A/T advances or retards thrust levers to provide 500 FPM vertical speed for each 1000 feet altitude change
- AFDS attempts to reach the MCP selected altitude within two minutes if able with available thrust. Otherwise, A/T uses IDLE or CLB thrust to reach the MCP selected altitude
- with a higher altitude set in the ALT window, reference thrust limit changes to CLB when CRZ displayed and to CON with an engine inoperative

6 Flight Level Change Light

Illuminated - flight level change pitch mode active.

Autopilot Flight Director Heading and Bank Angle Controls



MODE CONTROL PANEL (MCP)

1 Heading (HDG) Window

Displays selected heading.

Displays selected heading on PFDs and NDs.

HDG window, PFD, and ND headings set to 000 when power first applied.

Changes to the approach course at LOC or FAC 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

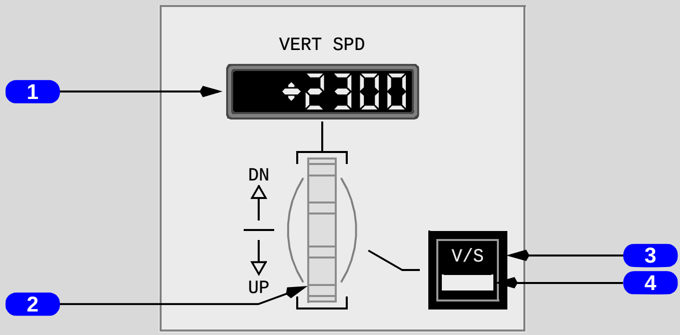
Push -

- selects heading hold (HDG HOLD) roll mode
- HDG HOLD roll mode displays in green (active) on PFD roll flight mode annunciation
- AFDS commands wings level and holds heading

6 Heading Hold Light

Illuminated - HDG HOLD roll mode active.

Autopilot Flight Director Vertical Speed (V/S) Controls



MODE CONTROL PANEL (MCP)

1 Vertical Speed (VERT SPD) Window

Blank when vertical speed (V/S) pitch mode not selected.

Displays current V/S when V/S pitch mode selected.

Displays selected V/S in 100 fpm increments.

Display range is -8000 to +6000 fpm.

Vertical speed displays on the PFD V/S indication.

2 Vertical Speed (V/S) Selector

UP or Down (DN) - sets V/S in VERT SPD window and on both PFDs.

3 Vertical Speed (V/S) Switch

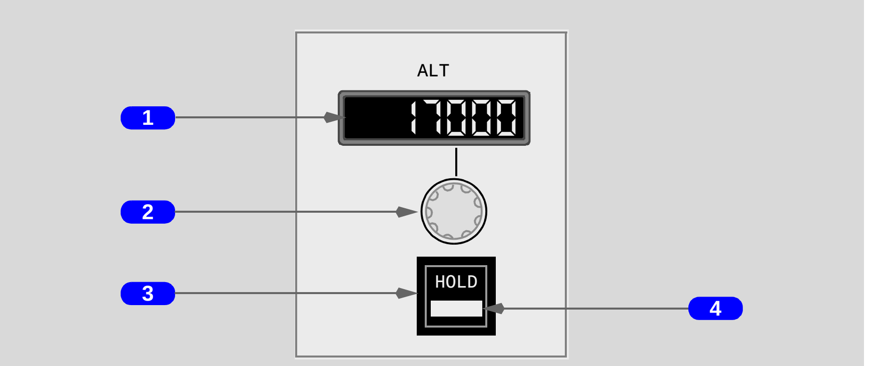
Push -

- selects V/S pitch mode
- V/S pitch mode displays in green (active) on PFD pitch flight mode annunciation
- displays current V/S in V/S window
- AFDS pitch maintains V/S displayed in the V/S window. When selected altitude reached, pitch flight mode annunciation changes to ALT
- A/T operates in speed (SPD) mode, if armed

4 Vertical Speed (V/S) Light

Illuminated - vertical speed pitch mode is active.

Autopilot Flight Director Altitude Controls



MODE CONTROL PANEL (MCP)

1 Altitude (ALT) Window

Displays selected altitude in 100 feet increments. Display range is 0 to 50000 feet.

Displays selected altitude on PFDs.

Displayed altitude is reference altitude for altitude alerting and level off.

ALT window and PFD altitudes set to 10000 feet when power first applied.

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

2 Altitude Selector

Rotate - sets altitude in ALT window and selected altitude on both PFDs.

Push -

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

3 Altitude HOLD Switch

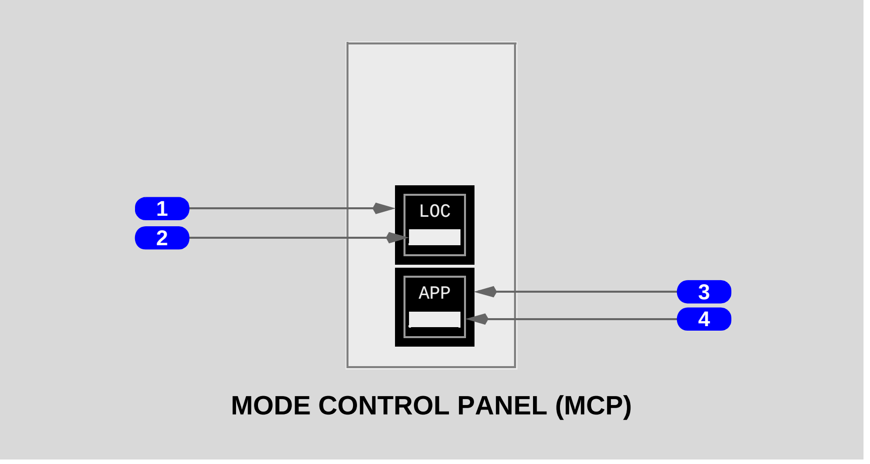
Push -

- 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, or captures localizer or IAN final approach course as roll mode
- displays LOC, FAC, or B/CRS in white (armed) on PFD roll flight mode annunciations before localizer or final approach course capture
- displays LOC, FAC, or B/CRS in green (active) on PFD roll flight mode annunciations after localizer or final approach course capture
- arms AFDS to capture and track inbound on front course or IAN final approach course
- capture point varies based on range and intercept angle
- localizer or final approach course capture can occur when intercept track angle is within 120 degrees of the localizer or final approach course

Note: After localizer or final approach course capture, flight director roll commands may appear inconsistent with A/P roll maneuvers for one to two minutes.

LOC or FAC mode can be disarmed before localizer or final approach course capture by:

- pushing localizer switch a second time, or
- selecting LNAV

LOC or FAC mode can be deactivated after localizer or final approach course 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 - approach modes (LOC or FAC) armed or active.

3 Approach (APP) Switch

Push -

- arms, disarms, or captures localizer (LOC) or final approach course (FAC) as roll mode and glideslope (G/S) or glidepath (G/P) as pitch mode
- displays LOC (or FAC) and G/S (or G/P) in white (armed) on PFD roll and pitch flight mode annunciations before localizer (or final approach course) and glideslope (or glidepath) capture
- displays LOC (or FAC) and G/S (or G/P) 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

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- either localizer (or final approach course) or glideslope (or glidepath) can be captured first
- localizer (or final approach course) captures when intercept track angle is within 120 degrees of localizer (or final approach) course

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- glideslope (or glidepath) captures when intercept track angle is within 80 degrees of localizer course

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- glideslope (or glidepath) capture is inhibited until localizer capture (or final approach course) and intercept track angle is within 80 degrees of localizer (or final approach) course

Note: After localizer (or final approach course) 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 final approach course) or glideslope (or glidepath) capture by:

- pushing approach switch a second time, or
- selecting LOC, LNAV, or VNAV

Approach mode deselects:

- with localizer (or final approach course) captured and glideslope (or glidepath) armed, by selecting another roll mode other than LNAV; by selecting LOC mode initiates a localizer approach; by selecting APP, roll mode changes to HDG HOLD

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- with glideslope (or glidepath) captured and localizer (or final approach course) armed, by selecting another pitch mode other than VNAV; by selecting APP, pitch mode changes to V/S
- after localizer (or final approach course) and/or glideslope (or glidepath) are captured, by selecting TO/GA mode or disengaging autopilot and positioning both F/D switches off

4 Approach Light

Illuminated - approach modes (LOC or FAC and G/S or G/P) armed or active.

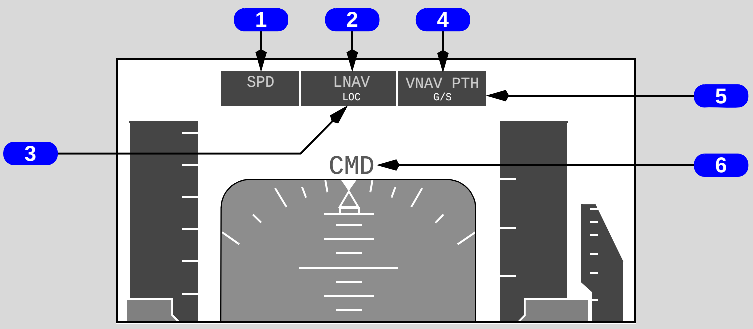
PFD Flight Mode Annunciations (FMAs)

Note: When first activated, autothrottle, 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 the autopilot is engaged and a flight mode fault is detected.

Note: NO AUTOLAND displays on the PFD if failures cause the system to degrade from multi-channel engage status (LAND 3 or LAND 2) to single channel status during an autoland. The mode change is emphasized for 10 seconds by an amber box.

NO AUTOLAND also displays on PFD if multi-channel approach selected but multi-channel engage status (LAND 3 or LAND 2) has not been annunciated by 600 feet AGL. Under these conditions, flare and rollout modes are not armed.



PFD

1 Autothrottle Modes (Active)

Displayed (green) -

- THR
- THR REF
- HOLD
- IDLE
- SPD

2 AFDS Roll Modes (Active)

Displayed (green) -

- HDG HOLD
- HDG SEL
- LNAV
- LOC
- FAC
- ROLLOUT
- TO/GA
- ATT
- B/CRS

3 AFDS Roll Modes (Armed)

Displayed (white) -

- LOC
- FAC
- ROLLOUT
- LNAV
- B/CRS

4 AFDS Pitch Modes (Active)

Displayed (green) -

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

5 AFDS Pitch Modes (Armed)

Displayed (white) -

- G/S
- G/P
- FLARE
- VNAV

6 AFDS (Active)

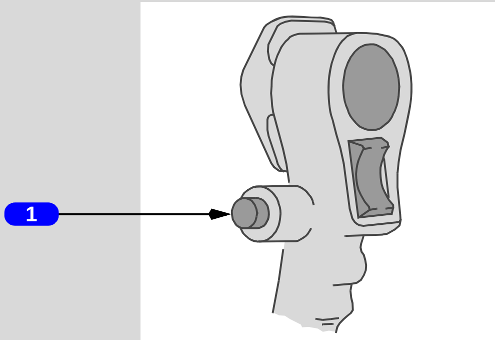
Displayed (green) -

- FD
- CMD
- LAND 3
- TEST

Displayed (green with white triangles) - ▷LAND2◁

Displayed (amber) - NO AUTOLAND

Autopilot Disengage Switch



CONTROL WHEELS

1 Autopilot Disengage 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

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- sounds a siren aural warning

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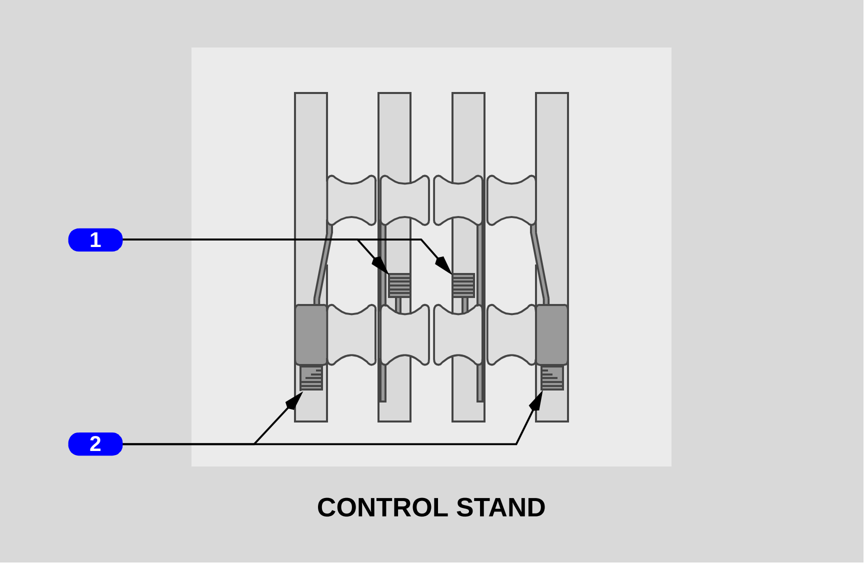
- sounds a wailer aural warning for a minimum of one second

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) -

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- removes takeoff and climb derates and assumed temperature thrust reduction; ~~Quiet Climb set to OFF~~

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- removes takeoff and climb derates and assumed temperature thrust reduction; Quiet Climb set to OFF
- 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/glidepath captured) -

- activates A/T in THR mode with GA reference thrust limit displayed. Thrust adjusts to provide a 2000 feet per minute climb
- selects TO/GA roll and pitch modes
- activates F/D with no A/P or F/D active
- arms or activates LNAV if an LNAV path is available

Second push (go-around active with flaps out of up, LNAV armed, TO/GA roll and pitch mode) - activates autothrottle in THR REF using GA reference thrust, or

Second push (go-around active with flaps out of up, LNAV active, TO/GA pitch mode) - activates autothrottle in THR REF using GA reference thrust, roll mode remains LNAV, or

Second push (go-around active with flaps out of up, HDG SEL or HDG HOLD active, TO/GA pitch mode) - activates autothrottle in THR REF using GA reference thrust, selects TO/GA roll and pitch modes

2 Autothrottle Disconnect Switches

Push (either switch) -

- disconnects autothrottle
- illuminates master caution lights
- displays the EICAS caution message AUTOTHROT DISC
- if autothrottle automatically disconnects, resets master caution lights and EICAS message

Second push - resets master caution lights and EICAS message.

Autothrottle remains armed.

Intentionally
Blank

Deferred Systems Content

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This section contains deferred systems description content.

Deferred content is printed with strike-through text. For example, ~~Quiet Climb set to OFF~~

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 (AFDS)

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 occur only during a multi-A/P approach. Nose wheel steering is available during rollout from an automatic landing. During an approach with all three A/Ps engaged, separate electrical sources power the 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 to indicate the mode is armed or active. PFD roll and pitch flight mode annunciations indicate mode activation. 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, and below 1500 ft AGL, the localizer and glideslope modes can 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 respective command bar to disappear.

Flight Director Display

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The flight director steering indications normally display any time the respective Flight Director switch is ON.

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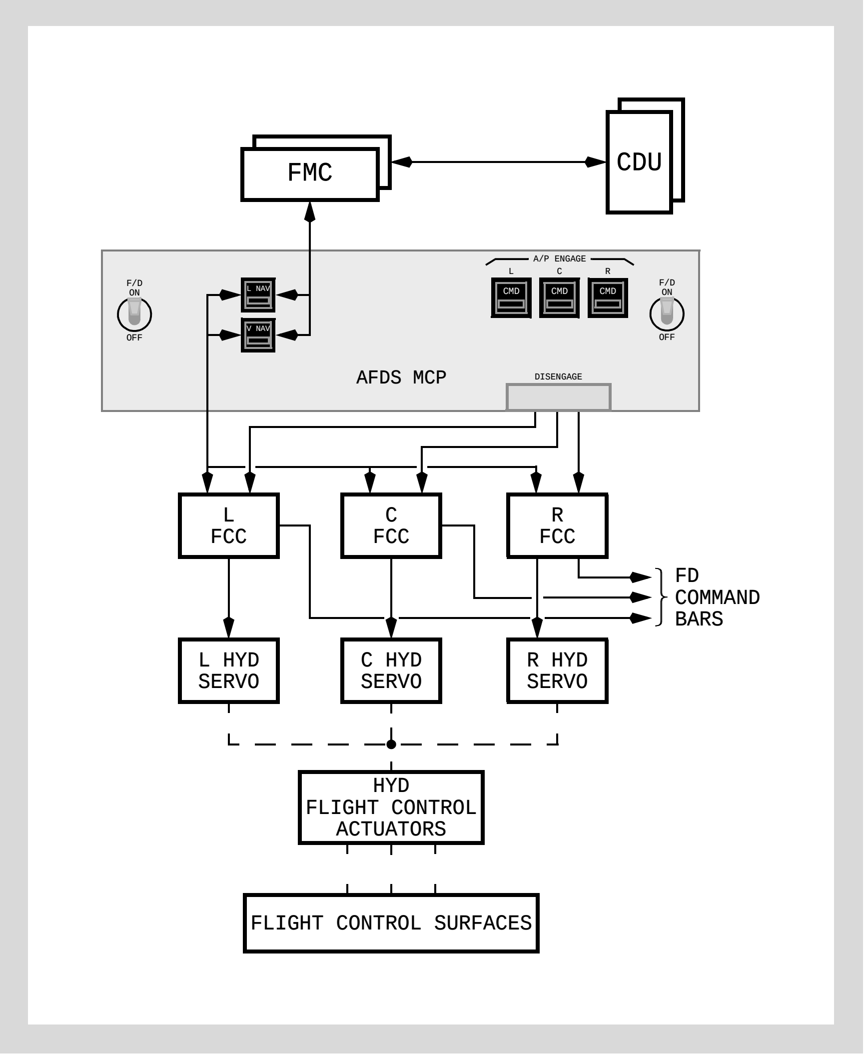
The flight director steering indications normally display any time the respective Flight Director switch is ON and the selected flight director source is not the same as the engaged autopilot.

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 radio altitude, 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 annunciation 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

FAC -

- FAC - (armed) - AFDS set to capture the IAN final approach course
- FAC - (active) - AFDS tracks the IAN inbound final approach course

TO/GA -

- On the ground, TO/GA annunciates by positioning either Flight Director switch ON when both flight directors are OFF. TO/GA roll guidance becomes active at lift-off
- In flight, TO/GA is armed when flaps are out of up or glideslope is captured. There is no flight mode annunciation for TO/GA armed. TO/GA is activated in flight by pushing a TO/GA switch. The roll steering indication provides guidance to maintain the ground track present at mode engagement

ROLLOUT -

- ROLLOUT (armed) - displays below 1,500 feet radio altitude and activates below 5 feet
- ROLLOUT (active) - after touchdown, AFDS uses rudder and nosewheel steering to steer the airplane on the localizer centerline

Pitch Modes

Pitch annunciations are:

TO/GA -

- On the ground, TO/GA annunciates by positioning either Flight Director switch ON when both flight directors are OFF. The flight director pitch bar indicates an initial pitch of eight degrees up. TO/GA pitch guidance becomes active at 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 when 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 closed). 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 closed). 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:

- G/S (armed) - AFDS armed to capture the ILS or GLS glideslope
- G/S (active) - AFDS follows the ILS or GLS glideslope

G/P - AFDS follows the IAN glidepath:

- G/P (armed) - AFDS armed to capture the IAN glidepath
- G/P (active) - AFDS follows the IAN glidepath

FLARE -

- FLARE (armed) - during autoland, FLARE displays below 1,500 feet radio altitude
- FLARE (active) - during autoland, flare activates between 60 and 40 feet radio altitude. FLARE deactivates at touchdown and the nosewheel smoothly lowers to the runway

Autothrottle System

The autothrottle system provides thrust control from takeoff through landing.

Autothrottle operation is controlled from the MCP and the CDUs. The MCP allows mode and speed selection. The CDU allows FMC reference thrust limit selection. When a pitch mode is active, FMC selects autothrottle modes and target thrust values. Refer to Chapter 11, Flight Management, Navigation, for FMS and CDU operation.

The autothrottle can be operated without using the flight director or the autopilot.

When autothrottle is used during manual landing, thrust reduces to IDLE at 25 feet radio altitude when the pitch mode is VNAV SPD, VNAV PTH, V/S, or G/S. The autothrottle does not retard if pitch mode is TO/GA or FLCH.

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. During conditions that cause the autothrottle to automatically activate, the autothrottle can be disconnected and automatic activation prevented by positioning the Autothrottle Arm switch to OFF. 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. Switching between FMCs with the autothrottle active causes the autothrottle to disconnect; the autothrottle 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, annunciation 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:

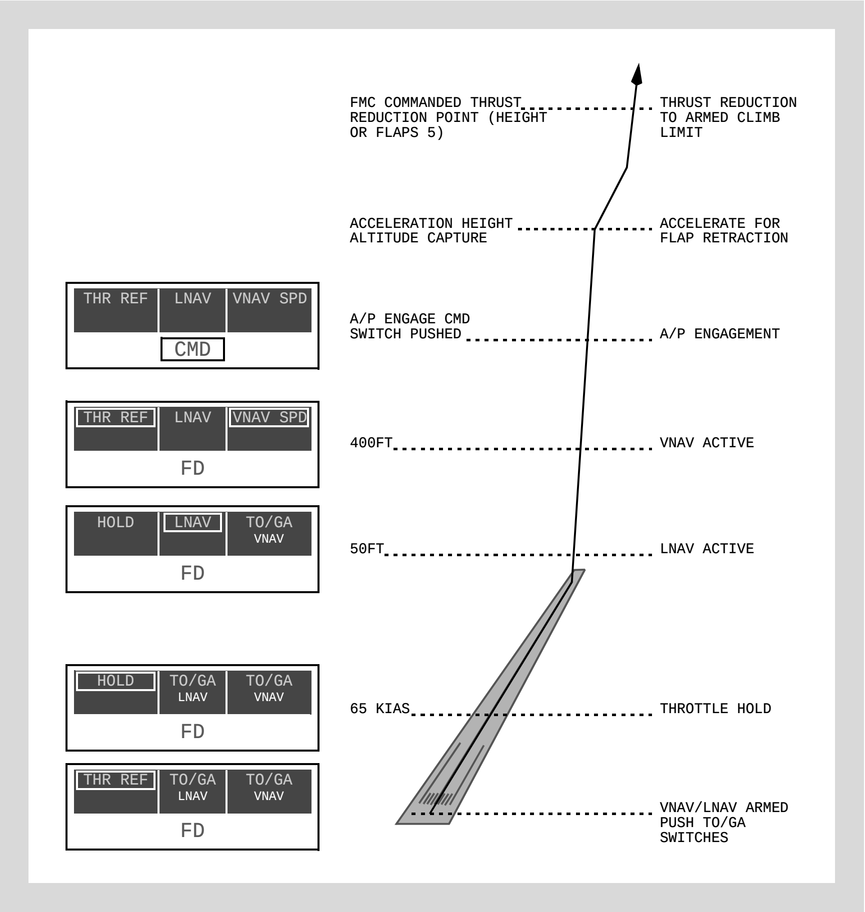
  914
  - removes takeoff and climb derates and assumed temperature thrust reduction; ~~Quiet Climb set to OFF~~

806

  - removes takeoff and climb derates and assumed temperature thrust reduction; Quiet Climb set to OFF
  - 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:
  - flaps up maneuver speed + 20 kts, 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 approaches.

914
Pushing the APP switch arms localizer (or final approach course) in roll mode and glideslope (or glidepath) in pitch mode. Either localizer (or final approach course) or glideslope (or glidepath) can be captured first.

806
Pushing the APP switch arms localizer (or final approach course) in roll mode and glideslope in pitch mode. Glideslope capture is inhibited until the localizer (or final approach course) is captured.

Pushing the LOC switch arms only the localizer. Localizer capture can occur when the intercept angle is less than 120 degrees.

Integrated Approach Navigation

Integrated Approach Navigation (IAN) allows the use of consistent procedures for all types of instrument approaches. Any approach having a Glide Path Angle (GP) published in the navigation database can be flown using procedures, indications, and alerts similar to those used for an ILS approach.

Approaches flown with IAN procedures always use FMC computed glidepath (G/P) for vertical path guidance. Depending on the type of approach flown, lateral guidance is from the FMC or localizer.

Roll and Pitch Modes for IAN			
Type of Approach	**Roll Mode**	**Pitch Mode**	**Notes**
B/CRS	B/CRS	G/P	
GPS	FAC	G/P	
IGS	LOC	G/P	G/S must be selected OFF
ILS	LOC	G/P	G/S must be selected OFF
LDA	LOC	G/P	G/S must be selected OFF
LOC	LOC	G/P	
NDB	FAC	G/P	
RNAV	FAC	G/P	
SDF	LOC	G/P	G/S must be selected OFF
VFR	FAC	G/P	
VOR	FAC	G/P	

IAN requires using the APP (or LOC for roll mode) switch on the MCP to arm the roll and pitch modes as the airplane nears the final approach seqment. Approaches are flown to published minimums using normal flight director guidance.

IAN does not support automatic landings, the pilot flying must disengage the autopilot and complete the landing manually. A NO AUTOLAND annunciation displays on the PFD if the autopilot remains engaged below 100 feet RA.

Runway Alignment and Asymmetric Thrust Compensation

AFDS controls the rudder during multiple autopilot approaches to compensate for crosswind landings and engine-out asymmetric thrust conditions. With LAND 2 or LAND 3 annunciated, autopilot 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 autopilots 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:

- between 30 and 15 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.

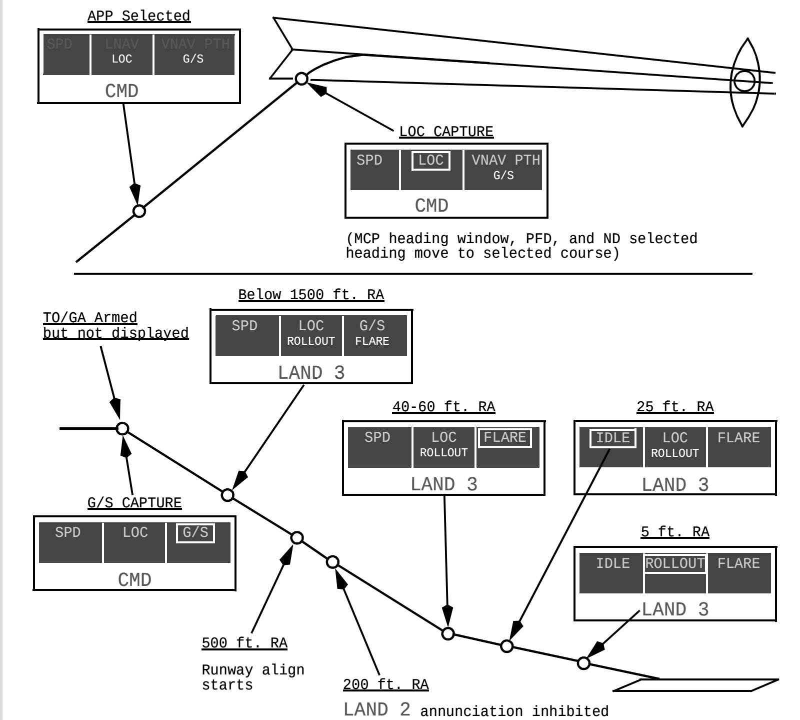
The autopilot controls rudder and nose wheel steering to track the localizer centerline.

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 off, pushing either TO/GA switch displays the Flight Director Bars.

An automatic go-around cannot be initiated after touchdown.

With the first push of either TO/GA switch:

- roll and pitch activate in TO/GA
- autothrottle activates in thrust (THR) to establish a 2,000 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.

When an LNAV path is available, LNAV activates above 50 feet RA with no autopilot engaged; and above 200 feet RA, LNAV activates with an autopilot engaged. TO/GA remains the active roll mode until LNAV automatically activates or another mode is selected.

Note: Automatic activation of LNAV following TO/GA from a LAND 2 or LAND 3 approach causes the autopilot to discontinue control of the rudder. During an engine out missed approach, manual control of the rudder may be necessary to prevent large roll and yaw excursions.

TO/GA level-off:

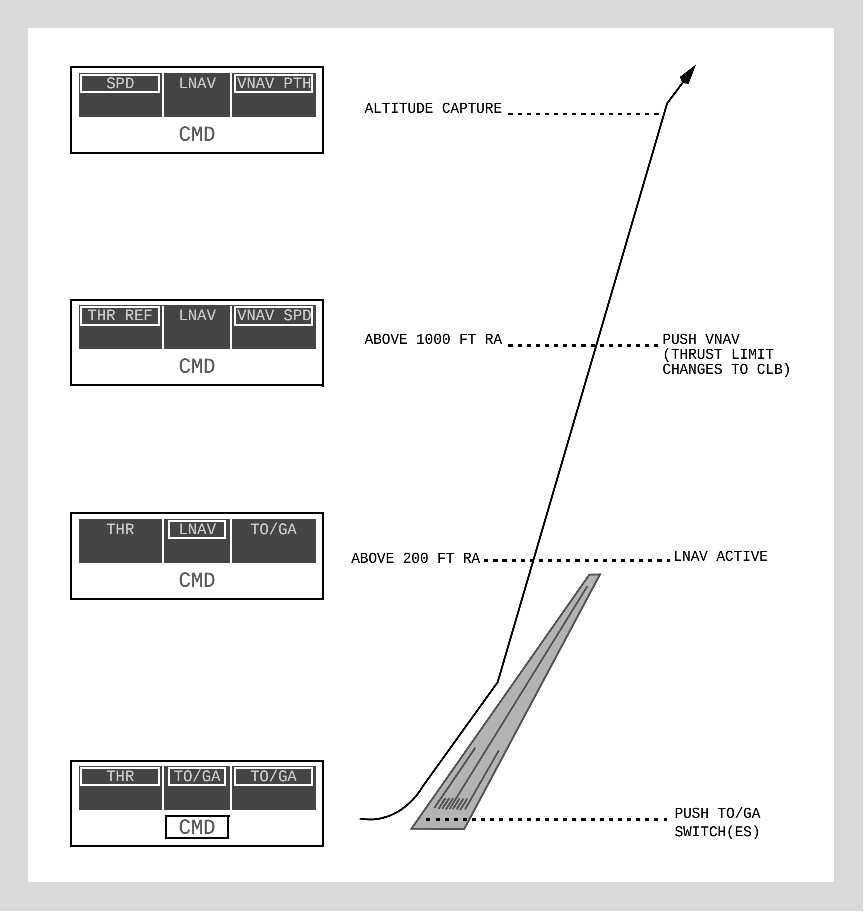
- when reaching the altitude set in the Altitude window, the AFDS pitch flight mode annunciation changes to altitude hold (ALT); all autopilots, except first in command (CMD), disengage
- A/T remains in THR or THR REF until SPD mode is selected. Speed protection prevents exceeding the maximum operating, gear extended, or flap placard speed

TO/GA mode termination:

- below 400 feet radio altitude, disengage autopilot and turn off both flight directors, or automatic LNAV activation (after automatic LNAV activation, a different roll mode can be selected)
- above 400 feet radio altitude, select a different roll or pitch mode; all autopilots, except first in CMD, disengage

If autopilot systems are compensating for an asymmetric thrust condition when they revert to a single autopilot 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).

With the autopilot not engaged when go-around is initiated, the pilot must fly the windshear recovery following the flight director commands. With the autothrottle 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 vertical speed 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.

With A/T armed, the A/T automatically activates if no autopilot or F/D active, or an autopilot or F/D is in VNAV PTH, VNAV ALT, ALT, V/S, or G/S, and:

- speed less than an FMC calculated value for one second
- thrust below reference thrust
- airplane altitude above 100 feet RA on approach, or airplane barometric altitude 400 feet above airport on takeoff

Note: During a descent in VNAV SPD, the autothrottle may activate in HOLD mode. In this mode, it does not provide stall protection.

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.

Intentionally
Blank

EICAS Alert Messages

Message	Level	Aural	Message Logic
AUTOPILOT	Caution	Beeper	Selected autopilot operating in degraded mode. Active roll and/or pitch mode may have failed.

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AUTOPILOT DISC	Warning	Siren	All engaged autopilots have disengaged.

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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 2 or LAND 3 annunciates. Message is an advisory if fault occurs before LAND 2 or LAND 3 annunciates.
NO AUTOLND GLS	Advisory		Loss of GLS autoland capability before LAND 2 or LAND 3 annunciates.
NO AUTOLND ILS	Advisory		Loss of ILS autoland capability before LAND 2 or LAND 3 annunciates.

Message	Level	Aural	Message Logic
NO LAND 3			Autoland system does not have redundancy for triple channel autoland.
	Caution	Beeper	Message is a caution if fault occurs after LAND 3 annunciates.
	Advisory		Message is an advisory if fault occurs before LAND 3 annunciates.
NO LAND 3 GLS	Advisory		Loss of triple channel redundancy for GLS autoland while not in approach mode.
NO LAND 3 ILS	Advisory		Loss of triple channel redundancy for ILS autoland while not in approach mode.

Communications — Chapter 5
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Audio Control Panel

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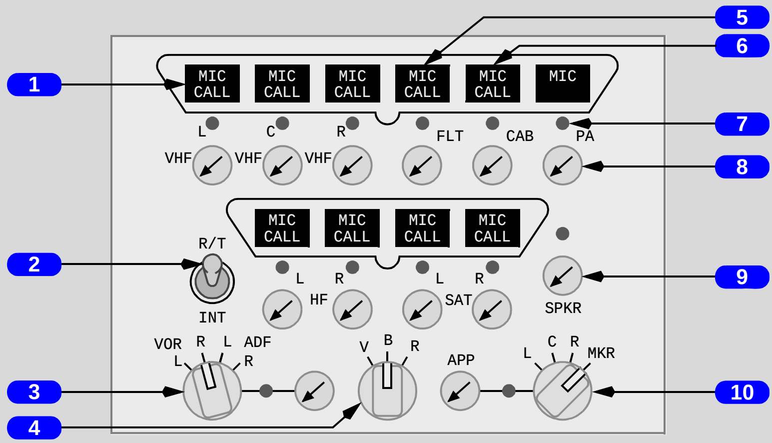

AFT AISLE STAND AND OBSERVER’S PANEL

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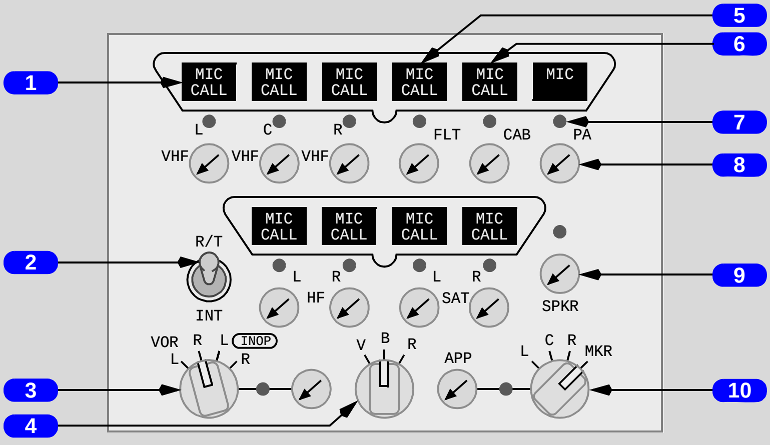

AFT AISLE STAND AND OBSERVER'S PANEL

1 Transmitter Select Switches

Push -

- MIC light illuminates
- MIC light for any other transmitter extinguishes
- selects respective transmitter (radio or intercommunications) for transmission from this crew station (only one can be selected at a time for each crew station)
- selects receiver audio on, if not previously selected on manually

806

- pushing CAB transmitter select switch twice within three seconds places a priority call to a selected cabin station

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.

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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

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3 VOR Receiver Selector

Selects VOR receiver to be monitored:

- VOR L - left VOR
- VOR R - right VOR

4 Navigation Filter Selector

914
Filters VOR, ADF, or ILS audio:

806
Filters VOR 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:

806
- cabin interphone (CAB)
- flight interphone (FLT)

914
- upper deck crew rest area (FLT)

914
- main deck cargo area (FLT)
- SATCOM (SAT)
- SELCAL (VHF or HF)

Resets when respective transmitter select switch pushed or; when already pushed, by pressing a MIC/INTERPHONE switch.

SATCOM CALL light remains illuminated until call ends.

PA does not have a call indication.

7 Receiver Lights

Illuminated (green) - indicates respective receiver audio manually selected on.

8 Receiver Volume Controls

Push - selects respective receiver audio on.

Rotate - controls receiver volume.

Second push - deselects respective receiver audio.

Note: Will not select off when respective transmitter selected ON or 121.500 tuned in radio tuning panel Active Frequency window.

9 Captain and First Officer Speaker (SPKR) Volume Control

Push - turns respective flight deck speaker on.

Rotate - controls flight deck speaker volume.

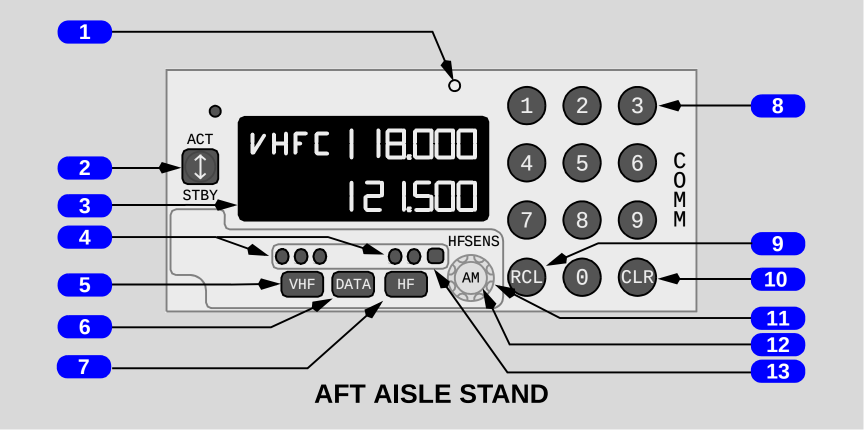
Second push - deselects respective receiver audio.

10 Approach (APP) Receiver Selector

Selects approach receiver to be monitored:

- APP L - left ILS
- APP C - center ILS
- APP R - right ILS
- MKR - marker beacon

Radio System
Radio Tuning Panel



1 Offside Tuning Light

Illuminated (white) - 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

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 Frequency Transfer Switch

Push -

- transfers STBY frequency/channel to ACT frequency/channel and tunes the selected radio to the new active frequency/channel
- transfers ACT frequency/channel to STBY frequency/channel

806
- can reconfigure any or all VHF radio(s) to the data mode

914
- can reconfigure any or all radio(s) to the data mode

3 Active (ACT)/Standby (STBY) Frequency Window

Displays radio selection and tuned frequencies/channels.

4 VHF/HF Selected Radio Lights

Illuminated (green) - indicates VHF-L, -C, or -R, or HF-L or -R radio selected.

5 VHF Select Switch

Push - selects VHF-L, -C, or -R radio.

Push and hold - removes automatic squelch on selected VHF radio until switch is released.

6 Data Switch

Push - selects standby VOICE or DATA for VHF and HF radios.

7 HF Select Switch

Push - selects HF-L or -R radio.

8 Numeric Keypad

Push - selects frequency/channel digit.

9 Recall (RCL) Key

Push - recalls the last selected frequency/channel.

10 Clear (CLR) Key

Push - clears last selected digit.

Push and hold - clears all selected digits.

11 HF Sensitivity (SENS) Control

Rotate - adjusts sensitivity of selected HF receiver.

12 AM Switch

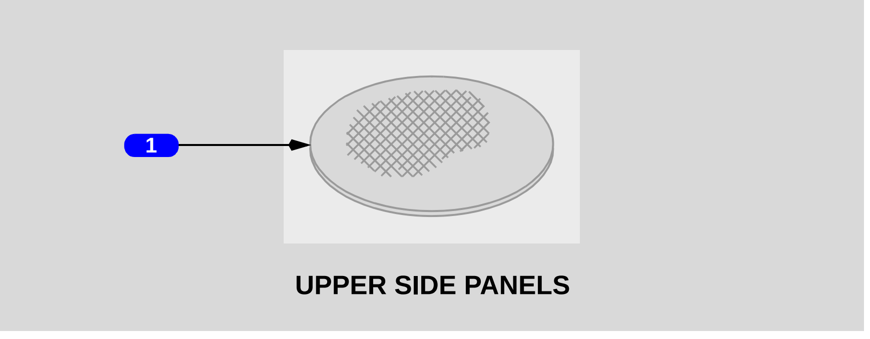
Push - sets AM (amplitude modulation) or USB (upper side band) mode for selected HF radio.

13 AM Light

Illuminated (green) - HF AM selected.

Extinguished - HF USB selected.

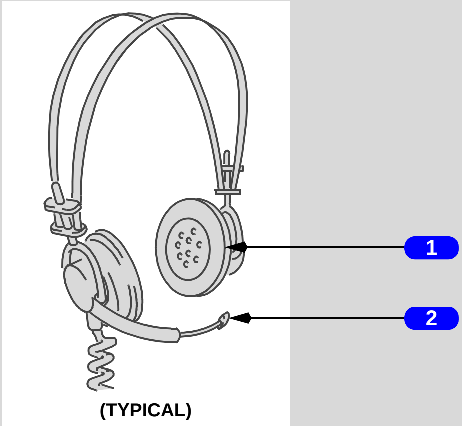
Miscellaneous Communication Controls
Flight Deck Speaker



1 Flight Deck Speaker

Controlled by speaker volume control on respective audio control panel.

Headphone/Boom Microphone



SIDEWALL PANELS

1 Headphone

Used to monitor audio from respective audio control panel.

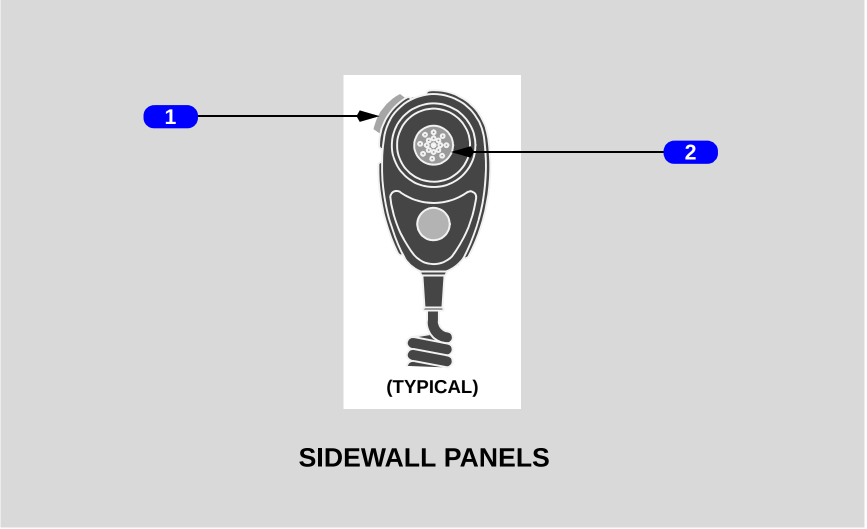
Audio volume adjusted using audio control panel controls for the respective station.

Available at all four flight deck stations.

2 Boom Mic

Activation of a control wheel, glareshield, or audio control panel mic/interphone switch transmits on the system selected for use at that station.

Hand Microphone



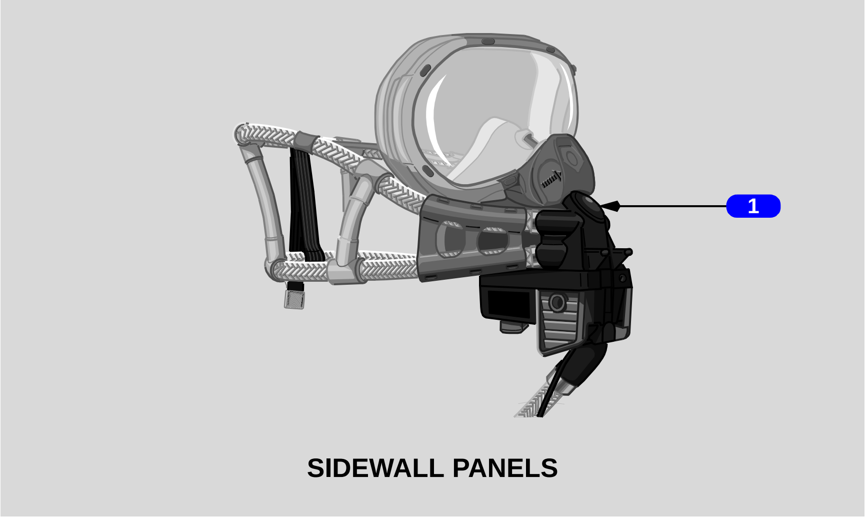
1 Hand Microphone Push To Talk Switch

Push - activates hand microphone.

2 Hand Microphone

Transmits on system selected by audio control panel.

Oxygen Mask Microphone

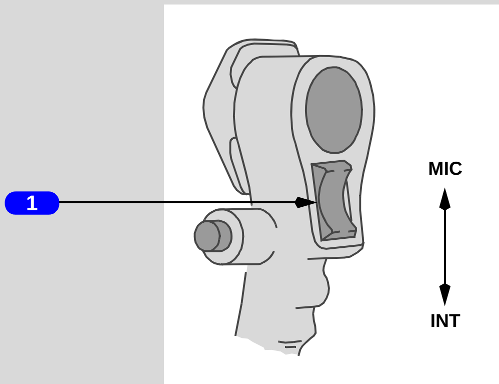


1 Oxygen Mask Microphone

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



CONTROL WHEELS

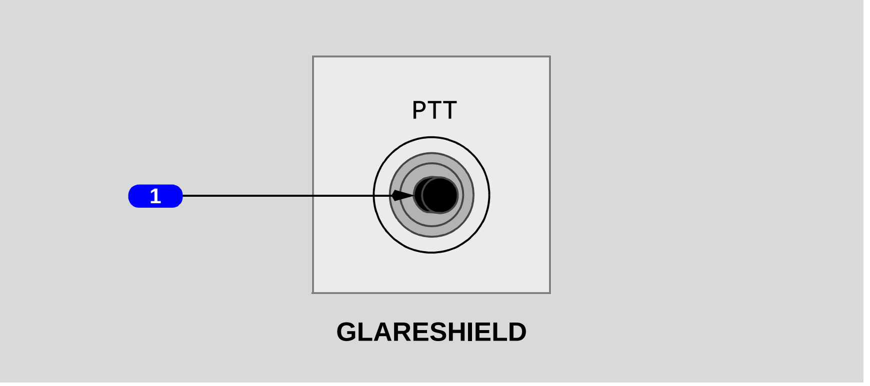
1 Control Wheel Mic/Interphone Switch

MIC - allows oxygen mask or boom microphone transmission on selected transmitter. Spring-loaded to center.

Center - off position.

INT - allows oxygen mask or boom microphone transmission on flight interphone system. 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

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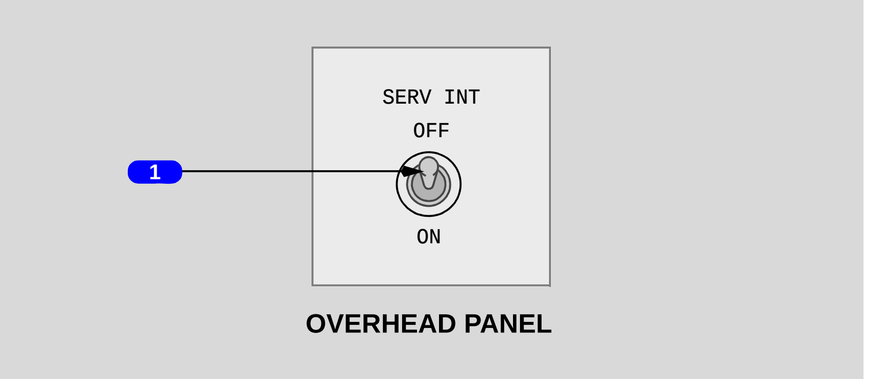

1 Service Interphone (SERV INT) Switch

OFF - allows independent operation of service and flight interphone systems.

ON - connects service and flight interphone systems.

Service and Cargo/Cabin Interphone Switches

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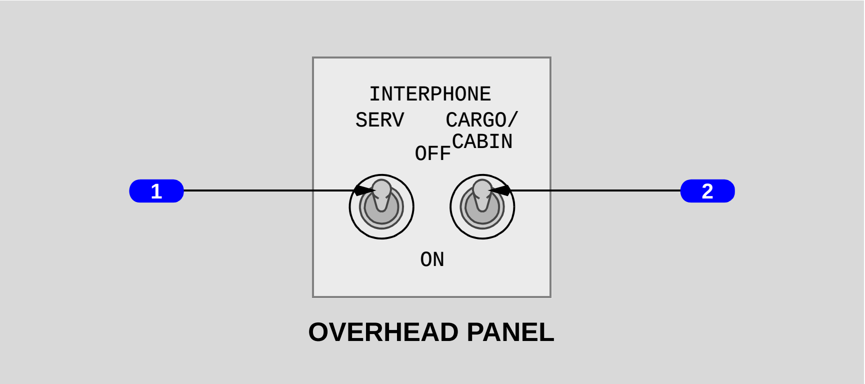


1 Service (SERV) INTERPHONE Switch

OFF - allows independent operation of service and flight interphone systems.

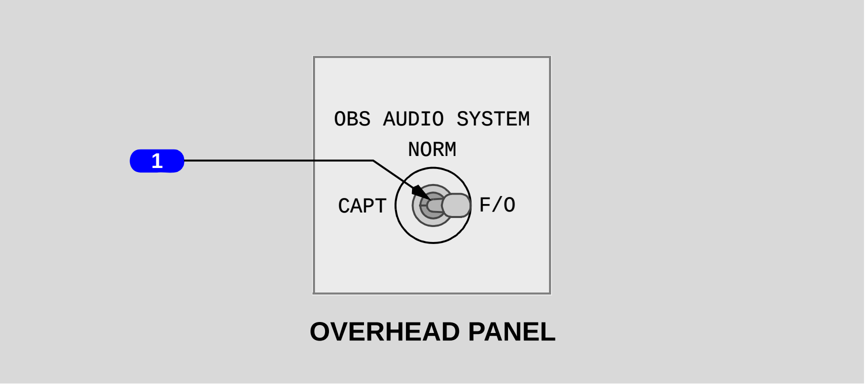
ON - connects service and flight interphone systems.

2 CARGO/CABIN INTERPHONE Switch

OFF - allows independent operation of cargo, upper deck, and flight interphone systems.

ON - connects cargo, upper deck, 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

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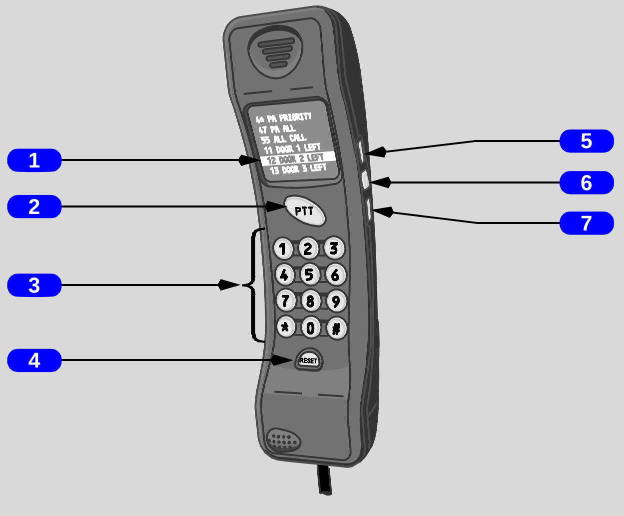
Handset provides communication with other handsets or PA system.



AFT AISLE STAND PANEL

1 Handset Display

Displays -

- a directory of dial codes
- a dial code and label of predefined station or station groups for incoming or outgoing call
- INVALID ENTRY message when incorrect dial code is entered
- PUSH RESET when handset is off hook and not being used for more than 30 seconds

2 Handset PA Push To Talk (PTT) Switch

Push –

- connects the handset microphone to the selected PA area
- only used in the PA mode

3 Handset Numeric Keys

Push – selecting a code calls the respective station or PA area.

Note: Dial codes entered using the handset are not displayed on the CDU cabin interphone pages.

4 Handset Reset Switch

Push – cancels a call or incorrectly selected code.

5 Handset Dial Code Step Up Switch

Push – moves up and highlights dial code from a list of predetermined crew station(s) and PA areas.

6 Handset Dial Code Select Switch

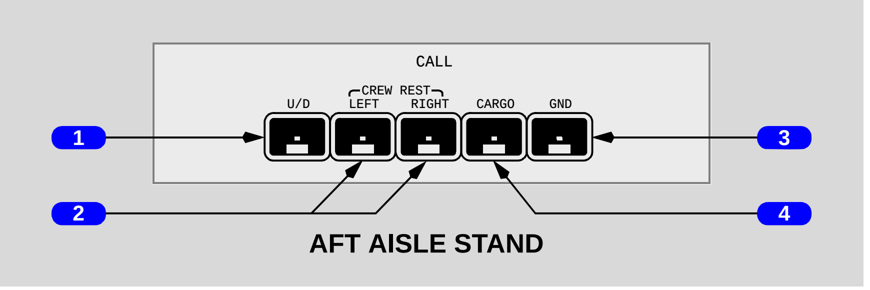
Push – initiates a call to the selected crew station(s) or PA area dial code

7 Handset Dial Code Step Down Switch

Push – moves down and highlights dial code from a list of predetermined crew station(s) and PA areas.

Call Panel

914



1 Upper Deck (U/D) Call Switch

Push - illuminates call light and sounds chime in upper deck seating area.

2 CREW REST LEFT, RIGHT Call Switches

Illuminated (white) - indicates call received from respective upper deck crew rest.

Push - illuminates Flight Deck switch on respective crew rest handset cradle and sounds chime in upper deck crew rest area.

3 Ground (GND) Call Switch

Illuminated (white) - indicates call received from nose wheel well.

Push - sounds three second horn in nose wheel well.

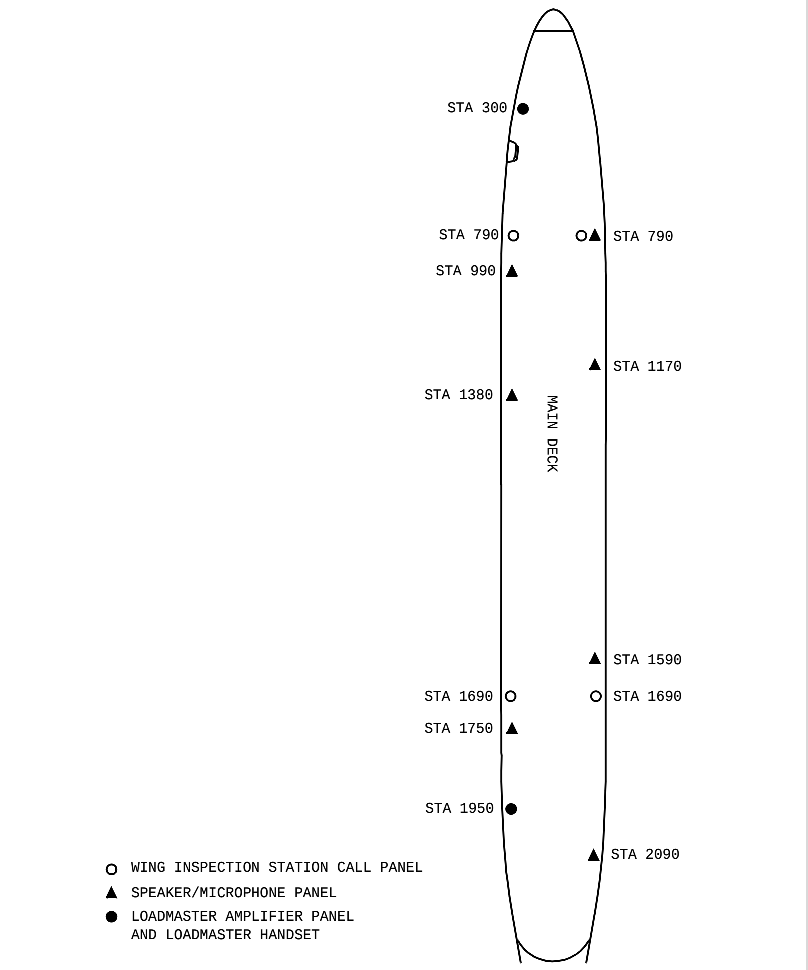
4 CARGO Call Switch

Illuminated (white) - indicates call received from main deck cargo area.

Push - illuminates Flight Deck switch on loadmaster amplifier panels and wing inspection station call panels and sounds a tone in main cargo deck area.

Cargo Interphone Component Locations

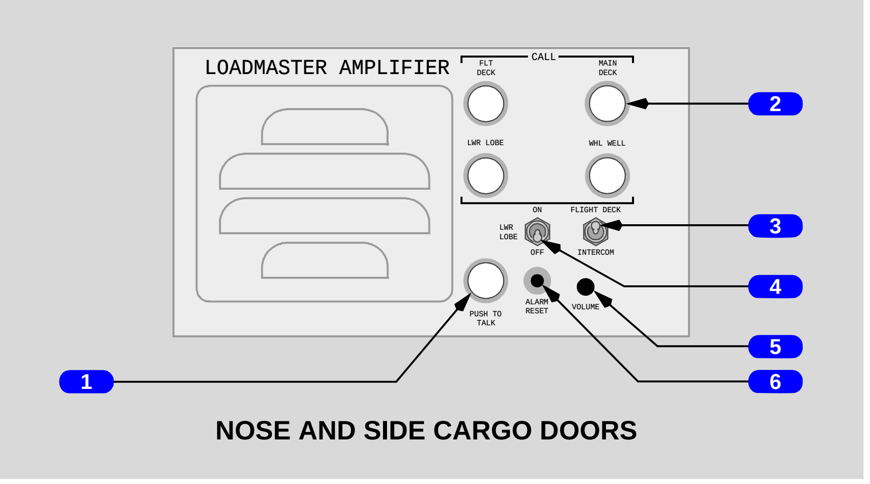
914



Cargo Interphone Components

914

Loadmaster Amplifier Panel



1 PUSH TO TALK Switch

Push - activates loadmaster amplifier panel microphone and connects to any selected area except flight deck.

2 CALL Switches

Illuminated (white) - indicates a call from the respective area. Extinguishes when pushed.

Push - sounds a chime in area being called.

3 FLIGHT DECK/INTERCOM Switch

FLIGHT DECK - connects loadmaster amplifier panel handset to flight deck interphone. Handset must be used for communication with flight deck.

INTERCOM - connects loadmaster panel to main cargo deck speaker/microphone panels.

4 LOWER LOBE Switch

ON - activates lower lobe speaker/microphone panels.

OFF - deactivates lower lobe speaker/microphone panels.

5 VOLUME Selector

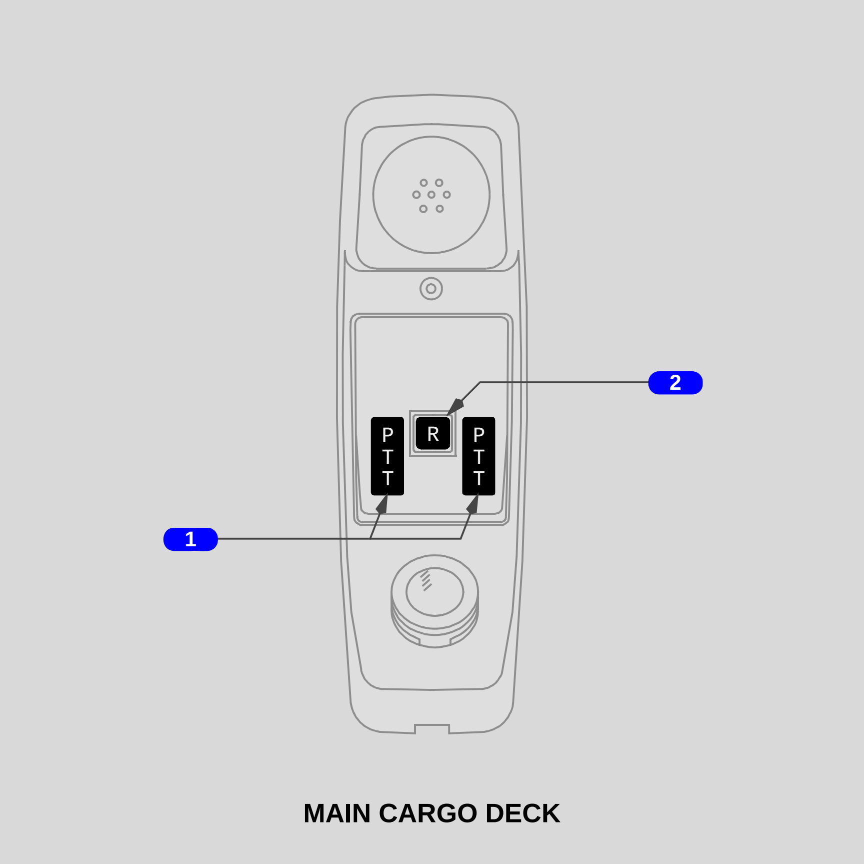
Rotate - adjusts loadmaster amplifier panel speaker volume.

6 **ALARM RESET Switch**

Push - resets aft CG audio alarm.

Loadmaster Handset

The loadmaster handset provides communications on cargo interphone and intercom systems.



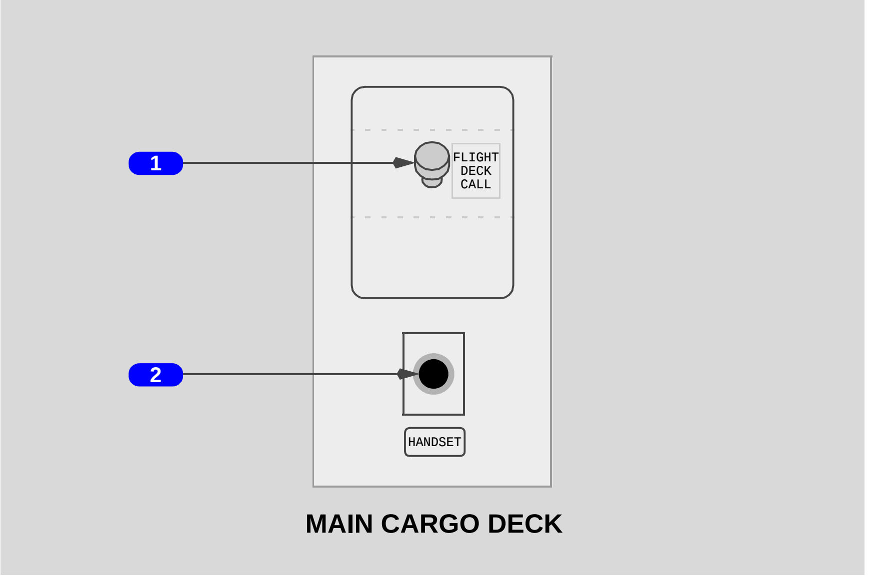
1 **Push To Talk (PTT) Switches**

Push - extinguishes Call switch lights.

2 **Reset Switch**

Push - resets handset.

Wing Inspection Station Call Panel



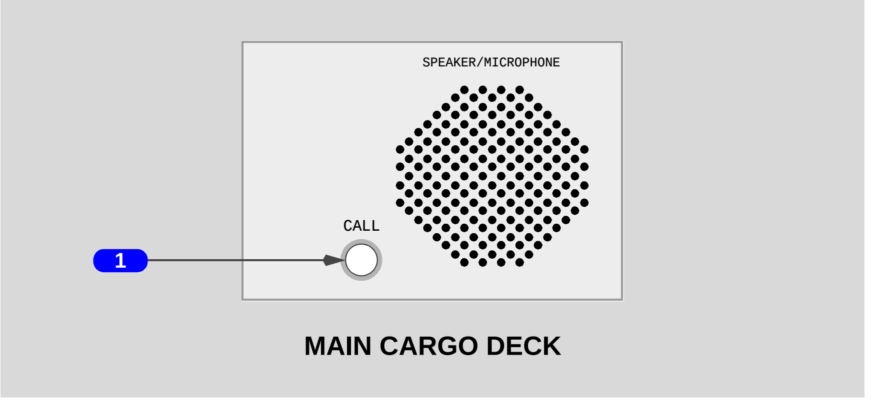
1 FLIGHT DECK CALL Switch

Push - sounds a chime in the flight deck, displays location (CARGO) on flight deck call panel, and illuminates flight (FLT) Call indication on the audio control panel.

2 HANDSET Jack

Receptacle for handset connection.

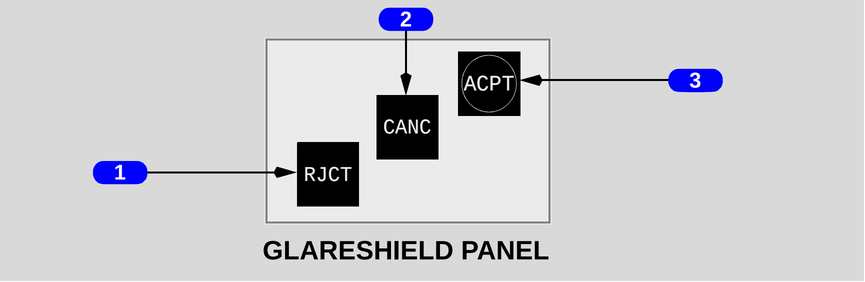
Main Cargo Deck Speaker/Microphone Panel



1 CALL Switch

Push - sounds a tone and illuminates Main Deck Call switch at each loadmaster amplifier panel.

Data Link Reject/Cancel/Accept Switches



1 Reject (RJCT) Switch

Push -

- a negative response to a displayed message is downlinked to the origin of the displayed message
- functions the same as pushing the REJECT line select key on a CDU ATC Uplink page

2 Cancel (CANC) Switch

Push -

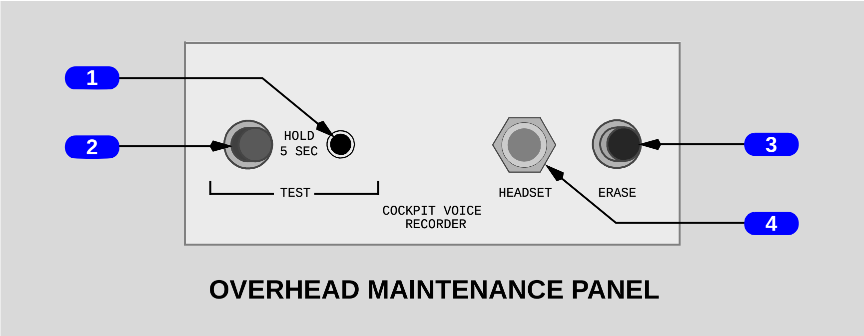
- message is removed from the EICAS display

3 Accept (ACPT) Switch

Push -

- a positive response to the displayed message is downlinked to the origin of the displayed message
- functions the same as pushing the ACCEPT line select key on a CDU ATC Uplink page

Cockpit Voice Recorder System
Cockpit Voice Recorder Panel



1 STATUS Light

Illuminated - test completed successfully. Extinguished after button is released.

2 TEST Switch

Push and hold for five seconds - tests all four cockpit voice recorder channels (1 per second).

3 ERASE Switch

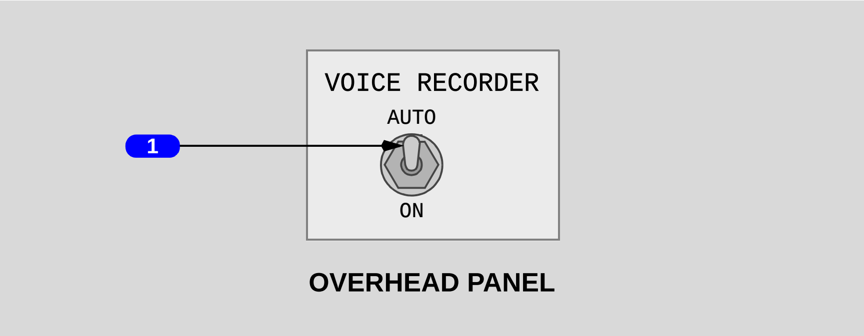
Push and hold for three seconds - erases voice recorder if on the ground, AC power on, and parking brake set.

4 Headset Jack

A headset can be plugged in to monitor playback of voice audio, or to monitor tone transmission during test.

Cockpit Voice Recorder Switch

806

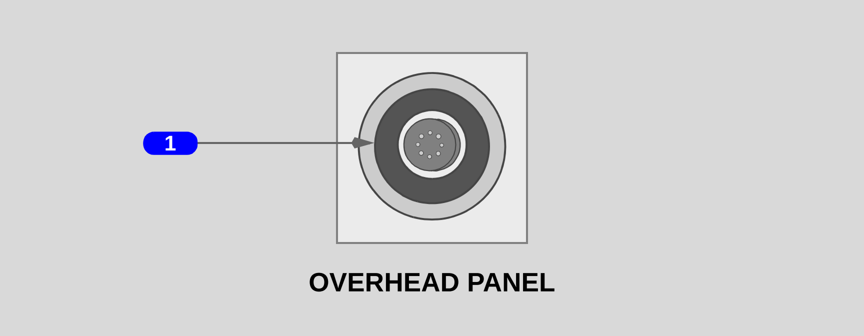


1 Cockpit VOICE RECORDER Switch

ON - records before engine start. Spring loaded to AUTO at engine start.

AUTO - records from first engine start until ten minutes after last engine shut down. Always records in flight.

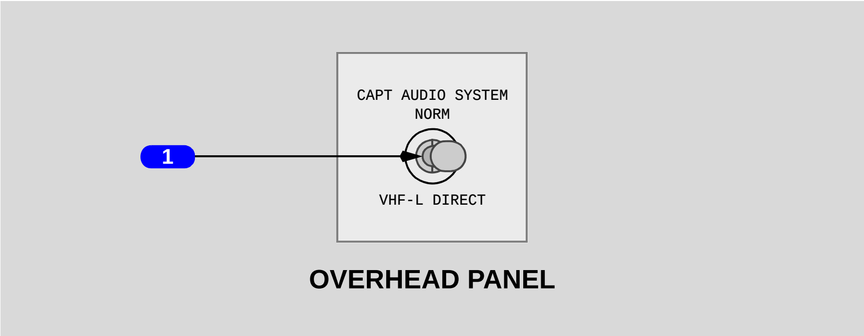
Cockpit Voice Recorder Microphone



1 Cockpit Voice Recorder Microphone

Area microphone for the voice recorder.

Miscellaneous Communication Switches
Captain Audio System Switch

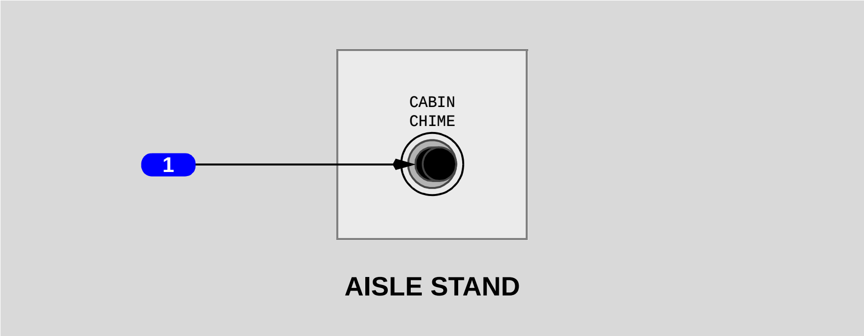


1 CAPT AUDIO SYSTEM Switch

Normal (NORM) - all communication systems operate normally.

VHF-L DIRECT - bypasses audio system by connecting Captain's boom/mic headset and control wheel push to talk switches directly to VHF-L transceiver. Allows Captain to communicate on VHF-L transceiver if audio system failure causes loss of communication. Volume control is not available.

Cabin Chime Switch
806

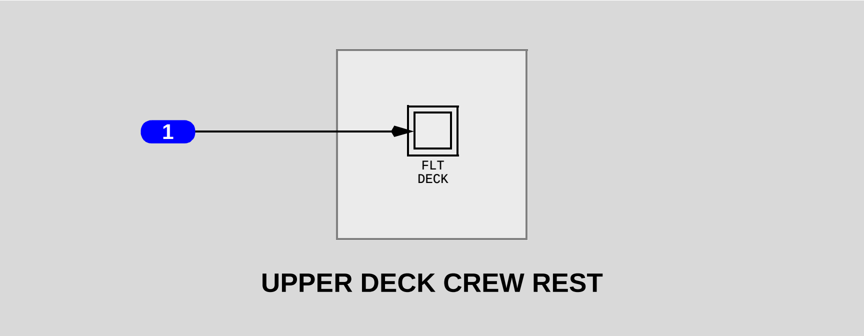


1 CABIN CHIME Switch

Push - signals ready for takeoff to the cabin.

Upper Deck Crew Rest Call Switch

914

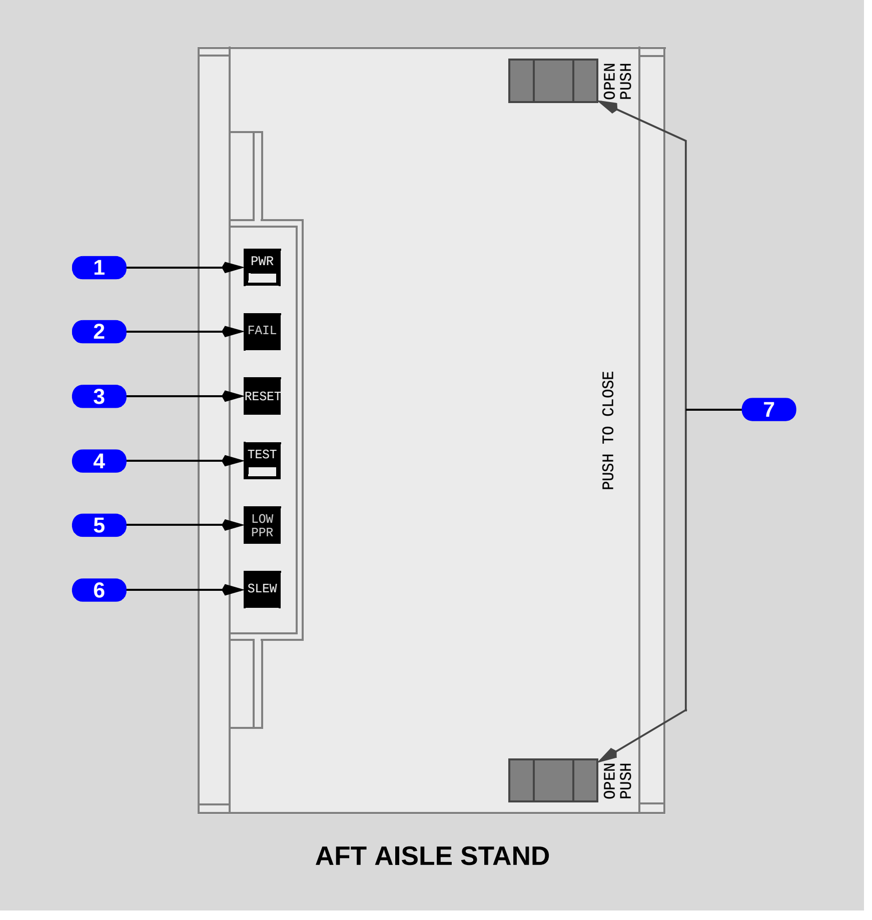


1 Flight (FLT) DECK Call Switch

Illuminated (white) - interphone call from flight deck received, chime also sounds in upper deck crew rest area.

Push - sounds chime in flight deck, displays location (CREW REST LEFT, RIGHT) on flight deck call panel, and illuminates the Flight (FLT) call indication on audio control panel.

Printer Controls



1 Power (PWR) Switch

Push - turns printer on or off.

Illuminated (white) - indicates printer off.

2 FAIL Light

Illuminated (amber) - indicates:

- printer failure, or
- printer out of paper, or
- door open

3 RESET Switch

Push - cancels active print job and resets printer.

4 TEST Switch

Push -

- tests printer
- prints test pattern

Illuminated (white) - test in progress.

5 LOW Paper (PPR) Light

Illuminated (amber) - less than 10 feet of paper remain in printer.

6 SLEW Switch

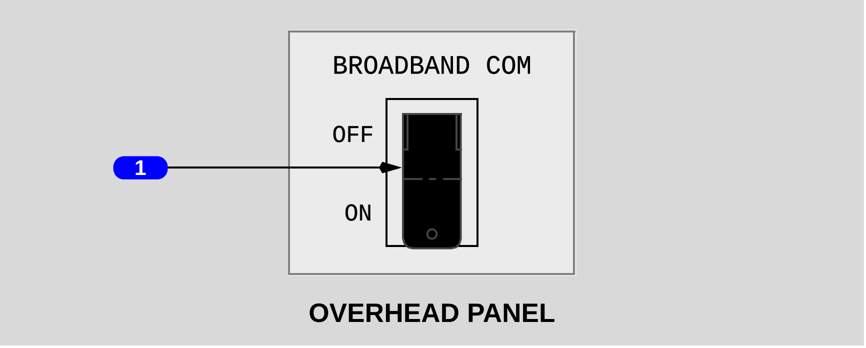
Push and hold - advances paper.

7 Printer Paper Door Latches

Push - opens printer paper door.

Broadband Communication Switch

806



1 BROADBAND Communication (COM) Switch

OFF – disables the broadband communication system.

ON (guarded position) – enables the broadband communication system.

Intentionally
Blank

Communications — Chapter 5
System Description — Section 20

Introduction

The communication system includes:

- cockpit voice recorder system
- radio communication system
- interphone communication system
- air traffic services datalink communications
- company datalink communications

The radio tuning and audio control panels control the communications systems.

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.

The second observer audio control panel is installed on the sidewall panel.

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 datalink communications and 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.

806
Recording continues for 10 minutes after last engine shutdown.

914
Recording continues for 10 minutes after AC electrical power is off.

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.

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

Radio Communication System

The radio communication system consists of:

- Very High Frequency (VHF)
- High Frequency (HF)
- Aircraft Communication Addressing and Reporting System (ACARS)
- Selective Calling (SELCAL)
- Satellite Communications (SATCOM)

VHF and HF

There are three VHF radios (VHF L, C, R) and two HF radios (HF L, R). Any VHF or HF radio can be controlled by any radio tuning panel. The audio control panels control voice transmission and receiver monitoring.

VHF L, VHF C, or VHF R can be configured for voice or ACARS data communication.

VHF radios are equipped with 8.33 kHz channel spacing.

914
HF L or HF R can be configured for voice or ACARS data communication.

The two HF radios share a common antenna. A HF voice transmission disables the opposite side HF radio during transmission. Simultaneous use of both HF radios is limited to receive only.

HF radio sensitivity can be adjusted using any radio tuning panel with the receiver selected. Sensitivity control is rendered inoperative by radio tuning panel failure or by power being removed from the panel.

When a HF transmitter is keyed after a frequency change, the antenna tunes while an audio tone may be heard through the audio system. A tone lasting longer than 7 seconds indicates failure of the system to tune. Data is stored in memory for the last 100 tuned frequencies. Stored frequencies may tune quickly and a tone may not be noticeable.

Stuck Mic Protection

On the ground, any VHF radio transmitting for longer than 35 seconds is disabled following annunciation of an audio tone. The radio is enabled when the microphone switch for that radio is released.

Aircraft Communication Addressing and Reporting System (ACARS) 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.

806
ACARS communicates through VHF L/C/R or SATCOM (if VHF is unavailable).

914
ACARS communicates through VHF L/C/R or SATCOM (if VHF is unavailable) or HF L/R (if VHF and SATCOM are unavailable).

If ACARS is not available due to lost communication, information to be transmitted is stored and transmitted automatically when communication is regained.

914
VHF L/C/R or HF L/R data mode can be selected by pushing the DATA switch on the radio tuning panel and then pushing the frequency transfer switch. The VHF or HF radio is in data mode when the word DATA is displayed in the active field of the radio tuning panel frequency window.

806
VHF L/C/R data mode can be selected by pushing the DATA switch on the radio tuning panel and then pushing the frequency transfer switch. The VHF radio is in data mode when the word DATA is displayed in the active field of the radio tuning panel frequency window.

914
When a VHF L/C/R or HF L/R standby frequency is transferred to the active field of the frequency window, the VHF or HF radio returns to voice communication mode and DATA is displayed in the standby field of the window. If a new frequency/channel is subsequently selected in the standby field of the window, DATA is replaced by the new frequency. DATA can be returned to the standby field of the window by pressing the DATA switch.

806
When a VHF L/C/R standby frequency is transferred to the active field of the frequency window, the VHF radio returns to voice communication mode and DATA is displayed in the standby field of the window. If a new frequency/channel is subsequently selected in the standby field of the window, DATA is replaced by the new frequency. DATA can be returned to the standby field of the window by pressing the DATA switch.

914
HF datalink operation is inhibited on the ground. When a HF radio is in data mode during flight, the opposite side HF is available for voice communications and will preempt any HF datalink operation in progress. HF datalink resumes after a short period following completion of the voice transmission.

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 select switch on the audio control panel or transmitting on that radio.

Satellite Communications (SATCOM)

The SATCOM system provides ACARS data communications.

ACARS can use the SATCOM system when the airplane is beyond VHF communication range. Switching between VHF and SATCOM is automatic. ACARS data is controlled through the control display units (CDUs).

The SATCOM system also provides voice communications. Voice transmission is controlled using the CDUs and audio control panels. Calls can be initiated using the CDU.

Incoming SATCOM voice calls are answered automatically. Calls are annunciated by a SELCAL chime and illumination of a CALL light on the audio control panel. Pressing the respective transmitter select switch connects the call to the pilot headset/hand mic. SATCOM calls are terminated when the CALL light extinguishes (ground party hang-up or pilot ends call).

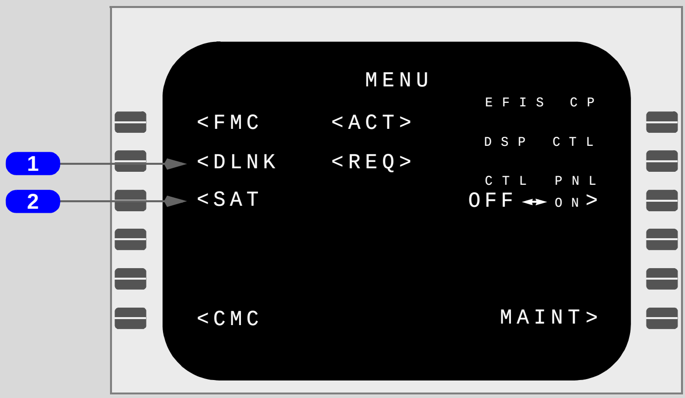
The SATCOM CDU control pages display by selecting SAT on the MENU page.

CDU Menu Page

Pushing the CDU MENU key displays the CDU menu page.

CDU ACARS Datalink and SATCOM Access

Normally, ACARS datalink and SATCOM displays are viewed on the center CDU. ACARS datalink and SATCOM prompts are available on the menu page of all CDUs.



CDU

1 Datalink (DLNK)

Push -

- displays ACARS page
- activates ACARS control of CDU

2 SAT

Push -

- displays SATCOM page
- activates SATCOM control of CDU

SATCOM Phone Pages [Typical]

The SATCOM phone pages allow the flight crew to initiate, receive, and terminate calls, monitor call status, and access lower-level pages. Control functions are active when displayed with a caret.

SATCOM Phone Page 1/2

CDU

1 Channel L Control Field

Push – selects active control function or manual phone number entry from scratchpad. Call status information displays in small font.

2 Channel R Control Field

Push – selects active control function or manual phone number entry from scratchpad. Call status information displays in small font.

3 PRIORITY

For channel L, the following call priority levels can display:

- EMG (Emergency) - emergency and distress calls (activates ground station alarm)
- HGH (High) - regulatory and flight safety calls
- LOW - non-safety related service calls
- PUB (Public) - passenger correspondence calls

Push (channel not in use) – toggles between levels for selecting call priority.

4 DIRECTORY

Push – displays SATCOM directory index page.

5 PRIORITY

For channel R, the call priority level displays SBB (SwiftBroadband) PUB when SBB voice service is available.

SATCOM Phone Page 2/2

914

CDU

806

CDU

1 LOG

Push – displays SATCOM log page for manual selection and control of log-on process.

2 Directory (DIR) DETAILS

Push – displays SATCOM directory details page.

3 Built-In-Test-Equipment (BITE) Status

Displays current BITE status.

Push – displays SATCOM BITE status page for access to system fault information.

4 CONFIG

Push – displays SATCOM config page for access to system configuration information.

5 SWIFT

Push – displays SBB status page for access to high speed SATCOM services information.

806

6 Cabin Telephone Unit (CTU) CALLS

Push – selects desired cabin call status by toggling between enabled and disabled. Selecting enabled prompt displays the SATCOM CTU disable page for confirmation. If pilot confirms disabled, cabin calls in progress are terminated.

SATCOM Directory Index Page [Typical]

The SATCOM directory index page (X/2) is used to access directory pages.

CDU

1 Index Labels

Push – displays SATCOM directory page associated with selected index label. Index labels are defined by the operator.

2 RETURN

Push – display returns to SATCOM phone page 2/2.

SATCOM Directory Page [Typical]

The SATCOM directory page (XX/20) contains a list of phone numbers used for making line-selectable calls.

CDU

1 Phone Number List

Push – preselects phone number for making call, selects voice channel via left (SAT-L) or right (SAT-R) line select key, and returns display to SATCOM phone page 1/2. Phone number labels and content are defined by the operator.

2 RETURN

Push – display returns to SATCOM directory index page.

3 Index Label

Displays index label associated with selected SATCOM directory page.

Printer

The flight deck printer can be used to print selected information from the communication system, EFB, or FMC. The CDU is used to manually select communications or FMC information for printing. The EFB display unit is used to manually select EFB information for printing. Automatic selection of information for printing is controlled by source system logic. The flight deck printer is capable of printing in both text and graphics formats, and uses a server to manage a print job queue.

Note: Printer response time can be delayed approximately 20 to 45 seconds, depending on print job file size and format.

Refer to the following chapters for additional information:

- Chapter 5, Communications, Section 33, for printing from the communication system
- Chapter 10, Flight Instruments, Displays, Section 45, for printing from the EFB
- Chapter 11, Flight Management, Navigation, Sections 40 and 43, for printing from the FMC

Printer paper can be loaded as follows:

- push open both printer paper door latches to open door
- remove empty paper roll
- snap in new paper roll and unroll approximately 12 inches of paper
- push to close printer door

Interphone Communication System

The interphone communication system includes the:

806
- flight interphone system
- service interphone system
- passenger address (PA) system
- cabin interphone system

914
- flight interphone system
- service interphone system
- personnel address (PA) system
- upper deck interphone system
- cargo interphone system
- cargo intercom system

The flight interphone, service interphone, and PA systems are normally operated through the audio control panel.

806
The cabin interphone system is operated through the audio control panel, CDU, and flight deck handset.

914
The cargo interphone and upper deck interphone systems can be connected to the flight interphone with the Cargo Interphone switch.

Flight Interphone System

The flight interphone system provides communications between flight deck crew members. The flight interphone system also provides communications between the flight deck and ground crew through two flight interphone jacks 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

806

Crew alerting of a ground crew initiated call is provided by an aural alert chime, the GROUND CALL communication message, and illumination of a CALL light on the audio control panel. The CALL light is reset by selecting the FLT transmitter select switch or transmitting on that transmitter.

914

Crew alerting of a ground crew initiated call is provided by an aural alert chime, illumination of the FLT call indication on the audio control panel, and illumination of the Ground Call switch on the call panel. The Ground Call switch is reset after a 60 second delay. Pushing the Ground Call switch on the call panel sounds a three second horn in the nose wheel well.

914

An incoming call from the left or right upper deck crew rest area illuminates the FLT call indication on the audio control panel, sounds a chime, and illuminates the respective Crew Rest switch on the call panel. The call indication is reset after a 60 second time delay. Pushing either Crew Rest Left or Right switch on the call panel sounds a chime and illuminates the Flight Deck switch on the respective crew rest handset cradle.

Service Interphone System

The service interphone system provides voice communications between ground crew stations at various locations around the airplane. The system can be connected to the flight interphone system through the service interphone switch on the overhead panel.

Passenger Address System

806

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

Personnel Address System

914

The personnel address (PA) system is used by the flight crew to make announcements to the upper deck seating area and crew rest areas. The PA system is accessed using the boom microphone, oxygen mask microphone, or hand microphone.

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.

Cabin Interphone System

806

The cabin interphone system provides voice communications between the flight deck and the flight attendant stations. Boom microphones, oxygen mask microphones, and hand microphones are used by selecting the CAB (cabin) transmitter select switch on an audio control panel and pushing the mic/interphone switch to the MIC position. A cabin interphone station(s) must be selected and a call initiated from the center CDU to alert the desired station to pick up the call.

EICAS communication messages and chimes alert the pilots to incoming cabin calls. Normal priority calls from the cabin display the CABIN CALL communication message. Normal priority calls made to the flight deck while another call is in progress result in a busy signal at the handset, the calling station being displayed in the call queue, and the CABIN CALL communication message being set in EICAS. The call queue and communication messages are cleared when communication is established between that calling station and the flight deck. Priority calls from the cabin display the CABIN ALERT communication message. Priority calls automatically disconnect lower priority cabin interphone calls. Priority calls placed while a priority call is in progress are automatically connected as a conference call.

The cabin interphone call queue, speed dial numbers, and directories are accessed from the center CDU cabin interphone menu.

Calls are initiated by:

- line selecting the call location on the CDU display, or
- entering a valid two digit call code in the CDU scratchpad and selecting SEND

Pushing the audio control panel CAB transmitter select switch twice within one second places a priority call to an airline–designated call location. If the call location is in use, it is disconnected from the call in progress and connected directly to the flight deck.

Note: Flight deck initiated calls do not interrupt a current PA announcement from the dialed station.

Calls can be answered by selecting an audio control panel CAB transmitter select switch or, if a CAB transmitter select switch is already pushed in, by pressing a mic/interphone switch to the MIC position.

Calls can be ended by selecting the CDU prompt END CALL or de–selecting the CAB transmitter select switch on the audio control panel. The call also ends if the other party terminates the call.

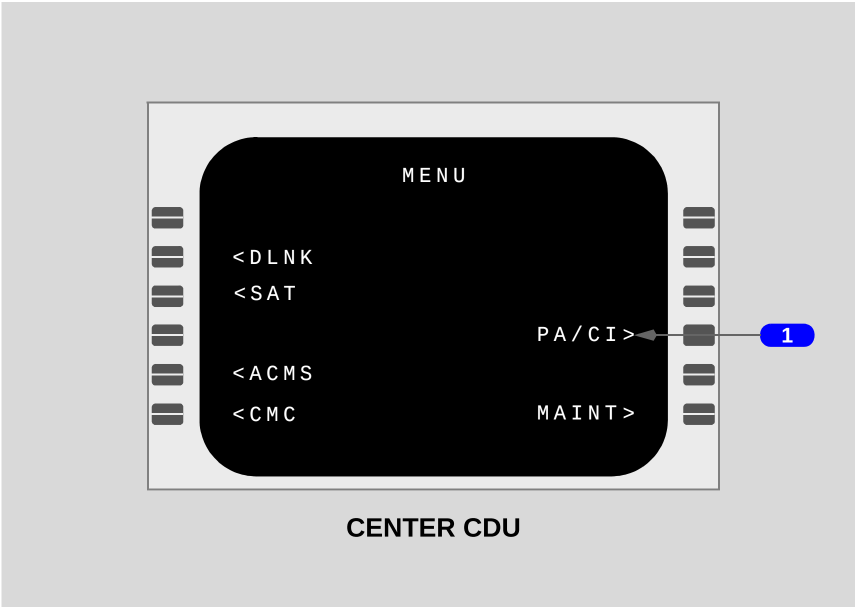
Calls can also be answered or placed using the flight deck handset. The desired call location is entered using the dial code step switches or numeric keys. The call is then made by pushing the dial code select switch. Pressing the handset reset switch or placing the handset back on the cradle terminates the call.

Note: The handset PA push to talk switch is not required to operate the handset except for PA announcements.

Note: The cabin interphone system provides access to voice gate link (if installed at the gate). Gate link allows phone calls to and from the flight deck while the airplane is at the gate.

CDU Menu Page

Pushing the center CDU MENU key displays the CDU menu page.

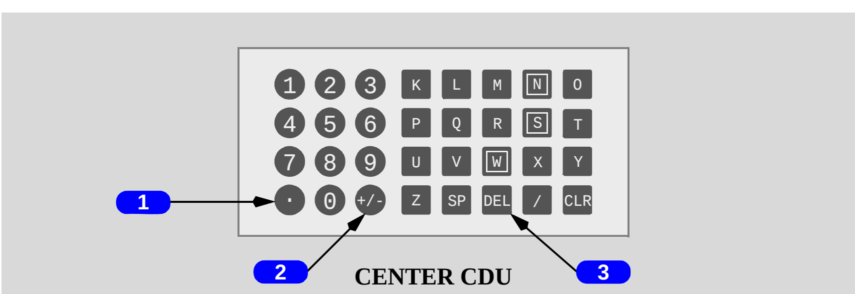


1 Passenger Address (PA)/Cabin Interphone (CI)

Push -

- displays cabin interphone menu page
- activates cabin interphone control of CDU

Cabin Interphone CDU Controls



1 Period (.) key

Push – displays an asterisk (*) in the scratchpad.

2 Plus/Minus (+/-) Key

Push – displays a pound sign (#) in the scratchpad.

3 Delete Key

Push –

- displays DELETE in the scratchpad
- used to delete calls from the call queue

Cabin Interphone Main Menu

The cabin interphone menu allows the pilots to send or end calls. Calls are sent by selecting a station from the speed dial page or the directory. Two digit station codes can be manually entered into the scratchpad and the call sent using the SEND prompt. A list of the two digit station codes is located on the handset.

The directory of stations is created by the customer airline and is not shown here. The following depict a typical main menu page and selected options.

Speed Dial

The speed dial menu provides a quick means to call up to five predefined stations or groups of stations. A single push initiates the selected call.

Call Queue

When the flight deck is involved in a call, additional incoming calls are displayed in the queue. Up to four calls can be displayed in order of the priority assigned as follows:

- PILOT ALERT
- conference calls
- cabin calls
- other calls

The PILOT ALERT queue entry is displayed only when the flight deck is using the PA and an incoming call is received.

When there are four calls in the queue and a new, higher priority call is received, the lowest priority call is removed from the queue and the new call is displayed in the proper priority.

Cabin Interphone Main Menu Page [Typical]

CENTER CDU

1 SPEED DIAL Labels

Lists the dial code labels of predefined stations, station groups, or functions:

- PA CALL – selects the passenger address system
- ALL CALL – selects all cabin interphone stations
- PURSER – selects the purser station
- GALLEY FWD – selects the forward galley station
- GND CREW – activates an alert horn in the nose wheel well. When selected, the horn sounds briefly to alert the ground crew for communications with the flight crew

Push – directly dials the selected station, station group or enables the selected call function.

2 SEND

A two–digit dial code may be manually entered with the CDU keyboard. If the dial code is valid, the dial code, dial code label, and SEND are displayed. If the dial code is invalid, INVALID CODE is displayed in the scratchpad.

Push – initiates a call to the selected station.

2 END CALL

Displayed during a connect call.

Push – disconnects all existing call connections.

3 CURRENT CALL

Displays the most recently selected dial code and label when a call is being connected. Dial code is removed when call is established.

4 CALL QUEUE Labels

Lists the dial code labels of unanswered calls to the flight deck.

Push –

- initiates a call back to the displayed station(s)
- adds station(s) to the existing call (if the flight deck is currently connected in a call)

5 DIRECTORY

Push – displays the cabin interphone DIRECTORY page.

6 IN USE Status

PA IN USE –

- a portion of the airplane PA system is in use, or
- both the PA and video entertainment systems are in use

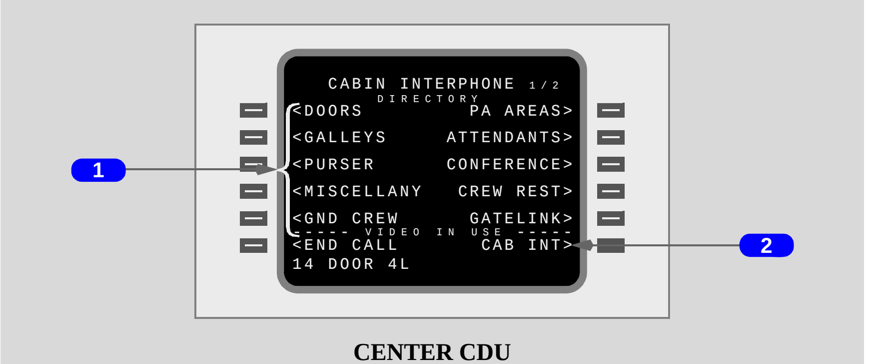
VIDEO IN USE – a portion of the video entertainment system is in use.

Blank (dashes) – neither the PA or video system is in use.

Cabin Interphone Directory Page [Typical]

The cabin interphone directory pages are used to access subdirectory pages. CDU cabin interphone directory pages and individual directory entries are predefined by the airline. Each directory label is the name of a subdirectory where the dial code labels of the individual stations or functions are listed.

Selection of the specific location(s) is accomplished on the subdirectory page.



CENTER CDU

1 Directories

Up to 20 subdirectories can be predefined.

Push – displays the appropriate subdirectory page

2 CAB INT

Push – returns the display to the cabin interphone main menu page.

Cabin Interphone Subdirectory Page [Typical]

Selecting a dial code label on the subdirectory page initiates a call to that station or station group.

The cabin interphone subdirectory pages are used to view and select individual locations through their dial code labels.

Typical stations or station groups are:

- individual cabin station
- two or more cabin stations for conference calls
- PA call to all cabin areas
- PA call to individual cabin areas
- PA priority call to all cabin areas
- ground crew alert
- gate station (on the ground)

CENTER CDU

1 Dial Code Labels

Push – initiates a call to the appropriate station(s).

2 CAB INT

Push – returns the display to the cabin interphone main menu page.

Upper Deck Interphone System

914

The upper deck interphone system permits communication between the flight deck and the upper deck crew rest areas. The upper deck interphone system can be connected to the flight interphone system with the Cargo/Cabin Interphone switch on the flight deck overhead panel.

Cargo Interphone System

914

The cargo interphone system provides communication between load personnel, the flight deck, and ground crew.

The cargo interphone system can be connected to the flight interphone system with the Cargo/Cabin Interphone switch on the flight deck overhead panel.

On the main cargo deck, two Loadmaster Amplifier panels and four Wing Station Call panels have two-way call capability with the flight deck. In addition, the Loadmaster Amplifier panels have two-way call capability with the nose wheel well and the lower lobe cargo compartments.

Cargo Intercom System

914

The cargo intercom system has eight speaker/microphone panels located throughout the main cargo deck, which are controlled from either Loadmaster Amplifier panel.

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.

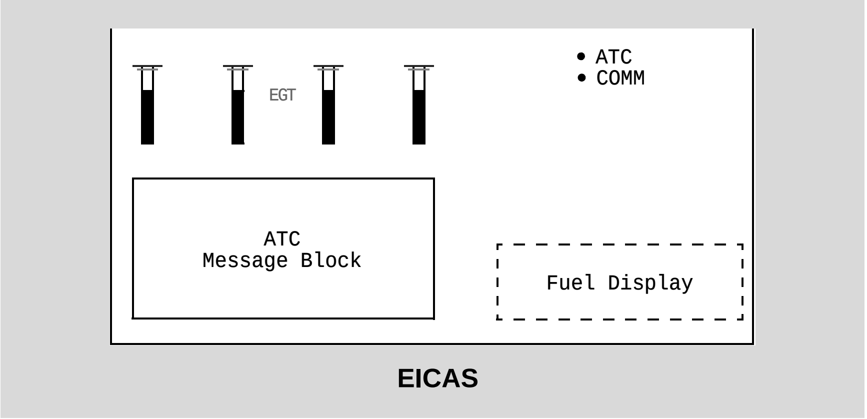
The FMC formats reports in response to requests from an ATS facility for reports and confirmation. These reports are accessible via the ATC REPORT page and display for review or modification on the VERIFY REPORT pages.

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.

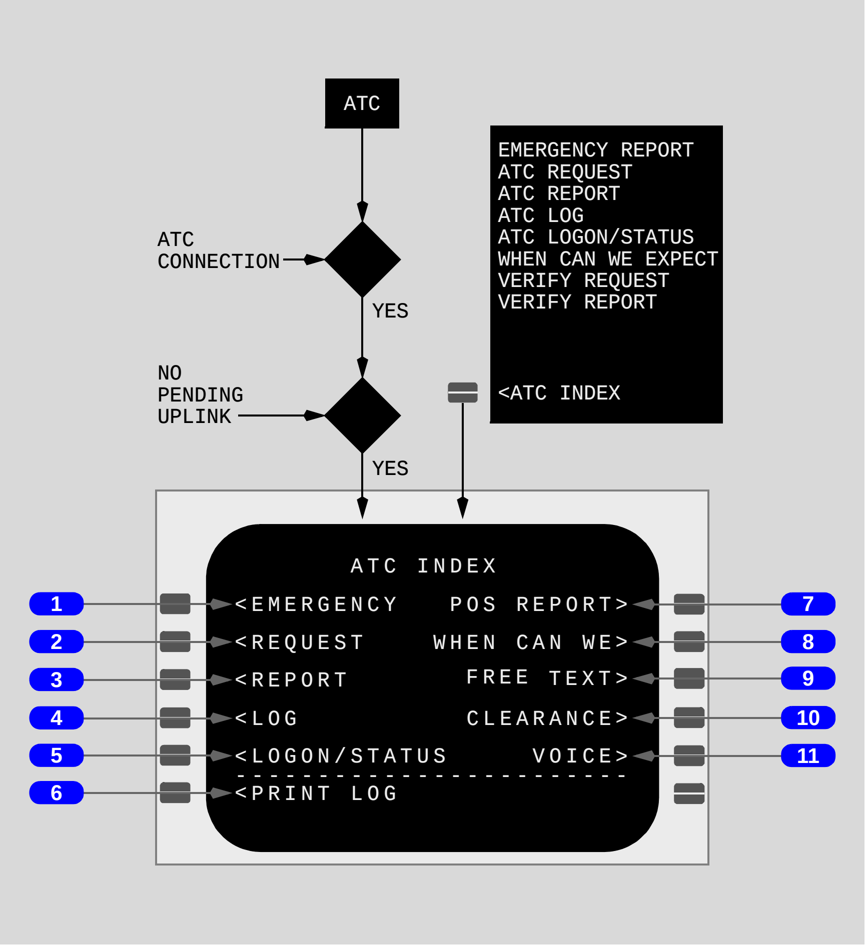
Selecting ACCEPT SEND> displays the VERIFY RESPONSE page with WILCO, ROGER, or AFFIRM in 1L. Selecting <REJECT displays the REJECT DUE TO page when the rejection message is not sending; then, displays the VERIFY RESPONSE page when the rejection message is sending. When the communications network sends 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

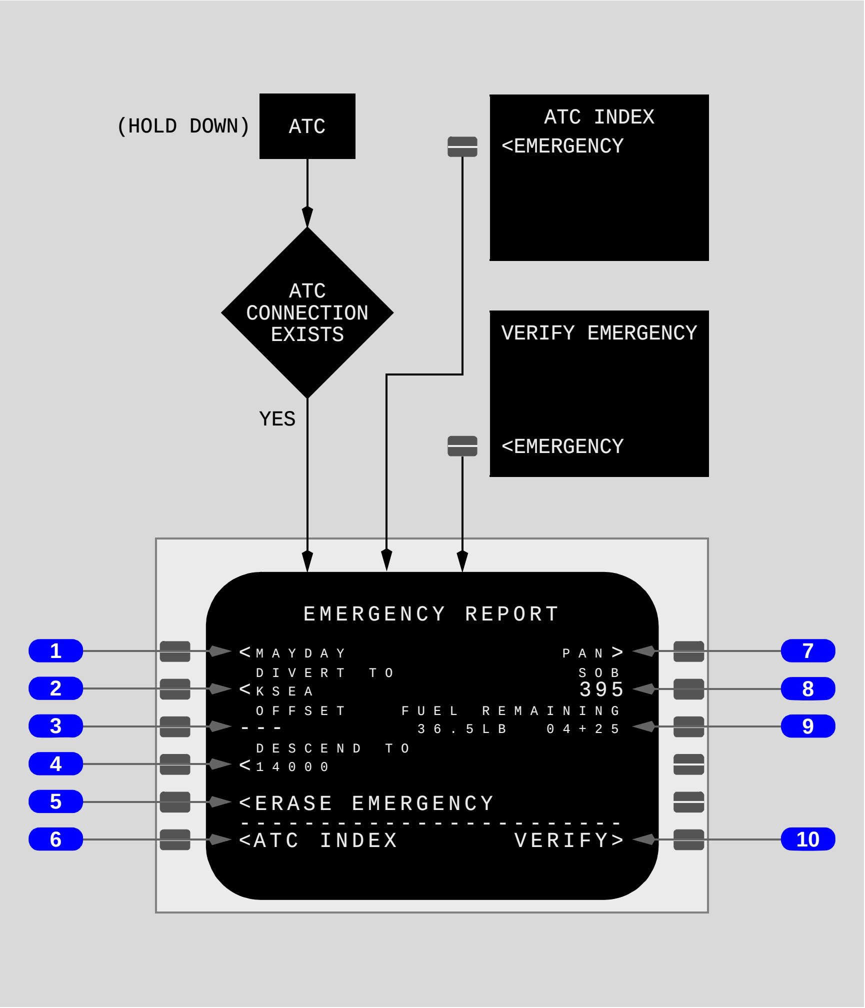
Push - displays VERIFY REQUEST pages for clearance request.

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.

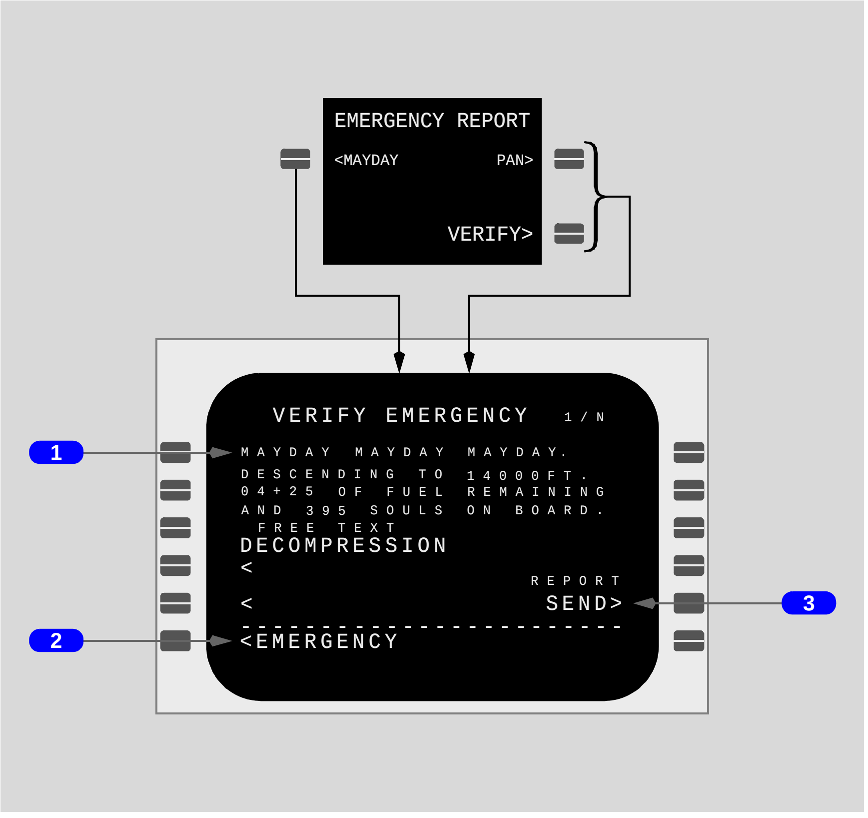
Valid entry is HH+MM (hours and minutes).

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

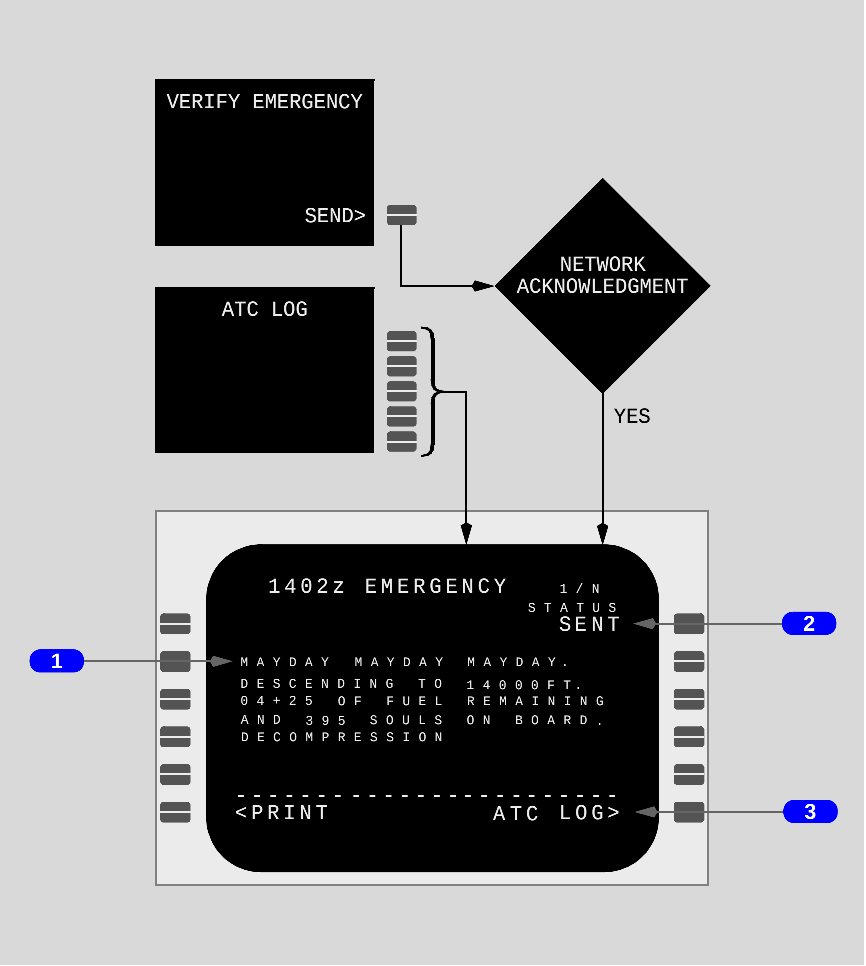
Displays on last VERIFY EMERGENCY page.

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.

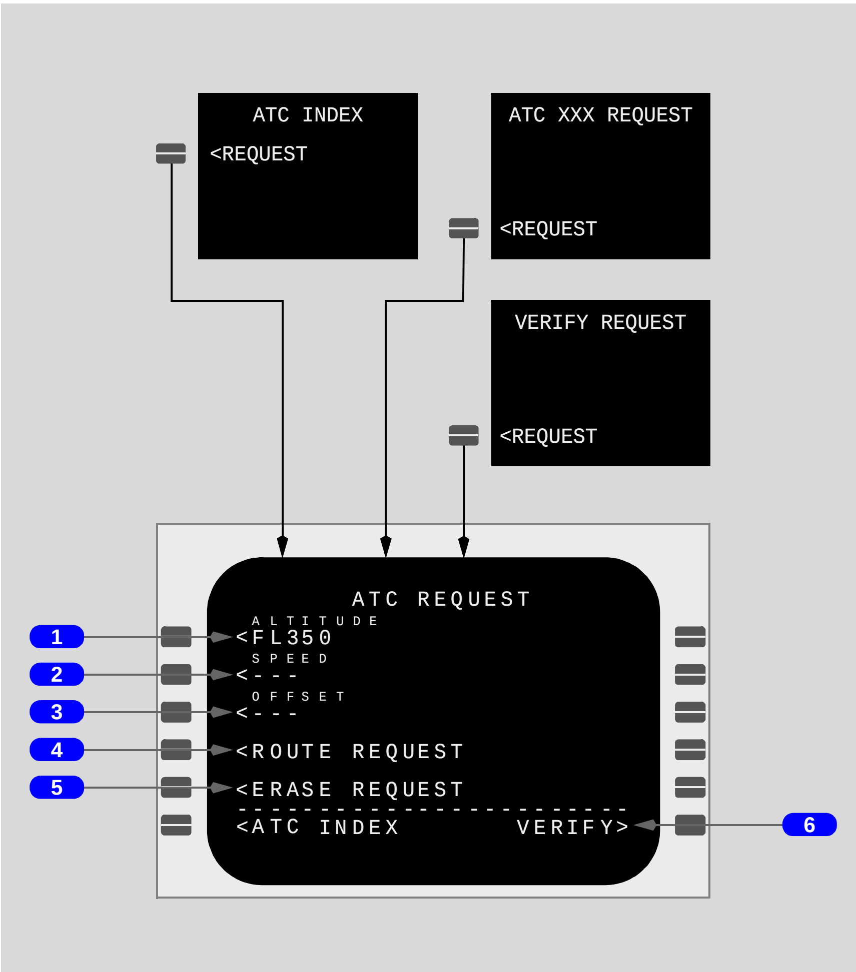
3 ATC LOG

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

Intially displays dashes.

Valid entry is IAS or Mach.

Entry may be deleted.

Push -

- with speed/Mach entered, displays ATC SPEED REQUEST page with speed/Mach on speed line
- with dashes displayed, displays ATC SPEED REQUEST page with dashes on speed line

3 OFFSET

Initially displays dashes.

Valid entry is L (or R) XX, or just XX. (XX is any number from 1 to 99).

Entry may be deleted.

Push -

- with offset entered, displays ATC OFFSET REQUEST page with offset on offset line
- with dashes displayed, displays blank ATC OFFSET REQUEST page

4 ROUTE REQUEST

Push - displays ATC ROUTE REQUEST page.

5 ERASE REQUEST

Push - erases entered or selected data and any or all of the ATC REQUEST pages.

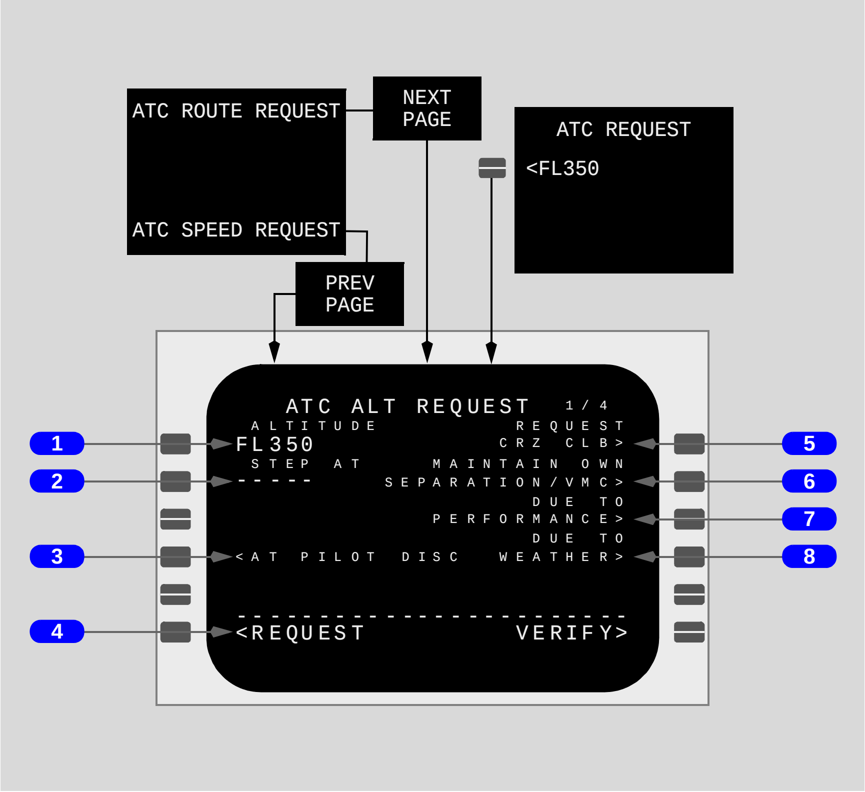
6 VERIFY

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 mesage element.

Selection may be deleted.

7 DUE TO PERFORMANCE

Push - displays PERFORMANCE in large font and selects DUE TO PERFORMANCE message element.

Selection may be deleted.

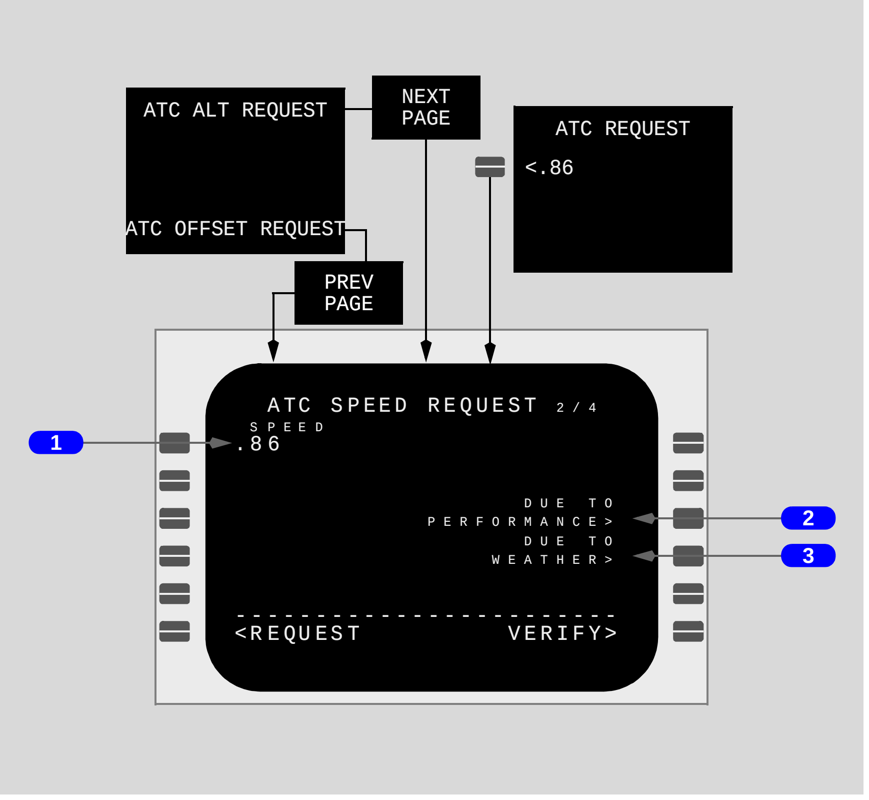
8 DUE TO WEATHER

Push - displays WEATHER in large font and selects DUE TO WEATHER message element.

Selection may be deleted.

ATC Speed Request Page 2/4

The ATC SPEED REQUEST page 2/4 allows downlink requests for speed changes.



1 SPEED

Initially displays dashes or speed/Mach requested on ATC REQUEST page.

Valid entry is IAS or Mach.

Entry selects a message requesting the speed or Mach.

Entry may be deleted.

2 DUE TO PERFORMANCE

Push - displays PERFORMANCE in large font and selects DUE TO PERFORMANCE message element.

Selection may be deleted.

3 DUE TO WEATHER

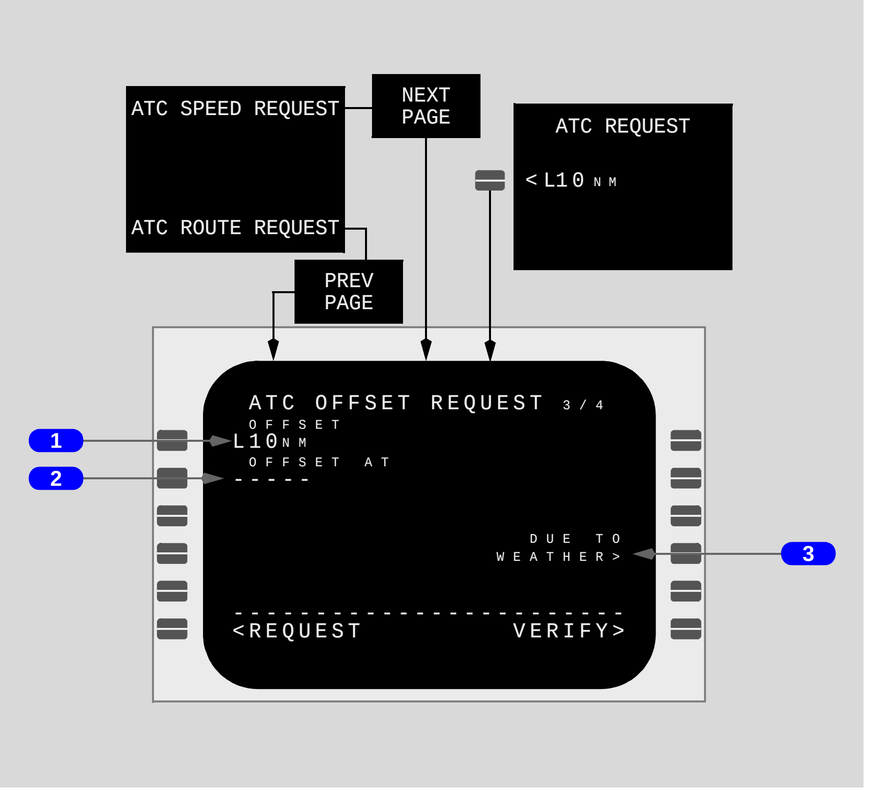
Push - displays WEATHER in large font and selects DUE TO WEATHER message element.

Selection may be deleted.

ATC Offset Request Page 3/4

The ATC OFFSET REQUEST page 3/4 allows downlink requests for 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

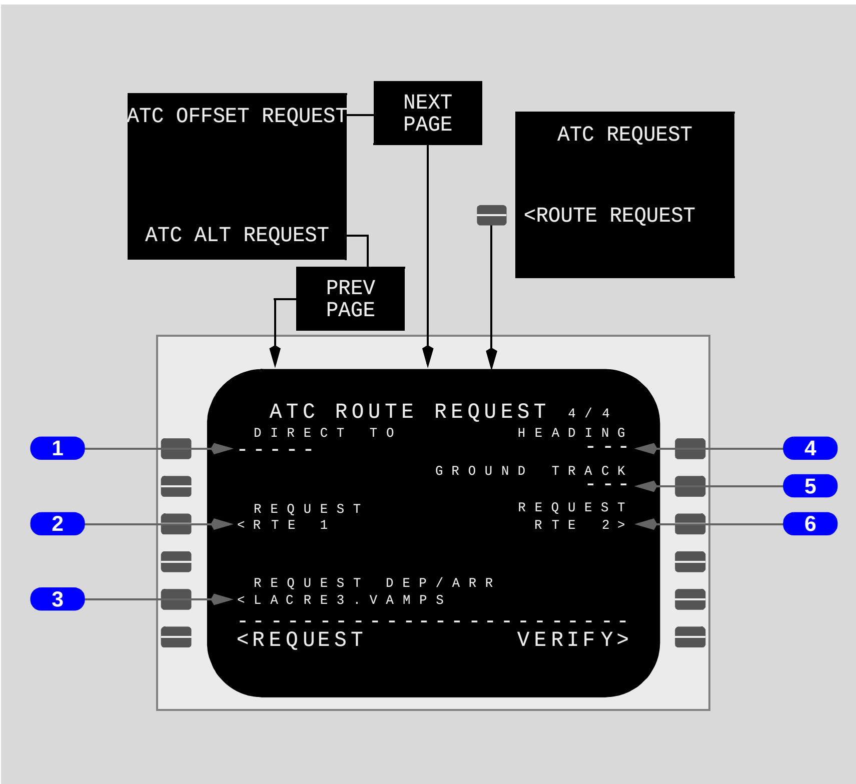
Push - displays WEATHER in large font and selects REQUEST WEATHER DEVIATION UP TO entered message element.

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)

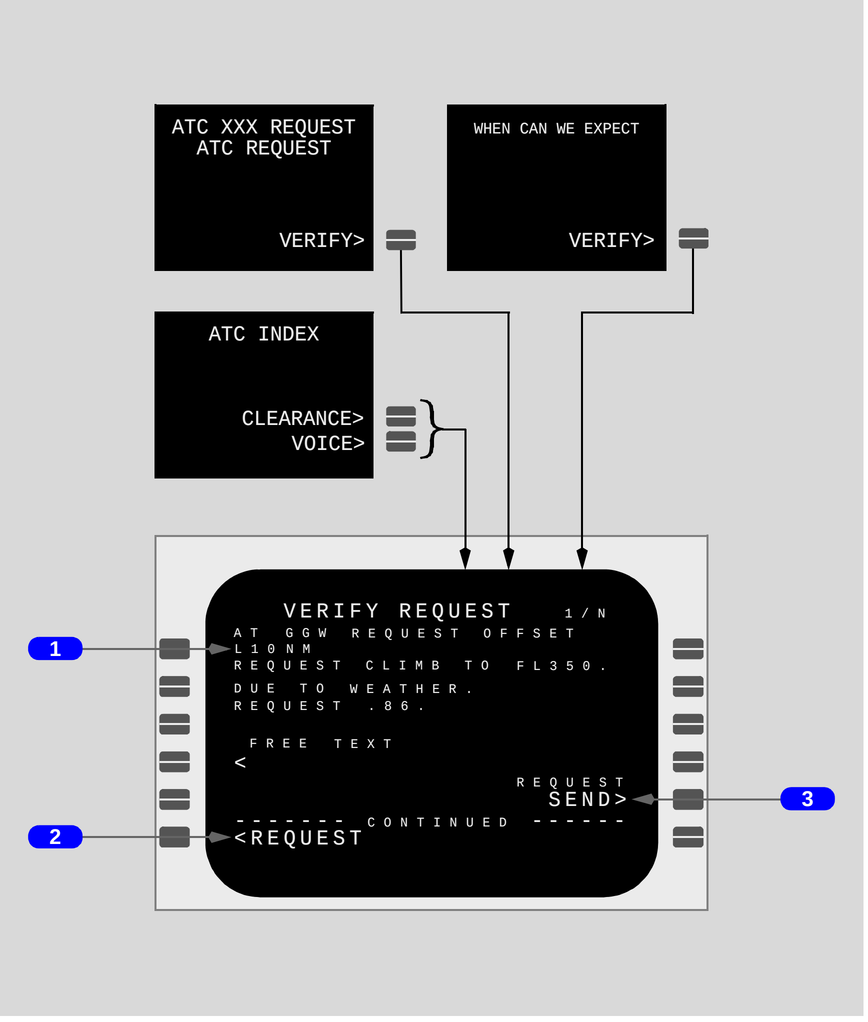
Push - selects route stored in RTE 2 for route request. When RTE 2 has a pending modification, the modified route is requested.

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

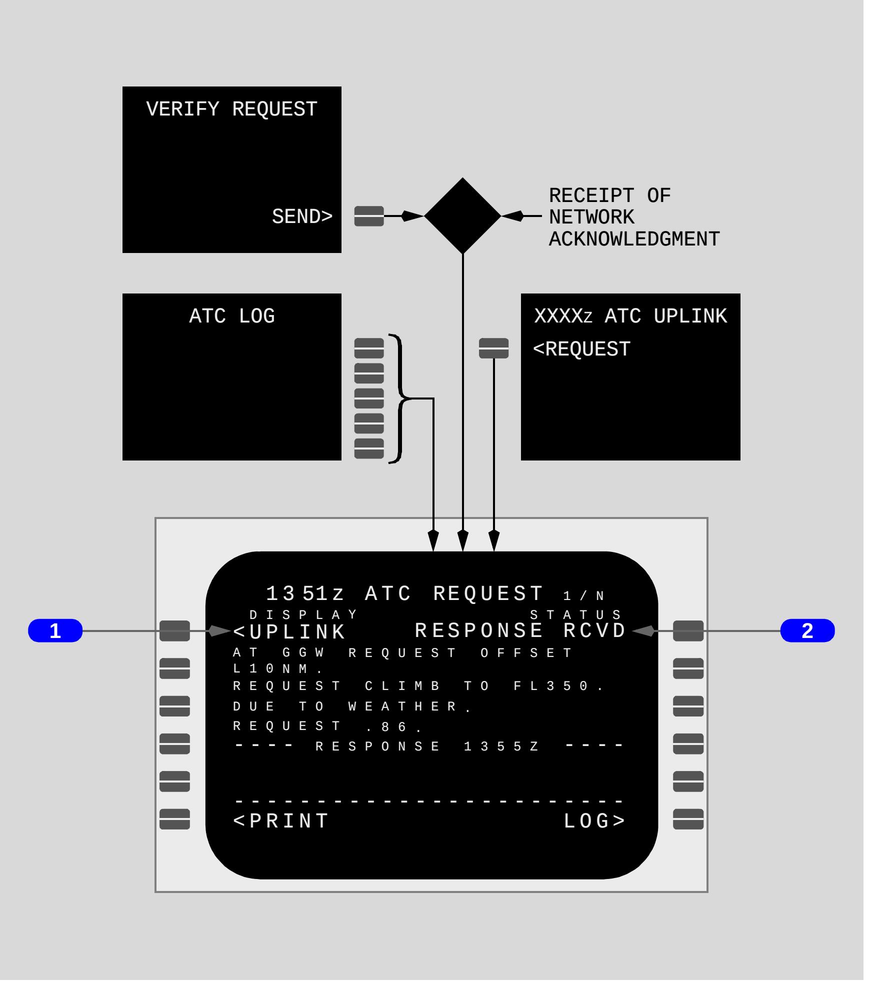
Displays on last VERIFY REQUEST page.

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.

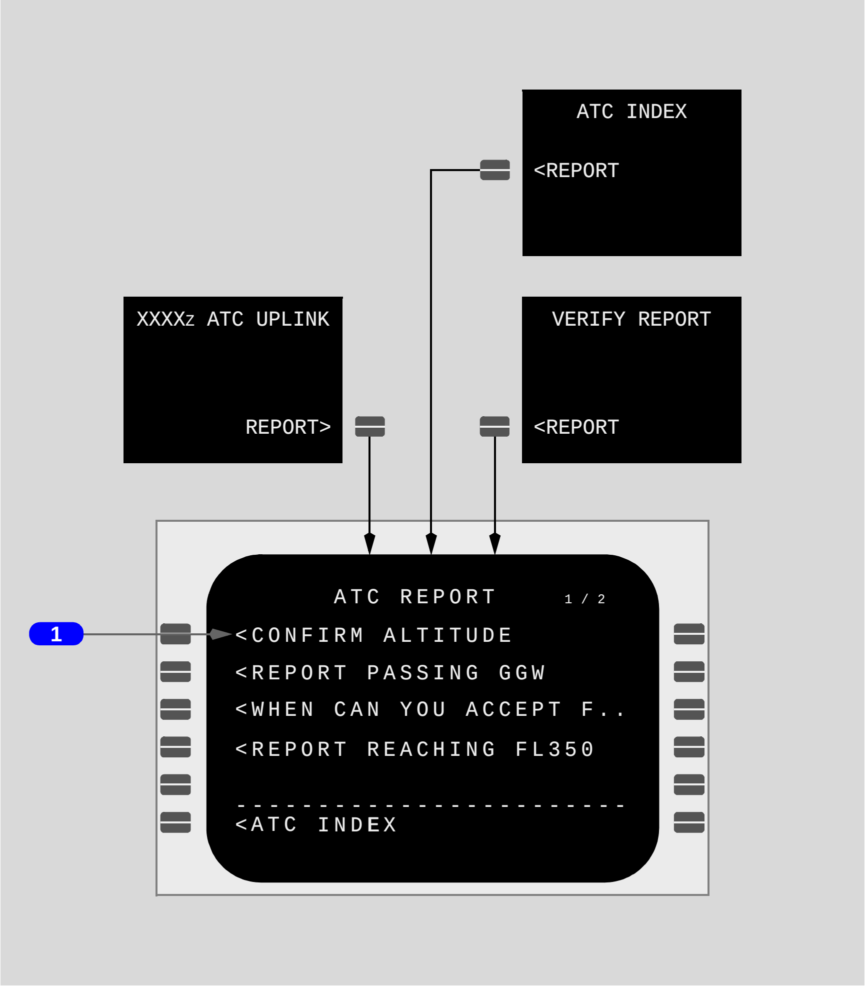
Response time of ATC uplink displays following text.

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.

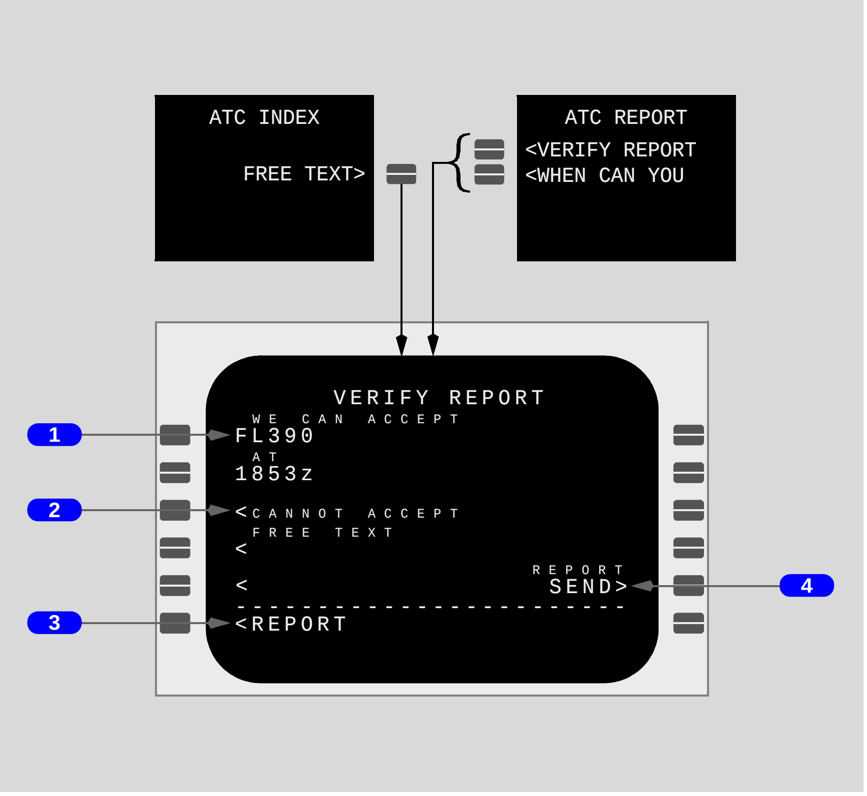
Pages 1/2 and 2/2 lines 1 to 5 display uplinked report or confirmation requests transmitted by ATC. Long messages are abbreviated and followed by two periods.

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 reponse to WHEN CAN YOU ACCEPT uplinks.

Push - selects a CANNOT ACCEPT messsage.

Selection may be deleted.

3 REPORT

Push - displays ATC REPORT page.

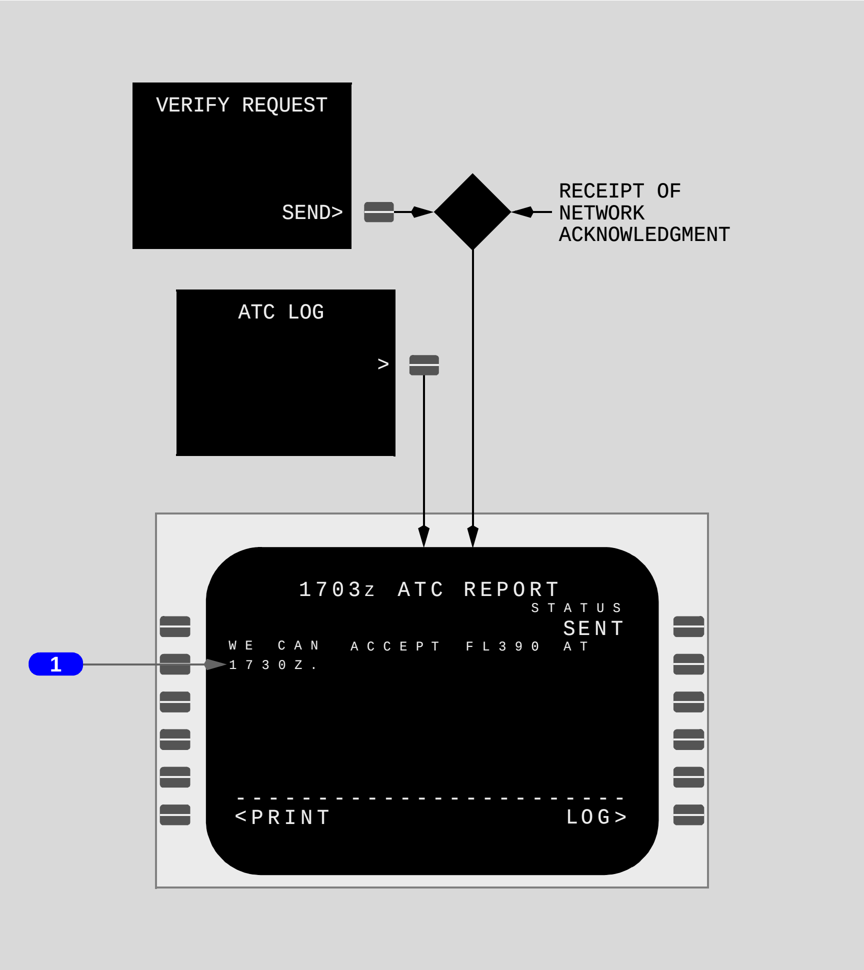
4 SEND

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.



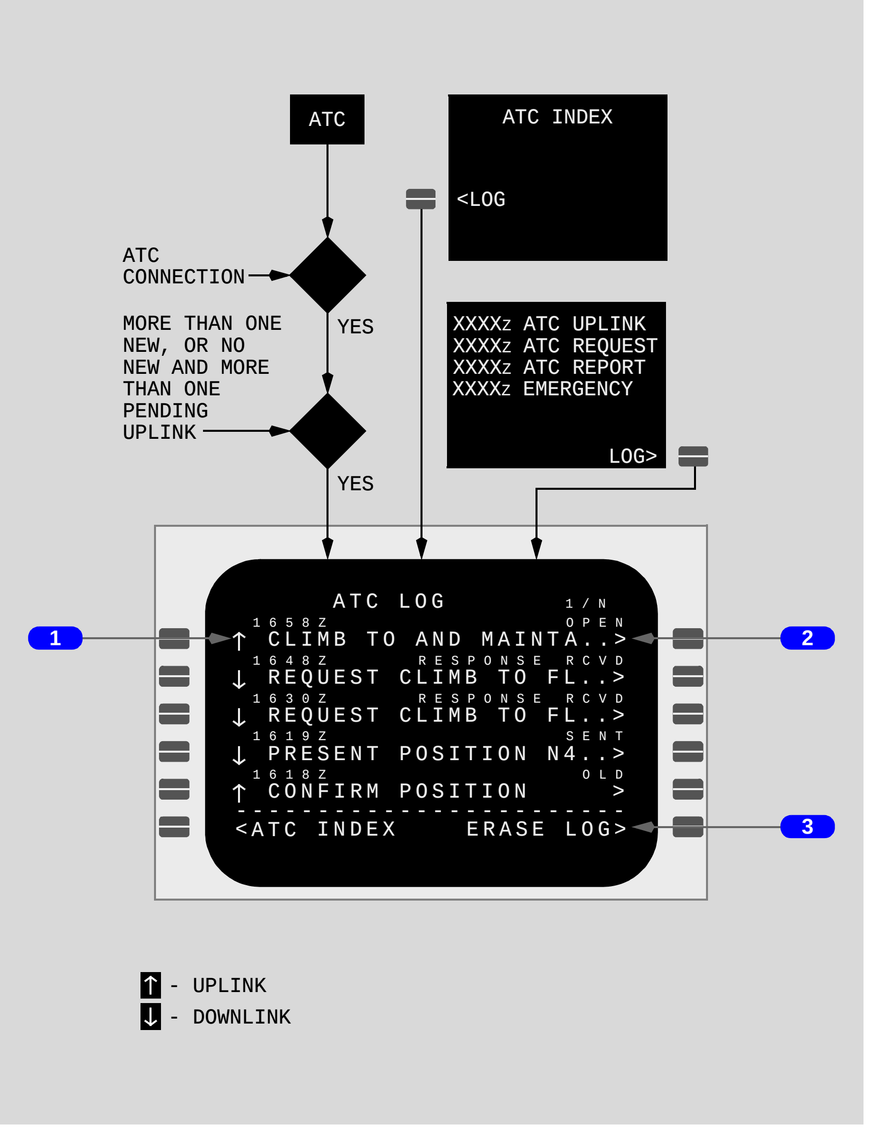
1 Report Text Lines 2 - 5

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 occured

Downlink -

- SENDING - SEND or RESEND prompt selected, network acknowledgement not yet received, message considered pending. Displays SENDING in field 5R on page downlink was initiated
- 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.

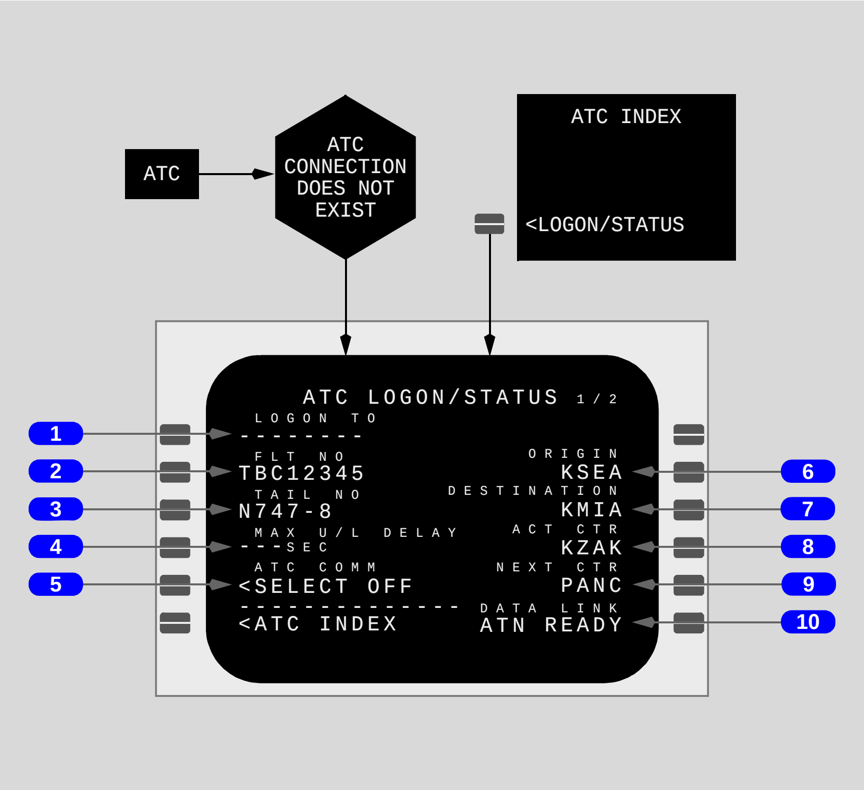
3 Erase Log

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)

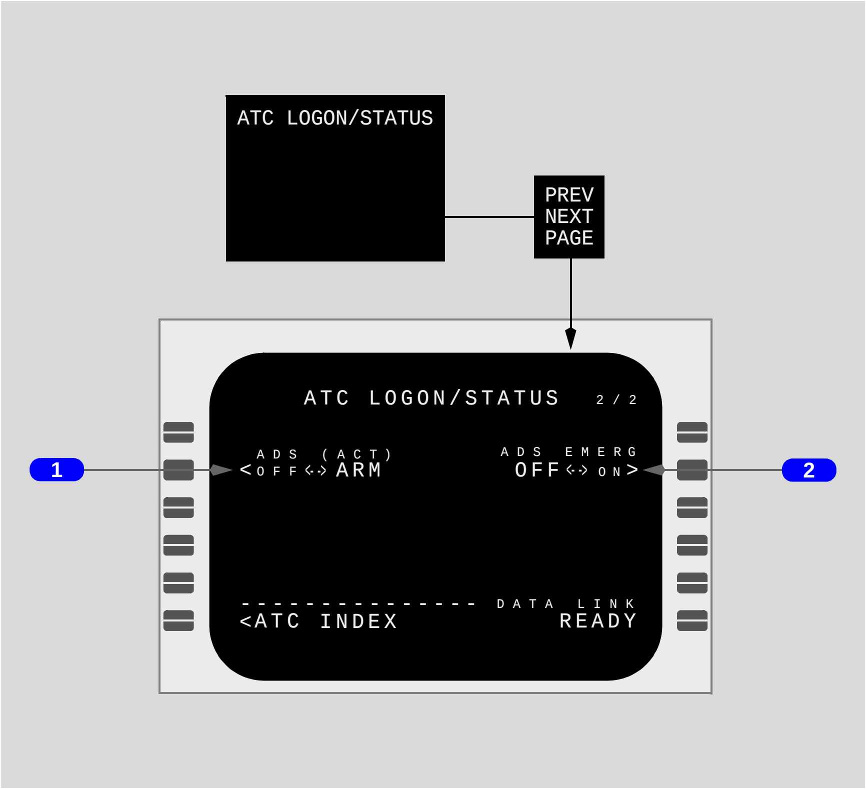
Displays four character identifier of next ATC center when valid uplink message containing the next center exists; otherwise, blank.

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 -

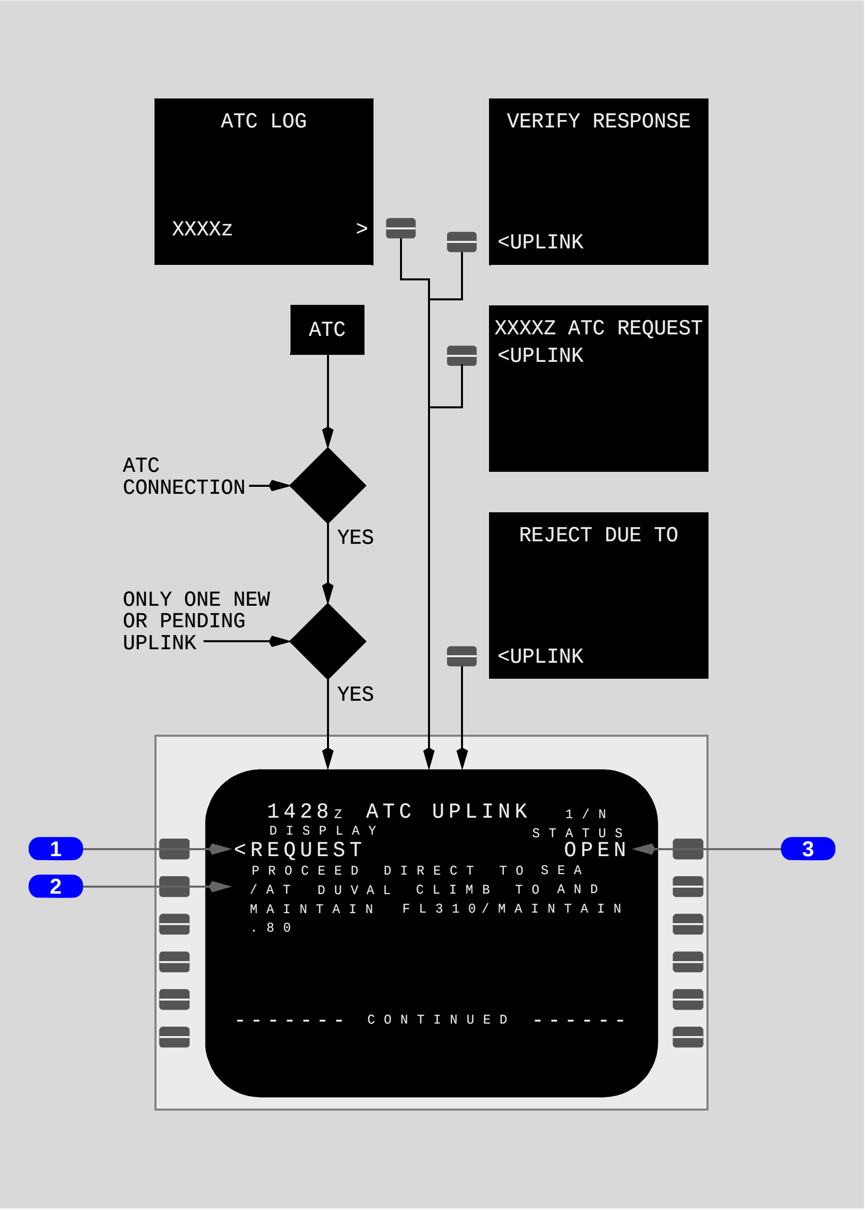
Push - puts ADS in emergency mode.

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.

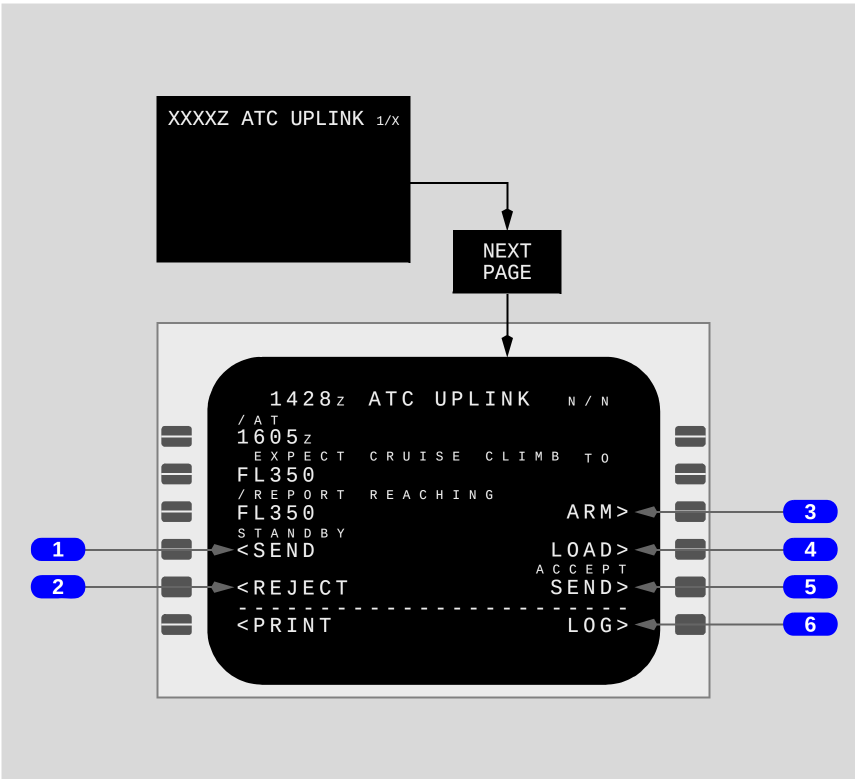
When the uplink message can not be fully displayed on lines 2 to 5, the message can be printed to review the full message.

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 -

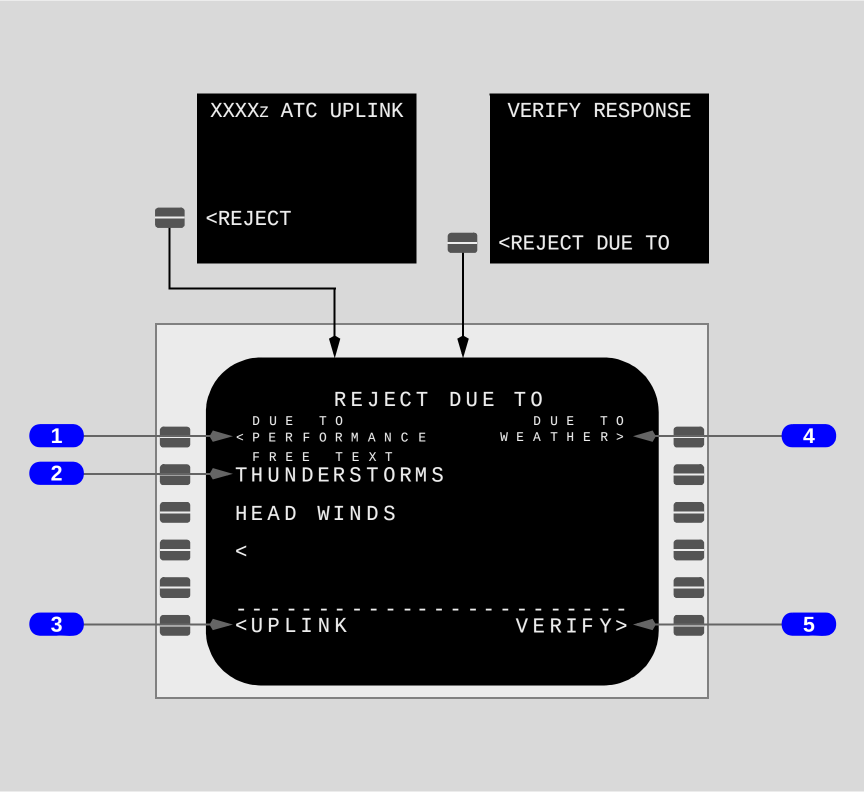
Push - displays ATC LOG page.

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.

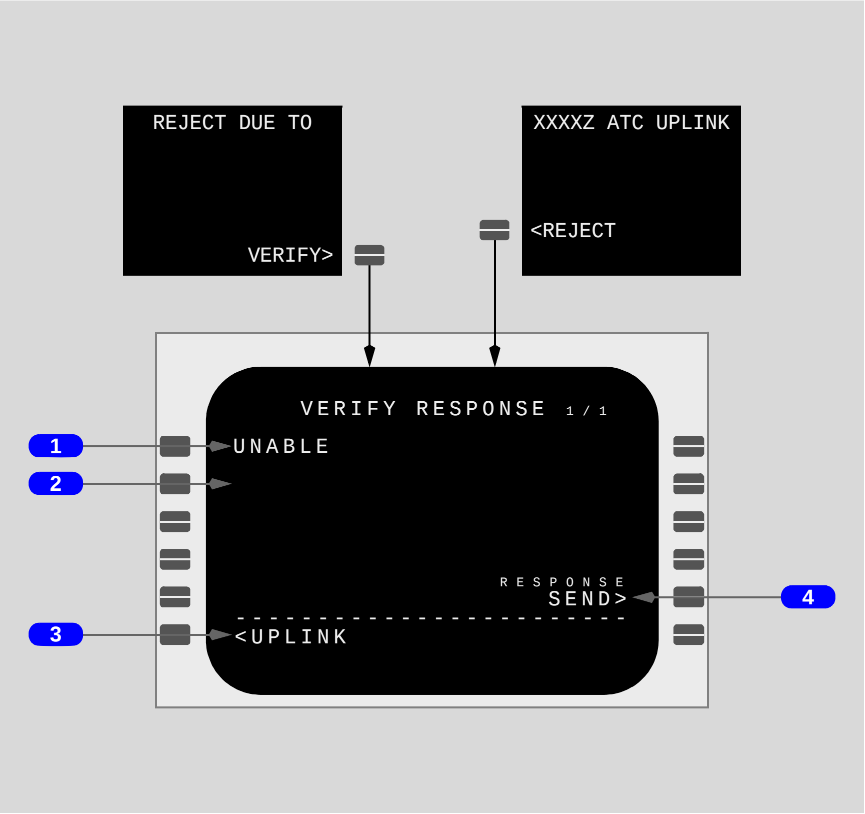
Push - selects DUE TO WEATHER message element in response downlink message.

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.

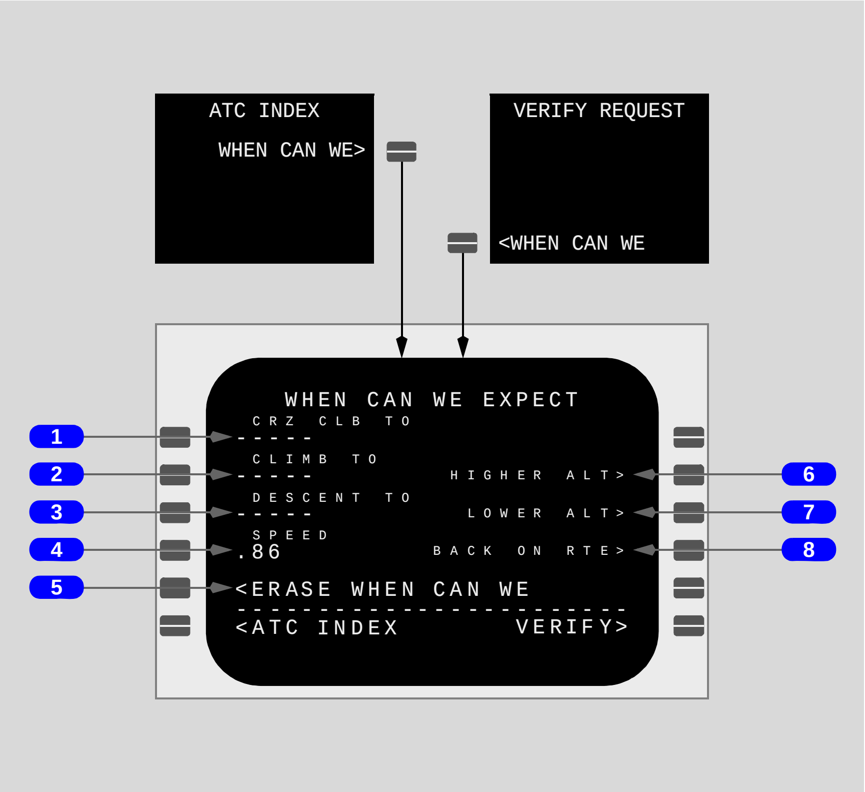
4 RESPONSE SEND

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.

Deferred Systems Content

914

This section contains deferred systems description content.

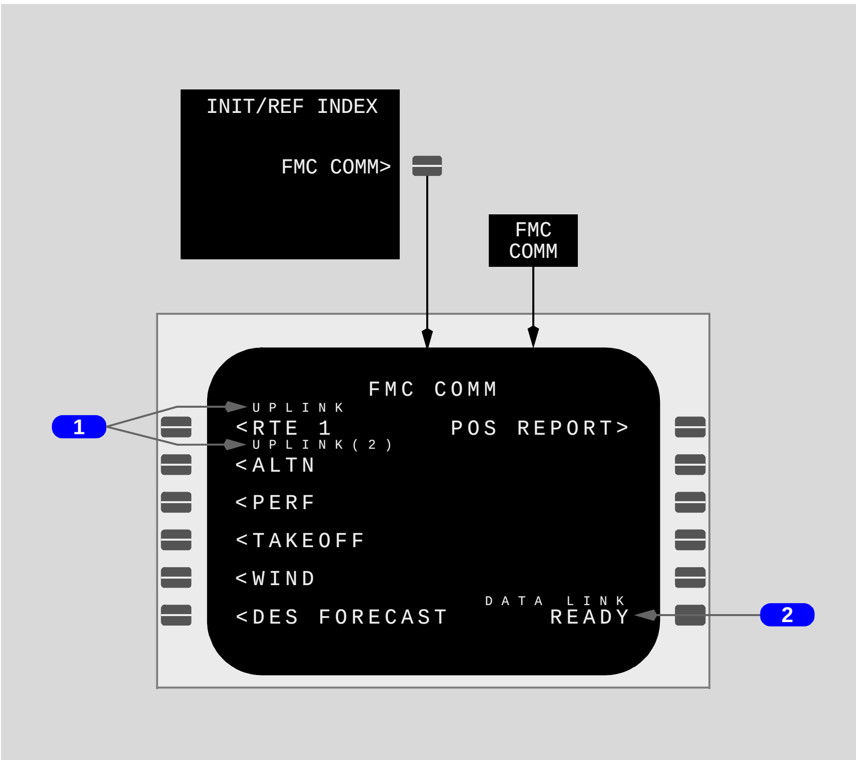
Deferred content is printed with strike-through text. For example, ~~ALTN LIST~~.

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:

914

- RTE X, ~~ALTN LIST~~, PERF, ~~TAKEOFF~~, and WIND uplinks are held until route activation or modifications are complete

806

- 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

914
~~When both ALTN and ALTN LIST uplinks are pending, "(2)" displays to the right of UPLINK in the line title.~~

806
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

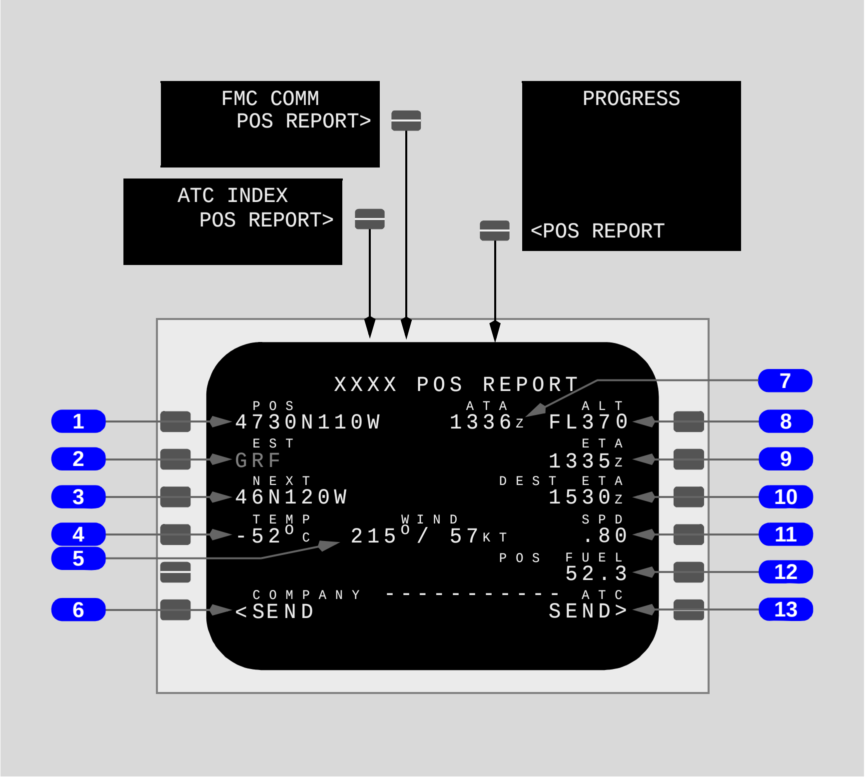
2 DATA LINK

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
- 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

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

Communications — Chapter 5
EICAS Messages — Section 40

EICAS Alert Messages

Message	Level	Aural	Message Logic
DATALINK LOST	Advisory		ACARS datalink is temporarily lost.
DATALINK SYS	Advisory		ACARS datalink is failed and not available.
HF DATA	Advisory		Selected HF radio failed and not available for ACARS data communication.
RADIO TRANSMIT	Advisory		VHF or HF radio is transmitting for 30 seconds or more.
SATCOM	Advisory		SATCOM system is failed.
SATCOM DATA	Advisory		ACARS data communication through SATCOM system is not available.
SATCOM VOICE	Advisory		SATCOM voice communication is not available. ACARS data communication through SATCOM is available.
SATVOICE LOST	Advisory		SATCOM voice communication is temporarily lost.

EICAS Communication Messages

Message	Level	Message Logic	Crew Action
•ATC	Medium	An ATC datalink message has been received.	Respond to message displayed on EICAS or push ATC key.
806			
•CABIN ALERT	Medium	Pilot alert received over cabin interphone.	Respond to the alert.
806			
•CABIN CALL	Medium	Pilot call received over cabin interphone.	Respond to the call.
806			
•CABIN READY	Medium	CABIN READY received over cabin interphone.	Crew awareness. Automatically removed after one minute.
•COMM	Medium/Low	A datalink message has been received.	Push MENU key. Select <DLNK.
•DATALINK AVAIL	Low	A lost datalink connection has been re-established.	Resume use of datalink communication.
•FMC	Medium	An FMC related datalink message has been received.	View the message title in the CDU scratchpad. Push FMC COMM key, or select appropriate CDU page.
806			
•GROUND CALL	Medium	Pilot call received over flight interphone from nose wheel well.	Respond to the call.

Message	Level	Message Logic	Crew Action
•PRINTER	Medium/Low	A datalink message has been received and sent to the printer.	Review the printed message.
•SATCOM CALL	Medium/Low	A SATCOM voice call has been received.	Respond to the call.
•SATVOICE AVAIL	Low	SATCOM voice capability re-established after a temporary loss.	Resume use of SATCOM voice.

EICAS Memo Messages

Message	Message Logic
HF DATA OFF	Selected HF radio in voice mode and not available for ACARS data communication.
VHF DATA OFF	All VHF radios in voice mode and not available for ACARS data communication.

FMC Messages

For FMC Message information, refer to Chapter 11.60.

Electrical — Chapter 6
Table of Contents — Section TOC

Intentionally
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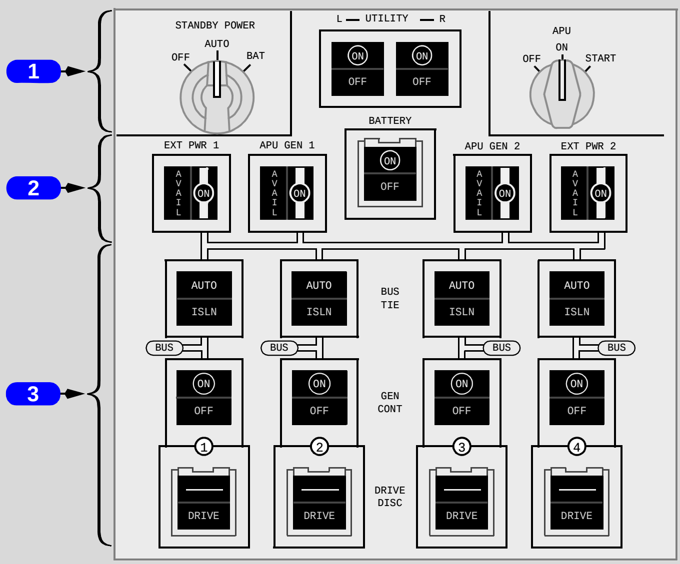
Electrical — Chapter 6
Controls and Indicators — Section 10

Electrical Panel



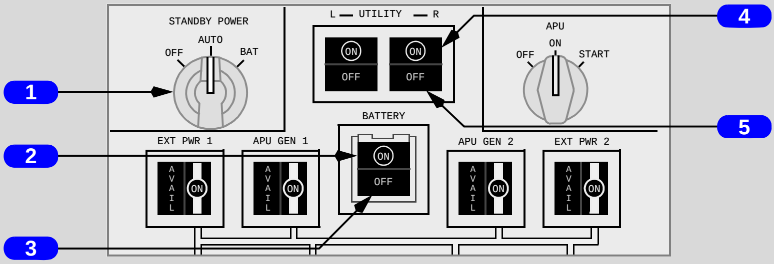
OVERHEAD PANEL

1 **Standby Power, Battery, and Utility Bus Controls**

2 **APU Generators and External Power Controls**

3 **AC Bus and Generator Controls**

Standby Power, Battery, and Utility Bus Controls



OVERHEAD PANEL

1 STANDBY POWER Selector

Push to turn.

OFF -

- standby power not available
- main standby bus and APU standby bus not powered

AUTO - main bus and APU standby busses powered from available sources.

BAT -

- BAT position for ground maintenance use only.
- main battery charger and APU battery charger are not powered.
- with Battery switch ON:
  - battery bus is powered from main battery through main hot battery bus
  - APU battery bus is powered from APU battery through APU hot battery bus
  - main standby bus is powered from main battery through main standby power inverter
  - APU standby bus is powered from APU battery through the APU standby power inverter.

2 BATTERY Switch

ON -

- main battery is available as backup power source for main battery bus and main standby bus
- APU battery is available as backup power source for APU battery bus and APU standby bus

Off (ON not visible) - main battery bus and APU battery bus are not powered.

3 BATTERY Switch OFF Light

Illuminated (amber) - Battery switch is off

4 UTILITY Power Switches

806
ON (each switch) - two utility Electrical Load Control Units (ELCUs) and two galley ELCUs are powered

914
ON - two utility Electrical Load Control Units (ELCUs) are powered

Off (ON not visible) -

- ELCUs are not powered
- resets ELCU fault protection system

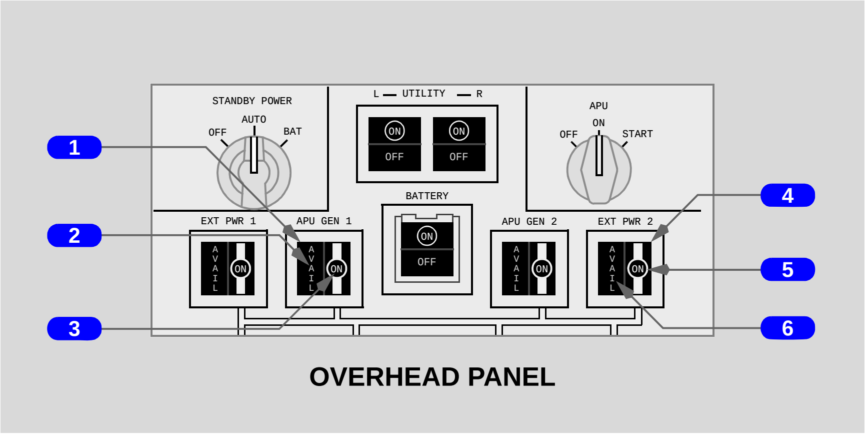
5 UTILITY Power OFF Lights

Illuminated (amber) -

- ELCU fault has occurred and ELCU is not powered, or

  806
- one or more Galley Emergency Power Off switches are off, or
- Utility Power switch is off.
- not illuminated during load shedding.

APU Generator and External Power Controls



1 APU Generator (APU GEN) Switches

Push -

- when APU Generator AVAIL light is illuminated, connects APU generator to the AC electrical system

914
Note: When the main deck cargo handling bus is powered by APU generator two, pushing APU Generator Two switch disconnects power to main deck cargo handling bus.

- when APU Generator ON light is illuminated, disconnects APU generator from the AC electrical system
- when External Power ON light is illuminated, disconnects external power from the AC electrical system

2 APU Generator Available (AVAIL) Lights

Illuminated (white) -

- APU generator power quality is acceptable

914
- when APU Generator Two AVAIL light is illuminated, main deck cargo handling bus is powered
- extinguished when respective APU Generator ON light is illuminated

3 APU Generator ON Lights

Illuminated (white) -

- APU generator is connected to the AC electrical system
- extinguished when respective APU Generator AVAIL light is illuminated

4 External Power (EXT PWR) Switches

Push -

- when External Power AVAIL light is illuminated, connects external power to AC electrical system

914
Note: When the main deck cargo handling bus is powered by external power two, pushing External Power Two switch disconnects power to main deck cargo handling bus

- when External Power ON light is illuminated, disconnects external power from the AC electrical system

5 External Power ON Lights

Illuminated (white) -

- respective external power is connected to AC electrical system
- extinguished when External Power Available light is illuminated

6 External Power Available (AVAIL) Lights

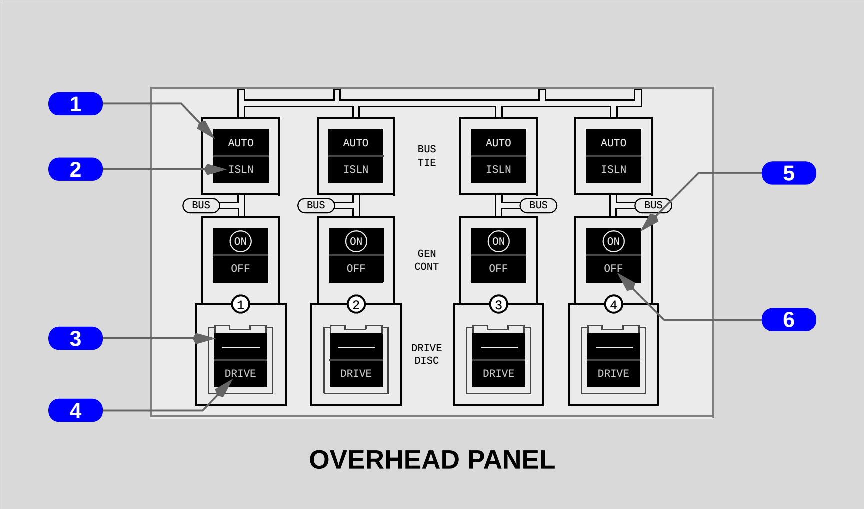
Illuminated (white) -

- external power source plugged in and power quality acceptable
- extinguished when respective External Power ON light is illuminated

  914
- main deck cargo handling bus is powered when External Power Two AVAIL light is illuminated

914
Note: When both External Power Two AVAIL and APU Generator Two AVAIL lights are illuminated, external power two powers the main deck cargo handling bus. Pushing the External Power Two switch connects APU generator two to the main deck cargo handling bus and disconnects external power two from the main deck cargo handling bus.

AC Bus and Generator Controls



1 BUS TIE Switches

AUTO -

- arms automatic AC bus tie circuitry
- respective DC isolation relay (DCIR) is closed

Off -

- BTB and respective DCIR are open
- resets fault logic circuitry

2 Bus Isolation (ISLN) Lights

Illuminated (amber) -

- BTB is open
- AC bus is disconnected from synchronous bus

3 Drive Disconnect (DRIVE DISC) Switches

Push -

- disconnects IDG from engine when above idle speed
- opens respective Generator Control Breaker (GCB)

Note: Ground maintenance action is required to reconnect IDG.

4 Drive Disconnect DRIVE Lights

Illuminated (amber) -

- IDG oil pressure low, or
- IDG oil temperature high, or
- GCB is open due to uncorrectable generator frequency fault

5 Generator Control (GEN CONT) Switches

ON - GCB armed to close when generator power quality acceptable

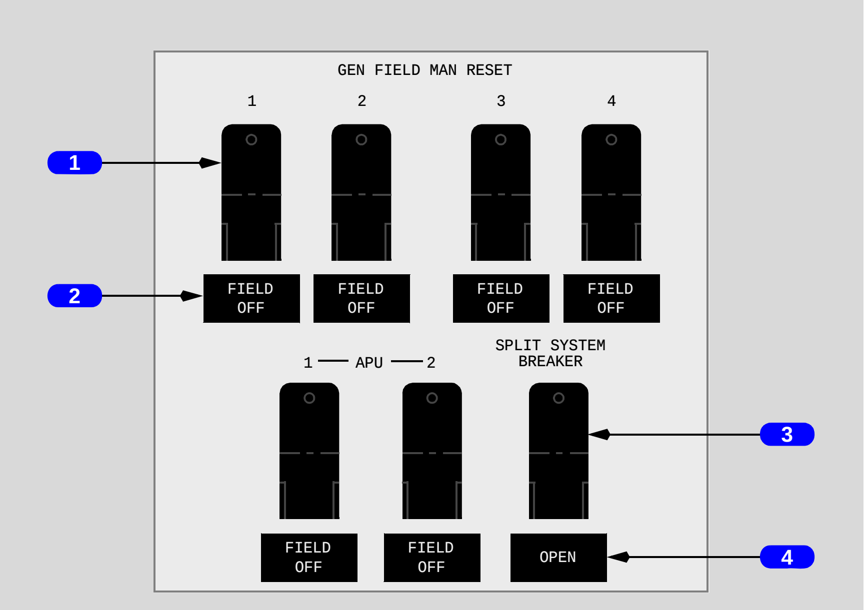
Off -

- generator field and GCB is open
- fault control logic circuitry is reset
- generator is disconnected from respective AC bus

6 Generator Control OFF Lights

Illuminated (amber) - GCB is open

Overhead Maintenance Panel
Generator Field Manual Reset and Split System Breaker Switches



OVERHEAD MAINTENANCE PANEL

1 Generator Field Manual Reset (GEN FIELD MAN RESET) Switches

Push - (spring-loaded toggle, guarded) opens or closes generator field if respective Generator Control switch or APU Generator switch is off

2 Generator FIELD OFF Lights

Illuminated (white) - generator field is not powered.

3 SPLIT SYSTEM BREAKER Switch

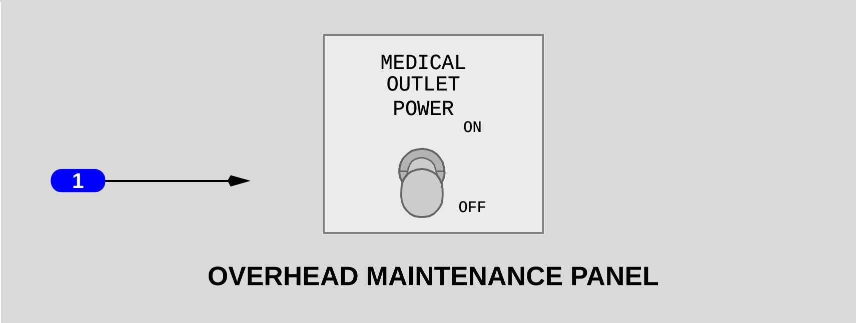
Push - (spring-loaded toggle, guarded) on the ground, opens or closes split system breaker.

4 Split System Breaker OPEN Light

Illuminated (white) - split system breaker is open.

Medical Outlets Switch

806

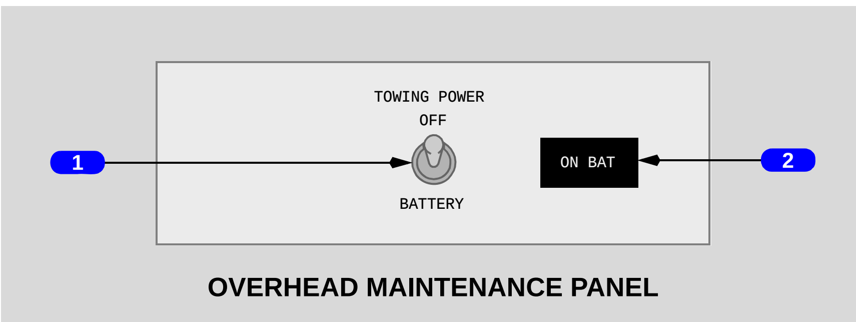


1 MEDICAL OUTLETS POWER Switches

ON - medical outlets in passenger cabin are powered.

OFF - medical outlets in passenger cabin are not powered.

Towing Power Switch



1 Towing Power Switch

BATTERY - towing power bus is powered from main battery.

Note: Standby Power selector must be OFF.

OFF - towing power bus is not powered.

2 ON BAT Light

Illuminated (flashing) - towing power bus is powered.

Electrical Synoptic Display

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

Power flow displayed is generated by various systems breakers, switch positions, and electrical equipment status. It does not display actual power flow, therefore the display may not represent actual system operation.

Symbols are displayed in low intensity white when source data is invalid or unavailable. DC power flow is not represented.

During autoland, when bus tie breakers 1, 2, and 3 are open, the message "ELECTRICAL SYNOPTIC INHIBITED FOR AUTOLAND" is displayed.

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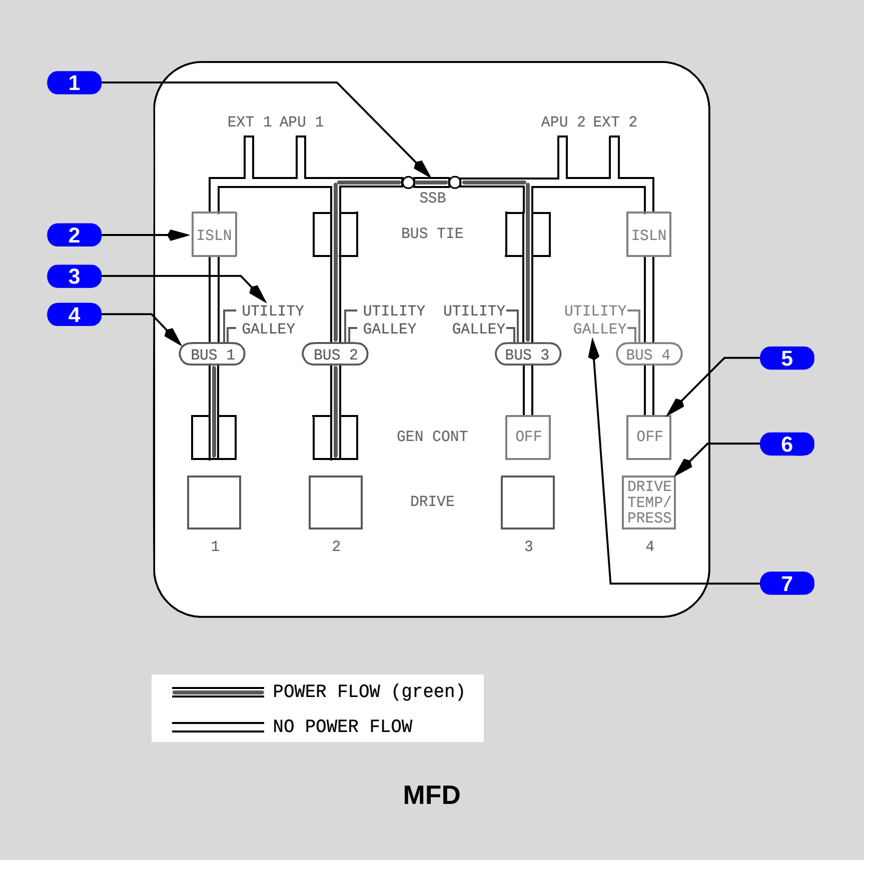

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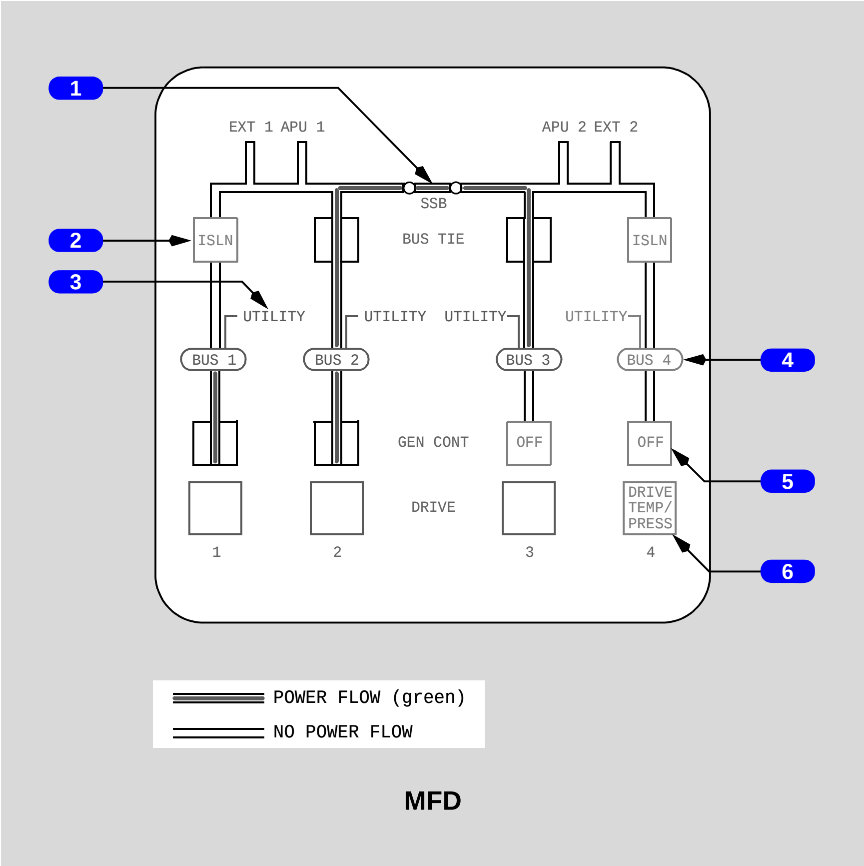

1 **SSB (Split System Breaker)**

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

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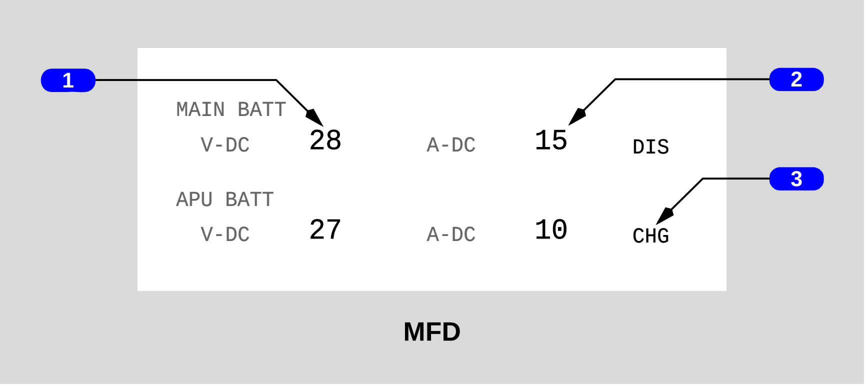
7 GALLEY

- green - galley bus powered
- amber - galley bus not powered

Battery Condition

Battery condition displays on the status page by pushing Status 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.

Electric power sources and the distribution system detects and isolates faults automatically. When a power source is not available, the system reconfigures automatically to ensure electrical power loads are within the capacity of the operating power sources.

AC Electrical System

The AC electrical system is the main source of airplane electrical power.

Electrical Load Management and Load Shedding

Electrical system overload protection is provided by a load management system configured to ensure power is available to critical and essential equipment.

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If electrical loads exceed power available (airplane or external), the load management system sheds AC loads by priority until the loads are within the capacity of airplane or ground power generators. Loads are shed one at a time through ELCUs in a programmed sequence until the overload condition is relieved. Galley busses are shed first, followed by utility busses. When an additional AC power source is available, loads are restored in reverse order.

914
If electrical loads exceed power available (airplane or external), the load management system sheds AC loads by priority until the loads are within the capacity of airplane or ground power generators. Utility bus loads are shed one at a time through ELCUs in a programmed sequence until the overload condition is relieved. When an additional AC power source is available, loads are restored in reverse order.

During load shedding, the EICAS advisory messages ELEC UTIL BUS and Utility Power Off lights are inhibited. However, the following EICAS alert messages may be displayed in the order shown depending upon fuel system configuration and the extent of load shedding:

- FUEL PUMP 3 FWD
- FUEL OVRD 2 FWD
- FUEL OVRD 3 FWD

- FUEL OVD CTR L
- FUEL PUMP 2 FWD

AC Electrical System Power Sources

The main AC electrical power sources are:

- four IDGs
- two 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. The EICAS advisory message DRIVE DISC when the Drive Disconnect switch is pushed and the generator frequency is less than 100 Hz. When an IDG is disconnected the generator cannot be reconnected by flight crew action.

The EICAS advisory message ELEC DRIVE is displayed for low IDG oil pressure or high IDG oil temperature.

The ELEC DRIVE message is also displayed if a GCB is open because an uncorrectable generator frequency fault occurred.

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Excessively high drive oil temperature disconnects the IDG automatically if not manually disconnected by flight crew action. The EICAS advisory message ELEC GEN OFF is displayed and the loss of generator power output causes the GCB to open.

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Excessively high drive oil temperature disconnects the IDG automatically if not manually disconnected by flight crew action. The EICAS caution message ELEC GEN OFF is displayed and the loss of generator power output causes the GCB to open.

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 to open or close 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 to maintain 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 that 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 or external power. The SSB remains open.

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Note: When cargo handling is required, selecting only the number one auxiliary or external power source ON ensures the main deck cargo handling bus remains powered.

AC Electrical Power Distribution

AC power is distributed by the following busses:

- four main busses
- two transfer busses
- ground service and ground handling busses

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- 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 is displayed 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

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- Each AC bus powers a utility bus

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- 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

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- upper deck emergency doors
- flight deck flood, navigation, and service lights
- miscellaneous service outlets and equipment

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- horizontal stabilizer fuel pump for defueling

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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.

914
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 cabin panel at door 1L.

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

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 EFIS control, right EIU, right FMC
- right CDU, right HF, right ND, right PFD

Utility and Galley Busses
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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 is displayed and the utility OFF light is illuminated 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 is displayed and utility OFF light is illuminated. Cycling the flight deck Utility Power switch OFF, then ON will not reset the indications. The flight deck Utility Power switch should remain ON after cycling, which permits the remaining utility and galley busses to be powered and controlled by their related ELCU.

Utility Busses
914

Each main AC bus powers one utility bus. Each utility bus is controlled by an ELCU that protects the electrical system from utility bus faults and provides load management through automatic load shedding. With the Left Utility Power switch ON, utility busses 1 and 2 are powered according to ELCU logic. With the Right Utility Power switch ON, utility busses 3 and 4 are powered according to ELCU logic.

Utility busses power individual equipment items such as:

- forward main fuel pumps 2 and 3
- forward override/jettison pumps 2 and 3
- center override/jettison pump
- galley equipment

The EICAS message ELEC UTIL BUS is displayed and the utility OFF light is illuminated if one or both utility busses are unpowered due to a fault, or the related utility power switch is OFF. Cycling the Utility Power switch OFF, then ON restores power to the affected bus if the fault is corrected.

Main Deck Cargo Handling Bus
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The main deck cargo handling bus is powered on the ground when external power 2 or APU generator 2 is available. An interlock prevents either source from powering main electrical busses and the main deck cargo handling bus simultaneously. Pushing the available power source switch ON deengergizes the main deck cargo handling bus. When both external power 2 and APU generator 2 are available, external power is used. Pushing External Power 2 switch ON transfers main deck cargo handling loads to APU generator 2.

Note: When cargo handling is required, selecting only the number one auxiliary or external power source ON ensures the main deck cargo handling bus remains powered.

The main deck cargo handling bus powers equipment items such as:

- main deck cargo handling equipment and lighting
- nose and side cargo doors

Towing Power Bus

The towing power bus powers systems required during airplane towing operations. With the Standby Power Selector OFF and Towing Power Switch in the BATTERY position, the towing power bus is powered by the main battery through the main hot battery bus. The towing power bus powers these equipment items:

- brake pressure indicator and integral lighting
- Captain and center panel flood lights
- Captain interphone
- parking brake valve
- position/navigation lights

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 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
- main and APU batteries
- main and APU standby inverters
- Standby Power selector

Main Standby Bus

The main standby bus is normally powered by AC bus 3. With the Battery switch ON, Standby Power selector in AUTO, and AC bus 3 not powered, the main standby bus is powered by the main standby inverter. The main standby inverter, normally unpowered, is activated and receives power from the main battery charger through the main hot battery bus. The main battery charger is normally powered by AC bus 1 through the ground service bus.

With the Battery switch ON, Standby Power selector in AUTO, and both AC bus 1 and AC bus 3 not powered, the main standby bus is powered by the main standby inverter. The main standby inverter, normally unpowered, is activated and receives power from the main battery through the main hot battery bus. With the main battery charger unpowered, the main battery can provide power to the main standby bus for a minimum of 30 minutes.

The main standby bus powers individual equipment items such as:

- left EIU, left CDU, left ILS, left VOR
- various flight control components
- standby ignition for all engines
- primary EICAS display, standby instrument lights
- left ADC, left transponder, left EFIS control panel

APU Standby Bus

The APU standby bus is normally powered by the Captain transfer bus. With the Battery switch ON, Standby Power selector in AUTO, and the Captain transfer bus not powered (loss of AC busses 1 and 3), the APU standby bus is powered by the APU standby inverter. The APU standby inverter, normally unpowered, is activated and receives power from the APU battery through the APU hot battery bus. With the APU battery charger unpowered, the APU battery can provide power to the APU standby bus for a minimum of 30 minutes.

The APU standby bus powers these equipment items:

- left FMC
- left ND
- left PFD

Standby Power Selector - BAT Position

With the Battery switch ON and Standby Power selector in BAT, main and APU battery chargers are disabled. Each AC standby bus is powered by its related battery and inverter. Each battery can provide power for a minimum of 30 minutes.

Note: The Standby Power selector must be in AUTO for flight. The BAT position is for ground maintenance use only.

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 integrated air system controllers
- wing anti-ice control
- engine-driven and hydraulic demand pump control
- fuel transfer and jettison valve control
- individual engine nacelle inlet anti-icing 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

- ISFD

Note: The ISFD is powered by a dedicated battery/charger system capable of providing power for up to 150 minutes after loss of power to the main battery bus.

The APU battery bus powers individual equipment items such as:

- APU DC fuel pump, engine start air control
- Cargo, First Officer, and service interphones, PA system
- APU and engine fire/overheat detection loops A and B
- APU fire warning horn

Each hot battery bus is normally powered by the ground service bus through its related battery charger, which acts as a TRU for the hot battery bus while simultaneously maintaining its related battery fully charged. Each battery is directly connected to its related hot battery bus.

With the Battery switch ON, the main and APU hot battery busses power their related battery busses if either AC bus 3 or DC bus 3 is unpowered.

The main hot battery bus powers individual equipment items such as:

- APU fuel shutoff valve, spar valves (all engines)
- APU and lower cargo fire extinguishers
- engine fire extinguishers (all engines), fire switch unlock (all engines)

The APU hot battery bus powers individual equipment items such as:

- IRU left, center, right DC power
- left and right outflow valves
- APU inlet door, APU controller (primary)

Electrical System Diagram

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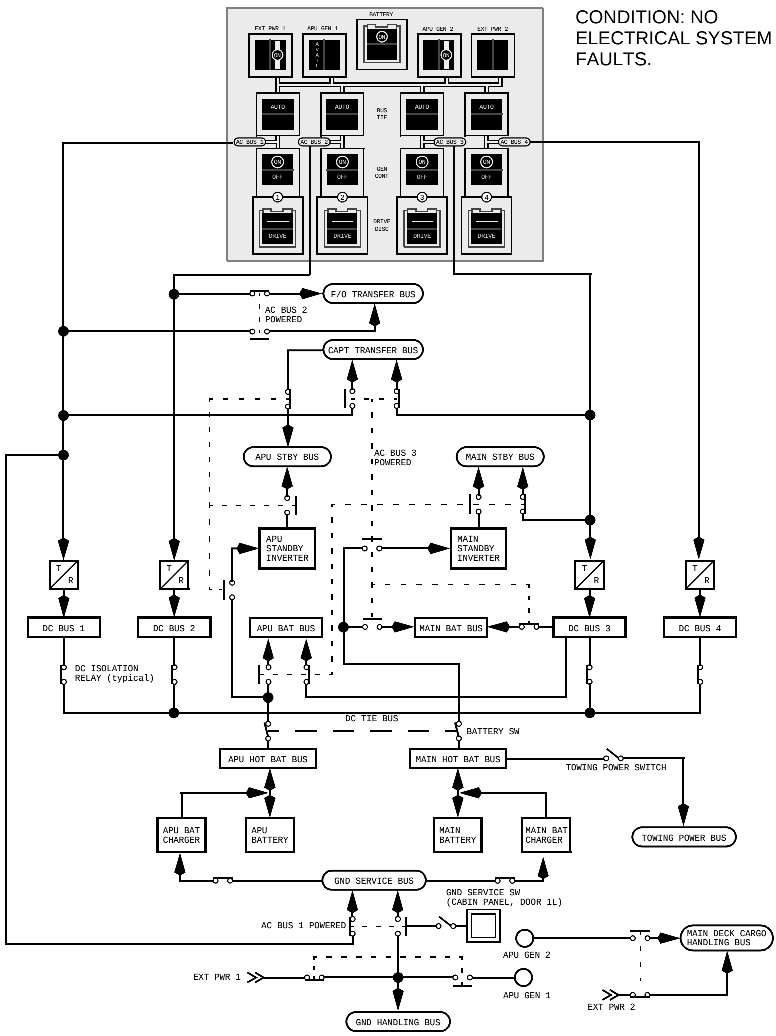

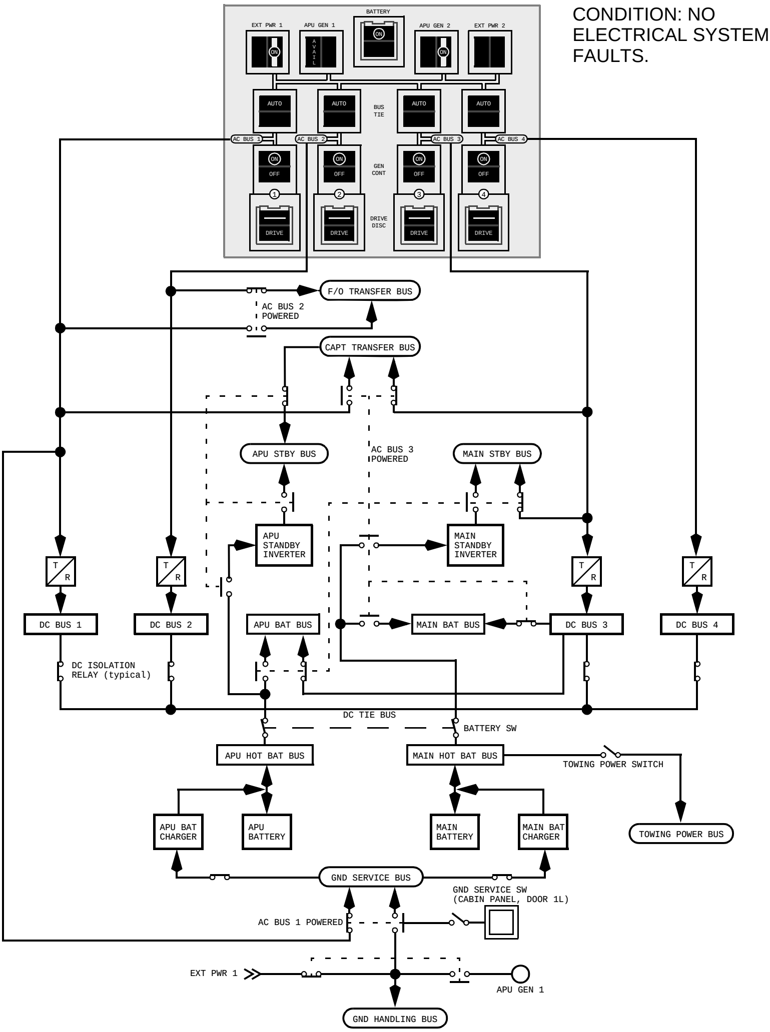
CONDITION: NO ELECTRICAL SYSTEM FAULTS.
EXT PWR 1
APU GEN 1
BATTERY
APU GEN 2
EXT PWR 2
ON
AVAIL
AUTO
BUS TIE
AC BUS 1
AC BUS 2
AC BUS 3
AC BUS 4
OFF
GEN CONT
DRIVE
DRIVE DISC
F/O TRANSFER BUS
AC BUS 2 POWERED
CAPT TRANSFER BUS
APU STBY BUS
AC BUS 3 POWERED
MAIN STBY BUS
APU STANDBY INVERTER
MAIN STANDBY INVERTER
T R
DC BUS 1
DC BUS 2
APU BAT BUS
MAIN BAT BUS
DC BUS 3
DC BUS 4
DC ISOLATION RELAY (typical)
DC TIE BUS
BATTERY SW
APU HOT BAT BUS
MAIN HOT BAT BUS
TOWING POWER SWITCH
APU BAT CHARGER
APU BATTERY
MAIN BATTERY
MAIN BAT CHARGER
TOWING POWER BUS
GND SERVICE BUS
GND SERVICE SW (CABIN PANEL, DOOR 1L)
AC BUS 1 POWERED
EXT PWR 1
APU GEN 1
GND HANDLING BUS

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EICAS Alert Messages

Message	Level	Aural	Message Logic
BAT DISCH APU	Advisory		APU battery is discharging.
BAT DISCH MAIN	Advisory		Main battery is discharging.
BATTERY OFF	Advisory		Battery switch is OFF.
DRIVE DISC 1, 2, 3, 4	Advisory		Engine generator drive is disconnected.
ELEC AC BUS 1, 2, 3, 4	Caution	Beeper	AC bus is not powered
ELEC BUS CONTROL	Caution	Beeper	Both bus control units (BCUs) are failed and automatic load shedding is inhibited.
ELEC BUS ISLN 1, 2, 3, 4	Advisory		Bus tie breaker is open.
ELEC DRIVE 1, 2, 3, 4	Advisory		IDG oil pressure low, oil temperature high, or GCB open due to uncorrectable generator frequency fault.

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Message	Level	Aural	Message Logic
ELEC GEN OFF 1, 2, 3, 4	Advisory		Generator control breaker is open.

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Message	Level	Aural	Message Logic
ELEC GEN OFF 1, 2, 3, 4	Caution	Beeper	Generator control breaker is open.
ELEC SSB OPEN	Advisory		Split system breaker is failed open.

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Message	Level	Aural	Message Logic
ELEC UTIL BUS L, R	Advisory		One or more galley or utility busses are not powered.

Message	Level	Aural	Message Logic

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Message	Level	Aural	Message Logic
ELEC UTIL BUS L, R	Advisory		One or more utility busses are not powered.
STBY BUS APU	Advisory		APU standby bus is not powered.
STBY BUS MAIN	Advisory		Main standby bus is not powered.

Engines, APU — Chapter 7
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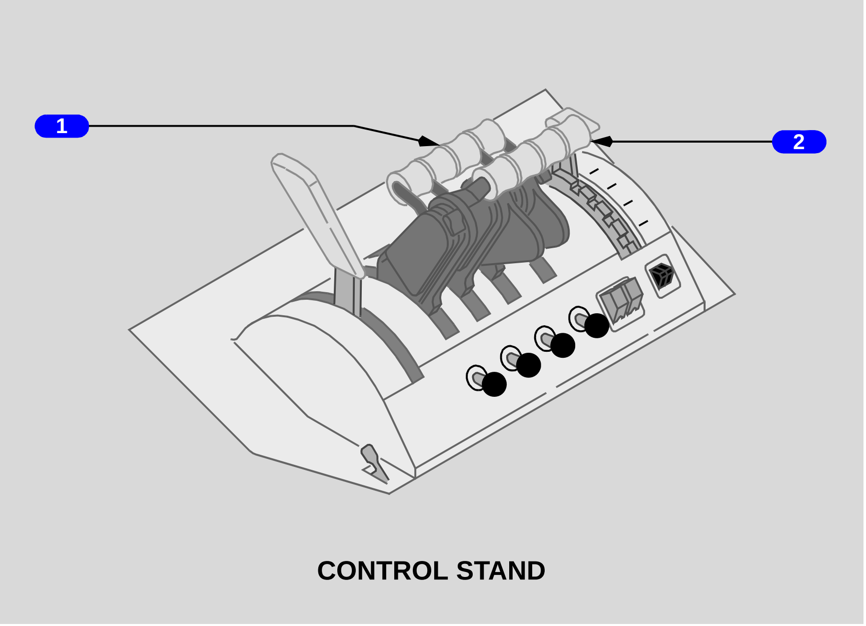
Engine Controls
Thrust Levers



1 Reverse Thrust Levers

Control engine reverse thrust.

Reverse thrust can only be selected when Forward Thrust levers are closed.

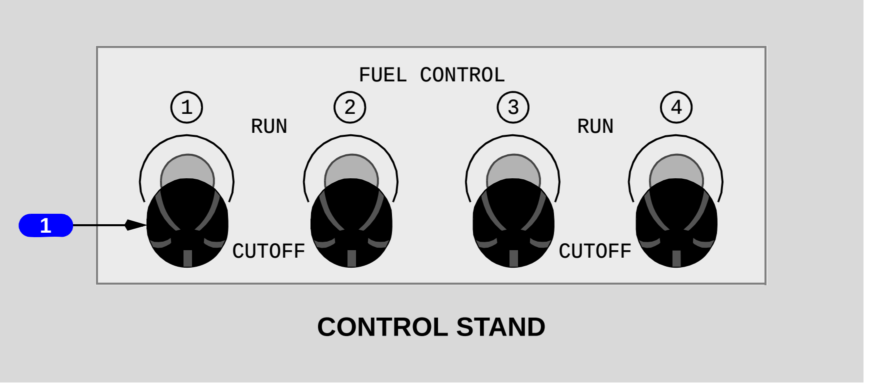
Actuates automatic speedbrakes (refer to Chapter 9, Flight Controls).

2 Forward Thrust Levers

Control engine forward thrust.

Thrust levers can only be advanced when Reverse Thrust levers are down.

Fuel Control Switches



1 FUEL CONTROL Switches

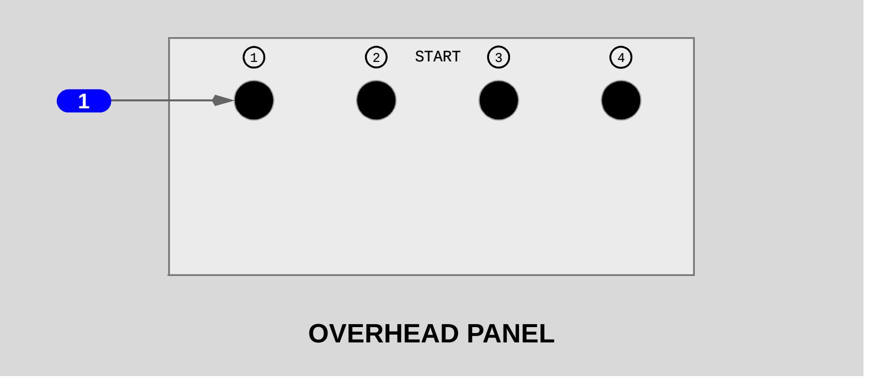
RUN -

- opens spar fuel valve
- arms the engine fuel valve (the EEC opens the valve when required)
- arms the selected igniter(s) (the EEC turns the igniters on when required)

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

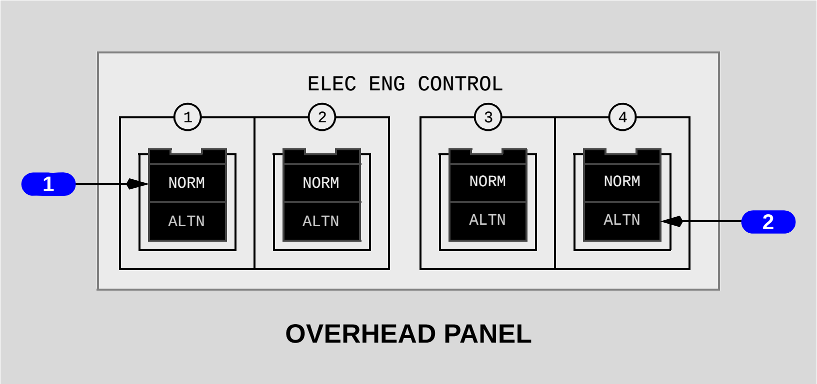
Pull -

- EEC opens start valve

Releases at idle N2 RPM -

- EEC closes start valve prior to release

Electronic Engine Control Panel



1 Electronic (ELEC) Engine (ENG) CONTROL Switches

NORM (Normal) -

- selects normal engine control mode
- electronic engine control sets thrust using N1 RPM as the controlling parameter

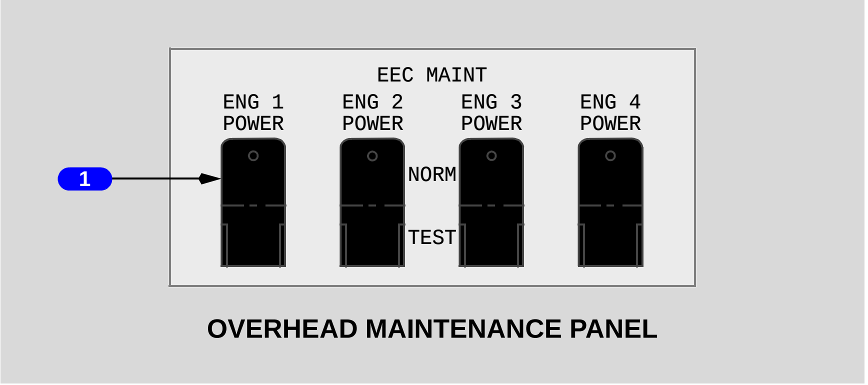
Alternate -

- selects alternate engine control mode
- thrust set using N1 RPM as controlling parameter

2 EEC Alternate (ALTN) Lights

Illuminated (amber) - alternate engine control mode selected.

Electronic Engine Control Maintenance Panel



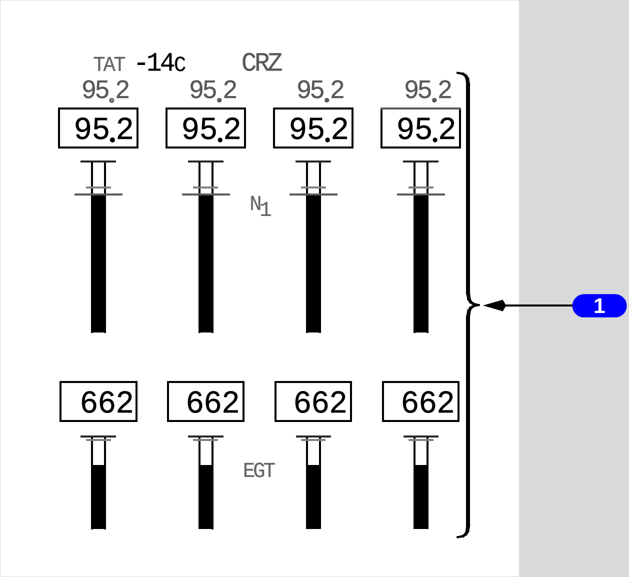
1 EEC Maintenance (MAINT) POWER Switches

Normal (NORM) - supplies electrical power for normal EEC operation.

TEST - supplies electrical power for EEC maintenance testing when engine not running.

Primary Engine Indications

Primary Engine Display



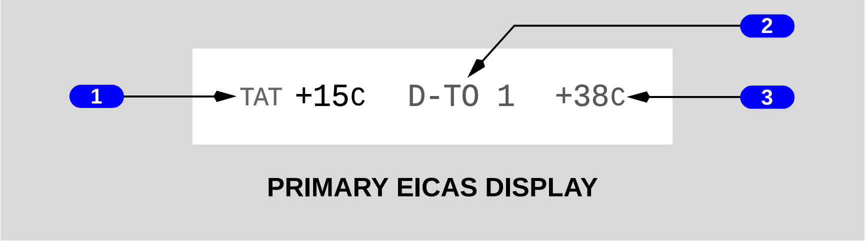
PRIMARY EICAS DISPLAY

1 Primary Engine Indications

Displayed full time on EICAS display:

- N1
- EGT

Total Air Temperature (TAT), Thrust Reference, and Assummed Temperature Indications



1 Total Air Temperature (TAT)

(white) - TAT (degrees C).

2 Thrust Reference

(green) -

- TO - maximum rated takeoff thrust
- TO 1 - derate one takeoff thrust
- TO 2 - derate two takeoff thrust
- D-TO - assumed temperature derated takeoff thrust
- D-TO 1 - derate one assumed temperature derated takeoff thrust
- D-TO 2 - derate two assumed temperature derated takeoff thrust
- CLB - maximum rated climb thrust
- CLB 1 - derate one climb thrust
- CLB 2 - derate two climb thrust
- Q-CLB - quiet climb thrust
- CRZ - maximum rated cruise thrust
- CON - maximum rated continuous thrust
- GA - maximum rated go-around thrust

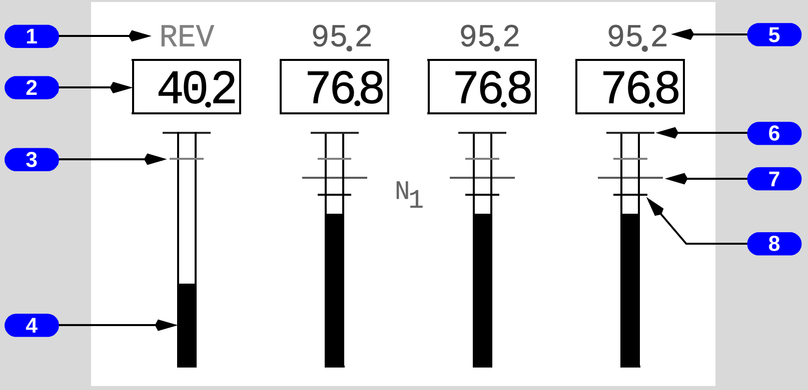
3 Assumed Temperature

(green) - selected assumed temperature (degrees C) for reduced thrust takeoff.

N1 Indications

Note: When reverse thrust is activated, the following indications are not displayed:

- command N1
- reference N1



PRIMARY EICAS DISPLAY

1 Thrust Reverser Indication

Displayed REV (amber) - reverser in transit.

Displayed REV (green) - reverser fully deployed.

2 N1

Digital N1 RPM displayed:

- (white) - normal operating range
- (red) - operating limit reached

3 Maximum N1 Line

Displayed (amber).

4 N1 Indication

N1 RPM, displayed:

- (white) - normal operating range
- (red) - operating limit reached

5 Reference N1

Displayed (digital, green) - reference thrust selected by FMC.

6 N1 Red Line

Displayed (red) - N1 RPM operating limit.

7 Reference N1 Indicator

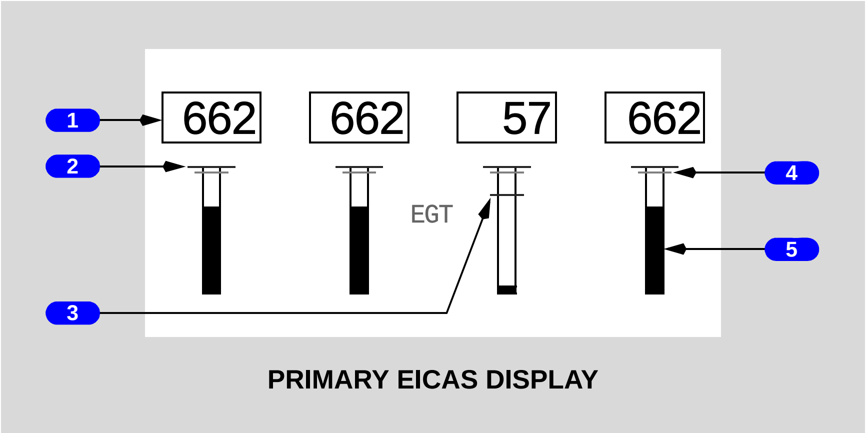
Displayed (green) - reference N1.

Displayed (magenta) - target N1 commanded by FMC.

8 Command N1 Indicator

Displayed (white) - N1 RPM commanded by thrust lever position.

EGT Indications



1 EGT

EGT (degrees C), displayed:

- (white) - normal operating range
- (amber) - continuous limit reached
- (red) - start or takeoff limit reached

Note: Indication remains white during TO or GA for five minutes (or ten minutes if one engine fails or is shut down) even though continuous EGT limit is reached.

2 EGT Red Line

Displayed (red) - takeoff or in-flight start EGT limit.

3 EGT Start Limit Line

Displayed (red):

- with Fuel Control switch in CUTOFF
- until N2 reaches idle RPM

4 EGT Amber Band

Displayed (amber) - continuous EGT limit.

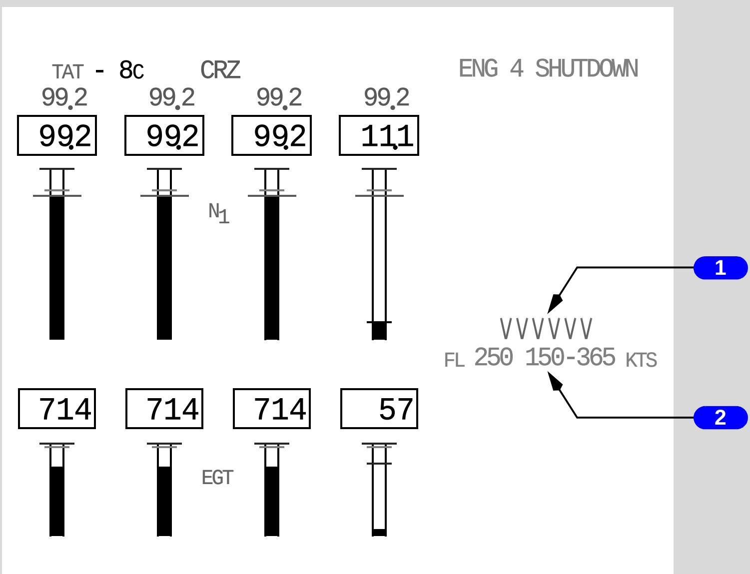
5 EGT Indication

Displayed:

- (white) - normal operating range
- (amber) - continuous limit reached
- (red) - start or takeoff limit reached

Note: Indication remains white during TO or GA for five minutes (or ten minutes if one engine fails or is shut down) even though continuous EGT limit is reached.

Secondary Exceedance Cue and In-flight Start Envelope



PRIMARY EICAS DISPLAY

1 Secondary Engine Exceedance Cue

Displayed (cyan) -

- when a secondary engine parameter exceedance occurs
- until exceeding parameter returns to normal operating range
- uses same character field as status cue (replaces status cue if displayed)

2 **In-Flight Start Envelope**

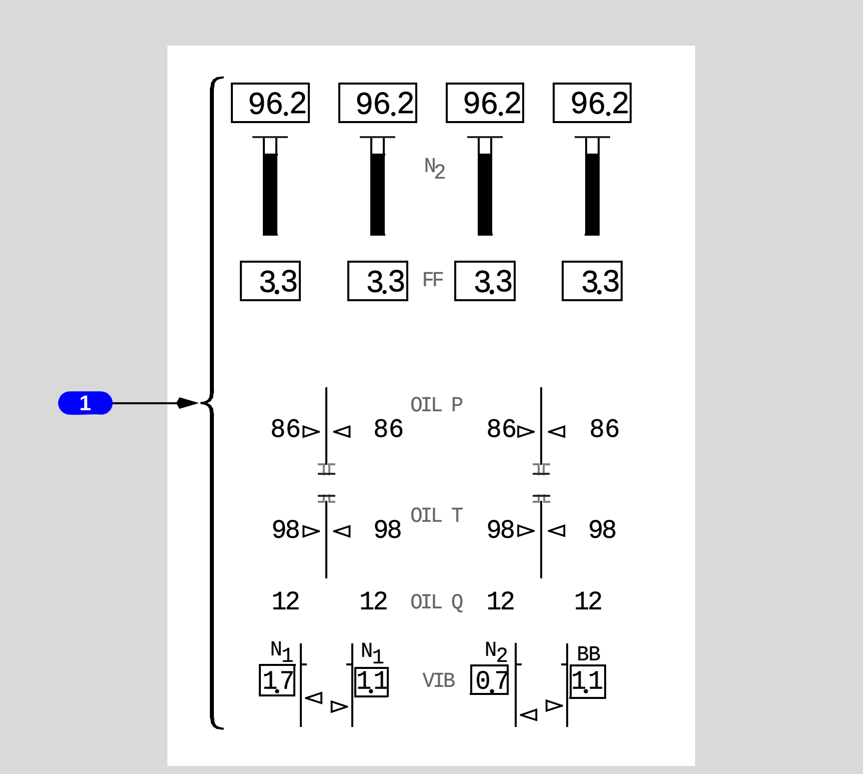
Displayed (magenta) - airspeed range for an in-flight start at the current flight level or maximum flight level (whichever is less) when the respective Engine Fire switch is in and a Fuel Control switch is in CUTOFF.

Secondary Engine Indications

See Chapter 10, Flight Instruments, Displays, for display selection of Secondary Engine indications.

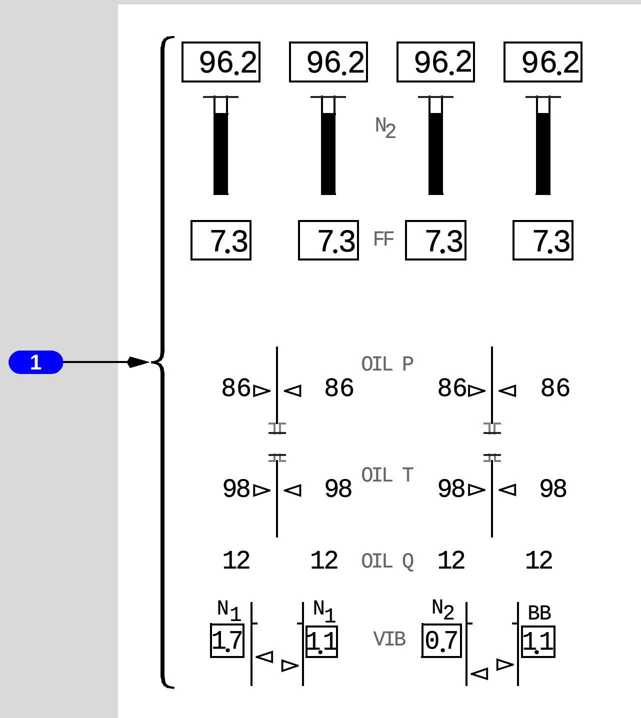
Secondary Engine Display

806



SECONDARY EICAS DISPLAY

914



SECONDARY EICAS DISPLAY

1 Secondary Engine Display

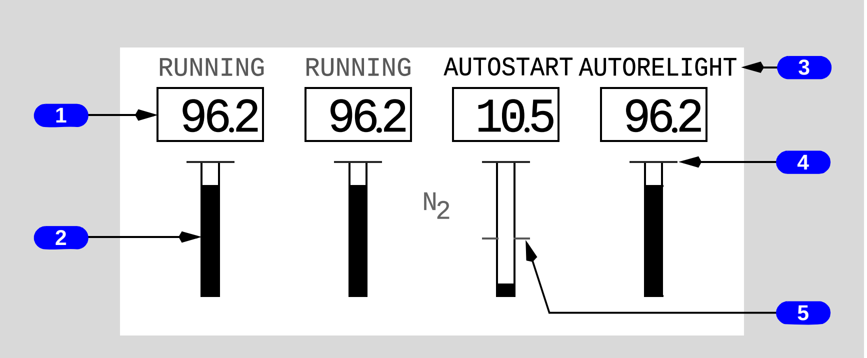
Displays:

- N2 RPM
- fuel flow (FF)
- oil pressure (OIL P)
- oil temperature (OIL T)
- oil quantity (OIL Q)
- vibration (VIB)

Displays when:

- EICAS initially receives power
- in flight, when a Fuel Control switch is moved to CUTOFF

N2 Indications



SECONDARY EICAS DISPLAY

1 N2

N2 RPM, displayed:

- (white) - normal operating range
- (red) - operating limit reached

2 N2 Indication

N2 RPM, displayed:

- (white) - normal operating range
- (red) - operating limit reached

3 Start Mode Indications

RUNNING, displayed:

- (green) - engine at or above idle after start, blanks 30 seconds after achieving idle RPM

AUTOSTART, displayed:

- (white) - engine in start mode
- ground start: engine START switch pulled, Fuel Control switch in RUN
- in flight: engine below idle, Fuel Control switch moved from CUTOFF to RUN

AUTORELIGHT, displayed:

- (white) - engine below idle, Fuel Control switch in RUN and not cycled to CUTOFF

4 N2 Red Line

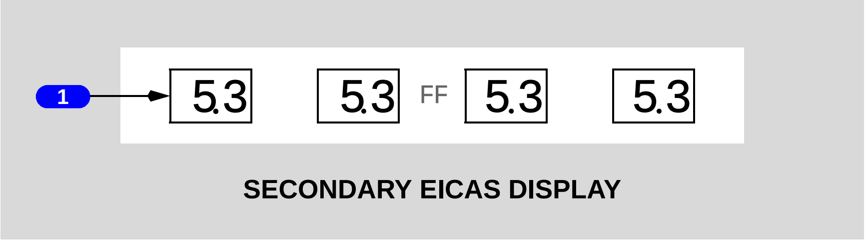
N2 RPM operating limit, displayed (red).

5 Idle Target Indication

Displayed (green) - engine is below idle and the Fuel Control switch is in RUN.

Set by the EEC and is an approximate target of idle N2 RPM which is a function of ambient conditions.

Fuel Flow Indications

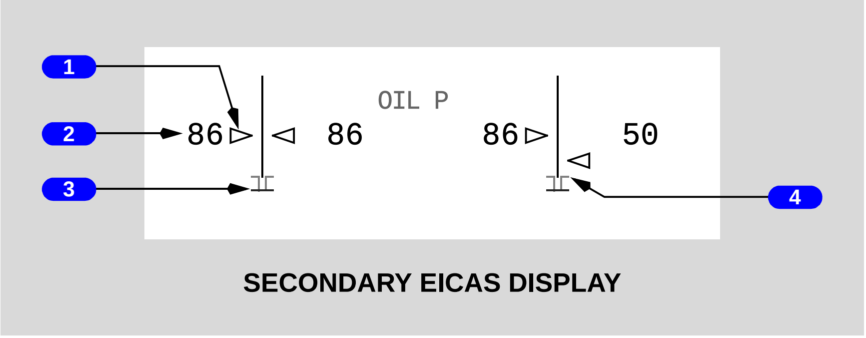


1 Fuel Flow

806
Displayed (white) - fuel flow to the engine (kilograms per hour x 1000).

914
Displayed (white) - fuel flow to the engine (pounds per hour x 1000).

Oil Pressure Indications



1 Oil Pressure Indicator

Engine oil pressure, displayed:

- (white) - normal operating range
- (amber) - caution range reached
- (red) - operating limit reached
- indication remains white when engine shut down 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 shut down and during start

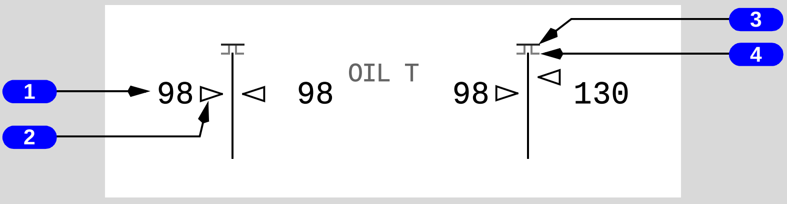
3 **Oil Pressure Red Line**

Displayed (red) - oil pressure operating limit.

4 **Oil Pressure Amber Band**

Displayed (amber) - oil pressure caution range.

Oil Temperature Indications



SECONDARY EICAS DISPLAY

1 **Oil Temperature**

Engine oil temperature (degrees C), displayed:

- (white) - normal operating range
- (amber) - caution range reached
- (red) - operating limit reached

2 **Oil Temperature Indicator**

Engine oil temperature, displayed:

- (white) - normal operating range
- (amber) - caution range reached
- (red) - operating limit reached

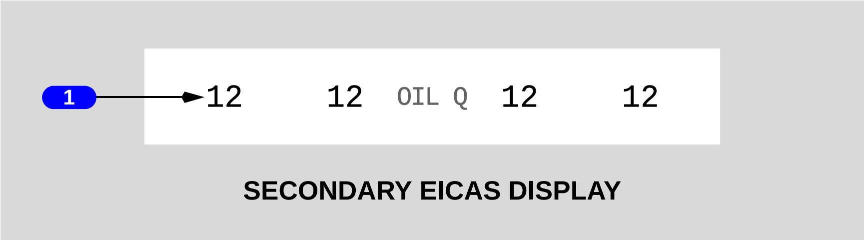
3 **Oil Temperature Red Line**

Displayed (red) - oil temperature operating limit.

4 **Oil Temperature Amber Band**

Displayed (amber) - oil temperature caution range.

Oil Quantity Indications



1 **Oil Quantity**

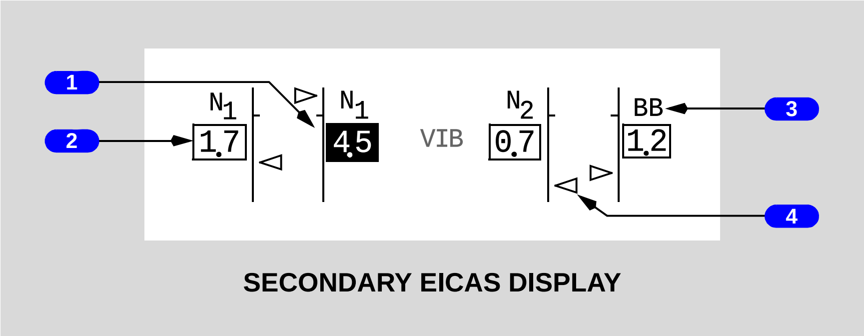
806
Usable oil quantity (liters).

914
Usable oil quantity (U.S. quarts).

Displayed:

- (white) - normal quantity
- (magenta) - low quantity

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
- (black on white) - vibration above display threshold

3 Engine Vibration Source

Identifies the vibration source being displayed.

Displayed (white) - vibration source with the highest vibration:

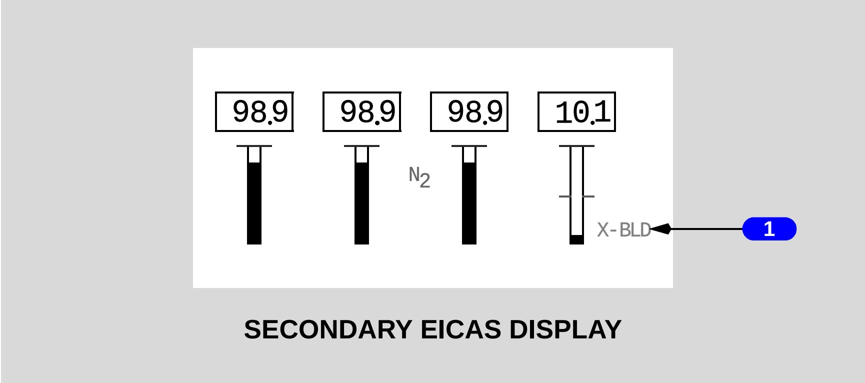
- N1 - N1 fan/turbine vibration
- N2 - N2 rotor vibration

If vibration source BB (broad band vibration) displayed, source is unknown and average vibration displayed.

4 Engine Vibration Indicator

Displayed (white) - engine vibration.

Crossbleed Start Indications



1 Crossbleed (X-BLD) Start Indication

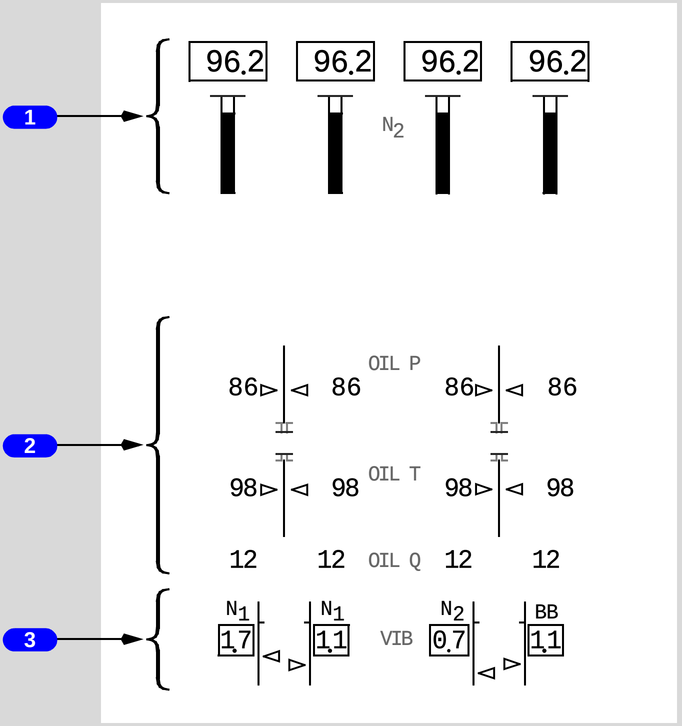
Indicates crossbleed air is recommended for in-flight start.

Displayed (magenta):

- in-flight start envelope displayed, and
- airspeed lower than for a windmilling start

Partial Secondary Engine Indications

Partial secondary engine indications can display when the secondary engine display is not selected.



SECONDARY EICAS DISPLAY

1 N2

Displays if an operating limit reached.

2 OIL P, OIL T, OIL Q

Displays if:

- a caution range or operating limit reached
- oil quantity low

3 Vibration (VIB)

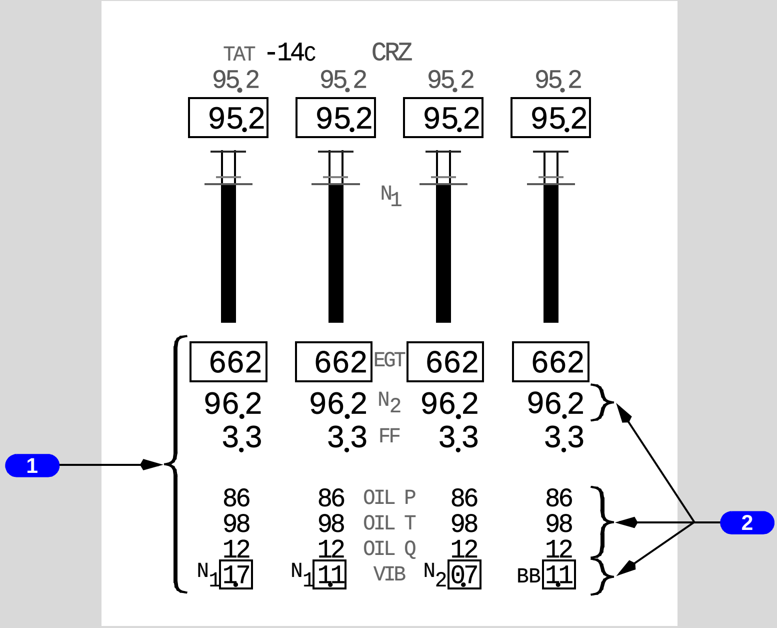
Displays if a display indicator reached.

Compact Engine Indications

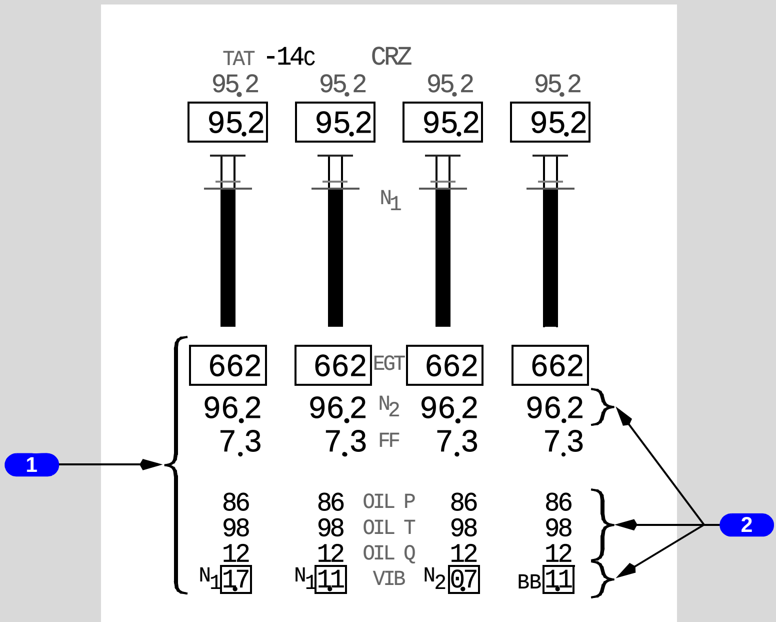
Compact engine indications are used when only one display unit is available for EICAS.

Compact Engine Display

806



PRIMARY EICAS DISPLAY



PRIMARY EICAS DISPLAY

1 Compact Engine Indications

Displayed continuously:

- N1
- EGT

Displayed when selected by secondary engine display switch, or in flight if a Fuel Control switch is moved to CUTOFF:

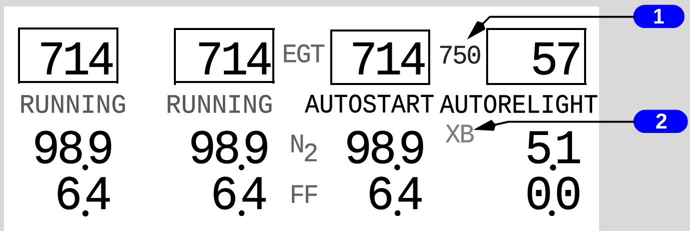
- N2
- FF
- OIL P
- OIL T
- OIL Q
- VIB

2 Partial Compact Engine Indications

N2, or OIL P, OIL T, OIL Q, or VIB display if:

- a secondary engine parameter exceedance occurs when secondary engine indications are not selected, or
- a secondary EICAS display other than secondary engine is selected when partial secondary engine indications are displayed on secondary EICAS

Compact Start Indications



PRIMARY EICAS DISPLAY

1 EGT Start Limit

Displays red.

2 Crossbleed Start

Displays magenta.

Intentionally
Blank

Engines, APU Chapter 7
Engine System Description Section 20

Introduction

The airplane is powered by four General Electric GEnx-2B67 engines. The engines are rated at 66,500 pounds of takeoff thrust each.

The engines are dual rotor axial flow turbofans of high compression and bypass ratio. The N1 rotor consists of a fan, a low pressure compressor section, and a low pressure turbine section on a common shaft. The N2 rotor consists of a high pressure compressor section and a high pressure turbine section on a common shaft. The N1 and N2 rotors are mechanically independent. The N2 rotor drives the engine accessory gearbox.

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 Intermix

The engines are set to operate at the same thrust rating. Replacement engine thrust rating is increased or decreased to match the thrust rating of the installed engine configuration. An EGT amber band (maximum continuous limit) difference between engines may be indicated, but these indications are normal.

Engine Indications

Primary and secondary engine indications are displayed on the engine indication and crew alerting system (EICAS) display.

Primary Engine Indications

N1 and EGT are primary engine indications and are always displayed on the EICAS display. Normally the EICAS is on the upper center display unit. If that unit fails, the EICAS display automatically moves to the lower center display unit.

Secondary Engine Indications

N2, 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:

- the displays initially receive electrical power
- selected using the ENG display switch on the display select panel
- a Fuel Control switch is moved to CUTOFF in flight

The secondary engine parameters can be cleared by pushing the ENG display switch on the display select panel except in flight when a Fuel Control switch is in CUTOFF.

Normal Display Format

Each engine indication consists of a digital indicator and, except for fuel flow and oil quantity, a moving vertical indicator. The digital readouts display numerical values while the moving indicators display relative value. The digital indicator for N1, EGT, N2, and fuel flow is enclosed in a box. The vertical indicator displays the normal operating range, caution range, and operating limit.

The normal operating range display on the vertical indicator is white. An indication is white when the engine parameter is in the normal operating range.

Oil pressure and oil temperature indicators have caution ranges displayed by amber bands. The indication changes color to amber if the parameter reaches the caution range.

The EGT indicator has a continuous limit displayed by an amber band. The indication changes color to amber if EGT reaches the continuous limit.

EGT indications are inhibited from changing color to amber during takeoff or go-around for five minutes after the TO/GA switch is pushed, even though EGT reaches the continuous limit. The amber color change is inhibited for ten minutes if one engine fails or is shut down.

The EGT indicator has a takeoff limit displayed by a red line. The indication changes color to red if EGT reaches the takeoff limit.

N1, N2, oil pressure, and oil temperature indicators have operating limits displayed by red lines. The indication changes color to red if the parameter reaches the operating limits.

An indication changes color back to white when the parameter returns to the normal operating range. The box enclosing the digital indicator remains red as a reminder of the exceedance. The red box color can be selectively canceled to white or recalled to red by pushing the cancel recall (CANC RCL) switch on the Display Select panel.

The oil quantity indication changes color to magenta if low oil quantity is detected.

Maximum N1 is displayed by an amber line. The N1 indication does not change color when maximum N1 is reached. The reference N1 indicator displays the reference N1 selected by the FMC. The command N1 indicator displays N1 RPM commanded by Thrust lever position. It equals actual N1 RPM when the engine is stabilized. The command N1 indicator moves when the Thrust lever moves to display the new commanded N1.

Compact Display Format

If only one display unit is available for use by EICAS, primary EICAS always displays. Primary engine indications display in the normal format. Secondary engine indications are selected by pushing the Engine (ENG) display switch. Pushing the switch displays the primary and secondary engine indications on primary EICAS in compact format. In compact format, N1 displays by digital and vertical indicators while all other engine indications display by digital indicators. Pushing the switch again removes the secondary engine indications and returns the primary engine indications to normal format.

Partial Display Format

Secondary engine indications display in partial format if a secondary engine parameter exceeds the normal operating range when the secondary engine display is not selected. The secondary engine exceedance cue displays on primary EICAS when an exceedance occurs.

If an N2 RPM increases to the operating limit, the N2 indications display. If an oil pressure decreases or an oil temperature increases to the caution range or operating limit, or if an oil quantity decreases to the low level, the oil indications display. If an engine vibration increases to the display indicator, the vibration indications display.

Pushing the engine (ENG) switch while the secondary engine display is in the partial format displays the entire secondary engine display. Pushing the switch again returns the secondary engine display to partial format.

Selecting another secondary EICAS display while the secondary engine display is in partial format removes the secondary engine display from secondary EICAS. The partial secondary engine indications display with the primary engine indications on primary EICAS in compact format.

If only one display unit is available for use by EICAS and a secondary engine parameter exceedance occurs, the primary and partial secondary engine indications display on primary EICAS in compact format.

If the secondary engine exceedance cue displays and partial secondary engine indications are not displayed, pushing the Status (STAT) switch on the Display Select panel displays the primary and partial secondary engine indications on primary EICAS in compact format.

In all cases, the partial secondary engine indications and secondary engine exceedance cue remain displayed until the exceeding engine parameter returns to the normal operating range.

Electronic Engine Control (EEC)

Each EEC has full authority over engine operation. The EEC uses Thrust lever inputs to control forward and reverse thrust. The EEC has two control modes: normal and alternate. In both normal and alternate modes, the EEC uses N1 RPM as the controlling parameter for setting thrust. Electrical power for each EEC is provided by an alternator mounted on the engine accessory gearbox.

The EEC calculates an N1 value between idle and maximum N1. Maximum N1 is the maximum allowable thrust available from the engine. The calculated N1 is compared to actual N1 RPM. The EEC commands the fuel metering unit to adjust fuel flow until actual N1 equals calculated N1.

EEC Normal Mode

In normal mode, EEC sets thrust by controlling N1 based on Thrust lever position. N1 is commanded by positioning the Thrust levers either with the autothrottles, or by the flight crew.

When the engine is stabilized, EEC keeps thrust constant independent of outside air temperature and pressure. The EEC adjusts thrust for changes in engine and wing anti-ice and airplane pressurization bleed requirements. This allows a fixed Thrust lever position throughout a climb.

Maximum N1 represents the maximum rated thrust available from the engine. The EEC continuously computes maximum N1. Thrust is limited to maximum N1 at the full forward Thrust lever position. Maximum thrust is available during any phase of flight by moving the Thrust lever to the full forward position.

EEC Alternate Mode

The EEC uses alternate mode as a backup to normal mode. If EEC detects a fault and can no longer control the engine using the normal mode, it transfers control to alternate mode. Alternate mode can also be selected manually using the EEC Mode switch.

Alternate mode does not provide thrust limiting at maximum N1. Maximum N1 is reached at a Thrust lever position less than full forward. Thrust levers must be adjusted to maintain desired thrust as environmental conditions and bleed requirements change.

Alternate mode provides equal or greater thrust than normal mode for the same Thrust lever position. Thrust does not change when EEC transfers control from normal mode to alternate mode. Thrust increases when alternate mode is selected manually. When thrust is greater than idle, the Thrust lever should be moved aft prior to manually selecting alternate mode so thrust does not exceed maximum N1.

If 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 manually transferred to alternate mode.

EEC Idle Selection

The EEC selects minimum idle or approach idle. Minimum idle is a lower thrust than approach idle. Approach idle is selected in flight when:

- engine anti-ice is ON, or

806
(914 ; SB installs EEC 060 software)

- landing gear is down, or
- 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. Approach idle is selected during thrust reverser operation.

EEC Overspeed Protection

At thrust settings above idle, the EEC monitors N1 and N2 RPM to prevent rotor overspeed. If a rotor approaches overspeed, the EEC commands the fuel metering unit to reduce fuel flow to keep rotor speed from exceeding the operating limit even though the Thrust lever is commanding more thrust.

Thrust Control Malfunction Protection

The EEC provides protection against thrust control malfunctions that can result in an idle thrust asymmetry condition on the ground.

The EEC commands shut down of the affected engine when:

- airplane is on the ground,
- thrust lever is approximately at idle, and
- engine is above command N1 speed and not decelerating normally

Engine Start and Ignition System

Start Indications

Start indicators display with engine indications when an engine is shut down. A start limit displays on the EGT indication when the Fuel Control switch is in CUTOFF. The start limit remains displayed until N2 reaches idle RPM. The EGT indication changes color to red if the EGT start limit is reached.

When a Fuel Control switch is moved to CUTOFF during flight, the in-flight start envelope displays on the primary EICAS display and the secondary engine indications display on the secondary EICAS display. The in-flight start envelope displays the airspeed range recommended for 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 respective airspeed range display. X-BLD displays next to the N2 indication if crossbleed air is required for start.

Autostart

During a ground or starter-assisted in-flight start, air from the bleed air duct powers the starter motor, which is connected to the N2 rotor. During a ground start, the starter air source is normally the APU, but air from ground carts or another running engine can be used.

The EEC controls the start valve, fuel, and ignition; and aborts the start for certain conditions. Pulling the Start switch out (held out by a solenoid) initiates the start sequence, and the EEC opens the start valve to motor the engine. Moving the Fuel Control switch to RUN opens the spar fuel valve, and arms the engine fuel valve and igniter(s).

At a predetermined N2, the EEC energizes the igniter(s), and opens the engine fuel valve and fuel metering valve. The EEC selects a single igniter for ground starts and two igniters for in-flight starts.

806
(914 ; SB installs EEC 060 software)
When an engine has been shut down for 45 to 360 minutes and the EGT is greater than 30 degrees C, motoring continues an additional 40 seconds when N2 reaches 20%. The start then continues normally.

Starter cutout occurs at approximately 54% N2 RPM. At idle N2 RPM, the Start switch is released to the in position. Ignition is discontinued at 50% N2 RPM for ground starts and idle N2 RPM for in-flight starts.

During start, the EEC monitors EGT, N2 RPM, and other engine parameters until the engine stabilizes at idle. Oil pressure is monitored during start and if there is a problem, the EICAS caution message ENG OIL PRESS is displayed after start.

Ground Autostart

During a ground start, the EEC monitors engine parameters and will abort the start for any of the following:

- sheared starter shaft
- low starter air pressure
- impending starter duty cycle exceedance
- no N1 rotation (locked rotor)
- no oil pressure
- EGT exceedance

If one of the above conditions is detected, the EEC aborts the start sequence without motoring and will not make another attempt. The EICAS caution message ENG AUTOSTART is displayed.

The EEC will attempt corrective action for the following conditions:

- hot start
- hung start
- no EGT rise
- compressor stall

If the EEC detects no EGT rise, it cuts off fuel and ignition. The engine motors for 30 seconds. The EEC applies a fuel adjustment and ignition to both igniters for another attempt. The EEC makes three complete attempts before aborting the start sequence by cutting off fuel and ignition. The engine is then motored for 30 seconds, the start valve is closed, and the EICAS caution message ENG AUTOSTART is displayed.

If there is an EGT rise, but the EEC detects an impending hot start or a stalled start, the EEC cuts off fuel, motors the engine for approximately 4 seconds, adjusts the fuel schedule and then reapplies fuel for another attempt. The EEC makes three attempts before aborting the start sequence by cutting off fuel and ignition. The engine motors for 30 seconds before the start valve closes.

If the EEC detects a hung start, it will make two adjustments to the fuel schedule before aborting the start sequence. There is no fuel shutoff or motoring between the fuel adjustments.

A start can be aborted by moving the Fuel Control switch to CUTOFF, which closes the engine fuel valve and removes igniter power. The engine will continue to motor until the Start switch is pushed in or the starter duty cycle is reached.

In-flight Autostart

During an in-flight flameout and/or start, the EEC reacts to a hung start, a start stall, or EGT reaching the start limit. If the EEC detects the EGT reaching the start limit or a hung start, it first adjusts fuel to clear the condition. For a start stall, the EEC cuts off fuel briefly and reapplies fuel to clear the condition. The EEC protects the in-flight EGT start limit for the first four start attempts. On the fifth attempt, the EEC increases the start limit by 25 degrees C. This is repeated on each subsequent attempt until a start is achieved or the takeoff EGT limit is reached. The start sequence is not automatically aborted. The EEC continues making start attempts until the engine stabilizes at idle or the Fuel Control switch is moved to CUTOFF.

Auto-Relight

An auto-relight capability is provided for flameout and rollback protection. Whenever the EEC detects an engine flameout or rollback, both igniters are activated. A flameout is detected when a rapid decrease in N2 occurs. A rollback is detected when N2 falls below idle RPM or compressor pressure falls below idle minimums.

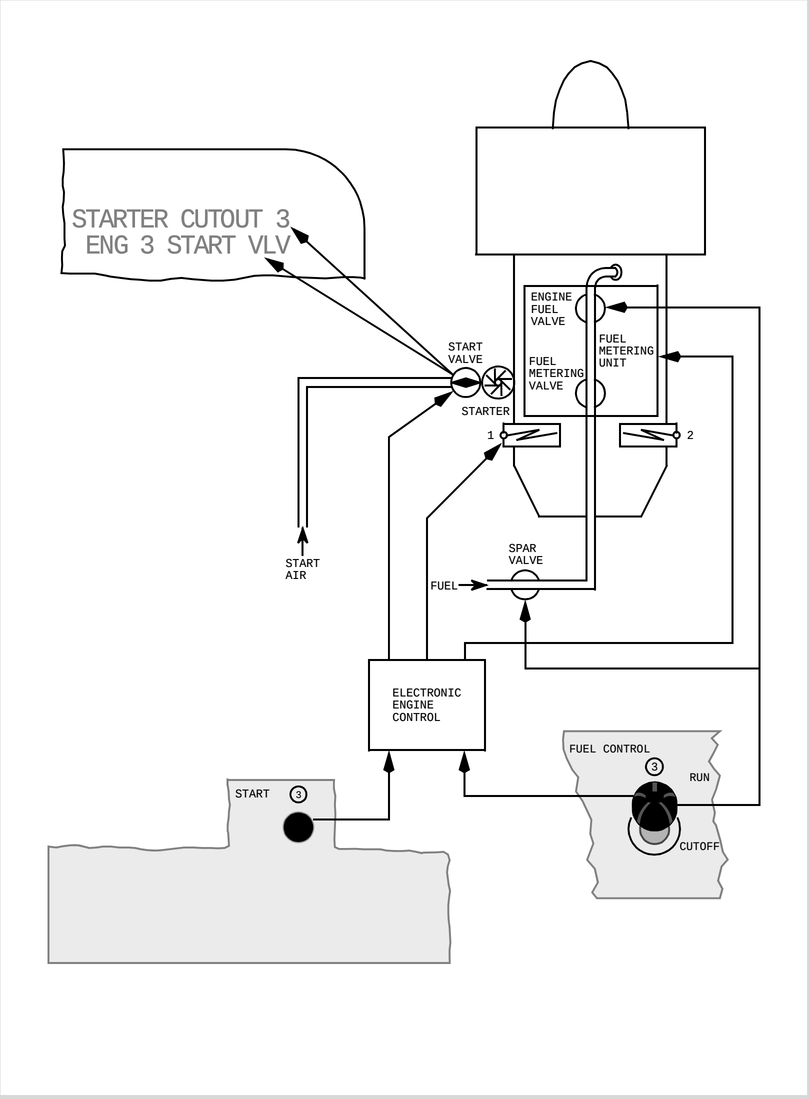
Engine Ignition

Each engine has two igniters. The igniters operate separately or together as selected by the EEC.

The EEC alternates igniters for successive ground starts. Dual igniters are always used for in-flight starts.

The AC power system is the normal power source for ignition. The standby power system provides a backup source. If the AC power system is not powered, the standby power system supplies power continuously to both igniters.

Engine Start and Ignition System Schematic



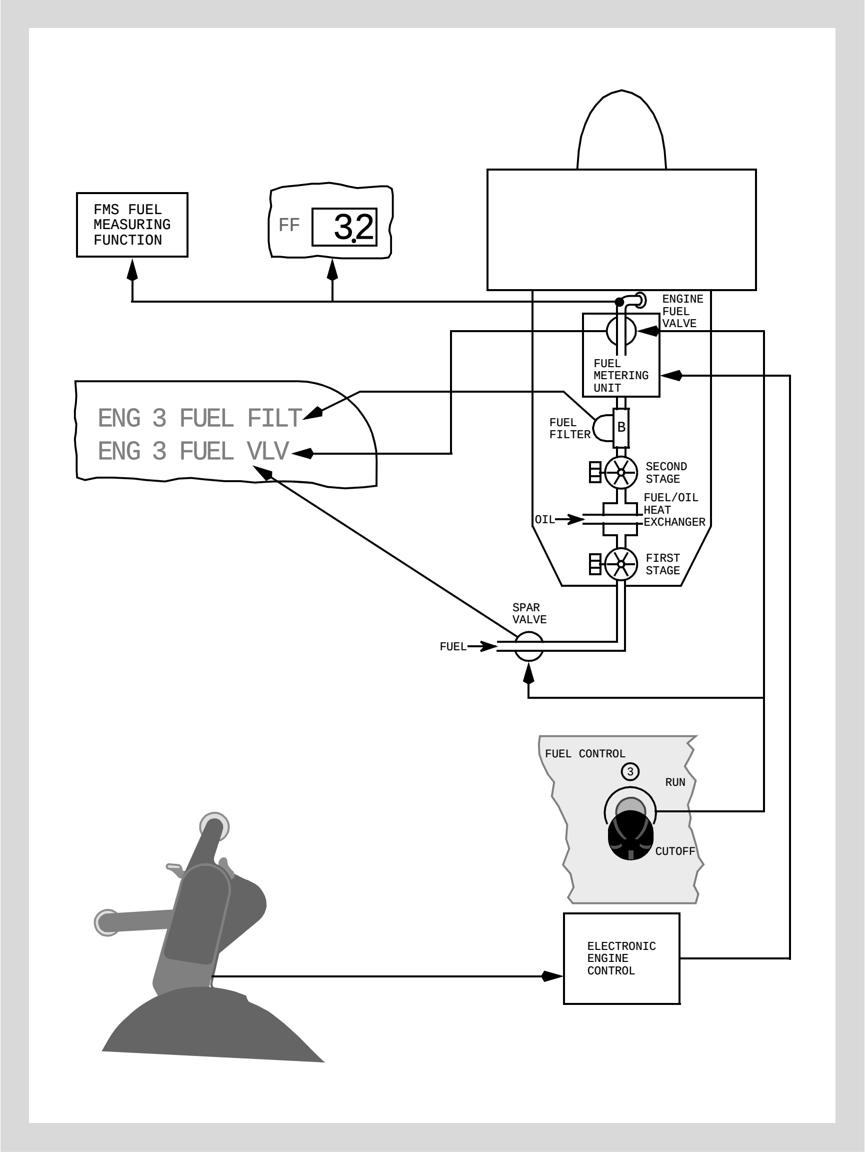
Engine Fuel System

Fuel is supplied under pressure from pumps located in the fuel tanks. Fuel for each engine flows through a spar fuel valve located in the respective main tank. The first and second stage engine fuel pumps add additional pressure to the fuel. Engine oil heats the fuel as it flows through the fuel/oil heat exchanger. A fuel filter removes contaminants. The fuel metering unit adjusts fuel flow to meet thrust requirements. The fuel flows through the engine fuel valve to the engine.

The engine fuel valve, fuel metering valve, and spar valve allow fuel flow to the engine when all valves are open. The valves open when the Engine Fire switch is in and the Fuel Control switch is in RUN, and the engine pumps are supplying fuel pressure. The pumps supply pressure when the N2 rotor is turning. During engine start and operation, fuel metering valve position is controlled by the EEC. The engine fuel valve, fuel metering valve, and spar valve close when either the Fuel Control switch is in CUTOFF or the Engine Fire switch is out.

Fuel flow is measured downstream of the engine fuel valve and displays on the secondary engine display. Fuel flow information is also provided to the FMS.

Engine Fuel System Schematic

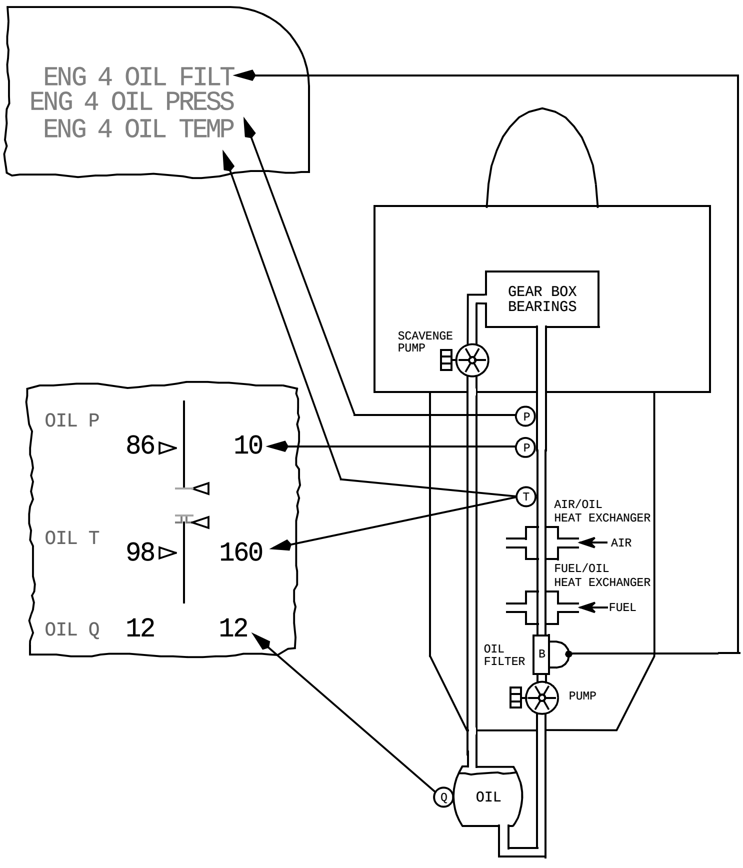


Engine Oil System

The oil system cools and lubricates engine bearings and the accessory gearbox. Oil is pressurized by an oil pump. The oil is cooled by fuel as it flows through the fuel/oil heat and air/oil heat exchangers. An oil filter removes contaminants. If the filter becomes saturated with contaminants, oil bypasses the filter. The oil cools and lubricates the engine. The scavenge pump scavenges oil from the engine and returns it to the oil reservoir.

Oil pressure, temperature, and quantity display on the secondary engine display. Oil pressure is measured by dual oil pressure sensors prior to entering the engine. Oil temperature is measured prior to entering the engine by dual oil temperature transmitters.

Engine Oil System Schematic



Thrust Reverser System

Each engine has a hydraulically actuated fan air thrust reverser. Each thrust reverser is powered by hydraulic pressure from the respective hydraulic system. The reverser does not operate if the engine is not running. Reverse thrust is available only on the ground.

An interlock mechanism in the Thrust lever assembly prevents simultaneous movement of the Forward and Reverse Thrust levers. The Reverse Thrust levers can be raised only when the Forward Thrust levers are in the closed position. When the Reverse levers are down, the reversers are locked in the stowed position.

Raising the Reverse Thrust levers to the idle detent locks the Forward Thrust levers in position. Hydraulic pressure unlocks and extends the reversers aft to the deployed position. A thrust reverser status annunciator displays above the digital indicator of each N1 indication. The annunciator displays in amber when the respective reverser is unlocked or moving. The annunciation changes color to green when the reverser is fully deployed. The interlock releases and the Reverse Thrust levers can be moved to full reverse.

Pushing the Reverse Thrust levers to the full down position retracts the reversers to the stowed and locked position. The REV indication changes color back to amber while the reverser is moving. When the reverser is stowed and locked, the REV indication is removed. The Thrust levers cannot be moved forward until the Reverse Thrust levers are fully down.

The thrust reversers are protected against deploying inadvertently. If a reverser unlocks and deploys inadvertently, the reverser system applies hydraulic pressure to stow and lock the reverser.

Airborne Vibration Monitoring System

The airborne vibration monitoring system monitors engine vibration levels. The vibration indications display on the secondary engine display. The vibration source indication also displays. If the vibration monitoring system cannot determine the source (N1 or N2), broadband (BB) displays for the affected engine. Broadband vibration is the average vibration detected.

Certain engine malfunctions can result in airframe vibrations from the windmilling engine. As the airplane transitions from cruise to landing, there can be multiple, narrow regions of altitudes and airspeeds where the vibration level can become severe. In general, airframe vibrations can best be reduced by descending and reducing airspeed. However, if after descending and reducing airspeed, the existing vibration level is unacceptable, and if it is impractical to further reduce airspeed, the vibration level may be reduced to a previous, lower level by a slight increase in airspeed.

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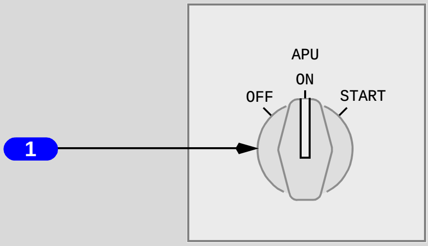
APU Controls and Indications

APU Selector



OVERHEAD PANEL

1 APU Selector

OFF -

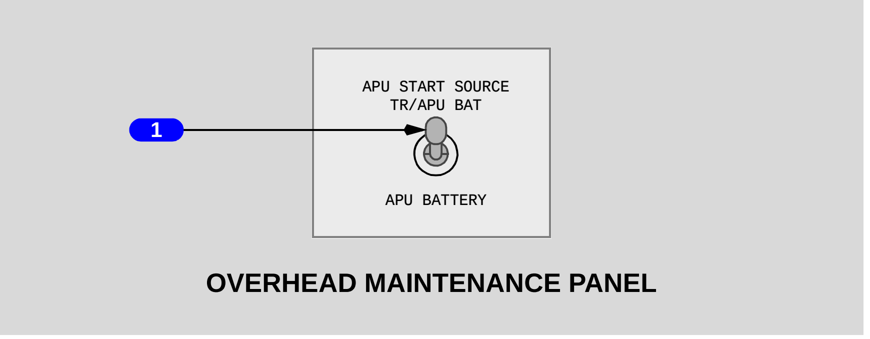
- closes APU bleed air isolation valve
- initiates normal shutdown
- resets auto shutdown fault logic except when shut down due to APU bleed duct leak

ON (APU operating position) -

- opens APU fuel valve and inlet door
- arms APU bleed air isolation valve
- activates DC or two AC fuel pumps

START (momentary position, spring-loaded to ON) - initiates automatic start sequence.

APU Start Source



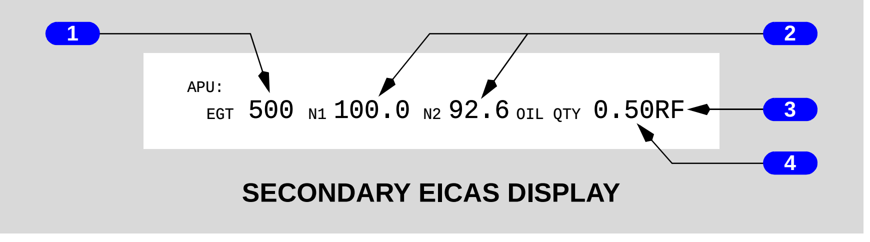
1 APU START SOURCE

TR - normal switch position. Selects TR or APU battery for start (except when TR fails).

APU BATTERY - selects APU battery power for APU starting. Removes TR from APU starting circuit.

APU Indications

Located on status (STAT) display.



1 EGT

APU exhaust gas temperature in degrees Celsius.

2 RPM

APU rotation speeds in percent.

3 Refill (RF)/Low (LO)

Displayed RF or LO (magenta) - oil quantity below prescribed level.

4 APU OIL Quantity

APU oil quantity (1.00 indicates full).

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

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The APU DC electric starter is powered by an APU start transformer rectifier (TR) whenever galley bus 2 is powered. Galley bus 2 may be powered from either an external or internal AC power source through the synchronous bus. If galley bus 2 is not powered, starter power is supplied by the 24 volt APU battery. The battery has a charger which disconnects during APU starter engagement. The APU battery powers the inlet door, APU controller, DC fuel pump, and APU fire detection system. The main battery supplies power for the APU fire extinguisher, APU fuel valve, and standby power for the APU controller. During a battery start sequence, the APU starter is powered by the APU battery and all APU components except the starter are powered by the main battery while the APU starter is engaged.

914
The APU DC electric starter is powered by an APU start transformer rectifier (TR) whenever utility bus 4 is powered. The utility bus may be powered from either an external or internal AC power source through the synchronous bus. If utility bus 4 is not powered, starter power is supplied by the 24 volt APU battery. The battery has a charger which disconnects during APU starter engagement. The APU battery powers the inlet door, APU controller, DC fuel pump, and APU fire detection system. The main battery supplies power for the APU fire extinguisher, APU fuel valve, and standby power for the APU controller. During a battery start sequence, the APU starter is powered by the APU battery and all APU components except the starter are powered by the main battery while the APU starter is engaged.

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.

Engines, APU — Chapter 7
EICAS Messages — Section 40

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.
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.
ENG 1, 2, 3, 4 AUTOSTART	Caution	Beeper	Autostart did not start the engine during a ground start, or EGT start limit has been exceeded.
ENG 1, 2, 3, 4 CONTROL	Advisory		EEC system fault present. Inhibited in flight.
ENG 1, 2, 3, 4 EEC MODE	Advisory		EEC in alternate control mode.
ENG 1, 2, 3, 4 CORE AI	Advisory		Engine booster anti-ice valve is failed closed. Inhibited above 80 knots.
ENG 1, 2, 3, 4 FAIL	Caution	Beeper	Engine failure or flameout. Inhibited on the ground.
ENG FL FILT MULT	Advisory		Impending fuel filter bypass exists on more than one affected engine.
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.
ENG 1, 2, 3, 4 LIM EXCEED	Caution	Beeper	An engine limit exceedance occurs.
ENG 1, 2, 3, 4 LIM PROT	Caution	Beeper	EEC in alternate control mode and command N1 exceeds maximum rating.

Message	Level	Aural	Message Logic
ENG 1, 2, 3, 4 OIL FILT	Advisory		Engine oil filter contamination approaching bypass condition.
ENG 1, 2, 3, 4 OIL PRESS	Caution	Beeper	Oil pressure reaches red line limit, or below amber limit and airspeed less than 80 knots.
ENG 1, 2, 3, 4 OIL TEMP	Advisory		Oil temperature reaches amber band.
ENG 1, 2, 3, 4 REV CMD	Caution	Beeper	The reverse thrust lever is not in the down position in flight.
ENG 1, 2, 3, 4 REVERSER	Advisory		A fault occurs in the thrust reverser system on the ground.
ENG 1, 2, 3, 4 REV LIMTD	Advisory		After landing, engine thrust reverser will not deploy, or only idle reverse thrust will be available.
ENG 1, 2, 3, 4 RPM LIM	Advisory		Engine thrust limited by N2 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.
ENG 1, 2, 3, 4 SURGE	Caution	Beeper	An engine surge or stall is detected. Inhibited on the ground.
ENG 1, 2, 3, 4 THRUST	Caution	Beeper	The engine thrust is more than the commanded thrust, or the engine thrust is less than commanded thrust. Inhibited on the ground.
ENG REV AIR/GND	Caution	Beeper	The air/ground thrust reverser logic is failed.
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%.

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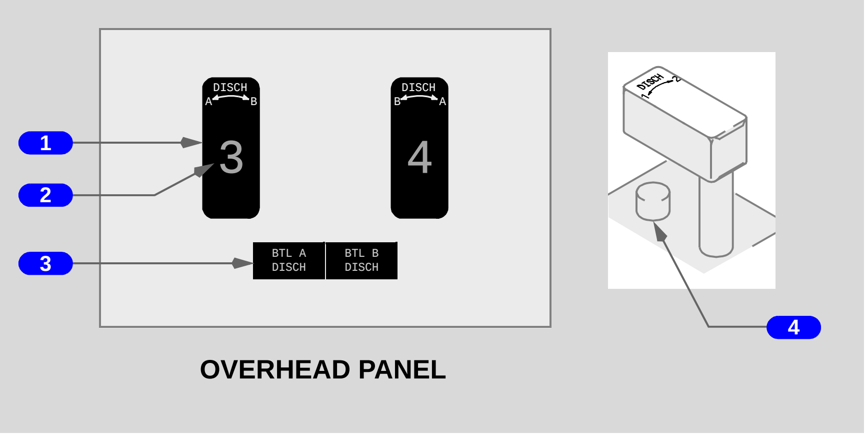
Fire Protection — Chapter 8
Table of Contents — Section TOC

Fire Protection — Chapter 8
Controls and Indicators — Section 10

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 respective engine and spar fuel valves
- closes the respective engine bleed air valve
- trips off the respective engine generator
- shuts off hydraulic fluid to the respective engine-driven hydraulic pump
- depressurizes the respective engine-driven hydraulic pump
- arms both respective engine fire extinguishers

Rotate to A or B - discharges selected fire extinguisher into the engine nacelle.

2 Engine Fire Warning Lights

Illuminated (red) -

- an engine fire is detected, or
- the Fire/Overheat Test switch is pushed

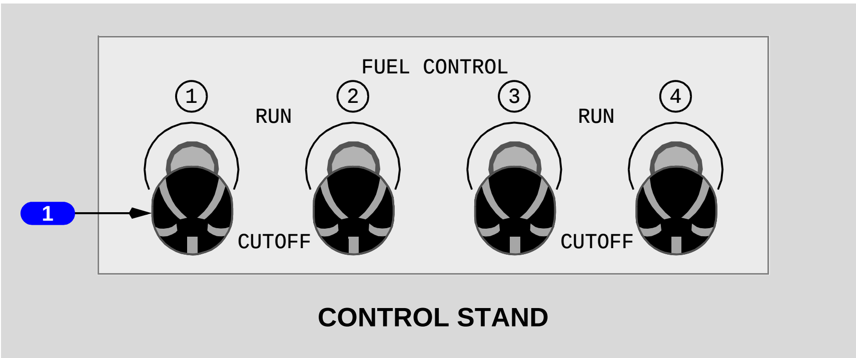
3 Bottle Discharged (BTL DISCH) Lights

Illuminated (amber) - the extinguisher bottle is discharged or has low pressure.

4 **Engine and APU Fire Override Switches**

Push - unlocks the fire switch.

Fuel Control Switches

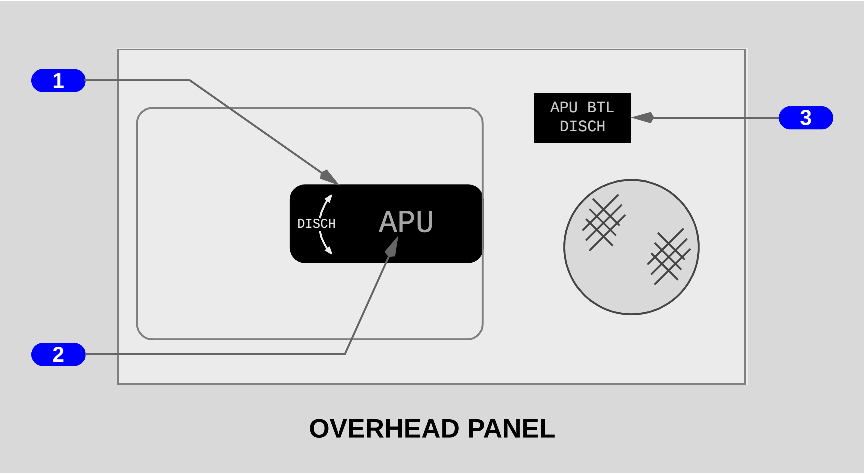


1 **FUEL CONTROL Switch Fire Warning Lights**

Illuminated (red) -

- a respective engine fire is detected, or
- the Fire/Overheat Test switch is pushed

APU Fire Panel



1 APU Fire Switch

In - normal position, mechanically locked; unlocks for a fire warning.

Out -

- arms APU fire extinguisher bottle
- closes APU fuel valve
- closes APU bleed air valve
- closes APU air inlet door
- trips APU generator field and generator breaker
- shuts down APU (if automatic shutdown does not occur)

Rotate - discharges APU fire extinguisher into APU compartment.

2 APU Fire Warning Light

Illuminated (red) -

- an APU fire is detected, or
- the Fire/Overheat Test switch is pushed

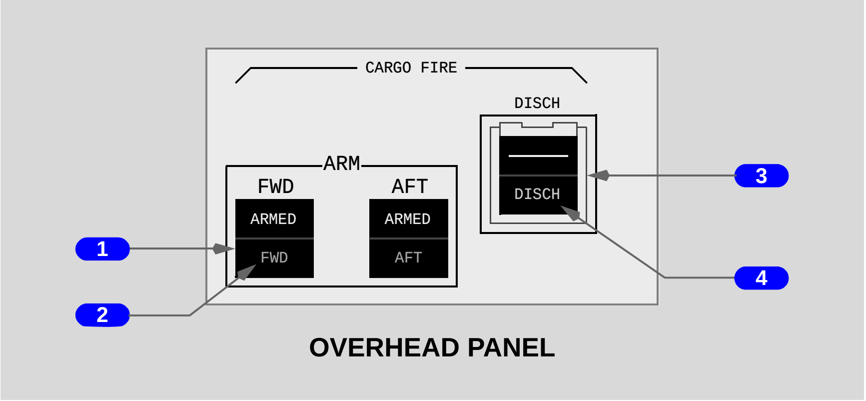
APU automatically shuts down for a detected fire.

On the ground, the APU extinguisher automatically discharges.

3 APU Bottle Discharged (BTL DISCH) Light

Illuminated (amber) - extinguisher bottle is discharged or has low pressure.

Cargo Fire Panel
Passenger
806



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
- turns off nitrogen generation system

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
- turns off nitrogen generation system

2 CARGO FIRE Warning Light

Illuminated (red) -

- fire in respective cargo compartment, or
- the Fire/Overheat Test switch is pushed

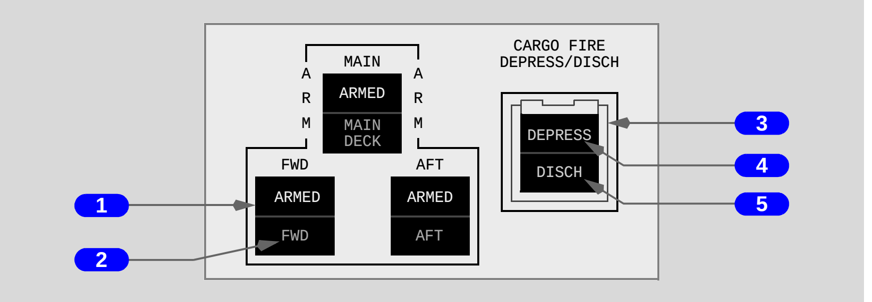
3 CARGO FIRE Discharge (DISCH) Switch

Push - initiates extinguisher discharge sequence to provide effective agent concentration for 195 minutes.

4 CARGO FIRE Discharged (DISCH) Light

Illuminated (amber) - cargo fire extinguishers discharged.

Freighter
914



OVERHEAD PANEL

1 CARGO FIRE ARM Switches

MAIN - ARMED -

- enables main deck fire suppression
- turns off two packs
- configures equipment cooling to closed loop and turns off all airflow to main deck and airflow and heat into lower cargo compartments
- closes all zone trim air valves to occupied areas, the main deck, and lower lobe cargo compartments
- galley chiller is shutdown
- turns off all recirculation fans
- turns off nitrogen generation system

FWD or AFT - ARMED -

- turns off two packs
- arms lower cargo compartment fire extinguishers
- configures equipment cooling to override mode and turns off all airflow and heat into lower cargo compartments and reduces airflow to main deck cargo compartment
- closes zone trim air valves to the main deck, and lower lobe cargo compartments
- turns off all recirculation fans
- turns off nitrogen generation system

2 CARGO FIRE Warning Light

Illuminated (red) -

- fire in respective cargo compartment, or
- the Fire/Overheat Test switch is pushed

3 CARGO FIRE Depressurization/Discharge (DEPRESS/DISCH) Switch

Push -

MAIN - ARMED - initiates airplane depressurization.

FWD or AFT - ARMED - initiates extinguisher discharge sequence to provide effective agent concentration for 210 minutes.

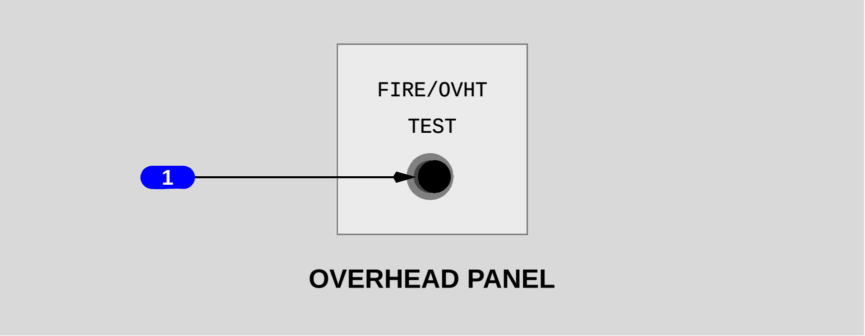
4 CARGO FIRE Depressurization (DEPRESS) Light

Illuminated (amber) - airplane depressurization initiated.

5 CARGO FIRE Discharged (DISCH) Light

Illuminated (amber) - cargo fire extinguishers discharged.

Fire/Overheat Test Switch

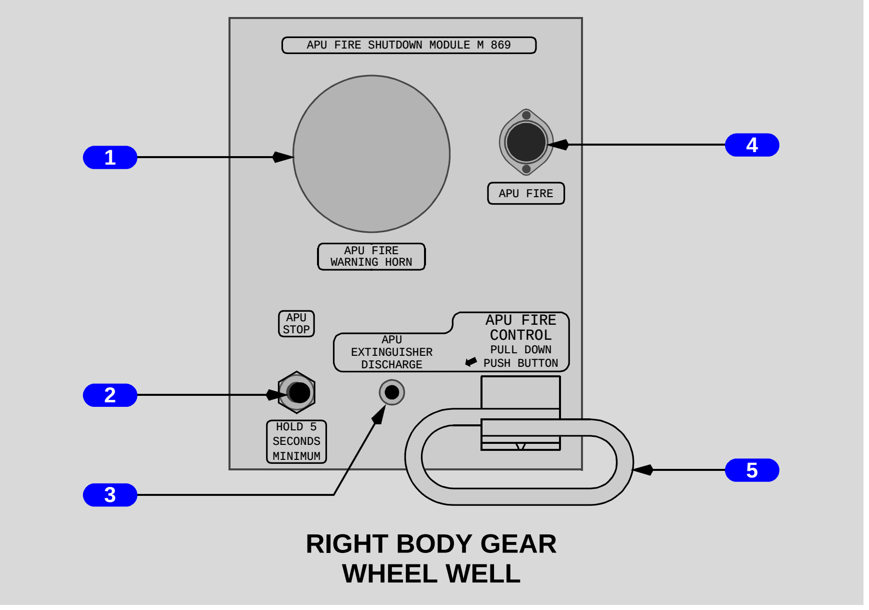


1 FIRE/Overheat (OVHT) TEST Switch

Push and hold -

- sends fire/overheat test signals to the engine, APU, wheel well, cargo, and bleed duct leak detectors
- tests flight deck fire and overheat indications (see Fire and Overheat Detection System Manual Fault Test, Section 20)

APU Ground Control Fire Protection Panel



1 APU FIRE WARNING HORN

Sounds during ground operation for an APU fire or fire test.

2 APU STOP Switch

Push - shuts down APU.

3 APU EXTINGUISHER DISCHARGE Switch

Push - discharges APU fire extinguisher, when armed, into APU compartment.

4 APU FIRE Light

The APU automatically shuts down for a detected fire.

Illuminated (red) -

- fire in APU compartment, or
- the Fire/Overheat Test switch is pushed

5 APU FIRE CONTROL Switch

Pull down -

- shuts down APU
- arms APU fire extinguisher

Fire Protection — Chapter 8
System Description — Section 20

Introduction

There are fire detection and extinguishing systems for the:

- APU
- cargo compartments
- engines
- lavatories

The crew rest compartments and main gear wheel wells have fire detection systems, but no fire extinguishing systems.

The engines also have overheat detection systems.

Refer to the following chapters for additional information:

- Chapter 2 - Air Systems, for descriptions of equipment smoke evacuation, and bleed duct leak and overheat detection
- Chapter 3 - Anti-Ice, Rain, for a description of engine anti-ice system protection

Fire Warnings

914
If a fire is detected, the flight deck warning bell rings one second on, then 10 seconds off. If an APU fire occurs on the ground, the APU fire warning horn also sounds on the APU ground control panel in the right body gear wheel well.

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If a fire is detected, the flight deck warning bell rings two seconds on, then 3 seconds off. If an APU fire occurs on the ground, the APU fire warning horn also sounds on the APU ground control panel in the right body gear wheel well.

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If a main deck fire is detected, horns sound on the main deck; and the main deck ceiling lights flash.

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 dual loop overheat detector. In normal operation, both loops in a detector must detect a fire or overheat condition to cause an engine fire warning or overheat caution unless configured for single loop operation.

APU Fire/Overheat Detection

A dual loop fire detector is installed in the APU compartment. There is no overheat detection in the APU compartment. 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

806
The passenger airplane lower lobe forward and aft cargo compartments have area smoke detectors installed in:

- the forward lower lobe cargo compartment
- the aft lower lobe cargo compartment

Note: If any two detectors in the same lower lobe compartment detect smoke, the fire warning is activated. If any detector in a lower lobe cargo compartment has failed, then the fire warning is activated if a single non-failed detector in the compartment or zone detects smoke.

914
The freighter main deck and lower lobe cargo compartments have area smoke detectors installed in:

- the main deck cargo compartment (detectors in three zones)
- the forward lower lobe cargo compartment

- the aft lower lobe cargo compartment

Note: If any two detectors in the same lower lobe compartment or main deck zones detect smoke, the fire warning is activated. If any detector in a lower lobe cargo compartment or in one of the main deck zones has failed, then the fire warning is activated if a single non-failed detector in the compartment or zone detects smoke.

Wheel Well Fire Detection

Each main gear wheel well has a single loop detector.

Crew Rest Area Smoke Detection

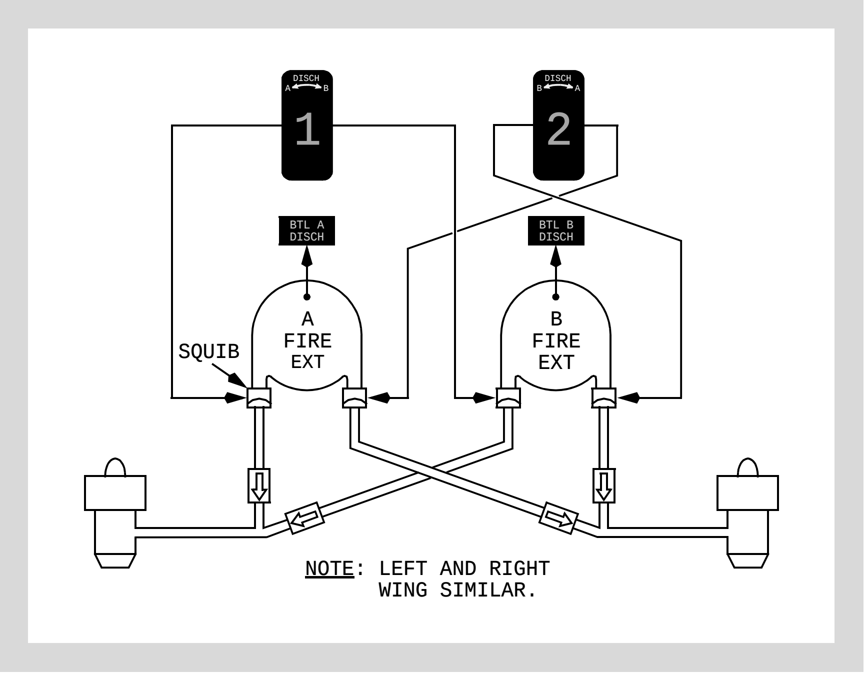
Smoke detectors are installed in crew rest areas. An aural warning sounds in the crew rest compartment when smoke is detected in that compartment.

Lavatory Smoke Detection

Smoke detectors are installed in the lavatories. An aural warning sounds in a lavatory when smoke is detected in that lavatory. An automatic fire extinguisher is located in the waste compartment in each lavatory.

Fire Extinguishing

Engine Fire Extinguishing



There are two fire extinguisher bottles in each wing for the two engines on that wing. One or both bottles can be discharged in either engine on a wing.

The Engine Fire switches are mechanically locked in. If an engine fire occurs, the 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 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.

Lower Cargo Compartment Fire Extinguishing

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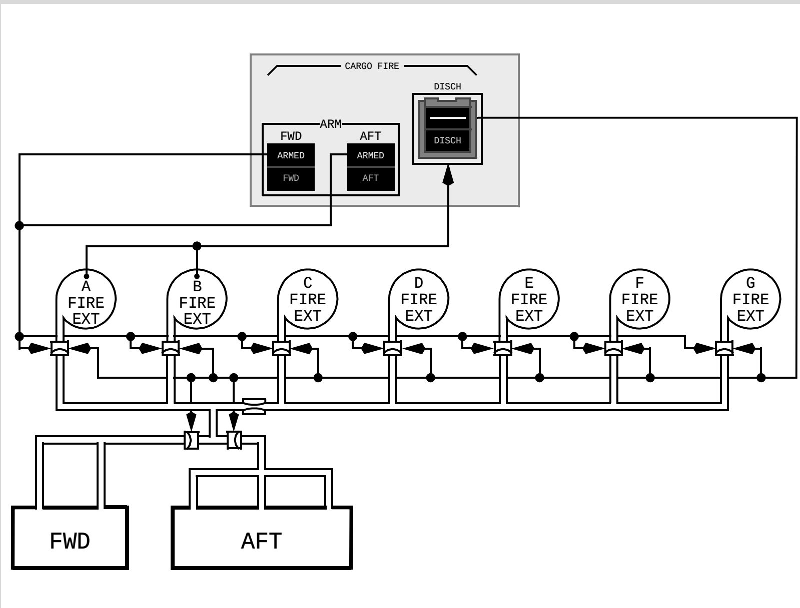

There are seven fire extinguisher bottles for the forward and aft cargo compartments. Pushing the Cargo Fire Discharge switch discharges two bottles immediately. The other five bottles discharge after a brief delay, or upon touchdown.

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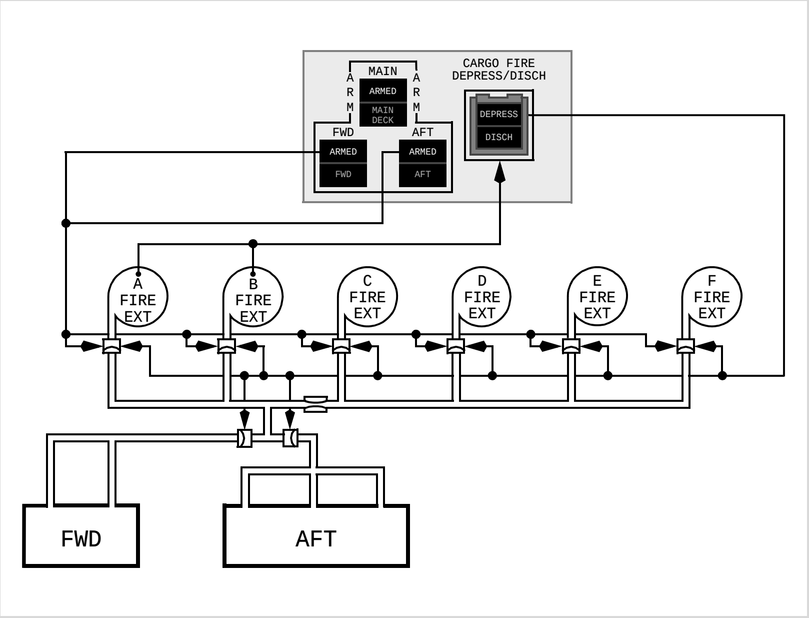

There are six fire extinguisher bottles for the forward and aft cargo compartments. Pushing the Cargo Fire Discharge switch discharges two bottles immediately. The other four bottles discharge after a brief delay, or upon touchdown.

Freighter Main Deck Cargo Compartment Suppression

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The freighter main deck cargo compartment is a Class E compartment. Pushing the Main Deck Cargo Fire Arm switch configures equipment cooling to closed loop and turns off two packs and airflow to all cargo compartments. Subsequently pushing the Cargo Depress/Disch switch opens the outflow valves to initiate a controlled cabin depressurization.

Fire and Overheat Detection System Fault Test

The fire overheat detection system has automatic and manual fault testing.

Fire and Overheat Detection System Automatic Fault Test

Engine fire/overheat and cargo detection systems are continuously tested and reconfigure for single sensor operation if a fault is detected in an engine loop or cargo compartment or zone.

Fire and Overheat Detection System Manual Fault Test

The fire and overheat detection systems can be tested manually by pushing and holding the FIRE/Overheat (OVHT) TEST switch.

The indications for a manual fire and overheat detection system test are:

- fire bell rings
- APU fire warning horn sounds (on the ground)
- EICAS message TEST IN PROG is displayed
- these lights illuminate:
  - master WARNING lights
  - engine fire warning lights
  - APU fire warning light
  - FWD and AFT cargo fire warning lights

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  - MAIN DECK fire warning light
  - Fuel Control switch fire warning lights

The EICAS warning message FIRE TEST PASS or FIRE TEST FAIL replaces the TEST IN PROG message, failed system EICAS messages display with the FIRE TEST FAIL message.

The 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.

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Fire Protection — Chapter 8
EICAS Messages — Section 30

EICAS Alert Messages

Message	Level	Aural	Message Logic
BTL LO L, R ENG A, B	Advisory		Engine fire extinguisher bottle pressure is low.
BOTTLE LOW APU	Advisory		APU fire extinguisher bottle pressure is low.
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 CARGO AFT, FWD	Advisory		Smoke detection system in the lower lobe cargo compartment is failed.
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.

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Message	Level	Aural	Message Logic
DET MAIN DECK	Advisory		Smoke detection system in the main deck cargo compartment is failed

Message	Level	Aural	Message Logic
FIRE APU	Warning	Bell	Fire is detected in the APU.
FIRE CARGO AFT, FWD	Warning	Bell	Smoke is detected in the lower cargo compartment.
FIRE ENG 1, 2, 3, 4	Warning	Bell	Fire is detected in the engine.

914

Message	Level	Aural	Message Logic
FIRE MAIN DECK	Warning	Bell	Smoke is detected in more than one main deck cargo zone.

Message	Level	Aural	Message Logic

914

Message	Level	Aural	Message Logic
FIRE MN DK AFT, FWD, MID	Warning	Bell	Smoke is detected in the main deck cargo zone.
FIRE WHEEL WELL	Warning	Bell	Fire is detected in a main wheel well.
OVHT ENG 1, 2, 3, 4 NAC	Caution	Beeper	Overheat is detected in the engine nacelle, or EEC overheat, or EEC detects high temperature HP air during engine start with the start valve failed open.
SMOKE CREW REST	Caution	Beeper	Smoke is detected in the upper deck crew rest.
SMOKE LAVATORY	Caution	Beeper	Smoke is detected in a lavatory.

System Test Messages

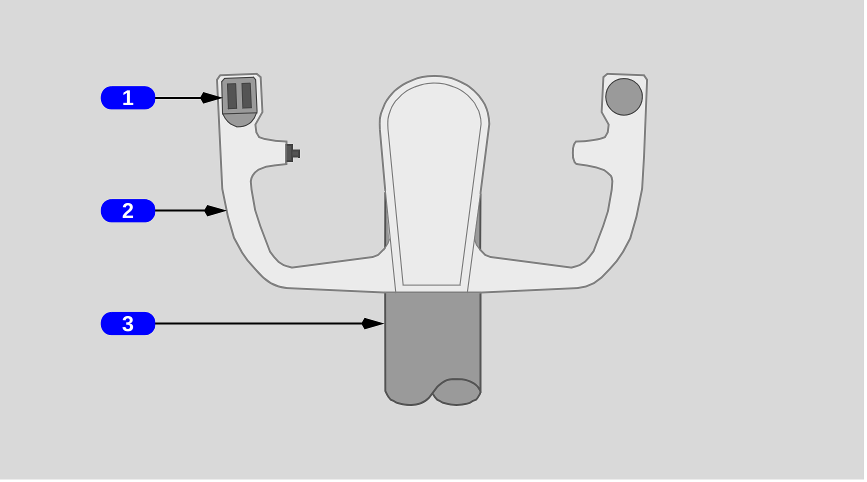
The following messages are associated only with the manually-initiated fire test.

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 in progress.

Flight Controls — Chapter 9
Table of Contents — Section TOC

Flight Controls — Chapter 9
Controls and Indicators — Section 10

Pitch and Stabilizer Trim Systems
Control Wheel and Column



1 Stabilizer Trim Switches

Spring-loaded to neutral.

Push (both switches) - trims stabilizer in desired direction.

2 Control Wheel

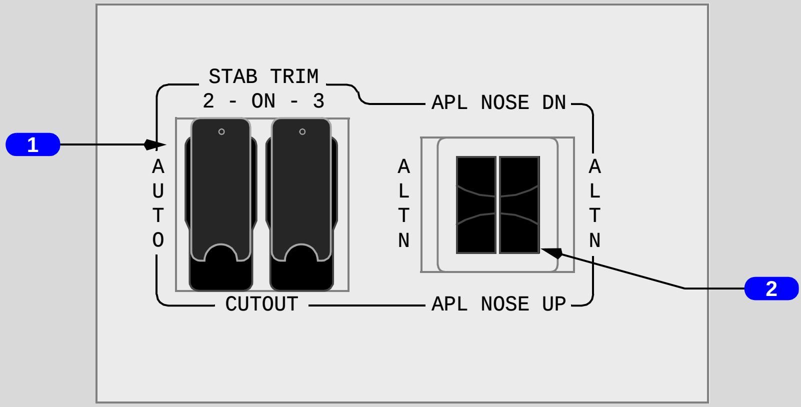
Rotate - deflects ailerons and spoilers in desired direction.

3 Control Column

Push/pull -

- deflects elevators in desired direction
- prevents stabilizer trim in opposite direction

Stabilizer Trim Controls



CONTROL STAND

1 Stabilizer (STAB) TRIM CUTOUT Switches

ON - supplies hydraulic power for stabilizer trim.

AUTO (guard closed) -

- supplies hydraulic power for stabilizer trim
- shuts off respective system hydraulic power if unscheduled trim detected

CUTOUT - shuts off respective hydraulic power to stabilizer trim.

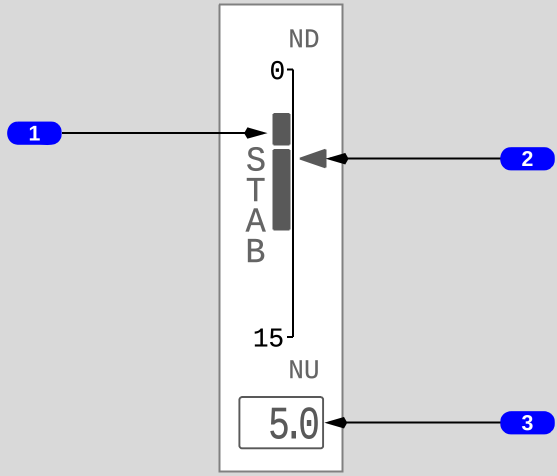
2 Alternate (ALTN) Stabilizer Trim Switches

Push (both switches) - trims stabilizer using alternate control channel.

Airplane (APL) NOSE Down (DN) - trims stabilizer in nose down direction

Airplane (APL) NOSE UP - trims stabilizer in nose up direction

Stabilizer Trim Indicator



PRIMARY EICAS STABILIZER TRIM DISPLAY

1 Stabilizer Green Band

- illuminated - indicates allowable range for takeoff while on the ground
- gap - separates the mid-band segment from additional nose up (NU) or nose down (ND) segment, if displayed

2 Stabilizer Trim Pointer

Indicates stabilizer position in units of trim

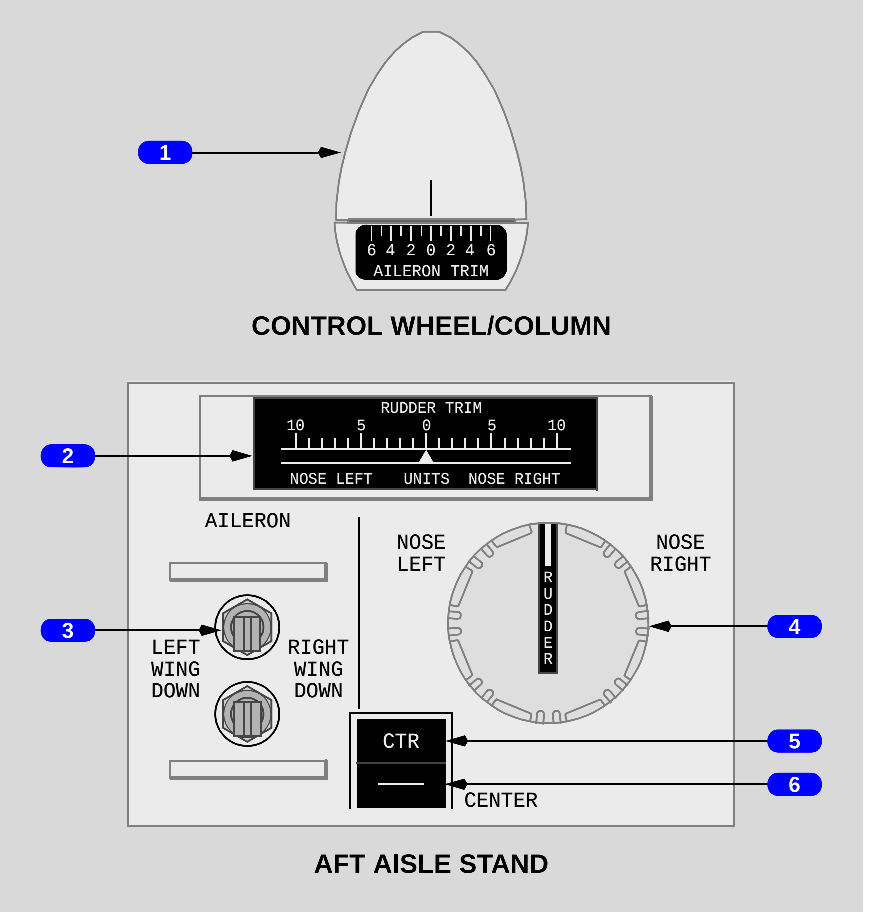
- green - in takeoff range
- white - in flight or on the ground and outside takeoff range
- blank - input is invalid or missing

3 Stabilizer Trim Digital Readout

Indicates stabilizer position in units of trim while on the ground

- green - in takeoff range
- white - outside takeoff range
- amber "X" - stabilizer trim is inoperative
- blank - input is invalid or missing

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
- cancels rudder trim centering

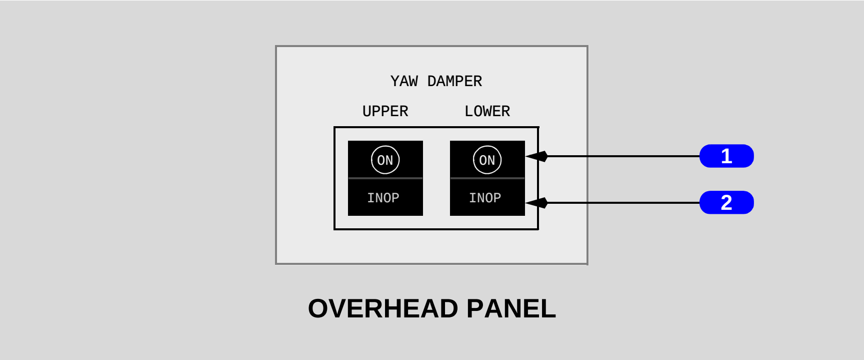
5 Rudder Trim Center (CTR) Light

Illuminated - Rudder Trim Center switch has been pushed and trim is moving to zero units.

6 Rudder Trim Centering (CENTER) Switch

Push - rudder trim moves to zero units.

Yaw Damper Controls



1 YAW DAMPER Switches

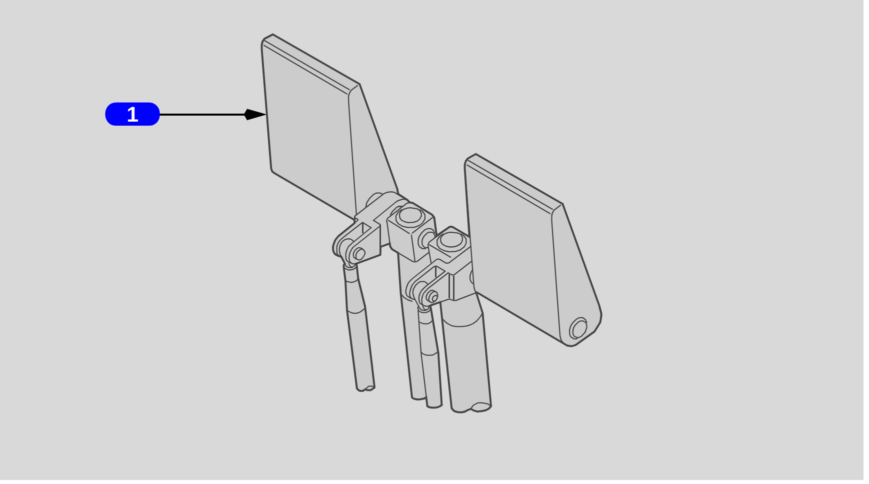
ON - yaw damper powered.

2 Yaw Damper Inoperative (INOP) Light

Illuminated -

- Yaw Damper switch off, or
- yaw damper inoperative

Rudder/Brake Pedals



1 Rudder Pedals

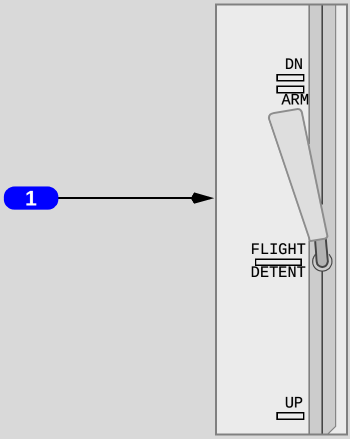
Push - deflects rudders in desired direction.

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



CONTROL STAND

1 Speedbrake Lever

DN (down) (detent) - all spoiler panels retracted

ARM (armed) -

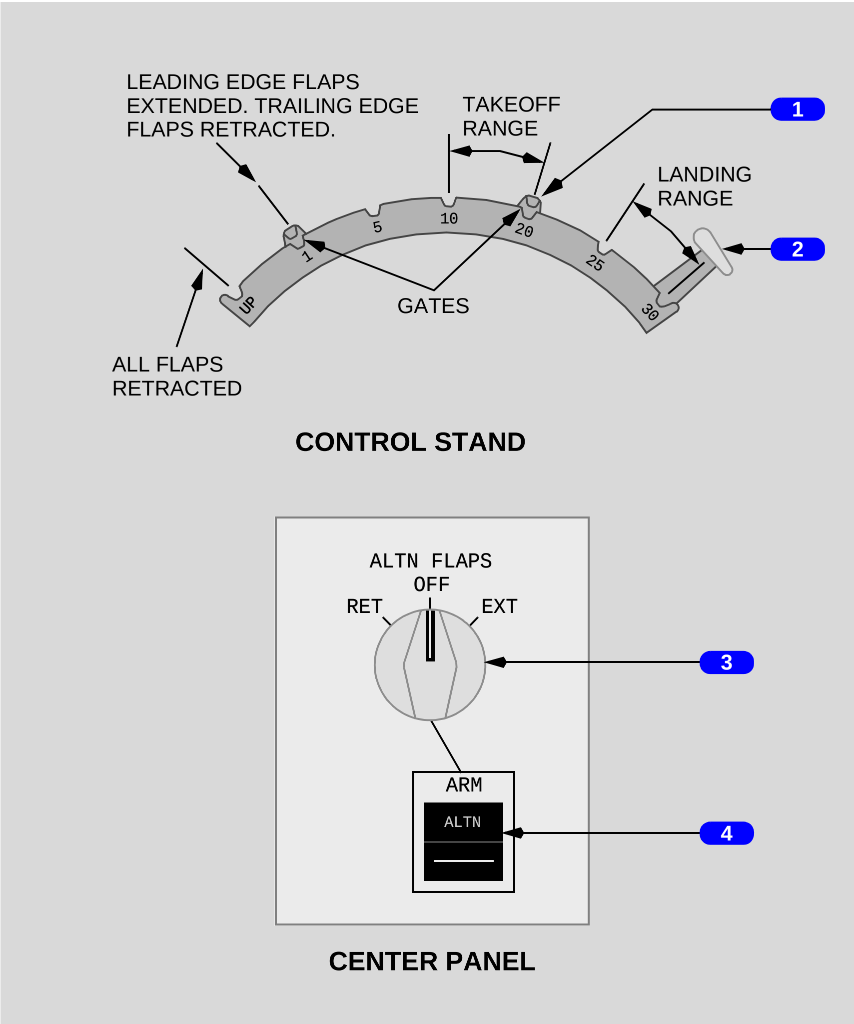
- automatic speedbrake system armed
- after landing, Speedbrake lever moves to UP and spoiler panels extend if engine 1 and engine 3 Thrust levers retarded

FLIGHT DETENT -

- spoiler panels extend to their maximum in-flight positions
- panel extension is limited by the fly-by-wire system; tactile feel when at FLIGHT DETENT

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 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, skew, disagree, and uncommanded motion protection not available
- Flap lever inoperative

Flap Limit Placard

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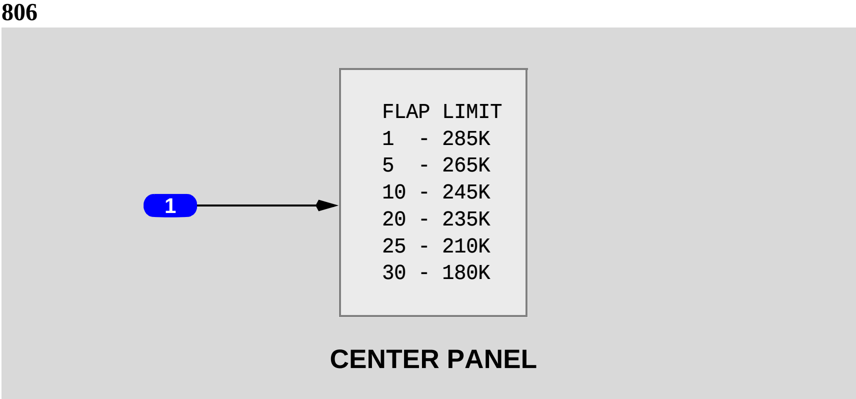

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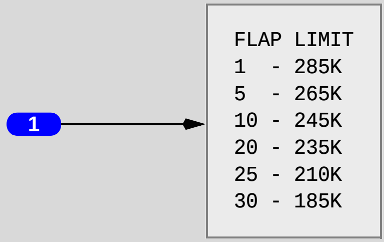


CENTER PANEL

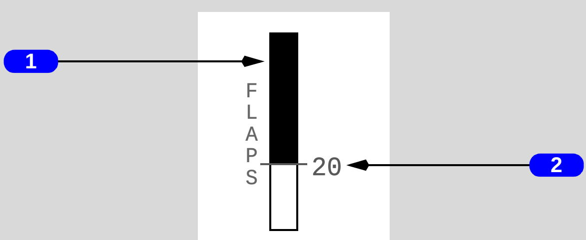
1 FLAP LIMIT Placard

Flaps extended speed limits.

Normal Flap Position Indication

Displays combined leading and trailing edge flap positions when all surfaces are operating normally and control is in the primary mode. The indicator shows continuous motion.

Indication is no longer displayed 10 seconds after flap retraction.



EICAS DISPLAY

1 Flap Position (white)

UP - all leading and trailing edge flaps retracted.

Between UP and 1 -

- all leading edge flap groups in transit
- all trailing edge flaps retracted

1 -

- all leading edge flap groups extended
- all trailing edge flaps retracted

Between 1 and 30 - actual position of slowest trailing edge flap group.

2 Flap Lever Position (line and number)

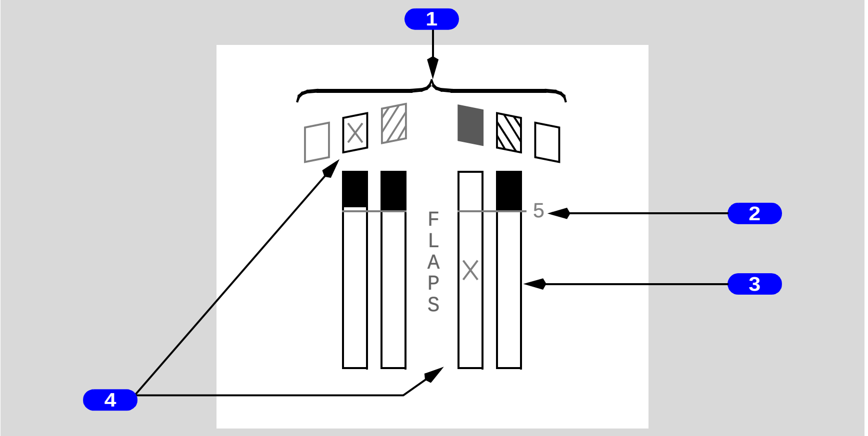
Magenta - flaps in transit to position selected by Flap lever.

Green - flaps in selected position.

Secondary Mode Expanded Flap Position Indication

If any flap position is non-normal or if flap control is in secondary mode, all flap positions are displayed.

Indicator motion is continuous between flap detents.



EICAS DISPLAY

1 Leading Edge Flaps Indication

White Box Outline - leading edge flap group retracted.

White Crosshatch - leading edge flap group in transit.

Solid Green Box - leading edge flap group extended.

Amber 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
- flap panel failure has occurred.

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, skew, or drive failure has occurred in respective group.

4 **Inoperative Sensor**

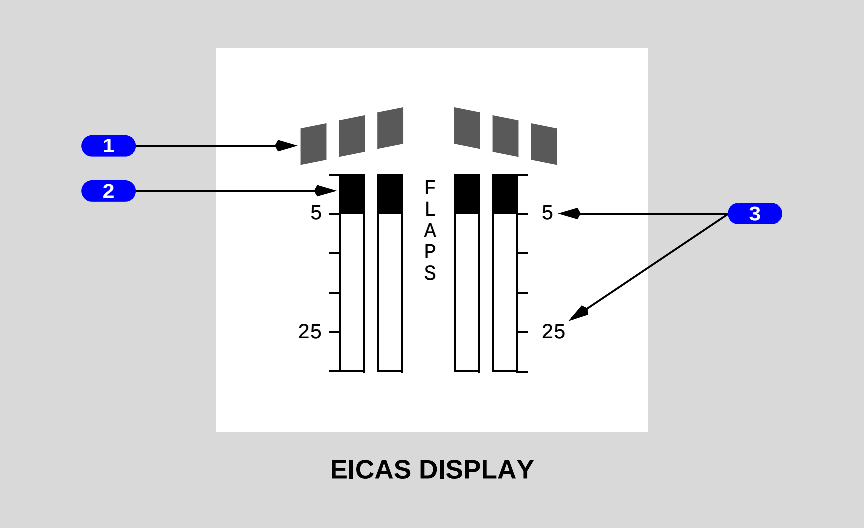
X (amber) - position sensor for respective flap has failed.

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 be displayed without position data if all three flap control units 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**

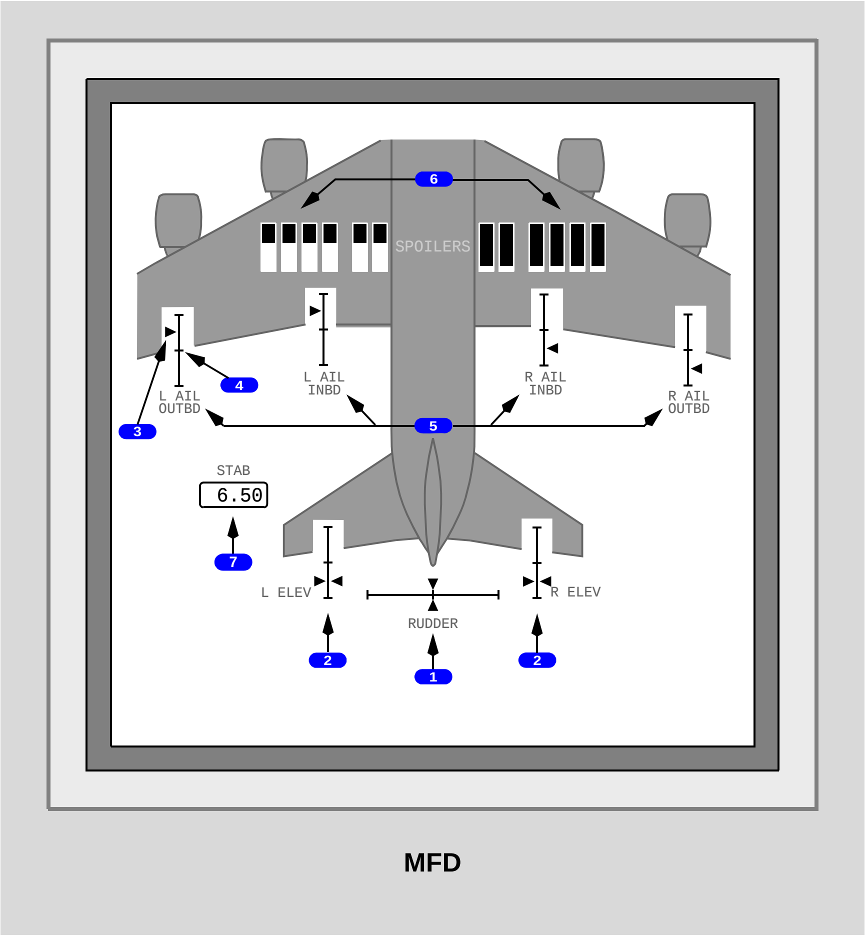
Reference flaps 5 and 25 positions.

Surface Position Indication

The surface position indication is displayed by pushing the FCTL Synoptic 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.

Normal Flight Control Synoptic



MFD

1 Rudder Position

Indicates upper and lower rudder positions.

2 Elevator (ELEV) Position

Indicates left and right elevator positions.

3 Outboard Aileron Position Pointer

The outboard aileron is neutral if the neutral position index mark is within any portion of the outboard aileron position pointer (white triangle).

4 **Neutral Position Index Mark**

Indicates neutral aileron position with flaps not in a takeoff position.

5 **Aileron (AIL) Position**

Indicates inboard and outboard aileron positions.

6 **Spoiler Position**

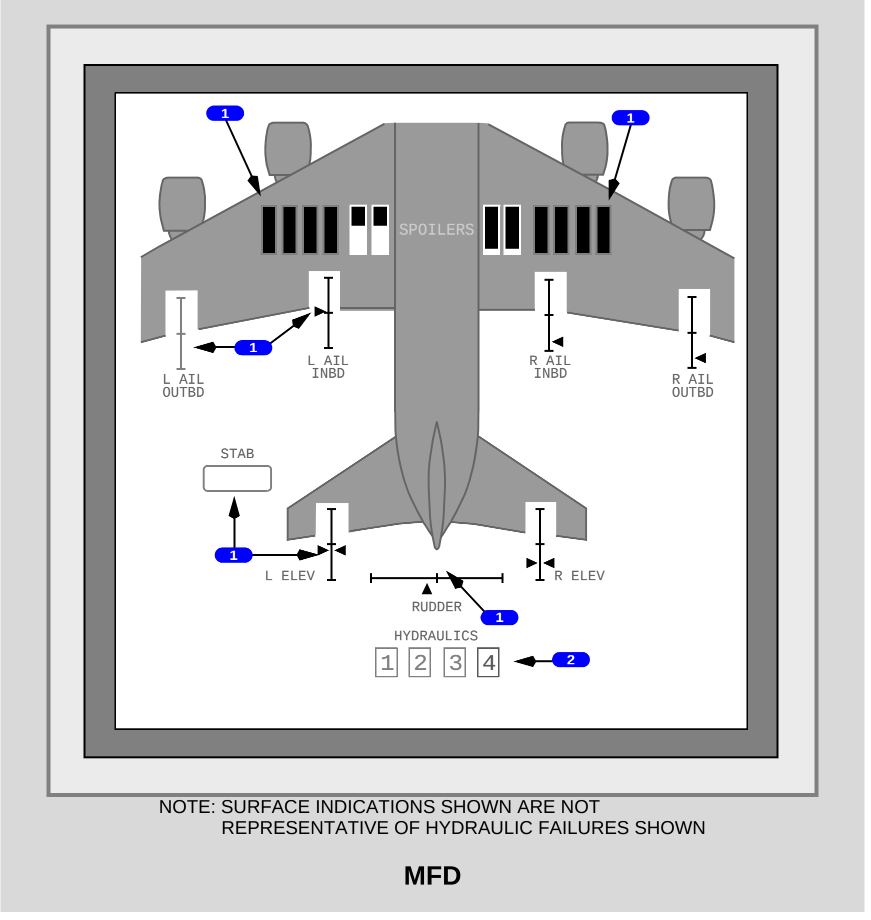
Indicates flight spoiler positions.

7 **Stabilizer (STAB) Trim Position**

White - in flight or on the ground and the trim is outside of the green band.

Green - on the ground and trim is inside the green band.

Non-Normal Flight Control Synoptic



1 Surface Position

Blank -

- Inoperative control surface, or
- Surface position is unknown

Non-responsive - position of inoperative surface.

2 Low Hydraulic Pressure

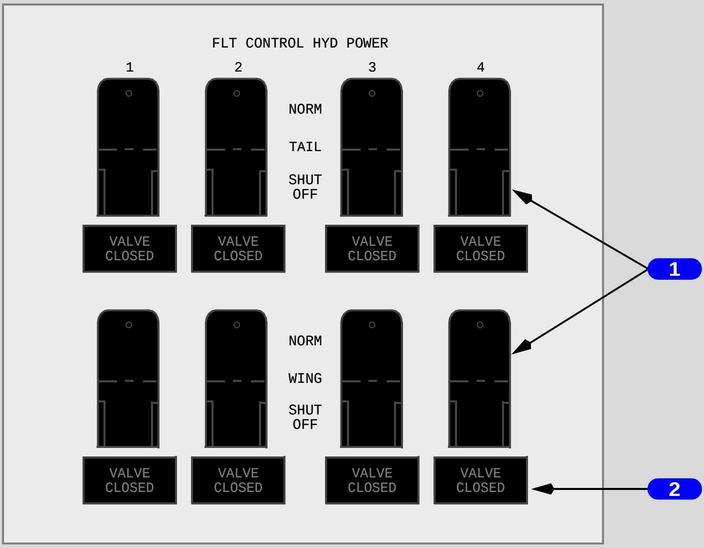
Indicates one or more hydraulic systems have low pressure.

Green – operative system

Amber – inoperative system

Note: Hydraulic synoptic lists inoperative control surfaces.

Flight Control Hydraulic Power Controls



OVERHEAD MAINTENANCE PANEL

1 Flight (FLT) CONTROL Hydraulic (HYD) POWER SHUTOFF Switches

NORM - allows hydraulic power availability for respective 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.

Intentionally
Blank

Flight Controls — Chapter 9
System Description — Section 20

Introduction

The primary flight controls are elevators, ailerons, and rudders. The control column, control wheel, and rudder pedals control the primary 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.

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 symmetric actuation of the spoilers.

Trim switches allow the pilots to adjust flight control surfaces to reduce flight control pressures.

Flight Control Surfaces

Pitch is controlled by:

- four elevator surfaces
- a moveable horizontal stabilizer

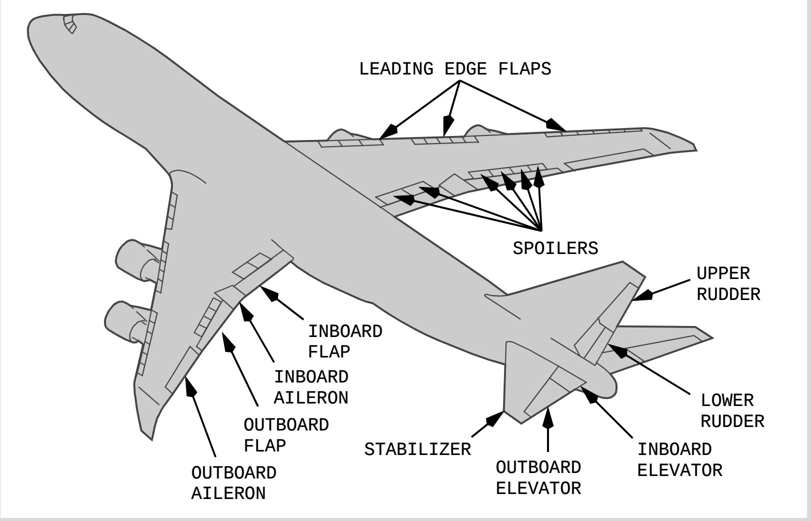
Roll is controlled by:

- four ailerons
- twelve spoilers

Yaw is controlled by an upper and lower rudder.

Leading and trailing edge flaps increase lift and decrease stall speed for takeoff and landing.

Flight Control Surface Locations



Pitch Control

Four elevator surfaces are hinged at the rear of the moveable horizontal stabilizer.

Elevator Control

Control column inputs transfer mechanically to hydraulic actuators on the inboard elevator control surfaces. Inboard elevator position controls input for the respective adjacent outboard elevator actuator. Shearouts between the elevators allow elevator control to be regained if a jam occurs and a significant manual force is applied to the control columns.

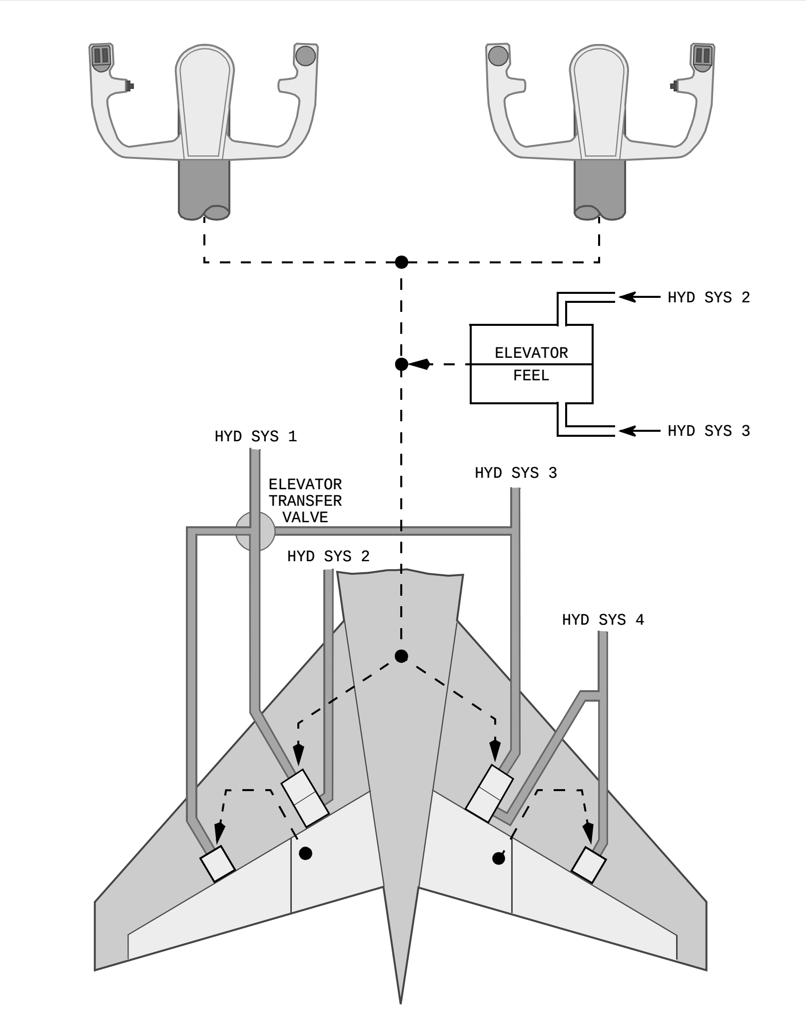
The left elevator hydraulic source is transferred from system 1 to system 3 by the elevator transfer valve when the ram air turbine is deployed.

Elevator positions display on the flight control synoptic page on the MFD. 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.

The pitch augmentation system assists pitch stability and landing flare.

Elevator Control Diagram



Stabilizer Trim

The stabilizer trim system varies 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 Stabilizer Trim switches and the Alternate Stabilizer Trim switches use separate control channels. The Alternate Stabilizer Trim switches command 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, in trim units, is displayed on the MFD.

The stabilizer trim indicator incorporates a 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.

Green band and stabilizer trim takeoff setting are calculated based on the FMC calculated gross weight, center of gravity, takeoff thrust derate selection, and takeoff flap entry. Flap position overrides flap entry when set for takeoff. 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.

Actual trim setting values are displayed in a highlight box at the bottom of the display while on the ground. The box and readout are green while trim is inside the green band. The highlight box and readout are white when the trim is set to a value outside the green band.

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 respective hydraulic system if unscheduled stabilizer trim is detected. With a Stabilizer Trim Cutout switch in CUTOUT, hydraulic power to the respective trim control module is shut off. Positioning a switch to ON overrides the automatic cutout function and supplies hydraulic power to the respective 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 more than one autopilot is 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 Cutout

Control column inputs in the direction opposing stabilizer trim will cutoff electric trim commands to the control modules. The control column trim cutout function does not affect alternate trim inputs.

Stability Trim

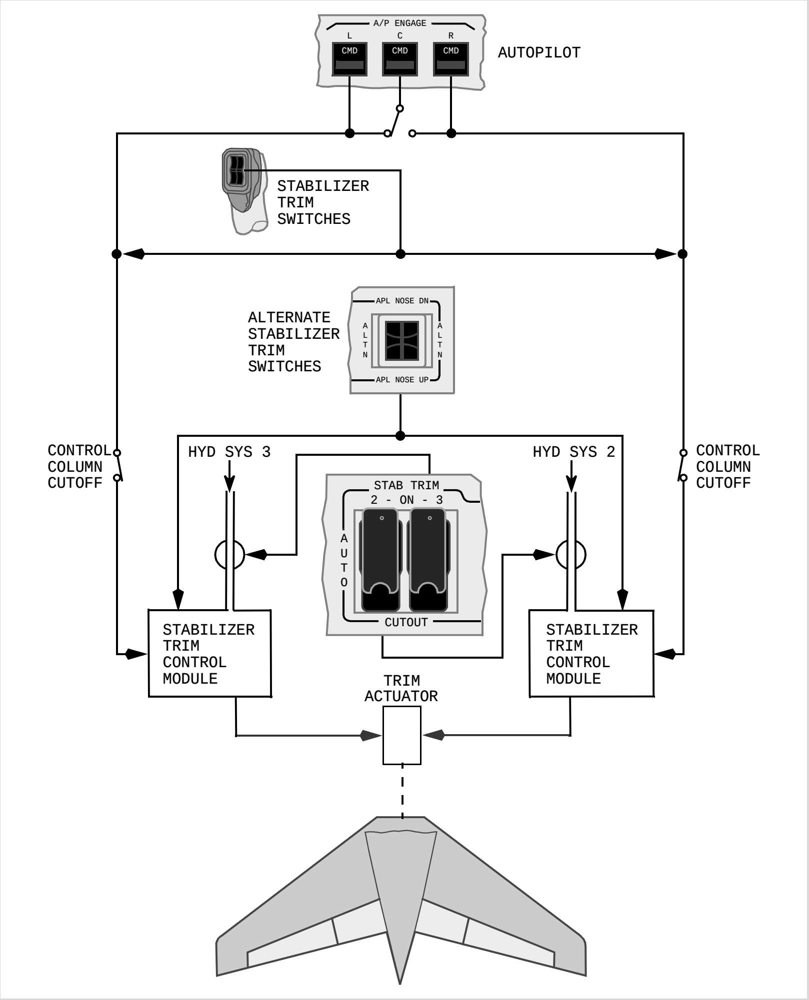
Stability trim uses stabilizer trim to improve handling characteristics of the airplane in the lower and higher speed ranges.

Activating the Stabilizer Trim switches or engaging an autopilot inhibits stability trim.

Tail Strike Protection

During takeoff or landing, the stabilizer trim system calculates if a tail strike is imminent and decreases elevator deflection, if required, to reduce the potential for tail ground contact. Activation of tail strike protection does not provide feedback to the control column.

Stabilizer Control Diagram



Roll Control

Inboard ailerons are mechanically controlled and hydraulically powered. Outboard ailerons and all spoilers are electronically controlled and hydraulically powered.

Aileron and Spoiler Roll Control

Rotating either control wheel positions ailerons and spoilers. Above approximately 258 knots/.53 Mach, the outboard ailerons are commanded to the neutral position to prevent overcontrolling. The outboard ailerons become operational at lower airspeeds. Inboard aileron deflection is limited when flaps are extended beyond 10.

To improve takeoff performance and reduce noise, the outboard aileron is deflected down for flap detent positions 10 and 20. The downward deflection is removed if the angle of attack is above stick shaker. The inboard aileron is deflected down when the flaps are selected to 10 or greater.

All spoiler panels operate with the ailerons. Spoiler panels are deflected up or down based on Speedbrake lever and control wheel inputs.

Aileron positions are displayed on the flight control synoptic page on the MFD. 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.

Control Wheel Jam

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 available through the outboard ailerons and spoilers on both wings, and the inboard aileron on the wing corresponding to the free wheel.

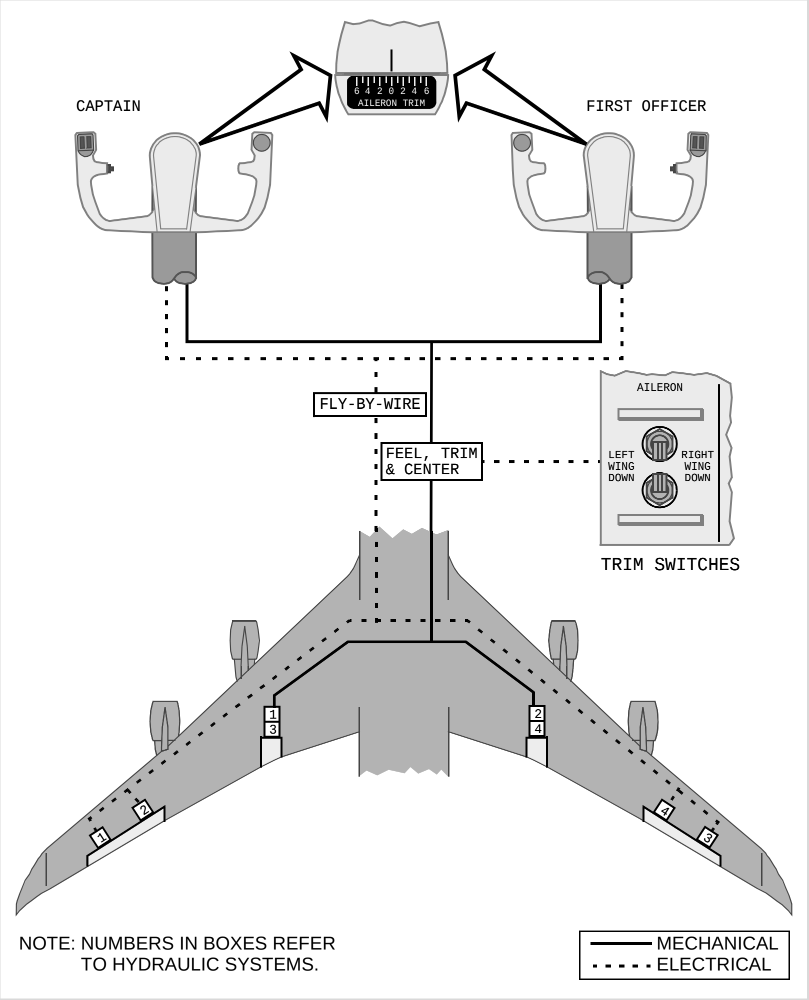
Each side of the mechanical system also incorporates shearouts which may allow the jammed control wheel to be freed when a significant manual force is applied to the jammed wheel.

Aileron Trim

Pushing both Aileron Trim switches in the desired direction causes the feel and trim mechanism to reposition the inboard and outboard aileron neutral point. Both control columns have an aileron trim indicator.

If the Aileron Trim switches are actuated 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 system controls yaw.

Rudder Control and Trim

Either pilot's rudder pedals control the hydraulically powered upper and lower rudders. The lower rudder is double-hinged, with a mechanically slaved tab, for increased rudder authority. The lower rudder and rudder tab have different thermal characteristics. Altitude and temperature changes affect the lower rudder and rudder tab differently, and may cause increased rudder trim adjustments during flight. Rudder pedal inputs mechanically transfer to a single feel, trim, and centering mechanism, then transfer through separate ratio changers to the upper and lower rudder hydraulic actuators.

Rudder positions are displayed on the flight control synoptic page on the MFD. 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 and override mechanisms allow the upper or lower rudder to be controlled if the other rudder is jammed downstream of the rudder ratio changer and a significant manual force is applied to the rudder pedals. A secondary linkage allows full control of both rudder surfaces in case of a primary linkage disconnect.

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.

Pushing the Rudder Trim Center switch causes rudder trim to move to the zero units position. Rudder trim centering can be cancelled by using the Rudder Trim selector or pushing the Rudder Trim Center switch a second time. The zero position achieved by the centering function is not as accurate as manually trimming to zero units.

Rudder Ratio Changers

Two rudder ratio changer systems gradually reduce each rudder surface's response to pedal inputs as airspeed changes. As airspeed increases, the rudder surface response is reduced to protect the vertical tail structure from stresses which could result from large rudder surface deflections at high airspeeds. In certain low speed conditions, the rudder surface response is adjusted to ensure sufficient roll authority to counteract yaw.

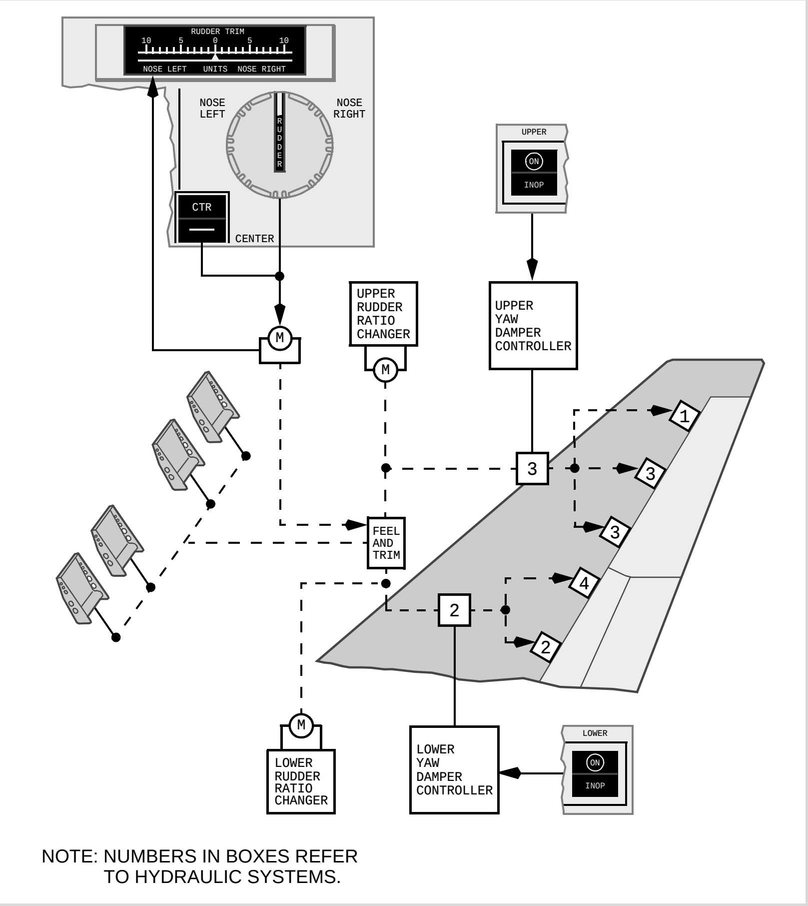
If a ratio changer system fails, the response of the respective rudder surface to pedal inputs remains the same as when the failure occurred, regardless of changes in airspeed. Rudder response to pedal inputs is no longer adjusted, reducing the airplane crosswind capability for both manual and automatic 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 respective yaw damper INOPERATIVE light illuminates.

Rudder Control Diagram



Spoilers

There are six spoilers on each upper wing surface just forward of the trailing edge flaps.

The position of the spoiler panels are displayed on the Flight Control Synoptic page on the MFD.

When landing flaps are extended and airspeed is above VREF + 10 knots, system logic can deflect some spoilers a programmed amount to assist in maintaining proper approach and landing pitch attitude. The amount of spoiler deflection is dependent on airplane gross weight and speed. If gross weight information is not available from the FMC, the system defaults to the maximum programmed amount of deflection and airframe buffet may occur.

Speedbrakes

In flight, moving the Speedbrake lever to flight detent partially extends the inboard and two middle spoiler panels. The two outer panels are not used in flight as speedbrakes. Further surface extension is prevented if the Speedbrake lever is moved aft of flight detent.

On the ground, moving the Speedbrake lever fully aft to the UP position extends all six spoiler panels on each wing to their full travel positions.

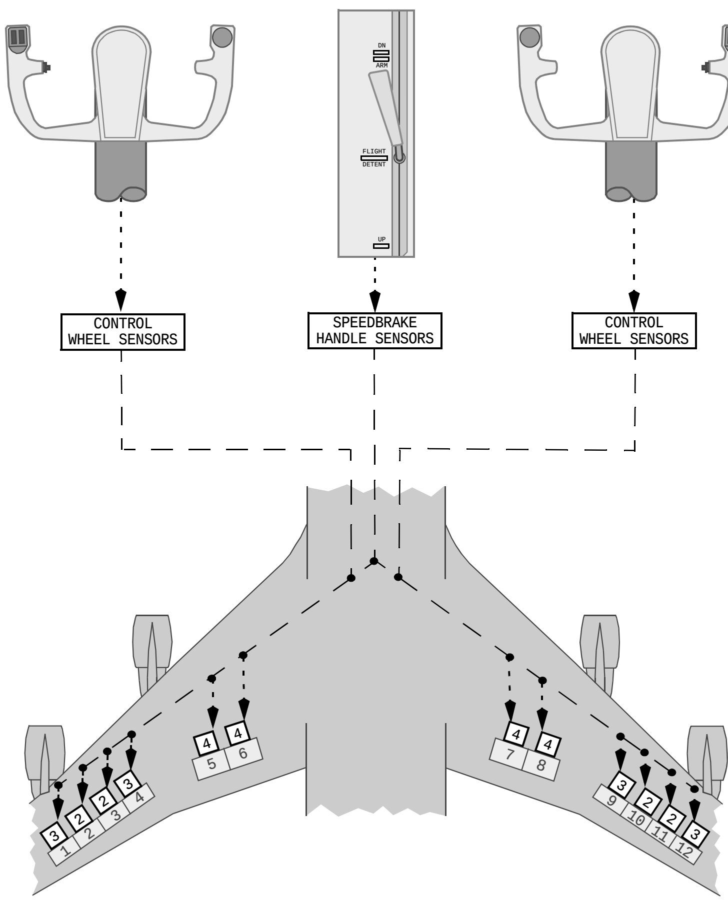
When the Speedbrake lever is in the ARMED position, Thrust levers 1 and 3 are near the idle position, and the main landing gear touch down, the Speedbrake lever is automatically driven to the UP position, extending all spoiler panels.

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 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 auto speedbrake extension can occur with the Speedbrake lever in the DN position. The spoilers can be operated manually.

Spoiler Control Diagram



NOTE: NUMBERS IN SQUARES REFER TO HYDRAULIC SYSTEMS.
NUMBERS ON PANELS REFER TO SPOILER NUMBER.

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, skew, 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 or skew 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 20, 25, or 30 selected. To reduce or eliminate the exceedance, the flaps will retract to:

Selected Flaps	Relief Position
30	25 or 20
25	20
20	10

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 are fully retracted.

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 all leading edge flap groups extend. When the Flap lever is moved to the flaps 5, 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.

Leading Edge Fault Indication

The leading edge fault indication system monitors the midspan section to alert the crew when maneuverability and stall speed are affected by panel damage or position disagreement. The EICAS message FLAPS DRIVE displays when a leading edge fault is detected.

Flap Indications

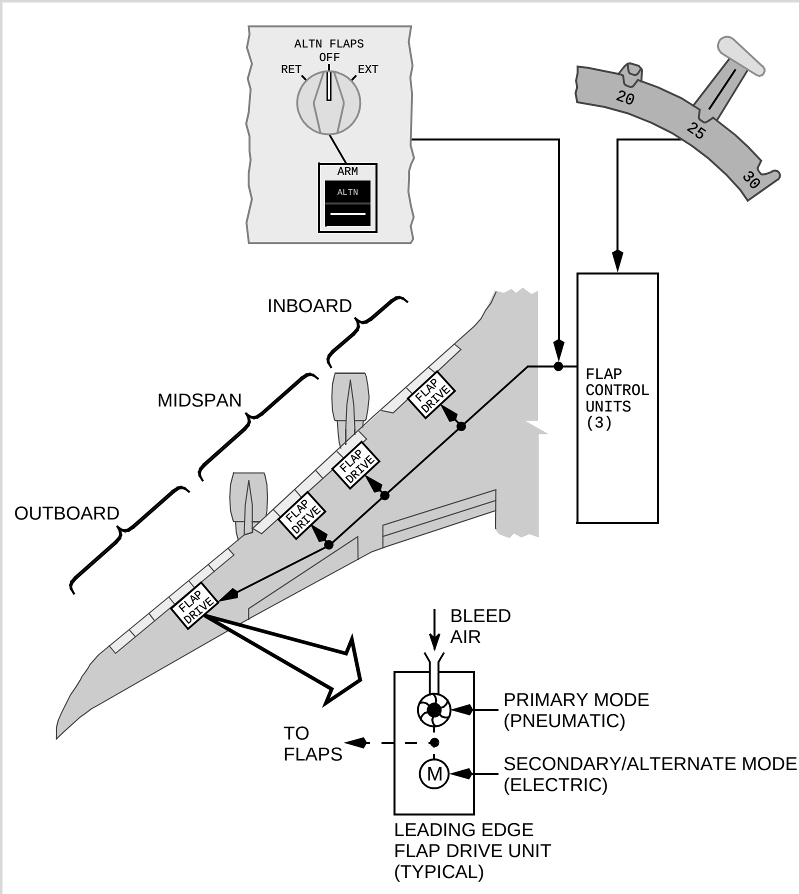
Flap position indications and the flap position commanded by the Flap lever are displayed on the EICAS. Leading and trailing edge positions are combined as a single vertical indicator. Ten seconds after all flaps are up, the entire indication is no longer displayed.

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.

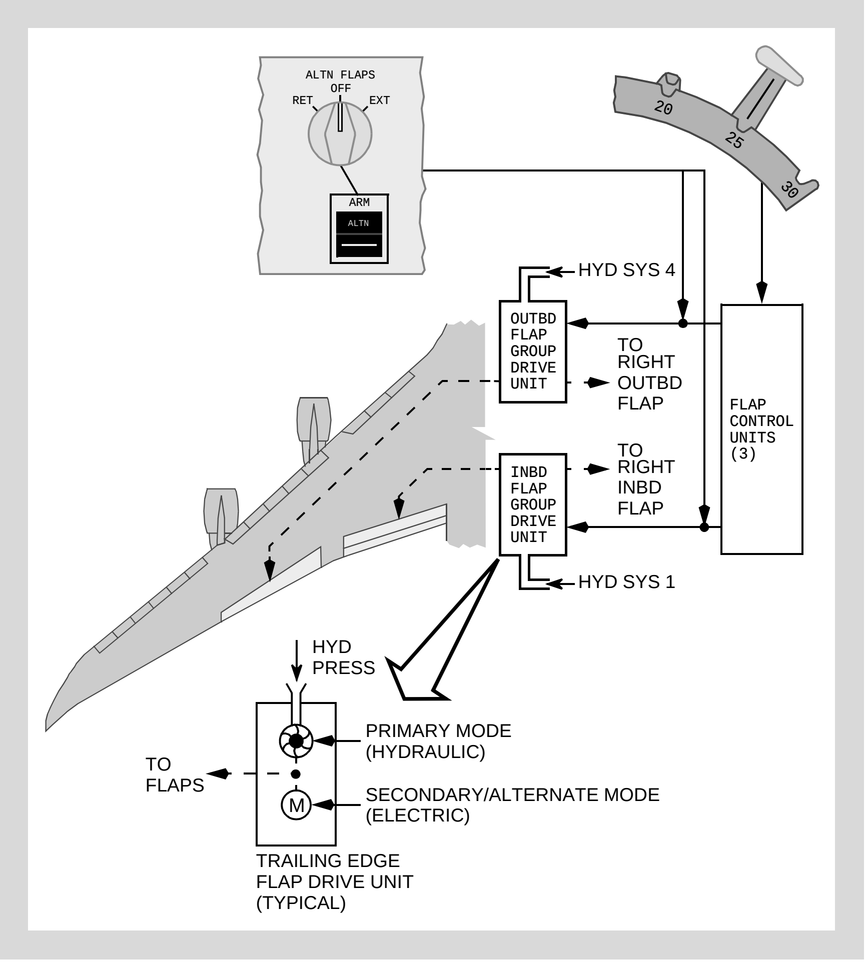
If the standby bus is the only powered AC bus, the left wing trailing edge flap position sensors are not powered. An expanded indication is displayed with an amber X on the left outboard and inboard trailing edge flap indications.

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 OUTBD	Advisory		One or both outboard ailerons are inoperative.
ELEVATOR FEEL	Caution	Beeper	An elevator feel system fault occurs.
FLAP RELIEF	Advisory		Flap load relief occurs.
FLAPS CONTROL	Caution	Beeper	All flap control units are failed, or Alternate Flaps Arm switch in ALTN.
FLAPS DRIVE	Caution	Beeper	One of these occurs: • A flap group failed to move in secondary mode • A flap asymmetry or skew is detected • A leading edge fault indication is detected
FLAPS PRIMARY	Caution	Beeper	One or more flap groups primary mode is failed.
FLARE ASSIST	Caution	Beeper	Landing flare assist is inoperative.
FLIGHT CONTROLS	Caution	Beeper	A flight control system fault occurs.
FLIGHT ENVELOPE	Advisory		Pitch stability when approaching flight envelope boundaries is reduced.
FLT CONT VLVS	Advisory		One or more flight control shutoff valves are closed.
RUD RATIO DUAL	Advisory		Both rudder ratio changers are failed.

Message	Level	Aural	Message Logic
RUD RATIO SNGL	Advisory		One rudder ratio changer is failed.
SPEEDBRAKE AUTO	Advisory		An automatic ground Spoiler system fault occurs.
SPEEDBRAKE EXT	Caution	Beeper	The speedbrakes are extended and one or more of these occur: • The radio altitude is between 15 and 800 feet • The Flap lever is in a landing setting • Two or more Thrust levers are not at idle
SPOILERS	Advisory		One or more spoiler pairs are inoperative.
STAB GREENBAND	Advisory		The nose gear pressure switch disagrees with stabilizer green band calculated by the FMC.
STAB TRIM 2, 3	Advisory		One of these occurs: • Automatic cutout of hydraulic system power to stabilizer trim • Stabilizer Trim Cutout switch is in Cutout • Trim is commanded and the actuator does not move
STAB TRIM UNSCHD	Caution	Beeper	One of these occurs: • Unscheduled stabilizer movement with no automatic cutout • The Alternate Stabilizer Trim switches are used with an autopilot engaged

Message	Level	Aural	Message Logic
YAW DAMPER LWR, UPR	Advisory		A yaw damper is inoperative because one of these occurs: • A yaw damper system is failed • An IRS is not aligned

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Flight Instruments, Displays — Chapter 10
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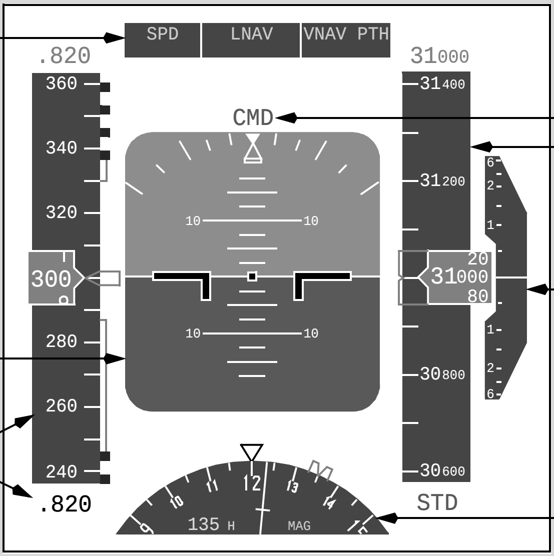
Primary Flight Display (PFD)



LEFT AND RIGHT FORWARD PANELS

1 Flight Mode Annunciations

Refer to Chapter 4, Automatic Flight.

2 Attitude, Steering, and Miscellaneous Displays

Displays IRS 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.

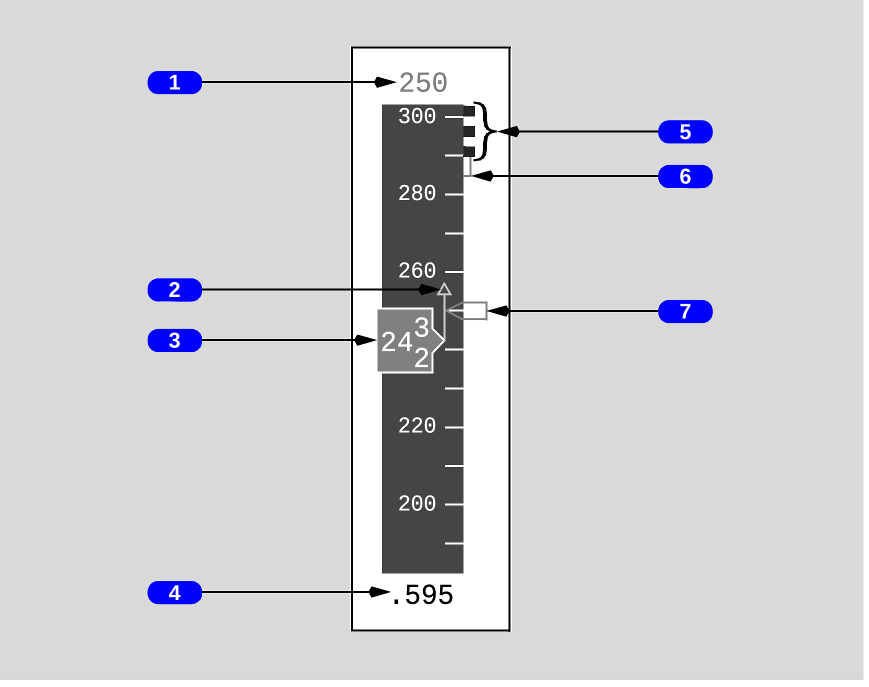
6 Vertical Speed Display

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



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

The tip of the arrow indicates predicted airspeed in ten seconds based on airspeed, inertial data, and winds. Rapidly changing wind speed or direction can affect predicted airspeed with no change to indicated airspeed.

3 Current Airspeed

Displays ADC airspeed.

Displays 30 knots with no computed information.

Airspeed box changes color to amber if current airspeed less than minimum maneuvering speed.

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4 Current Mach

Displays ADC Mach when Mach .40 or greater.

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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 maneuvering capability to high speed buffet (or an alternative approved maneuvering capability as preset by maintenance). May display when operating at high altitude at relatively high gross weights.

Note: 1.3g maneuvering capability occurs at 40 degrees of bank in level flight.

7 Command Speed

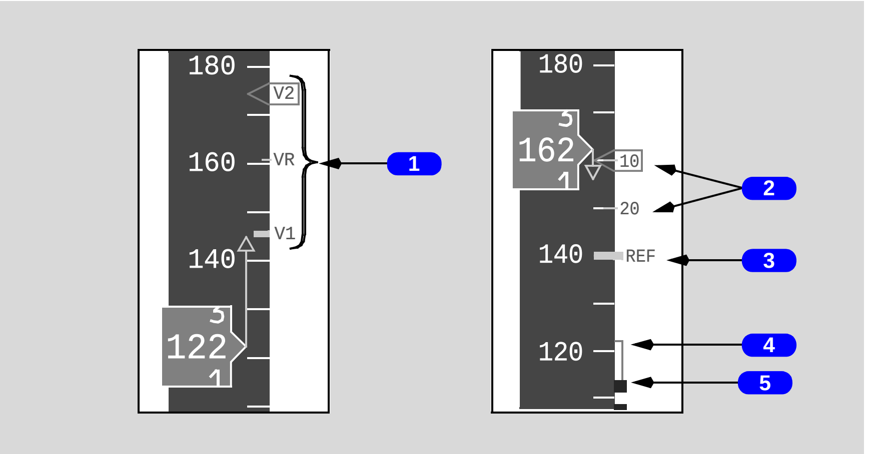
Points to airspeed/Mach set in MCP IAS/MACH window.

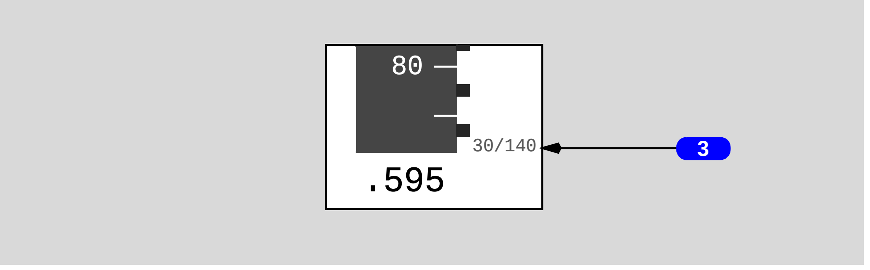
Points to FMC-computed airspeed when MCP IAS/MACH window blank.

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





1 Takeoff Reference Speeds

Displays takeoff reference speeds V1, VR (displays R when VR within 4 knots of V1), and V2 selected on the CDU (refer to Chapter 11, Flight Management, Navigation):

- displayed for takeoff
- NO V SPD displays when V speeds are not selected on the CDU
- V1 displays at the top of the airspeed indication when selected and if the value is off the scale
- V1 and VR are removed at lift-off
- V2 is removed on climb-out when flap retraction begins

2 Flap Maneuvering Speeds

Displays flap maneuvering speed for flap retraction or extension for current flap setting and next lesser flap setting.

Not displayed above approximately 20,000 feet altitude.

3 Selected Landing Flap/Landing Reference Speed

Displays landing flaps and VREF speed selected on the CDU (refer to Chapter 11, Flight Management, Navigation).

VREF speed displays at the bottom of the airspeed indication when the value is off the scale.

4 Minimum Maneuvering Speed

Top of amber bar indicates minimum maneuvering speed. This airspeed provides:

- 1.3g maneuver capability to stick shaker at or below 20,000 FT
- 1.3g maneuver capability to low speed buffet (or an alternative approved maneuver capability as preset by maintenance) above 20,000 FT

Displayed with first flap retraction after takeoff.

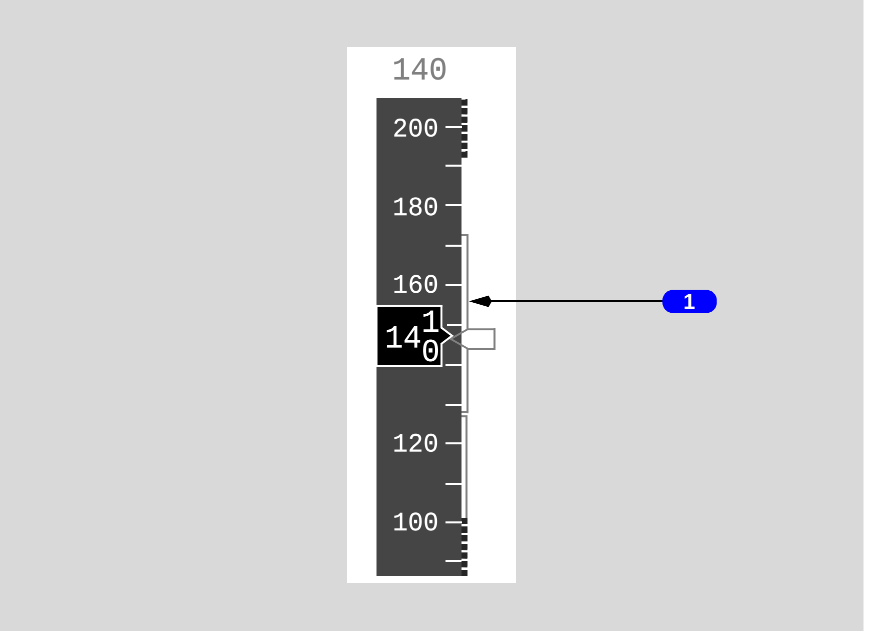
Note: 1.3g maneuver capability occurs at 40 degrees of bank in level flight.

CAUTION: Reduced maneuver capability exists when operating within the amber regions below the minimum maneuvering speed or above the maximum maneuvering speed. During non-normal conditions the target speed may be below the minimum maneuvering speed.

5 Minimum Speed

Indicates airspeed where stick shaker or low speed buffet occurs.

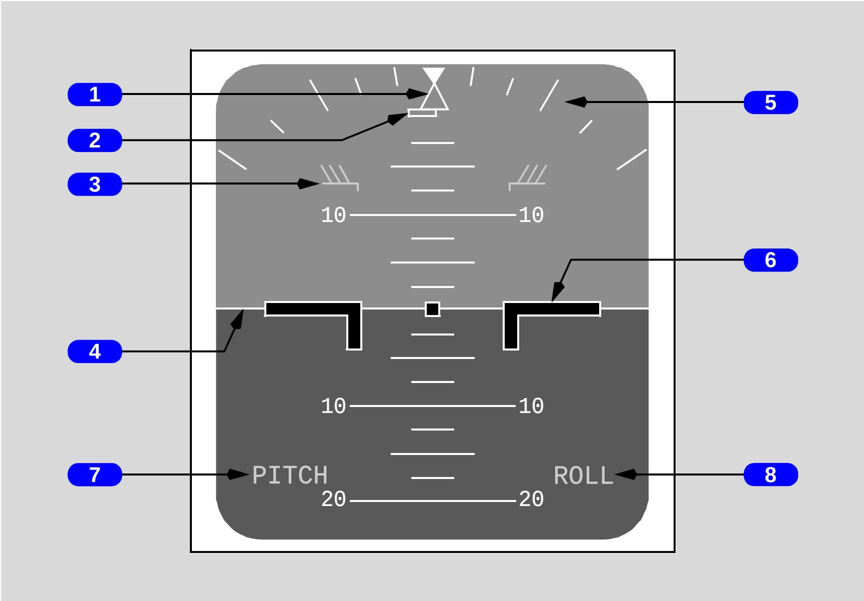
VNAV Speed Band



1 VNAV Speed Band (magenta)

Indicates acceptable airspeed range for VNAV path (VNAV PTH) pitch mode. Available with flaps up.

Attitude Indications



1 Bank Pointer

Indicates IRS bank in reference to bank scale.

Fills solid amber when bank angle is 35 degrees or greater.

2 Slip/Skid Indication

Displaces beneath bank pointer to indicate slip or skid.

When bank angle is:

- less than 35 degrees, indicator fills solid white when fully displaced
- 35 degrees or greater, indicator outline changes to amber
- 35 degrees or greater, indicator fills solid amber when fully displaced

3 Pitch Limit Indication

Indicates pitch limit (stick shaker activation point for existing flight conditions). Limited to a maximum of +30 degrees.

Displayed when flaps are not up, or at slow speeds with flaps 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**

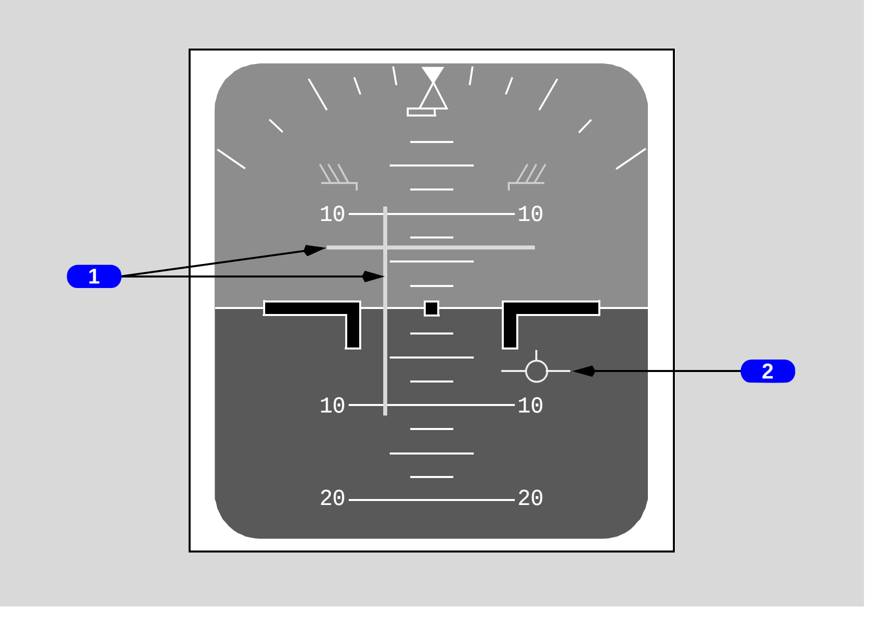
Displays if Captain’s and First Officer’s PFD pitch attitude disagree.

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.



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.

Radio Altitude Indications

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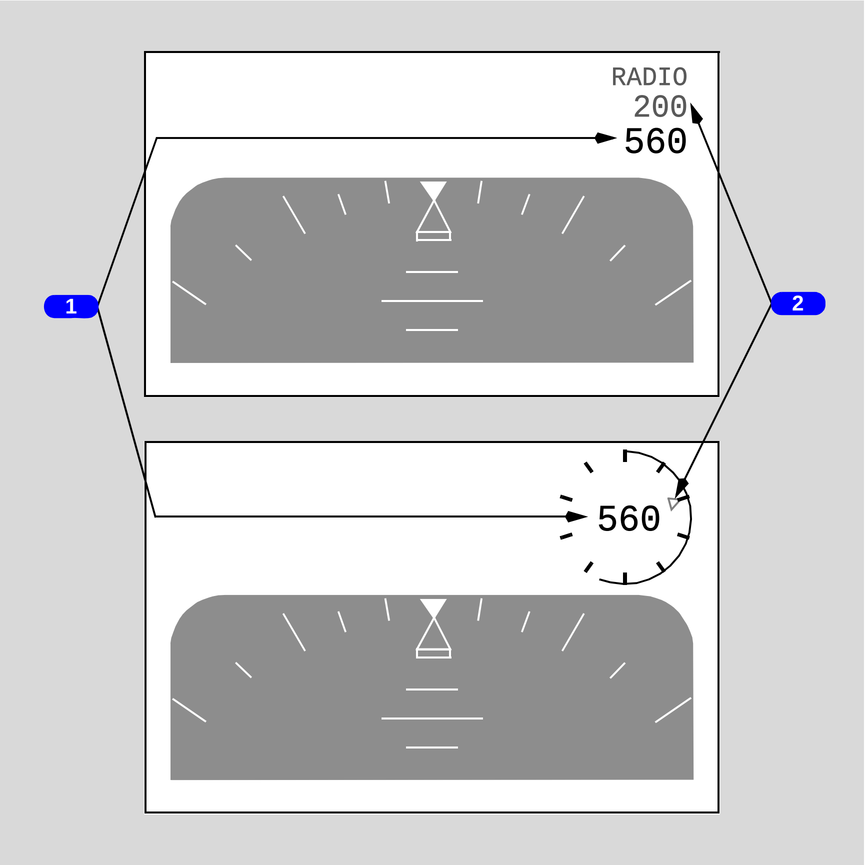

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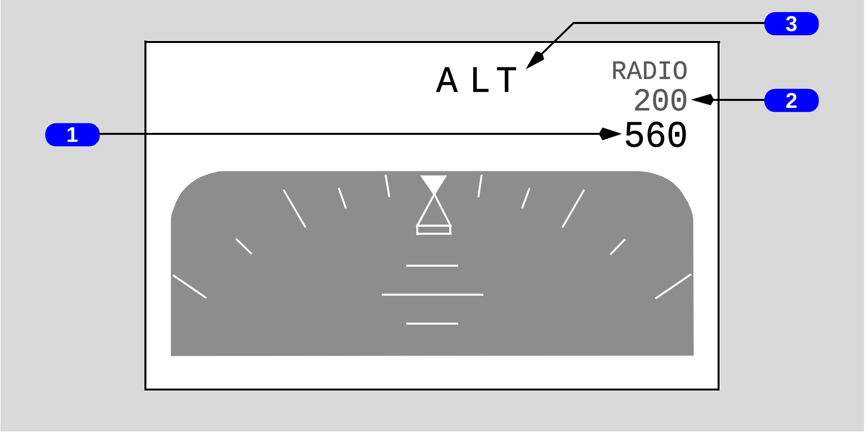

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1 **Radio Altitude**

Displays airplane radio altitude below 2,500 feet AGL.

Highlighted for 10 seconds by a white box when the display appears descending through 2,500 feet.

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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

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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 resets:

- upon landing
- on go-around at 75 feet above the set radio altitude
- when MINS RST switch is pushed

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2 RADIO Minimums

Displays radio altitude set on EFIS control panel.

RADIO and the altitude setting change color to amber and flash when radio altitude is at or below the setting.

RADIO not displayed when set below 0 feet.

Flashing amber RADIO and the altitude setting reset:

- upon landing
- on go-around at 75 feet above the setting
- when MINS RST switch is pushed

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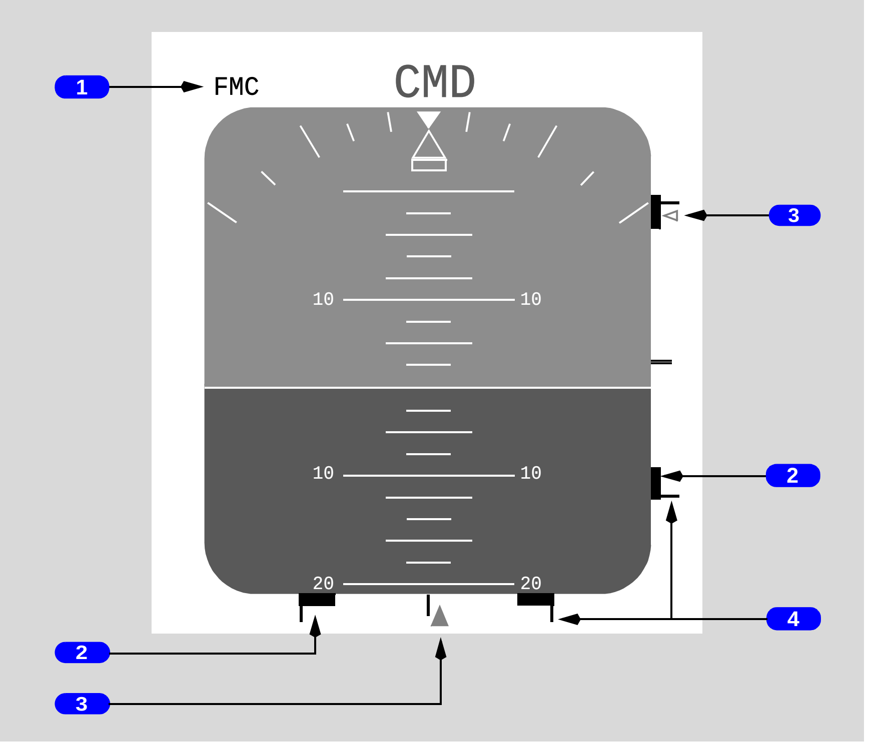
3 Height Alert

Displays between 2,500 feet and 500 feet AGL during descent.

Does not display when MINS RST switch pushed.

Navigation Performance Indications

Actual Navigation Performance (ANP) and Required Navigation Performance (RNP) indications display when LNAV, VNAV, or TOGA are active modes, or when LNAV is armed.



1 Navigation Source Reference

Displays the source of navigation performance for the deviation scales.

When lateral and vertical scales are from the same source, only one is shown. If different sources are used, the lateral scale source is shown first, then the vertical scale source is shown after the slash. Possible annunciations are:

- FMC
- GLS
- GLS/FMC

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- FMC/GLS

- ILS
- ILS/FMC

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- FMC/ILS

Different lateral and vertical sources may display momentarily prior to the single annunciation while the signals are tuned.

2 Actual Navigation Performance (ANP) Bars

ANP bars move inward as ANP approaches RNP. The distance between the bars represents the navigation performance available to remain within RNP criteria.

ANP bars change color to amber if the pointer moves into bar area for five seconds.

Vertical ANP bars display only during the VNAV descent phase.

If ANP equals or exceeds RNP, the bars meet in the middle and change color to amber.

If lateral ANP equals or exceeds RNP, the EICAS message UNABLE RNP displays.

3 Navigation Path Pointer

Indicates the active navigation path relative to airplane position.

Pointer:

- is an unfilled magenta triangle when parked at deflection limit
- is a filled magenta triangle when navigation path within scales
- displays on lateral deviation scale whenever the scale displays
- displays on vertical deviation scale only in the VNAV descent phase
- flashes for ten seconds if pointer moves into ANP bar area for five seconds

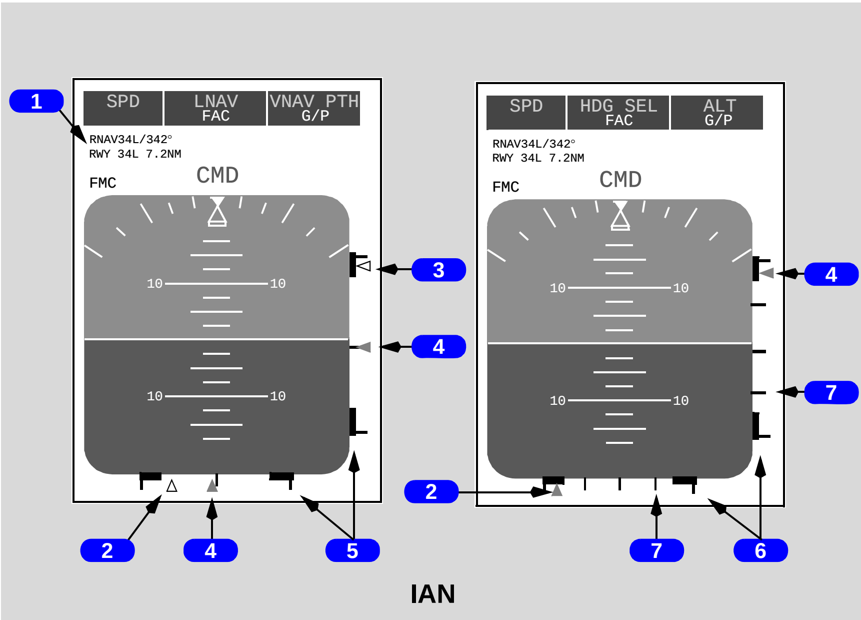
4 Required Navigation Performance (RNP) Scale

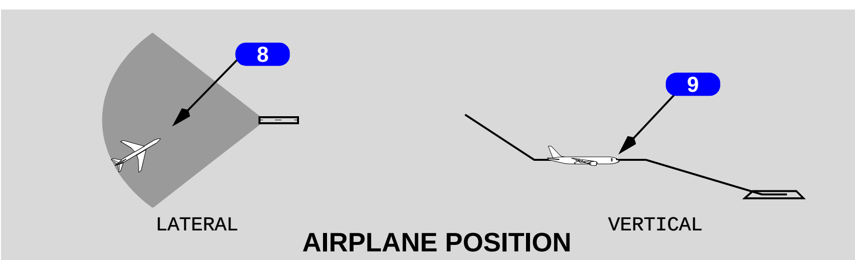
Indicates RNP for the active phase of flight.

RNP scale:

- changes color to amber if pointer moves into bar area for five seconds
- vertical navigation performance scales display only during the descent phase

Integrated Approach Navigation (IAN) Indications





1 Approach Reference

Displays –

- type of approach, runway, approach front course.
- missed approach waypoint name, distance to missed approach waypoint.

Approach reference data displays when the approach has been selected to the active route and the airplane is:

- < 150 NM from the destination airport, or
- < 50 NM from top of descent, or
- FMC is in descent mode

2 Lateral Anticipation Cue

Indicates the position of the armed FAC relative to the airplane prior to capture.

Displays when the airplane is:

- within 25 NM of the MAP
- within 60 degrees of the final approach course

3 Vertical Anticipation Cue

Indicates the position of the armed G/P relative to the airplane prior to capture.

Displays when the airplane is:

- within 25 NM of the MAP
- within 60 degrees of the final approach course
- track is within 90 degrees of the final approach course
- less than 6,000 feet above field elevation

4 Navigation Performance Scales Pointer

Indicates the position of the FMC course relative to the airplane.

Pointer:

- unfilled magenta triangle when parked at deflection limit.
- filled magenta triangle when not parked at deflection limit.
- displayed on lateral deviation scale whenever the scale is displayed.
- displayed on vertical deviation scale only in descent phase of flight.
- flashes for ten seconds if pointer migrates into bar area for five seconds.

5 Navigation Performance Scales

Indicates RNP and ANP for the active phase of flight.

RNP scale:

- bars represent difference between RNP and ANP
- area between bars indicate margin available to remain within RNP criteria
- if ANP equals RNP the white bars meet in the middle and turn amber indicating RNP operations can no longer be maintained and the UNABLE RNP EICAS message is shown
- turns amber if pointer migrates into bar area for five seconds

6 IAN Scales

Displays when:

- LNAV or VNAV are not active modes
- approach is in the active flight plan
- < 150 NM from the destination airport, or

- < 50 NM from top of descent, or
- FMC is in descent mode

7 IAN Mid-scale Indicator

Equal to one half of the RNP.

8 Airplane Lateral Position Reference

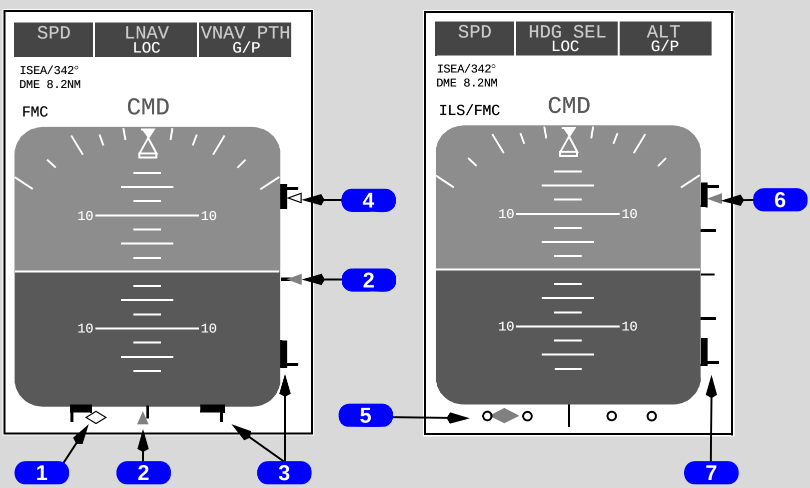
Indicates represented airplane position.

Shaded area indicates where anticipation cues may display.

9 Airplane Vertical Position Reference

Indicates represented airplane position separated into three sections:

- Descent
- Final approach course intercept
- Final approach course



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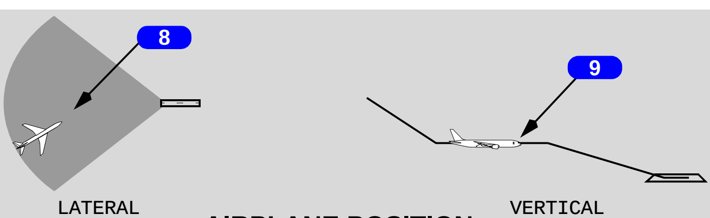


AIRPLANE POSITION

1 Lateral Anticipation Cue

Indicates the relative position of the localizer course prior to capture.

Displays when the airplane is:

- within 25 NM of the MAP
- localizer signal is valid

2 Navigation Performance Scale Pointer

Indicates the LNAV or VNAV path position relative to the airplane.

Pointer:

- unfilled magenta triangle when parked at deflection limit.
- filled magenta triangle when not parked at deflection limit.
- displayed on lateral deviation scale whenever the scale is displayed.
- displayed on vertical deviation scale only in descent phase of flight.
- flashes for ten seconds if pointer migrates into bar area for five seconds.

3 Navigation Performance Scales

Indicates RNP and ANP for the active phase of flight.

Navigation Performance Scale:

- bars represent difference between RNP and ANP
- area between bars indicate margin available to remain within RNP criteria
- if ANP equals RNP the white bars meet in the middle and turn amber indicating RNP operations can no longer be maintained and the UNABLE RNP EICAS message is shown
- turns amber if pointer migrates into bar area for five seconds

4 Vertical Anticipation Cue

Indicates the position of the armed glidepath relative to the airplane prior to capture.

Displays when the airplane is:

- within 25 NM of the MAP
- within 60 degrees of the final approach course
- track is within 90 degrees of the final approach course
- less than 6,000 feet above field elevation

5 Localizer (LOC) Pointer and Scale

Pointer – indicates localizer position relative to the airplane.

6 Glide Path (G/P) Pointer

Indicates glidepath position relative to the airplane.

Pointer:

- unfilled magenta triangle when parked at deflection limit.
- filled magenta triangle when not parked at deflection limit.
- flashes for ten seconds if pointer migrates into bar area for five seconds.

Displays when the airplane is:

- within 25 NM of the MAP
- within 60 degrees of the final approach course
- track is within 90 degrees of the final approach course
- less than 6,000 feet above field elevation

7 IAN Deviation Scale

Displays when:

- LNAV or VNAV are not active modes
- approach is in the active flight plan
- < 150 NM from the destination airport, or
- < 50 NM from top of descent, or
- FMC is in descent mode

8 Airplane Lateral Position Reference

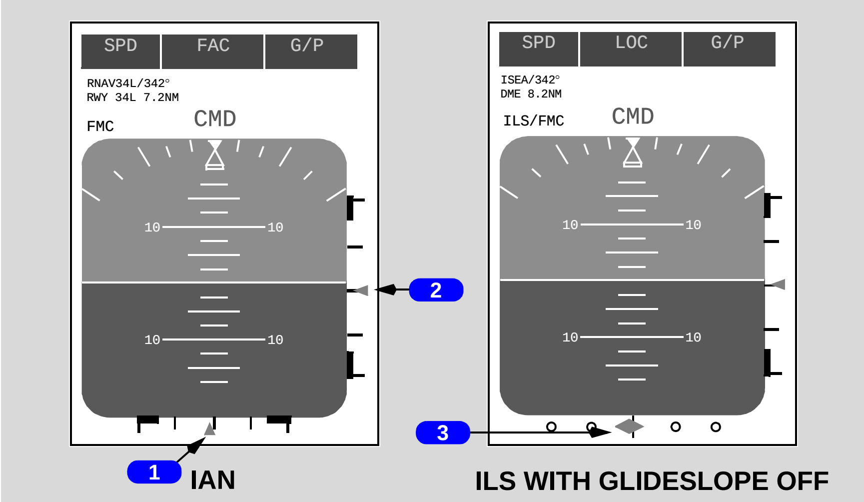
Indicates represented airplane position.

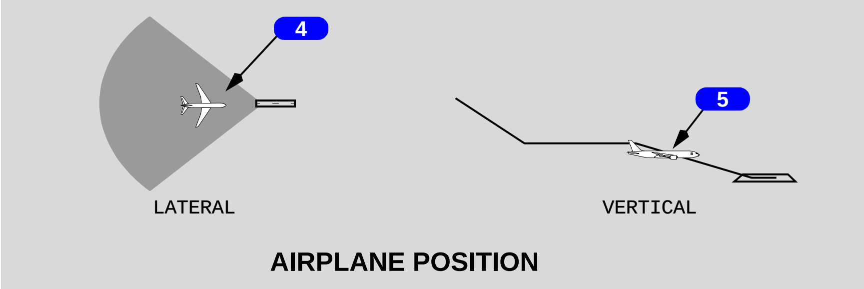
Shaded area indicates where anticipation cues may display.

9 Airplane Vertical Position Reference

Indicates represented airplane position separated into three sections:

- descent
- final approach course intercept
- final approach course





1 Final Approach Course (FAC) Pointer

Pointer –

- indicates final approach course position relative to the airplane
- unfilled white triangle prior to FAC capture if LNAV is active
- unfilled magenta triangle prior to FAC capture if LNAV is not active
- filled magenta triangle when FAC captured

At low radio altitudes, with the autopilot engaged or flight director on, the scale turns amber and the pointer flashes to indicate excessive deviation.

At low altitudes, with LNAV active and FAC armed, the lateral deviation scale turns amber and the pointer flashes if the final approach course is not captured.

2 Glide Path (G/P) Pointer

Pointer – indicates glidepath position relative to the airplane.

3 Localizer (LOC) Pointer and Scale

Pointer – indicates localizer position relative to the airplane.

4 Airplane Lateral Position Reference

Indicates represented airplane position.

Shaded area indicates where anticipation cues may display.

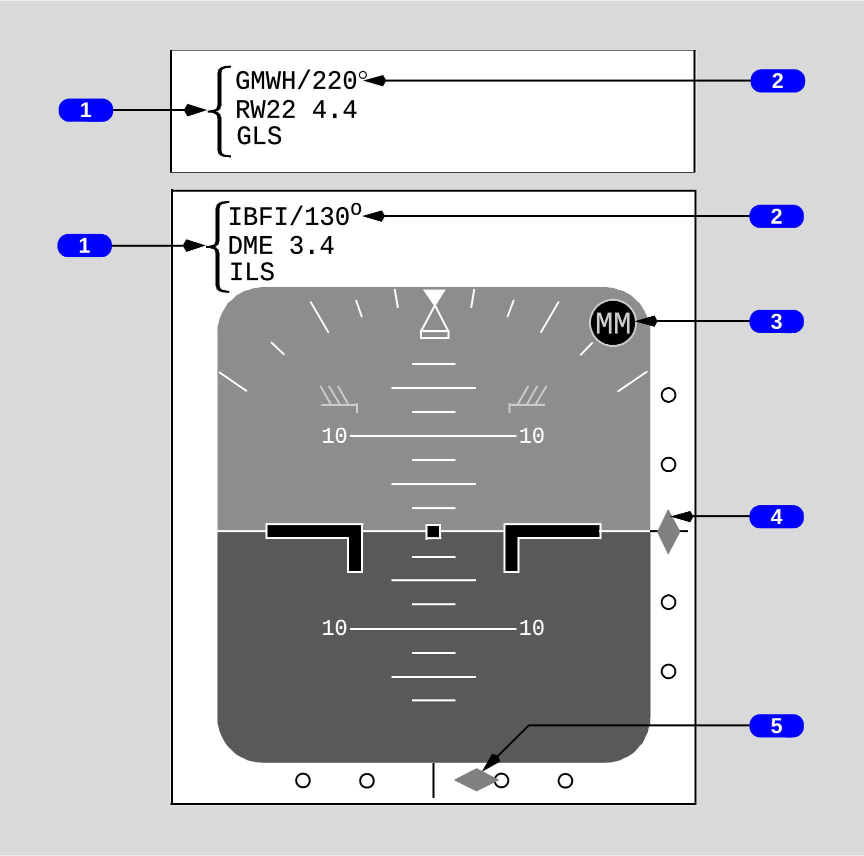
5 Airplane Vertical Position Reference

Indicates represented airplane position separated into three sections:

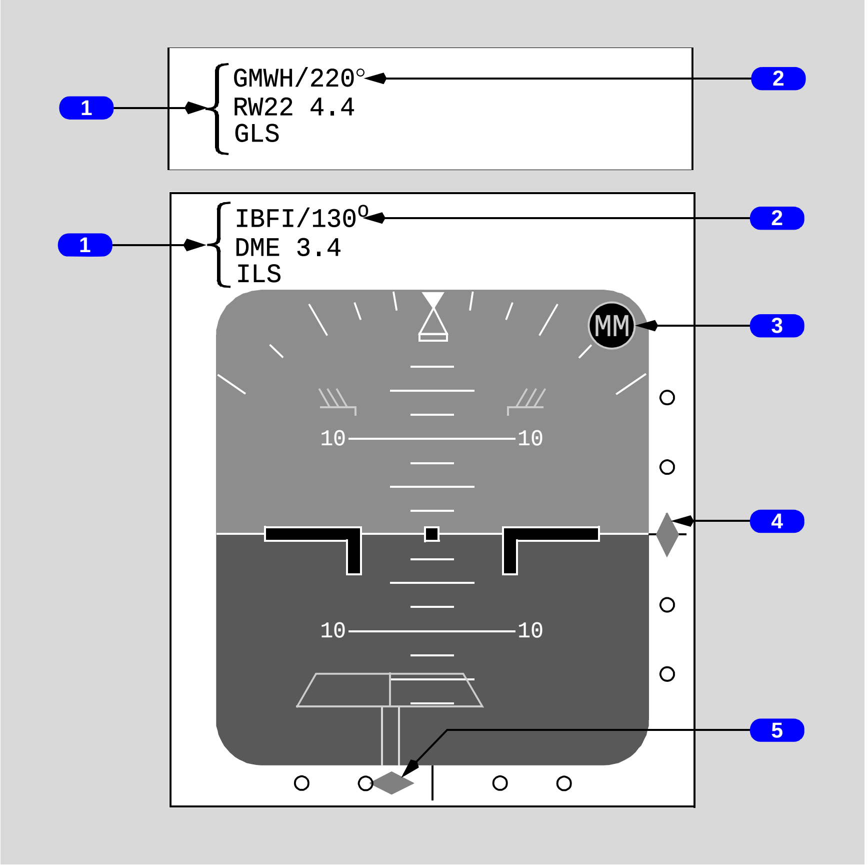
- descent
- final approach course intercept
- final approach course

Instrument Landing System Indications

806



914



1 Approach Reference

ILS -

- 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

GLS -

- displays the selected GLS identifier or five digit channel
- runway identifier and GLS distance to the runway threshold
- if the tuned GLS channels disagree, the channel displays in amber and an amber horizontal line is drawn through the channel

Refer to Chapter 11, Flight Management, Navigation.

2 Approach Course

Displays the selected approach course.

If the approach courses in the ILS receivers disagree, the course displays in amber and an amber horizontal line is drawn through the course.

GLS -

- if the approach courses disagree the course displays in amber and an amber horizontal line is drawn through the course
- if the approach course is invalid, the slash and course (e.g., "/220") are not displayed

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 engaged and the flight director on, scale changes to color amber and the pointer flashes to indicate excessive glideslope deviation.

5 Localizer Pointer and Scale

Localizer pointer:

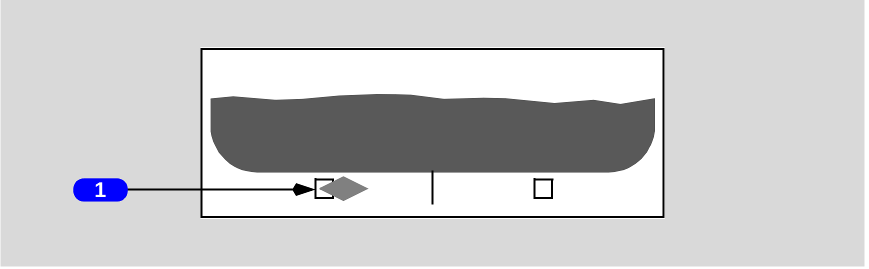
- indicates localizer position relative to the airplane
- is in view when the localizer signal is received
- fills in solid when within 2 1/3 dots from the center

Scale is in view after the frequency is tuned.

At low radio altitudes, with the autopilot engaged or flight director on, scale changes to color amber and the pointer flashes to indicate excessive localizer deviation.

At low altitudes, with LNAV active and LOC armed, localizer scale changes to color amber and the pointer flashes if localizer is not captured.

Expanded Localizer Indications



1 Expanded Localizer Deviation Scale

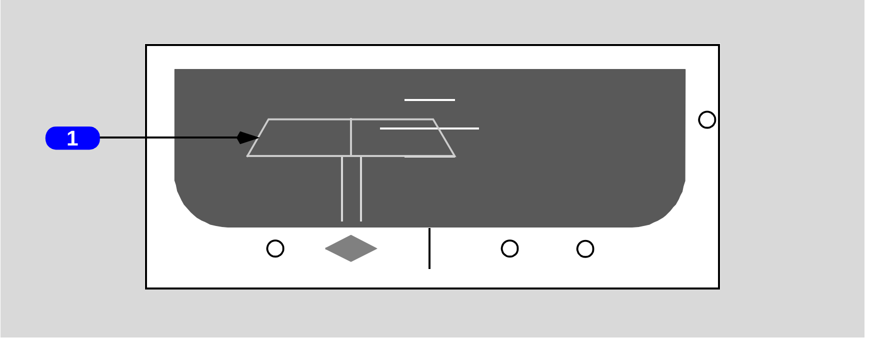
Displays when the airplane is close to the localizer centerline. Provides a more sensitive display.

A rectangle equals 1/2 dot deviation.

806
Displays only during autopilot approach.

Rising Runway Indications

914

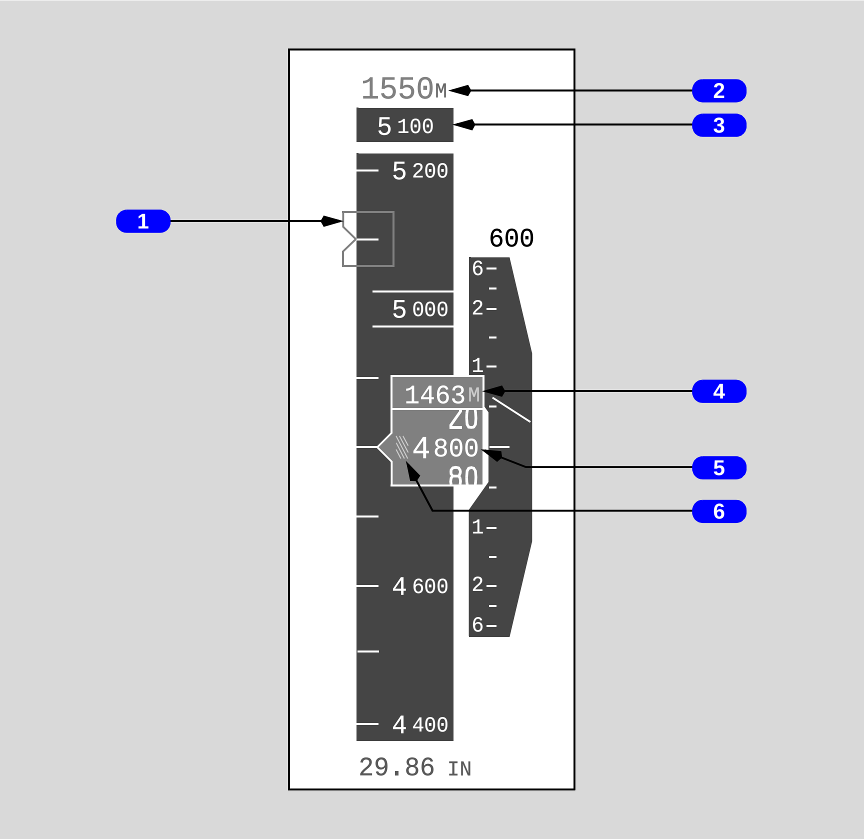


1 Rising Runway

Displays below 2,500 feet radio altitude when the localizer pointer is in view.

Moves toward the airplane symbol below 200 feet radio altitude.

Altitude Indications



1 Selected Altitude Pointer

Indicates altitude set in the MCP altitude window.

When selected altitude is off scale, pointer displays at the top or bottom of the tape with half the pointer visible.

2 Selected Altitude - Meters

Displays when MTRS selected on EFIS control panel MTRS switch.

Indicates selected altitude in meters (selected in feet in MCP altitude window).

Displays in 10 meter increments.

3 Selected Altitude

Displays altitude set in altitude window on MCP.

Selected altitude box is highlighted in white between 900 feet and 200 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.

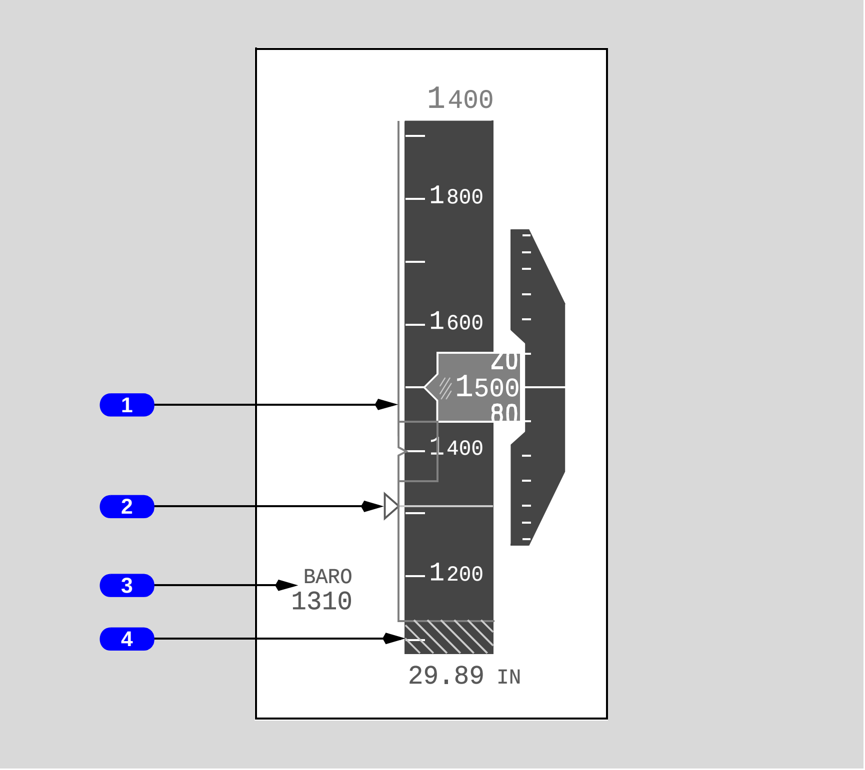
Altitude box is highlighted in white between 900 feet and 200 feet when approaching selected altitude.

Altitude box changes to amber when deviating from selected altitude between 200 feet and 900 feet.

6 Ten Thousand Digit Display

Cross hatch displays when altitude is below 10,000 feet.

Landing Altitude/Minimums Indications



1 Landing Altitude Reference Bar

Indicates height above touchdown.

White bar - 500 to 1,000 feet above landing altitude.

Amber bar - 0 to 500 feet above landing altitude.

2 BARO Pointer

Indicates barometric altitude set on EFIS control panel.

3 BARO Display

Displays barometric altitude set on EFIS control panel.

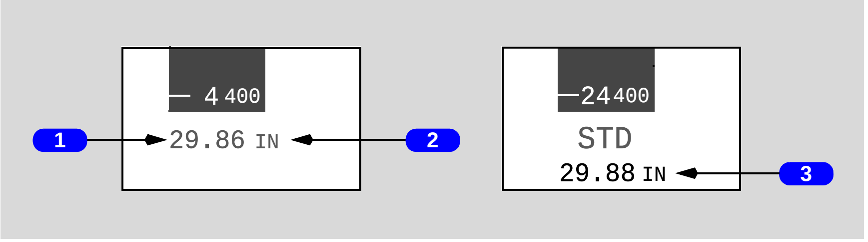
Not displayed when BARO set below -100 feet.

4 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

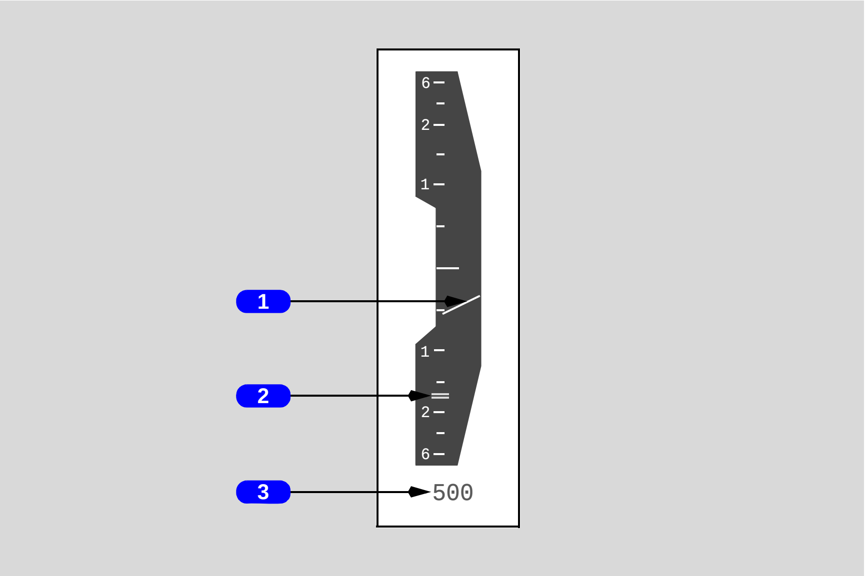
Displays barometric units selected on EFIS control panel barometric reference selector:

- 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

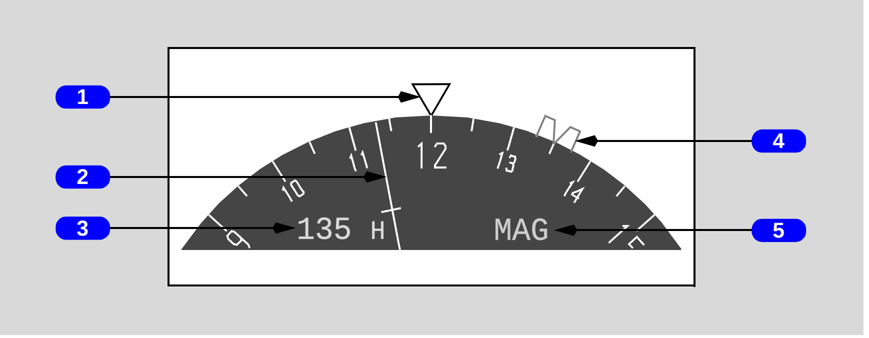
Indicates vertical speed set in MCP vertical speed window with V/S pitch mode active.

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



1 Heading Pointer

Indicates IRS heading.

2 Track Indicator

Indicates airplane track from selected FMC or selected IRS 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.

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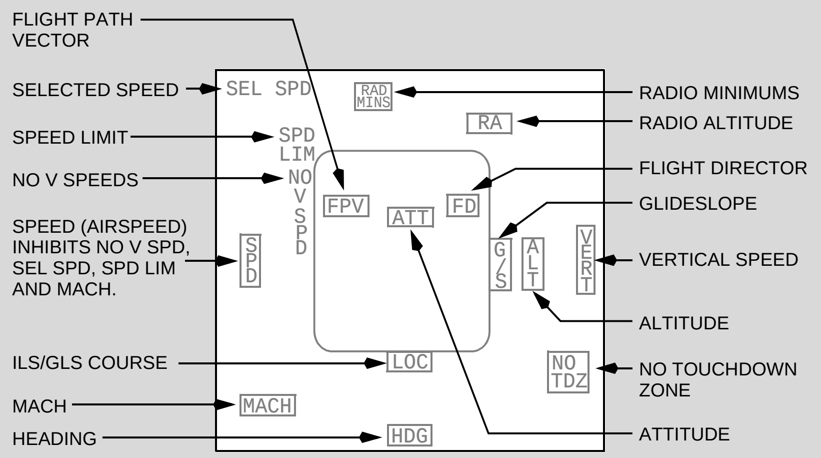
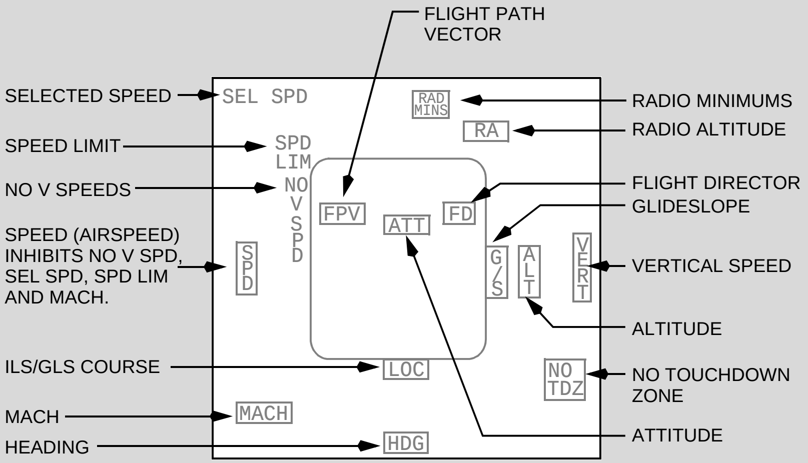


PFD

806


FLIGHT PATH
VECTOR
SELECTED SPEED
SEL SPD
RAD
MINS
RADIO MINIMUMS
RA
RADIO ALTITUDE
SPEED LIMIT
SPD
LIM
NO V SPEEDS
NO
V
S
P
D
FLIGHT DIRECTOR
GLIDESLOPE
FPV
ATT
FD
SPEED (AIRSPEED)
INHIBITS NO V SPD,
SEL SPD, SPD LIM
AND MACH.
S
P
D
G
/
S
A
L
T
V
E
R
T
VERTICAL SPEED
ALTITUDE
ILS/GLS COURSE
LOC
NO
TDZ
NO TOUCHDOWN
ZONE
MACH
MACH
HEADING
HDG
ATTITUDE

PFD

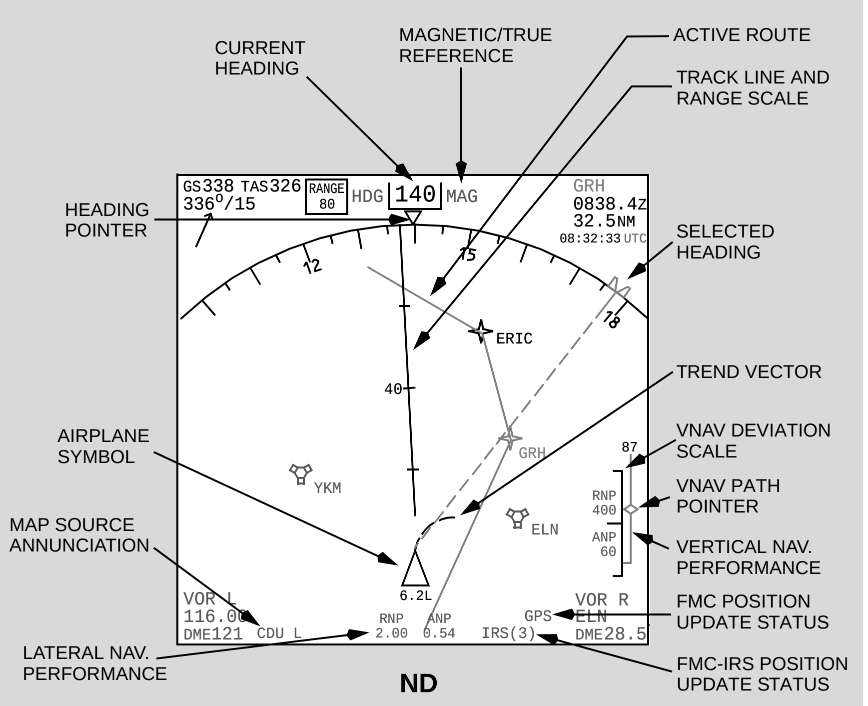
Navigation Display (ND)

Note: Refer to Navigation Display section of this chapter for a detailed explanation of ND symbology shown on the following pages.

Map Mode

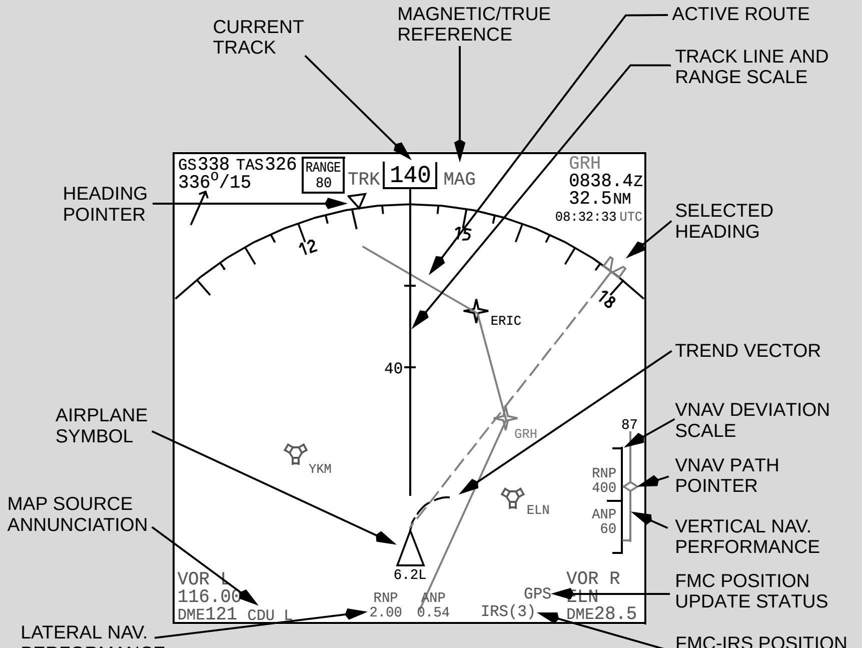
Expanded Map Mode

806



ND

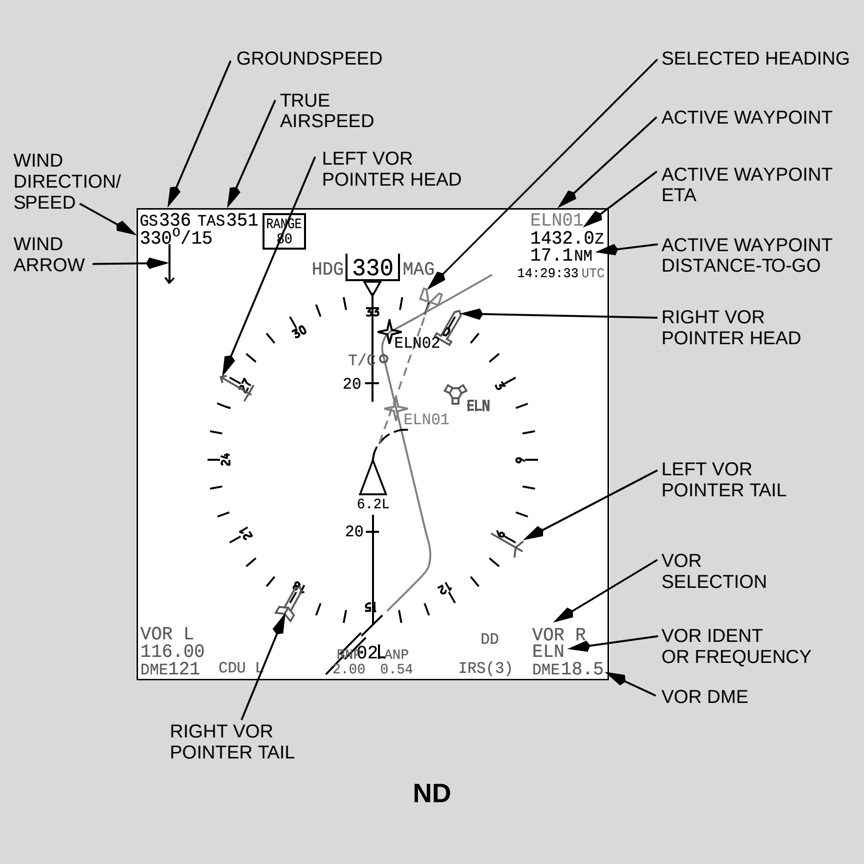
914


CURRENT TRACK
MAGNETIC/TRUE REFERENCE
ACTIVE ROUTE
TRACK LINE AND RANGE SCALE
HEADING POINTER
SELECTED HEADING
TREND VECTOR
AIRPLANE SYMBOL
VNAV DEVIATION SCALE
VNAV PATH POINTER
MAP SOURCE ANNUNCIATION
VERTICAL NAV. PERFORMANCE
FMC POSITION UPDATE STATUS
LATERAL NAV. PERFORMANCE
FMC-IRS POSITION UPDATE STATUS
GS338 TAS326
336°/15
RANGE 80
TRK 140 MAG
GRH
0838.4Z
32.5NM
08:32:33 UTC
12
15
18
40
ERIC
GRH
YKM
ELN
87
RNP 400
ANP 60
6.2L
VOR L
116.00
DME121 CDU L
RNP 2.00
ANP 0.54
IRS(3)
GPS
VOR R
ELN
DME28.5

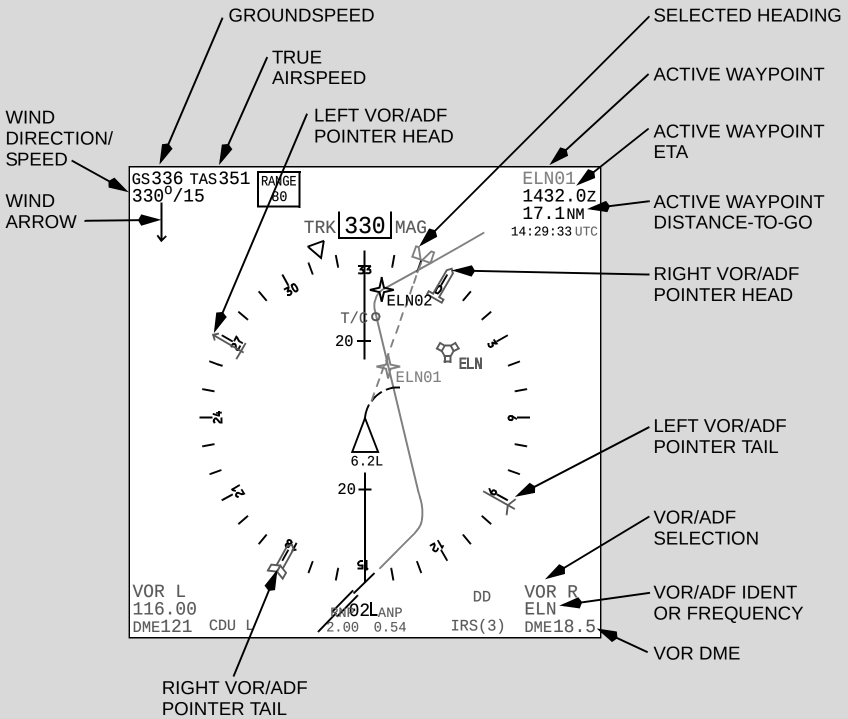
ND

Centered Map Mode

806



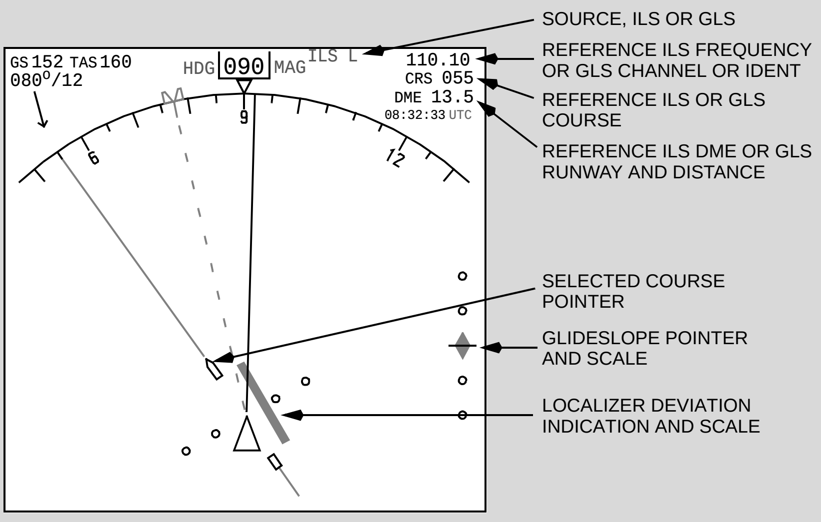
914


GROUNDSPEED
TRUE AIRSPEED
WIND DIRECTION/ SPEED
WIND ARROW
LEFT VOR/ADF POINTER HEAD
SELECTED HEADING
ACTIVE WAYPOINT
ACTIVE WAYPOINT ETA
ACTIVE WAYPOINT DISTANCE-TO-GO
RIGHT VOR/ADF POINTER HEAD
LEFT VOR/ADF POINTER TAIL
VOR/ADF SELECTION
VOR/ADF IDENT OR FREQUENCY
VOR DME
RIGHT VOR/ADF POINTER TAIL
GS336 TAS351
330°/15
RANGE 80
TRK 330 MAG
ELN01
1432.0Z
17.1NM
14:29:33 UTC
ELN02
T/C
ELN
ELN01
6.2L
VOR L
116.00
DME121
CDU L
RNP
02L
ANP
2.00 0.54
DD
IRS(3)
VOR R
ELN
DME18.5

ND

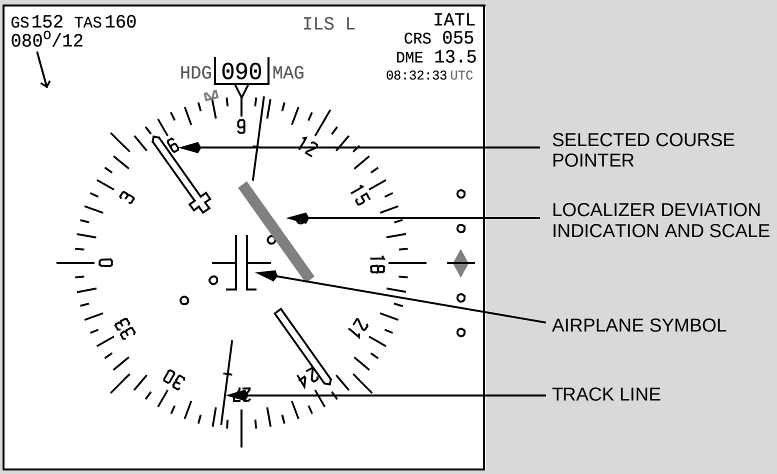
Approach Mode

Expanded Approach Mode



ND

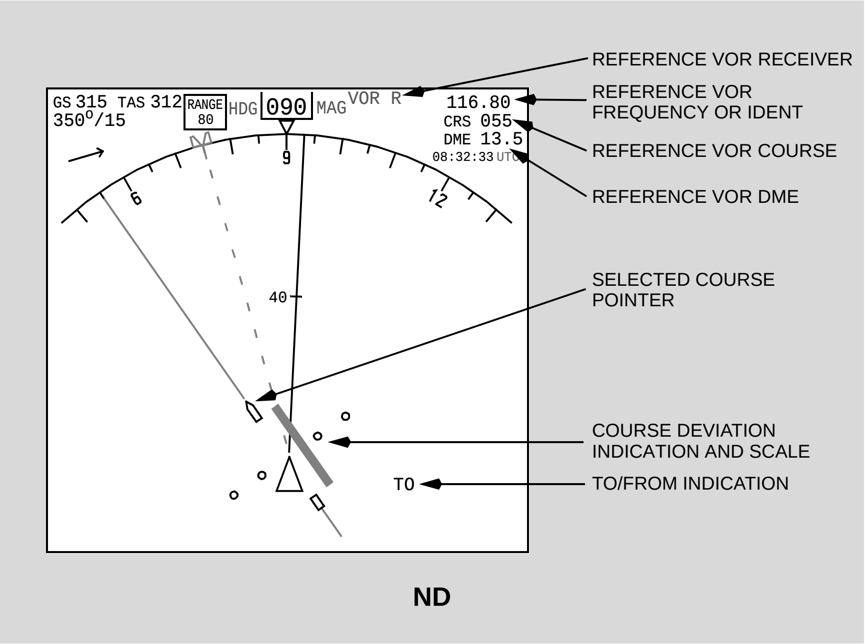
Centered Approach Mode



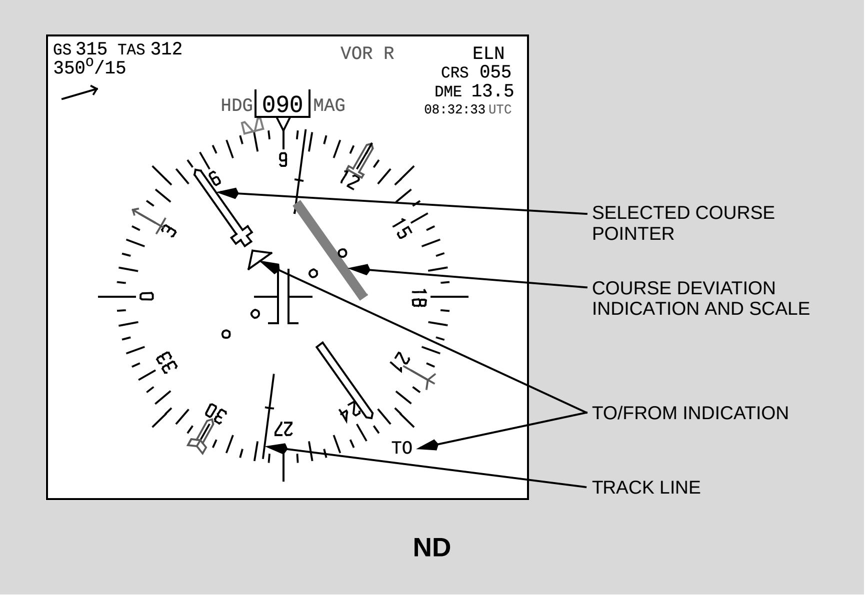
ND

VOR Mode

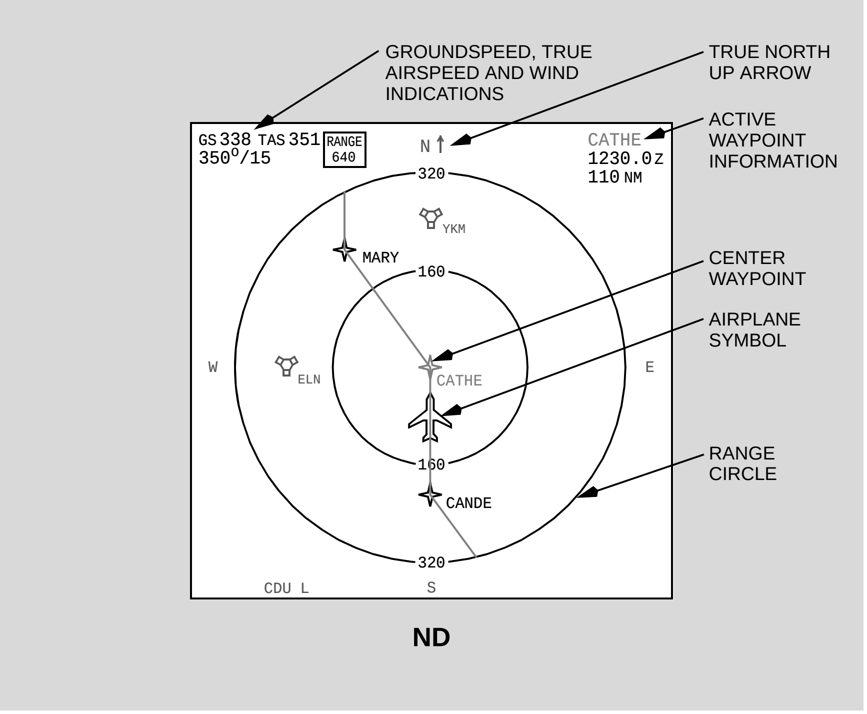
Expanded VOR Mode



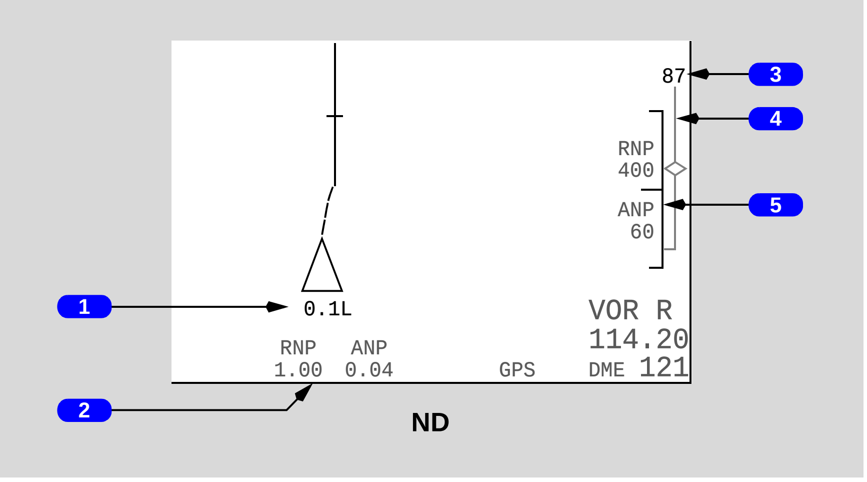
Centered VOR Mode



Plan Mode



Navigation Performance Indications



1 Lateral Path Deviation

A digital value is displayed below the airplane symbol to show the lateral deviation (in NM) when an active path is defined. The numeric value is followed by an R or L to indicate the airplane position relative to the path.

If map range is greater than 10NM or deviation is 10NM or greater, the lateral deviation is rounded to the nearest 0.1NM.

If map range is 10NM or less and deviation is less than 10NM, the lateral deviation is rounded to the nearest 0.01NM.

2 Lateral RNP / ANP

Digital display (in NM) of the RNP and ANP. The RNP can be changed on the CDU RNP PROGRESS page 4.

Normally green, changes to color amber when ANP exceeds RNP.

3 Vertical Path Deviation

Digital vertical path deviation (in feet) displays when value exceeds 20 feet.

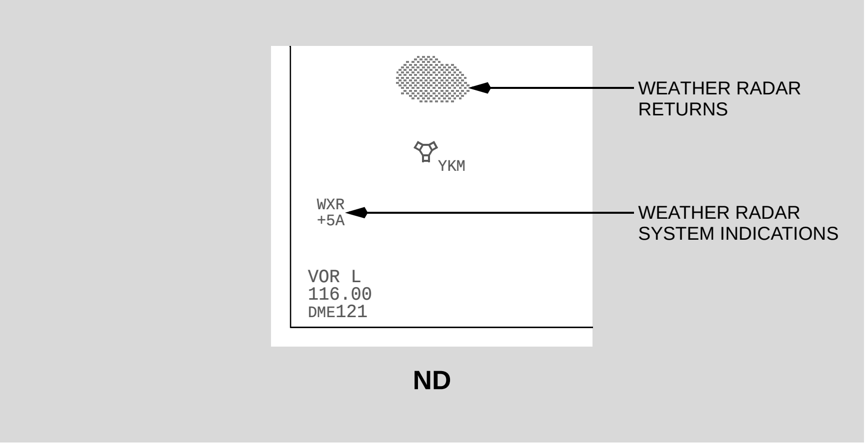
4 Vertical Path Deviation Band

Band is centered on VNAV path pointer and represents current vertical RNP.

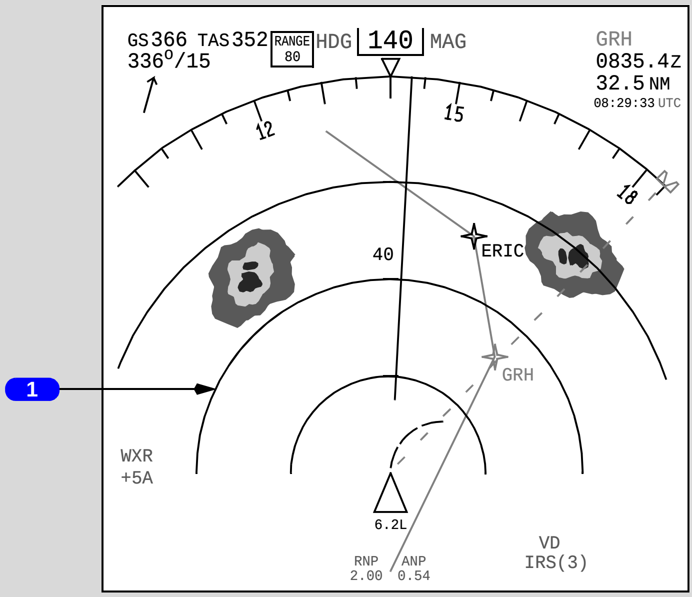
5 Vertical RNP /ANP

Digital vertical deviation values (in feet). RNP can be changed on the CDU RNP PROGRESS page 4.

Weather Radar System Display Indications



806


GS 366 TAS 352
336°/15
RANGE
80
HDG
140
MAG
GRH
0835.4Z
32.5 NM
08:29:33 UTC
12
15
18
40
ERIC
GRH
1
WXR
+5A
6.2L
RNP
2.00
ANP
0.54
VD
IRS(3)

ND

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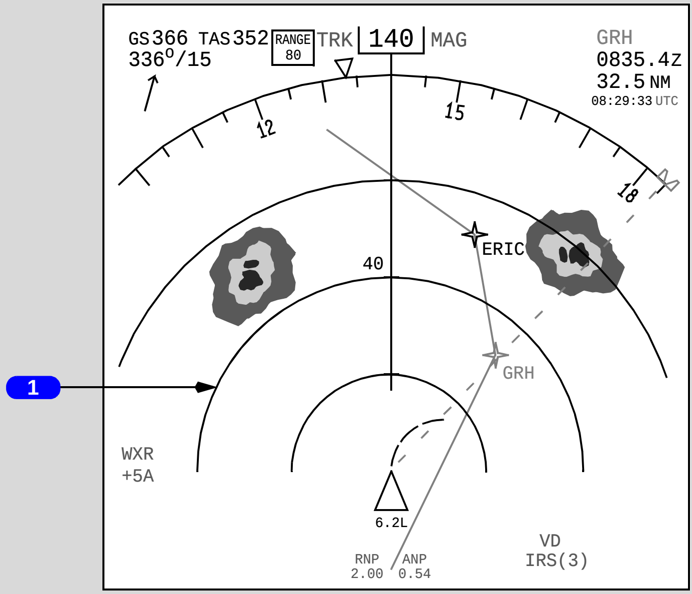


ND

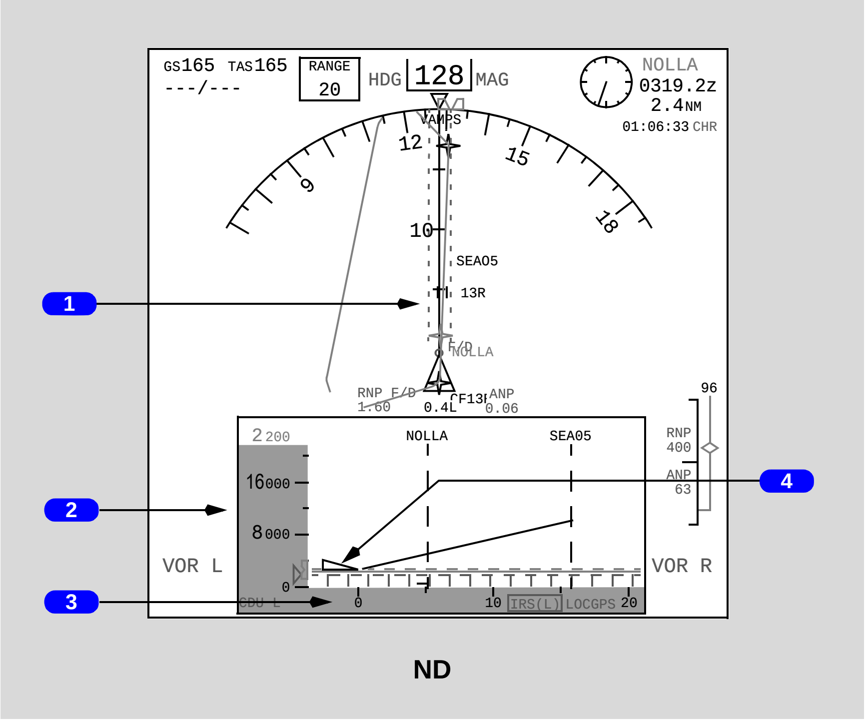
1 Weather Radar Range Arcs

Three range arcs display in place of range scale tics on map when weather radar or terrain selected.

Vertical Situation Display (VSD)

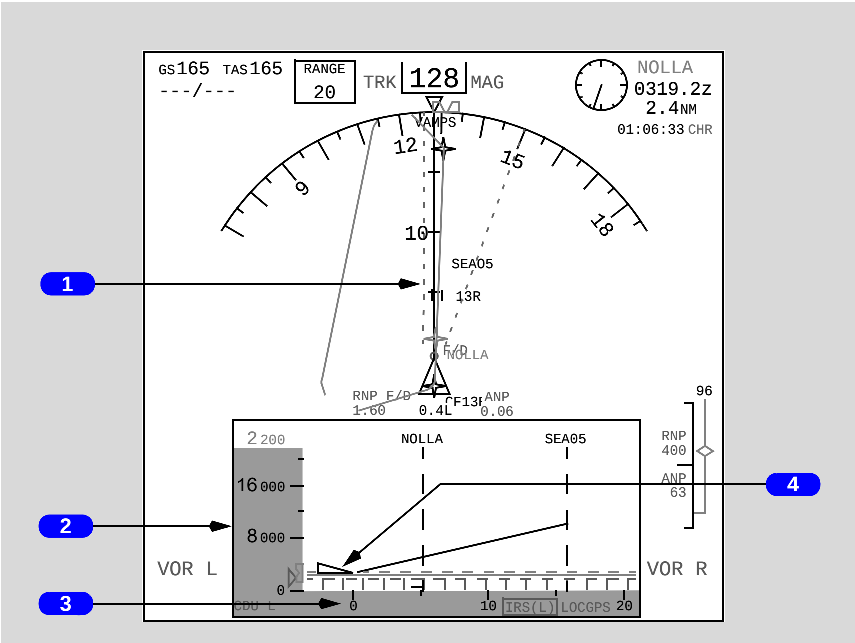
VSD Reference Scales

806



ND

914



ND

1 Enroute Swath

Indicates area mapped by the VSD.

2 Altitude Reference Scale

Displays altitude in reference to the vertical position of the airplane symbol, terrain, and other objects in the VSD background display.

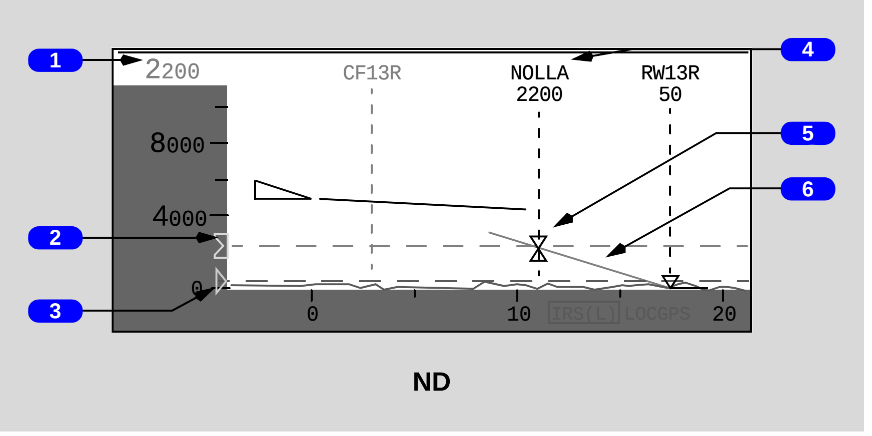
3 Horizontal Reference Scale

Displays range in nautical miles. Range shown on VSD is the range selected on the EFIS control panel, a minimum of 2.5NM, or maximum of 320NM.

4 Airplane Symbol

Indicates current airplane altitude (bottom of the triangle) and lateral position (point of the triangle) relative to terrain.

VSD General Background



1 MCP Selected Altitude Readout

Displays the altitude set in the MCP altitude window.

2 Selected Altitude Indicator

Indicates the altitude set in the MCP altitude window.

When the selected altitude is off scale, the indicator is parked at the top or bottom, with only one half the indicator visible. The dashed line does not park.

3 BARO Minimums Pointer

Pointer and dashed line indicate the barometric minimums selected on the EFIS control panel.

4 Waypoint ID and Anchor Line

Displayed with any altitude constraint directly beneath. Dashed vertical line depicts lateral position.

5 Altitude Constraint Symbol

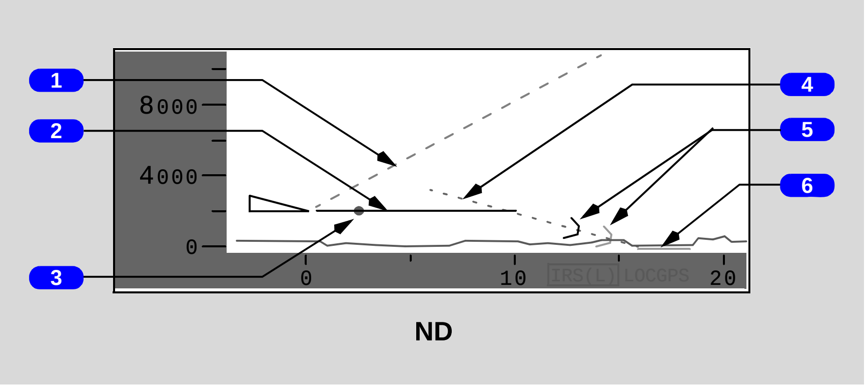
Displayed as triangle(s) on waypoint anchor line.

6 FMC Approach Glidepath Angle Line

Displayed for approaches that include a designated approach angle.

- extends 10 NM for situational awareness
- anchored to the missed approach waypoint, not the runway

VSD Flight Path Background



ND

1 MCP Selected Vertical Speed (V/S)

Displays the selected vertical speed as a dashed target angle line when the MCP V/S mode is selected.

2 Vertical Flight Path Vector

Indicates current flight path angle as a function of vertical speed and ground speed. The length of the vector is fixed at one half of the VSD range.

3 Range to Target Speed Dot (RTSD)

Indicates where the airplane will achieve the FMC or MCP target speed.

- dot is blanked within 5 knots of target speed
- dot reappears if speed increases 10 knots or more faster than target speed
- replaced with an unfilled dot at vector end if target speed will not be achieved within length of the vertical flight path vector line

4 3-Degree Reference Line

Displayed for approaches that do not have an FMC approach glidepath angle.

- dashed line extends 10 NM for situational awareness
- anchored to the runway centerline, 1000’ past the runway threshold
- for reference only, line may intersect terrain

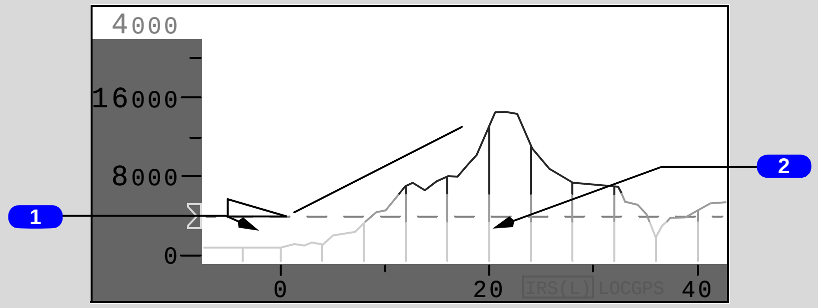
5 Decision Gates

Displayed on the FMC approach glidepath angle line or 3 degree reference line.

6 Runway

Represents the selected runway.

VSD Terrain Background



ND

1 Terrain Profile Line

Represents the highest terrain within the enroute swath.

- highest points of the terrain below and ahead of the airplane
- terrain is depicted so the true altitude separation between the airplane and terrain is shown
- terrain behind the airplane is drawn equal to the terrain at the current position
- VSD terrain uses the same color coding used to depict EGPWS terrain on the lateral map:
  - green: terrain 500 feet (250 feet with gear down) or more below the airplane
  - amber: terrain from 250 feet or 500 feet below to 2000 feet above the airplane
  - red: terrain more than 2,000 feet above the airplane

2 Vertical Support Lines

Vertical terrain vectors placed at constant intervals along the terrain profile line.

Airport Map Display

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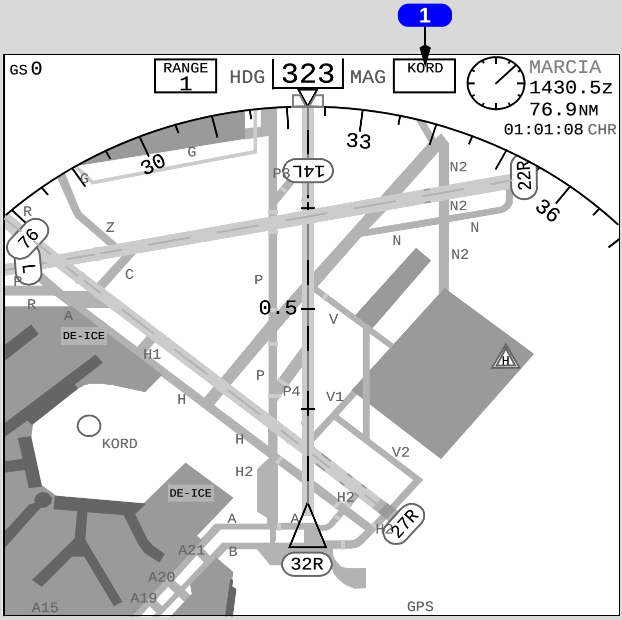
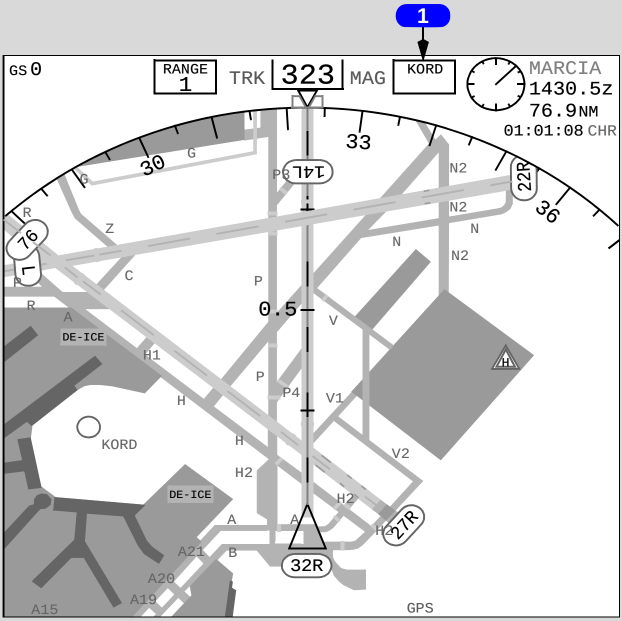


ND

914



ND

1 ICAO ID box

Annunciations associated map status:.

- LOAD indicates map image is loading
- DATE displays before engine start when the active airport map database is expired
- WXR ON displays when the weather radar is selected on
- ARPT MAP displays when a fault exists in the map display, a problem exists with the airport map database, or airplane position accuracy is degraded

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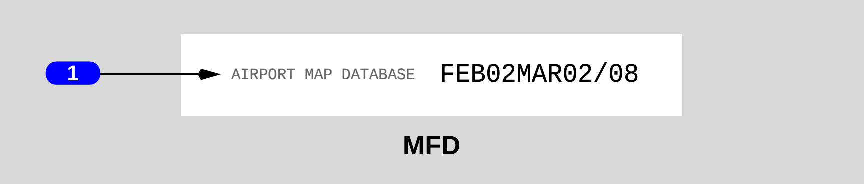
- Grid heading has priority during FMC polar operations

Airport Map Database Indications

Located below oxygen indications on the status (STAT) display.



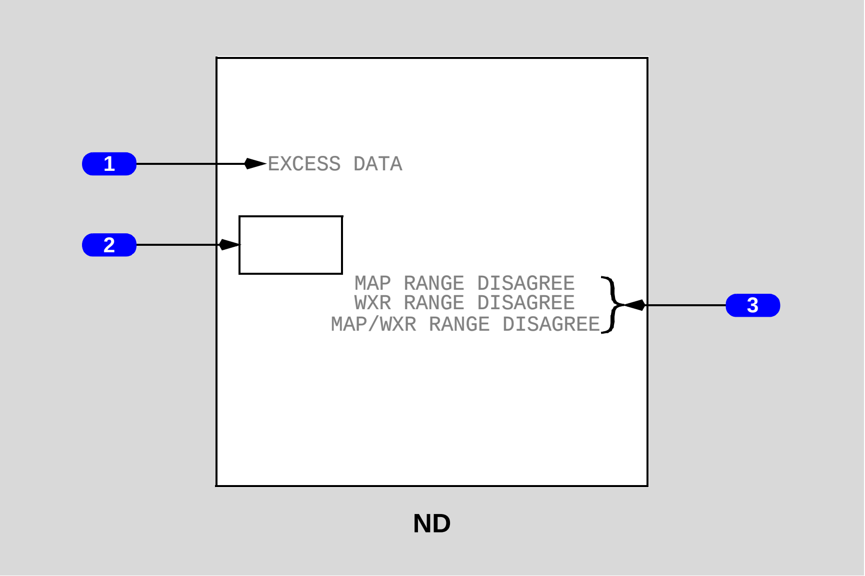
1 Airport Map Database

On electrical power up, the IDS selects current map database based on FMC date.

Dates are blank if there is no Airport map database available.

ND Failure Indications and Flags

Failure Messages



1 Excess Data

Amount of map information sent to the primary display system is too great to display. Deselecting EFIS WXR, STA, WPT, ARPT, DATA, or POS switches may clear the condition.

2 System Failures

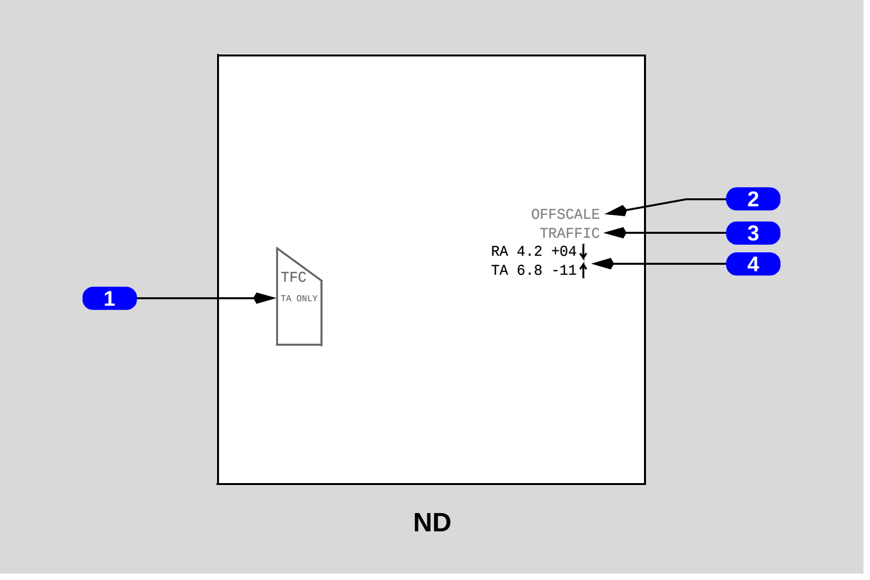
Displays system failure messages (refer to section 40, this chapter).

3 MAP/WXR Range Disagree

Selected range and range of display information disagree.

Map information is removed.

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 ONLY mode selected; displayed in all ND modes.

TCAS OFF (amber) - TCAS selected off and displayed in MAP, MAP CTR, VOR, and APP ND modes with TFC selected.

2 Offscale

TA (amber) or RA (red) traffic beyond ND display range.

Displayed in MAP, MAP CTR, VOR, and APP ND modes with TFC selected.

3 **Traffic**

Displayed during 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 display, as appropriate. Flag location varies, depending on ND mode selected. Expanded compass rose locations are shown in the following displays.

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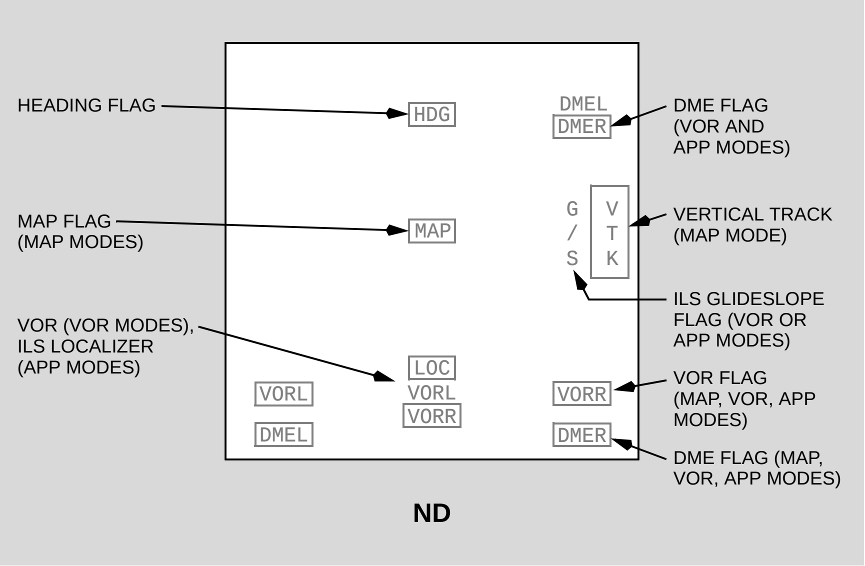
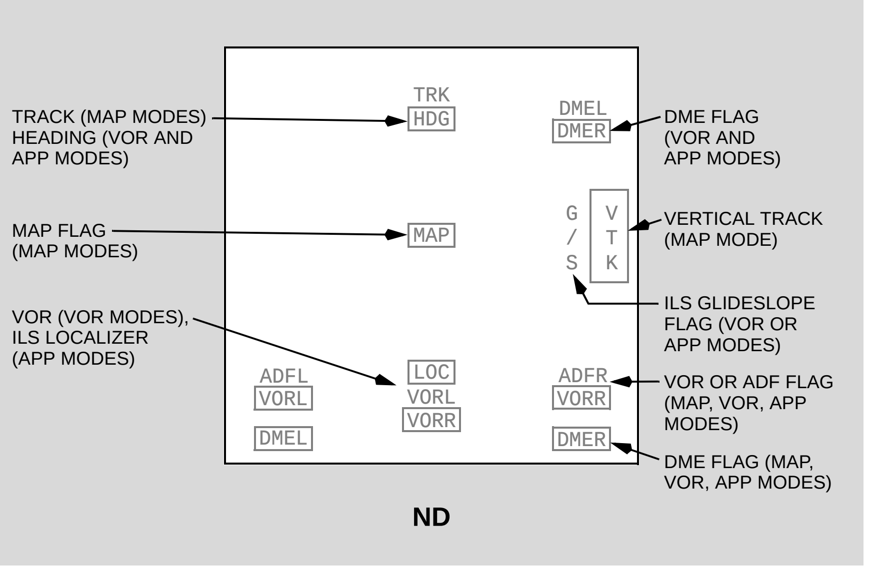
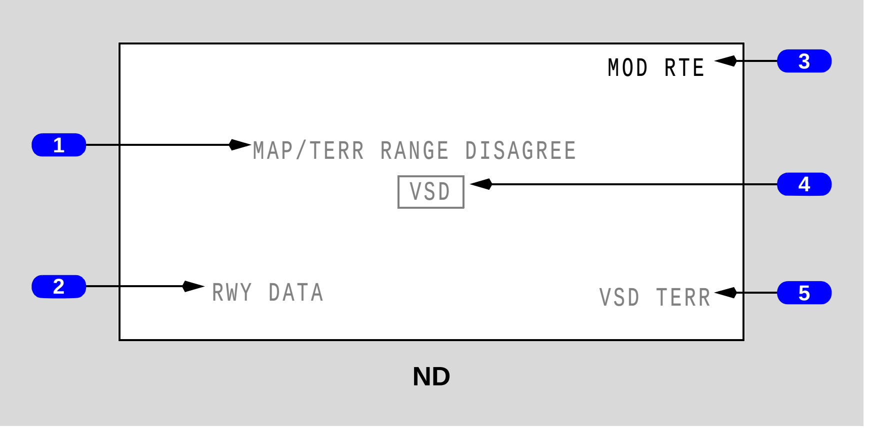


914



Vertical Situation Display Failure Indications and Flags



1 Range Disagreement Annunciations

MAP RANGE DISAGREE (amber) - Indicates selected range on the EFIS control panel is different than the MAP display range.

TERR RANGE DISAGREE (amber) - Indicates selected range on the EFIS control panel is different than the Terrain display range.

MAP/TERR RANGE DISAGREE (amber) - Indicates selected range on the EFIS control panel is different than the MAP and Terrain display ranges.

2 Runway Data Annunciation (amber)

FMC runway data is not available.

3 Route Waypoints Modification Annunciation (white)

MOD RTE is displayed when RTE 2 is activated. The modified route is shown in white dashes and the active route is shown in magenta.

4 VSD Failure Flag (amber)

VSD cannot be displayed.

5 Terrain Data Failure Annunciation (amber)

EGPWS terrain data is not available. Annunciation is replaced with VSD TERR OVRD when GND PROX control panel TERR OVRD switch is in the OVRD position.

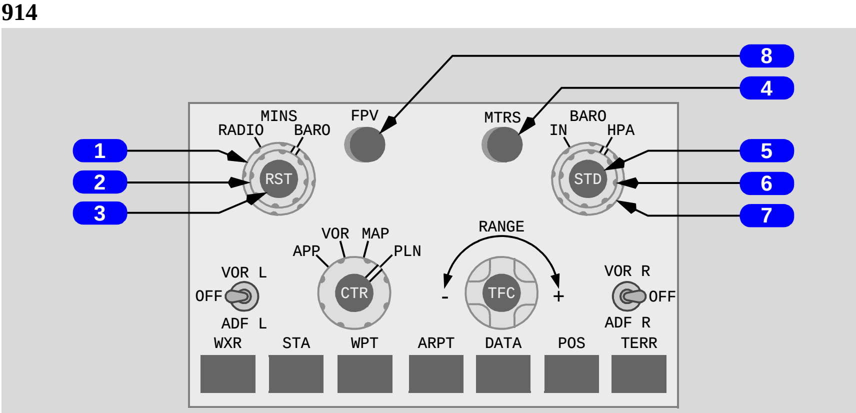
EFIS Control Panels

The left EFIS control panel controls the left PFD and ND. The right EFIS control panel controls the right PFD and ND.

Displays can also be controlled through the related CDU.

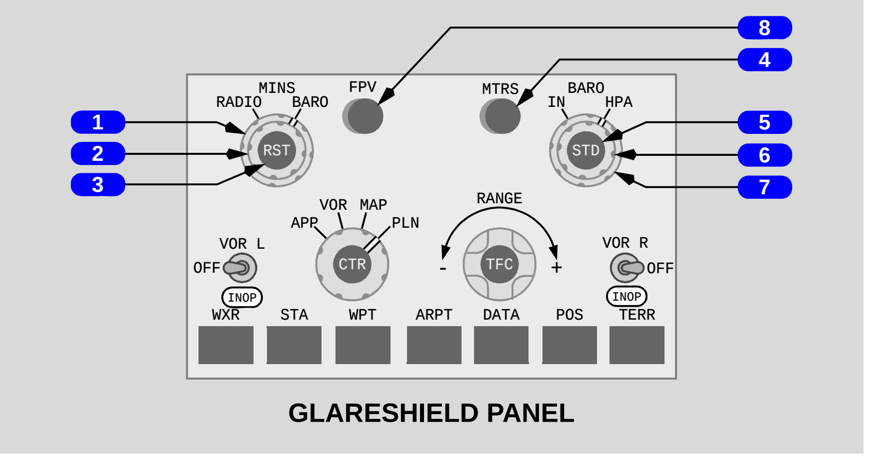
Control Panel PFD Controls

914



GLARESHIELD PANEL

806



914

1 Minimums (MINS) Selector (outer)

RADIO - selects radio altitude for display on the PFD.

BARO - selects barometric altitude for display on the PFD.

806

1 Minimiums (MINS) Selector (outer)

RADIO - selects radio altitude for display on the PFD.

BARO - selects barometric altitude for display on the PFD.

The radio or barometric altitude selected on the left PFD is used as a reference for the minimums voice alert.

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 one foot increments. BARO pointer indicates the same altitude on the altitude display

914

3 Minimums Reset (MINS RST) Switch (inner)

Push - resets PFD flashing amber RADIO.

806

3 Minimums Reset (MINS RST) Switch (inner)

Push - resets PFD flashing amber RADIO.

Clears HEIGHT ALERT display on related PFD.

4 Meters (MTRS) Switch

Push - displays PFD altitude meters indications.

5 Barometric Standard (BARO STD) Switch (inner)

Push -

- selects standard barometric setting (29.92 inches Hg/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.

7 Barometric (BARO) Reference Selector (outer)

IN - selects inches of mercury as PFD barometric reference.

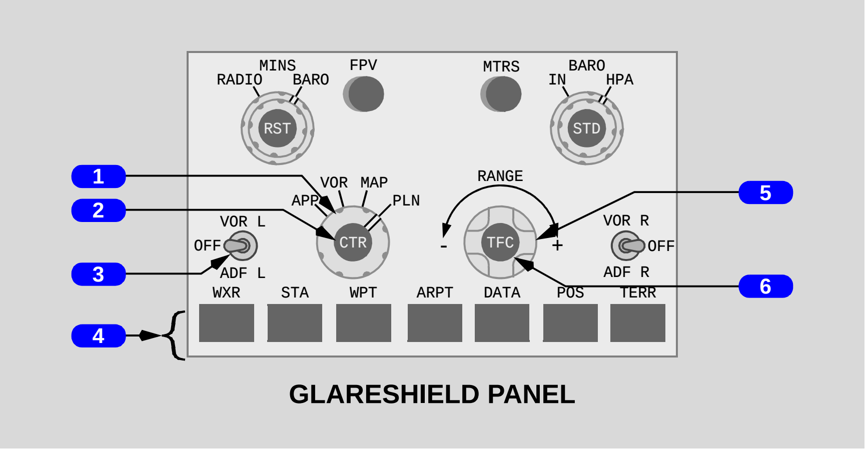
HPA - selects Hectopascals as PFD barometric reference.

8 Flight Path Vector (FPV) Switch

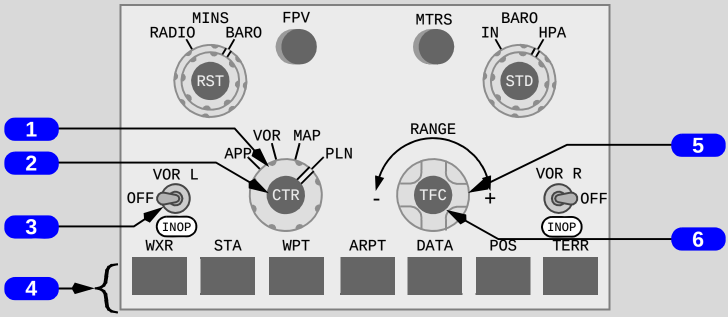
Push - displays PFD flight path vector.

Control Panel ND Controls

914



806



GLARESHIELD PANEL

1 ND Mode Selector (outer)

Selects desired ND display.

APP -

- displays localizer and glideslope information in heading-up format
- displays reference ILS receiver, ILS frequency or identification, course, and DME, or
- displays reference GLS channel or identification, course, runway, and DME
- look-ahead terrain, weather radar, PWS, and TCAS do not display 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 do not display in VOR CTR mode

MAP -

806
- displays heading up, partial compass rose, FMC-generated route and map information, airplane position, heading, and track

914
- displays track up, partial 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 do not display in PLN mode

2 ND Center (CTR) Switch (inner)

Push -

- APP and VOR modes: displays full compass rose (centered), subsequent pushes alternate between expanded and centered displays
- MAP mode: cycles the format from expanded MAP to MAP CTR to VSD to expanded MAP

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.

914
ADF - displays ADF pointer and frequency or identification in all modes except PLAN.

806
ADF - displays ADF INOP.

4 WXR, STA, WPT, ARPT, DATA, POS, TERR Switches

The switches:

- select detailed ND data displays
- displays can be selected simultaneously (except WXR and TERR)
- EXCESS DATA message displays on ND if amount of data selected is more than can be displayed
- second push removes information

WXR (weather radar) -

- powers radar transceiver selected on weather radar control panel
- displays in expanded MAP, MAP CTR, VSD, 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 expanded MAP, MAP CTR, and VSD modes:

- displays high and low altitude navigation aids when ND Range selection is 40 NM or less
- displays high altitude navigation aids when ND Range selection is 80, 160, 320, or 640 NM

WPT (waypoint) - in expanded MAP, MAP CTR, and VSD modes, displays waypoints when ND Range selection is 40 NM or less.

ARPT (airport) - in expanded MAP, MAP CTR and VSD modes, displays the airport symbols on all ranges, and airport map for ranges of 5NM or less. Subsequent presses of the ARPT switch cycles between displaying airport symbols and airport map, and removing airport symbols and airport map.

DATA - in PLAN, expanded MAP, MAP CTR, and VSD modes, displays FMC estimated time of arrival, altitude at each waypoint, and altitude constraints at each waypoint.

POS (position) - in expanded MAP, MAP CTR, and VSD 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 IRS 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. Available settings in nautical miles are 0.25, 0.5, 1, 2, 5, 10, 20, 40, 80, 160, 320, 640, and 1280, unless VSD is selected, then the maximum map range is 640NM. The selected range displays at the top of the ND.

The available range for the VSD is 2.5 NM to 320 NM. If a lower range is selected, the expanded map scale is the selected range while the VSD scale is 2.5 NM. If the 640 range is selected, the expanded map scale is the selected range while the VSD scale is 320 NM.

Clockwise rotation increases range to the maximum, counter clockwise decreases range to the minimum.

6 ND Traffic (TFC) Switch (inner)

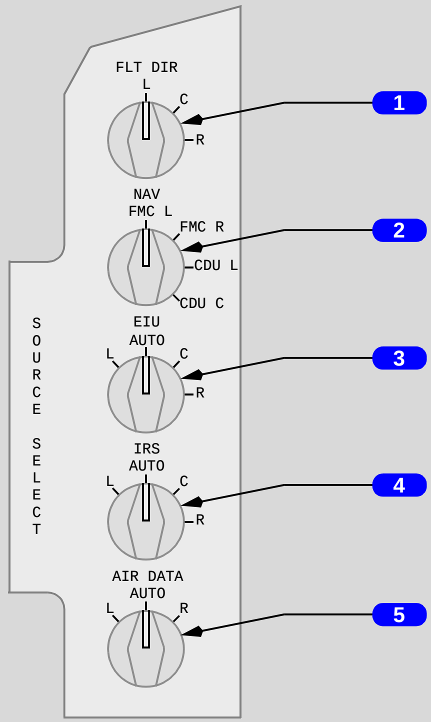
Push - in VOR, APP, MAP, MAP CTR, and VSD modes:

- 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.



PILOT’S PANELS

1 Flight Director (FLT DIR) Source Selector

L - left FCC selected

C - center FCC selected

R - right FCC selected

2 Navigation (NAV) Source Selector

FMC L - left FMC provides information to PFD and ND.

FMC R - right FMC provides information to PFD and ND.

CDU L (Captain's panel) - left CDU provides information to ND during alternate navigation.

CDU C - center CDU provides information to ND during alternate navigation.

CDU R (F/O's panel) - right CDU provides information to ND during alternate navigation.

3 EFIS/EICAS Interface Unit (EIU) Source Selector

L - left EIU provides information to PFD and ND.

AUTO - selects operable EIU. Captain's selects left, then center, then right; F/O's selects right, then center, then left.

C - center EIU provides information to PFD and ND.

R - right EIU provides information to PFD and ND.

Determines which localizer and glideslope receivers provide information to the respective PFD and ND.

4 IRS Source Selector

L - left IRS 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 IRS provides attitude and vertical speed information to PFD.

R - right IRS 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, IRSs, and position of the Navigation and IRS source selectors.

IRS selected by Captain provides autobrakes reference.

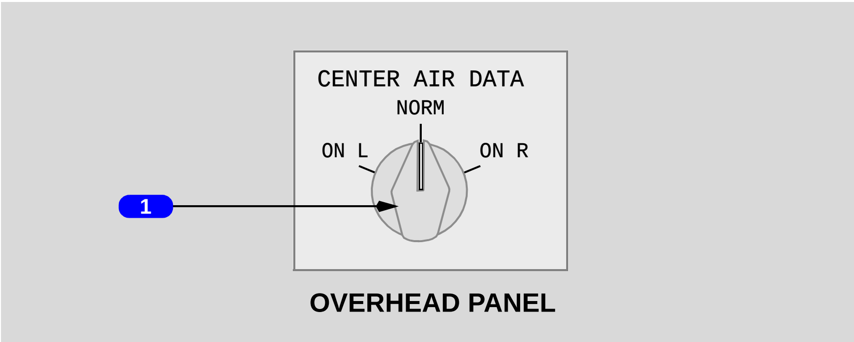
5 AIR DATA Source Selector

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.

R - right ADC provides information to the PFD and ND.

Center Air Data Selector



1 CENTER ADC Selector

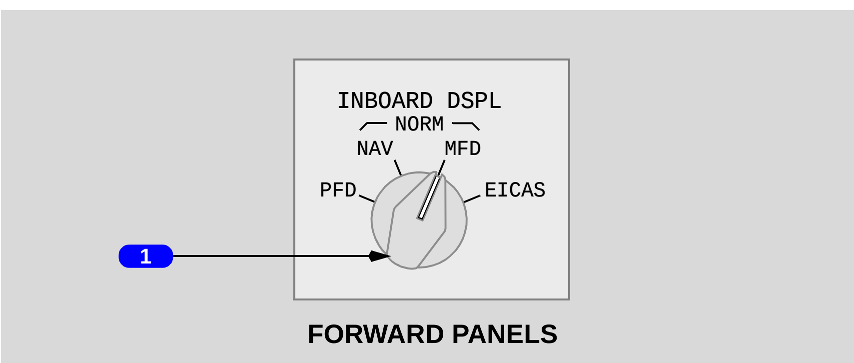
ON L - the center ADC replaces the left ADC

NORM - the center ADC is available for automatic selection when the AIR DATA selector is in AUTO

ON R - the center ADC replaces the right ADC

The center ADC uses a dedicated pitot probe and air data modules but receives static pressure and AOA inputs from the same probes as the ADC it replaces and uses the second element of the opposite side TAT probe.

Heading Reference, Inboard and Lower Displays
Inboard Display Controls



1 INBOARD Display (DSPL) Selector

PFD - displays the PFD, blanks the PFD on the outboard display unit, and inhibits selections made from the Display Select Panel.

NAV - displays the ND and inhibits selections made from the Display Select Panel.

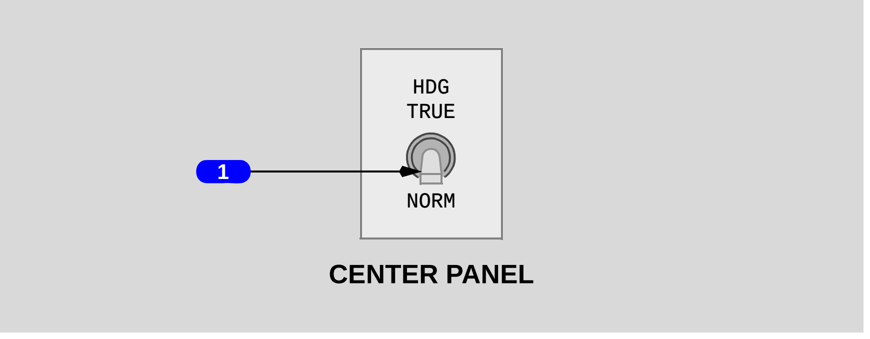
MFD - displays the selections made on the Display Select Panel.

EICAS -

- displays EICAS
- inhibits most selections made from the display select panel (limited ENG, FUEL, and GEAR displays can be selected)
- blanks the upper center display unit.

Note: The PFD automatically appears on an inboard display unit if the adjacent outboard display unit fails, regardless of switch position.

Heading Reference Switch



1 Heading (HDG) Reference Switch

Selects heading reference for PFDs, NDs, AFDS, and FMCs.

TRUE - references true north.

NORM -

- references magnetic north

(914 ; before SB, 2015 MAG VAR table not installed)

- references true north when north of 82°N latitude (or north of 70°N between 80°W and 130°W) or south of 82°S latitude (or south of 60°S between 120°E and 160°E) for PFDs, NDs, and FMCs. Provides no reference for AFDS roll modes other than LNAV in these areas; HDG SEL, HDG HOLD, and localizer modes are inoperative.

806
(914 ; SB installs 2015 MAG VAR table)

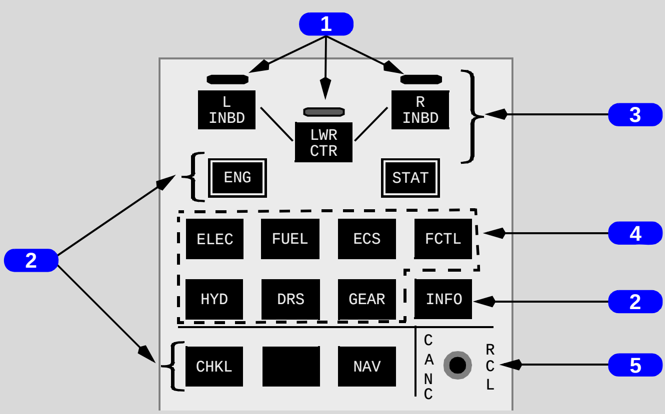
- references true north when north of 82°N latitude (or north of 73°N between 80°W and 170°W) or south of 82°S latitude (or south of 60°S between 120°E and 160°E) for PFDs, NDs, and FMCs. Provides no reference for AFDS roll modes other than LNAV in these areas; HDG SEL, HDG HOLD, and localizer modes 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, unless the LOC or FAC mode is armed.

Do not change the HEADING reference switch position after arming LOC or FAC mode. Once LOC or FAC mode is armed, the AFDS will not respond to changes in the HEADING reference switch position until after approach or go-around roll mode is exited.

If the HEADING reference switch position is changed after arming LOC or FAC mode, HDG SEL, if engaged, will not change to HDG HOLD, and will not appear to control the MCP selected heading. In addition, subsequent LOC/FAC capture and tracking performance may be degraded.

Display Select Panel



GLARESHIELD PANEL

1 Display Lights

Illuminates to show the display unit the display select panel controls.

2 Display Switches

Push - displays the associated display. Pushing the same switch a second time blanks the display; or for the inboard display units, redisplays the ND. If there are more than one page of status messages, pushing STAT pages through the messages before blanking the display or returning the inboard display to ND.

- ENG - secondary engine EICAS (Ch. 7)
- STAT - status page:
  - hydraulic system indications (Ch. 13)
  - APU indications (Ch. 7)
  - oxygen system indications (Ch. 1)
  - status messages for dispatch determination (Ch. 15).
- CHKL - checklist (Ch. 10)
- NAV - navigation display (Ch. 10)
- INFO - available for future function. INFO FUNCTION NOT AVAILABLE will be displayed

3 Multifunction Display (MFD) Switches

Push - select the left inboard, lower center, or right inboard display unit for MFD display. The left or right inboard display units can display MFD (or EICAS) information only if the appropriate left or right INBOARD DISPLAY selector is in the MFD (or EICAS) position. Pushing the lower center switch displays MFD information.

4 Synoptic Switches

Push - display the associated synoptic. Synoptics present a simplified view of system status as an aid for crew situational awareness. Pushing the same switch a second time blanks the display; or for inboard display units, redisplays the ND.

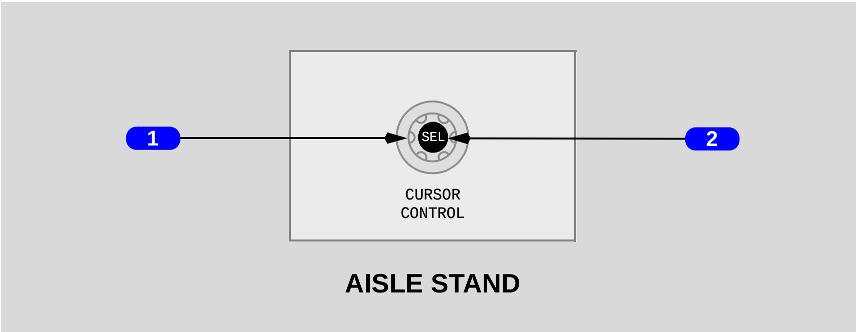
- ELEC - electrical (Ch. 6)
- FUEL - fuel (Ch. 12)
- ECS - air systems (Ch. 2)
- FCTL - flight controls (Ch. 9)
- HYD - hydraulics (Ch.13)
- DRS - doors (Ch.1)
- GEAR - landing gear (Ch.14)

5 Cancel/Recall (CANC/RCL) Switch

Refer to Warning Systems, Chapter 15.

Cursor Control

One on each side of the aisle stand, aft of the CDU keypad.



1 Cursor Control Selector (Outer)

Rotate - moves the highlight in a predetermined path to another selection on the active MFD.

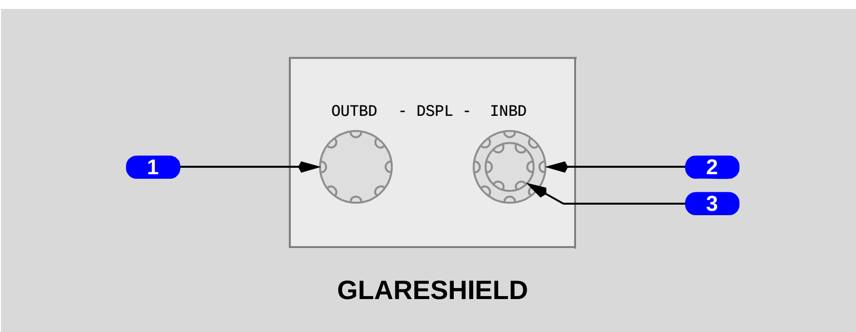
2 Cursor Select (SEL) Switch (Inner)

Push - selects the highlighted key on the MFD.

Display Brightness Controls

The left panel is shown.

Outboard/Inboard Display (DSPL) Brightness Controls



1 Outboard (OUTBD) Display Brightness Control

Rotate - adjusts brightness of outboard display.

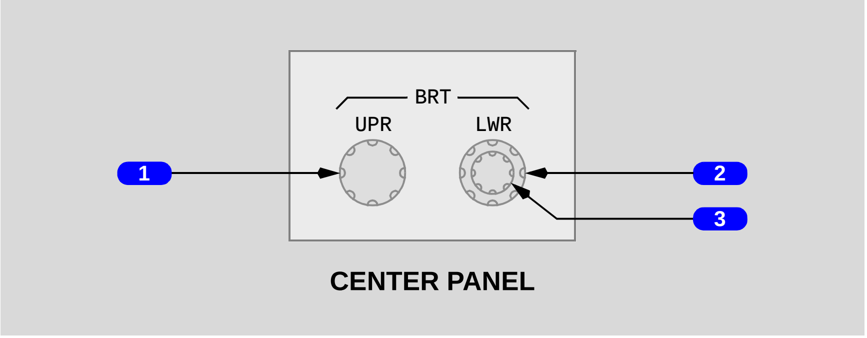
2 Inboard (INBD) Display Brightness Control (outer)

Rotate - adjusts brightness of inboard display.

3 Inboard (INBD) Display Brightness Control (inner)

Rotate - adjusts weather radar or terrain display brightness on inboard display.

Upper/Lower Display Brightness Controls



1 Upper (UPR) Display Brightness Control

Rotate - adjusts brightness of upper display.

2 Lower (LWR) Display Brightness Control (outer)

Rotate - adjusts brightness of lower display.

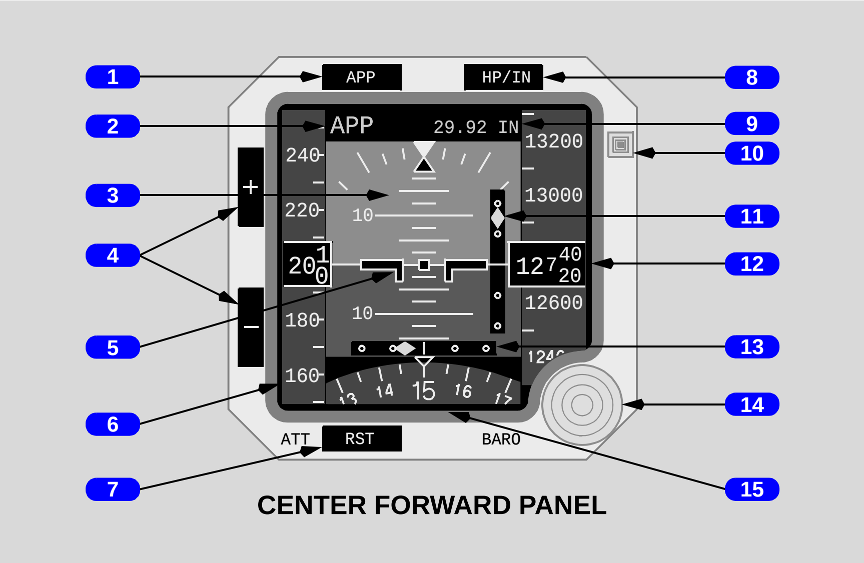
3 Lower (LWR) Display Brightness Control (inner)

Rotate - adjusts weather radar or terrain display brightness on lower display.

Standby Flight Instruments

Integrated Standby Flight Display (ISFD)

Provides an independent source of attitude, airspeed, and altitude information.



1 Approach (APP) Switch

Push -

- when blank, selects APP
- when APP displayed, selects BCRS
- when BCRS displayed, blanks

2 Approach Mode Annunciation

Indicates approach mode selected.

Blank - no approach deviation data displayed.

APP - course and glideslope deviation data displayed.

BCRS (back course) - reverses sensing for course pointer during back course approaches.

3 Attitude Display

Displays airplane attitude.

Indicates bank in reference to the bank scale.

Indicates the horizon relative to the airplane symbol.

Beyond 30 degrees pitch, large red arrowheads (V-shaped) indicate the attitude has become excessive and the direction to the horizon line.

4 Display Brightness Switches

Push -

- + increases display brightness
- - decreases display brightness

5 Airplane Symbol

Indicates airplane position with reference to the horizon.

6 Airspeed Indications

Indicates airspeed when above 30 knots.

7 Attitude Reset (RST) Switch

Push and hold at least two seconds -

- aligns horizon with the airplane symbol
- reset takes approximately ten seconds
- starts new initialization sequence if previous attempt failed (ground only).

8 Hectopascal/Inch (HP/IN) Switch

Push - changes units of barometric reference.

9 Barometric Setting

Indicates the barometric setting selected with the barometric selector.

STD display when selected with the barometric selector.

10 Ambient Light Sensor

Automatically adjusts display brightness for ambient lighting condition.

11 Glideslope Pointer and Scale

The glideslope pointer indicates glideslope position relative to the airplane -

- the pointer is in view when the glideslope signal is received
- the scale is in view when the APP mode is selected
- the pointer and scale are removed when the BCRS mode is selected

12 Current Altitude

13 Course Pointer and Deviation Scale

The course pointer indicates course position relative to the airplane -

- the pointer is in view when the course is received
- the scale is in view when either the APP or BCRS mode is selected

14 Barometric Selector (BARO)

Rotate - changes barometric setting.

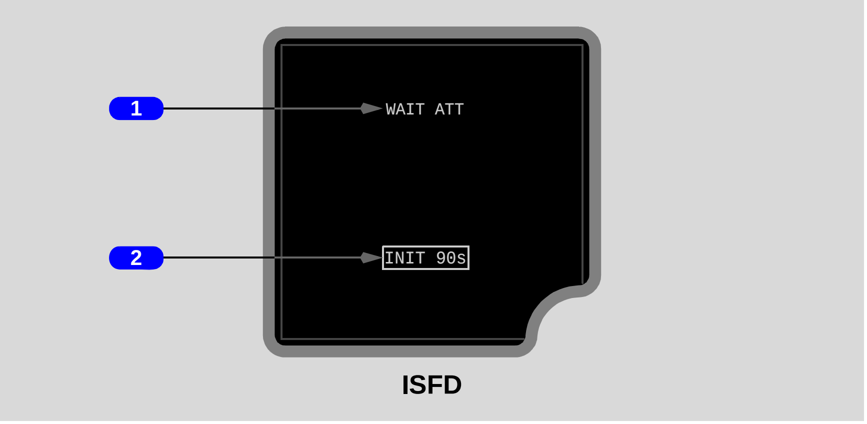
Push -

- selects standard barometric setting (29.92 inches Hg/1013 HPA)
- if STD displayed, selects the preselected barometric setting

15 Heading Indication

Displays airplane heading.

ISFD Messages



1 Attitude Messages

Indicates attitude display status.

ATT:RST - attitude must be reset using the attitude reset switch.

ATT 10s - 10 second attitude realignment in progress.

WAIT ATT - indicates temporary self correcting loss of attitude.

2 Initialization Message

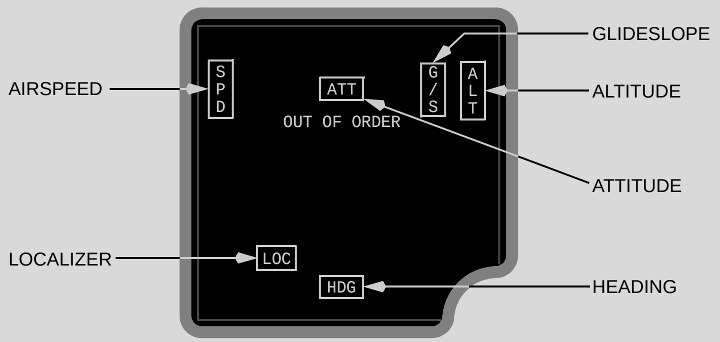
INIT 90s - countdown of 90 second initialization -

- countdown stops if excessive motion is detected
- countdown resumes when motion stops
- ATT:RST displays if initialization is not complete within six minutes.

ISFD Failure Flags

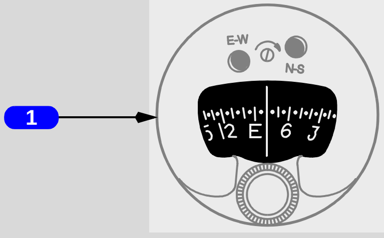
Failure flag replaces appropriate display.

OUT OF ORDER indicates instrument system failure.



ISFD

Standby Magnetic Compass

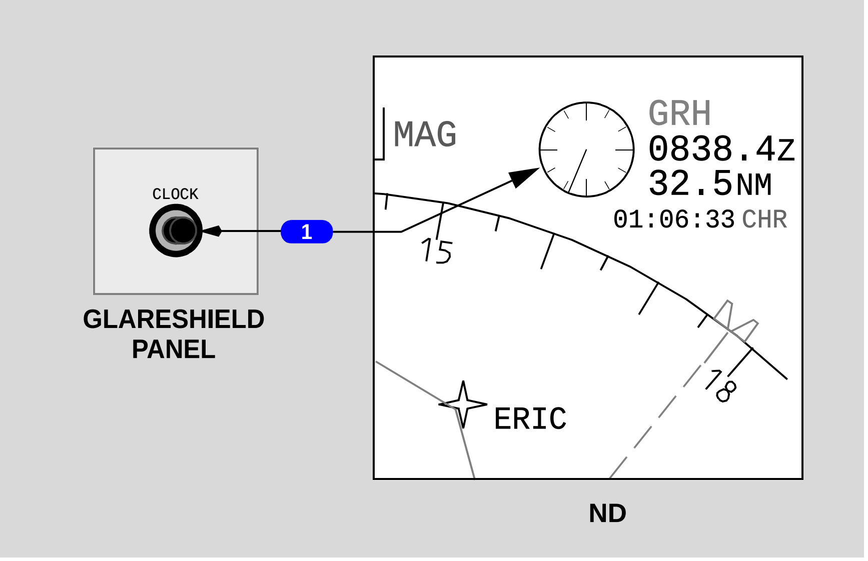


CENTER POST
ABOVE GLARESHIELD

1 Standby Magnetic Compass

Displays magnetic heading.

Clock



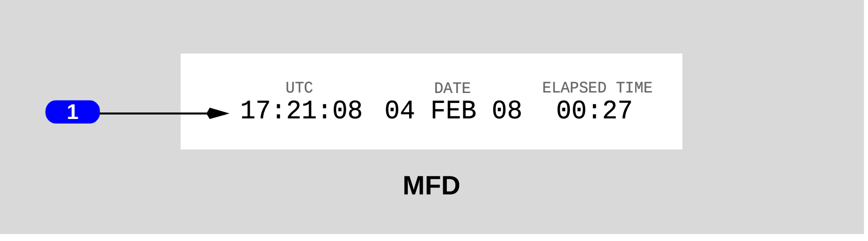
1 CLOCK Switch

Push - subsequent pushing starts chronograph, stops chronograph, returns to UTC display (digital display only).

- displays in hours, minutes, seconds
- analog chronograph pointer indicates seconds
- dashes displayed if no data
- chronograph available without FMC or GPS
- UTC and CHR displays not available in PLAN mode
- UTC sources are, in order, GPS, FMC, IDS, or manual entry on CDU POS INIT page

Time/Date/Elapsed Time Display

Located on lower right corner of the status (STAT) display.



1 Status Page Indications

Dashed lines are displayed if information is not available.

Elapsed time:

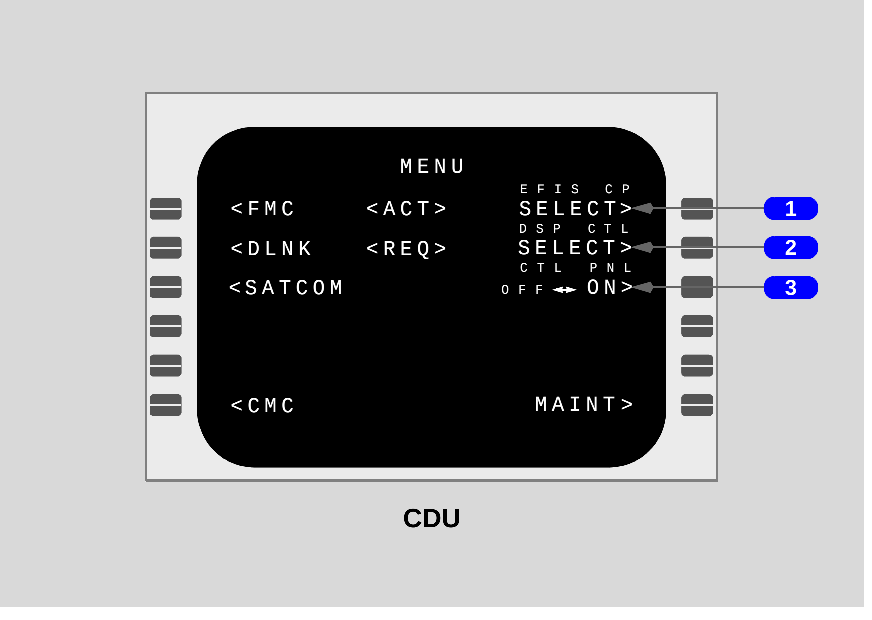
- displays zeros when electrical power is applied
- begins advancing at lift-off
- stops advancing at touchdown
- reset after engines are shut down and origin airport is entered or upon all doors being closed for departure

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.

Note: The control callouts on the following pages correspond to the control names on the EFIS control panels and the display select panel. Explanations of the CDU functions are the same as on the related control panels except where described.

CDU EFIS/DSP Control Selection



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 DSP Control

Push - (with SELECT displayed) displays alternate DISPLAY MODES page.

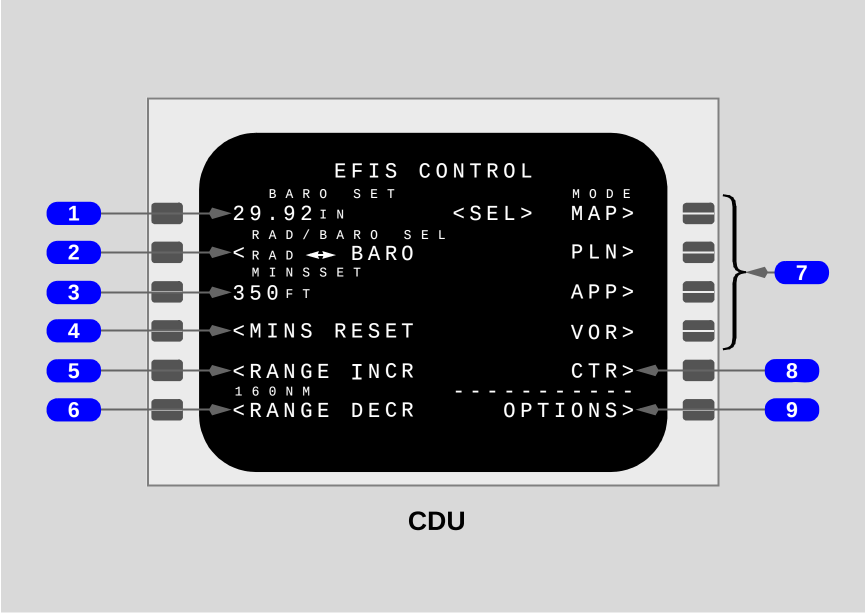
SELECT is displayed when the control panel (CTL PNL) prompt is selected ON or there is a failure of the control panel. The line title DSP CTL remains when the SELECT prompt is removed.

3 Control Panel Switch

Push - alternately selects the EFIS CP and DSP CTL SELECT prompts ON and OFF. ON is displayed if the associated EFIS 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.

Note: The associated EFIS control panel is disabled while ON is selected.

EFIS Control Page



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)

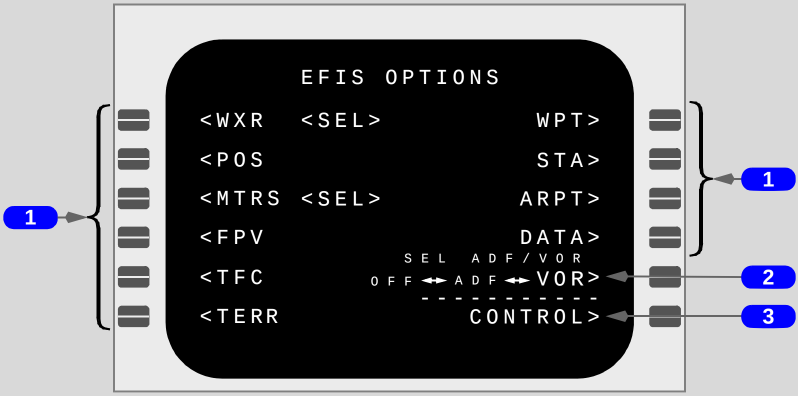
Push - alternately displays centered and expanded in APP and VOR modes. Cycles through expanded MAP, MAP CTR, and VSD in MAP mode. Deactivated in PLN mode.

9 OPTIONS

Push - displays EFIS OPTIONS page.

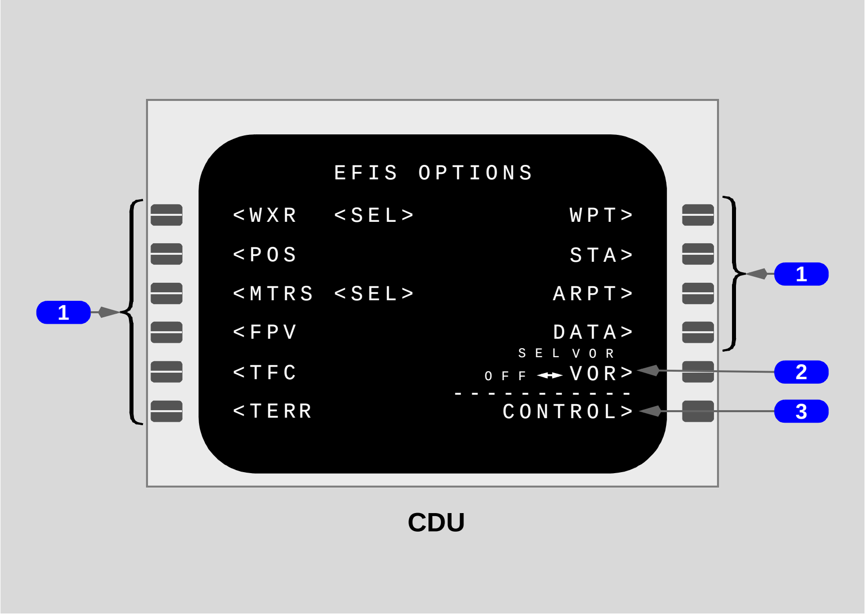
EFIS Options Page

914



CDU

806



1 **WXR, POS, MTRS, FPV, TFC, TERR, WPT, STA, ARPT, DATA**

Push - selects related PFD/ND options.

914

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.

806

2 **VOR**

Push - sequentially selects VOR or OFF for the pointer display on the ND.

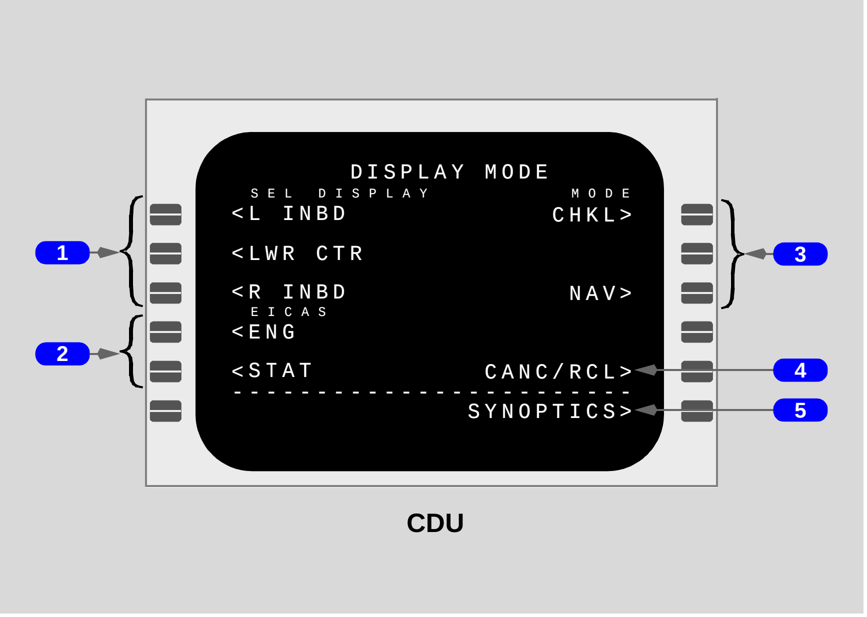
VOR - displays the VOR pointer, frequency, and associated DME on the ND in all modes except PLAN.

OFF - removes VOR data from the ND.

3 CONTROL

Push - selects EFIS CONTROL CDU page.

Display Select Panel (DSP)



1 SEL DISPLAY

Push - selects display to be used.

2 EICAS

Push - selects EICAS display mode.

3 MODE

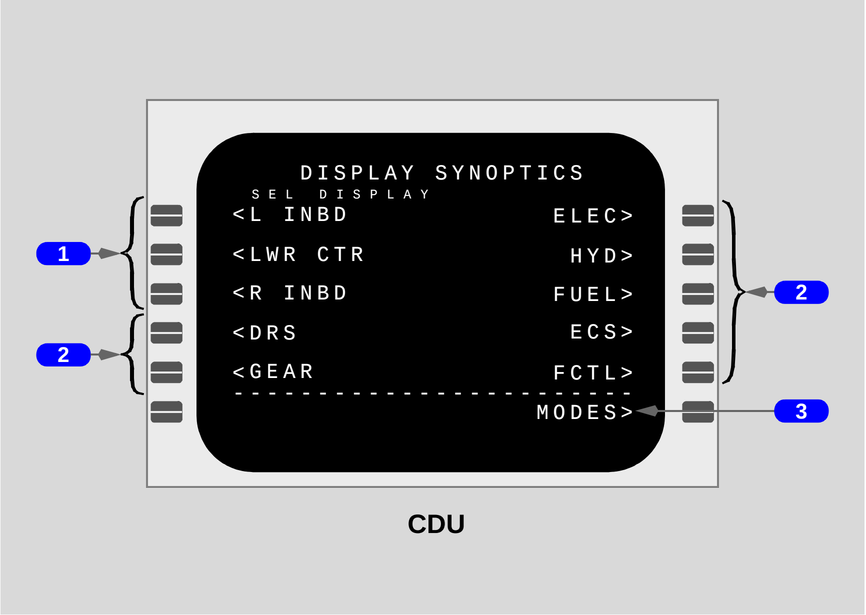
Push - selects display mode.

4 CANC/RCL

Push - cancels/recalls EICAS messages. Refer to Warning Systems, Chapter 15.

5 SYNOPTICS

Push - selects DISPLAY SYNOPTICS page



1 SEL DISPLAY

Push - selects display to be used.

2 Synoptics

Push - selects desired synoptic.

3 MODES

Push - selects DISPLAY MODES page.

Flight Instruments, Displays — Chapter 10
System Description — Section 20

Introduction

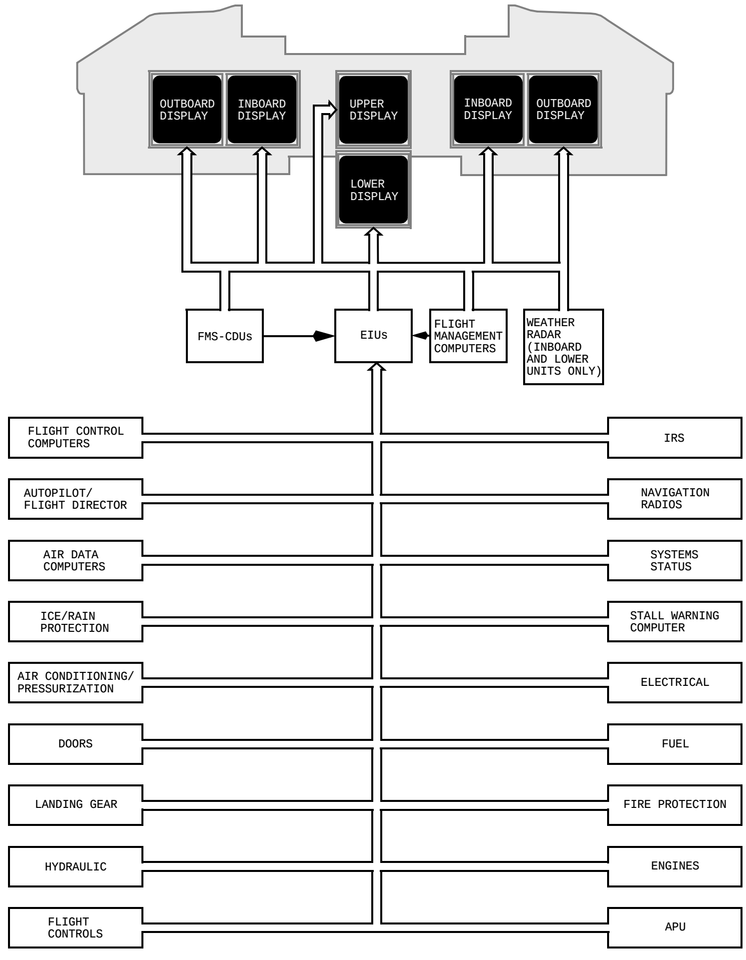
The integrated display system consists of three identical EFIS/EICAS interface units (EIUs) which receive and display airplane systems information. The EIUs supply information to the flight crew on six display units:

- Captain and First Officer primary flight display (PFD)
- Captain and First Officer navigation display (ND)
- engine indication and crew alerting system (EICAS)
- the multifunction display (MFD). The lower display can be used as the Multifunction Display (MFD), refer to Airplane General, Chapter 1.22

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.

When a Multifunction Display (MFD) switch is pushed on the Display Select Panel, the lower EICAS or inboard displays serve as the MFD and display information for the system selected.

Integrated Display System



Display Selection and Control

During normal operations:

- the inboard display selectors are set to MFD
- PFDs display on the two outboard display units
- NDs display on the two inboard display units
- EICAS displays on the upper center display unit
- the display select panel-selected MFD information display on the lower center display unit, or the display is blank. (The secondary engine display is the default display at power-up.)

Inboard Display Selectors

The inboard display selectors are used to select PFD, ND (NAV position), MFD, or EICAS displays on the inboard display units.

The normal position is MFD. With MFD selected, ND information displays on the inboard display units if NAV is selected on the display select panel (refer to Display Select Panel in this section).

In the ND, PFD, and EICAS positions, only the selected displays can appear on the inboard display units.

With MFD selected on the Inboard Display selector:

- if both pilots have an ND on the inboard displays, then each EFIS control panel controls its corresponding ND display
- if there is an ND display on one inboard display unit and on the lower center display unit, then the pilot who does not have an ND on the inboard display unit controls the ND on the lower center display unit
- if neither pilot has an ND display on the inboard display unit, and there is an ND display on the lower center display unit, then the left EFIS control panel controls the lower center display unit
- if both pilots have an ND display on the inboard display unit, and there is an ND on the lower center display unit, then the left EFIS control panel controls the left inboard display unit and the lower center display unit. The ND on the left inboard and the lower center display units are identical.

EFIS Control Panels

The EFIS control panels control display options, mode, and range for the respective PFDs and NDs. Refer to the PFD and ND sections of this chapter.

If an EFIS control panel fails, the displays can be controlled through the related CDU. This CDU capability is available at all times, but inhibits inputs from the respective EFIS control panel.

Display Select Panel

The display select panel controls the MFD format on the left and right inboard display units and the lower center display unit. The selected display is indicated by the illuminated annunciator light on the display select panel (L INBD, R INBD, LWR CTR).

After a display unit is selected, the appropriate display is selected (ENG, STAT, ELEC, FUEL, ECS, FCTL, HYD, DRS, GEAR, CHKL, or NAV).

A new display selection automatically replaces the previous one. A second selection of the same display blanks the display or for inboard display units redisplays the ND. If there are more than one page of status messages, pushing STAT pages through the messages before blanking the display or returning the inboard display to ND.

Pushing the CHKL switch for either inboard display unit shows the selected display. The cursor highlight box automatically appears on the checklist.

Display select panel control is also available through the left and right CDUs. This capability is available at all times.

When used as an MFD, the lower center display unit and the two inboard display units can display the following displays:

- ND (NAV switch)
- status page (STAT switch)
- secondary engine EICAS (ENG switch)
- system synoptics (ELEC, FUEL, ECS, FCTL, HYD, DRS, and GEAR switches)
- electronic checklist (CHKL switch)
- information system (INFO switch) INFO FUNCTION NOT AVAILABLE displays

When an inboard display selector is in the PFD position, new displays selected from the display select panel to that inboard display are inhibited. The annunciator light above the associated display select panel switch is also inhibited.

When an inboard display selector is in the EICAS position, only the ENG, FUEL, and GEAR switches can affect the display. Pushing one of those switches causes the display of the respective compacted blocks of information on the EICAS display. The cancel/recall switch operates normally. Refer to these chapters for more information on compact EICAS displays:

- Chapter 7, Engines, APU
- Chapter 12, Fuel
- Chapter 14, Landing Gear.

The inboard display selectors have no effect on the inboard displays if an outboard display unit fails; the PFD automatically moves to the inboard display unit regardless of the position of the inboard display selector.

Upper center display unit failure automatically switches the EICAS display to the lower center display unit. A subsequent EICAS selection on either of the inboard display selectors brings the EICAS display to that inboard display unit, and the lower center display unit displays secondary engine instruments. Following this initial display configuration, the lower center display unit can be used in its usual MFD mode.

Display Brightness Control

The 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 and terrain.

Light sensors above the glareshield and near each display and CDU measure ambient light level and adjust display brightness to maintain the desired illumination.

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 Selection and Control Examples

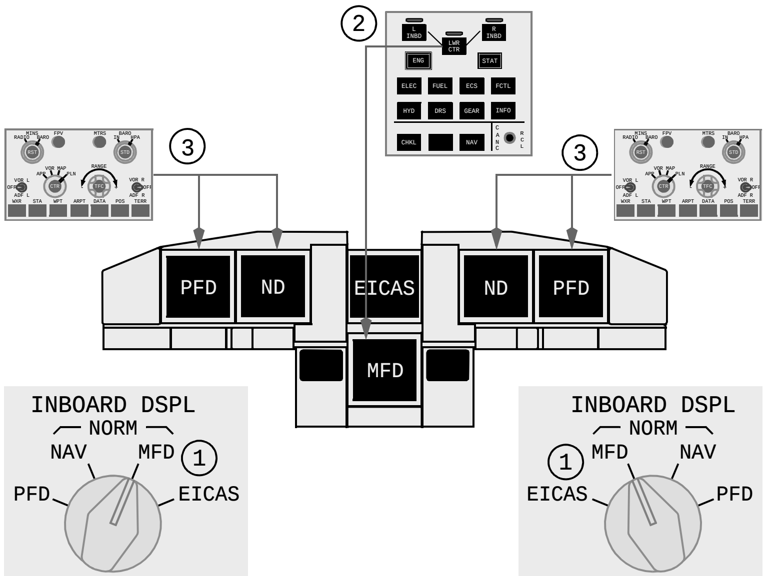
The following examples show display selections.

Normal Display Configuration

1 The INBOARD Display (DSPL) selectors are set to MFD.

2 The lower center display unit is the preferred MFD controlled by the display select panel.

3 The outboard display units display PFDs and the inboard display units display NDs. The related control panel controls what is on the PFD and ND.

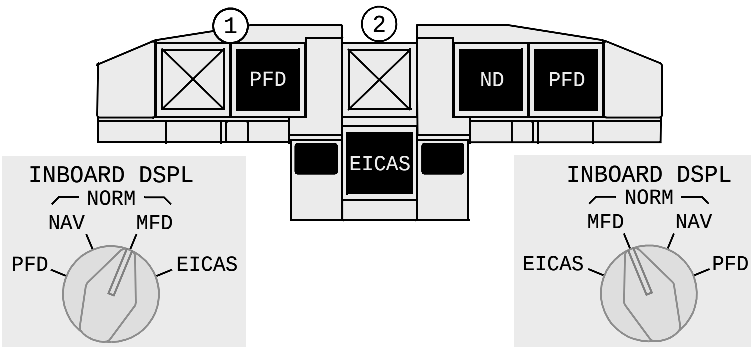


Display Unit Failure Automatic Switching

1 If an outboard display unit fails, the PFD automatically moves to the inboard display unit.
The INBOARD Display (DSPL) selector and the display select panel no longer have any control over that inboard display unit.

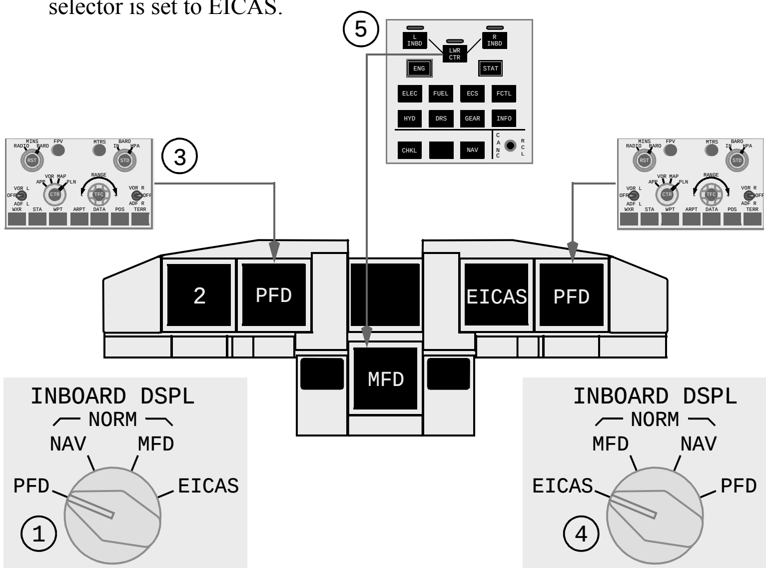
2 If the upper center display unit fails, the EICAS display automatically moves to the lower center display unit.

Pushing the ENG display switch switches EICAS between primary and compacted modes if no pop-up condition is active.
The display select panel can still display compact engine, gear, and fuel synoptics. The CANCEL/RECALL switch operates normally.



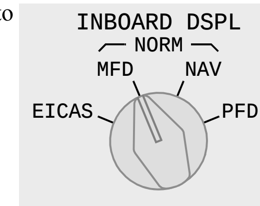
Inboard Display Switching

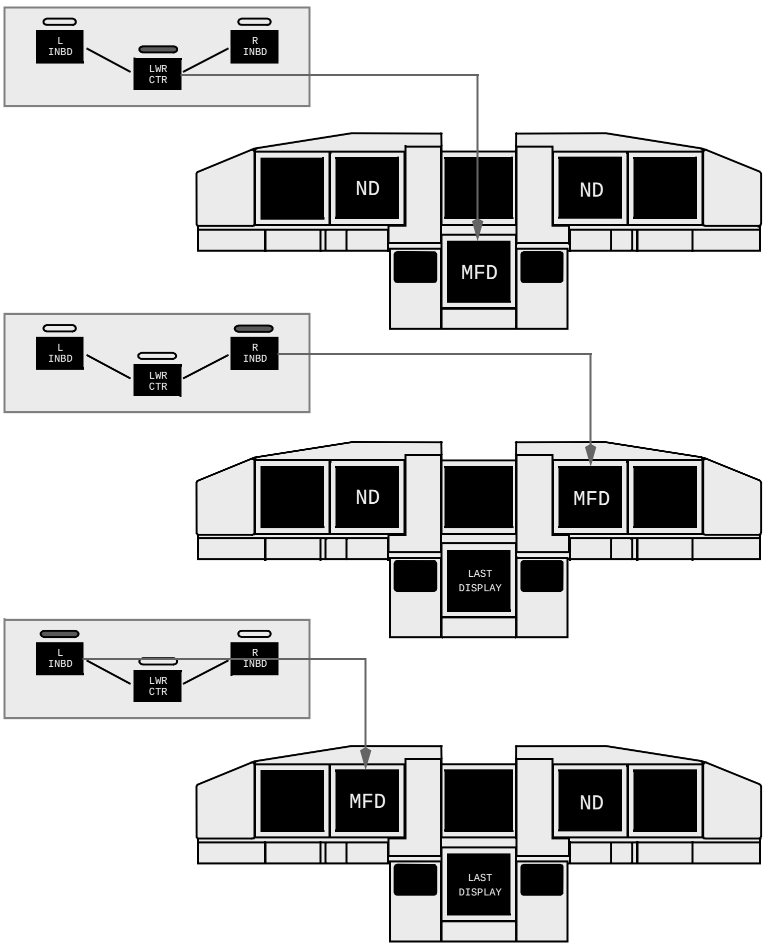
1. The left INBOARD Display (DSPL) selector is set to PFD.
   With an INBOARD Display (DSPL) selector in any position other than MFD, the selector position alone determines what is displayed on the display unit.
   The left inboard display cannot display any selections made on the display select panel.
2. The left outboard display blanks and the PFD moves to the left inboard display unit.
3. The left EFIS control panel controls the PFD.
4. The right INBOARD Display (DSPL) selector is set to EICAS.
   The right inboard display cannot display selections made on the display select panel, except for compact engine, gear, and fuel synoptics, and the CANCEL/RECALL switch functions.
5. The upper center display blanks and the EICAS display moves to the right inboard display unit. Now there is no ND visible. Either pilot could use the display select panel to display an ND on the lower center display unit (refer to the following pages).



Display Select Panel MFD Selection

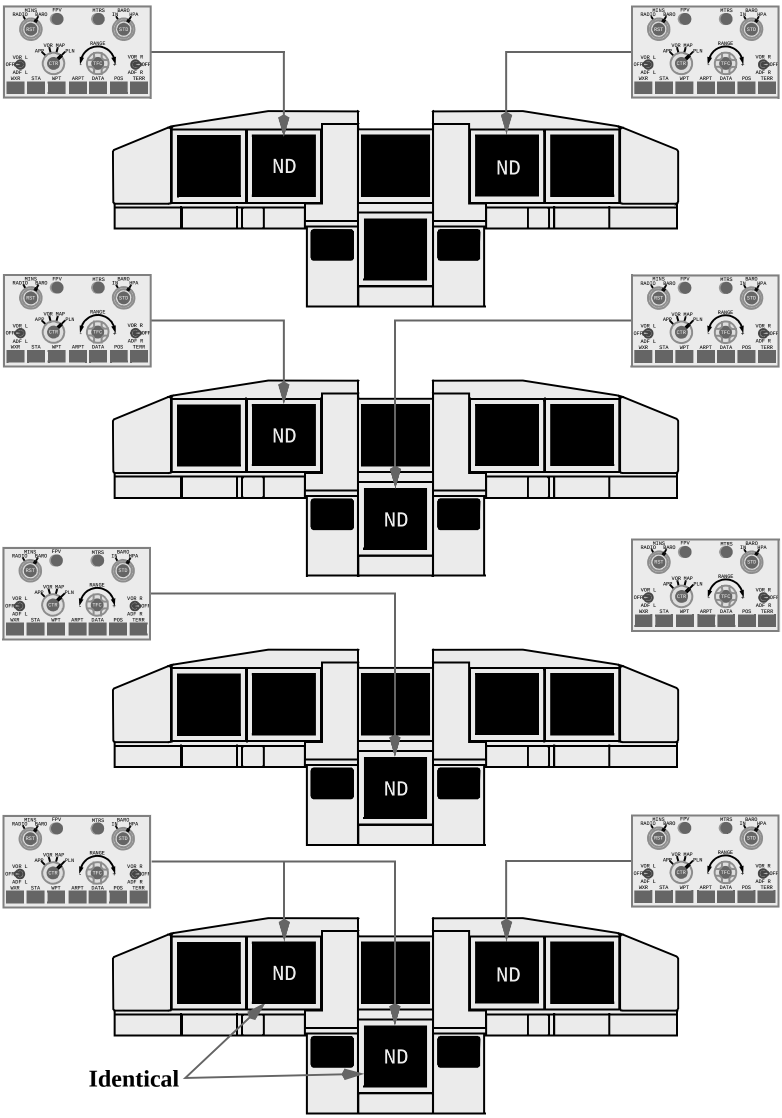
With the INBOARD Display (DSPL) selectors set to MFD, the display select panel display switches are used to designate a display as an MFD. The designated display (L INBD, LWR CTR, or R INBD) is then controlled by the other display select panel selections (ENG, STAT, CHKL, NAV or one of the system synoptics).





EFIS Control Panel Multiple ND Control

This shows which EFIS control panel controls which ND when multiple NDs are displayed, or when the ND is displayed on the lower center display unit.



Cursor Control

The cursor controls provide control of the display highlight on a predetermined path and selection of the highlighted key.

Either cursor control is able to control the cursor highlight. If both cursor controls are operated simultaneously, the highlight movement is the algebraic sum of the inputs.

Standby Flight Instruments

The standby flight instruments include:

- integrated standby flight display
- standby magnetic compass

Integrated Standby Flight Display (ISFD)

The ISFD displays attitude, airspeed, altitude, ILS, GLS, and heading information. The ISFD receives pitot and static pressure from auxiliary pitot and alternate static sources. Attitude information is provided by internal inertial sensors. ILS or GLS information is provided by the left approach receiver. Heading information is provided by the left ADIRU. In non-polar regions, the ISFD displays magnetic heading. In polar regions, the ISFD displays true heading with TRU displayed on the left side of the compass rose.

Note: The standby magnetic compass must be used to validate heading information.

The main battery bus powers the ISFD. Selecting the battery switch ON activates the ISFD. After 10 seconds, a 90 second initialization sequence begins. ATT and INIT 90s messages display during initialization. Initialization will stop if airplane movement is excessive and will resume when airplane movement is acceptable for initialization. Upon completion of the initialization sequence, attitude information displays.

Detection of a momentary out-of-limit ISFD condition may cause the attitude display to blank and the WAIT ATT or ATT:RST message to display. When the ATT:RST message displays, pushing the Attitude Reset switch resets the horizon line with the airplane symbol.

On the ground, pushing the Attitude Reset switch must be accomplished with the airplane stationary. In flight, pushing the Attitude Reset switch must be accomplished with the airplane in wings level, non-accelerated flight. During attitude reset, the ATT 10s message displays. Failure to maintain straight and level flight for 10 seconds may result in an ATT:RST message. If attitude reset is unsuccessful, the ATT:RST message remains displayed and the attitude will not be displayed.

Standby Magnetic Compass

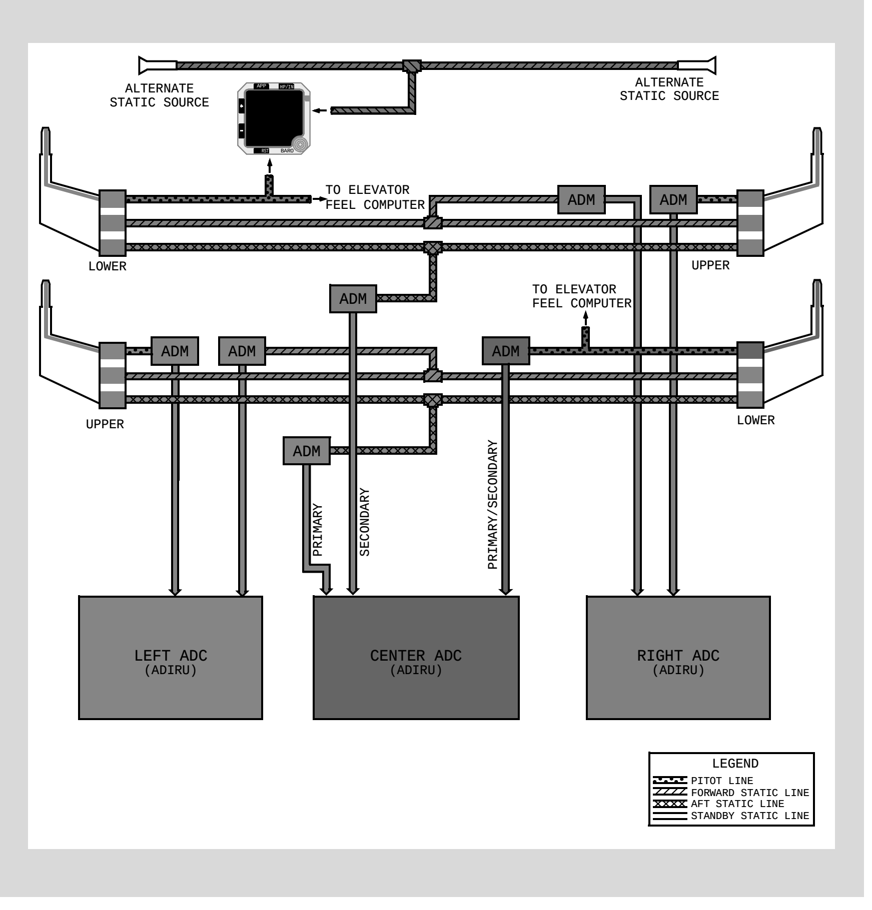
A standard liquid-damped magnetic standby compass is located on the center post above the glareshield. A card located near the compass provides heading correction factors.

Display System Information Sources

Pitot Static System

The pitot static system provides pitot pressure and static pressure to the air data modules (ADMs), integrated standby flight display, and elevator feel computer. The ADMs convert the inputs to digital data for use by the Air Data Computers (ADCs).

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 standby ADC and may be selected as a replacement using the Center Air Data selector. The center ADC has its own pitot probe and ADMs but receives static pressure and AOA inputs from the same probes as the ADC it replaces and uses the opposite side TAT probe.

Angle-of-Attack (AOA)

There are two angle-of-attack vanes, one located on each side of the forward fuselage. The vanes measure airplane angle-of-attack relative to the air mass.

Total Air Temperature (TAT)

Left and right dual total air temperature probes sense outside air temperature (OAT) and heat of compression. TAT displays on primary EICAS. TAT indication on the ground approximates OAT. The TAT probe must be aspirated by bleed air to provide accurate information.

Static Air Temperature (SAT)

SAT displays on Progress page 2.

Intentionally
Blank

Flight Instruments, Displays — Chapter 10
Primary Flight Displays (PFDs) — Section 30

Introduction

PFDs present a dynamic color display of parameters necessary for flight path control. PFDs provide the following information:

- flight mode annunciation
- airspeed
- altitude
- vertical speed
- attitude
- steering information
- radio altitude
- instrument landing system display
- approach minimums
- heading/track indications
- time critical warnings

Failure flags display for airplane system failures. Displayed information is removed or replaced by dashes if no valid information is available to the display system (because of out-of-range or malfunctioning navigation aids). Displays are removed when a source fails or when no system source information is available.

Flight mode annunciations are described in Chapter 4, Automatic Flight.

TCAS resolution advisories are described in Chapter 15, Warning Systems.

Alerts on the PFD display in capital letters between the attitude display and the compass rose. Refer to Chapter 15, Warning Systems.

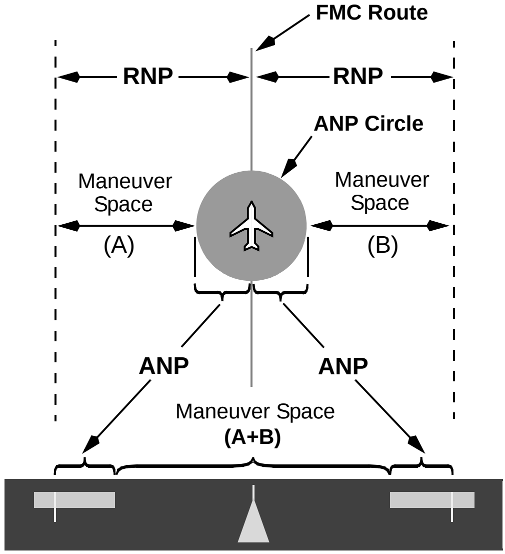
Navigation Performance Indications

Navigation performance scales and pointers present a real-time display of the location of the LNAV and VNAV path relative to the airplane. The airplane position is represented by the center index (or tic mark) on the scale and the LNAV or VNAV path by a magenta pointer (triangle).

The deviation scales are proportional to RNP. The deviation represented by the distance from the center index to the outer index is equal to the RNP value in the FMC. If RNP is equal to 1 NM, then the distance between the center index and outer index represents 1 NM.

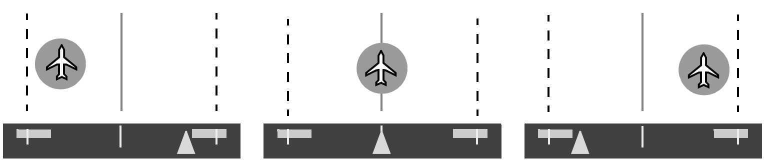
The ANP bars are anchored to the outer index, or tic marks, and vary in length depending on the precision of the navigation system. When GPS updating is available, the ANP value is small and the bars are short. When GPS updating is not available, position uncertainty increases and the ANP bars extend toward the center of the scale. The gap between the ANP bars is the area where the magenta pointer can be and the airplane still remains within the RNP for that part of the route. (Refer to Chapter 11, Section 31, for additional information).

If the deviation pointer moves into an ANP bar for 5 continuous seconds, the ANP bars and scale turn amber and the pointer flashes for 10 seconds. When ANP equals or exceeds RNP, the ANP bars touch at the center of the scale. The ANP bars change color to amber, the deviation pointer flashes for 10 seconds, and the EICAS message UNABLE RNP displays.



NOTE: If ANP value increases (Navigation system performance decreases), the ANP bars become longer, extending toward the center of the scale.

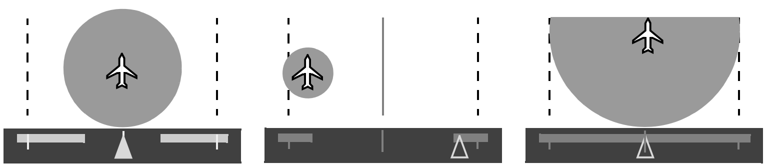
Circle around airplane (2 x ANP) represents where the airplane is estimated to be 95% of the time.



Left of Route

On Route

Right of Route

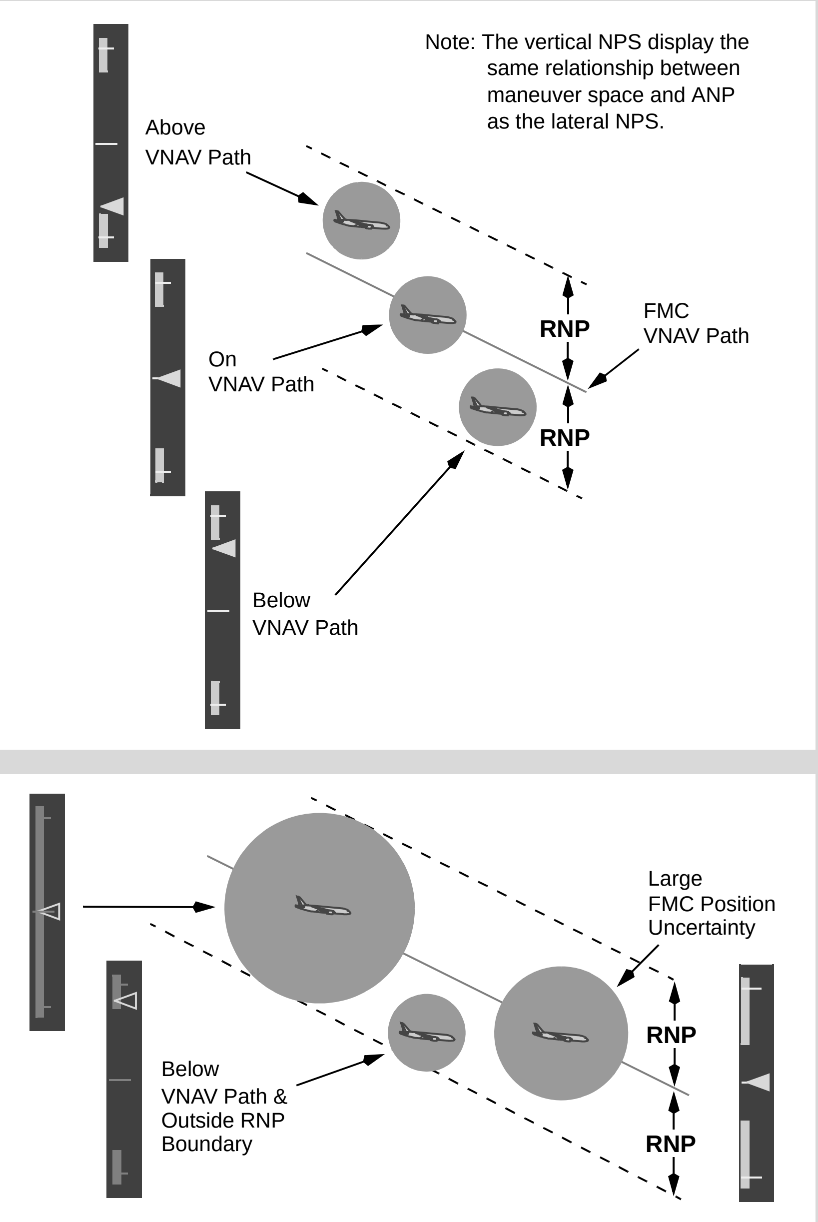


Large FMC
Position Uncertainty

Left of Route
Outside RNP boundary

UNABLE RNP
EICAS Message

LATERAL NAVIGATION PERFORMANCE SCALES



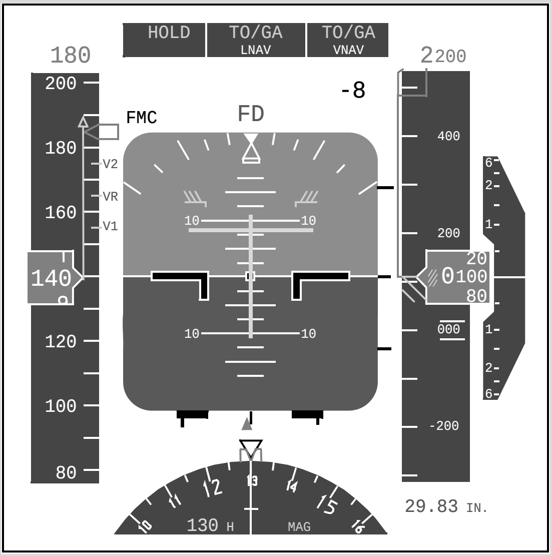
VERTICAL NAVIGATION PERFORMANCE SCALES

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

806



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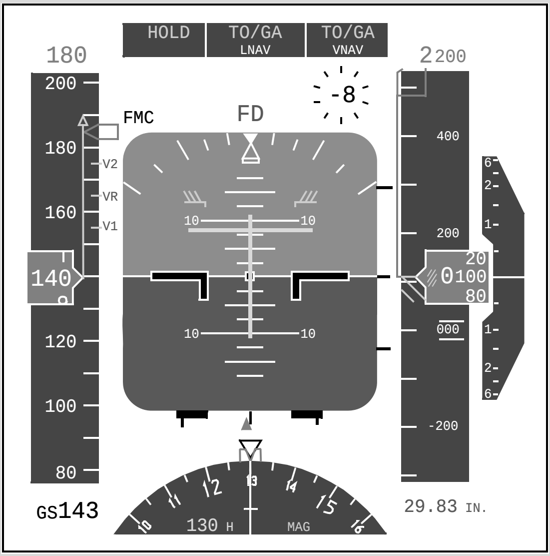
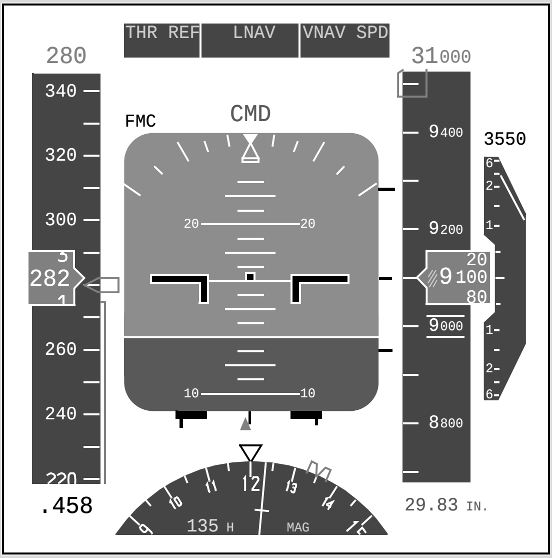
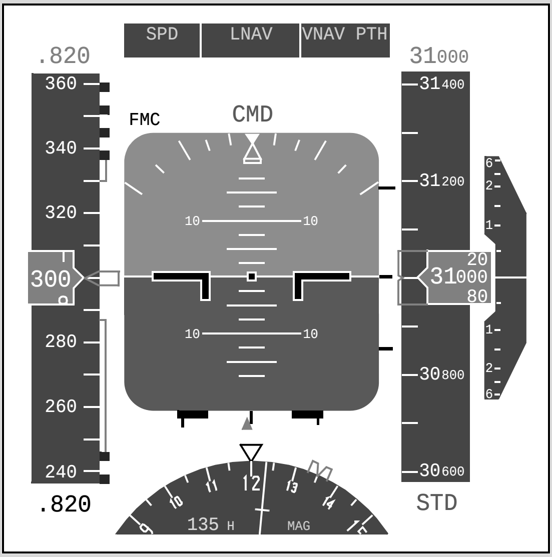

HOLD
TO/GA
LNAV
TO/GA
VNAV
180
200
180
160
140
120
100
80
FMC
V2
VR
V1
FD
-8
10
10
2200
400
200
20
0100
80
000
-200
6
2
1
1
2
6
GS143
130 H
MAG
29.83 IN.

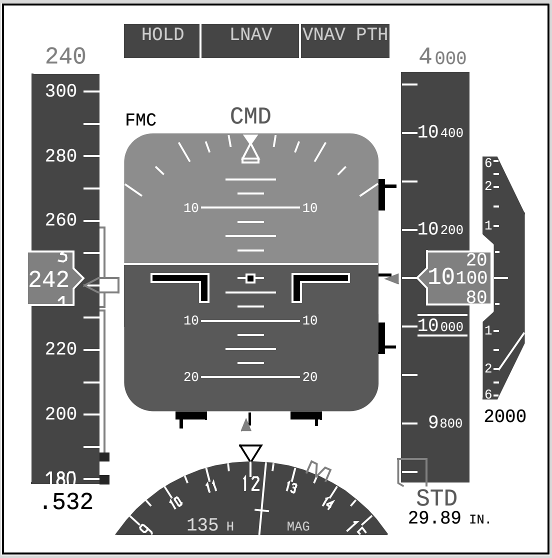
PFD Climb Display



PFD Cruise Display

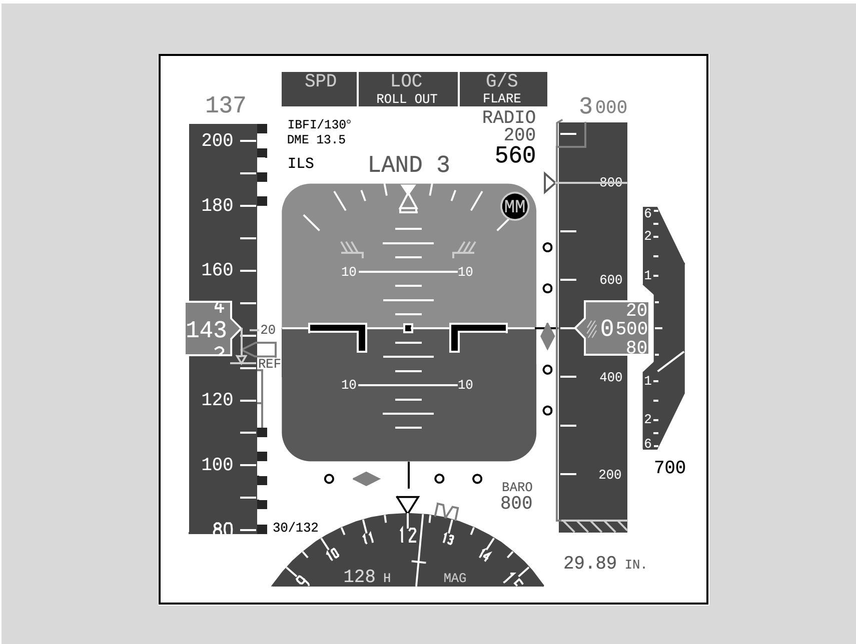


PFD Descent Display

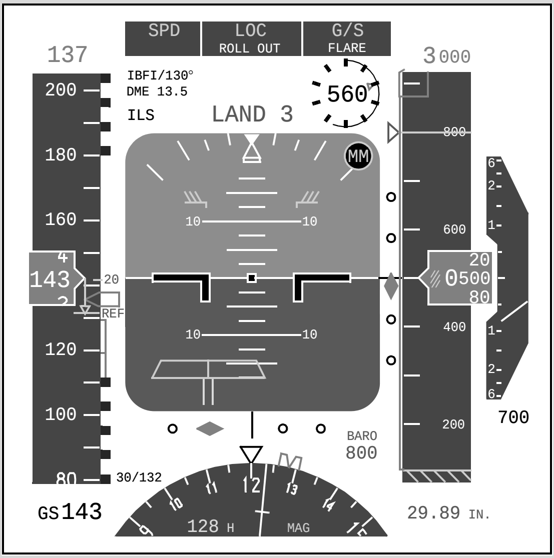


PFD Approach Display

806

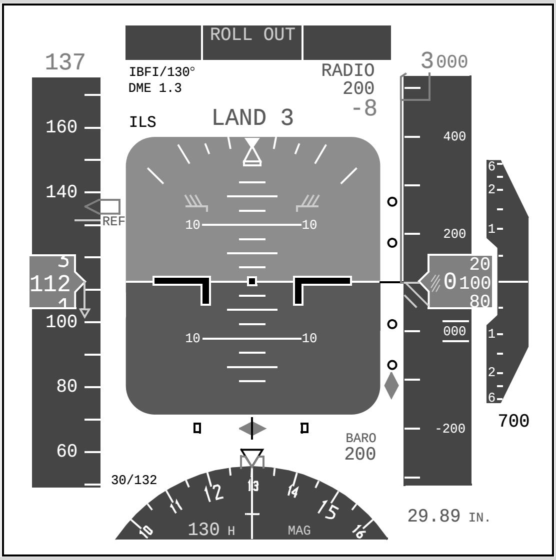


914

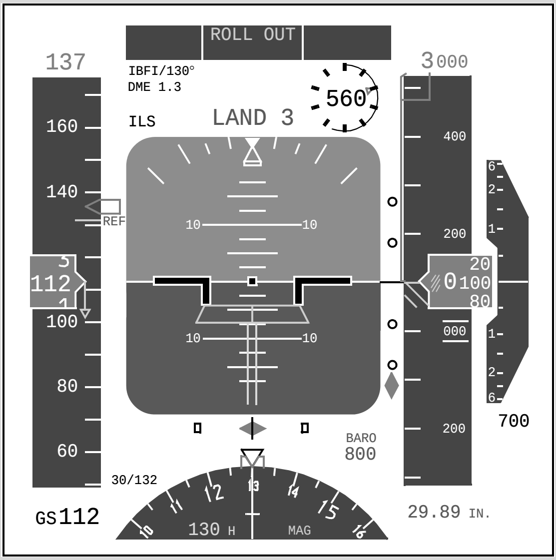

SPD
LOC
ROLL OUT
G/S
FLARE
137
IBFI/130°
DME 13.5
ILS
LAND 3
560
3000
MM
200
180
160
143
20
REF
120
100
80
30/132
GS143
10
10
10
10
BARO
800
128 H
MAG
800
600
0500
20
80
400
200
700
29.89 IN.

PFD Landing Display

806



914


ROLL OUT
137
IBFI/130°
DME 1.3
560
ILS
LAND 3
3000
160
140
REF
112
100
80
60
400
200
20
0100
80
000
200
700
6
2
1
10
BARO
800
30/132
GS112
130 H
MAG
29.89 IN.

Flight Instruments, Displays — Chapter 10
Navigation Displays — Section 40

Introduction

The NDs provide a mode-selectable color flight progress display. The modes are:

- MAP
- VOR
- APP (approach)
- PLN (plan)

MAP, VOR, and APP modes can be switched between an expanded mode with a partial compass rose and a centered mode with a full compass rose.

The VSD displays at the bottom of a third MAP mode.

Map Mode

The MAP mode is recommended for most phases of flight.

806
Presented heading up, this mode shows airplane position relative to the route of flight against a moving map background.

914
Presented track up, this mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- track
- heading
- route
- position trend vector
- range to selected altitude
- map range scale
- ground speed
- true airspeed
- Vertical Situation Display
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- RNP and ANP
- selected navigation data points
- TCAS Traffic Display
- time or chronograph function

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.

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.

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 or GLS approach information.

ND Information

Heading

(914 ; before SB, 2015 MAG VAR table not installed)
Heading is supplied by the selected IRU. The ND compass rose can be referenced to magnetic north or true north. The Heading Reference switch is used to manually select magnetic or true reference. The compass display references true north when the airplane is north of 82° N latitude (or north of 70°N between 80° W and 130° W) or south of 82° S latitude (or south of 60°S between 120° E and 160°E).

806
(914 ; SB installs 2015 MAG VAR table)
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.

Vertical Situation Display (VSD)

The VSD represents a profile view of the airplane and its environment along the current track. Information shown within the cyan dashed lines (enroute corridor) on the ND is shown in profile on the VSD.

The VSD displays with the MAP EXP mode by selecting the EFIS Control Panel ND Mode Selector to MAP and using the Center (CTR) Switch. Pushing the switch cycles the formats from MAP EXP to MAP CTR to VSD to MAP EXP.

Airport Map Display

The origin and destination airports display in the MAP, MAP CTR, or VSD modes when the range is 5 NM or less. Airport details are added or removed depending on weather radar and range selections. When weather radar is selected on, only runways and taxiways are displayed along with their associated identifiers and markings. More detail is added as the range is decreased. Pressing the ARPT switch cycles between displaying and removing the airport map.

Pressing the DATA switch on the EFIS Control Panel when the range is 2NM displays or inhibits some taxiway identifiers.

Failure Flags and Messages

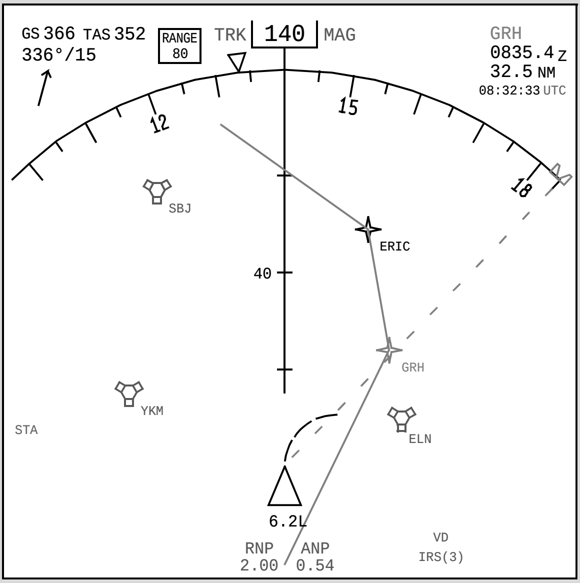
Failure flags display for system failures or invalid information. Indications are removed or replaced by dashes when source system information is not available.

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

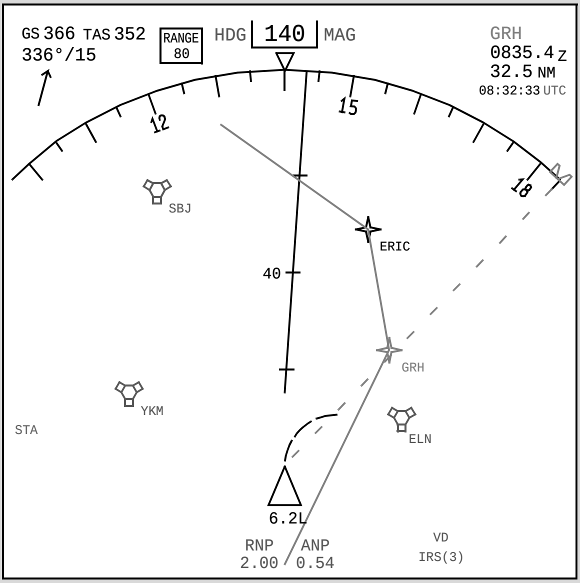
The following pages show typical ND map displays. Section 10 shows examples of other ND displays (centered map, approach, VOR, and plan modes).

914



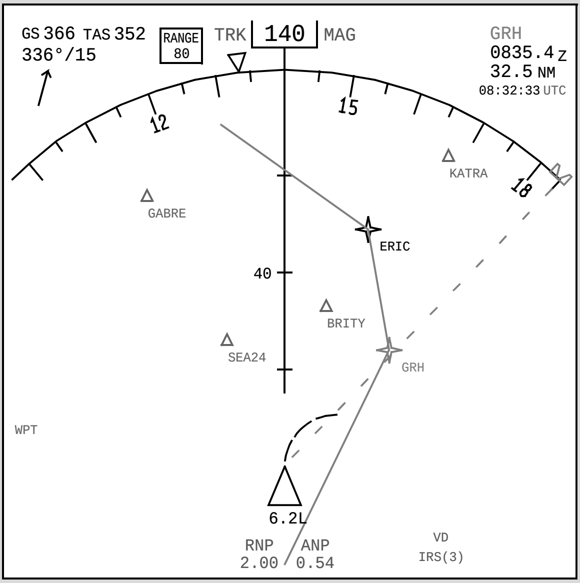
STA (STATION) SELECTED

806



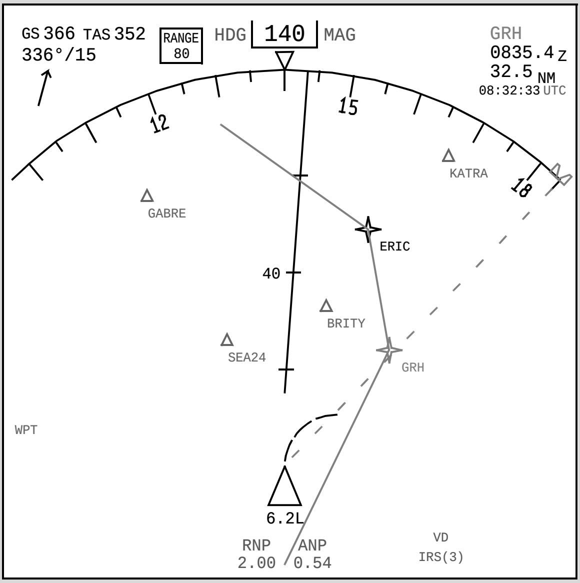
STA (STATION) SELECTED

914



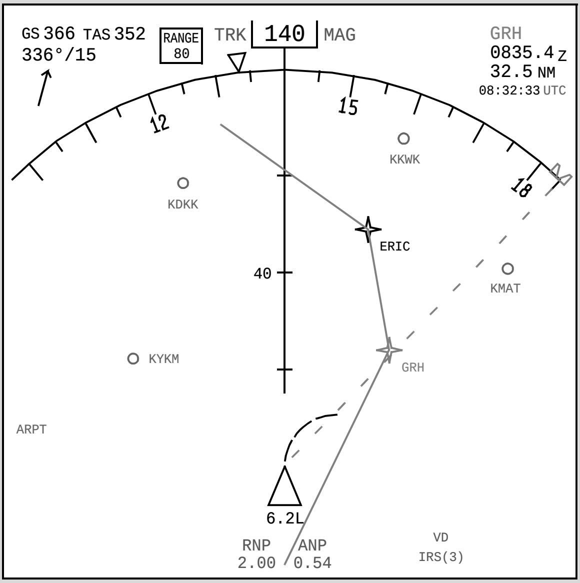
WPT (WAYPOINT) SELECTED

806



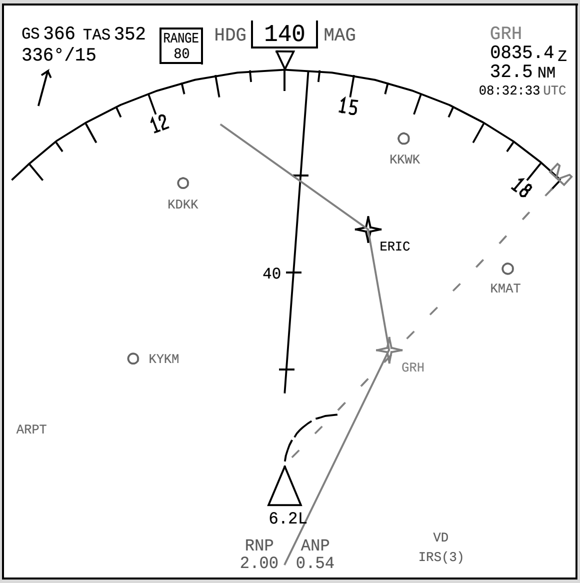
WPT (WAYPOINT) SELECTED

914



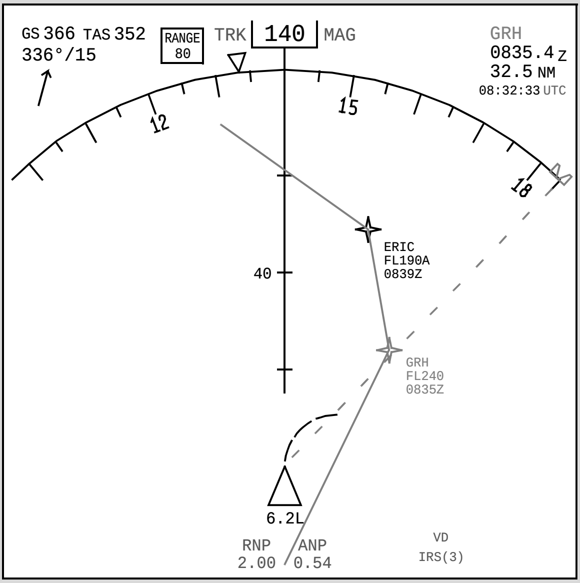
ARPT (AIRPORT) SELECTED

806



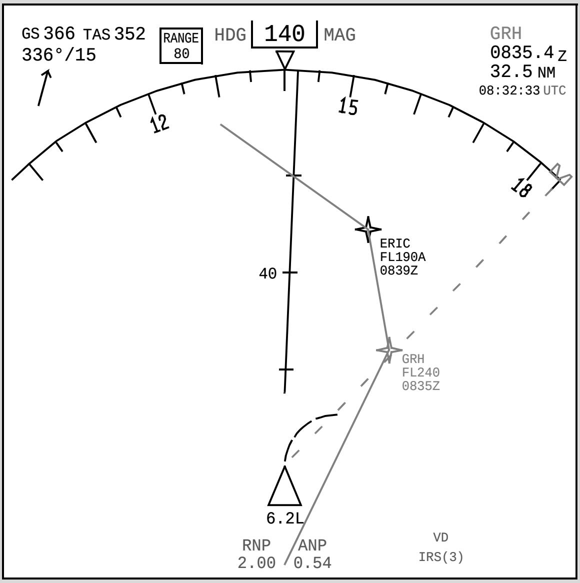
ARPT (AIRPORT) SELECTED

914



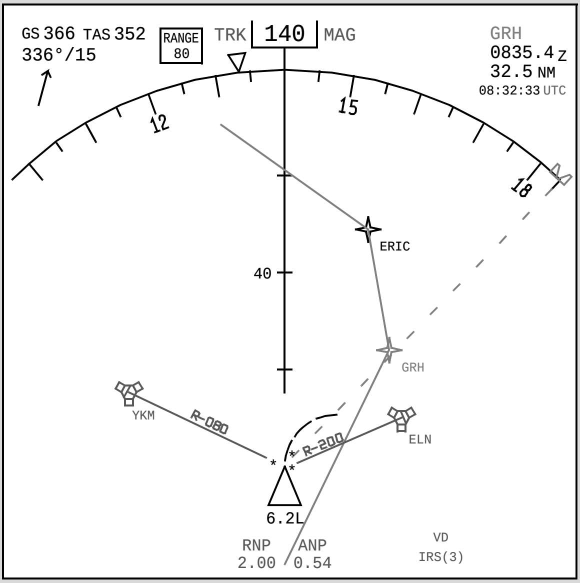
DATA SELECTED

806



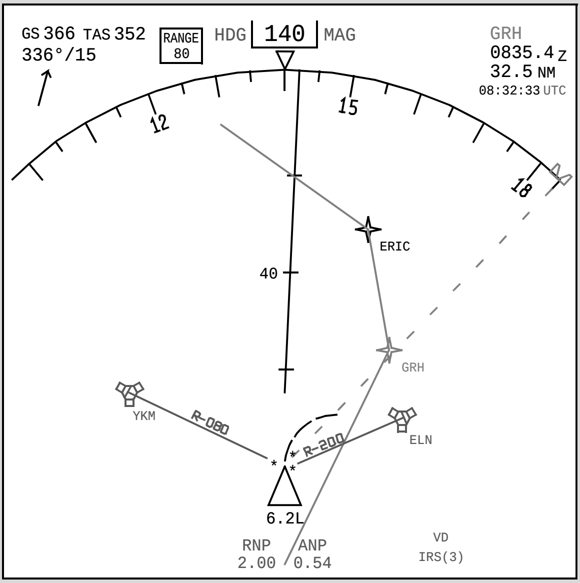
DATA SELECTED

914



POS (POSITION) SELECTED

806



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

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- B (blue) - inactive or background information

914

- 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 (except VSD mode). Displays 120 degrees of compass rose (VSD mode).

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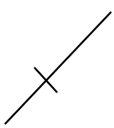
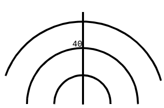
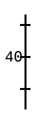
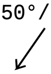
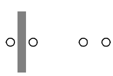
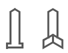
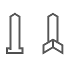
Symbol	Name	ND Mode	Remarks
GRID 237	Grid heading (W)	MAP, MAP CTR, PLAN	Displays grid heading during FMC polar operations (when aircraft is north of 70°N or south of 60°S)
GS310	Groundspeed (W)	All	Displays ground speed in large font below 30 knots; small font at 30 knots and above.
MAG OR TRU	Heading/track reference (G) box (W) in TRU, box (A) if TRU displayed in descent	All except PLAN	Indicates heading/track is referenced to magnetic north or true north. Switching from TRU to NORM displays a box around MAG for 10 seconds.

Symbol	Name	ND Mode	Remarks
914			
TRK 062 MAG	Track orientation (G), current heading (W), heading reference (G), and heading pointer (W)	MAP, MAP CTR, PLAN	Displays TRK as display orientation, current heading, MAG or TRU as heading reference, and points to the heading on the compass rose.
HDG 263 MAG ▽	Heading orientation (G), current heading (W), heading reference (G), and heading pointer (W)	VOR, VOR CTR, APP, APP CTR	Displays HDG as display orientation, current heading, MAG or TRU as heading reference, and points to the heading on the compass rose.
806			
HDG 263 MAG ▽	Heading orientation (G), current heading (W), heading reference (G), and heading pointer (W)	All	Displays HDG as display orientation, current heading, MAG or TRU as heading reference, and points to the heading on the compass rose.
TIME TO ALIGN L 4 MIN C 7+ MIN R 5 MIN	IRU time to align (W)	All	Indicates time remaining for IRU alignment. Replaces wind direction/speed and wind arrow, on the ground, during alignment.

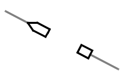
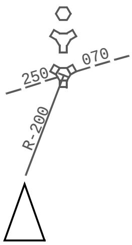
Symbol	Name	ND Mode	Remarks
	Selected heading (M)	All except PLAN	Displays MCP-selected heading. A dashed line (M) may extend from the marker to the airplane symbol. In MAP mode with LNAV, LOC, or ROLLOUT engaged, dashed line is removed 10 seconds after the selected heading is moved.
	Track indicator (W)	VOR, VOR CTR, APP, APP CTR	Indicates airplane track when selected mode has heading orientation.
	Track line and range arcs (W)	MAP, VOR, APP	Line indicates track. Number indicates range. Displays in VOR and APP when WXR or TERR on.
	Track line and range scale (W)	MAP, MAP CTR, VOR, APP	Line indicates track. Number indicates range. Displays when WXR or TERR not on. Displays in VOR and APP when TFC on.
TAS312	True airspeed (W)	All	Displays true airspeed above 100 knots.
350°/15 	Wind direction/ speed and wind arrow (W)	All	Indicates wind bearing, speed, and direction, with respect to display orientation and heading/track reference. Arrow not displayed in PLAN map mode.

Radio Navigation

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.
	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.
21894 OR GXBF	GLS (G) Reference receiver channel or identifier display	APP, APP CTR	Displays frequency before the identifier is decoded. The decoded identifier replaces the frequency.
	ILS localizer, GLS, or VOR course deviation indication (M) and scale (W)	VOR, VOR CTR, APP, APP CTR	Displays LOC, GLS, or VOR course deviation. Deviation indicator points in direction of VOR or ILS selected course. For ILS or GLS deviation, indicator fills (M) when less than 2 1/2 dots from center.
111.70 OR ISZI	ILS (G) Reference receiver frequency or identifier display	VOR, VOR CTR, APP, APP CTR	Displays frequency before the identifier is decoded. The decoded identifier replaces the frequency. Small size characters indicate only DME information is being received.

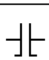
Symbol	Name	ND Mode	Remarks
914			
520 OR BF	ADF frequency or identifier (B)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Displays frequency before identifier is decoded. Decoded identifier replaces the frequency.
	Left VOR (G) or ADF (B) pointer head and tail	MAP, MAP CTR, VOR, VOR CTR, PLAN	Indicates bearing to (head) or from (tail) the tuned station, if selected on respective EFIS control panel.
	Right VOR (G) or ADF (B) pointer head and tail		
VOR L, R ADF L, R	VOR (G) or ADF (B) selection	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Located lower left or right corner. Represents positions of VOR/ADF switches.
806			
	Left VOR (G) pointer head and tail	MAP, MAP CTR, VOR, VOR CTR, PLAN	Indicates bearing to (head) or from (tail) the tuned station, if selected on respective EFIS control panel.
	Right VOR (G) pointer head and tail		
VOR L, R	VOR (G) selection	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Located lower left or right corner. Represents positions of VOR switches.

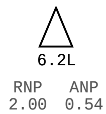
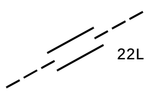
CRS 135	Reference GLS, ILS, or VOR course (W)	VOR, VOR CTR, APP, APP CTR	Displays VOR course or FMC runway course.

Symbol	Name	ND Mode	Remarks
VOR L, R ILS L, C, R GLS L, C, R	Reference receiver (G)	VOR, VOR CTR, APP, APP CTR	Located upper right corner. Displays selected receiver as display reference.
RW22 24.6	Runway & distance (G)	APP, APP CTR	Displays GLS distance to the runway threshold.
	Selected course pointer (W) and line (M)	VOR, VOR CTR, APP, APP CTR	Indicates CDU-selected course.
TO FROM	To/from indication (W)	VOR, VOR CTR	Displays VOR to/from indication.
	To/from indication (W)	VOR CTR	Located near airplane symbol. Displays VOR TO/FROM indication.
	VOR (B, G), DME/TACAN (B, G), VORTAC (B, G)	MAP, MAP CTR	Displays appropriate navaids (B) when EFIS control panel STA switch selected on. Tuned VHF navaids display in green, regardless of switch selection. When a navaid is manually tuned, the selected course and reciprocal display.
	VOR/DME raw data radial and distance (G)		Extends station radial from the airplane to the CDU-tuned VOR when POS on. If co-located DME data received, tick mark displays at DME distance from airplane; extends to edge of display if no valid DME data displayed.

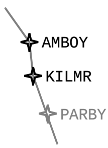
Symbol	Name	ND Mode	Remarks
116.80 OR SEA	VOR frequency or identifier (G) **806** ADF INOP (W)	MAP, MAP CTR, VOR, VOR CTR, APP, APP CTR	Displays frequency before identifier is decoded. Decoded identifier replaces the frequency. Small size characters indicate only DME information is being received.

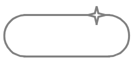
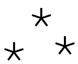
Map

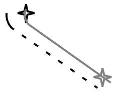
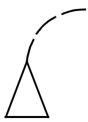
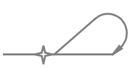
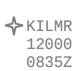
Symbol	Name	ND Mode	Remarks
124 NM	Active waypoint distance (W)	MAP, MAP CTR, PLAN	Distance to active waypoint.
0835.4z	Active waypoint ETA (W)	MAP, MAP CTR, PLAN	Displays FMS-calculated ETA at the active waypoint.
ABCDE	Active waypoint identifier (M)	MAP, MAP CTR, PLAN	Displays active flight plan waypoint, the next waypoint on the route of flight.
	Airplane symbol (W)	MAP, MAP CTR, VOR, APP	Airplane position is at the apex of the triangle.
	Airplane symbol (W)	PLAN	Indicates actual position and track along the flight plan route in plan mode only.
	Airplane symbol (W)	VOR CTR, APP CTR	Airplane position is at the center of the symbol.

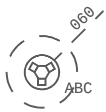
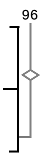
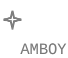
Symbol	Name	ND Mode	Remarks
	Airplane symbol (W), lateral deviation (W), lateral RNP (G/A), lateral ANP (G/A)	MAP, MAP CTR	Airplane position is at the apex of the triangle. Displays lateral path deviation distance. When ANP exceeds RNP, the ANP/RNP labels and values are displayed amber.
	Airport (B)	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 40 NM or less. Dashed runway centerlines extend 14.2 NM.
	Airport and runway (W)	MAP, MAP CTR, PLAN	Display when selected as the origin or destination and ND range is greater than 40 NM.
	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 FIX page display altitude/ETA along with the profile point. Deceleration points have no identifier.

Symbol	Name	ND Mode	Remarks
Q-CLB	Quiet Climb (G)	MAP, MAP CTR	Displays when Quiet Climb is ON. Indicates the map position for start thrust reduction.
CLBx	End Quiet Climb Point (G)	MAP, MAP CTR	Displays when Quiet Climb is ON. "x" is blank, 1, or 2. Indicates the map position for end Quiet Climb.
○ F10 166 ○ 250	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.
	Altitude range arc (G)	MAP, MAP CTR	Displays position where MCP altitude will be reached based on vertical speed and groundspeed.

Symbol	Name	ND Mode	Remarks
	Energy management circles (B, W)	MAP, MAP CTR	Displays clean (B) and drag (W) energy management circles as defined on CDU OFFPATH DES page.
	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.
LOCGPS GPS	FMC-GPS position update status (G)	MAP, MAP CTR	Displays FMC-GPS update mode. LOCGPS, localizer and GPS; GPS, GPS only.
IRS (3) IRS (L) IRS (C) IRS (R)	FMC-IRS position update status (G)	MAP, MAP CTR	Displays FMC-IRS status based on IRUs. Transition from IRS (3) to any other annunciation highlighted by a green box for 10 seconds.
DD VD LOC LOC DD LOC VD	FMC-radio position update status (G)	MAP, MAP CTR	Displays FMC-radio update mode. DD, DME DME; VD, VOR DME; LOC, localizer; LOC DD, localizer and DME DME; LOC VD, localizer and VOR DME.

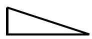
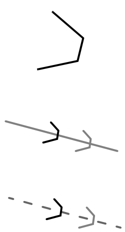
Symbol	Name	ND Mode	Remarks
	GPS position (W)	MAP, MAP CTR	Displays GPS position relative to FMC position when POS switch selected on.
	Holding pattern: active route (M), modified route (W), inactive route (B)	MAP, MAP CTR, PLAN	Displays holding pattern when in flight plan. Pattern increases to correct size when entering holding.
	IRU positions (W)	MAP, MAP CTR	Displays IRU positions relative to FMC position when POS switch selected on.
CDU L, C, R	Map source annunciation (G)	MAP, MAP CTR, PLAN	Displays ND source if: • CDU is selected on respective Navigation Source Select switch • both FMCs fail, or • a manually selected FMC fails
N↑	North up arrow (G)	PLAN	Indicates map background is oriented and referenced to true north.
△ MLF	Off route waypoint (B)	MAP, MAP CTR	Displays waypoints not on selected route displayed in ND ranges of 40 NM or less when WPT switch selected on.

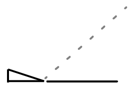
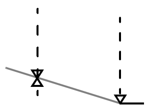
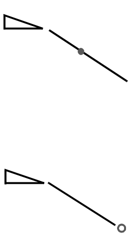
Symbol	Name	ND Mode	Remarks
	Offset path and identifier: active route (M), modified route (W)	MAP, MAP CTR, PLAN	Presents a dashed line parallel to and offset from the active or modified route.
	Position trend vector (W) (dashed line)	MAP, MAP CTR	Predicts position at the end of 30, 60, and 90 second 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, 2 NM, 1 segment • =1 NM or less, not displayed
	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 entering the procedure turn.
	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.
STA WPT ARPT WXR	Selected map options (B)	MAP, MAP CTR	Indicates STA, WPT, ARPT, and WXR switches selected on.

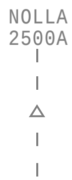
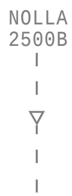
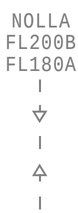
Symbol	Name	ND Mode	Remarks
	Selected reference point and bearing distance information (G)	MAP, MAP CTR, PLAN	Displays reference point selected on CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).
	VNAV path pointer (M) and deviation scale (W)	MAP, MAP CTR	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates ± 400 feet deviation. Digital display displays when the pointer indicates more than ± 20 feet.
	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.
	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.

Symbol	Name	ND Mode	Remarks
 	Alternate airports (B)	MAP, MAP CTR, PLAN	PLAN: displays up to four alternate airports at all times. MAP, MAP CTR, VSD: displays the FMC or pilot selected primary alternate airport. Displays up to four alternate airports when the EFIS control panel APRT map switch is selected on. Offscale airports (those beyond 640NM with 640 scale selected), directional arrow relative to airplane position or PLAN center point and distance (distance removed in PLAN).

Vertical Situation Display (VSD)

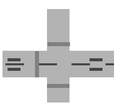
Symbol	Name	Remarks
	Airplane symbol (W)	Current airplane altitude is the bottom of the triangle. Current airplane lateral position relative to terrain is the point of the triangle.
	BARO minimums pointer and line (G)	Pointer indicates the barometric minimums selected on the EFIS control panel. Dashed line extends from pointer to background display boundary.
	Decision gates (W, A)	Indicates suggested points where airplane should be path and speed stable on approach. Gates are placed on the 3 Degree Reference Line or FMC Approach Glidepath Angle Line. Decision gates that are below the missed approach waypoint altitude will not be displayed.
	Enroute swath (dashed lines) (B)	Indicates area of map that is shown on the VSD. Display is inhibited both on takeoff and approach when airplane is within 6 NM of the runway and less than 3000 feet above field elevation. During turns, the swath edge leading the turn opens in the direction of the turn.
	Flight path vector (W)	Fixed length line indicates current flight path angle and rotates about the point of the triangle. Angle of the line is dependent on the vertical speed and ground speed of the airplane.

Symbol	Name	Remarks
	MCP selected vertical speed vector (M)	Dashed line indicates the selected vertical speed as a target angle when the MCP V/S mode is selected. Extends to the edge of the background display and rotates about the point of the triangle.
	Approach Glidepath Angle (M)	FMC Glidepath extends 10NM from MAP.
	3-Degree Reference Line (C)	Reference line extends 10NM from 1000’ down the runway from the threshold for approaches where FMC glidepath is not available.
	Range to target speed dot (G)	Indicates where the airplane will achieve the FMC or MCP target speed. If the airplane is within 5 knots of the target speed the dot will be blanked. If the airplane increases 10 knots or more faster than the target speed the dot will reappear. Displayed at the end of the Flight Path Vector as an unfilled dot if the target speed will not be achieved within the vector length.
	Selected altitude bug and line (M)	Bug indicates the altitude set in the MCP altitude window. When the selected altitude is off scale, the bug is parked at the top or bottom, with only one half the bug visible. Dashed line extends from bug to background display boundary. Line does not park.

Symbol	Name	Remarks
	Waypoint altitude constraint: active (M), inactive (W)	At Altitude example (active route).
	Waypoint altitude constraint: active (M), inactive (W)	At or Above Altitude example (active route).
	Waypoint altitude constraint: active (M), inactive (W)	At or Below Altitude example (active route).
	Waypoint altitude constraint: active (M), inactive (W)	Block Altitude example (active route).

Airport Map Display

Symbol	Name	ND Range
	Airport Beacon (W)	1 NM or less
	Airport Identifier (W)	5 NM or less
	Apron (gray)	5 NM or less

Symbol	Name	ND Range
	Construction Area (A)	2 NM or less
DE-ICE	Deicing area identifier (B, W)	1 NM or less
	Runway (gray)	5 NM or less
14L	Runway Identifier (B, W)	2 NM or less
	Closed Runway (A)	5 NM or less
	Stopway (gray)	5 NM or less
 H	Taxiway (gray)	5 NM or less
	Taxiway Identifier (B)	2 NM or less
	Taxiway hold line (A)	1 NM or less
	LAHSO line (A)	2 NM or less
	Parking (B)	0.5 NM or less
	Building (B)	5 NM or less
	Helipad identifier (B,W)	1 NM or less
	Service Road (gray)	2 NM or less
	Water (B)	5 NM or less

TCAS

For more information, refer to Chapter 15, Warning Systems.

Symbol	Name	ND Mode
TCAS OFF	TCAS mode (A)	MAP, MAP CTR, APP, VOR
TCAS FAIL	TCAS mode (A)	MAP, MAP CTR, APP, VOR
TA ONLY	TCAS mode (B)	All
TCAS TEST	TCAS mode (B)	All
TFC	TCAS mode (B)	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
OFFSCALE	TCAS off scale message (RA-R, TA-A)	MAP, MAP CTR, APP, VOR
+09 ◊ ↑	TCAS other traffic, relative altitude (W)	MAP, MAP CTR, APP, VOR
♦ ↓ -05	TCAS proximate traffic, relative altitude (W)	MAP, MAP CTR, APP, VOR
■ ↑ -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

Symbol	Name	ND Mode
TRAFFIC	TCAS traffic alert message (RA-R, TA-A)	All

Radar

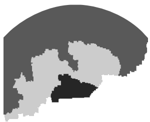
For more information, refer to Chapter 11, Flight Management, Navigation.

Symbol	Name	ND Mode
CAL	Antenna gain control failure (A)	MAP, MAP CTR, APP, VOR
ATT	IRS stabilization signal failure (A)	MAP, MAP CTR, APP, VOR
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
+5A	WXR antenna automatic tilt mode selected (B)	MAP, MAP CTR, APP, VOR
+5M	WXR antenna manual tilt mode selected (B)	MAP, MAP CTR, APP, VOR
AUTOTILT FAIL	Automatic tilt mode failure (A)	MAP, MAP CTR, APP, VOR
CNTL	WXR control panel failure (A)	MAP, MAP CTR, APP, VOR
+G2	WXR manual gain setting (MIN thru -/+ G levels thru MAX) (B)	MAP, MAP CTR, APP, VOR
WXR	WXR precipitation only mode (B)	MAP, MAP CTR, APP, VOR

Symbol	Name	ND Mode
R/T	WXR receiver transmitter failure (A)	MAP, MAP CTR, APP, VOR
TEST	Weather radar (WXR) test mode (A) (B)	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

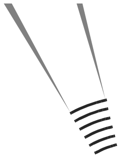
Look-Ahead Terrain

For more information, refer to Chapter 15, Warning Systems.

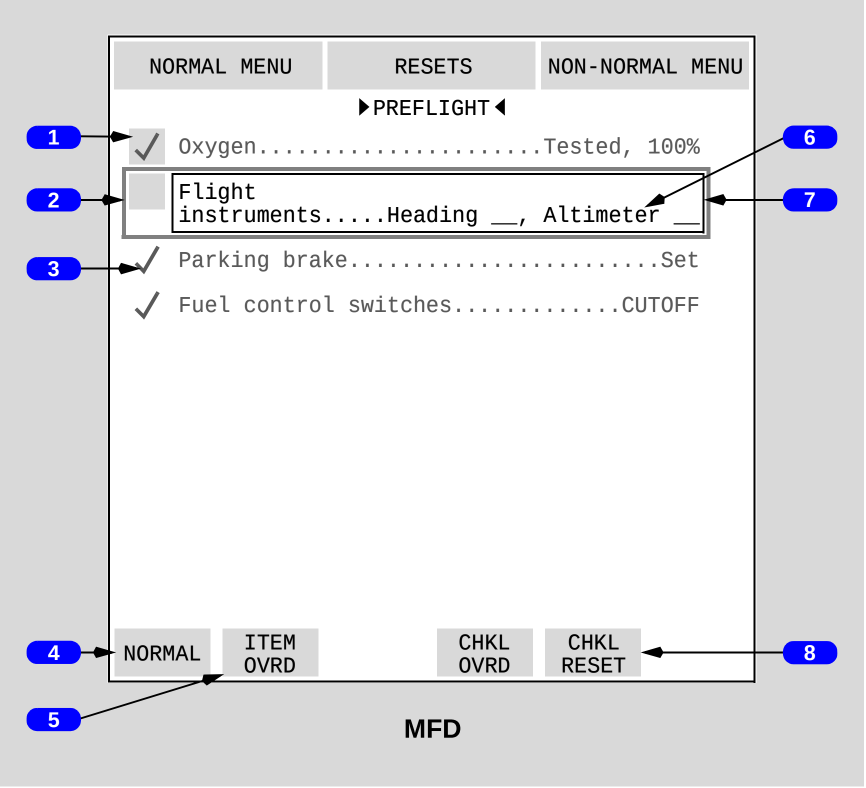
Symbol	Name	ND Mode
■	Obstacle display (R, A, G)	MAP, MAP CTR, APP, VOR
OBSTACLE	Obstacle annunciation (R, A)	All
TERRAIN	Terrain annunciation (R, A)	All
	Terrain display (R, A, G, M)	MAP, MAP CTR, APP, VOR
TERR OVRD	Terrain status annunciations (A)	MAP, MAP CTR, APP, VOR
TERR FAIL	Terrain status annunciations (A)	MAP, MAP CTR, APP, VOR
TERR POS	Terrain status annunciations (A)	MAP, MAP CTR, APP, VOR
TERR TEST	Terrain test mode annunciation (B)	All
TERR 060 030	Terrain mode annunciation (B) and highest and lowest terrain or obstacle altitudes (R, A, G, M)	MAP, MAP CTR, APP, VOR
MAP/TERR RANGE DISAGREE	Terrain range status annunciations (A)	MAP, MAP CTR
TERR RANGE DISAGREE	Terrain range status annunciations (A)	MAP, MAP CTR, APP, VOR

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

Normal Checklist



1 Open Loop Indicator

Indicates the line item is an open loop action item. Requires flight crew confirmation to become complete.

2 Cursor Selection Box

Highlights the cursor selection area.

3 Complete Indicator

Indicates the line item is complete.

4 Normal Checklist (NORMAL) Key

Select -

- shows the next incomplete normal checklist
- shows normal checklists menu page when all normal checklists are complete

5 Line Item Override (ITEM OVRD) Key

Select - overrides the line item in the current line item box. Item shows cyan.

6 Action Item

Shows (white) - the action item is incomplete.

Shows (green) - the action item is complete.

Shows (cyan) - the action item is inactive or overridden.

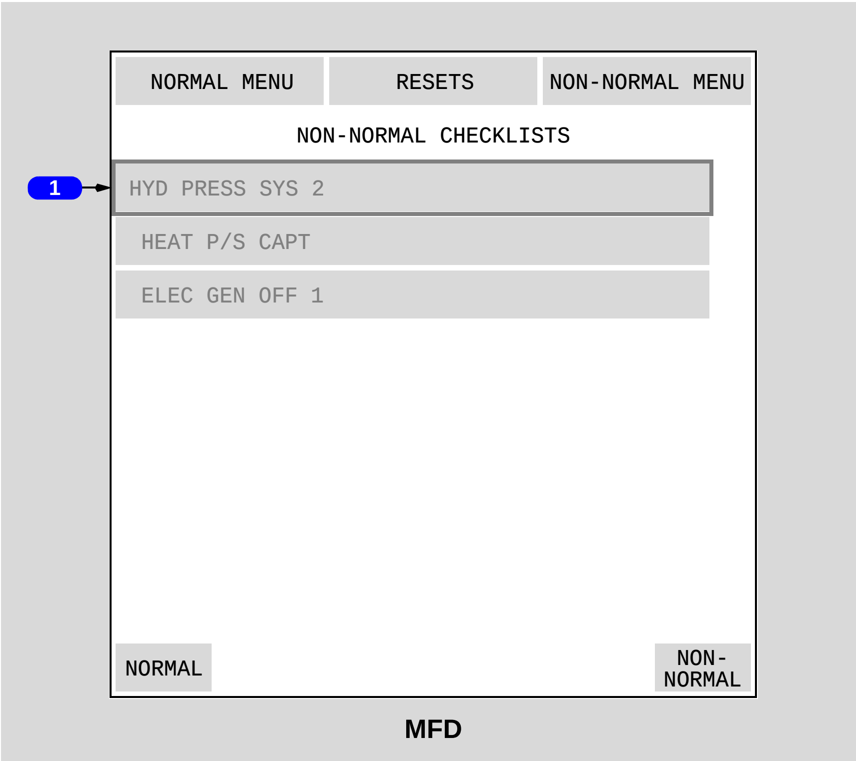
7 Current Line Item Box

Highlights the current incomplete line item.

8 Checklist Reset (CHKL RESET) Key

Select - starts the current checklist from the beginning. All line items become incomplete and the current line item box and the cursor selection box move to the first incomplete line item.

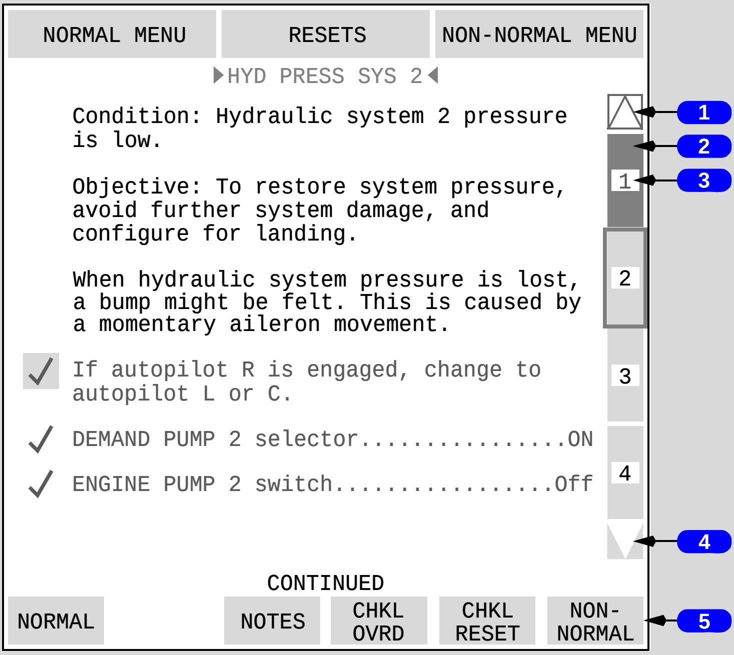
Non-Normal Checklist Queue



1 Checklist Key

Select - shows the checklist for the title on the key.

Non-Normal Checklist



MFD

1 Previous Page Key

Select - shows the previous checklist page.

Shows (gray) - the previous page is available.

Shows (cyan) - the key is inactive. The first page of the checklist is shown.

2 Checklist Page Key

Select - shows the checklist page corresponding to the page number on the key.

Shows (white) - the checklist page corresponding to the page number on the key is currently shown.

Shows (gray) - the checklist page corresponding to the page number on the key is not currently shown.

3 Checklist Page Number

Shows (white) - the checklist page is incomplete.

Shows (green) - the checklist page is complete.

4 Next Page Key

Select - shows the next checklist page.

Shows (gray) - the next page is available.

Shows (cyan) - the key is inactive. The last page of the checklist is shown.

5 Non-Normal Checklist (NON-NORMAL) Key

Shows when there are additional incomplete non-normal checklists in the checklist queue.

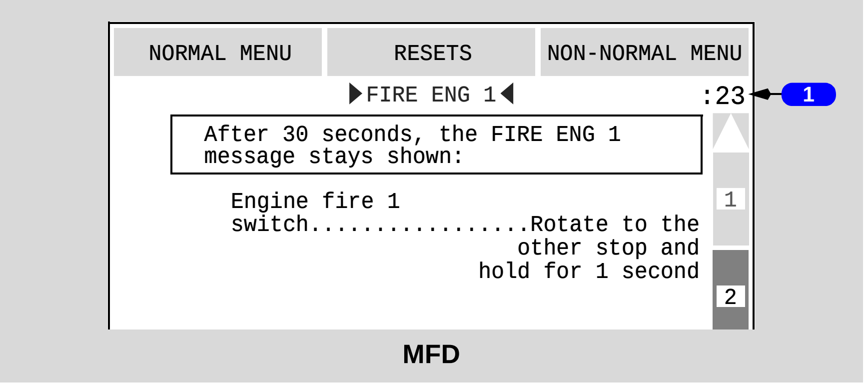
Select -

- shows the next incomplete non-normal checklist when one incomplete non-normal checklist is in the checklist queue
- shows the non-normal checklist queue when more than one incomplete non-normal checklist is in the checklist queue

Shows (white) - an incomplete non-normal checklist has not been shown.

Shows (amber) - an incomplete non-normal checklist has been shown but is not currently shown.

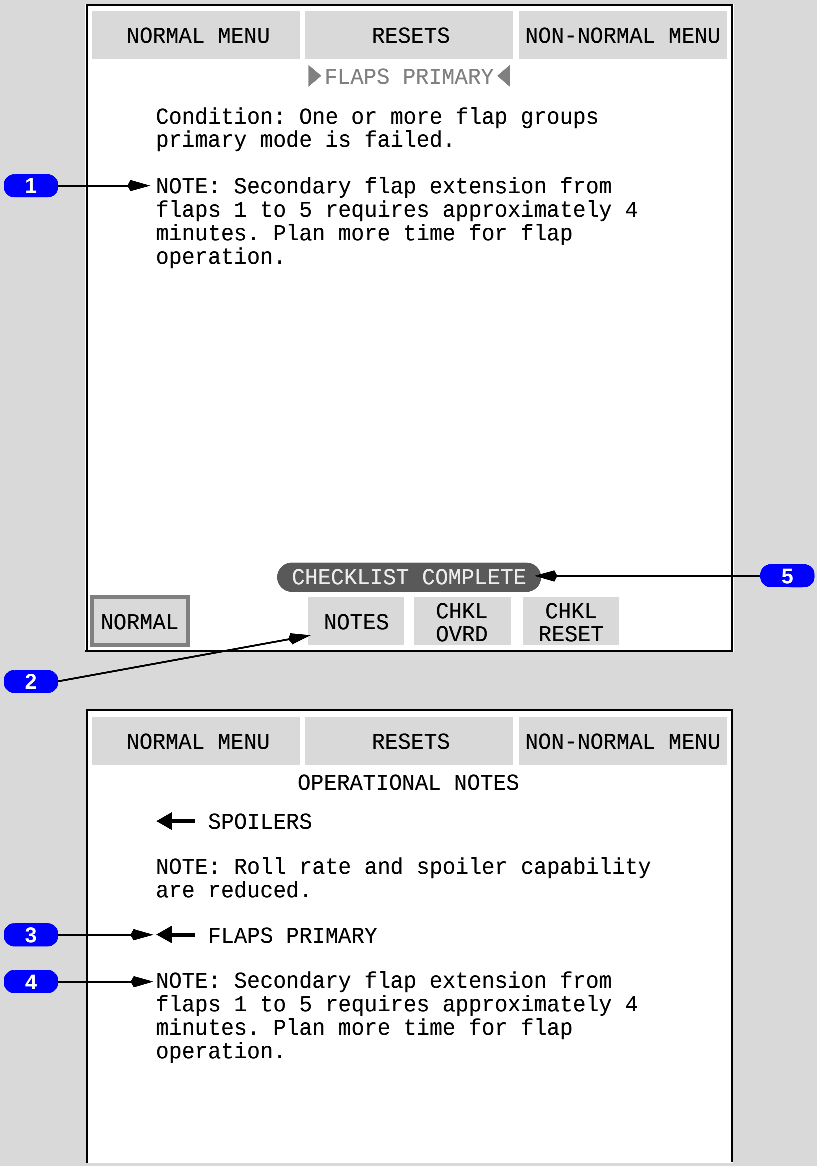
Checklist Timer



1 Timer

Shows the time remaining of a time delay for the current line item. If the line item is complete, the current line item box stays on the line item until the timer expires.

Operational Note



MFD

1 Operational Notes

Shown in a non-normal checklist.

2 Operational Notes (NOTES) Key

Select - shows the operational notes page.

3 Checklist Reference

Indicates the non-normal checklist from which operational notes originated.

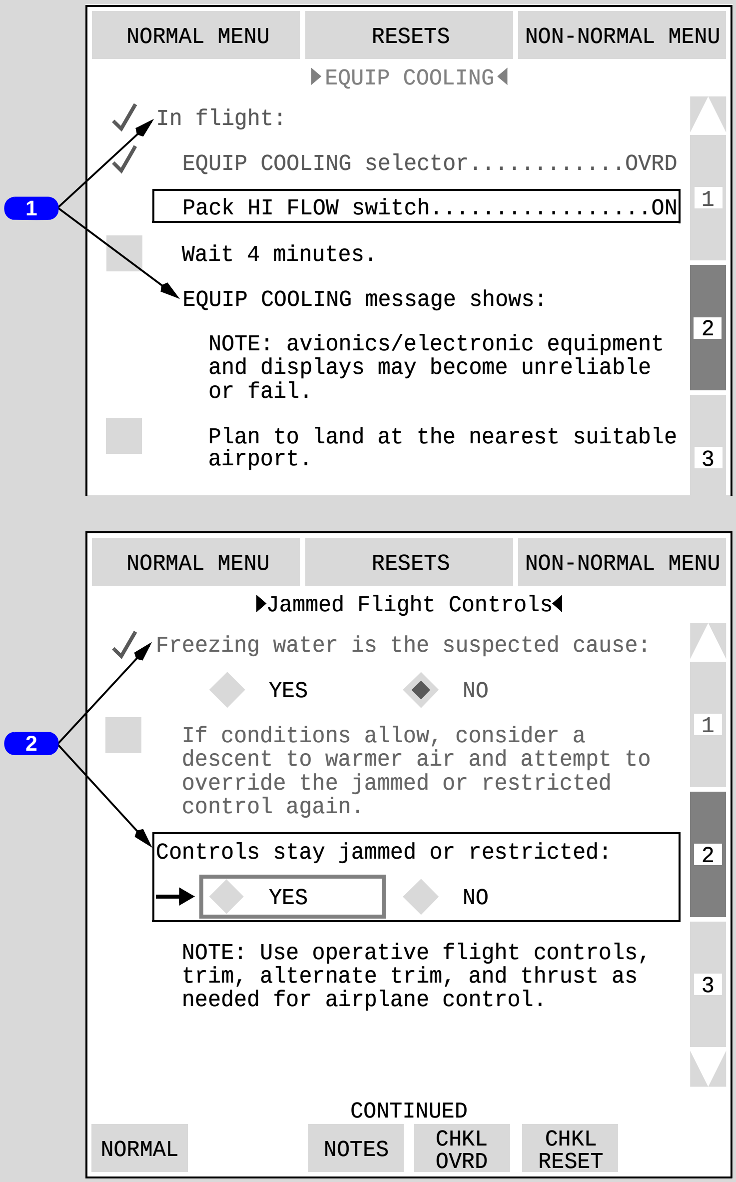
4 Operational Notes

Shown on the operational notes page.

5 CHECKLIST COMPLETE Indicator

Shows when all of the line items are either complete, inactive, or overridden, and all the pages have been shown.

Conditional Line Item



MFD

1 Closed Loop Conditional Line Items

Shows (white) - the conditional line item is incomplete.

Shows (cyan) - the conditional line item is sensed false. All line items indented below the conditional line item become inactive and show cyan. The current line item box and cursor selection box skip the inactive items and move to the next incomplete line item.

Shows (green) - the conditional line item is sensed true. The current line item box and cursor selection box move to the next incomplete line item.

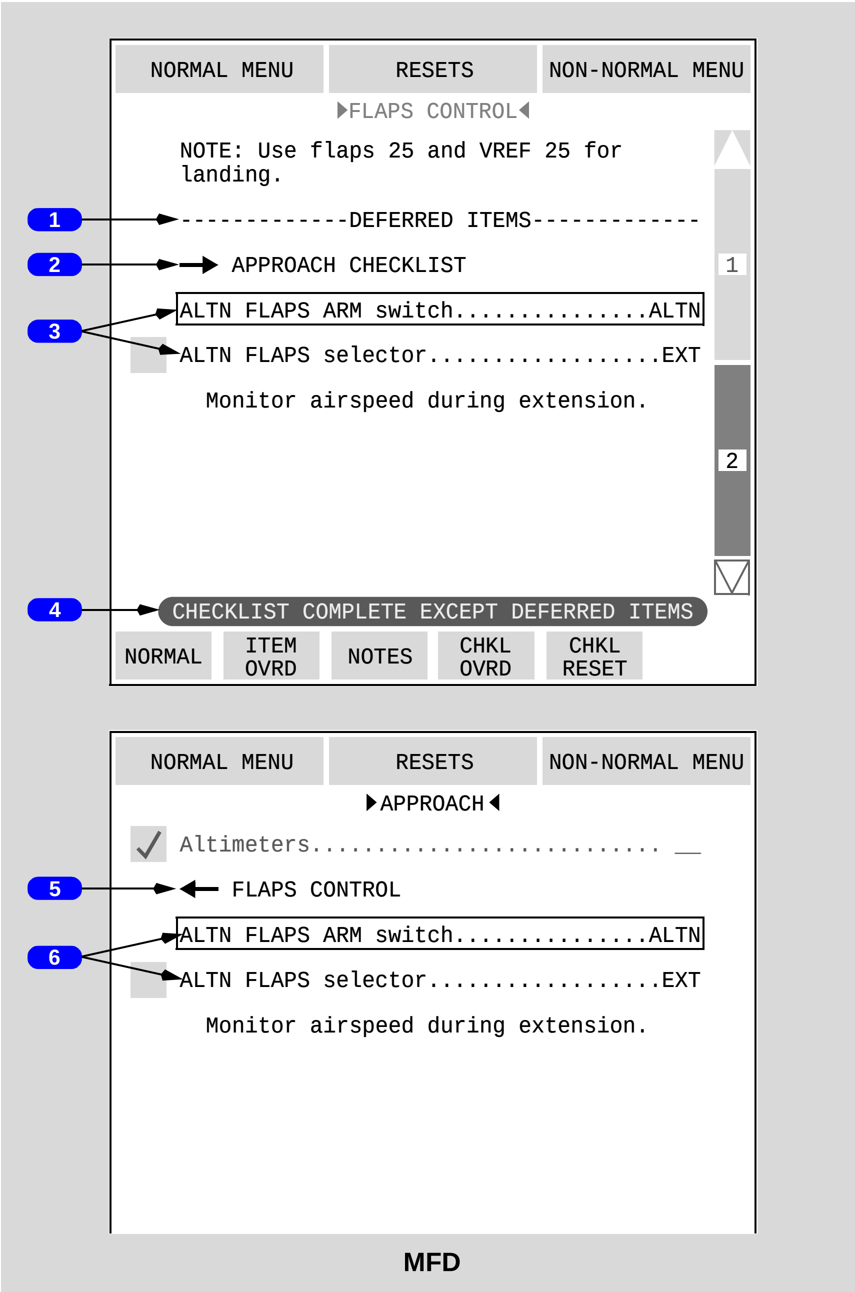
2 Open Loop Conditional Line Items

Shows (white) - the conditional line item is incomplete.

Shows (cyan) - the conditional line item is selected NO. All line items indented below the conditional line item become inactive and show cyan. The current line item box and cursor selection box skip the inactive items and move to the next incomplete line item.

Shows (green) - the conditional line item is selected YES. The current line item box and cursor selection box move to the next incomplete line item.

Deferred Line Item



1 **Deferred Line Items Separator**

Separates deferred line items from non-normal checklist line items. All the line items below the separator are deferred.

2 **Checklist Reference**

Indicates the normal checklist to which deferred line items go.

3 **Deferred Line Items**

Shown in a non-normal checklist.

4 **CHECKLIST COMPLETE EXCEPT DEFERRED ITEMS Indicator**

Shows when all line items except deferred line items are either complete, inactive, or overridden, and all pages before the deferred line items separator have been shown.

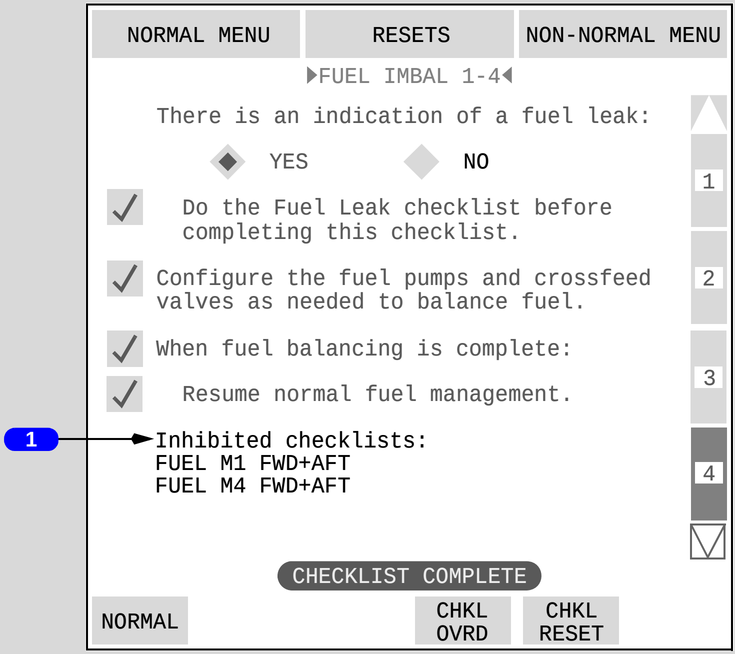
5 **Checklist Reference**

Indicates the non-normal checklist from which deferred line items originated.

6 **Deferred Line Items**

Shown in a normal checklist.

Inhibit Checklist Line Item

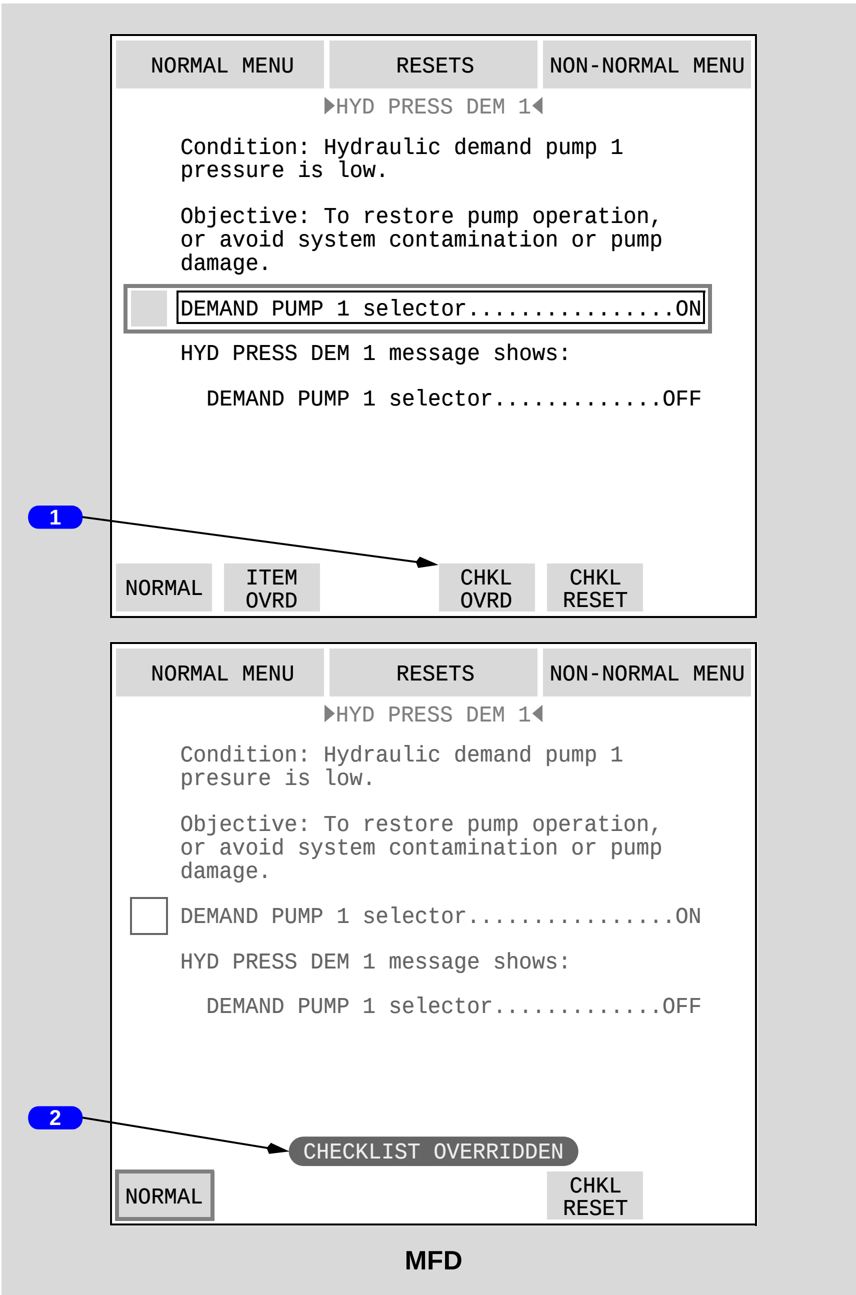


MFD

1 Inhibit Checklist Line Item

Shows checklists which are inhibited or removed from the checklist queue and whose checklist icons are inhibited or removed from the EICAS display.

Checklist Override



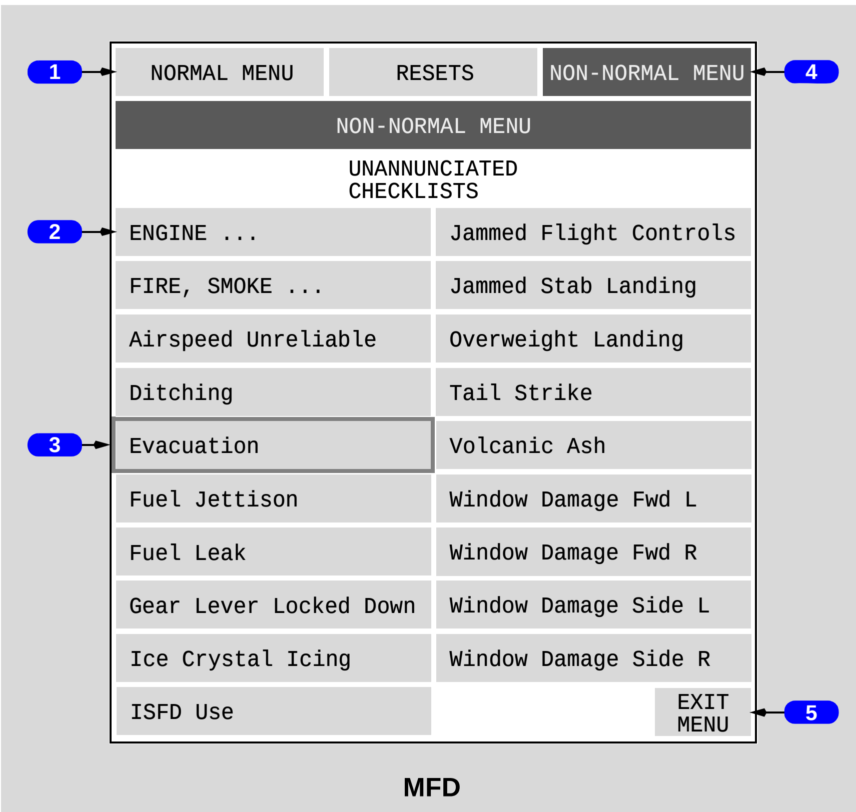
1 Checklist Override (CHKL OVRD) Key

Select - overrides the current checklist.

2 CHECKLIST OVERRIDDEN Indicator

Shows when the checklist is overridden. All the line items show cyan.

Checklists Menu Page



1 Normal Menu (NORMAL MENU) Key

Select - shows the normal checklists menu. The menu contains checklist keys for the normal checklists.

2 Menu Key

Indicated by three dots after the menu title.

Select - shows the checklists menu page for the title on the key.

3 Checklist Key

Select - shows the checklist for the title on the key.

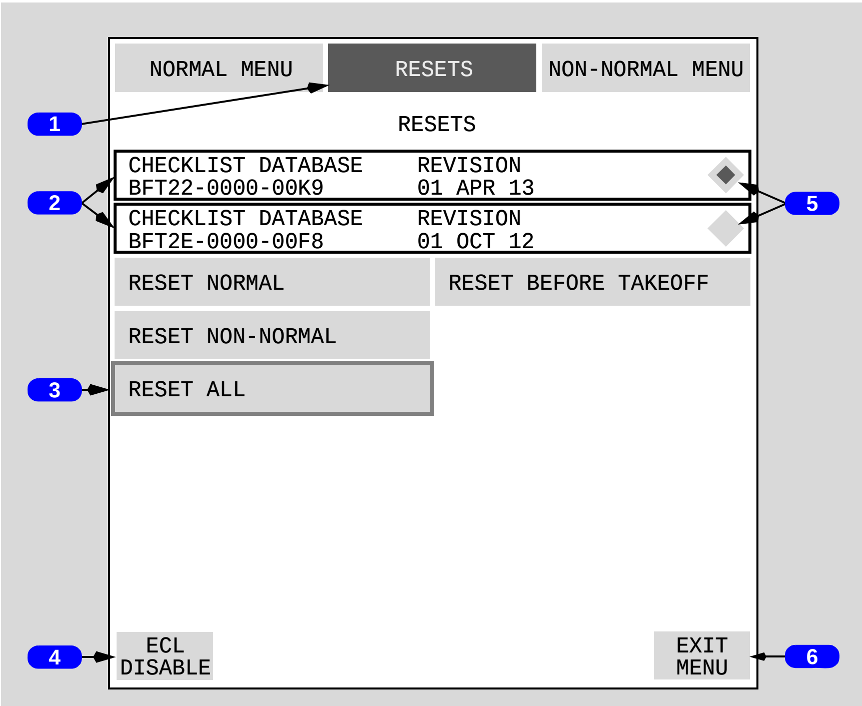
4 Non-Normal Menu (NON-NORMAL MENU) Key

Select - shows the non-normal checklists menu page. The page contains menu keys for the airplane systems.

5 Exit Menu (EXIT MENU) Key

Select - exits page for access to the normal and non-normal checklist keys.

Resets Menu Page



MFD

1 Resets Menu (RESETS) Key

Select - shows the checklist resets page.

2 Database Selection Keys

Select -

- activates associated checklist database
- selection is only available on the ground

Shows (white) - the database is available for selection.

Shows (cyan) - the key is inactive. Database is inhibited from selection or database is invalid.

3 Reset Key

Select - resets checklists corresponding to the title on the key. All affected checklists become incomplete.

4 Electronic Checklist Disable (ECL DISABLE) Key

Select -

- disables the electronic checklist. Performed by maintenance
- selection is only available on the ground

Shows (white) - the electronic checklist can be disabled.

Shows (cyan) - the key is inactive.

5 Active Database Indicators

Shows (green) - the database is active.

Shows (gray) - the database is inactive.

6 Exit Menu (EXIT MENU) Key

Select - exits page for access to the normal and non-normal checklist keys.

Flight Instruments, Displays — Chapter 10

Electronic Checklist Description — Section 60

Introduction

The electronic checklist (ECL) system shows normal and non-normal checklists on a multifunction display (MFD). The electronic checklist system is not required for dispatch, and a paper checklist or other approved backup checklist must be available on the flight deck.

The checklist display switch on the display select panel opens the electronic checklist. The flight crew operates the checklist with one of the two cursor controls. Cursor controls and MFD selection are described in the System Description section of this chapter.

Electronic Checklist Operation

Pushing the checklist display switch on the display select panel shows the correct checklist (see Checklist Priority, this section, for the checklist priority order). Only one checklist can show at a time.

Three types of checklists can show:

- normal
- non-normal for an EICAS message (annunciated)
- non-normal for a condition without an EICAS message (unannunciated)

After each normal checklist is complete, pushing the checklist display switch twice or selecting the normal key shows the next normal checklist in sequence.

Some checklist steps must be checked off by the flight crew to show as complete. Other checklist steps are automatically checked off from sensed flight deck control positions, airplane system status, or EICAS messages.

Checklist Pages

A checklist can have one or more pages. If a checklist is longer than one page, page keys show on the right side of the page.

When a checklist has more than one page and the line items on the current page are complete, the cursor selection box moves to the checklist page key for the next page. CONTINUED shows at the bottom of the page. Pushing the cursor select switch shows the next checklist page.

When a checklist is complete and there are no additional checklists in the non-normal checklist queue, the cursor selection box automatically moves to the normal checklist key in the lower left corner of the page. Pushing the cursor select switch shows the next normal checklist in sequence. If there are checklists in the non-normal queue, the cursor selection box moves to the non-normal key in the lower right corner of the page. Pushing the cursor select switch shows the next non-normal checklist (if only one is in the queue) or the non-normal checklist queue.

Checklist Status

The checklist complete indicator shows at the bottom of all pages of the checklist when all of the line items are either complete, inactive, or overridden, and every page has been shown. If the flight crew chooses not to do a line item, the line item can be overridden with the line item override key at the bottom of the page. When a line item is overridden, the text changes color to cyan and the current line item box moves down to the next incomplete line item. If the flight crew chooses to not complete a checklist, the checklist can be overridden by selecting the checklist override key at the bottom of the page. When a checklist is overridden, the text of the entire checklist changes color to cyan, and the checklist overridden indicator shows at the bottom of all pages.

Checklist Line Items

A checklist has one or more line items. These are the types of line items:

- free text
- action item
- operational note
- conditional
- inhibit checklist
- additional information

Free text items show text and have no further function. The other line item types are described below.

Incomplete line items have white text. Complete line items have green text with a complete indicator (a green check mark) to the left. Overridden and inactive line items have cyan text.

When the checklist is opened, the current line item box moves to the first incomplete line item and the cursor selection box encloses the current line item box. When the line item becomes complete the cursor selection box, and the current line item box move to the next incomplete line item.

Action Items

Each step in a checklist that requires a flight crew action is an action item. There are two types of action items: closed loop and open loop.

Closed Loop Action Items

Closed loop action items continuously monitor the position of a flight deck switch, lever, or selector. In a few cases, actual system state, such as flap or landing gear position, is monitored. When the control is in the required position, the action item color changes to green and the complete indicator shows to the left of the action item. The current line item box then moves to the next incomplete line item.

Open Loop Action Items

Open loop action items require the flight crew to manually confirm completion with the cursor control. Open loop action items do not monitor control position or system state. Open loop action items look different from closed loop action items. Open loop action items have an open loop indicator, a gray box to the left of the line item. When the cursor selection box is enclosing the current line item box and open loop indicator, and the cursor select switch is pushed, the action item color changes from white to green and a complete indicator shows on the open loop indicator. The current line item box then moves to the next incomplete line item.

Operational Notes

Operational notes are for the ongoing consequences of a non-normal condition, such as inoperative equipment or operational limitations. The flight crew should read all operational notes, but the current line item box does not stop on an operational note because no immediate flight crew action is required. Operational notes have white text, unless inactive or overridden.

The operational notes page stores active operational notes for easy access and review by the flight crew later in flight. After a non-normal checklist that has operational notes is opened, the operational notes are available for the rest of the flight on the operational notes page. Access to the operational notes page is by the operational notes key at the bottom of the checklist page. Operational notes on the operational notes page have a checklist reference with the title of the checklist from which they came.

If there is more than one page of operational notes, page keys show.

The status of an operational note is based on the status of the EICAS message for the checklist with the note. If the EICAS message blanks, unneeded notes can also blank from the notes page.

Conditional Line Items

Conditional line items control the path through a complex checklist. The current line item box steps through line items or it skips line items based on a condition.

There are two types of conditional line items: open loop and closed loop.

Open Loop Conditional Line Items

Open loop conditional line items have choices labeled YES and NO. When the conditional line item becomes the current line item, the cursor selection box moves to the YES - NO line. The flight crew uses the cursor control to select the correct answer.

If the flight crew selects YES, the line items indented below the conditional line item become active. The current line item box moves to the first incomplete line item.

If the flight crew selects NO, the line items indented below the conditional line item become inactive and change color to cyan. The current line item box skips the inactive items. Inactive operational notes are removed from the operational notes page. Inactive deferred line items are removed from their normal checklist. Inactive inhibit checklist line items have no effect.

The YES - NO choices remain available after a selection is made. The flight crew can change selections at any time.

A group of two or more open loop conditional line items can be a mutually exclusive set. When the flight crew selects YES on any one of the items in the exclusive set, all of the other items are automatically set to NO. However, the opposite is not true. If all but one of the items are selected NO, the last item is not automatically set to YES, and the current line item box returns to the first conditional in the exclusive set. The flight crew must manually select YES on one of the conditional line items in the exclusive set.

Closed Loop Conditional Line Items

A closed loop conditional line item works the same as an open loop item except the choice is made automatically based on a monitored flight deck control, an EICAS message, or an airplane system state. If the condition is true, the conditional line item changes color to green and the line items indented below it become active. If the condition is false, the conditional line item and the line items indented below it become inactive and change color to cyan. The current line item box skips the inactive items.

Inhibit Checklist Line Items

One airplane system failure can cause more than one EICAS alert message (a primary message and one or more consequential messages). The flight crew should do the checklist for the primary message not the consequential messages. Inhibit checklist line items remove unneeded non-normal checklists (consequential checklists) from the checklist queue.

Consequential EICAS alert messages can show for a primary failure condition. For example, the SPOILERS message shows due to a HYD PRESS SYS 2 condition. Consequential EICAS alert messages can also show due to flight crew actions in a non-normal checklist. For example, the APU message shows when the flight crew selects the APU off in the FIRE APU checklist. An inhibit checklist line item in the primary checklist inhibits the consequential checklists.

The inhibit checklist line item shows the consequential checklists which are inhibited. The inhibit has the following effects on a consequential checklist:

- the checklist icon is removed from the consequential EICAS message
- the consequential checklist is removed from the checklist queue
- operational notes from the consequential checklist are removed from the operational notes page
- deferred line items are removed from the normal checklists

If a consequential checklist has steps, notes, and information that are needed for the primary failure condition, then these are included in the primary checklist.

An inhibit checklist line item becomes active when the message for the primary condition shows, before its checklist is opened.

In the paper checklist, an inhibit checklist line item shows as "Do not accomplish the following checklist".

Deferred Line Items

Deferred line items are items that are part of a non-normal checklist, but must be done later in the flight, usually during approach.

When a non-normal checklist that has deferred line items is opened, the deferred line items are automatically added to the end of a normal checklist. Deferred line items in a normal checklist have a checklist reference with the title of the checklist from which they came. Any type of line item can be a deferred line item.

A non-normal checklist that has deferred line items is complete when all line items before the deferred line items are complete. The checklist complete except deferred items indicator shows at the bottom of the page.

If the non-normal condition occurs after completion of the normal checklist that would get the deferred line items, the non-normal checklist is complete when all line items, including the deferred line items, are complete.

Timers

Timers help the flight crew keep track of time delays that are part of checklists. The timer shows in the upper right hand corner of the checklist page. All timers are countdown timers. Timers can be part of action items or conditional line items.

A timer on a line item starts when the line item just before it is complete. Timers run in the background. This allows the flight crew to leave the checklist to accomplish other tasks and then return to the checklist. Timers are white when they are running. When the timer is done, it shows ":00" and the color changes to amber.

The current line item box does not move to the next incomplete line item until the line item with the timer is complete and the timer is done.

Additional Information

Additional information is provided for some checklists. It is located at the very end of the associated non-normal checklist. Viewing the information is not required to complete the checklist.

Additional information items also show on the operational notes page. Operational notes and additional information from the same checklist will show under the same checklist title, with the additional information showing after the notes.

Precautionary Text

Precautionary text is critical information which should be read before completing certain non-normal checklist actions. Precautionary text shows directly above the associated line item.

Checklist Menu Operation

Usually, the flight crew uses the checklist display switch on the display select panel and the normal and non-normal keys to select checklists. Checklists can also be selected and opened with menus. The normal menu, the resets page, and the non-normal menu can be selected with the keys at the top of the checklist page, using the cursor control.

An exit menu key is in the lower right corner of all menu pages. This exits the menu page to allow access to the normal and non-normal checklist keys.

Normal Menu

Normal checklists are on the normal menu in the sequence they are completed in a normal flight.

Non-Normal Menu

The non-normal menu has submenus by airplane system. An airplane system submenu has the checklists for that system. If a system has more checklists than can fit on a page, additional submenus group checklists by name. Submenu titles end with "...".

Resets Page

The resets page shows the checklist database part number and revision information and the following manual resets:

- RESET NORMAL
- RESET NON-NORMAL
- RESET ALL

Other manual resets can also be on this page. These can reset more than one checklist. See Checklist Resets in this section.

Note: RESET NORMAL, RESET NON-NORMAL, and RESET ALL are intended for ground use only. If they are used in flight, RESET NON-NORMAL and RESET ALL will reset completed non-normal checklists, requiring the crew to start the checklists over. It can also cause needed operational notes and deferred line items to be lost.

Dual Database

The dual database feature allows two ECL databases to be available. The flight crew can select either database on the RESETS menu using the cursor control. A green diamond shows the active database. The flight crew can select either ECL database on the ground. The database selection keys are inhibited in flight. Changing the active ECL database also resets all checklists.

Checklist Priority

Air/ground logic, fuel control switch and start switch position, and EICAS message level determine the priority for checklists when the checklist display switch is pushed.

On the ground with all fuel control switches in CUTOFF and all engine start switches not pulled, the priority is:

- checklists for EICAS warning messages
- NORMAL checklists (incomplete or not yet opened)

On the ground with any fuel control switch in RUN, or any engine start switch pulled; or in the air, the priority is:

- checklists for any EICAS alert messages that have icons
- incomplete unannunciated checklists
- NORMAL checklists

Normal Checklists

Normal electronic checklists are used the same way as paper checklists. The flight crew does the normal procedures from memory, then they read the checklist to confirm the actions.

Normal Checklist Access

The checklist sequence is:

- PREFLIGHT
- BEFORE START
- BEFORE TAXI
- BEFORE TAKEOFF
- AFTER TAKEOFF
- DESCENT
- APPROACH
- LANDING
- SHUTDOWN
- SECURE

When each normal checklist is complete, the normal checklist key shows the next incomplete normal checklist in the sequence.

The flight crew can open any normal checklist from the normal menu. If a completed normal checklist is opened from the menu, it is reset.

Normal Checklist Completion

When all of the line items in a checklist are complete, the checklist complete indicator (white text on a green background) shows at the bottom of the checklist page.

When a checklist is overridden, the checklist overridden indicator (white text on a cyan background) shows at the bottom of the checklist page.

Incomplete Normal Checklist Alerting

The EICAS caution message CHKL INCOMPLETE NORM shows to alert the crew when a critical normal checklist is not complete before the next phase of flight begins. Three normal checklists can cause the message to show. Also, the normal checklist key changes color to amber to show that one or more normal checklists is incomplete.

These are the three alerts:

- Before Takeoff Alert - Occurs if the BEFORE TAKEOFF checklist is not complete and the airplane is on the FMC takeoff runway, aligned for takeoff
- Approach Alert - Occurs if the APPROACH checklist is not complete, the airplane descends through the FMC transition level, and flaps are not in UP
- Landing Alert - Occurs if the LANDING checklist is not complete, and the airplane descends below 800 feet (or 500 feet by airplane option) above the FMC landing runway

The CHKL INCOMPLETE NORM message shows until the normal checklist is complete or overridden. The checklist icon shows with the CHKL INCOMPLETE NORM message to alert the flight crew to open the checklist, but there is no non-normal checklist for this EICAS message.

Non-Normal Checklists

Non-normal electronic checklists are used the same way as paper checklists. Non-normal checklists are done by read-and-do. If a checklist has memory steps, the flight crew does those steps before opening the checklist.

Non-Normal Checklist Access and Checklist Icon

Usually, the flight crew opens annunciated non-normal checklists by pushing the checklist display switch. Any non-normal checklist can be opened using the non-normal menu.

EICAS messages determine which non-normal checklist shows automatically. If the checklist for an EICAS alert message has not been opened or is incomplete, the message has an icon, a white box to the left of the message (See section 10.50 for information about the checklist icon).

If an EICAS alert message has no icon, the checklist is complete, there is no checklist for the message, or another checklist inhibits the icon.

If one EICAS alert message with an icon shows, pushing the checklist display switch shows the checklist for that message. If more than one EICAS alert message with an icon shows, pushing the checklist display switch shows a list with the non-normal checklist queue. If there are more than ten checklists in the queue, the queue has more than one page.

Checklists in the queue are in the same order as the messages show on EICAS. If there are any active unannunciated checklists, they show in the queue after all of the annunciated checklists.

When an EICAS alert message shows, its checklist automatically goes into the queue. When the checklist is complete, the EICAS alert message can still show, but the checklist is removed from the queue. A checklist is also removed from the queue when it is inhibited by another checklist that becomes active.

The flight crew uses the cursor control to select a checklist from the queue. When a checklist is open, the non-normal checklist key returns to the queue if there are other non-normal checklists in the queue.

If EICAS alert messages show or blank while the checklist queue is shown, the queue does not change automatically. The flight crew must exit the queue and open it again to see the checklists for the new EICAS messages.

Non-Normal Unannunciated Checklists

Non-normal checklists for conditions that do not have EICAS messages are unannunciated checklists. Unannunciated checklists can be opened only from menus. UNANNUNCIATED CHECKLISTS is the first submenu on the non-normal menu. This submenu provides quick access to all unannunciated checklists.

When an unannunciated checklist is opened, it remains in the checklist queue until it is complete.

If the flight crew opens an unannunciated checklist and chooses not to complete it, the checklist must be overridden.

Non-Normal Checklist Completion

When all of the line items in a checklist are complete or inactive, the checklist complete indicator (white text on a green background) shows at the bottom of the checklist page.

When all of the line items in a checklist are complete or inactive, except for the deferred items, the checklist complete except deferred items indicator (white text on a green background) shows at the bottom of the checklist page.

When a checklist is overridden, the checklist overridden indicator (white text on a cyan background) shows at the bottom of the checklist page.

If a checklist is opened and not completed, then another checklist is opened, the text in the non-normal checklist key changes color to amber.

Hidden Non-Normal Checklist Alerting

The EICAS advisory message CHKL NON-NORMAL shows when there is a non-normal checklist in the queue, its EICAS message is blank, and ECL is not open. The CHKL NON-NORMAL message alerts the flight crew to open ECL and complete the checklist. The message blanks when ECL is opened.

The hidden checklist condition usually occurs when the flight crew completes checklist memory items (for example, in response to an engine fire) that cause the EICAS message to blank, but there is still a checklist in the queue that must be completed. It also occurs when an unannunciated checklist is partially completed, then ECL is closed.

The checklist icon shows with the CHKL NON-NORMAL message to alert the flight crew to open the checklist, but there is no non-normal checklist for this EICAS message.

Checklist Resets

If a checklist is complete or partially complete and the flight crew wishes to begin the checklist again, the checklist can be reset. Selecting the checklist reset key at the bottom of the page resets the checklist: all action items and conditionals become incomplete. The current line item box moves to the first incomplete line item.

For some conditions, such as go-around, resets set the normal checklists back to a previous phase of flight. There are automatic resets and manual resets.

Normal Checklist Automatic Reset Conditions

Automatic checklist resets occur for the following conditions:

- Go-Around - if the airplane is in the air, the landing gear is not up, and TO/GA is selected, then all normal checklists beginning with the AFTER TAKEOFF checklist automatically reset
- Touch-and-Go - if the airplane has transitioned from air to ground, takeoff thrust is reached with ground speed greater than 80 knots, and the thrust reversers not deployed, then all normal checklists beginning with the AFTER TAKEOFF checklist automatically reset
- Normal Menu Selection - if a previously completed normal checklist is opened from the normal menu, it automatically resets

Normal Checklist Manual Resets

The following manual resets are available for normal checklists:

- Reset Normal - the RESET NORMAL key resets all normal checklists. The flight sequence begins again
- Individual Checklist Reset - the checklist reset key at the bottom of a checklist page resets the current checklist. The checklist can be started again

Non-Normal Checklist Manual Resets

The following manual resets are available for non-normal checklists:

- Reset Non-Normal - the RESET NON-NORMAL key resets all non-normal checklists. Icons show on any active EICAS messages with checklists that were previously completed. Use of the RESET NON-NORMAL function in flight is not recommended
- Individual Checklist Reset - the checklist reset key at the bottom of a checklist page resets the current checklist. The checklist can be started again

Manual Reset All

The RESET ALL key resets all normal and non-normal checklists. The flight sequence begins again for normal checklists. Icons show on any active EICAS messages with checklists that were previously completed. Use of the RESET ALL function in flight is not recommended.

Overrides

There are two types of override functions: item override and checklist override.

Item Override

The flight crew uses item override when they choose not to complete an action item. If the action has been done but the closed-loop sensing does not show the action item as complete, the flight crew can override the action item. This allows the checklist to be complete.

The line item override key is available on all checklists. When an item is overridden the color changes to cyan. Closed loop and open loop action items can be overridden.

Conditional line items (open loop or closed loop) cannot be overridden. Action items indented below a conditional line item can be overridden.

Checklist Override

The flight crew uses checklist override when a checklist in the non-normal queue will not be completed or if the flight crew opens a checklist from a menu but chooses not to complete it.

The checklist override key overrides the current checklist. All of the line items change color to cyan. The checklist overridden indicator shows at the bottom of the page. For a non-normal checklist, all of its operational notes are removed from the operational notes page, deferred line items are removed from their normal checklists, and inhibit checklist line items become inactive.

Electronic Checklist System Inoperative

If the checklist display switch is pushed and the electronic checklist system is inoperative, the message CHECKLIST NOT AVAILABLE shows on the MFD. If the electronic checklist system has been disabled by maintenance, the message CHECKLIST DISABLED shows on the MFD.

When the electronic checklist system is inoperative or disabled, checklist icons do not show with any EICAS messages.

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EICAS Alert Messages

Note: OVERSPEED warning and ALTITUDE ALERT caution messages are covered in Chapter 15, Warning Systems.

Message	Level	Aural	Message Logic
ADC LEFT, CENTER, RIGHT	Advisory		An air data computer is failed.
ADC SEL CAPT	Advisory		The captain's air data source selector is failed.
ADC SEL CENTER	Advisory		The center air data selector is failed.
ADC SEL F/O	Advisory		The first officer's air data source selector is failed.
ALT DISAGREE	Caution	Beeper	The captain's and first officer's uncorrected altitude indications disagree by more than 200 feet.
ATTITUDE	Caution	Beeper	The captain's and first officer's attitude indications disagree.
BARO DISAGREE	Advisory		The captain's and first officer's barometric settings disagree.
CHKL INCOMP NORM	Caution	Beeper	A normal checklist from the current phase of flight is not complete.
CHKL NON-NORMAL	Advisory		The ECL is not displayed and there are checklists in the queue without an associated EICAS message displayed, or there are unannunciated checklists in the accessed state.

Message	Level	Aural	Message Logic
EFIS CONTROL L, R	Advisory		One of these occurs: • The EFIS control panel is failed • CDU control of the EFIS control panel is used
EFIS/EICAS C/P	Advisory		One of these occurs: • Both EFIS control panels and the display select panel are failed • CDU control of both EFIS panels and the display select panel is used
EIU LEFT	Advisory		The left EFIS/EICAS interface unit is failed.
HEADING	Advisory		The captain’s and first officer’s selected IRS heading outputs disagree by 4 degree es or more.
IAS DISAGREE	Caution	Beeper	Captain and First Officer airspeed indicators disagree by five knots or more.
SNGL SOURCE GLS	Caution	Beeper	Both pilots’ displays referenced to the same GLS receiver.
SNGL SOURCE ILS	Caution	Beeper	Both pilots’ displays referenced to the same ILS receiver.
SNGL SOURCE RA	Advisory		Both primary flight displays use the same radio altimeter source.
SOURCE SEL ADC	Advisory		Both PFDs use the same air data source.
SOURCE SEL EIU	Advisory		Both pilots’ displays use the same EFIS/EICAS interface unit source.
SOURCE SEL F/D	Advisory		Both primary displays use the same flight director source.
SOURCE SEL IRS	Advisory		Both pilots’ displays use the same IRS source.

Message	Level	Aural	Message Logic
SOURCE SEL NAV	Advisory		Both pilots' displays use the same FMC source.
TAT DISAGREE	Advisory		Engine TAT and airplane TAT disagree.
TRACK	Advisory		The captain's and first officer's selected track outputs disagree by 6 degrees or more.

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Flight Management, Navigation — Chapter 11
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Deferred Systems Content

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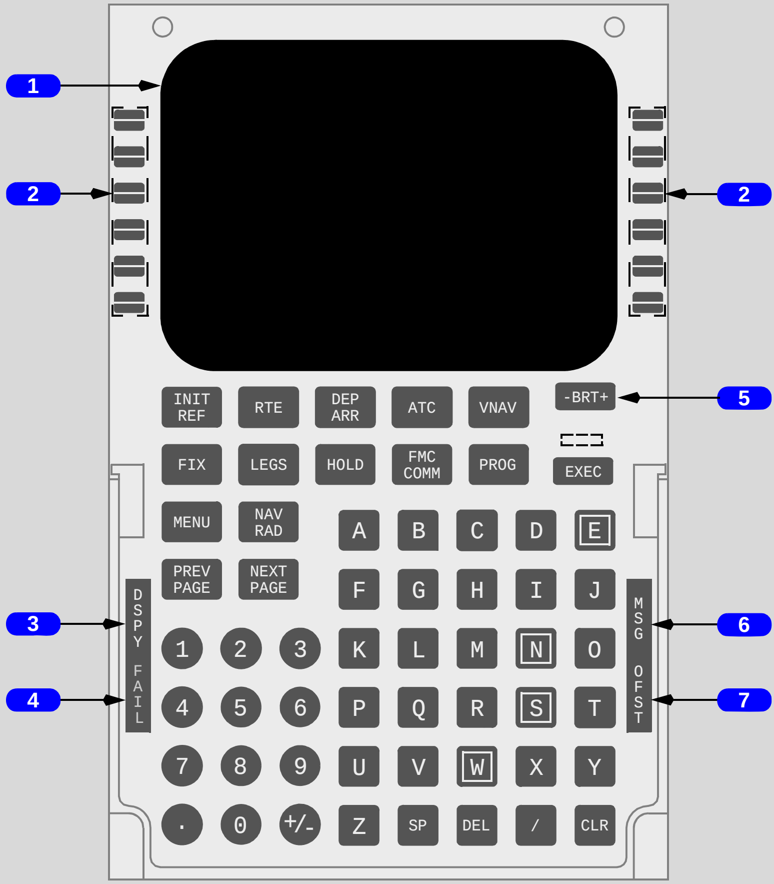
This section contains deferred systems description content.

Deferred content is printed with strike-through text. For example, ~~shaded white.~~

Flight Management System Control Display Unit (CDU)



FORWARD AISLE STAND PANEL

1 Control Display Unit (CDU) Display

Displays FMS data pages.

2 Line Select Keys

Push -

- moves data from scratchpad to selected line
- moves data from selected line to scratchpad
- selects page, procedure, or performance mode as applicable
- deletes data from selected line when DELETE is displayed in scratchpad

Conventions -

- scratch pad must be blank for line select transfer
- data cannot be transferred to a blank line
- a blank scratch pad cannot be transferred to a line
- not all data can be modified
- message displays if inappropriate entries attempted

3 Display (DSPY) Light

Illuminated (white) - indicates current display is not related to the active leg or current performance mode.

4 FAIL Light

Illuminated (amber) - indicates fault detected in FMC.

5 Brightness (BRT) Control

Push -

- "+" increases brightness
- "-" decreases brightness
- 24 segment light brightness bar displays in the scratchpad and remains displayed for 2 seconds after release of the + or - push. Existing scratchpad information is saved and displays following fade of the brightness bar

6 Message (MSG) Light

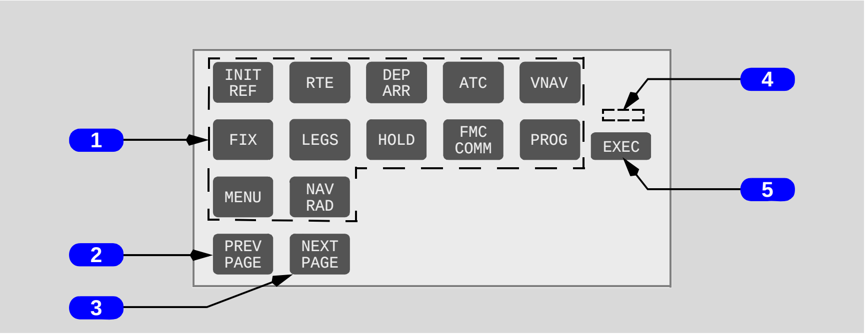
Illuminated (white) -

- 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
- ATC - displays ATC/ADS STATUS page
- VNAV - displays page to view or change vertical navigation path data
- FIX - displays page to create reference points on ND map
- LEGS -
  - displays page to evaluate or modify lateral and vertical route data
  - displays page to correlate route waypoints on ND
- HOLD - displays page to create holding patterns and holding pattern data, or to exit holding pattern
- FMC COMM - displays pages that access datalink, provides datalink status
- PROG - displays page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- MENU -displays page to choose subsystems controlled by CDU
- NAV RAD - displays page to view or control navigation radio tuning

2 Previous (PREV) PAGE Key

Push - displays previous page in multiple page displays.

3 NEXT PAGE Key

Push - displays next page in multiple page displays.

4 Execute Light

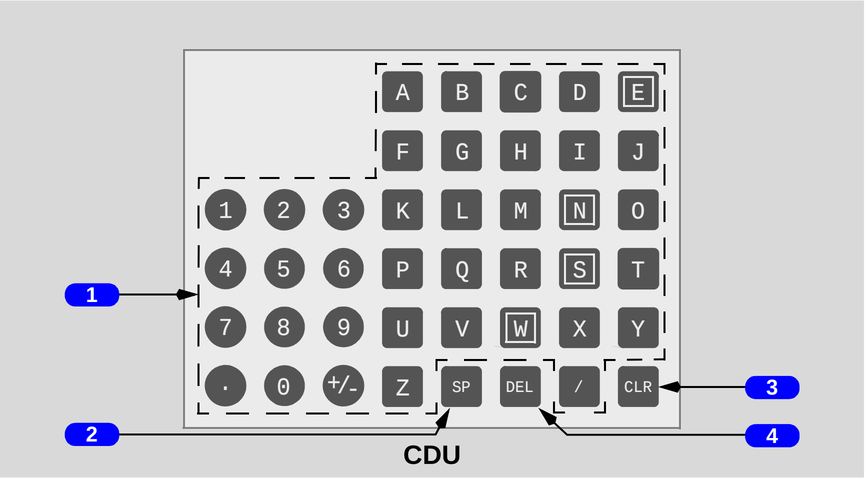
Illuminated (white) - active data modified but not executed.

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.

3 Clear (CLR) Key

Push -

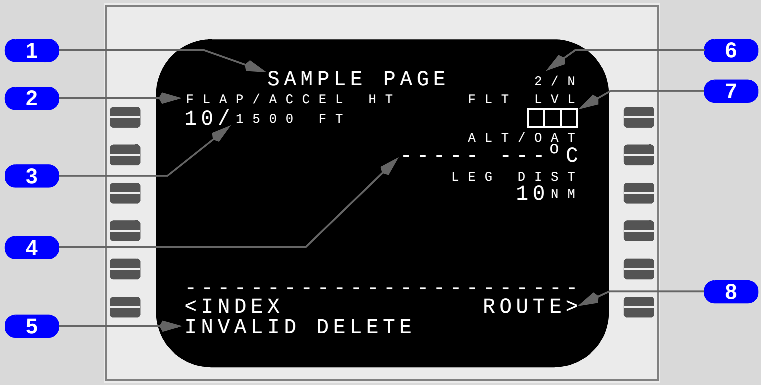
- clears last scratchpad character
- clears scratchpad message

Push and hold - clears all scratchpad data.

4 Delete (DEL) Key

Push - enters "DELETE" in scratchpad.

CDU Page Components



CDU

1 Page Title

Subject or name of data displays on page.

ACT (active) or MOD (modified) indicates whether page contains active or modified data.

2 Line Title

Title of data on line below.

3 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, N, is total number of related pages. Page number is blank when only one page exists.

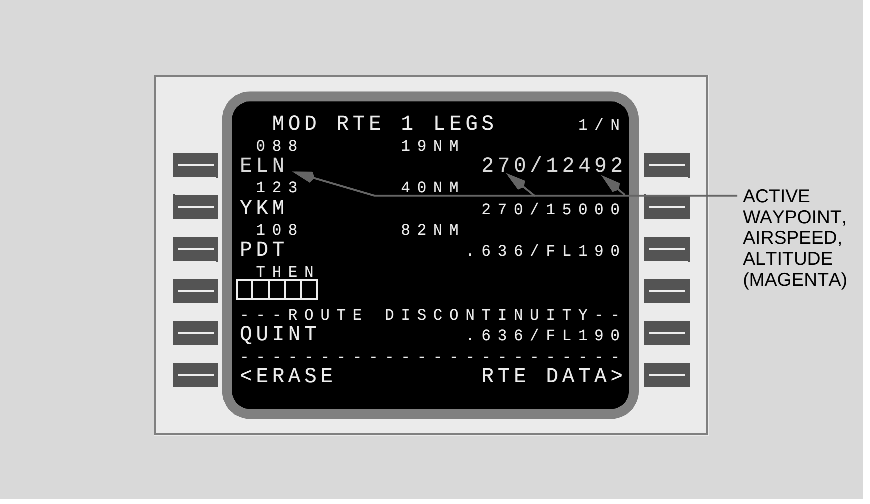
7 **Boxes**

Data input is mandatory.

8 **Prompts**

Display pages and control displays. Caret "<" or ">" is before or after prompt.

CDU Page Color



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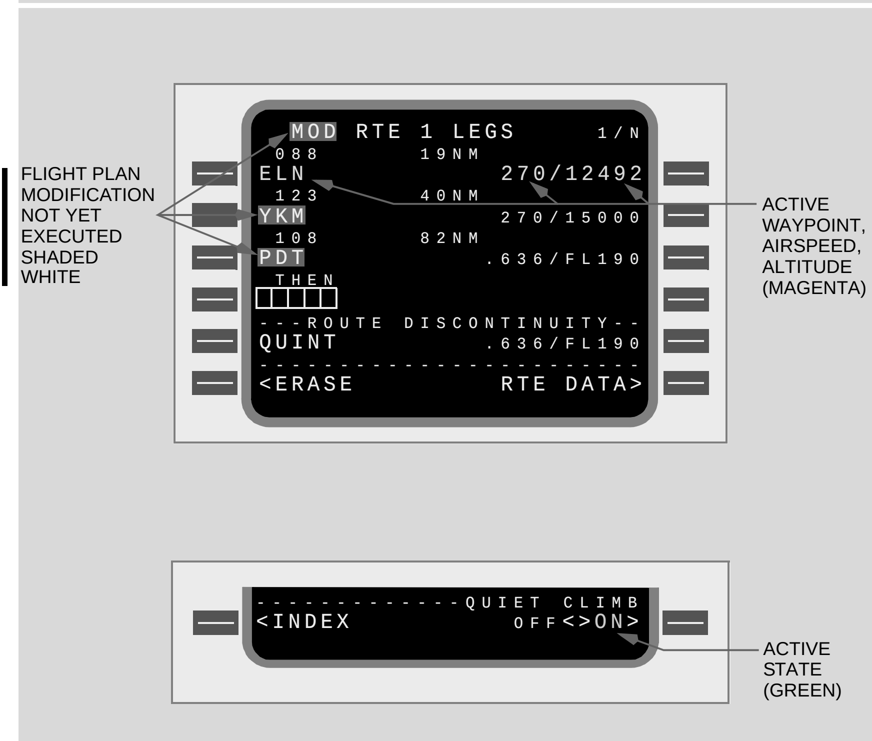

Color is used as follows:

- black - background color of page

cyan -

  - inactive RTE page title
- green -
  - navigation radio data
  - active state of two-position and three-position selectors
- magenta - data used by FMC for lateral and vertical flight commands
  - active waypoint
  - active airspeed
  - active altitude

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- ~~shaded white -~~
  - ~~modifications~~
  - ~~MOD precedes page titles of modified pages~~

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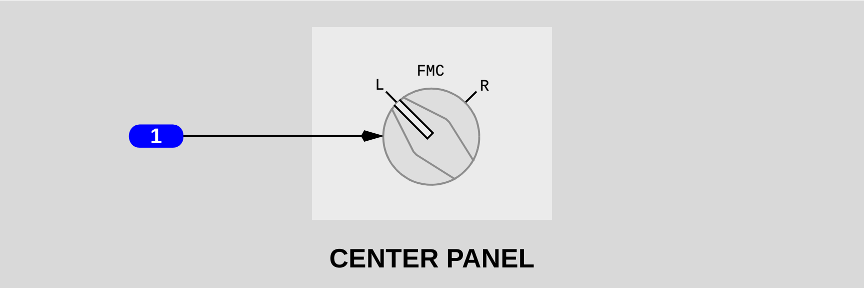
- shaded white -
  - modifications
  - MOD precedes page titles of modified pages
- white - most data.

FMC Selector



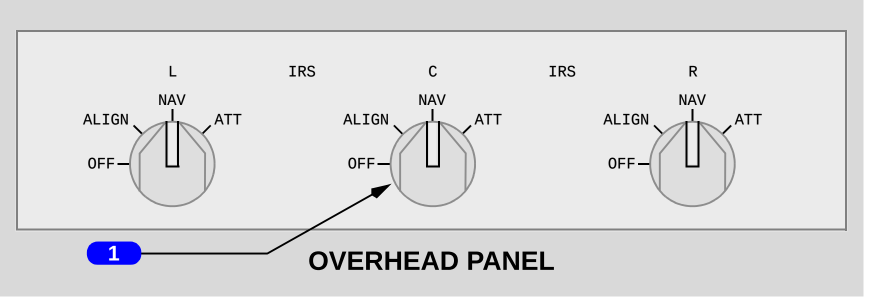
1 FMC Selector

L - selects left FMC to provide guidance commands.

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

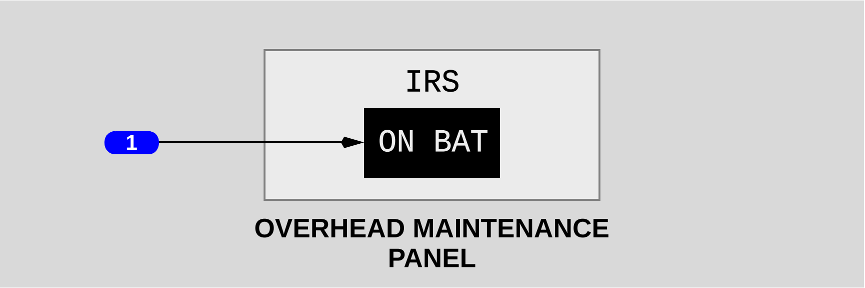
NAV (navigation) -

- 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

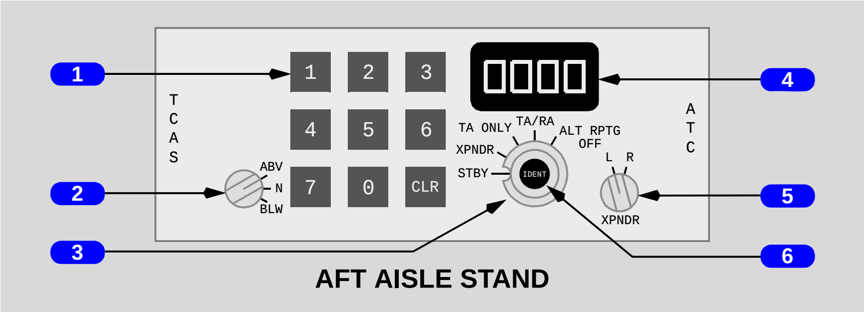
IRS On Battery Light



1 IRS ON Battery (BAT) Light

Illuminated (white) - IRS operating on backup electrical power (APU hot battery bus).

Transponder Panel



1 Transponder Code Switches

Push - sets transponder code.

CLR (clear) - deletes transponder code.

2 TCAS Airspace Selector

Refer to Chapter 15, Warning Systems.

3 Transponder Mode Selector

STBY (standby) - transponder disabled.

XPNDR (transponder) -

- transponder enabled
- in flight, altitude reporting enabled

TA ONLY (traffic advisory) and TA/RA (traffic advisory/resolution advisory) - Refer to Chapter 15, Warning Systems.

ALT RPTG OFF (altitude reporting) -

- transponder enabled
- altitude reporting disabled

4 Transponder Code Display

Displays transponder code.

5 Transponder (XPNDR) Selector

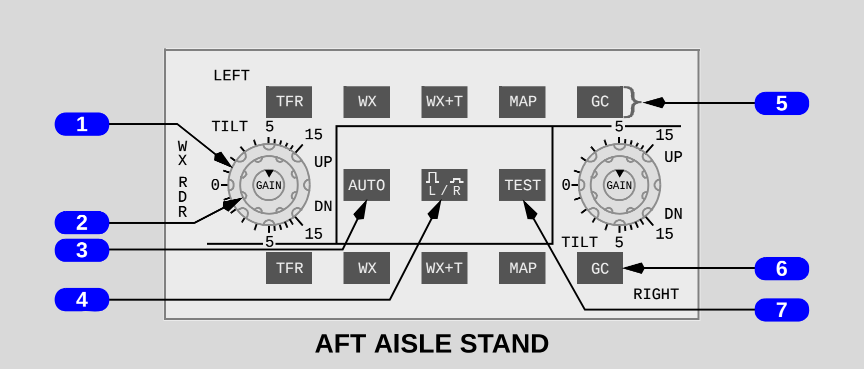
L - selects left transponder.

R - selects right transponder.

6 Identification (IDENT) Switch

Push - transmits ident signal.

Weather Radar Panel



1 TILT Control

Rotate outer knob clockwise - tilts radar antenna up.

Rotate outer knob counterclockwise - tilts radar antenna down.

2 GAIN Control

Rotate inner knob - sets receiver sensitivity. The 12 o'clock position sets receiver sensitivity at preset calibrated level. When not set at the 12 o'clock position, VAR displays on the ND. The gain control should be returned to the 12 o'clock position after use of variable gain.

3 AUTO Switch

IN - both Captain's and First Officer's controls operate in automatic mode to optimize long and short range weather detection. Ground clutter suppression is operative. Manual tilt control is not available.

OUT - both Captain's and First Officer's controls operate manually. Ground clutter suppression is not available.

4 System Select Switch

IN - selects right system.

OUT - selects left system.

5 Mode Switches

Control display on respective ND.

Push -

TFR (transfer) - selects display information and control settings from the opposite side, except range.

Note: Selecting both TFR switches at the same time results in the TEST mode; test pattern displays.

WX (weather) - displays weather returns out to 320 nm.

WX + T (weather + turbulence) - displays weather returns and turbulence returns. Turbulence display available within 40 nm in all range settings.

Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar. Many turbulence encounters may fall below the display threshold (moderate-severe to severe) and may not display even though the airplane may be experiencing turbulence.

MAP - displays ground returns at selected gain level.

6 Ground Clutter (GC) Switch

Push and hold - displays ground and weather returns.

Note: Continuous operation is not recommended; weather returns may be masked by ground clutter.

Release - returns radar to normal operating mode, ground clutter suppression active.

7 TEST Switch

Push -

- tests weather radar system operation without transmitting
- displays test pattern and PWS symbol at the end of the test and any fault message on ND with WXR selected (except in PLAN, CTR VOR, and CTR APP modes)
- when on the ground, selecting WXR on the EFIS control panel and TEST on the weather radar control panel activates a 12 second test. To activate the aural messages, TEST must be selected after WXR is selected on the EFIS control panel. Initially, the amber WINDSHEAR annunciation displays and the aural MONITOR RADAR DISPLAY sounds. Next, Master Warning Lights illuminate and the EICAS alert message WINDSHEAR SYS displays. Finally, the red WINDSHEAR annunciation displays and the aural GO AROUND WINDSHEAR AHEAD, and then WINDSHEAR AHEAD, WINDSHEAR AHEAD sounds
- the test pattern and PWS symbol remain displayed until WXR is selected off on the EFIS control panel, another mode is selected on the Mode Selector, or an actual PWS alert is detected. The source of any faults displays in the weather radar tilt field on the ND

Flight Management, Navigation — Chapter 11
Navigation Systems Description — Section 20

Introduction

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Navigation systems include global positioning system (GPS), inertial reference system (IRS), VOR, DME, ILS, GLS, ATC transponder, weather radar, and the flight management system (FMS). The FMS is described in the Flight Management System Description section of this chapter.

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Navigation systems include global positioning system (GPS), inertial reference system (IRS), VOR, DME, ILS, GLS, 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 3/4 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

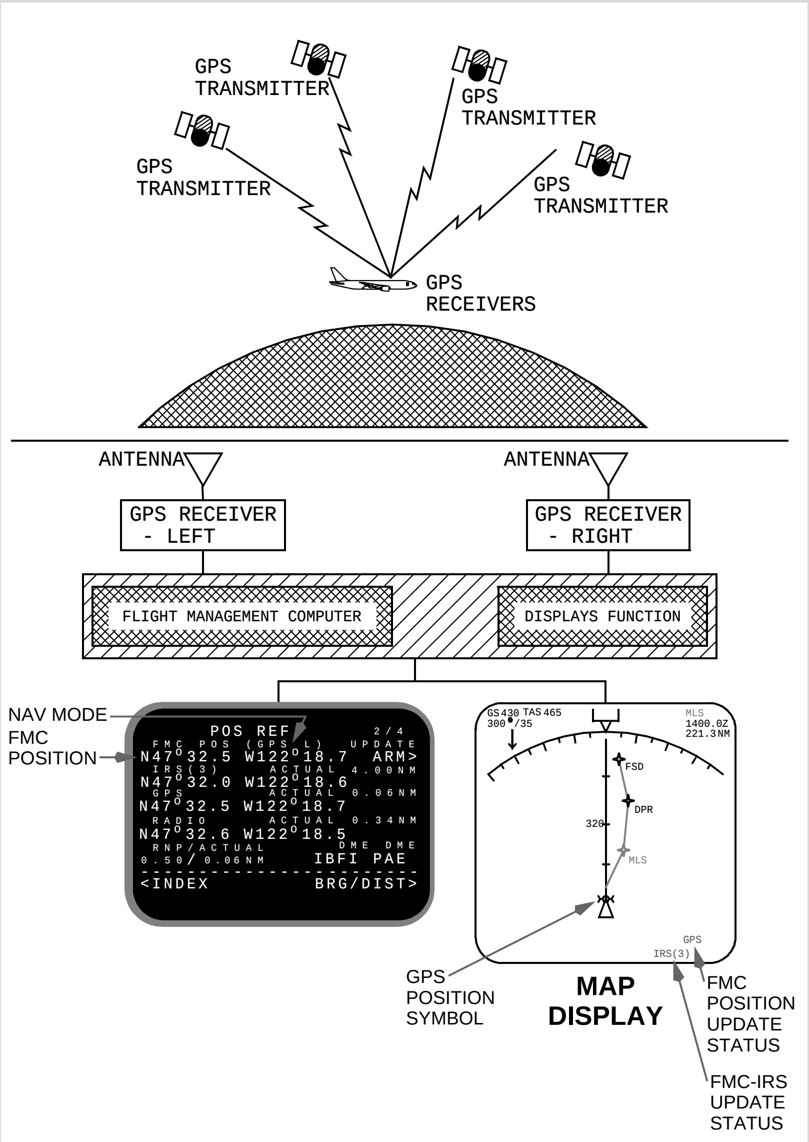
The FMC uses GPS position and velocity data to estimate errors in the inertial reference system (IRS) position and velocity. The IRS position and velocity are corrected to form the FMC position and velocity.

The flight crew can manually inhibit GPS updating. This is accomplished on the NAV OPTIONS page.

GPS position updates should be used during all approaches in which the FMC database and approach procedures are referenced to the WGS-84 reference datum. GPS updates should be inhibited for other approach operations not based on WGS-84 unless other appropriate procedures are used.

GPS position updates should be used for all operations unless a specific state requires the use of other update provisions within their airspace (eg, to accomodate a non-WGS reference datum or other reason).

GPS System Schematic



Inertial Reference System

The inertial reference system (IRS) calculates airplane position, acceleration, track, vertical speed, ground speed, true and magnetic heading, wind speed and direction, and attitude data for the displays, flight management system, flight controls, engine controls, and other systems.

The IRS consists of three air data inertial reference units (ADIRUs) 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 ADIRU detects motion during alignment. Alignment continues and completes in approximately ten minutes after motion stops. The IRS is aligned when all ADIRUs 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 ADIRU 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 ADIRU while in attitude mode. This heading is available for backup if all three ADIRUs fail. Heading information displayed on the PFD and ND is from an ADIRU 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 ADIRU operates on DC power for five minutes, then shuts down. If an ADIRU loses both AC and DC power, alignment is lost.

Radio Navigation Systems

Automatic Direction Finding (ADF)

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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 respective 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 three ILS receivers. The receivers can be tuned manually on the NAV RADIO page.

ILS Tuning

Receivers tune and frequency/course display when two conditions are true:

- an ILS, LOC, back course, LDA (localizer-type directional aid), or SDF (simplified directional facility) approach has been selected to the active route, and
- the airplane is within 150 nm of the destination airport, 50 nm of T/D, or in FMC descent

On initial takeoff, ILS autotuning is inhibited for 10 minutes to prevent clutter on the PFD. Selection and execution of a new approach in the active flight plan causes the ILS to autotune the new approach frequency, even if this is accomplished during the 10 minute takeoff inhibit period. ILS autotune inhibit does not apply to subsequent takeoffs on the same flight (for example, touch-and-go or stop-and-go landings).

All three ILS receivers can be manually tuned from the NAV RADIO page unless ILS approach tuning inhibit is active.

ILS approach tuning inhibit is active when:

- the autopilot is engaged and either the localizer or glideslope is captured
- the flight director is ON, and either the localizer or 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.

GPS Landing System (GLS)

The FMC usually tunes three GLS receivers. The receivers can be tuned manually on the NAV RADIO page.

GLS Tuning

Receivers tune and GLS channel displays after selecting a GLS approach and the airplane is within 150 nm of the destination airport, 50 nm of T/D, or in FMC descent.

Manual tuning is accomplished on the NAV RADIO page by entering a valid GLS channel between 20000 and 39999.

GLS autotuning is inhibited for 10 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 approach (APP) is selected and the autopilot is engaged in either LOC or G/S mode; and, when only the flight director is selected ON, LOC or G/S mode are active, and the airplane is below 500 feet radio altitude.

Manual and automatic GLS tuning is enabled upon exiting the approach mode or when disengaging the autopilot and turning OFF both flight director switches.

If both FMCs fail, GLS receivers can be tuned on the ALTN NAV RADIO page. The left GLS 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. If GLS was in autotune at the time of an FMC failure, the GLS channel is copied to the ALTN NAV RADIO page.

GLS Displays

GLS approach information displays above and to the left of the attitude display on the PFD; and, in the upper right corner of the ND in center approach and expanded approach modes. The first line of the PFD information displays either the selected GLS identifier, if valid, or the GLS channel and the selected GLS approach course. The second line displays the GLS runway identifier and the GLS distance to the runway threshold. The third line displays the source annunciation.

The first line of the ND information displays the navigation source and the selected GLS identifier, if valid, or the GLS channel. The second line displays the selected GLS approach course. The third line displays the runway and the GLS distance to the runway threshold.

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

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The Morse code identifier of a tuned VOR or ILS 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.

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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."

Note: It is essential to verify the identity of the tuned navigation station from the audio Morse code if the tuned frequency remains displayed or an incorrect identifier displays.

Transponder

The transponder panel controls two ATC transponders and the traffic alert and collision avoidance system (TCAS). Mode S operates continuously when the transponder mode selector is out of standby.

In flight, traffic displays if the transponder mode selector is in TA ONLY or TA/RA.

In flight, the selected transponder activates beacon and altitude reporting when the transponder mode selector is in XPNDR, TA ONLY, or TA/RA.

Refer to Chapter 15, Warning Systems, for a description of TCAS.

Transponders provide selective interrogation and downlink information, such as flight number, airspeed or groundspeed, magnetic heading, altitude, GPS position, etc., depending on the level of enhancement. Some airports use transponder information to monitor airplane position on the ground when the transponder is active (mode selector not in STANDBY or OFF). Transponder enhancements also enable air traffic controllers in some areas of the world to use Automatic Dependent Surveillance-Broadcast (ADS-B). TCAS modes should not be used on the ground for ground tracking.

The left and right GPS are connected to respective left and right transponders. Loss of the GPS connected to the selected transponder can prevent ADS-B reporting. Selection of the other transponder restores ADS-B reporting.

Weather Radar

The weather radar system consists of two receiver-transmitter units, an antenna, and a control panel.

Radar returns display on the navigation display (ND) in all modes except:

- plan
- VOR center
- approach center

The EFIS control panel weather radar (WXR) map switch controls power to the transmitter/receiver and controls the weather radar display on the ND. The radar display range adjusts to the ND range selected on the EFIS control panel. Weather radar operating modes and fault conditions display on the ND.

The weather radar system performs various levels of self test on power up, during each sweep, and when descending through 2,300 feet AGL.

There are two modes available for the MultiScan weather radar system. The Manual mode operates like traditional weather radar with full operator control over tilt and gain settings. The Automatic mode of the MultiScan weather radar collects data from multiple scans and merges the information into a total weather picture. MultiScan software then reduces ground clutter resulting in clutter-free viewing of significant weather out to 320 nm. During automatic mode operation, tilt control is inoperable. Gain may be adjusted as necessary; however, calibrated gain (12 o'clock) should be used during all phases of flight while in the automatic mode.

There are several key features of the MultiScan weather radar when operating in the automatic mode of operation.

The MultiScan weather radar displays weather only along the airplane flight path. Weather approximately 6,000 feet below the airplane and not a threat is intentionally not displayed to prevent unnecessary deviations. Weather may be observed from the flight deck, but not displayed on the ND.

Note: Since weather below the airplane does not display, Manual operation should be momentarily selected prior to top of descent to ensure there is no weather along the descent path. When below FL200, the weather radar uses a combination of tilt settings and system logic to eliminate ground clutter. At lower altitudes, weather below the flight path may not display at longer ranges. Detection range may be extended by increasing gain. When using increased gain, highly reflective weather (monsoons, significant convection patterns) may result in unnecessary warning of the actual threat. In such instances, the calibrated 12 o'clock position should be used.

The MultiScan weather radar uses automatic temperature-based gain to better represent non-reflective thunderstorm tops and lessen the possibility of inadvertent thunderstorm top penetration. As temperature decreases, the weather radar gain is automatically increased. As a result, at cruise altitudes, automatic calibration gain is approximately equivalent to the manual maximum gain setting. The radar also automatically adjusts radar settings to account for weather differences based on season and location.

At cruise altitudes (FL220 and above), the MultiScan radar prevents weather cells in the flight path from falling beneath the radar beam and off the weather display by retaining cell information in memory and on the display until the cell has passed behind the airplane.

The Multiscan weather radar system also contains an alignment feature that automatically senses and corrects for airplane and radar alignment tolerances to allow more precise antenna pointing accuracy. This feature operates during cruise altitude flight over terrain. Prior to automatic alignment, some ground clutter may be observed. If suspected ground clutter displays, momentarily switch to manual operation to validate the observation and return to automatic operation.

Turbulence Detection Capability of the MultiScan weather radar complies with FAA turbulence guidance developed by the FAA/NASA/Industry Turbulence Working Group which requires the radar to display magenta for moderate to severe turbulence. Many turbulence encounters may fall below the required display threshold and not display even though the airplane may be experiencing turbulence.

Note: Under some conditions, operating at mid to lower altitudes (between 10,000 and 20,000 feet), a magenta turbulence display may occur even though little or no turbulence is experienced. This is most common when encountering non-convective or stratiform rain. Under these conditions, with no other indications or convective weather observed, the turbulence indication may be considered an anomalous turbulence warning. Caution should be exercise for other indications of convective weather.

Turbulence can be sensed by the weather radar only when there is sufficient precipitation. Clear air turbulence cannot be sensed by radar.

If the EFIS control panel fails, the CDU can control the EFIS control panel functions, including the WXR. Weather radar operating modes and fault conditions display on the ND.

Flight Management, Navigation — Chapter 11
Flight Management System Description — Section 30

Introduction

The flight management system (FMS) aids the flight crew with navigation, in-flight performance optimization, fuel monitoring, and flight deck displays using Flight Management Computers (FMCs). Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for airplane orientation and command markers on the airspeed, altitude, and thrust indicators to help fly efficient profiles.

The flight crew enters the applicable route and flight data into the CDUs. The FMS then uses the navigation database, airplane position, and supporting system data to calculate commands for manual and automatic flight path control.

The FMS tunes the navigation radios and sets courses. The FMS navigation database supplies the necessary data to fly routes, SIDs, STARs, holding patterns, 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 and RNP approaches, and to supplement primary navigation during all types of instrument approaches.

Two ADIRUs in conjunction with one FMC and two FMS-CDUs meet the requirements as the sole means of navigation for flights up to 18 hours duration.

Control Display Units (CDUs)

The flight crew controls the FMC using three CDUs. The CDUs give alternate display and navigation capability if both FMCs fail (refer to the Alternate Navigation section of this chapter). Refer to Chapter 10, Flight Instruments, Displays for a description of alternate display control.

Flight Management, Navigation — Chapter 11
Flight Management System Operation — Section 31

Deferred Systems Content
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This section contains deferred and interim systems description content.

Deferred content is printed with strike-through text. For example, ~~required time of arrival (RTA).~~

Interim systems content is printed in italics. For example, *Step climbs must be entered as a Planned Step on the LEGS page.*

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.

Company data such as Route Data page 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 descent phase is active and flaps are out of up, 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 third 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.

The flight complete phase will not occur if modifications to the active route are made after landing and before engine shutdown; for example, deletion of the approach reference speed or entry of a waypoint in the active route.

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/FROM 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/FROM 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. New scratchpad entries are allowed over CDU entry error advisory messages. Entry clears the message.

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.

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~~Purge - select the PURGE prompt to remove all airports uplinked to the ALTN LIST.~~

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Purge - select the PURGE prompt to remove all airports uplinked to the ALTN LIST.

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.

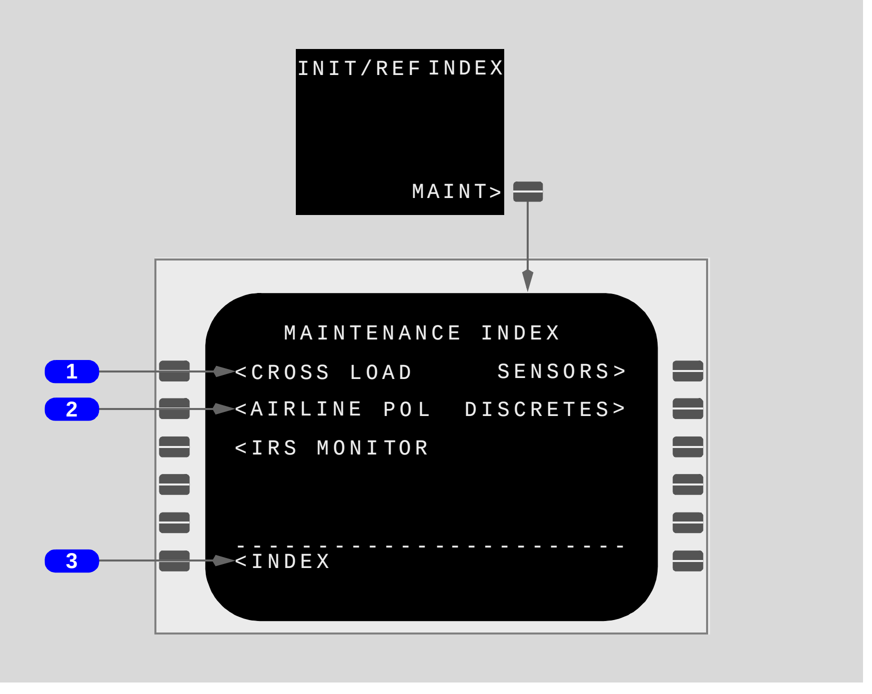
Speed restriction - an airspeed limit.

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 used only on the ground to crossload the FMC Nav Database, review FMC performance factors, and evaluate IRS integrity.



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.

Note: Display of the INIT/REF INDEX page is true for all cases except on the ARRIVALS page; here, pushing the INDEX key displays the DEP/ARR INDEX page. No further description of the 6L INDEX key will be made in Chapter 11.

Navigation Position

The FMC position is calculated from the ADIRU inertial position updated using GPS and navigation radios. When receiving reliable GPS data, the primary mode of navigation uses 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 GPS data and navigation radios are not available or reliable, the FMC position is calculated using the ADIRU inertial position.

FMC Position Update

The FMC position may be manually updated to any of the navigation positions. This update is accomplished on the POS REF page 2.

On the ground, the FMC calculates present position based on IRS and/or GPS data.

When GPS UPDATE OFF, pushing a TO/GA switch updates the FMC position to the runway threshold or to the position shift position, when entered as a distance. When making an intersection takeoff, the intersection displacement distance from the runway threshold must be entered on the TAKEOFF REF page. With GPS UPDATE ON, the TO/GA update is inhibited.

In flight, the FMC position is the ADIRU inertial 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.

The FMC automatically tunes VOR, DME, and ILS radios for position updating and displays them on the ND and NAV RADIO page. Selection is related to the active route and any procedure (SID, STAR, etc.) in the active route. Manually selecting VOR frequencies or identifiers precludes the FMC from autotuning other VOR/DME frequencies for position updating; however, the FMC continues to tune DME-DME pairs for position updating.

ADIRU inertial position updating occurs in the following priority order:

- GPS
- LOC and DME-DME
- LOC and collocated VOR/DME
- LOC
- DME-DME
- collocated VOR/DME

With all ADIRUs failed and GPS operative and valid, the FMC position is the GPS position.

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 2/4	ND Annunciation
GPS	GPS	GPS IRS (3)
LOC, DME DME valid; GPS invalid*	LOC-RADIO	LOC DD
LOC, VOR DME valid; GPS invalid*	LOC-RADIO	LOC VD
LOC valid; GPS, DME, VOR invalid*	LOC	LOC
DME valid; GPS invalid	RADIO	DD
VOR DME valid; GPS invalid	RADIO	VD
GPS, VOR, DME invalid	INERTIAL	INERTIAL
GPS valid, IRS failed	GPS	GPS
GPS invalid, IRS failed	blank	map not available

Localizer updating is inhibited if GPS IRS(3) is the navigation update mode.

* 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

The FMC begins polar operations when the computed airplane position enters a polar region as depicted by the shaded area in the Areas of High Latitude Operations figure below. The FMC provides all inputs to the flight displays referenced to true north while in the regions.

When entering the polar region, switching to a true north reference is annunciated by a white box around the word TRU on the ND. A TRUE heading reference can be selected with the heading reference switch inside or outside the polar region. The ND displays a green box around the word MAG to annunciate the change back to magnetic reference when leaving the polar region. If the heading reference is TRU in the descent phase, the ND displays a flashing amber box around the word TRU.

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The current GRID heading displays near the top of both NDs when the airplane is north of 70°N or south of 60°S. The GRID heading is not used by any airplane system.

Note: When operating the autopilot in the region in other than LNAV, the TRUE position on the heading reference switch must be selected.

Note: When operating north of 82°N or south of 82°S using the ND PLAN mode, the airplane position symbol transitions to a "⊗" symbol.

High Latitude Operations

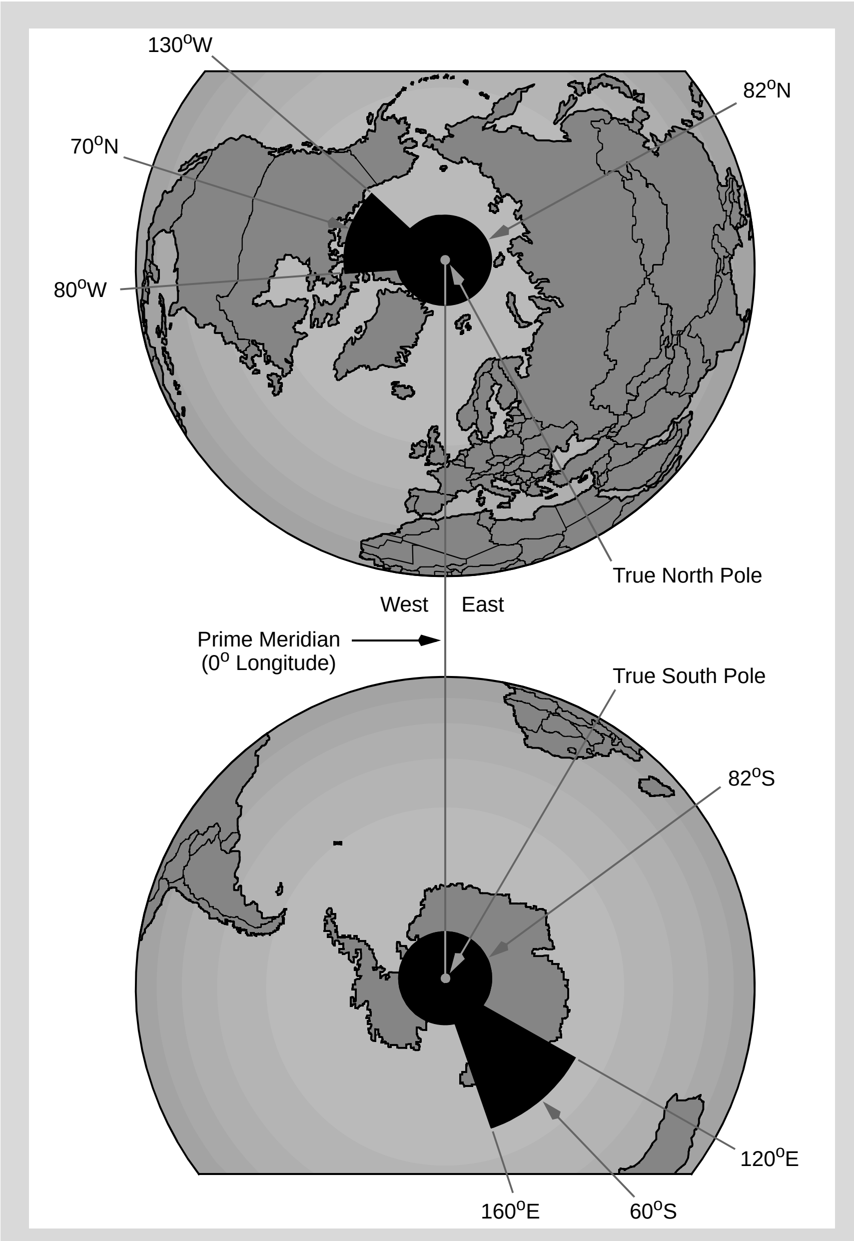
806
With the Heading Reference switch in NORM, the heading reference for PFDs and NDs changes to true north at 82°N (or north of 73°N between 80°W and 170°W) or at 82°S (or south of 60°S between 120°E and 160°E). Outside this region, heading reference is determined by Heading Reference switch position.

914
With the Heading Reference switch in NORM, the track reference for NDs changes to true north at 82°N (or north of 73°N between 80°W and 130°W) or at 82°S (or south of 60°S between 120°E and 160°E). Outside this region, the track reference is determined by Heading Reference switch position.

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.

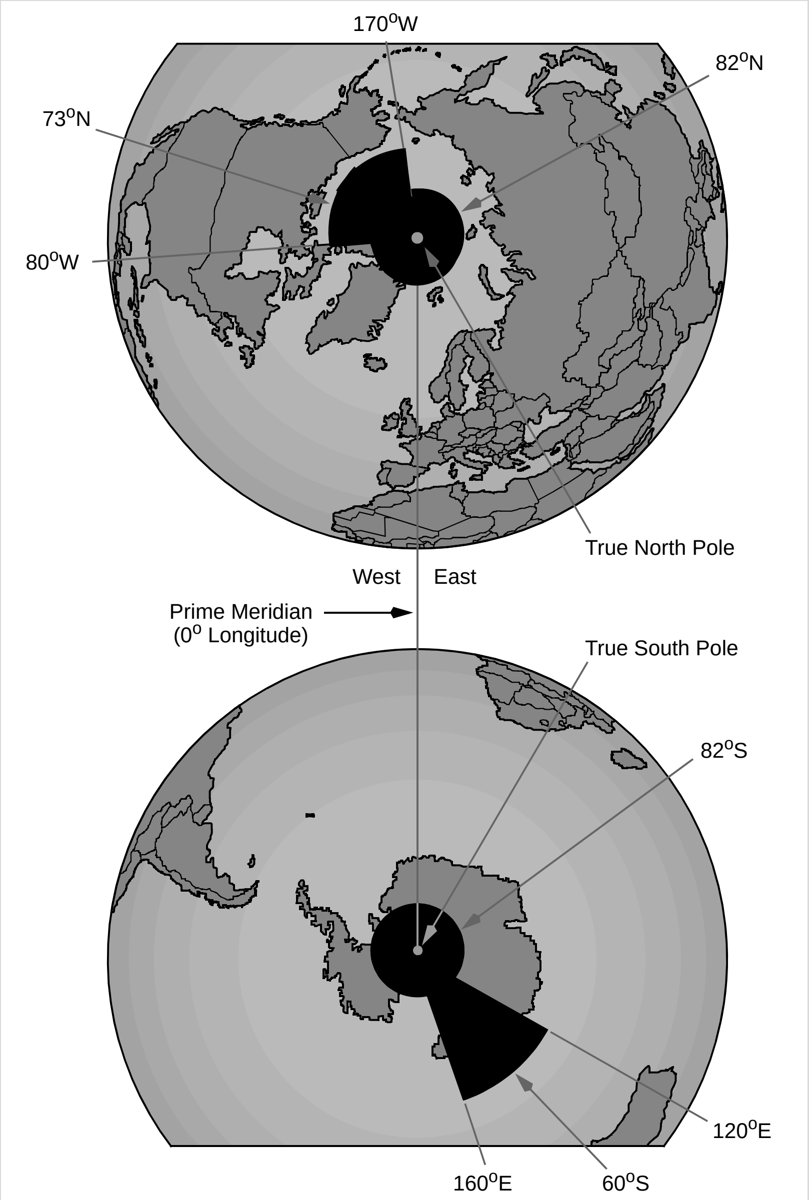
Note: For autopilot operation in high latitudes using a roll mode other than LNAV, the TRUE position on the Heading Reference switch should be selected.

Areas of High Latitude Operations (1995 or 2005 MAGVAR)
(914 ; before SB, 2015 MAGVAR not installed)



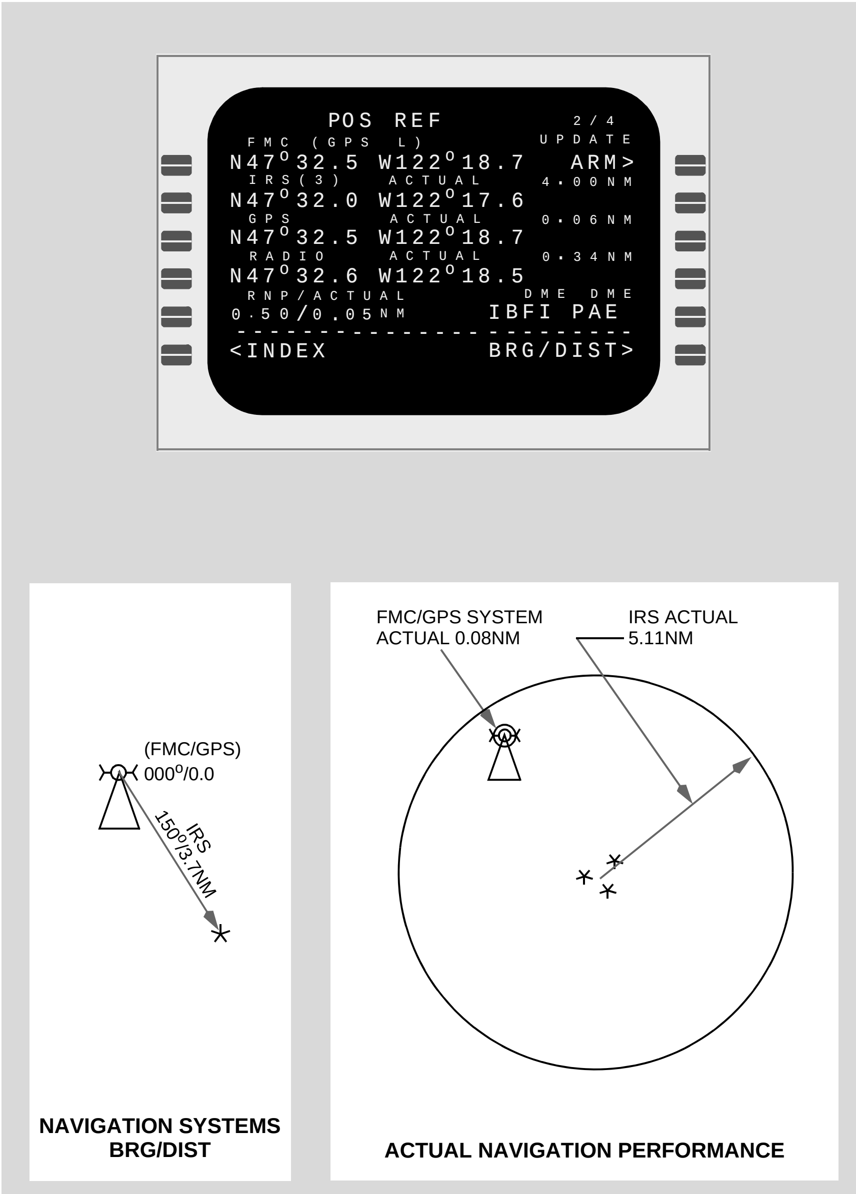
Areas of High Latitude Operations (2015 MAGVAR)

806
(914 ; SB installs 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.


POS REF 2/4
FMC (GPS L) UPDATE
N47°32.5 W122°18.7 ARM>
IRS(3) ACTUAL
N47°32.0 W122°17.6 4.00NM
GPS ACTUAL
N47°32.5 W122°18.7 0.06NM
RADIO ACTUAL
N47°32.6 W122°18.5 0.34NM
RNP/ACTUAL DME DME
0.50/0.05NM IBFI PAE
<INDEX BRG/DIST>
(FMC/GPS)
000°/0.0
IRS
150°/3.7NM
NAVIGATION SYSTEMS
BRG/DIST
FMC/GPS SYSTEM
ACTUAL 0.08NM
IRS ACTUAL
5.11NM
ACTUAL NAVIGATION PERFORMANCE

Actual Navigation Performance

Actual navigation performance (ANP) is the FMC current computed position accuracy. It is titled ACTUAL and displays on the POS REF page 2 for the navigation system displayed in title line 1. ACTUAL navigation performance is a circular prediction centered at the FMC position. Airplane position is estimated to be within this ACTUAL navigation performance circle 95 percent of the time.

After a manual position update, the ACTUAL navigation performance of the FMC changes to the ACTUAL navigation performance of the selected navigation system. Some automatic updates can be inhibited; GPS, VOR/DME, and DME/DME updates on NAV OPTIONS page. Inertial updates can not be inhibited.

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.

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.

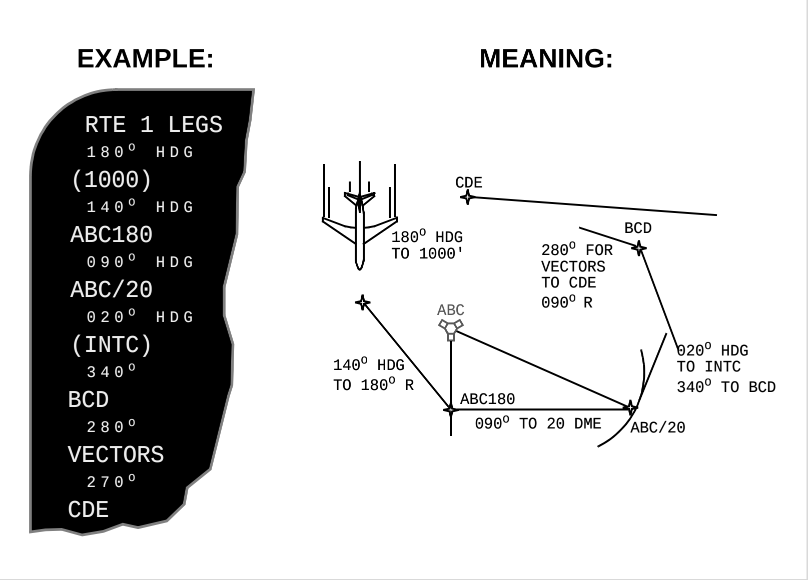
Conditional Waypoints

Conditional waypoints may display in the route when selecting a DEPARTURES or ARRIVALS page procedure. Usually, conditional waypoints cannot be manually entered on a route or legs page. These waypoints indicate when an event occurs and are not at a geographically-fixed position. The types of conditions are:

- climb/descent through an altitude
- flying a heading to a radial or DME distance
- intercepting a course
- heading vectors to a course or fix

Altitude and course intercept conditional waypoints display on the CDU inside (parenthesis) marks. The diagram below shows conditional waypoints.

(1000) is a conditional waypoint. LNAV guidance is to hold a 180° heading until above 1,000 feet; then, turn to a heading of 140°.



NOTE: ALL WAYPOINTS EXCEPT BCD AND CDE ARE EXAMPLES OF CONDITIONAL WAYPOINTS.

Manually Entered Latitude/Longitude Waypoints

Pilot defined waypoints entered as a latitude and longitude display in a seven-character format. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude are full degrees. Examples:

- N47° W008° is entered as N47W008 and displayed as N47W008
- N47° 15.4' W008° 3.4' is entered as N4715.4W00803.4 and displayed as N47W008

Manually Entered Place Bearing/Distance or Place Bearing/Place Bearing Waypoints

Waypoints entered as a place bearing/distance or place bearing/place bearing are identified by the first three characters of the entry followed by a 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 VAM-01

- ELN/-30 is 30 miles before ELN on the present route, and displays as ELN-01

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 dashed, cyan 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.

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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.

806
Map shift errors can be detected by comparing the position of the airplane on the ND map with data from the ILS, VOR, and DME systems.

Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight. Three VNAV CDU pages correspond to these flight phases. Pressing the VNAV function key displays the active phase page. Other VNAV pages display using the next or previous keys.

Vertical Actual Navigation Performance (VANP)

Vertical Actual Navigation Performance is the FMC estimate of the quality of altitude determination during descent. It displays on the RNP PROGRESS page. VANP is the estimated maximum altitude error. The FMC computes the vertical path and the certainty the actual altitude is within a vertical range equal to plus or minus the displayed VANP value.

Note: VANP is calculated from the baro-corrected altitude provided by the Air Data System. The pilot must set the baro setting reported by ATIS or by the setting given in the approach clearance for the display to be valid.

Speed/Altitude Constraints

VNAV controls the path and speed to comply with waypoint crossing constraints. Waypoint crossing constraints are entered on the LEGS page waypoint line by pushing the applicable key on the right side of the CDU. Barometric altitude constraints must be below the cruise altitude to be valid. Values entered as part of a procedure and manually entered constraints display in large font. FMC predicted values do not act as constraints, and display in small font.

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A waypoint constraint is magenta when it is active. The constraint does not have to be in line 1 to be active. Waypoints can have altitude or ~~airspeed/altitude~~ *speed only* constraints.

806
A waypoint constraint is magenta when it is active. The constraint does not have to be in line 1 to be active. Waypoints can have altitude or airspeed/altitude speed only constraints.

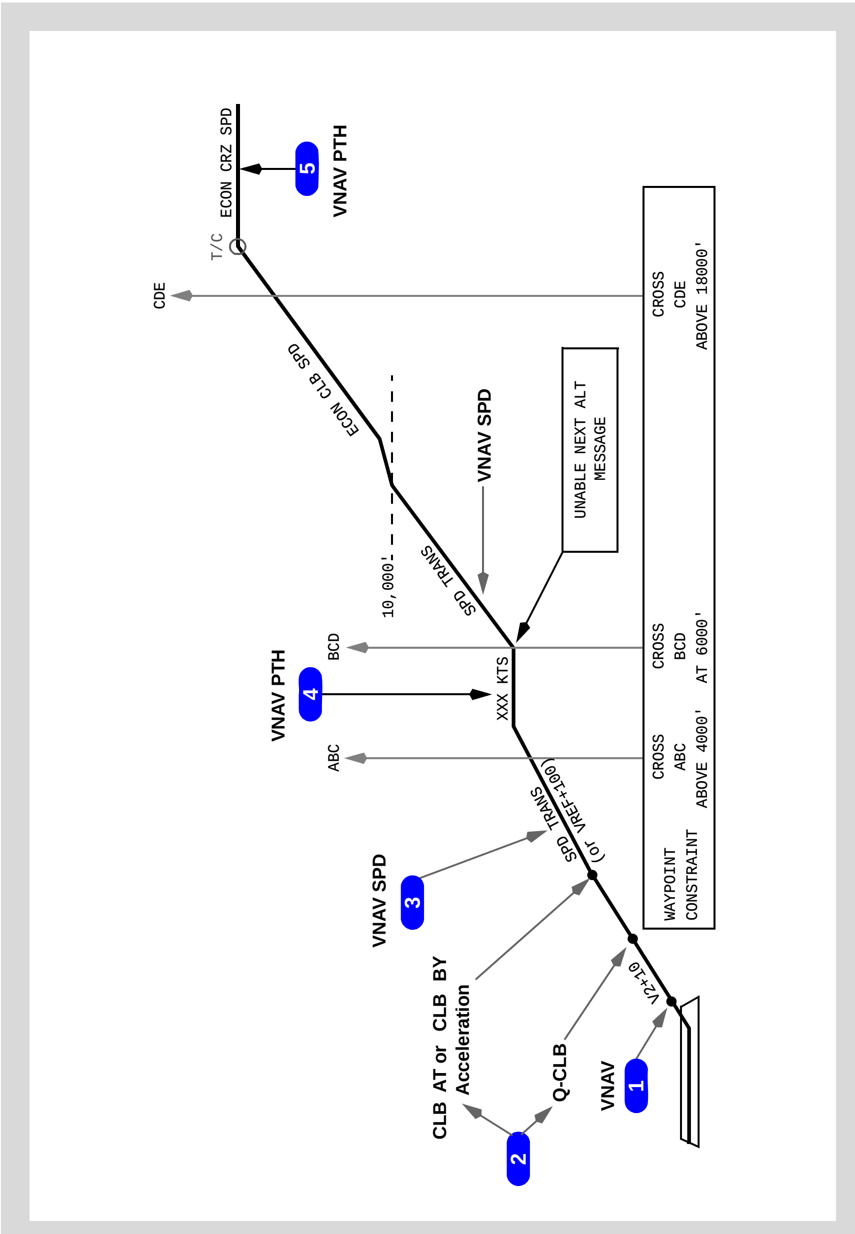
914
~~Modified waypoint constraints are shaded white until they are executed.~~ All speed constraints are considered by the FMC as at or below constraints.

806
Modified waypoint constraints are shaded white until executed. All speed constraints are considered by the FMC as at or below constraints.

At or above altitude constraints are entered with a suffix letter A (example: 220A). At or below altitude constraints are entered with a suffix letter B (example: 240B). Mandatory altitude constraints are entered without any suffix letter (example: 270).

Altitude constraints with two altitudes may be entered in either order. The lower altitude constraint, followed by a suffix letter A, and the upper altitude constraint, followed by a suffix letter B (example: 220A240B or 240B220A).

Takeoff and Climb



1 Takeoff

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.

914

2 Quiet Climb

~~When Quiet Climb is active (ON), thrust reduction occurs at the Q-CLB point. With FAST restore rate active, thrust rapidly increases to the selected climb reference thrust limit at the CLB AT point. With SLOW restore rate active, thrust slowly increases between the Q-CLB altitude and the CLB BY altitude to the selected climb reference thrust limit~~. At acceleration, 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 flaps up maneuvering + 20 kts speed or the speed transition associated with the origin airport, limited by configuration.

~~The FMC changes the reference thrust limit to the armed climb thrust value at the takeoff thrust reduction point; or, when Quiet Climb is ON, commands Quiet Climb thrust at the "Q-CLB AT" altitude.~~

806

2 Quiet Climb

When Quiet Climb is active (ON), thrust reduction occurs at the Q-CLB point. With FAST restore rate active, thrust rapidly increases to the selected climb reference thrust limit at the CLB AT point. With SLOW restore rate active, thrust slowly increases starting halfway between the Q-CLB altitude and the CLB BY altitude to the selected climb reference thrust limit. At the CLB AT or CLB BY 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 flaps up maneuvering + 20 kts speed or the speed transition associated with the origin airport, limited by configuration.

The FMC changes the reference thrust limit to the armed climb thrust value at the takeoff thrust reduction point; or, when Quiet Climb is ON, commands armed climb thrust at the "Q-CLB AT" altitude.

3 VNAV Climb

VNAV climb profile uses VNAV SPD or VNAV PTH at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude constraints of an active route Standard Instrument Departure. Autothrottle uses the armed climb thrust limit.

If the climb speed profile cannot achieve an altitude constraint, the UNABLE NEXT ALT scratchpad message displays.

4 Climb Constraints

VNAV enters the VNAV PTH mode to remain within departure or waypoint constraints. Speed maintained during this time can be:

- procedure based speed restriction
- waypoint speed restriction
- default VNAV climb speed
- manually entered climb speed

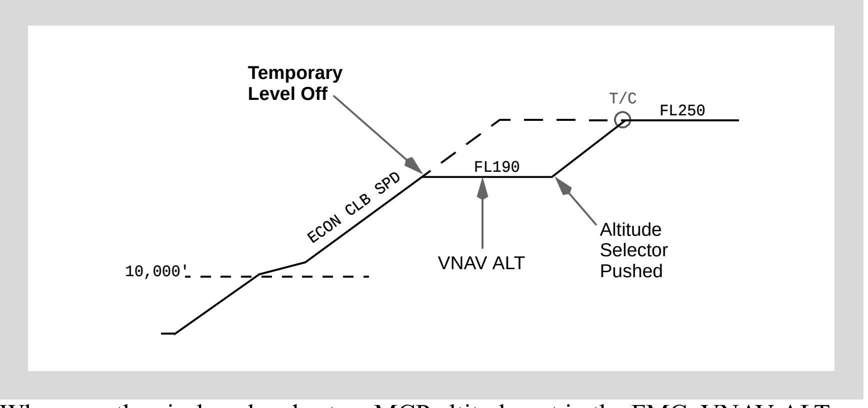
If the FMC predicts the airplane will not reach an altitude constraint, the FMS-CDU message UNABLE NEXT ALT displays. Speed intervention can be used by pushing the IAS/MACH selector and manually setting a lower airspeed to provide a steeper climb; or, climb derates can be deleted on the THRUST LIMIT page.

5 Top Of Climb (T/C)

The point where 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.

With a speed/altitude constraint active in the flight plan in climb or descent, an altitude intervention will not clear the speed constraint.

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)

914

- ~~flight crew entered speed~~

Note: *Cruise speed entry is only allowed on the VNAV page.*

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- flight crew entered speed

914

- ~~required time of arrival (RTA)~~

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- 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

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Step climbs must be entered as a Planned Step on the LEGS page. Once a Planned Step is entered, the CRZ page shows predictions to reach the altitude at the Planned Step point or after it if the Planned Step altitude cannot be attained by the waypoint.

~~Fuel and ETA predictions assume the airplane climbs at each predicted step climb point as airplane weight decreases. FMC predicted step climb increments are based on the step size shown on the CRZ page. Entering a step size of zero causes the FMC to assume a constant altitude cruise.~~

~~Flight crew entry of a STEP TO altitude on the CRZ page or "/S" on a waypoint on the LEGS page overrides FMC step climb predictions. Entry of a step altitude on the LEGS page overrides a STEP TO entry made on the CRZ page.~~

~~Predicted step altitudes display on the LEGS page. The distance and ETA to the next step point (predicted 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 label.~~

~~The FMC calculates step climb points as a function of lateral flight plan, speed mode, current cruise altitude, entered forecast winds and temperatures, step to altitude, step size, and gross weight.~~

~~The accuracy of FMC predicted step climb altitudes and locations depends on PERF INIT page gross weight, step size, cost index, and initial cruise altitude selection. The primary factor affecting step climb accuracy is the entry of accurate forecast cruise winds and temperatures on the WINDS page. Unless enroute winds are entered, all step climb altitudes and locations 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, predicted step climbs minimize trip fuel.~~

~~After entering gross weight, step size, cost index, initial cruise altitude, and enroute winds and temperatures, the FMC calculates a fully optimized vertical flight plan profile. Predicted step points are displayed on the ND (S/C); the next step displays on the ECON CRZ page. Flight plan predictions of time and fuel at destination are based on executing step climbs as predicted. Legs page waypoint altitudes reflect the optimum step climb profile.~~

~~In-flight 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. If 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, the flight plan predictions assume a constant cruise altitude until reaching the planned step waypoint. Optimized step climb predictions resume after passing the last planned step climb waypoint.~~

~~When the last planned step is a step descent, step climb predictions are not calculated for the remainder of the flight.~~

~~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 predictions are limited by maximum (MAX) altitude.~~

Step Climb

806

Fuel and ETA predictions assume the airplane climbs at each predicted step climb point as airplane weight decreases. FMC predicted step climb increments are based on the step size shown on the CRZ page. Entering a step size of zero causes the FMC to assume a constant altitude cruise.

Flight crew entry of a STEP TO altitude on the CRZ page or "/S" on a waypoint on the LEGS page overrides FMC step climb predictions. Entry of a step altitude on the LEGS page overrides a STEP TO entry made on the CRZ page.

Predicted step altitudes display on the LEGS page. The distance and ETA to the next step point (predicted 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 label.

The FMC calculates step climb points as a function of lateral flight plan, speed mode, current cruise altitude, entered forecast winds and temperatures, step to altitude, step size, and gross weight.

The accuracy of FMC predicted step climb altitudes and locations depends on PERF INIT page gross weight, step size, cost index, and initial cruise altitude selection. The primary factor affecting step climb accuracy is the entry of accurate forecast cruise winds and temperatures on the WINDS page. Unless enroute winds are entered, all step climb altitudes and locations 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, predicted step climbs minimize trip fuel.

After entering gross weight, step size, cost index, initial cruise altitude, and enroute winds and temperatures, the FMC calculates a fully optimized vertical flight plan profile. Predicted step points are displayed on the ND (S/C); the next step displays on the ECON CRZ page. Flight plan predictions of time and fuel at destination are based on executing step climbs as predicted. Legs page waypoint altitudes reflect the optimum step climb profile.

In-flight 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. If 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, the flight plan predictions assume a constant cruise altitude until reaching the planned step waypoint. Optimized step climb predictions resume after passing the last planned step climb waypoint.

When the last planned step is a step descent, step climb predictions are not calculated for the remainder of the flight.

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 predictions are limited by maximum (MAX) altitude.

If a climb is not inititated within 5 minutes after passing a step climb point, the EICAS 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)~~

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~~VNAV controls cruise speed to arrive at a specified waypoint within ± 30 seconds of a specified time. The FMC displays the scratchpad message, UNABLE RTA, if the RTA is not achievable. RTA is not available with engine out.~~

Required Time of Arrival (RTA)

806

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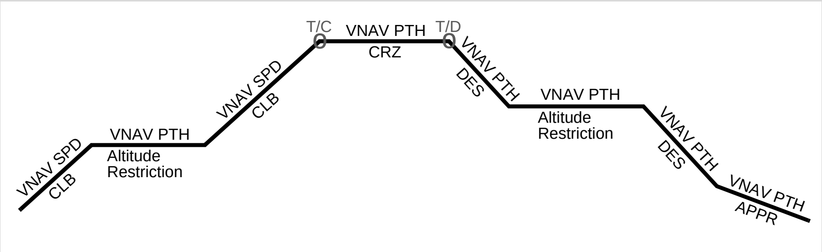
MCP Speed Intervention



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 in VNAV PTH throughout the descent as long as the speed remains within the VNAV Speed Band shown on the PFD. If speed deviates beyond the VNAV Speed Band, the pitch mode changes to VNAV SPD, speed is maintained by airplane pitch, and the airplane departs the VNAV path. Pitch controls speed in VNAV SPD mode, and thrust controls speed in VNAV PTH mode.

During a VNAV, non-I/GLS or IAN 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. 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
- predicted 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 VMO/MMO minus 16 knots or a pilot entered speed greater than 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.

Speed Reversion

If flight conditions such as unknown winds occur when above the first speed constraint, VNAV continues to maintain the path and allows the speed to vary up to the following limits:

- with greater than 15 knots below the target speed, and autothrottles not active, the scratchpad message THRUST REQUIRED displays. The maximum speed loss allowed is typically to the best hold speed and is limited to the minimum maneuver speed. If correction is required while the autothrottles are not active, 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 autothrottles active, this condition does not occur as thrust levers are in SPD and target speed is maintained during the descent
- with greater than VMO/MMO minus 16 knots, the scratchpad message DRAG REQUIRED displays. The maximum speed excursion allowed is VMO/MMO minus 11 knots to maintain the path. If correction is required, VNAV commands 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 VMO/MMO minus 16 knots, and the scratchpad message DRAG REQUIRED displays again. The speed tape displays a VNAV PTH speed band during descent

If flight conditions such as unknown winds occur when below the first speed constraint, VNAV continues to maintain the path and allows the speed to vary up to the following limits:

- with greater than 10 knots below the target speed, the autothrottles not active, the scratchpad message THRUST REQUIRED displays. The maximum speed loss allowed is 15 knots below the target speed and is limited to the minimum maneuvering speed. If correction is required while the autothrottles are not active, 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 10 knots less than the planned descent target speed (not less than minimum maneuvering speed), and the scratchpad message THRUST REQUIRED displays again. With autothrottles active, this condition does not occur as thrust levers are in SPD and target speed is maintained during descent

- 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 has descended below the speed transition altitude for the destination airport; and, if flaps are extended, is limited to 5 knots below the flap placard speed. If correction is required, VNAV commands 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 5 knots less than the maximum allowed speed excursion, and the scratchpad message DRAG REQUIRED displays again

Reversion to VNAV SPD and departure above the path for a condition of speed increase is inhibited with flaps in a landing position.

Reversion to VNAV SPD and departure below the path for a condition of speed decrease is inhibited when VNAV is in the "on approach" phase.

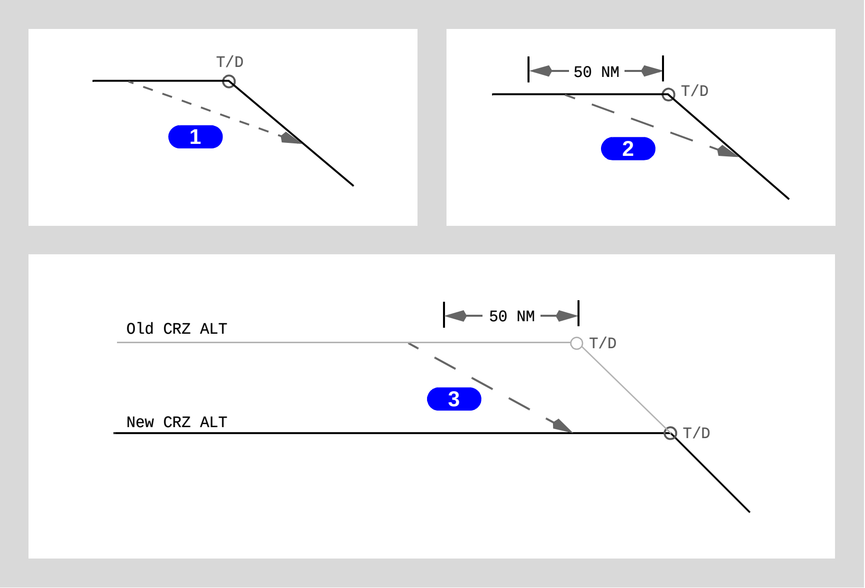
The DRAG REQUIRED message is inhibited when flaps are 5 or greater.

The THRUST REQUIRED message is inhibited when flaps are 20 or greater.

Early Descent

When a descent is started before the T/D, VNAV commands a descent at a reduced descent rate until the descent path is intercepted.

Start an early descent by setting a lower altitude and selecting the DES NOW prompt on the DES page or by pushing the MCP altitude selector. In an early descent, the autothrottle mode annunciation is initially THR, followed by HOLD, allowing the pilot to adjust the rate of descent. The pitch mode is VNAV SPD.



1 DES NOW

Use the DES NOW prompt on the VNAV DES page. VNAV starts an early descent and captures the off-idle descent path.

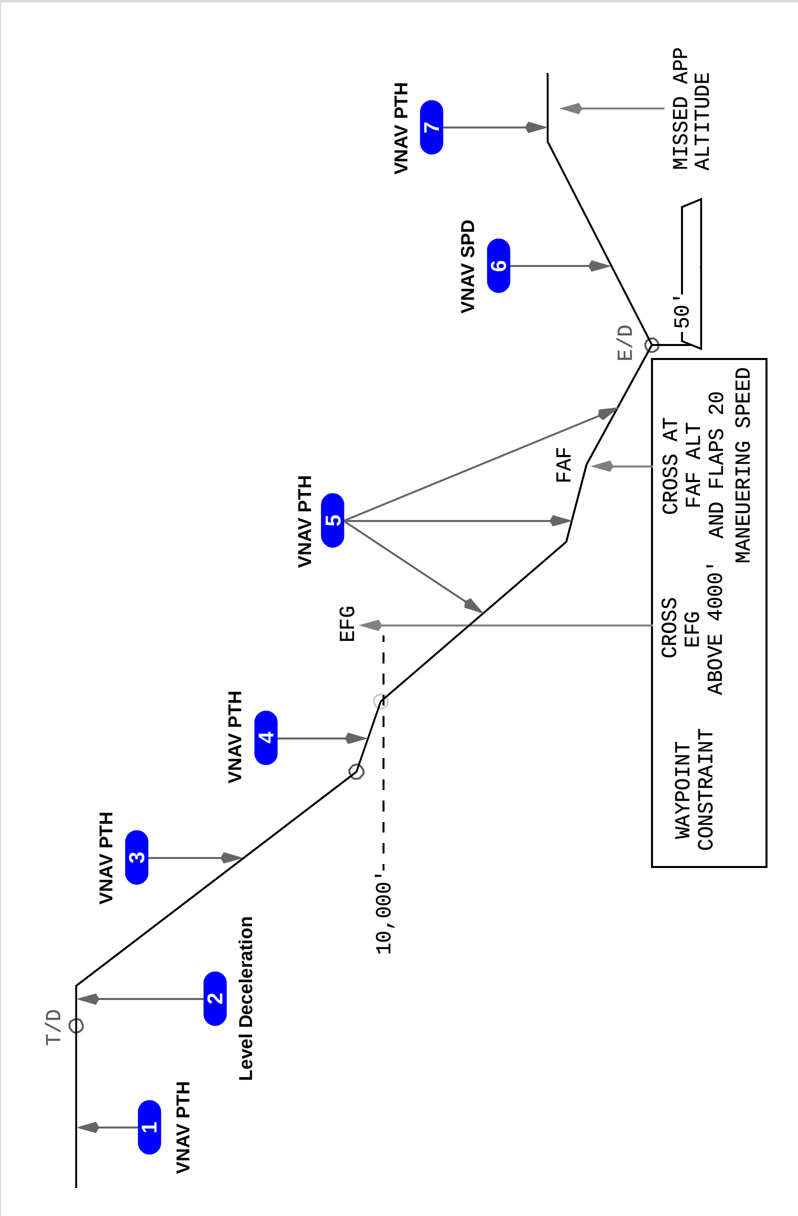
2 Within 50 NM of Top of Descent Point

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 the top of descent, FMC transitions to descent and commands the airspeed to ECON descent speed and maintains altitude in VNAV PATH.

The T/D green circle indicates the point where deceleration to ECON DES speed begins. After sequencing this point, the T/D green circle reappears indicating the end of the deceleration segment and intersection of the descent path.

3 Descent

Nearing descent speed, VNAV commands a descent in VNAV PATH at ECON descent speed.

4 Descent deceleration phase

Before the speed transition 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 approach condition may be delayed if the flight crew manually inserts, bypasses, or deletes an approach waypoint on the LEGS page.

The FMC transitions out of "on approach" under the following conditions:

- 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 glidepath 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 glidepath angle, VNAV commands level flight until the airplane intercepts the descent path

Note: Display of a specified glidepath 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.

Integrated Approach Navigation

Integrated Approach Navigation allows the use of consistent procedures for all types of instrument approaches. Any approach that has a Glide Path Angle (GP) published in the navigation database can be flown using procedures, indications and alerts similar to those used for an ILS approach.

Note: QFE operation is not authorized.

IAN supports the following approach types:

- B/CRS
- GPS
- IGS (G/S selected OFF)
- ILS (G/S selected OFF)
- LDA
- LOC (G/S selected OFF)
- NDB
- RNAV
- SDF (G/S selected OFF)
- VFR
- VOR

Depending on the type of approach flown, the FMC can provide:

- glidepath (G/P) deviations from the defined VNAV path
- final approach course (FAC) deviations from the defined LNAV path
- a source for deviation scales
- distance to the missed approach waypoint

When an approach is entered into the active route, the FMC generates the approach path information based on the details contained in the navigation database. IAN uses flight path guidance from the FMC, the navigation radios, or a combination of both.

RNP and vertical RNP are used to scale the displayed FAC and G/P deviations. RNP values can be accessed from POS REF 2/4 and RNP PROGRESS 4/4.

For a VFR approach using IAN procedures, the FPA can be accessed from the ARRIVALS page once a VFR approach is selected.

Missed Approach

A missed approach is accomplished by selection of either TOGA switch. The following features are available:

- VNAV can only be activated when the airplane climbs above 400 feet radio altitude
- if an LNAV path is available, LNAV automatically arms and activates:
  - above 50 feet radio altitude when autopilot is not engaged, or
  - above 200 feet radio altitude when autopilot is engaged

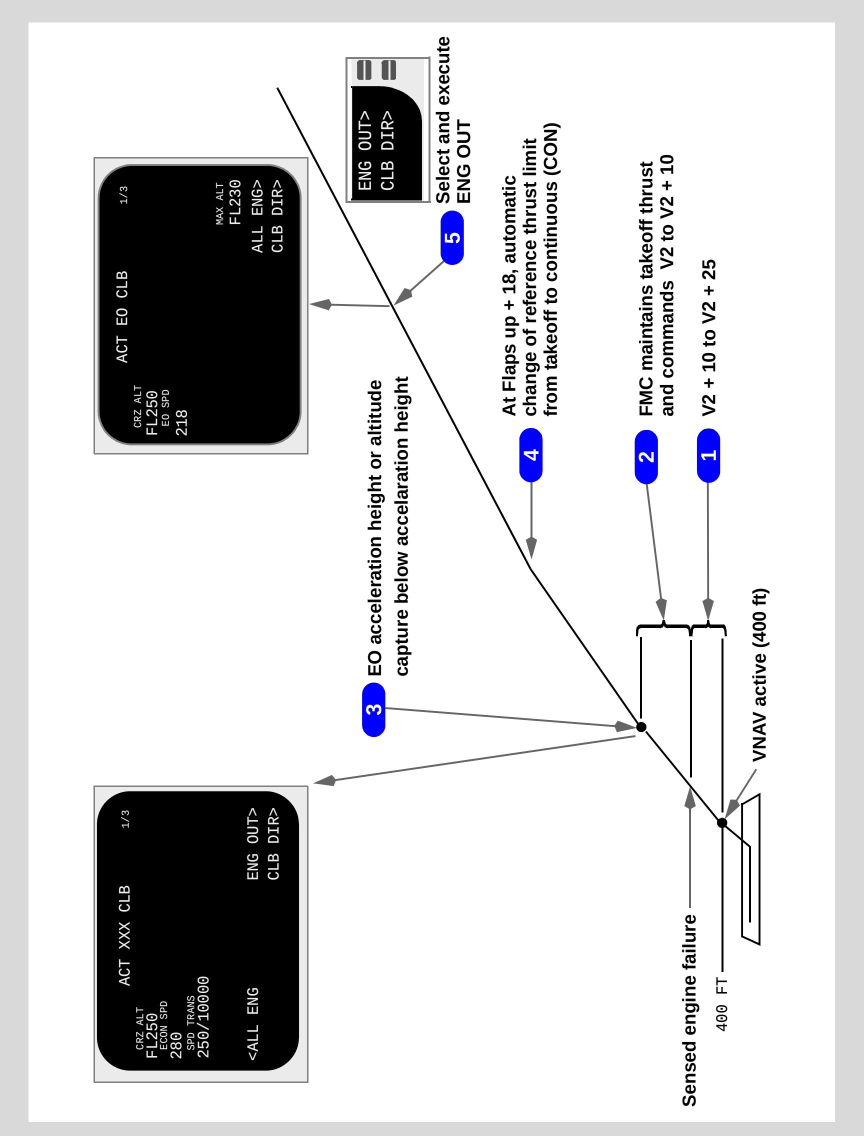
  Note: Automatic activation of LNAV following TO/GA from a land 2 or land 3 approach causes the autopilot to discontinue control of the rudder. During an engine out missed approach, manual control of the rudder may be necessary to prevent large roll and yaw excursions.

  Note: Route discontinuities after the missed approach point prevent the TO/GA to LNAV function from engaging.

- all descent altitude constraints below the current airplane altitude are deleted; the waypoints are retained in the active flight plan
- the new cruise altitude becomes the higher of the MCP altitude or the highest altitude in the missed approach procedure
- the FMC transitions from active descent to active climb. This transition also occurs when the airplane climbs toward the MCP altitude and flaps are retracted from a landing position (25 or 30 towards 20). For example, when a missed approach is accomplished without pushing the TO/GA switch.
- the VNAV speed target changes to the flaps up maneuvering speed
- 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 climb phase, best hold speed, or ECON cruise (above speed transition altitude)
- the FMC displays the missed approach segment in cyan to denote the inactive segment of the approach procedure. When sequencing the missed approach point, the missed approach becomes active and the cyan path turns magenta.

Engine Out Operation

Takeoff and Climb



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. The scratchpad displays T/O ENGINE OUT.

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 (TO). The FMC loads the EO SID as a flight plan modification. The modification may be either executed or erased.

3 Acceleration Height

Condition: at acceleration height or altitude capture below acceleration height.

Result: VNAV commands an acceleration to flaps up maneuver speed + 20 kts, limited by airplane configuration (flap placard). The VNAV climb page title shows ACT XXX KT CLB page.

4 Thrust Reduction

Condition: airplane has accelerated to flaps up maneuver speed + 18kts

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.

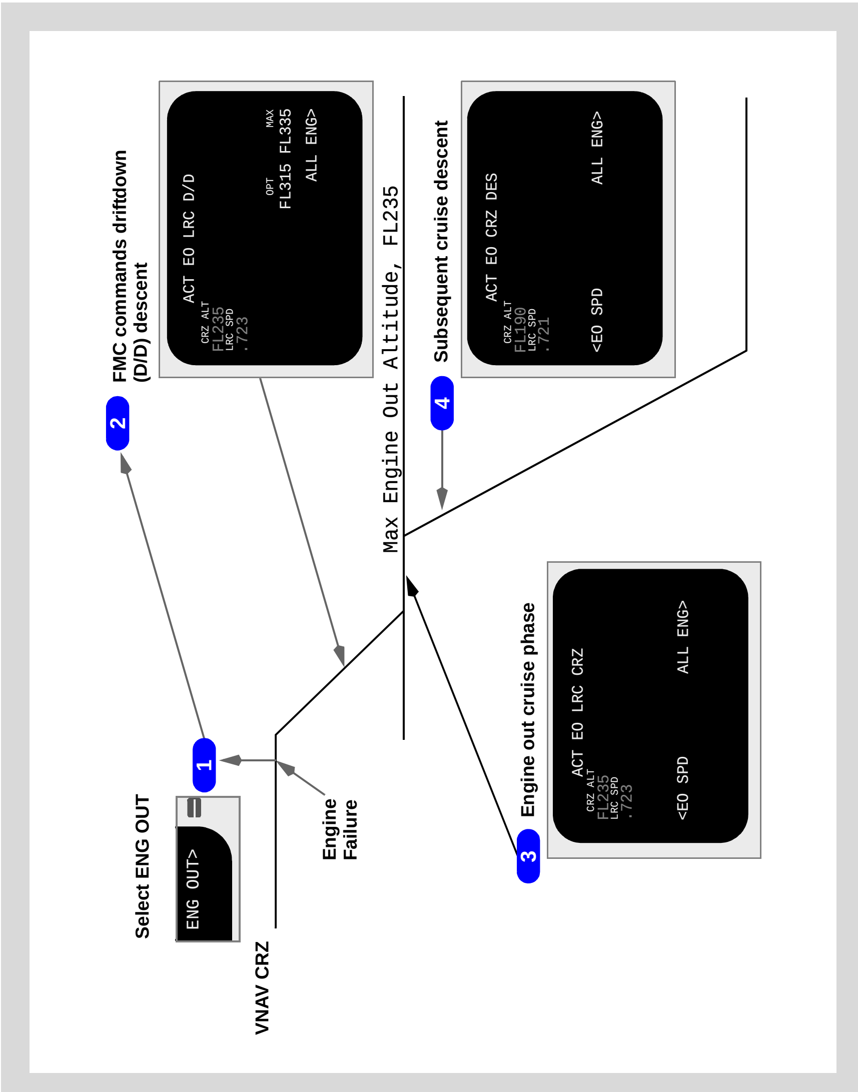
5 VNAV Climb (Engine Out)

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.

Cruise (Above EO Max Alt)

When the airplane is above the engine out maximum altitude, selection of the ENG OUT> prompt creates a modification and displays applicable engine out driftdown (D/D) performance data. Setting the altitude window lower and executing the modification activates engine out driftdown.



1 Engine Out Modification

Condition: Select the ENG OUT> prompt on the VNAV CRZ page.

Result: The FMC creates a modification and displays applicable engine out driftdown (D/D) performance data.

2 Drift Down Execution

Condition 1: Set the MCP altitude at or below E/O MAX altitude and execute the FMC modification. This Condition assumes clearance is approved to descend slowly to a non-standard altitude; for example, FL235.

Result: The autothrottle advances operating engines to CON thrust. VNAV commands the driftdown and E/O LRC SPD. The E/O MAX altitude becomes the cruise altitude displayed in 1L. The descent rate is controlled to a minimum of 300 feet per minute (fpm). Time and distance for the D/D to E/O MAX altitude display at 2R. VNAV captures the E/O MAX altitude and commands engine out LRC cruise.

Two other ways to activate EO D/D (to the clearance altitude) are discussed below.

Condition 2: Execute the ENG OUT modification. Then, set the clearance altitude (lower than E/O MAX) in the MCP and push the MCP altitude selector.

Result: Initially, the airplane remains at the MCP altitude, the pitch mode changes to VNAV ALT, the reference thrust limit is CON, and FMC speed is E/O LRC SPD. After setting the MCP altitude window and pushing the altitude selector, the airplane descends in a VNAV driftdown to the clearance altitude in 1L. Initial descent rate may be greater than Condition 1, depending how much airspeed is lost before pushing the altitude selector. If the airspeed has decreased below E/O LRC SPD, the descent rate increases to regain the airspeed.

Condition 3: Set the clearance altitude (lower than E/O MAX) in the MCP, push the altitude selector; then, after the descent is established, execute the FMC modification (ENG OUT).

Result: After pushing the altitude selector, the airplane descends in a normal VNAV cruise descent at four-engine economy cruise speed. The thrust limit is CLB/CRZ and the autothrottle maintains cruise airspeed. Executing the FMC modification while still above E/O MAX altitude sets the driftdown descent airspeed to E/O LRC SPD. The reference thrust limit becomes CON. The airplane initially descends at economy cruise airspeed and approximately 1,250 fpm. After executing the ENG OUT modification, the commanded airspeed is E/O LRC SPD. The rate of descent decreases to a minimum of 300 fpm.

3 Engine Out Cruise

Engine out cruise operates like normal cruise with engine out cruise speeds. Thrust limit remains in CON. VNAV PTH displays as the pitch mode.

4 Subsequent Cruise Descent

Condition: FMC in engine out mode, setting a lower MCP altitude, and pushing the altitude selector.

Result: VNAV cruise descent at approximately 1,250 feet per minute at E/O LRC airspeed. The thrust limit remains CON and the autothrottle adjusts to maintain the E/O LRC airspeed. The altitude set on the MCP becomes the CRZ ALT on the EO CRZ page.

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
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Deferred Systems Content

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This section contains deferred systems description content.

Deferred content is printed with strike-through text. For example, ~~Q-CLB - quiet climb.~~

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 airline modifiable information (AMI) database contains airline specified data. The scratchpad message CHECK AIRLINE POLICY displays if the FMC senses a conflict in an AMI parameter after a new AMI load.

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 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 flaps up maneuver speed + 18 kts. 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 1 or 5 for flaps 1 or 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 CLB 1 or CLB 2 on the THRUST LIM page. The scratchpad message TAKEOFF SPEEDS DELETED displays.

Derated Thrust Climb

During climb, CLB 1 and CLB 2 derates are gradually removed. In cruise, the thrust reference defaults to CLB or CRZ as set by maintenance.

806
Two fixed climb thrust derates can be selected on the THRUST LIM page. CLB 1 uses a 10% derate of CLB thrust to 10,000 feet, then increases thrust linearly with altitude to CLB thrust at 15,000 feet. CLB 2 uses a 20% derate of CLB thrust to 10,000 feet, then increases thrust linearly with altitude to CLB thrust at 15,000 feet.

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Two fixed climb thrust derates can be selected on the THRUST LIM page. CLB 1 uses a 10% derate of CLB thrust to 10,000 feet, then increases thrust linearly with altitude to CLB thrust at 30,000 feet. CLB 2 uses a 20% derate of CLB thrust to 10,000 feet, then increases thrust linearly with altitude to CLB thrust at 30,000 feet.

Note: When washout is complete, the derate 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 10 percent, maximum climb thrust is selected by the FMC. For takeoff thrust reductions or derates from 10 percent to less than 20 percent, CLB 1 is selected. CLB 2 is selected for all takeoff thrust reductions or derates equal to or greater than 20 percent. On the ground, the pilots may override the automatic climb derate selection after the takeoff selection is complete.

Quiet Climb

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~~With QUIET CLIMB selected ON and VNAV active, the FMC provides predictions for an all-engine climb path including altitude, speed, ETA, and altitude-based turn points. The FMC also calculates Quiet Climb thrust ensuring a minimum climb profile for one engine out. If an engine out condition is detected before reaching the start of the Quiet Climb profile, VNAV terminates Quiet Climb and initiates engine out climb.~~

Quiet Climb

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With QUIET CLIMB selected ON and VNAV active, the FMC provides predictions for an all-engine climb path including altitude, speed, ETA, and altitude-based turn points. The FMC also calculates Quiet Climb thrust ensuring a minimum climb profile for one engine out. If an engine out condition is detected before reaching the start of the Quiet Climb profile, VNAV inhibits Quiet Climb and initiates engine out climb.

Quiet Climb is disabled when one of the following actions or conditions is met:

- selecting Quiet Climb OFF on the TAKEOFF REF or THRUST LIM page
- changing thrust selection on the THRUST LIM page
- selecting TO/GA
- pushing the THR switch
- VNAV initiates a level off
- early flap retraction
- engine out detection before reaching the start of the Quiet Climb profile
- selection of a different vertical mode

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. Manual fuel entry made during preflight clears at engine start and the totalizer value is used. 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 for the inactive route or for the active route in a modified state, and the estimated fuel at destination 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

If the primary FMC fails, LNAV and VNAV de-activate, and the autothrottle disconnects. The EICAS message FMC LEFT, RIGHT displays. It will be necessary to select the secondary FMC. It may be necessary to activate and execute the flight plan, enter necessary performance data, and select LNAV and VNAV.

If the secondary FMC fails, LNAV, VNAV, and the autothrottle remain engaged and operative. The EICAS message FMC LEFT, RIGHT displays.

Note: If the CDU 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 L, R OPERATION displays after loss of the onside FMC.

In flight, the scratchpad message SINGLE FMC L, R 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 EICAS 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 L, R OPERATION displays on the CDU with the operative FMC.

Dual FMC Failure

Software failures and power interrupts can impact one or both FMCs. In most cases, the FMCs automatically recover in less than 1 minute. After the FMCs recover; ZFW, RESERVE fuel, CRZ ALT, and COST INDEX should be verified or entered, and the route activated. This will restore FMC functionality.

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 44 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.

Flight Management, Navigation Chapter 11
FMC Preflight Section 40

Deferred Systems Content

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This section contains deferred and interim systems description content.

Deferred content is printed with strike-through text. For example, ~~XXXXz ALTN page displays.~~

Interim systems content is printed in italics. For example, *If performance data changes due to new pilot entered values, such as takeoff flap setting:*

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 reference 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.

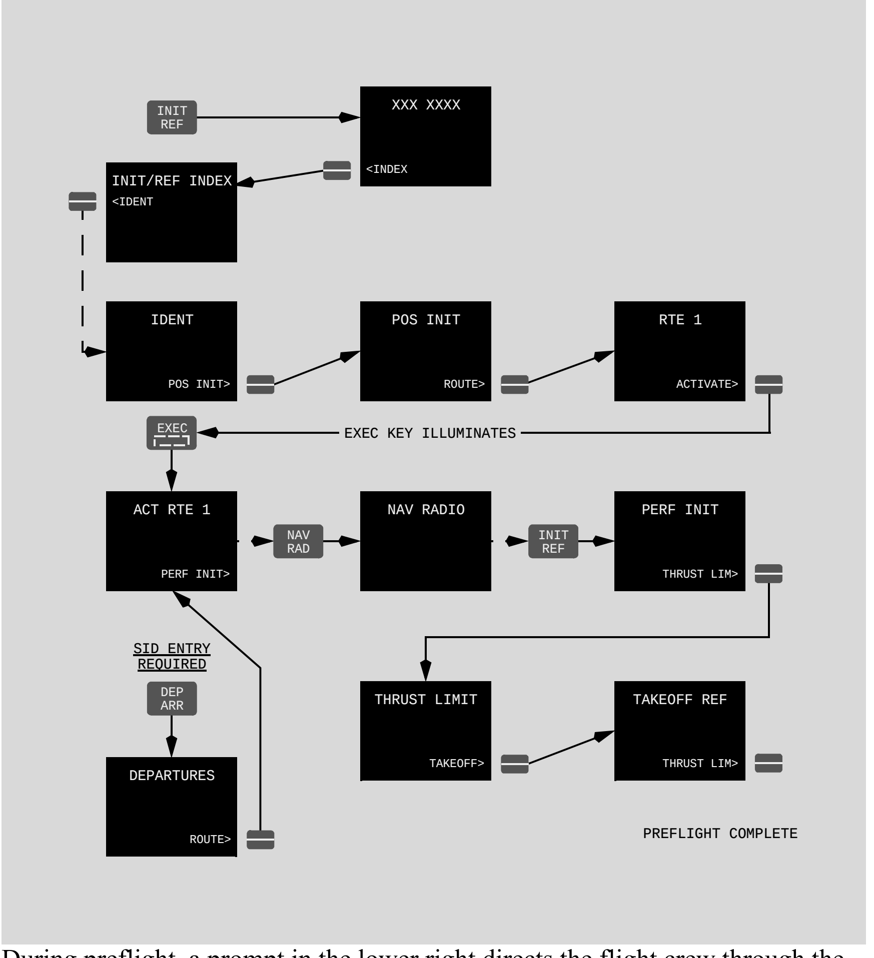
Preflight Page Sequence

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 the RTE LEGS page 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.

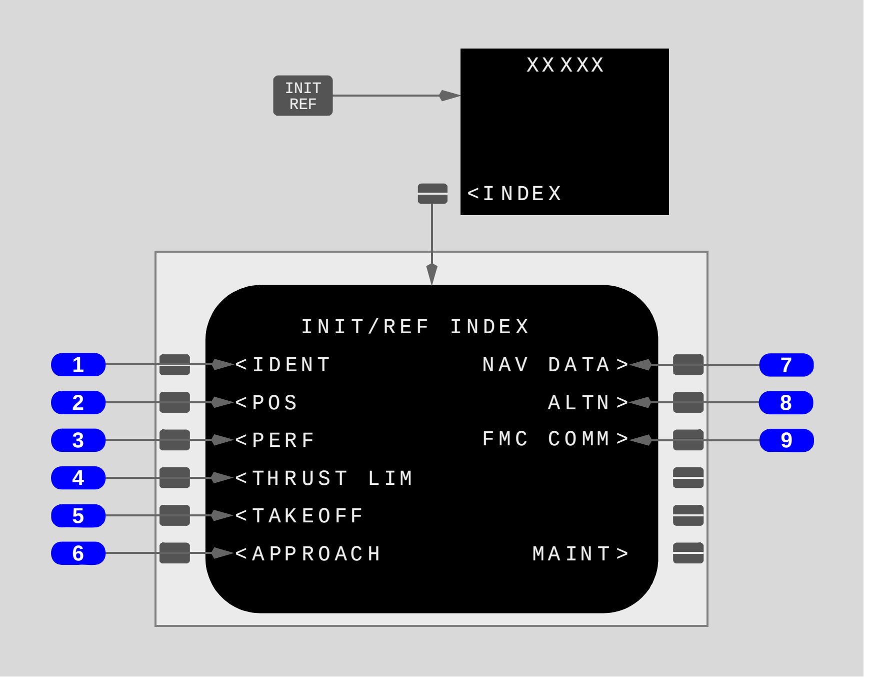
VNAV performance is improved if forecast winds and temperatures are entered during preflight. Wind and temperature data for specific waypoints is entered on the WIND page described in the FMC Cruise section of this chapter.

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.

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8 **Alternate (ALTN)**

~~XXXXz ALTN page displays. The page number depends on whether a pending alternate diversion exists.~~

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8 **Alternate (ALTN)**

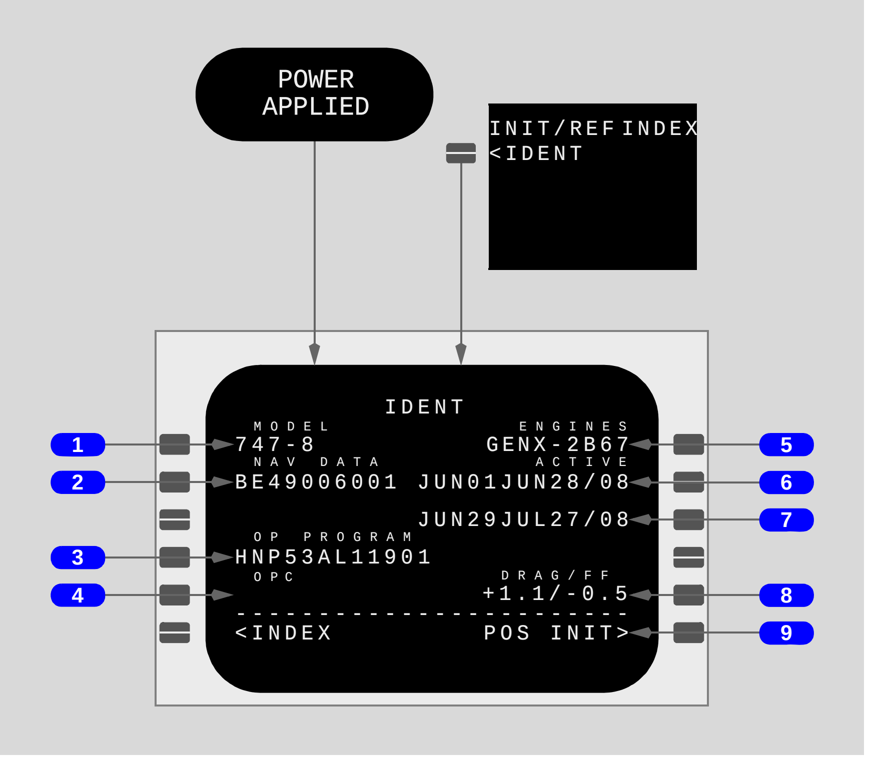
XXXXz ALTN page displays. The page number depends on whether a pending alternate diversion exists.

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)

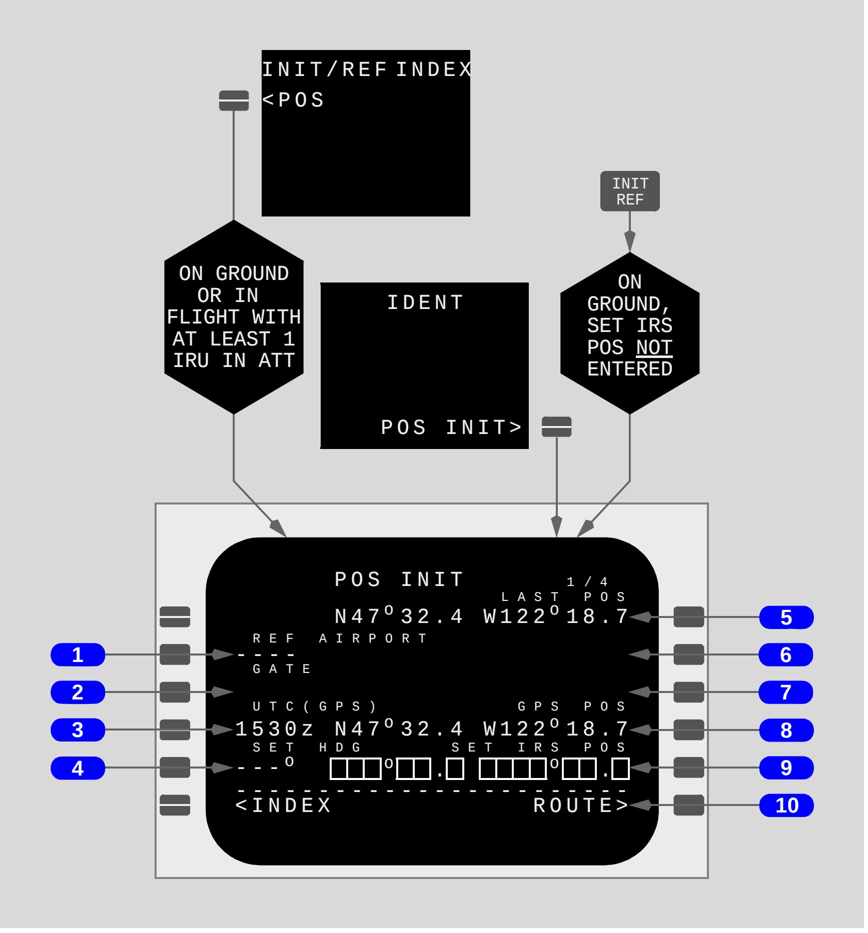
Displays airplane drag and fuel flow correction factors.

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 MMMDD/YY 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.

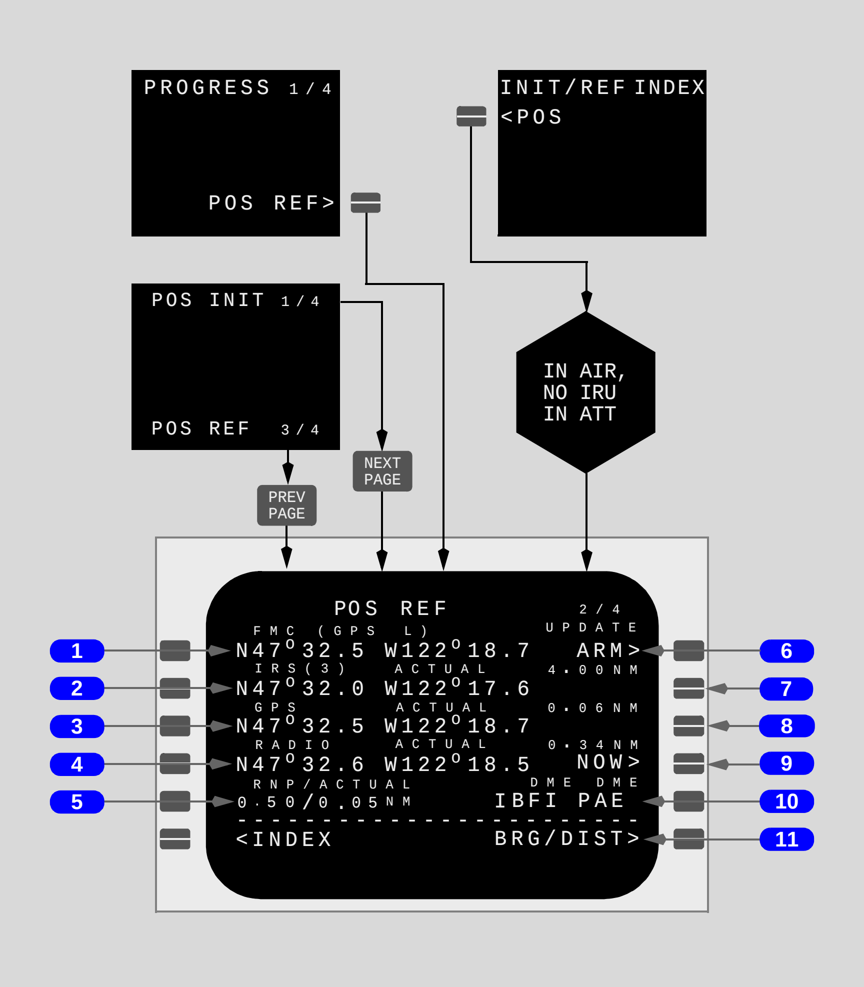
10 ROUTE

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 indentifiers 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.

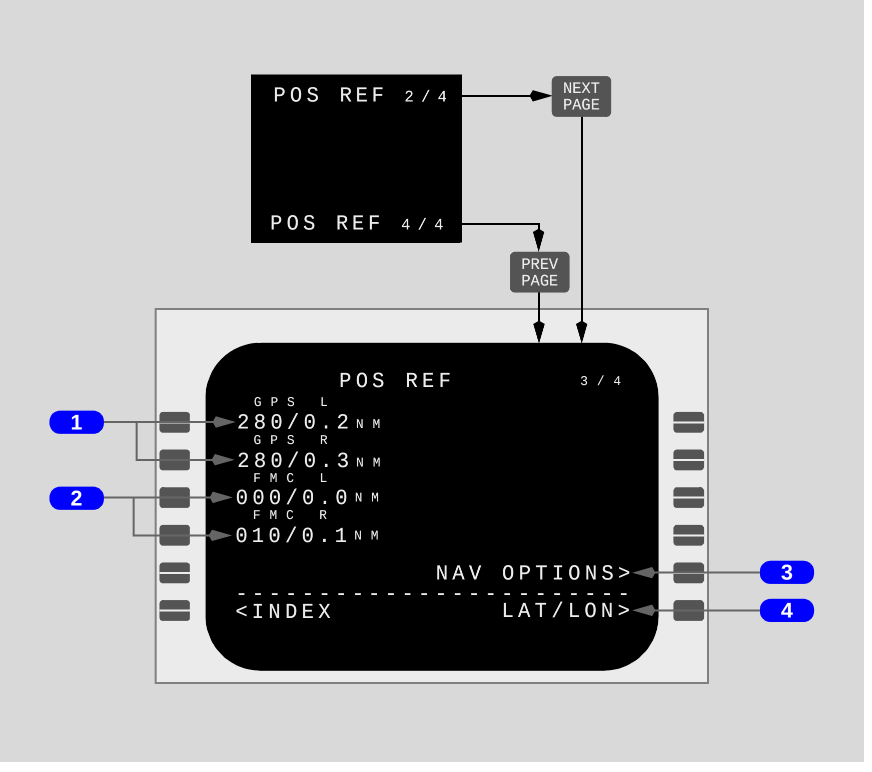
Push -

- 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)

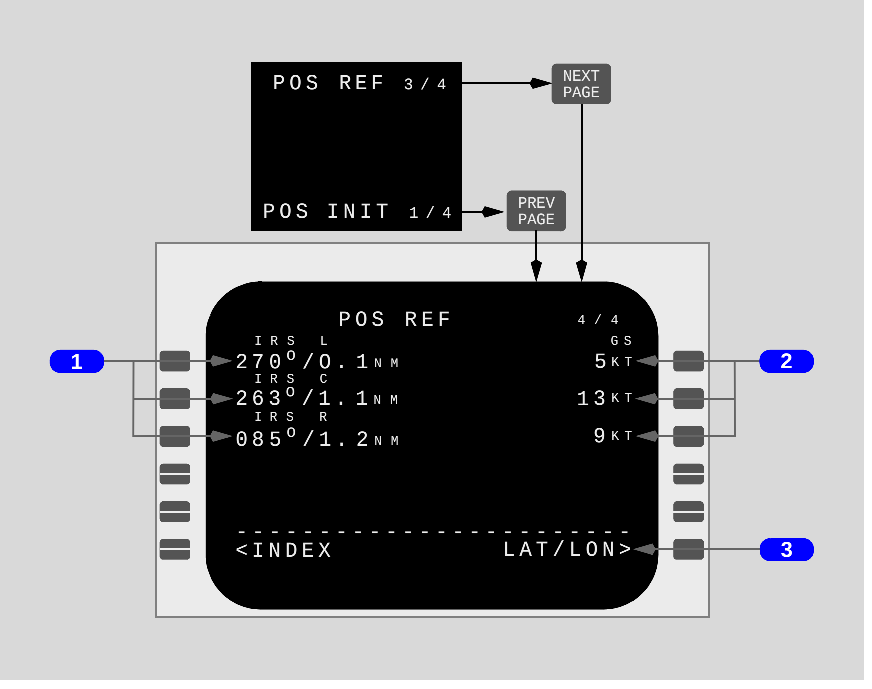
Selection displays the NAV OPTIONS page.

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.

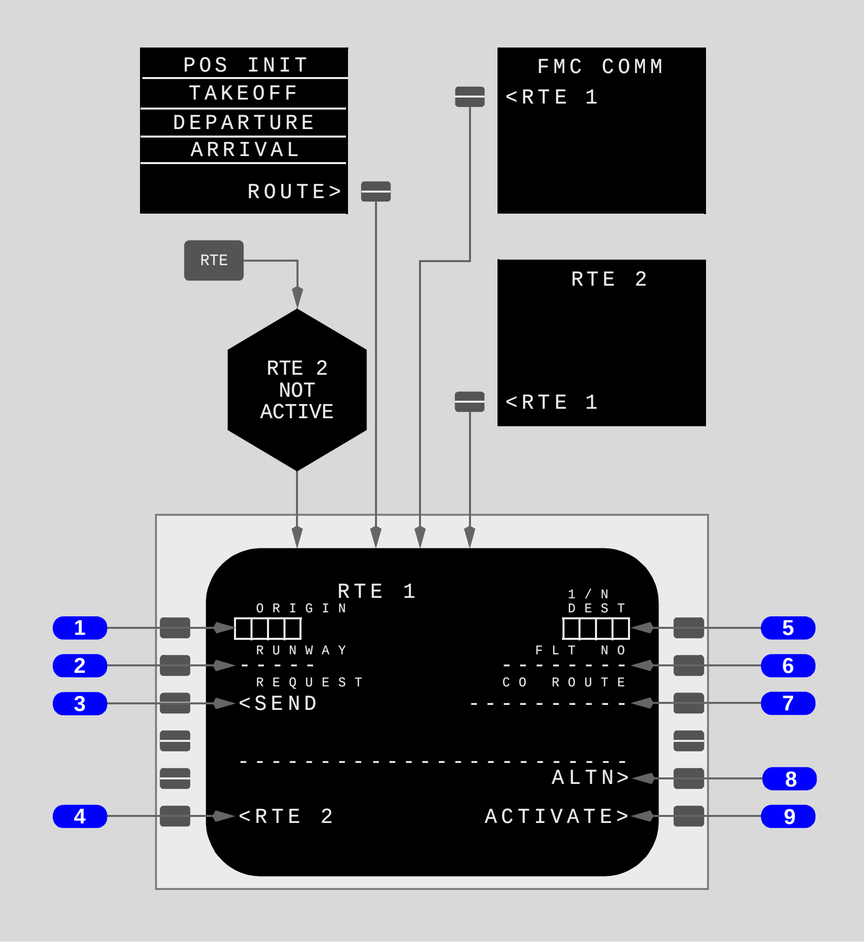
Preflight Pages - Part 1B

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.

914
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.~~

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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 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.

Transponder transmits flight number to ATC.

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.

914

8 **Alternate (ALTN)**

~~Push - displays the XXXX ALTN page when a pending alternate diversion exists.~~

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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.

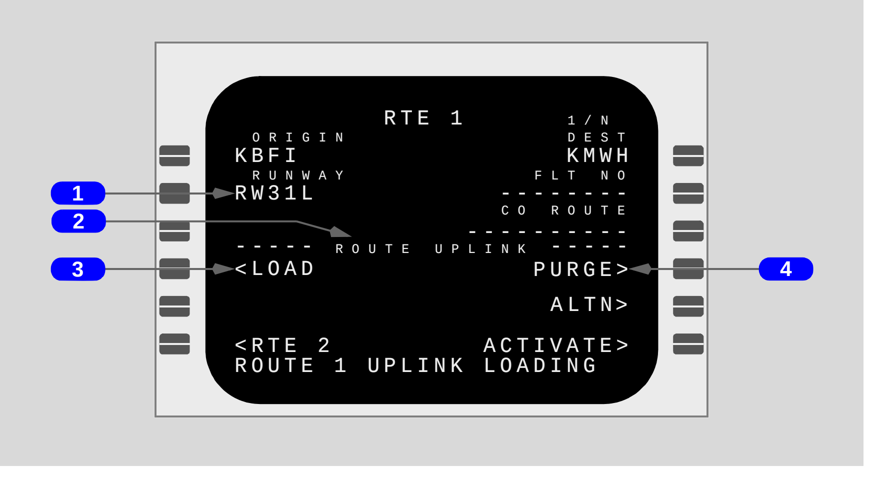
Push - arms the selected route for execution as the active route.

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 -

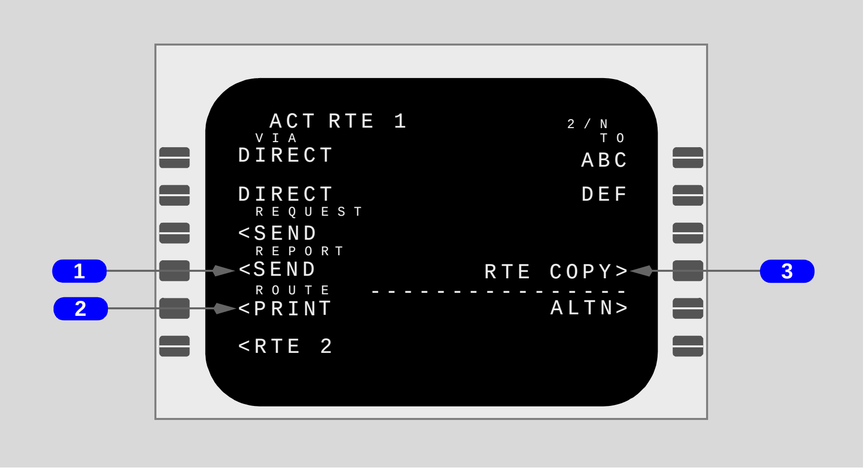
- loads uplinked flight plan
- in flight, when uplinked flight plan applies to active route, EXEC light illuminates and <ERASE displays at 6L
- when route inactive, blanks PURGE at 4R
- displays scratchpad message ROUTE 1 UPLINK LOADING

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.

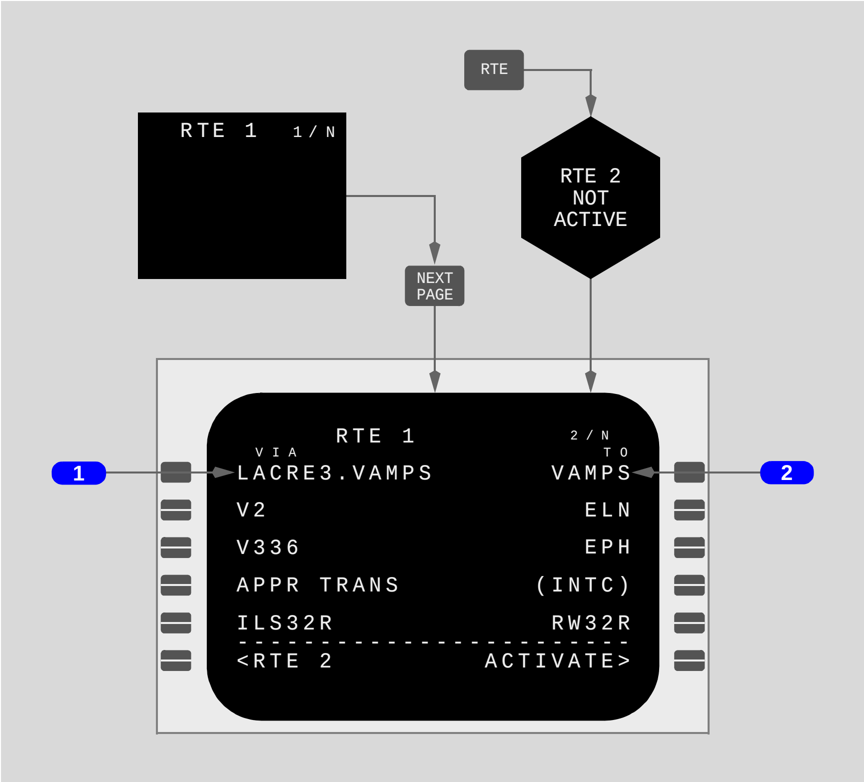
3 Route Copy (RTE COPY)

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 columnn.

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. The transition from the offset back to the original route displays as a dashed magenta line.

1 Route Offset

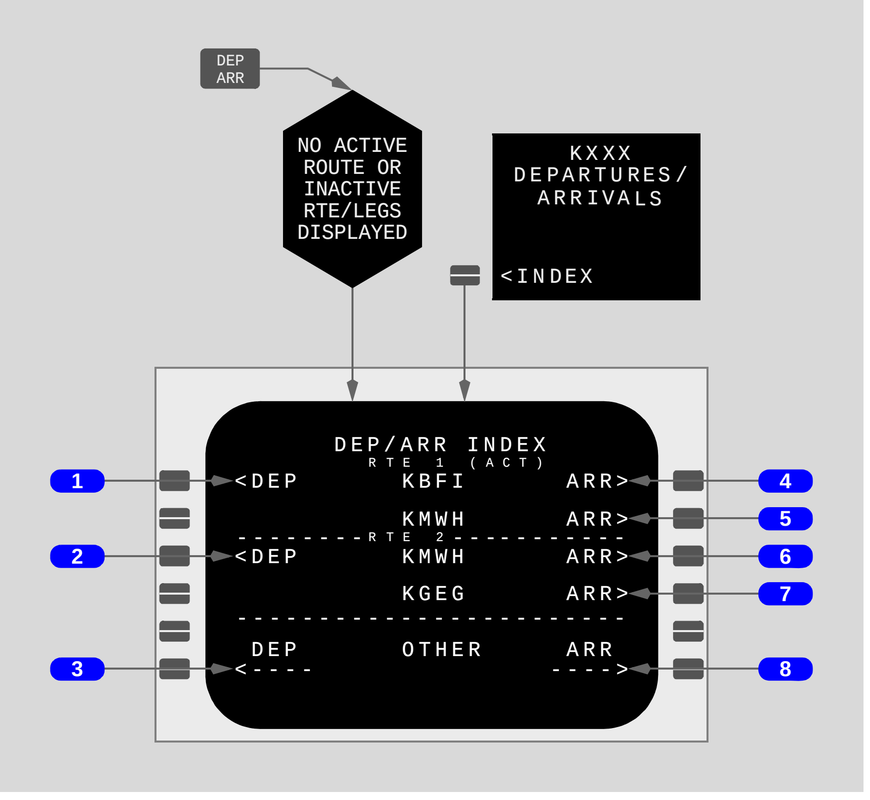
Valid entry is L (left) or R (right) XX (XX is any number between 1 and 99).

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.

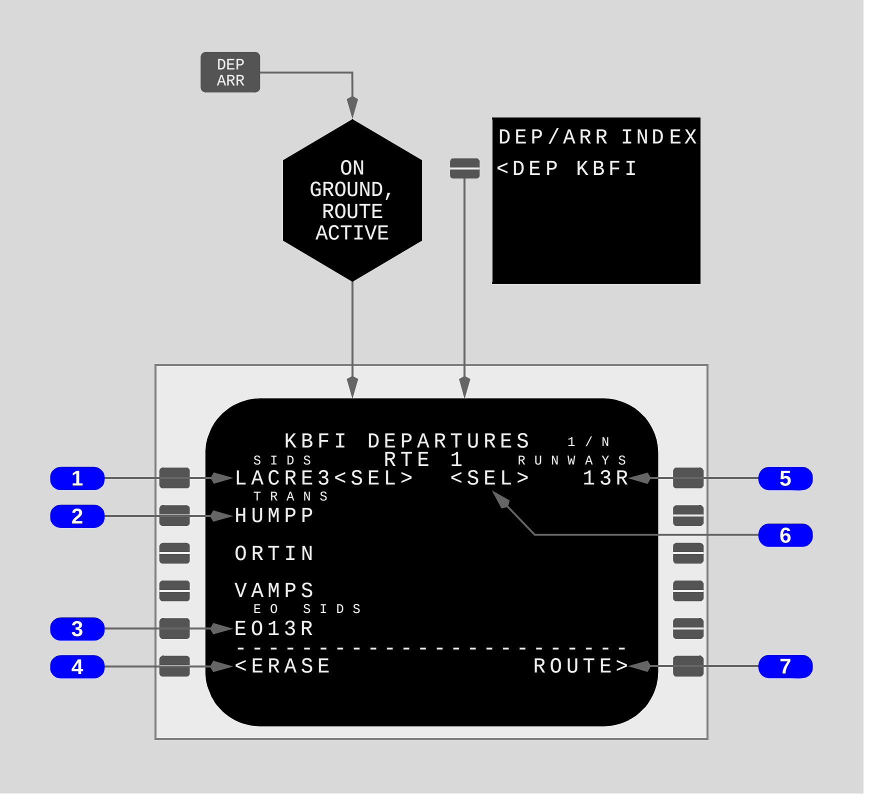
8 **Arrival (ARR) - Other**

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

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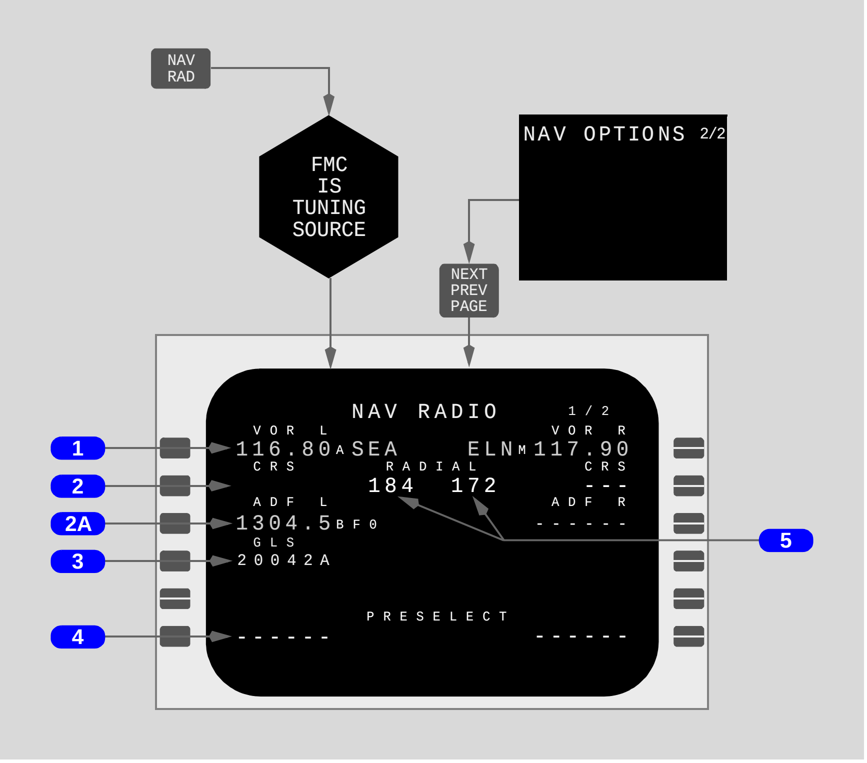
VOR, ILS, and GLS navigation radios are normally autotuned by the FMC. NAV RADIO page displays the VOR, ILS, and GLS radio status and allows manual control of these radios. Entering data on this page tunes the selected navigation radio. VOR courses can also be entered.

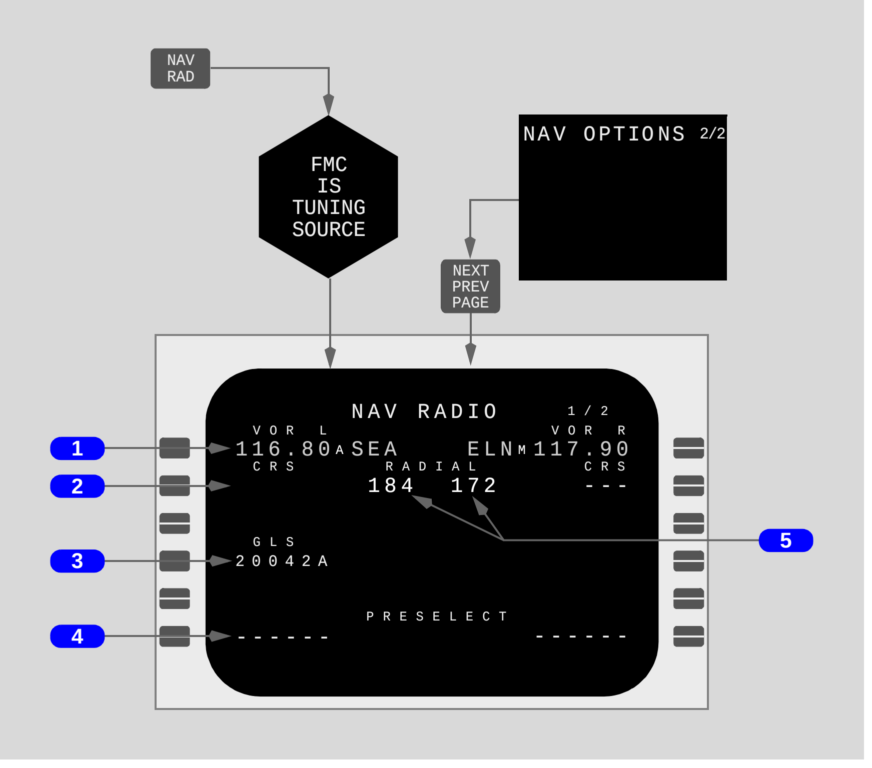
914

VOR, ILS, and GLS navigation radios are normally autotuned by the FMC. NAV RADIO page displays the VOR, ADF, ILS, and GLS 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.

914



806



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.

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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 GLS Channel or ILS Frequency and Course

The ILS/GLS receivers operate in FMC autotune or manual-tuning modes. The FMC autotunes ILS frequency and course or GLS channels when a localizer-based or GLS approach is selected. When the ILS/GLS is not autotuned or manually tuned, the FMC resets to PARK. This removes the displays from the PFD.

ILS/GLS 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; or for IAN, FAC or G/P is captured
- only the flight director is ON and either the localizer or glideslope is captured (or for IAN, FAC or G/P 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/GLS tuning is enabled when:

- pushing either TOGA switch
- disengaging the autopilot and switching off both flight directors.

GLS:

A valid entry is a GLS channel from 20000 to 39999.

ILS:

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.

GLS Tuning Status

Display initializes to PARK. Tuning status displays are:

- xxxxx PARK - GLS autotuned for selected approach but not being used
- A (autotune) - GLS autotuned for approach guidance
- M (manual) - GLS 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 - Channel and Park

GLS channel and PARK display when a GLS approach 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 GLS.

3 Tuning Status - Autotune

GLS channel and A display when an GLS approach 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 channel displays.

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 both of the following are true:

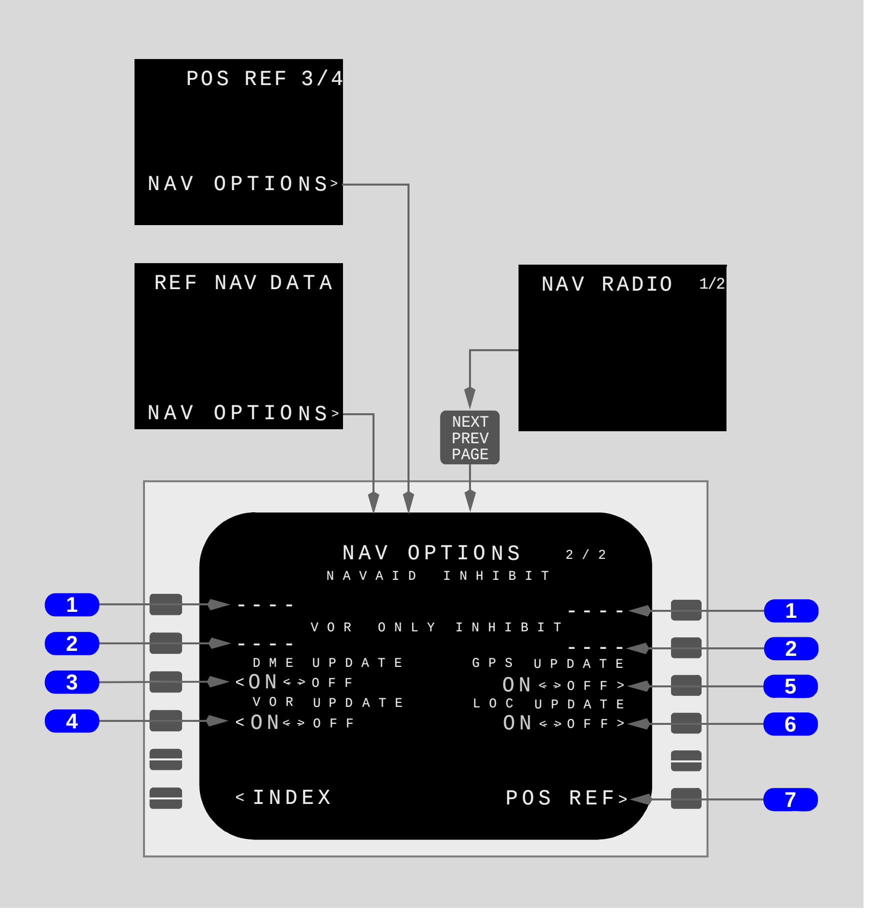
- an ILS, LOC, back course, LDA, or SDF approach has been selected to the active route, and
- the airplane is within 150 nm of the destination airport, 50 nm of T/D, or in FMC descent

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, green letters; OFF displays in small font, white letters.

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, white letters. "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.

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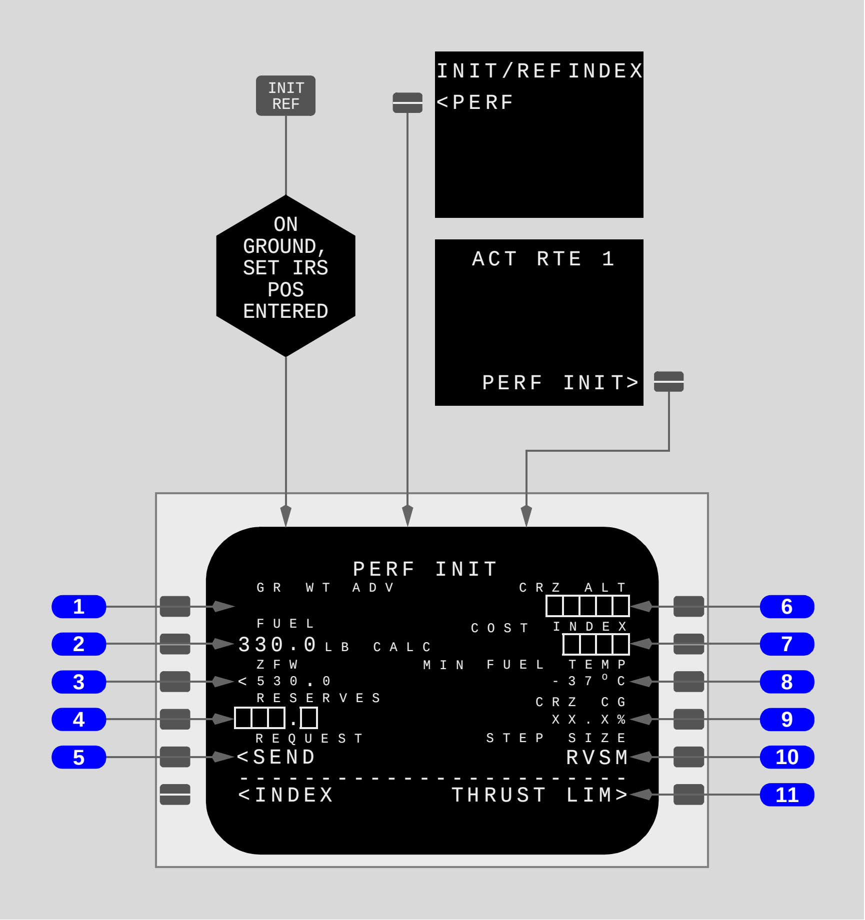

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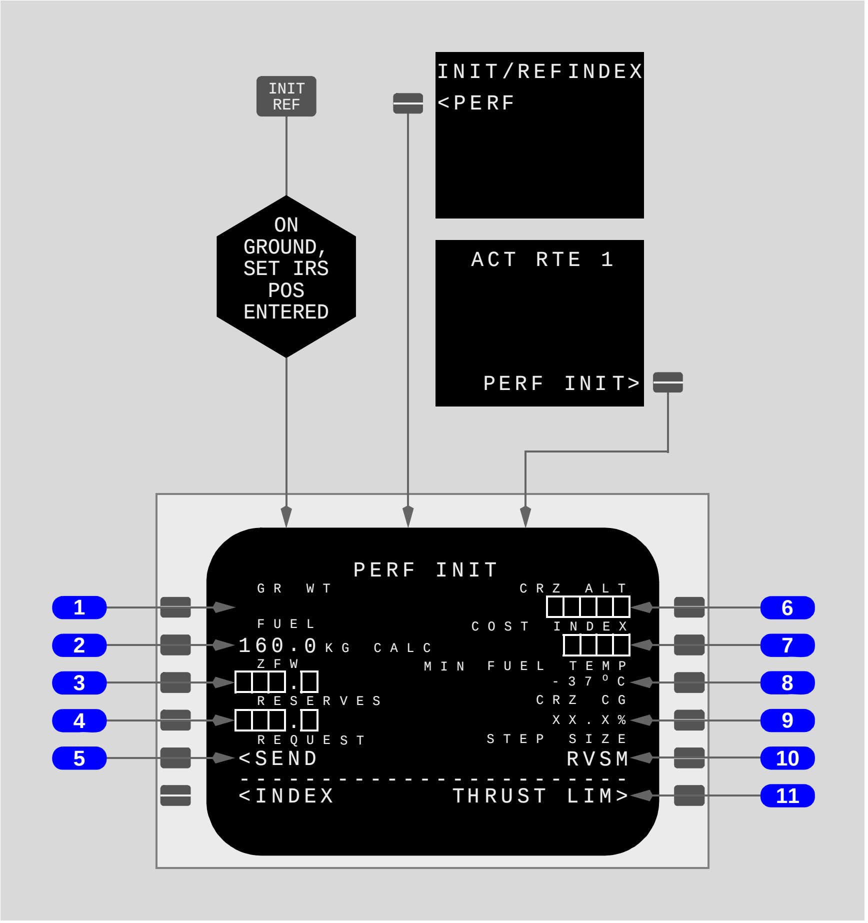

914

1 Gross Weight (GR WT)

The line title is GR WT ADV when gross weight is available from the weight and balance system (WBS).

Entry, selection, or deletion of airplane gross weight is inhibited.

Manual entry or selection of zero fuel weight (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. Accepting the PERF INIT uplink changes display to large font. If a large font ZFW was displayed prior to the uplink, "/YYY.Y" displays to the right where YYY.Y is the sum of the pre-uplink ZFW and the fuel weight.

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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.

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3 Zero Fuel Weight (ZFW)

ZFW can be manually entered or uplinked. Entry of ZFW results in calculation and display of gross weight.

When gross weight is available from the WBS, gross weight is not displayed in large font and with no PERF INIT uplink pending ACCEPT/REJECT, dataline displays <XXX.X in small font. With a PERF INIT uplink that includes ZFW is pending ACCEPT/REJECT, dataline displays XXX.X in small font. If a large font ZFW was displayed prior to the uplink, /YYY.Y displays in large font to the right where YYY.Y is the pre-uplink ZFW.

Valid entry is XXX or XXX.X.

When no data is available from the WBS and gross weight or ZFW have not been entered, boxers display.

Entry of a value after takeoff speeds are selected deletes V speeds and displays the scratchpad message TAKEOFF SPEEDS DELETED.

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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 oC.

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 messag 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.

914
Default value, 22.0, displays in small font.

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Default value, 11.0, displays in small font.

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.

914

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.~~

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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.

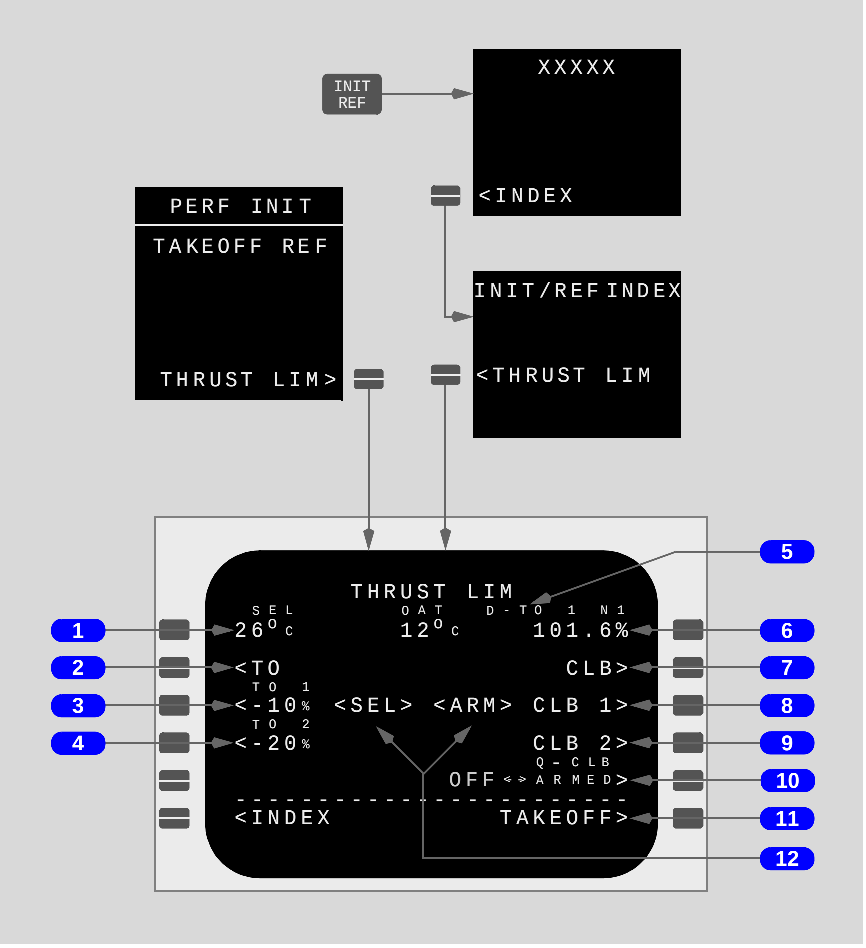
11 **Thrust Limit (THRUST LIM)**

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 N1 Limit

Displays takeoff N1 calculated by the thrust management system.

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.

914

10 QUIET CLIMB

~~Selection when OFF is displayed in green, large font arms the Quiet Climb System and changes ARMED to green, large font and OFF to white, small font.~~

~~Selection when ARMED is displayed in green, large font inhibits the Quiet Climb System and changes OFF to green, large font and ARMED to white, small font.~~

~~Following automatic transition to ON, the N1 thrust cutback value displays.~~

806

10 QUIET CLIMB

Push - alternately selects Quiet Climb ARMED or OFF.

OFF - displayed in green, large font. Quiet Climb is inhibited; this is the default state.

ARMED - displayed in green, large font. Reformats the TAKEOFF 2/2 page.

ON - displayed in green, large font. VNAV and autothrottle must be armed; automatic transition to ON from ARMED when N1 thrust cutback value calculated. If Q-CLB calculated N1 exceeds max continuous N1 thrust, OFF displays.

- on the ground, selection of a different runway causes OFF to display
- the scratchpad message TAKEOFF SPEED DELETED or Q-CLB UNAVAILABLE also causes OFF to display

11 TAKEOFF

Push - displays TAKEOFF REF page.

12 <SEL>, <ACT>

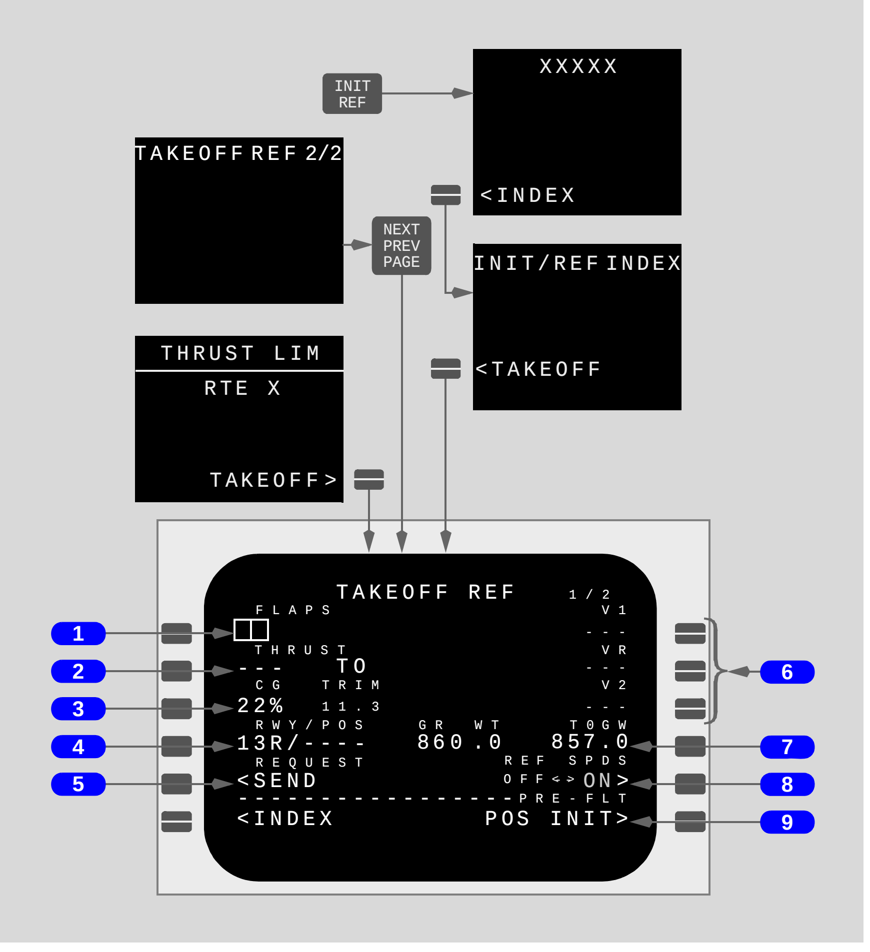
<SEL> - identifies selected takeoff thrust reference mode.

<ARM> - identifies armed climb thrust reference mode. <ARM> changes to <SEL> when armed climb mode becomes active.

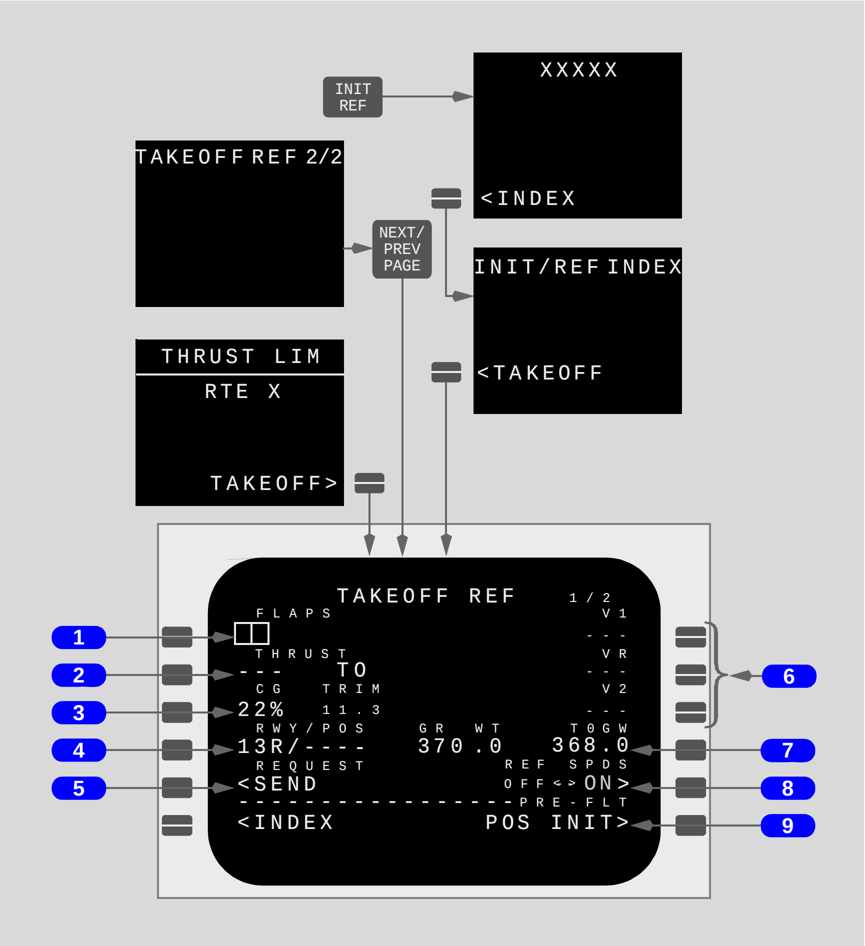
Takeoff Reference Page 1/2

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.

914

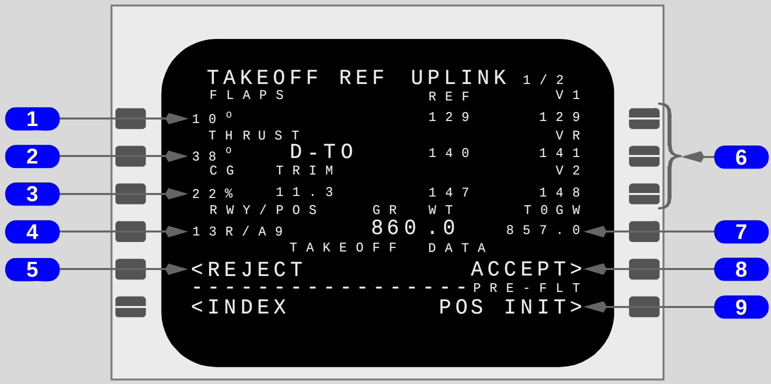


806


INIT REF
XXXXX
<INDEX
TAKEOFF REF 2/2
NEXT/ PREV PAGE
INIT/REF INDEX
<TAKEOFF
THRUST LIM
RTE X
TAKEOFF>
TAKEOFF REF 1/2
FLAPS
V1
THRUST
TO
VR
CG
TRIM
V2
22%
11.3
RWY/POS
GR WT
TOGW
13R/----
370.0
368.0
REQUEST
REF SPDS
<SEND
OFF<>ON>
PRE-FLT
<INDEX
POS INIT>
1
2
3
4
5
6
7
8
9

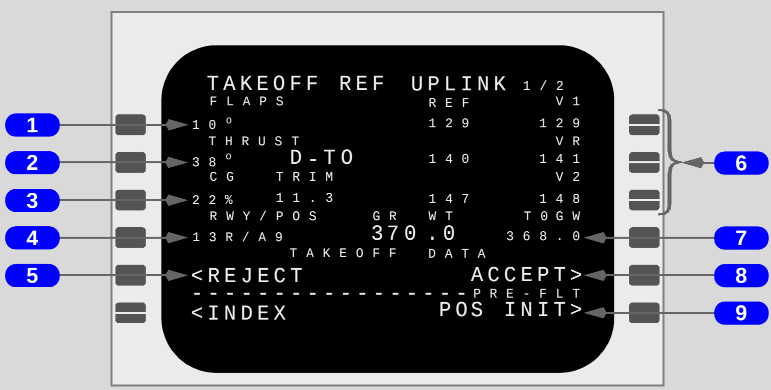
914

CDU following line selection of SEND and receipt of TAKEOFF data uplink pending ACCEPT/REJECT



806

CDU following line selection of SEND and receipt of TAKEOFF data uplink pending ACCEPT/REJECT



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.

806

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 (of CG expressed as a percentage of MAC) 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

914

3 Center of Gravity (CG), TRIM

CG displays in small font with caret. Calculated by FMC using WBS inputs.

Line selection or pilot entry displays CG in large font. Deletion of large font CG returns display of small font WBS CG value. Line title, "TRIM", displays only after a large font CG value displays.

Valid entries are one or two whole numbers (of CG expressed as a percentage of MAC) between the performance database limits.

Box prompts display if WBS CG value not available.

FMC computed trim displays in small font if within the stab trim green band range. Otherwise, the trim field remains blank.

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 (/).

806
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).

914
Valid position entry is a one or two numeric in the range 0-99. It must be followed by two zeros and preceded by a slash (preceding the entry with a "-" means a longer takeoff distance is available; for example, -0300 is 300 feet 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

Displays FMC calculated speeds when required information entered.

Flight crew entered or selected, or uplinked speeds display in large font and replace calculated speeds. Manually entered or accepted uplinked 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 the third engine is started, any combination of gross weight, OAT, or pressure altitude resulting in a change in any computed speed of more than one knot from the previously calculated speed, causes the FMC to calculate and display revised takeoff speeds.

7 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.

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.

914
~~Quiet Climb OFF (default state following FMC power up or flight complete):~~

806
Quiet Climb OFF (default state following FMC power up or flight complete):

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.

914
~~Quiet Climb ON:~~

806
Quiet Climb ON:

914

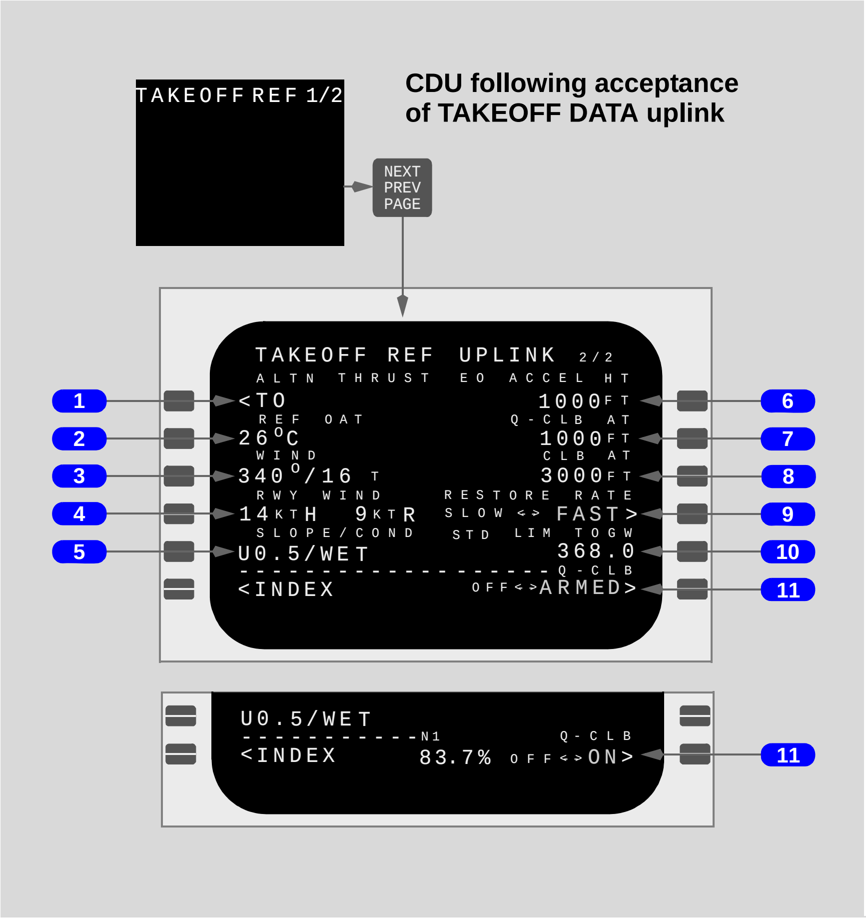
~~**Note:** Quiet Climb thrust reduction height is added to airport elevation causing thrust reduction at the desired MSL altitude. For example, for a airport elevation of 980 feet, an entry of 1020 "Q-CLB AT" height causes thrust reduction at 2,000 feet MSL. Entry of 3020 "CLB BY" height causes thrust to change to the armed climb thrust at 4,000 feet MSL.~~

806

Note: Quiet Climb thrust reduction height is added to airport elevation causing thrust reduction at the desired MSL altitude. For example, for a airport elevation of 980 feet, an entry of 1020 "Q-CLB AT" height causes thrust reduction at 2,000 feet MSL. Entry of 3020 "CLB BY" height causes thrust to change to the armed climb thrust at 4,000 feet MSL.

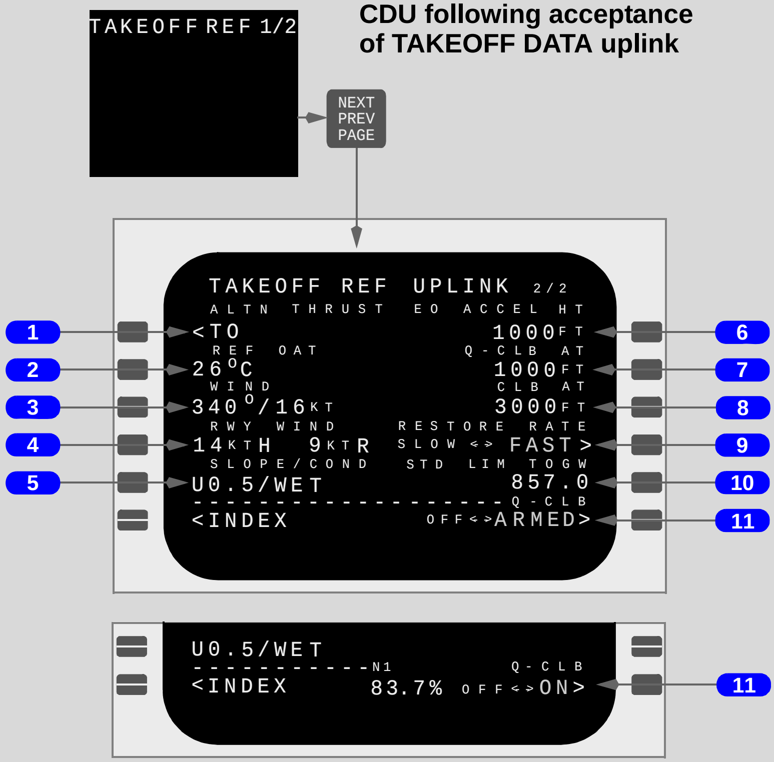
Takeoff reference page entries complete the normal preflight.

806

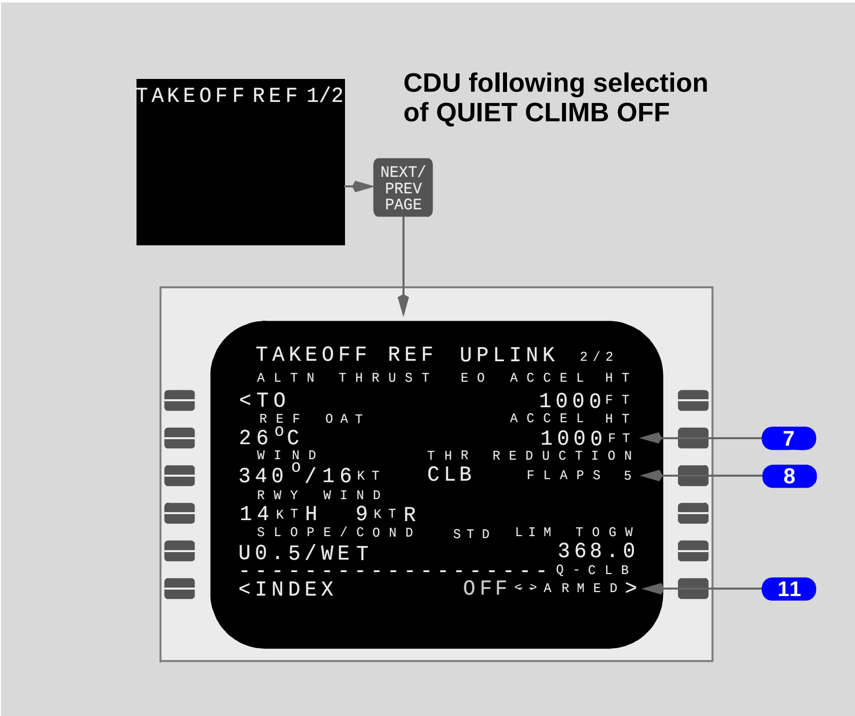

TAKEOFF REF 1/2
CDU following acceptance of TAKEOFF DATA uplink
NEXT PREV PAGE
TAKEOFF REF UPLINK 2/2
ALTN THRUST
<TO
REF OAT
26°C
WIND
340°/16 T
RWY WIND
14KTH 9KTR
SLOPE/COND
U0.5/WET
<INDEX
EO ACCEL HT
1000FT
Q-CLB AT
1000FT
CLB AT
3000FT
RESTORE RATE
SLOW <> FAST>
STD LIM TOGW
368.0
Q-CLB
OFF<>ARMED>
1
2
3
4
5
6
7
8
9
10
11
U0.5/WET
N1
<INDEX
83.7%
Q-CLB
OFF<>ON>
11

914

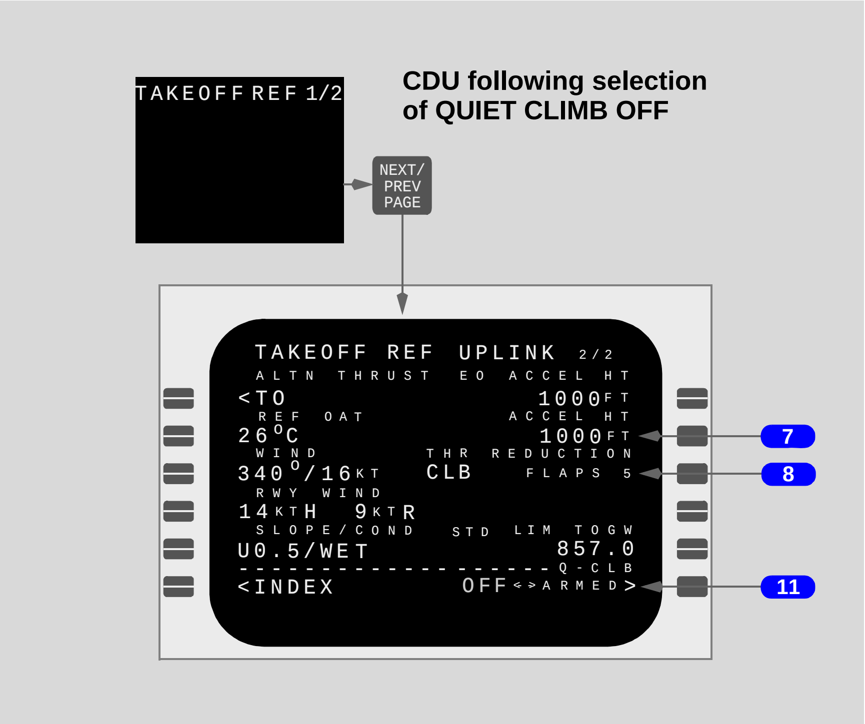
CDU following acceptance of TAKEOFF DATA uplink



806


TAKEOFF REF 1/2
CDU following selection of QUIET CLIMB OFF
NEXT/ PREV PAGE
TAKEOFF REF UPLINK 2/2
ALTN THRUST
EO ACCEL HT
<TO
1000FT
REF OAT
ACCEL HT
26°C
1000FT
WIND
THR REDUCTION
340°/16KT
CLB
FLAPS 5
RWY WIND
14KTH 9KTR
SLOPE/COND
STD
LIM TOGW
U0.5/WET
368.0
Q-CLB
<INDEX
OFF<>ARMED>
7
8
11

914



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 scratchpage 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.

914

7 Acceleration Height (ACCEL HT), ~~Quiet Climb At (Q-CLB AT)~~

ACCEL HT line title displays when Quiet Climb is OFF.

- displays acceleration height for flap retraction
- valid entry is a height from 400 to 9,999 feet

~~Q-CLB AT line title displays when Quiet Climb is ARMED.~~

- ~~displays the height (AGL) at which the reference thrust limit reduces from takeoff to Quiet Climb thrust~~
- ~~entry of a Q-CLB altitude greater than the CLB AT altitude in 3R results in an INVALID ENTRY~~

Default acceleration height ~~and quiet climb altitude~~ are from the Airline Modifiable File.

806

7 Acceleration Height (ACCEL HT), Quiet Climb At (Q-CLB AT)

ACCEL HT line title displays when Quiet Climb is OFF.

- displays acceleration height for flap retraction
- valid entry is a height from 400 to 9,999 feet

Q-CLB AT line title displays when Quiet Climb is ARMED.

- displays the height (AGL) at which the reference thrust limit reduces from takeoff to Quiet Climb thrust
- entry of a Q-CLB altitude greater than the CLB AT altitude in 3R results in an INVALID ENTRY
- entry of a Q-CLB altitude less than 800 feet results in an INVALID entry
- entry of a Q-CLB altitude more than 9,999 feet results in an INVALID entry

Default acceleration height and quiet climb altitude are from the Airline Modifiable File.

8 **Thrust (THR) Reduction, Climb By (CLB BY), CLIMB AT (CLB AT)**

THR REDUCTION line title displays when Quiet Climb is OFF.

- displays altitude for reduction from takeoff to climb thrust
- valid entry is a height from 400 to 9,999 feet, or
- 1 for flaps 1 or 5 for flaps 5; displays "FLAPS 1 or 5"

914
CLB BY ~~line title displays when SLOW restore rate is selected: Thrust increases slowly to the armed climb reference thrust limit at approximately half way between "Q-CLB AT" altitude and "CLB BY" altitude.~~

806
CLB BY line title displays when SLOW restore rate is selected: Thrust increases slowly to the armed climb reference thrust limit at approximately halfway between "Q-CLB AT" altitude and "CLB BY" altitude.

914
CLB AT ~~line title displays when FAST restore rate is selected: Thrust increases rapidly at the CLB AT altitude.~~

806
CLB AT line title displays when FAST restore rate is selected: Thrust increases rapidly at the CLB AT altitude.

Default thrust reduction altitudes are from the Airline Modifiable File.

Entry of less than 1,000 feet between Q-CLB AT and CLB AT or CLB BY altitudes causes an INVALID ENTRY message.

914
9 RESTORE RATE

~~Selection allowed only when Quiet Climb is ARMED or ON.~~

~~The active state, SLOW or FAST, displays in green, large font; the inactive state displays in white, small font.~~

~~Selection with SLOW displayed in large font inhibits the gradual increase in thrust to the selected climb value. Selection with FAST displayed in large font enables the Quiet Climb gradual thrust increase to the selected climb value.~~

806
9 RESTORE RATE

Selection only allowed when Quiet Climb is ARMED or ON.

Push - alternately selects FAST or SLOW restore rate.

FAST - displayed in green, large font; fast restore rate starts at restore altitude. FAST is the default state.

SLOW - displayed in green, large font; gradual increase in thrust to the selected climb value.

10 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

914

11 ~~QUIET CLIMB~~

~~Quiet Climb is a VNAV function; therefore, VNAV must be active for the automated thrust reduction and restoration.~~

~~The active states, OFF, ARMED, or ON display in green, large font; the inactive state displays in white, small font.~~

~~Selection of ARMED displayed in white, arms Quiet Climb; selection with ON displayed in green, large font inhibits Quiet Climb.~~

~~Following automatic transition to ON, the N1 thrust cutback value displays.~~

806

11 QUIET CLIMB

Quiet Climb is a VNAV function; VNAV and autothrottle must be active for the automated thrust reduction and restoration.

Push - alternately selects Quiet Climb ARMED or OFF.

OFF - displayed in green, large font. Quiet Climb is inhibited; OFF is the default state.

ARMED - displayed in green, large font. Reformats the TAKEOFF 2/2 page.

ON - displayed in green, large font. VNAV and autothrottle must be armed; automatic transition to ON from ARMED when N1 thrust cutback value calculated. If Q-CLB calculated N1 exceeds max continuous N1 thrust, OFF displays.

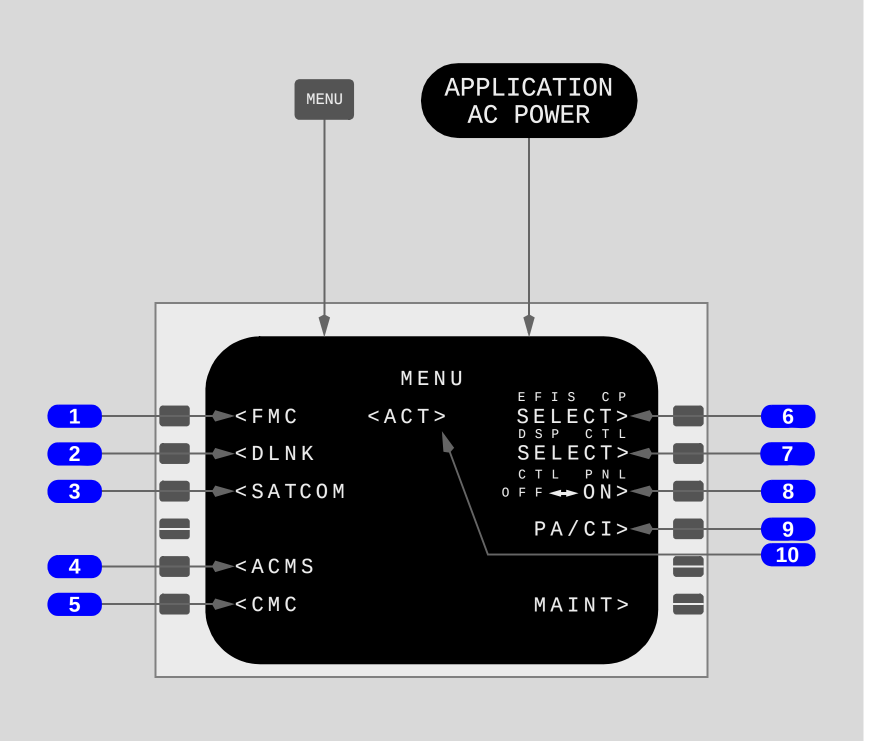
- on the ground, selection of a different runway causes OFF to display
- the scratchpad message TAKEOFF SPEED DELETED or Q-CLB UNAVAILABLE also causes OFF to display

Following automatic transition to ON, the N1 thrust cutback value displays.

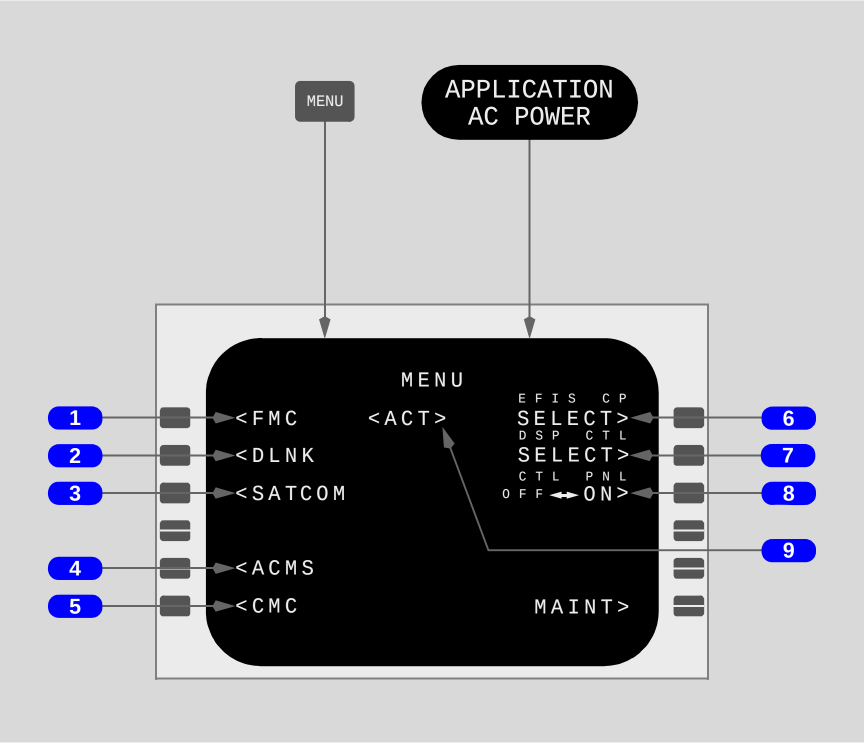
Menu Page

Provides access to other systems that use the CDU.

806



914



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.

806

9 **Passenger Address (PA)/Cabin Interphone (CI)**

Only displays on the center CDU.

See Chapter 5.30, Communications-Interphone Systems.

914

9 **Active (ACT)**

Indicates active CDU controller.

806

10 **Active (ACT)**

Indicates active CDU controller.

Deferred Systems Content

914

This section contains deferred and systems description content.

Deferred content is printed with strike-through text. For example, ~~With Quiet Climb Off and at acceleration height or altitude capture below acceleration altitude;~~

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

914
With Quiet Climb OFF and at acceleration height or altitude capture below acceleration altitude; or, with Quiet Climb ON and at the ~~"CLB BY"~~ altitude, 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.

806
With Quiet Climb OFF and at acceleration height or altitude capture below acceleration altitude; or, with Quiet Climb ON and at the "CLB BY" altitude, VNAV commands a speed 5 knots below flap placard speed for the existing flap setting. When flaps are retracted, VNAV commands the speed displayed on the SPD TRANS line.

914
~~The FMC commands thrust reduction to Quiet Climb thrust (when selected ON) at the selected height (AGL); or, when Quiet Climb is not active, at the selected thrust reduction altitude or flap setting. 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.~~

806
The FMC commands thrust reduction to Quiet Climb thrust (when selected ON) at the selected height (AGL); or, when Quiet Climb is not active, at the selected thrust reduction altitude or flap setting. 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.

914
~~The VNAV climb phase consists of two segments: a climb at the transition speed to the transition altitude specified in the Airline Modifiable Information (AMI) or a 250 knot climb to 10,000 feet, followed by an economy climb from the transition altitude specified in the AMI or 10,000 feet to the entered cruise altitude.~~

806
The VNAV climb phase consists of two segments: a climb at the transition speed to the transition altitude specified in the Airline Modifiable Information (AMI) or a 250 knot climb to 10,000 feet, followed by an economy climb from the transition altitude specified in the AMI or 10,000 feet to the entered cruise altitude.

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.

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.

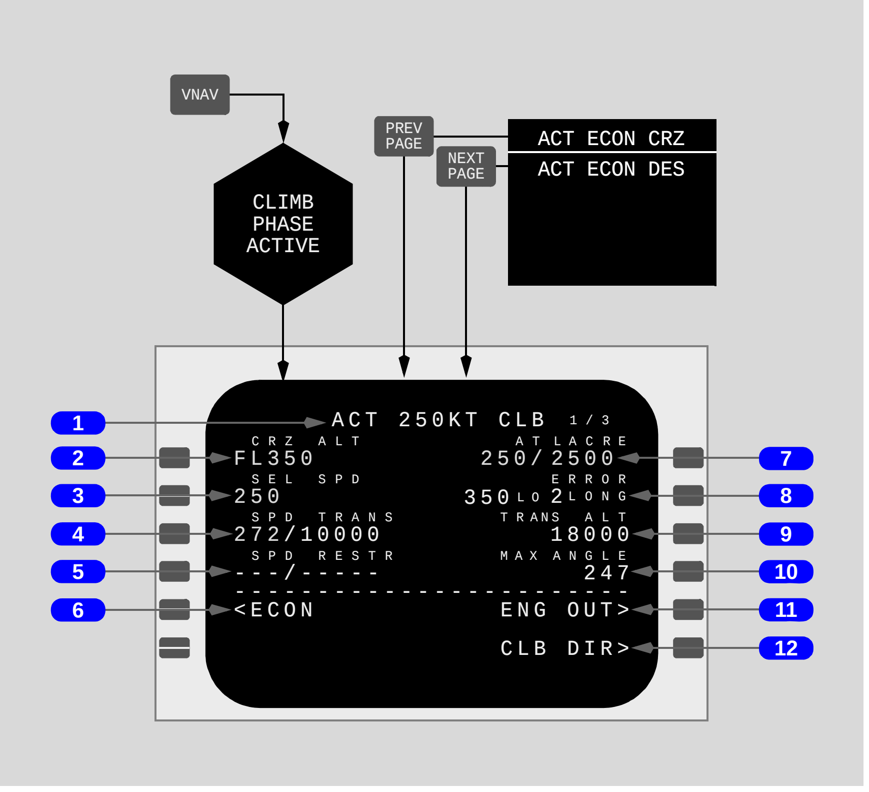
When the climb profile fails to reach a waypoint altitude constraint, the FMC displays the UNABLE NEXT ALT scratchpad message . Deleting climb derates or selecting a reduced climb speed thus giving a steeper climb angle, may enable the airplane to reach the altitude constraint.

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.

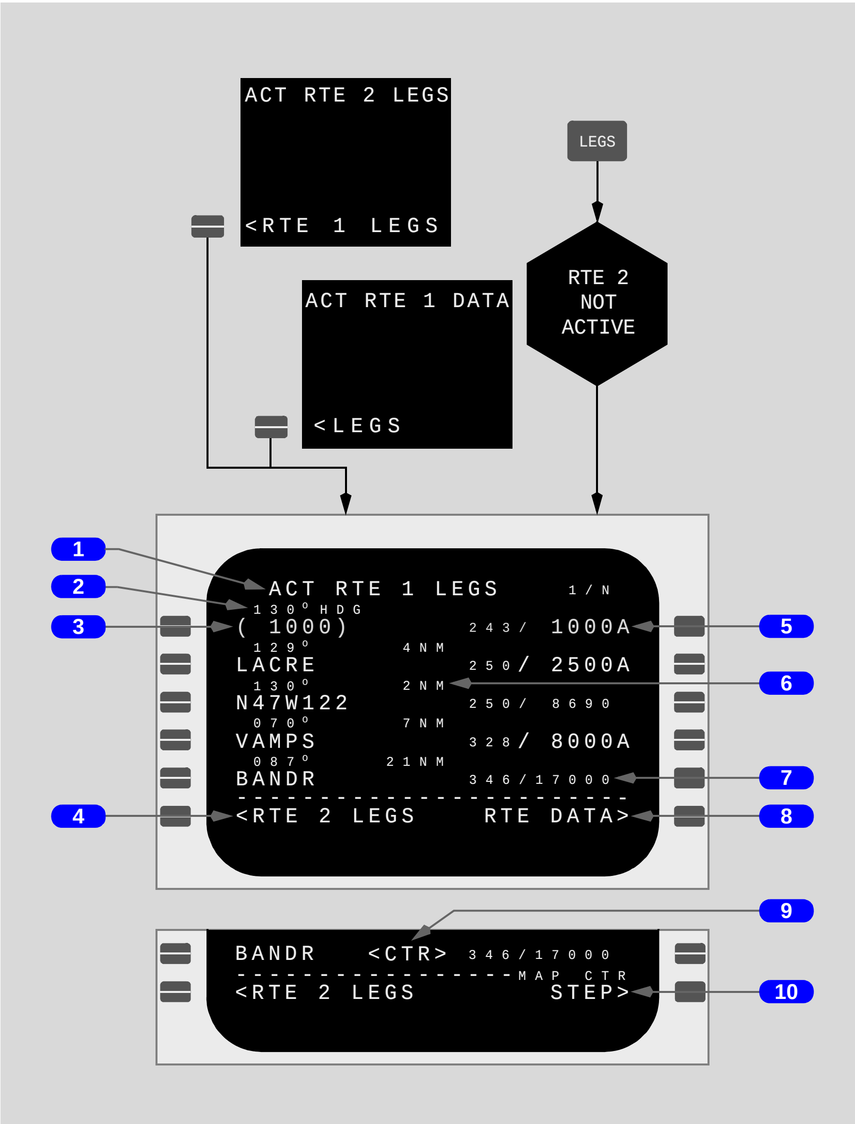
12 Climb Direct (CLB DIR)

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 is PLAN mode).

Push -

- ACTIVATE - prepares inactive flight plan for activation, illuminates the EXEC key, and displays LEGS page 1/N 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.

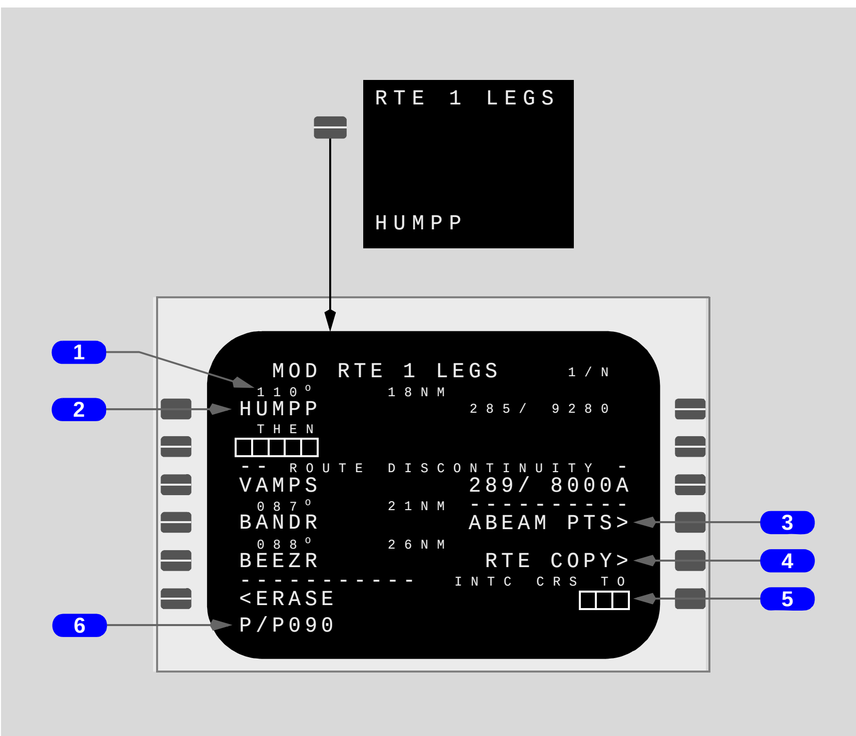
10 MAP Center (CTR) STEP

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.

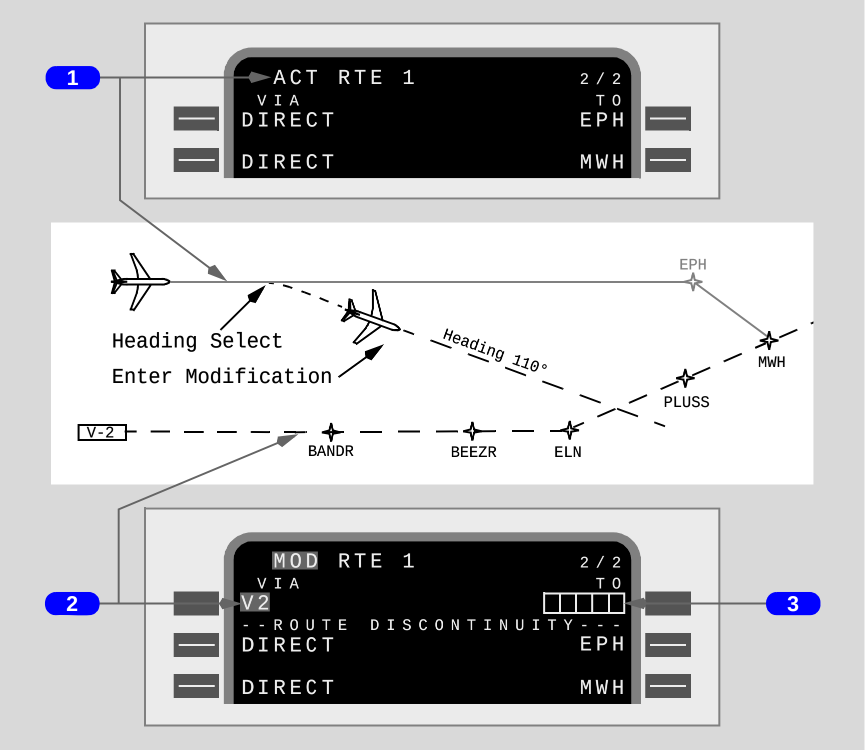
Airway Intercept

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**

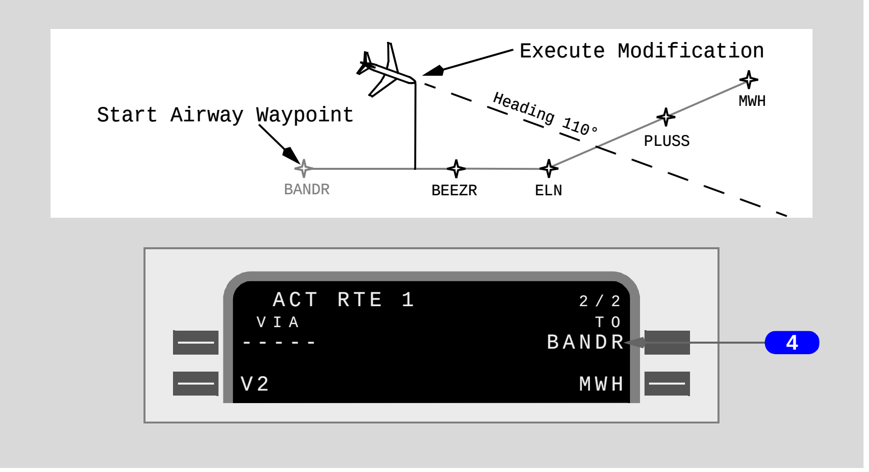
The route page before the ATC clearance.

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.



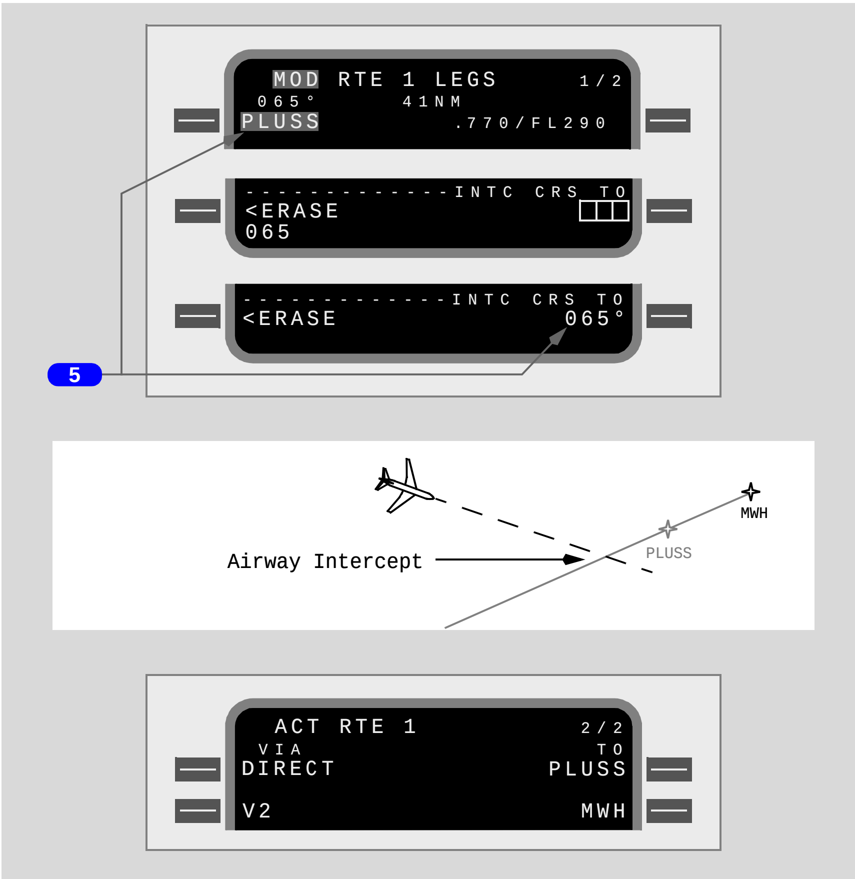
4 Start Airway Waypoint

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.

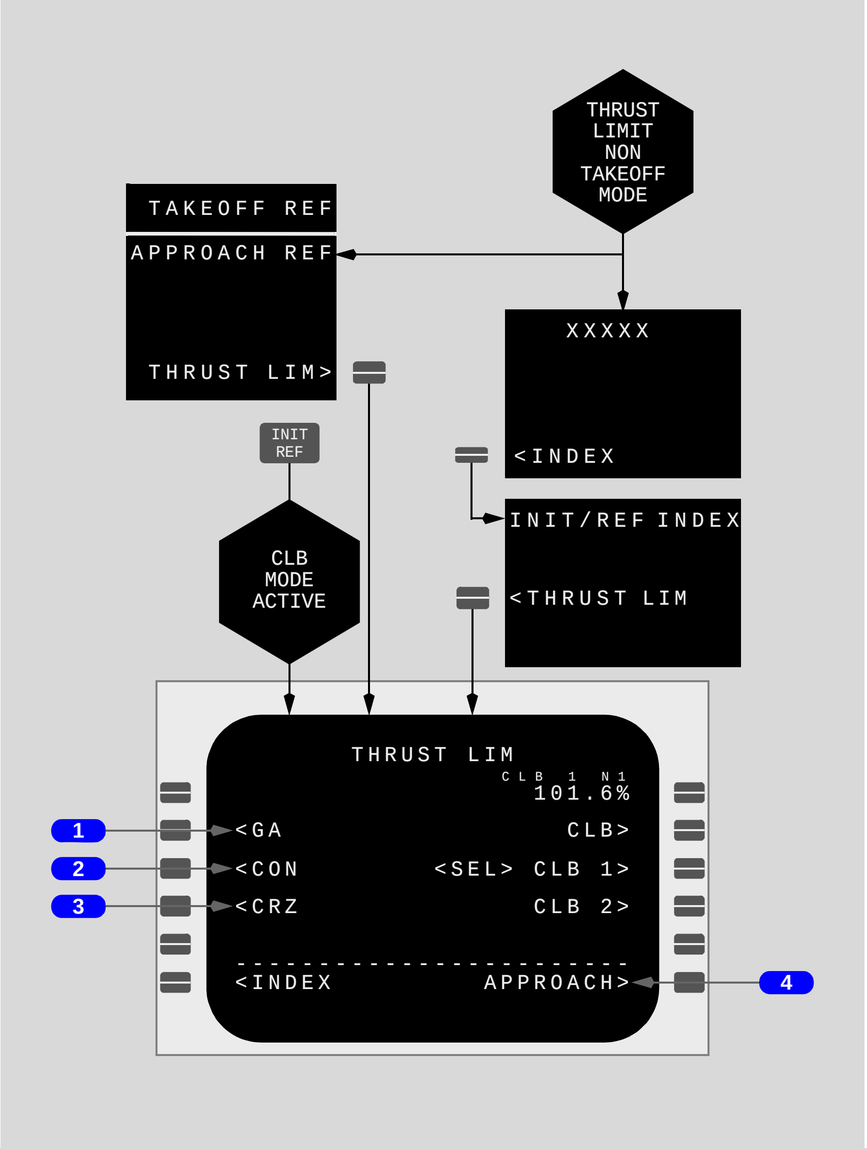
5 Latitude/Longitude

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**

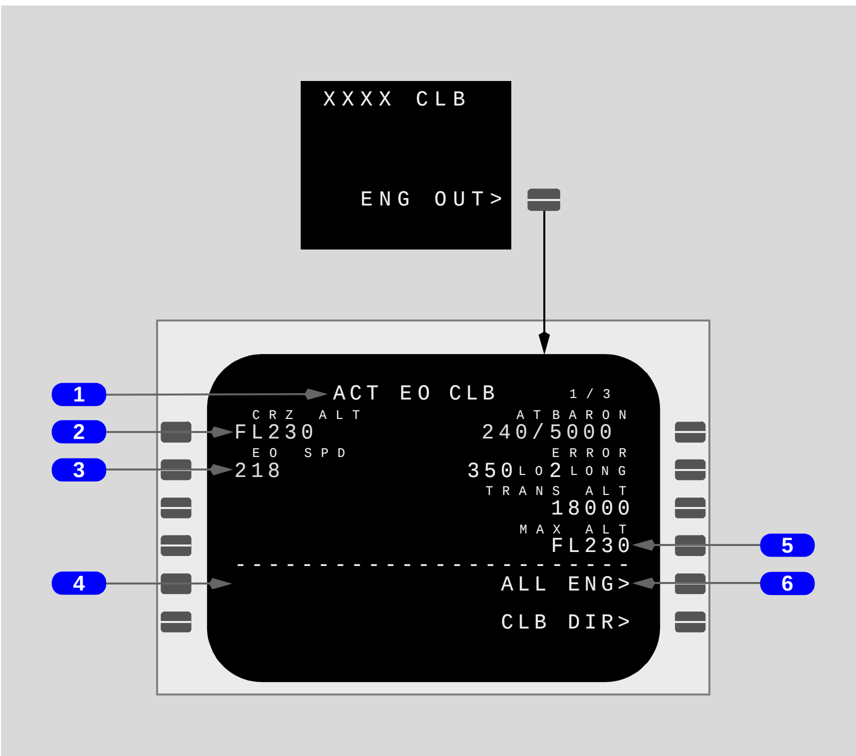
Push - displays APPROACH REF page.

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.

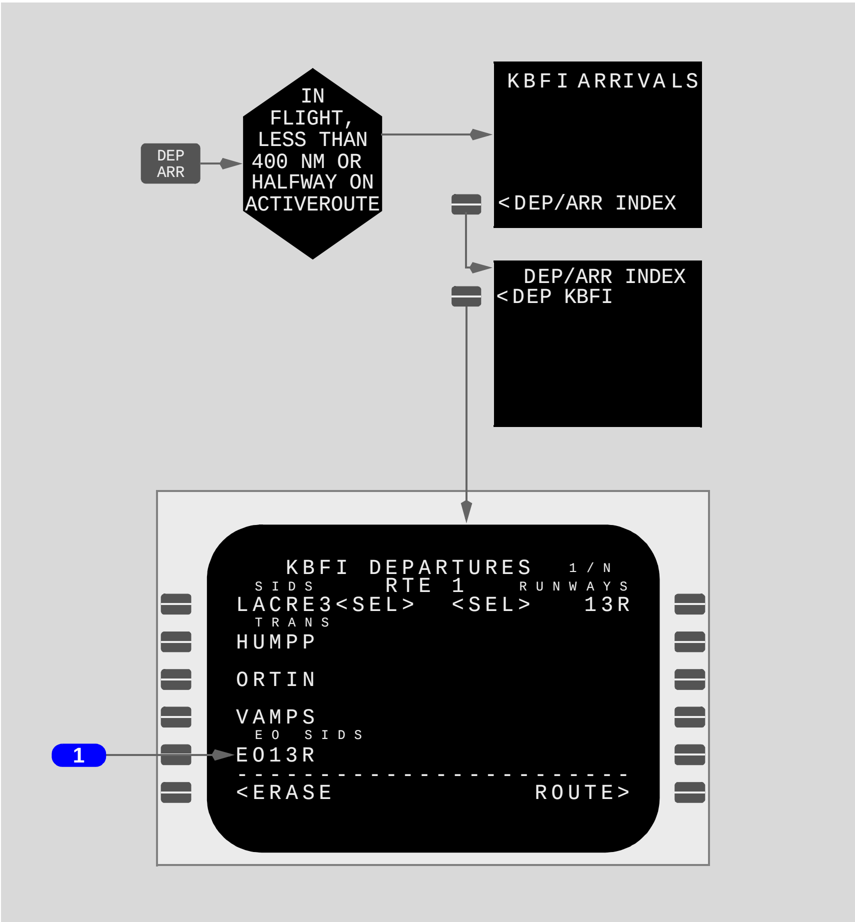
Entry not allowed.

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.

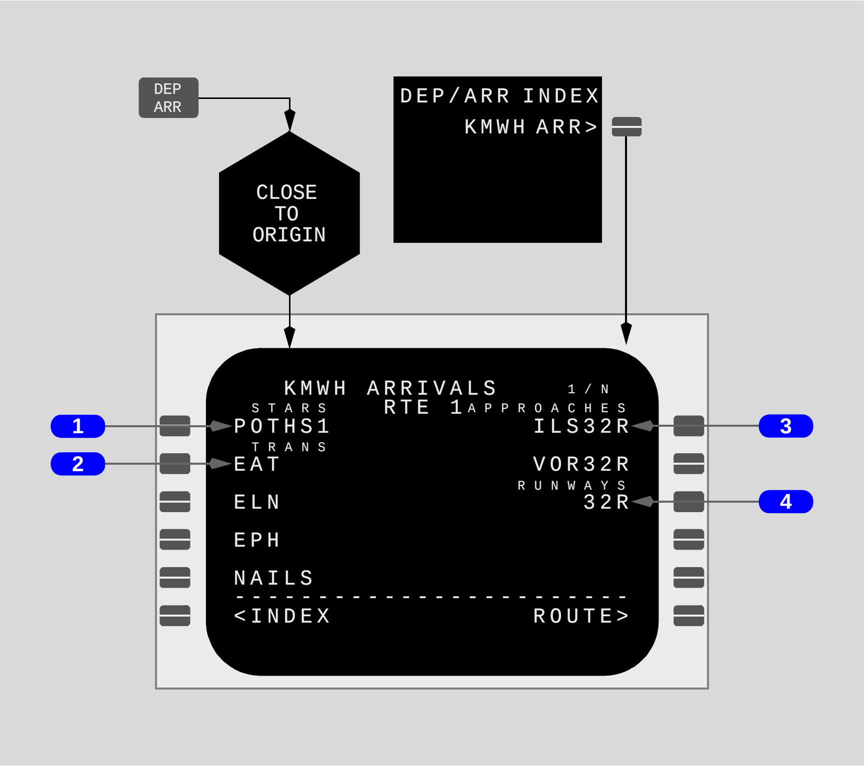
Push - displays EO SID as the selected SID.

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.

Flight Management, Navigation — Chapter 11
FMC Cruise — Section 42

Deferred Systems Content
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This section contains deferred and interim systems description content.

Deferred content is printed with strike-through text. For example, ~~Step size can be changed from the default value~~.

Interim systems content is printed in italics. For example, *manually entered.*

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

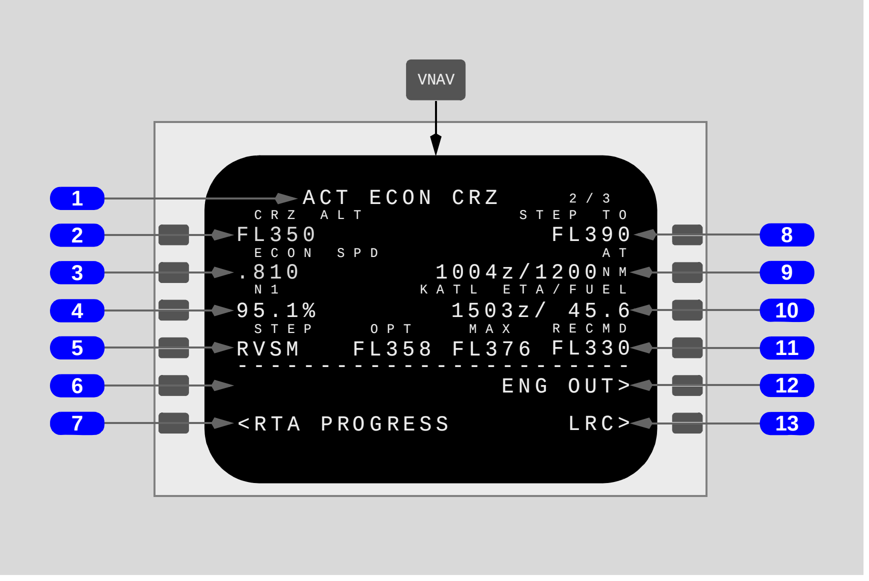
CLB page changes to CRZ at top of climb. CRZ CLB and CRZ DES pages change to CRZ at the new cruise altitude. CRZ page changes to DES at top of descent.

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

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- ~~RTA CRZ - RTA cruise selected~~

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- RTA CRZ - RTA cruise selected

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- ~~RTA CRZ CLB or CRZ DES - cruise climb or cruise descent with RTA selected~~

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- RTA CRZ CLB or CRZ DES - cruise climb or cruise descent with RTA selected

Fixed cruise speeds are for:

- a flight crew selected speed (SEL SPD)
- a speed constraint associated with an altitude

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- ~~waypoint speed constraints~~

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- waypoint speed constraints

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- ~~cruise speed segments~~

806

- 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 N1

Displays N1 to maintain level flight at command airspeed.

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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.~~

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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.

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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.

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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.

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7 ~~RTA PROGRESS~~

~~Push - displays RTA Progress page.~~

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7 RTA PROGRESS

Push - displays RTA Progress page.

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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~~

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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

914
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)~~

806
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).

914
Displays NOW passing the ~~optimum~~ manually entered step climb point.

806
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.

914

11 Optimum, Maximum, and ~~Recommended~~ Altitude (OPT, MAX, ~~RECMD~~)

Blank when RTA is active.

OPT - calulation 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.~~

806

11 Optimum, Maximum, and Recommended Altitude (OPT, MAX, RECMD)

Blank when RTA is active.

OPT - calulation 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

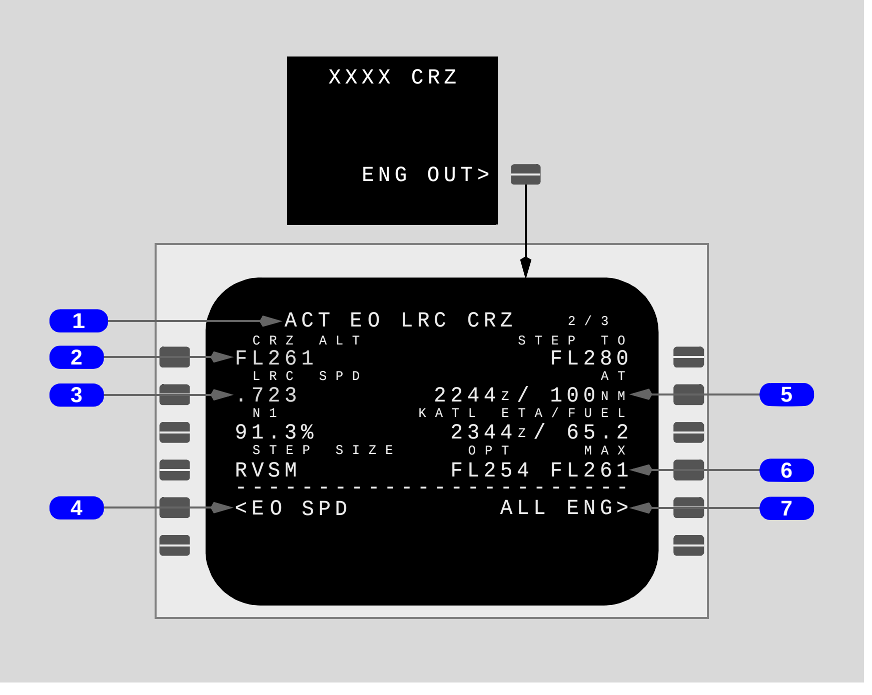
Engine out (EO) VNAV cruise guidance displays on EO CRZ page. EO CRZ page must be selected and executed by the flight crew. Engine out data is also available with all engines operating.

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.

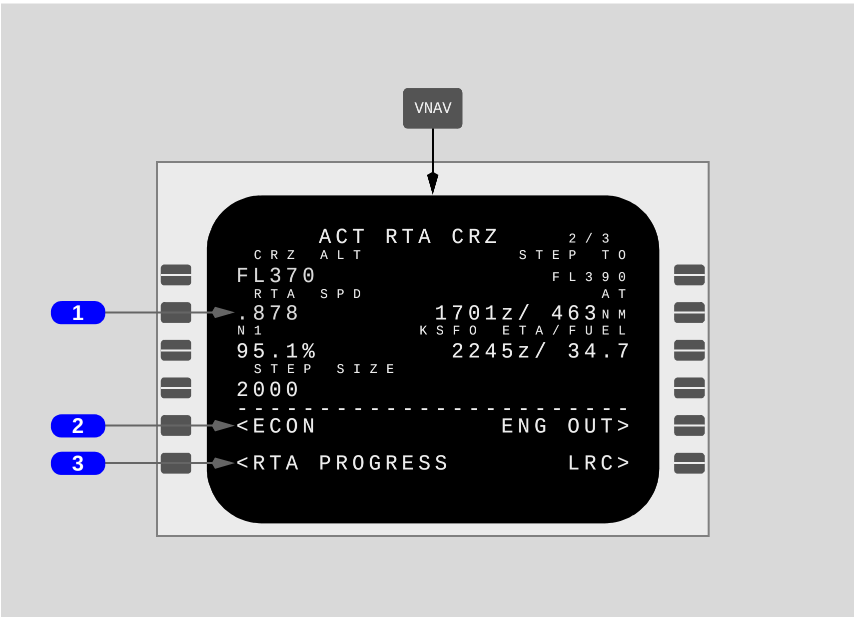
7 **ALL Engine (ENG)**

Push - displays and enables execution of MOD XXX CRZ page with performance based on all engines operating.

Required Time of Arrival (RTA) Cruise

914

~~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.~~

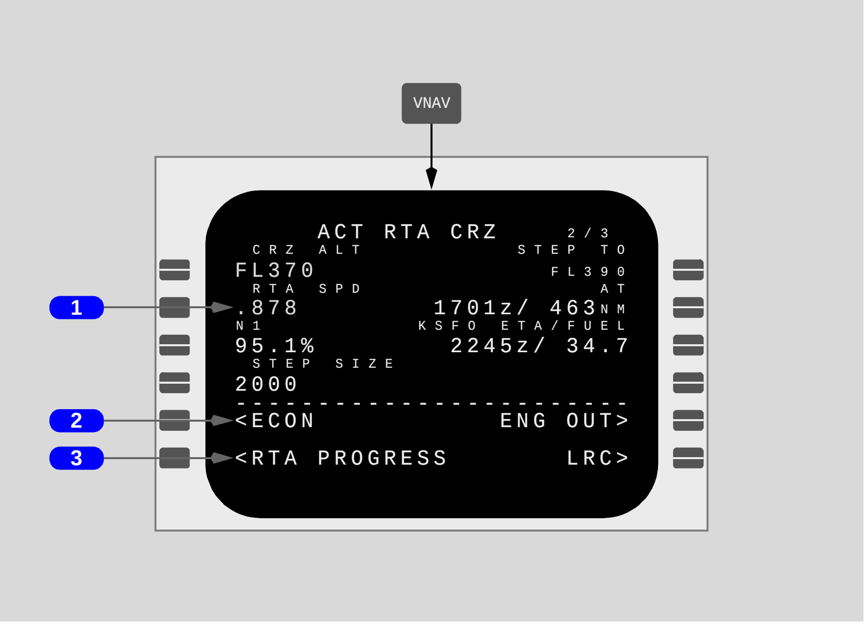
~~ERASE (displays when modification pending).~~

~~Push - erases pending modification.~~

Required Time of Arrival (RTA) Cruise

806

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.

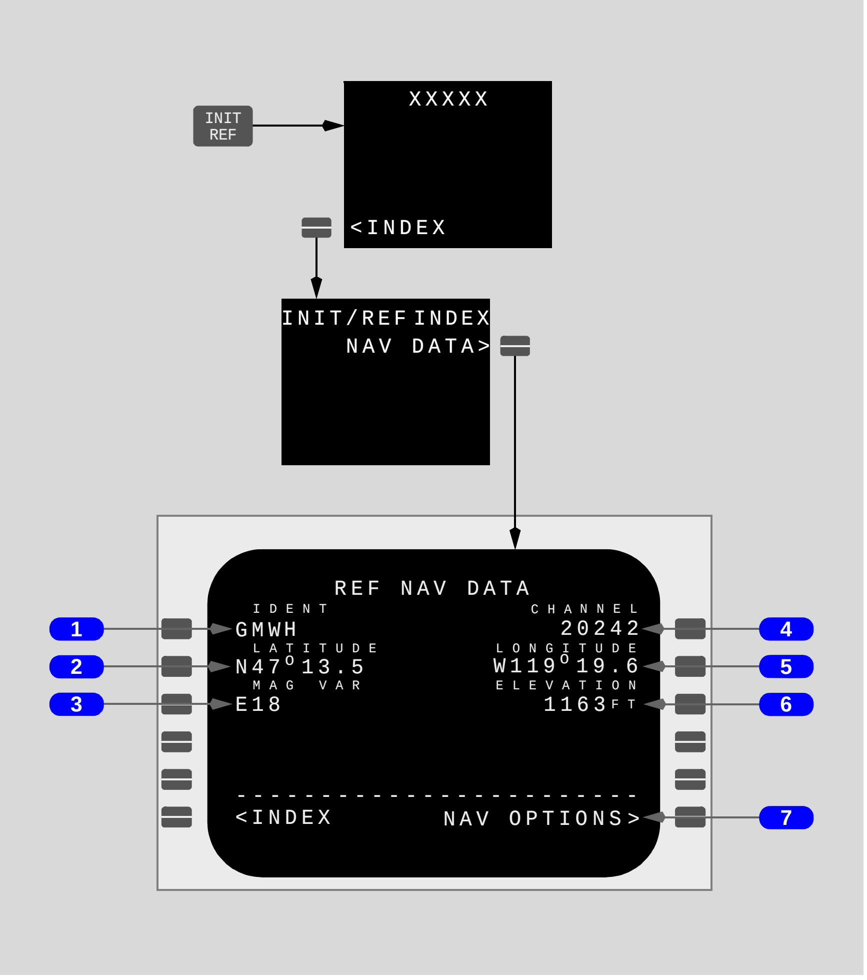
ERASE (displays when modification pending).

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)

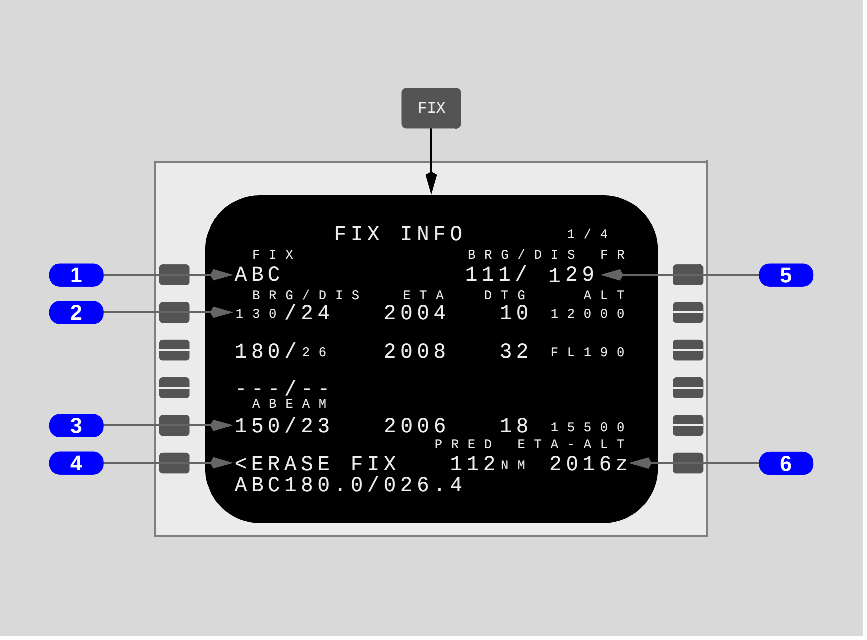
Selection displays the NAV OPTIONS page.

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 altidude, 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.

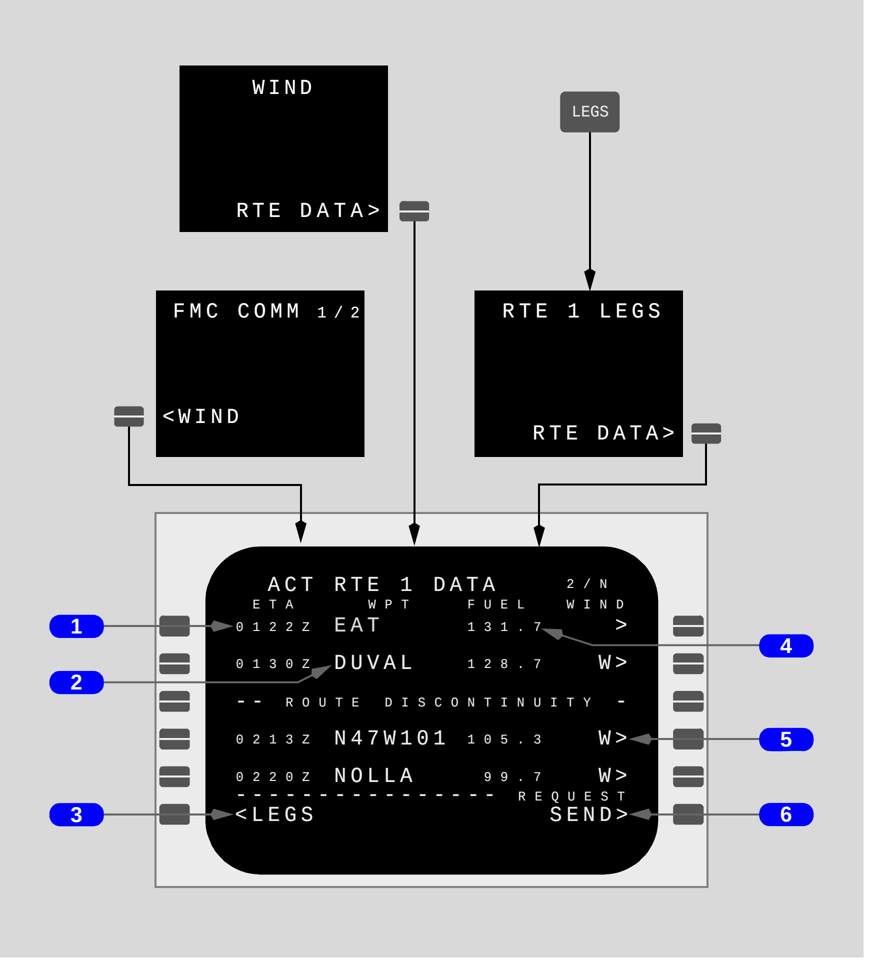
Route and Waypoint Data

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 -

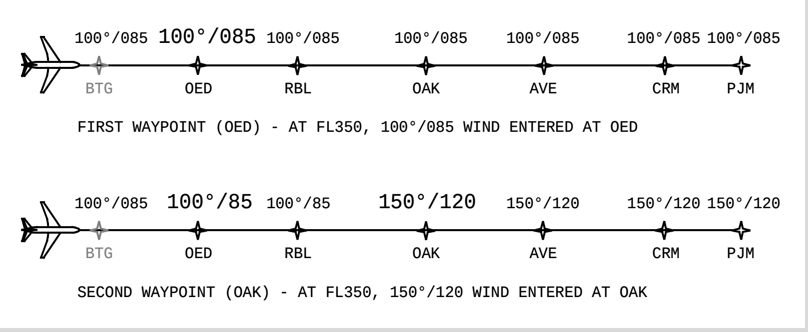
- applies enroute wind data to route and results in a modification
- displays ERASE and SEND prompts

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.

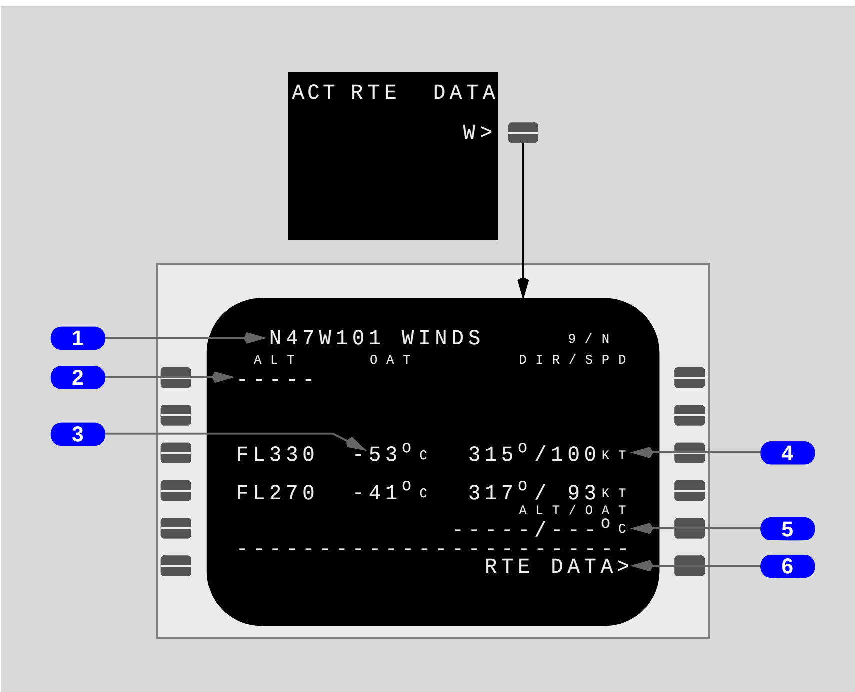
Wind Page

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

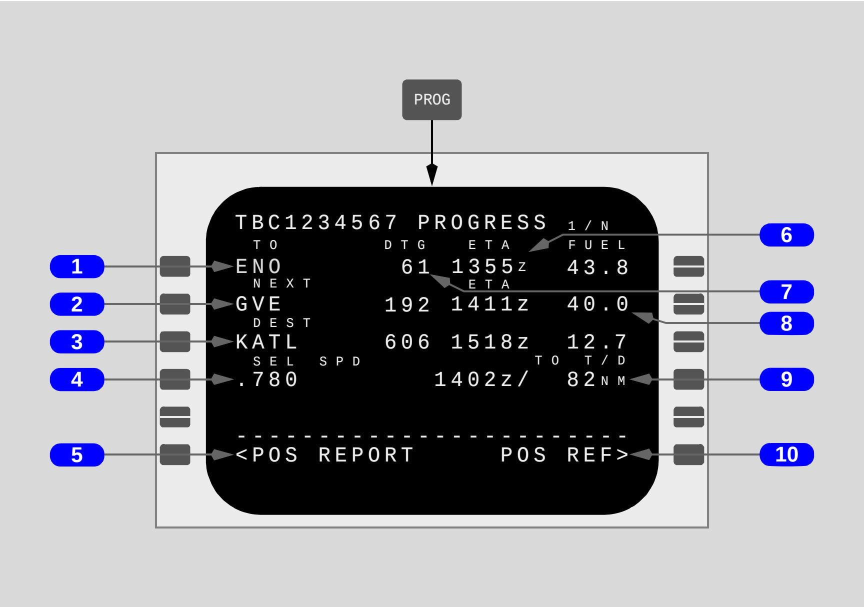
Progress Page 1/4

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

914

- RTA SPD - RTA SPD when RTA mode active

806

- 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 FUELvalues 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

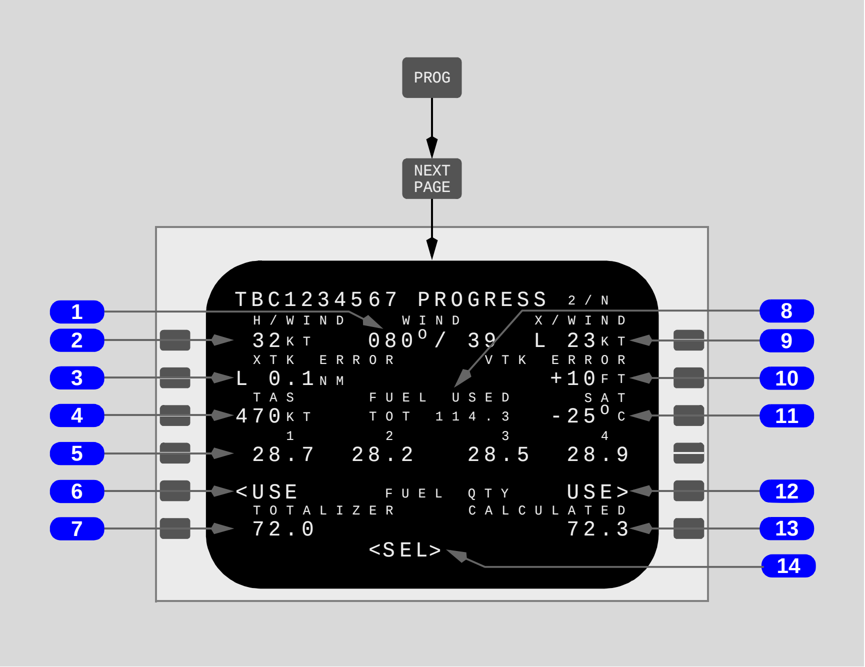
10 **Position Reference (POS REF)**

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 Cross Track (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

806
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.

914
Displays USE prompt and the EICAS message FUEL DISAGREE if a difference of 9,000 lbs 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

806
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.

914
Displays USE prompt and the EICAS message FUEL DISAGREE if a difference of 9,000 lbs 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

914
The fuel remaining line displays two independent fuel remaining values, TOTALIZER and CALCULATED. They can be compared to validate FMC calculations. Fuel flow rate sensing tolerances may allow the CALCULATED and the TOTALIZER fuel quantities to be different by as much as 60 to 85 pounds per hour.

806
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.

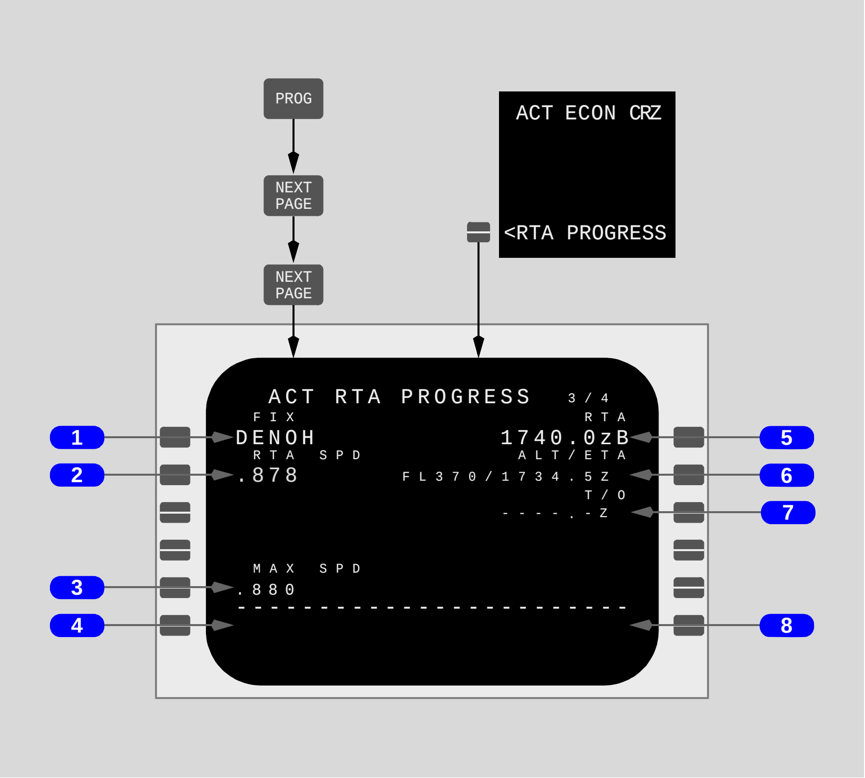
14 Select <SEL>

<SEL> shows which method is used to calculate fuel quantity, either TOTALIZER or CALCULATED. TOTALIZER or CALCULATED selected by the USE prompt.

RTA Progress Page 3/4

914

~~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.~~

~~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 an 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 prior RTA fix and time exists.~~

~~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. Entry can be Mach, LRC, RTA, or ECON. 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.~~

RTA Progress Page 3/4

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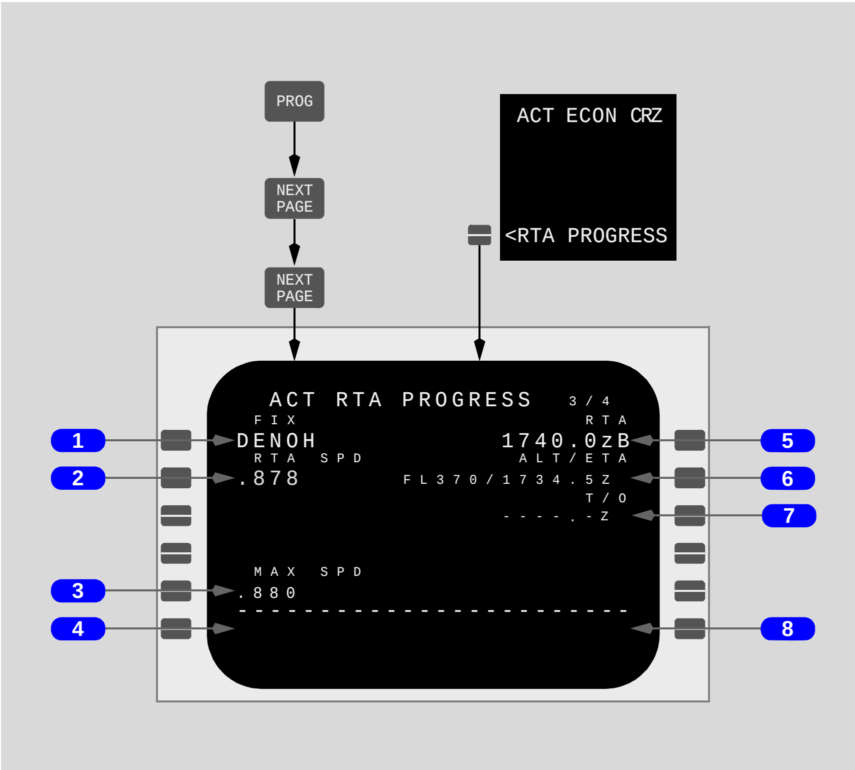
The RTA Progress page allows a time constraint to be specified at an existing flight plan fix. Entry of the fix activates the RTA function and changes the PROGRESS and CRZ page titles to include RTA. RTA operates only in cruise.



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.

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 an 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 prior RTA fix and time exists.

Push -

- displays previous RTA fix and time
- initiates RTA flight plan modification

Execution activates RTA function.

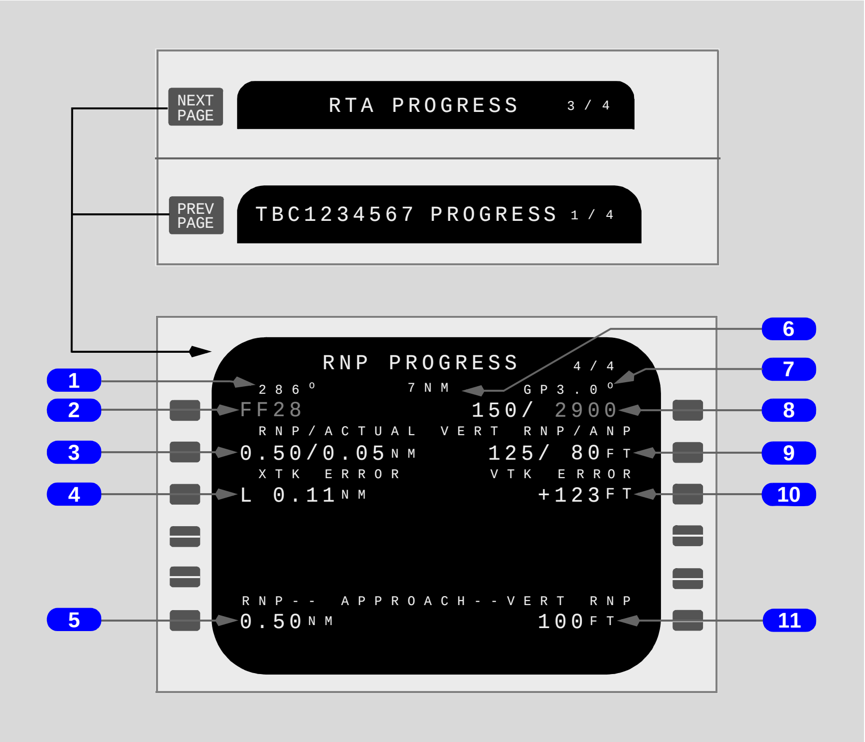
9 Cruise Speed Segment

Displays cruise speed segment start and end waypoints when entered on the Legs page. Valid entries are Mach, LRC or L, RTA or R, or ECON or E. The cruise speed segment shown ends at AVE and ECON airspeed is resumed. If an end waypoint has not been entered, the cruise speed segment ends at the T/D.

Entry of RTA or R after an RTA fix or entry of ECON or E before an RTA; 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.

Intentionally
Blank

Flight Management, Navigation — Chapter 11
FMC Descent and Approach — Section 43

Deferred Systems Content

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This section contains deferred systems description content.

Deferred content is printed with strike-through text. For example, ~~OFFPATH DES page - analyze descent performance with and without the use of speedbrakes.~~

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

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- ~~OFFPATH DES page - analyze descent performance with and without the use of speedbrakes~~

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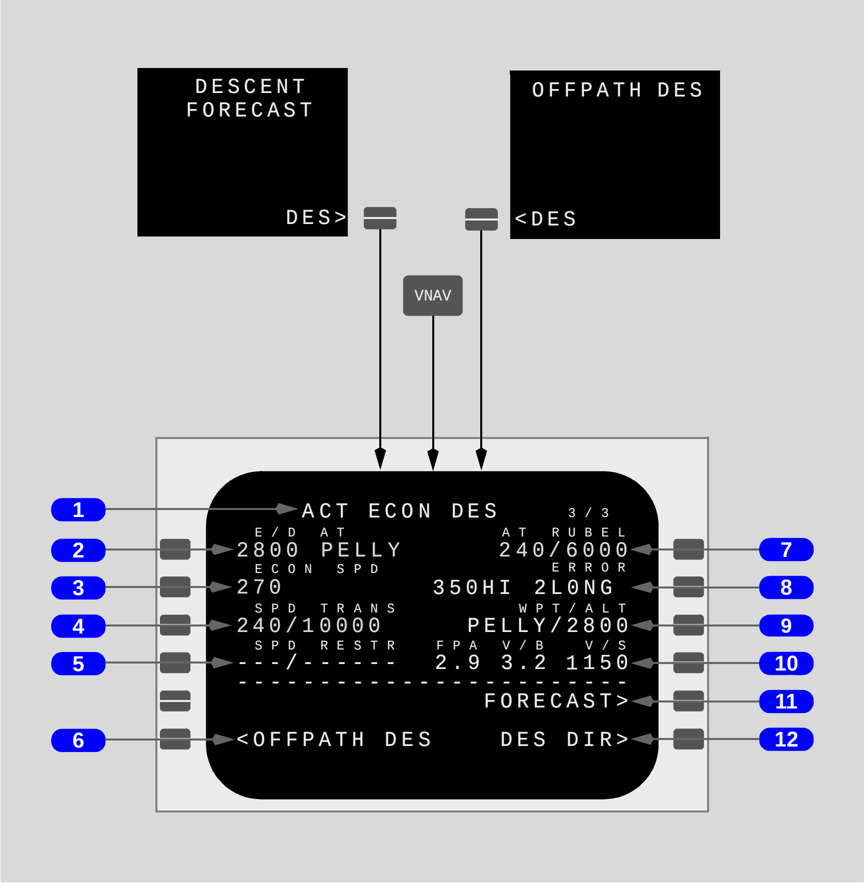
- OFFPATH DES page - analyze descent performance with and without the use of speedbrakes

Descent Page

The DES page is used to monitor and revise the descent path. Descent speeds are economy (ECON) and selected speed (SEL). The default VNAV descent speed is ECON. A selected speed descent is flown when speed intervention is used, a speed is entered on the DES page, or a speed contrained 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

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.

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~~6 Off Path Descent (OFFPATH DES)~~

~~Push - displays OFFPATH DES page.~~

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6 Off Path Descent (OFFPATH DES)

Push - displays OFFPATH DES page.

7 AT XXXXX

Displays the next waypoint constraint from RTE LEGS page. When the speed/altitude or altitude is the FMC target, it displays in magenta.

Line Title is:

- AT XXXXX, or
- HOLD AT XXXXX, where XXXXX is the constrained waypoint or holding fix, or
- AT VECTORS, or
- AT (INTC), or
- AAAA/DD or AAA RRR, where AAAA is a navaid name; DD is distance in nm and RRR is the radial

The constraint is an altitude or a speed/altitude; blank when no constraint exists; can be deleted on this page.

VNAV commands the lesser of constraint speed or present performance speed.

8 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.

9 **Waypoint/Altitude (WPT/ALT)**

Line title appears even though the descent page is blank. Defaults to the same waypoint/altitude restriction displayed on the AT line (1R); may be overwritten by pilot entry. Valid entry is any navigation database waypoint, latitude/longitude, or waypoint from the flight plan.

10 **Flight Path Angle, Vertical Bearing, Vertical Speed (FPA, V/B, V/S)**

Initially displays dashes. Following entry of waypoint/altitude:

- FPA - displays the current airplane flight path angle
- V/B - displays vertical bearing from current position to the entered waypoint and altitude
- V/S - displays required vertical speed to maintain the vertical bearing

Data blanks if airplane climbs or descends below the entered altitude.

11 **FORECAST**

Push - displays DESCENT FORECAST page.

12 **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.

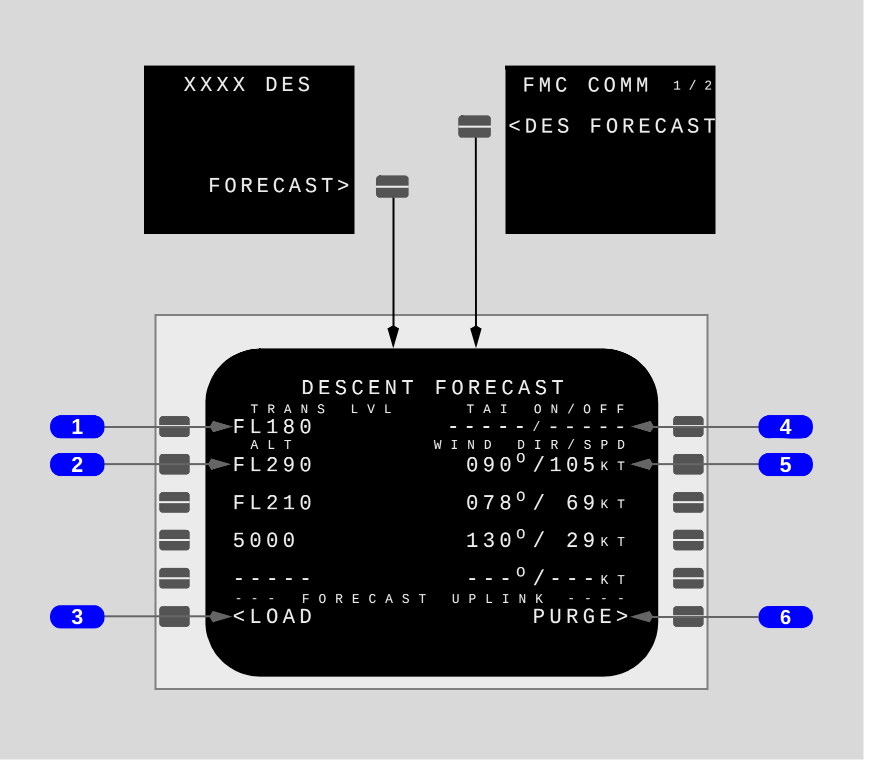
Push -

- 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

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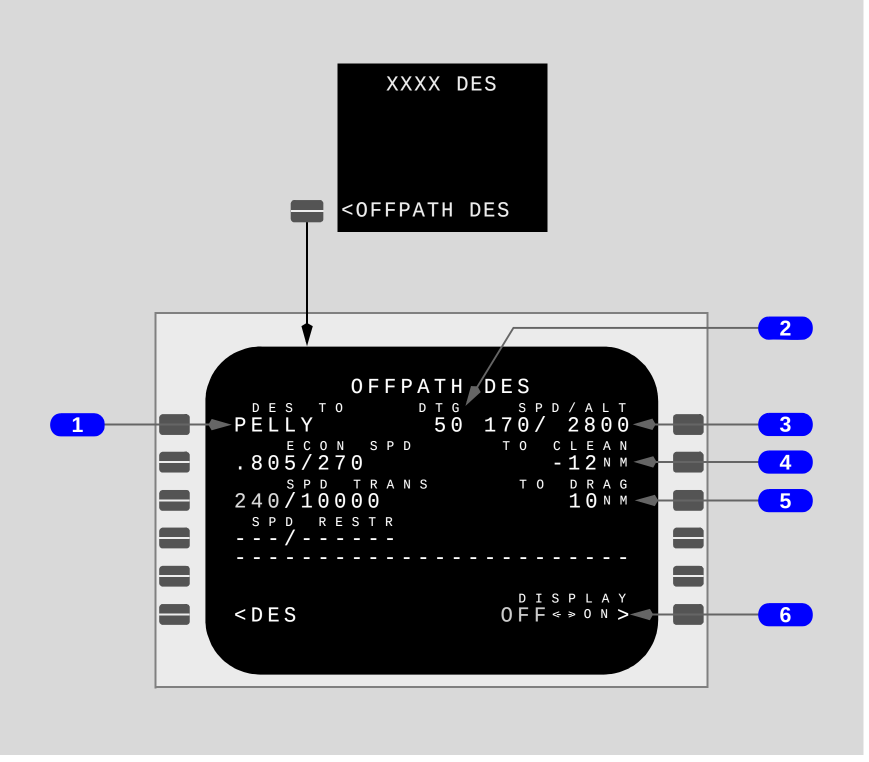
~~Offpath descent page allows the analysis of descent performance direct to a selected waypoint. Data entered displays clean and drag descent ranges on the page and on the ND. Ranges are based on an entered waypoint and altitude constraint. Range can be used to determine if the altitude constraint can 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~~

Offpath Descent Page

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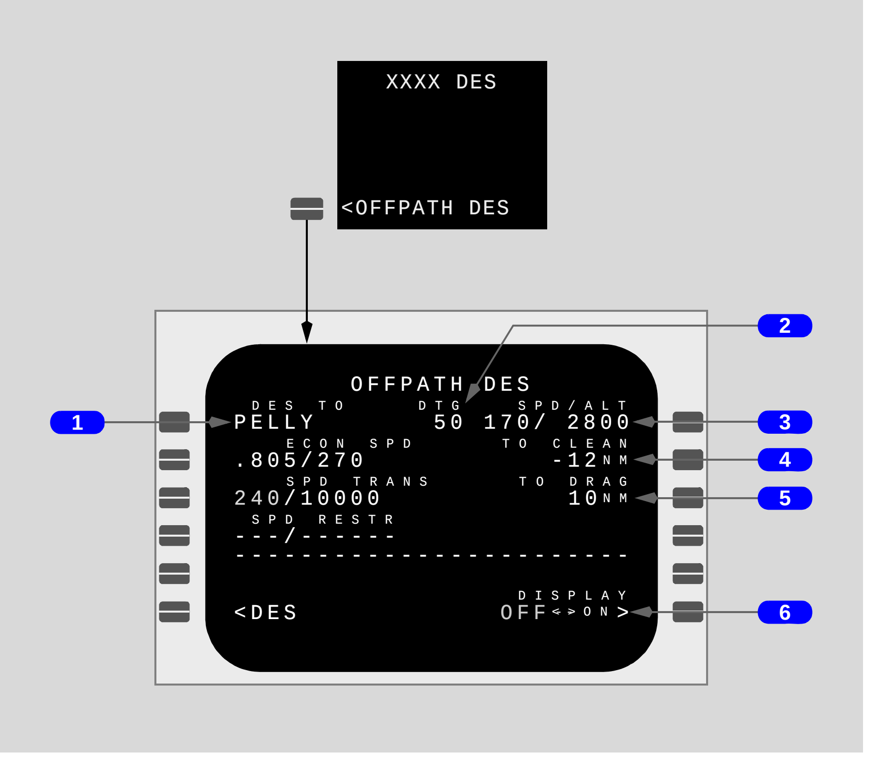
Offpath descent page allows the analysis of descent performance direct to a selected waypoint. Data entered displays clean and drag descent ranges on the page and on the ND. Ranges are based on an entered waypoint and altitude constraint. Range can be used to determine if the altitude constraint can 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 I/GLS 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

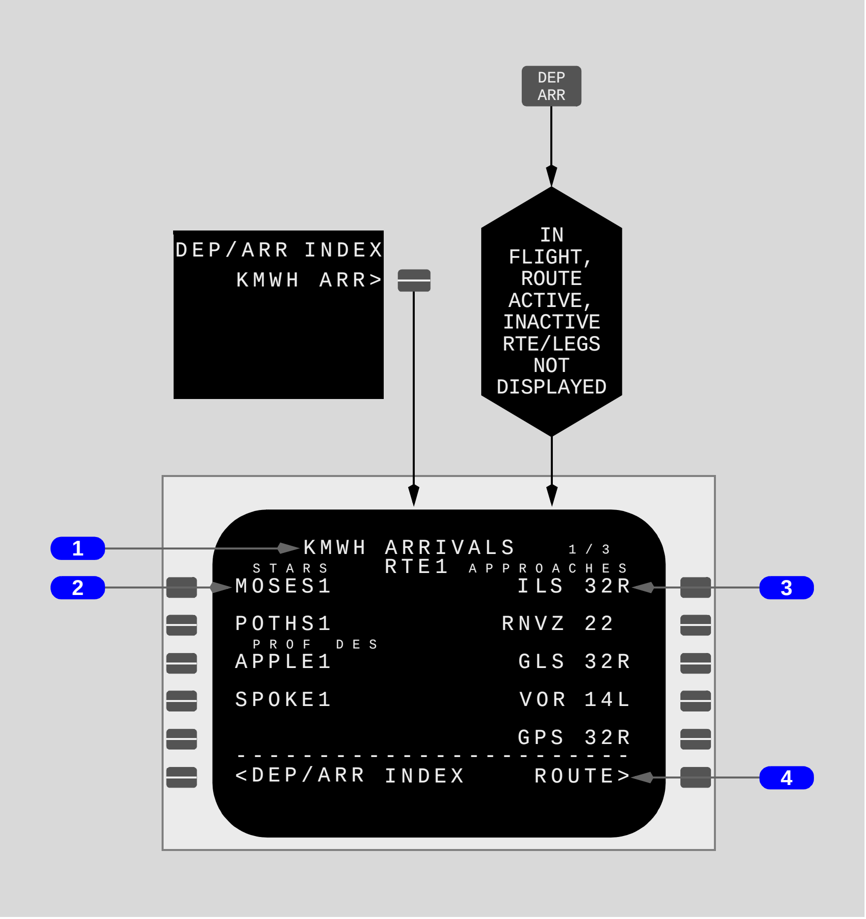
The arrivals page allows selection of a runway, approach, approach transition, and Standard Terminal Arrival Route (STAR) at the destination airport. This page can also be used to view data about a selected airport that is not the destination. Route 1 and route 2 have separate arrival pages.

Integrated Approach Navigation (IAN) allows instrument approaches to be flown using ILS look-alike flight crew procedures. The FMC computes lateral and vertical deviations similiar to localizer and glideslope deviations and sends this information to the FCC, IDS, GPWS, and flight data recorder. The deviations are based on the FMC multi-sensor navigation position and FMC barometric altitude relative to an extension of the final approach path for the selected approach.

Airports are using multiple RNAV/I/GLS approaches to the same runway. ICAO has developed a naming convention which adds an additional character to the approach name; Z, Y, X, ... in the approach title following the guidance source. The primary approach is identified as the "Z" approach; all subsequent procedures (normally with different missed approach paths) use the alpha characters in reverse order beginning with Y. This change requires approach names with up to eight characters to be encoded in the navigation database.

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

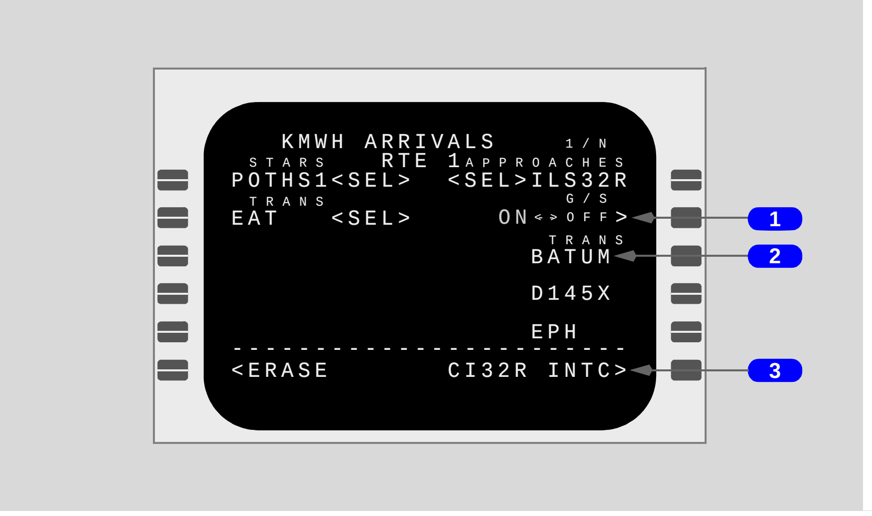
2 ERASE

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 -

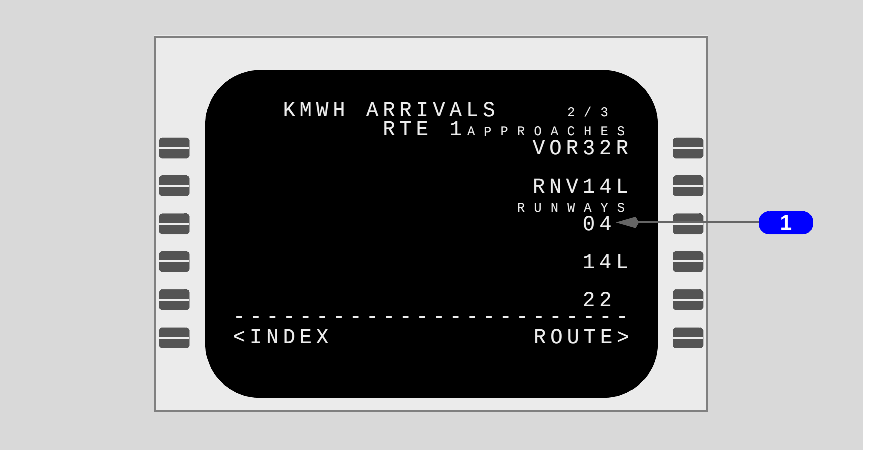
- displays RTE LEGS page and modifies route with approach intercept fix as the active waypoint
- selects approach course for selected approach as inbound course to approach intercept fix on LEGS page

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 APPR 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.

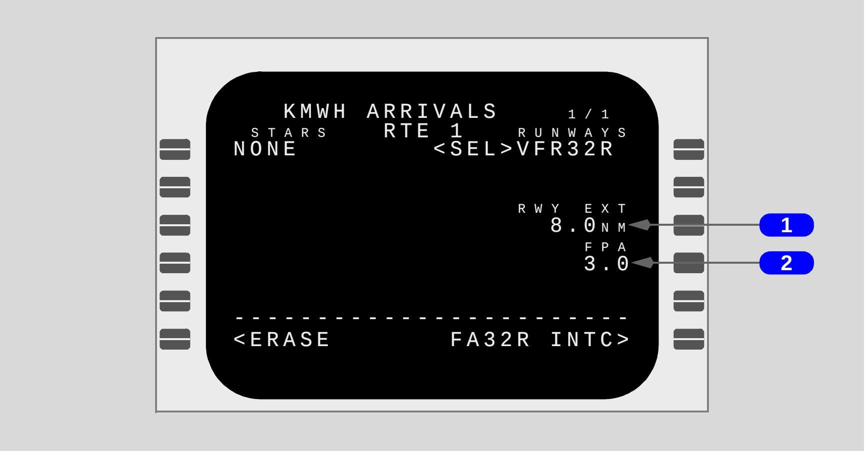
Deletes VFR APPR prompt.

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)

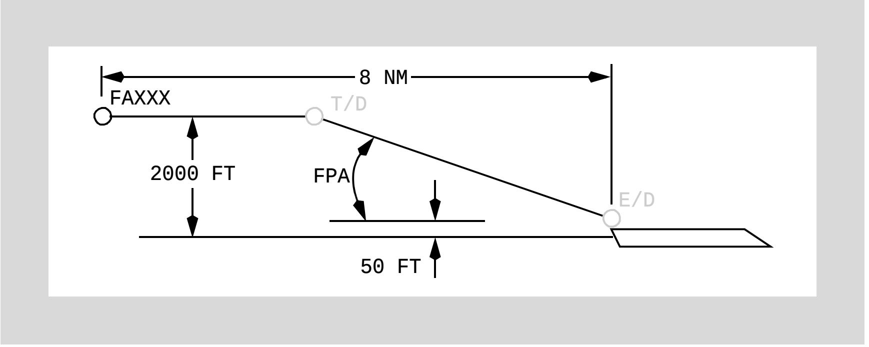
Following selection of a runway, the RWY EXT 8.0 NM waypoint, FAXXX, displays as part of VFR APPR. Distance cannot be changed.

2 Flight Path Angle (FPA)

Displays descent flight path angle to 50 foot runway waypoint. Default is 3.0°.

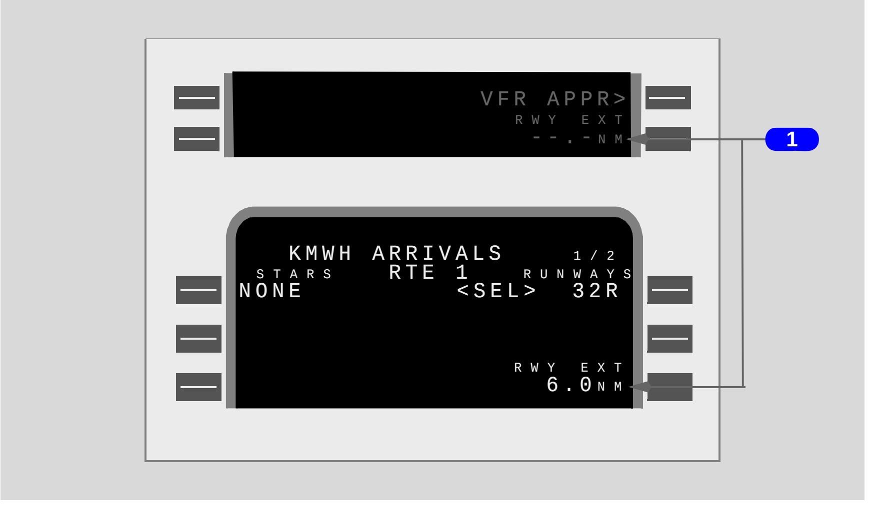
Valid entry is 2.4° to 3.7°.

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.

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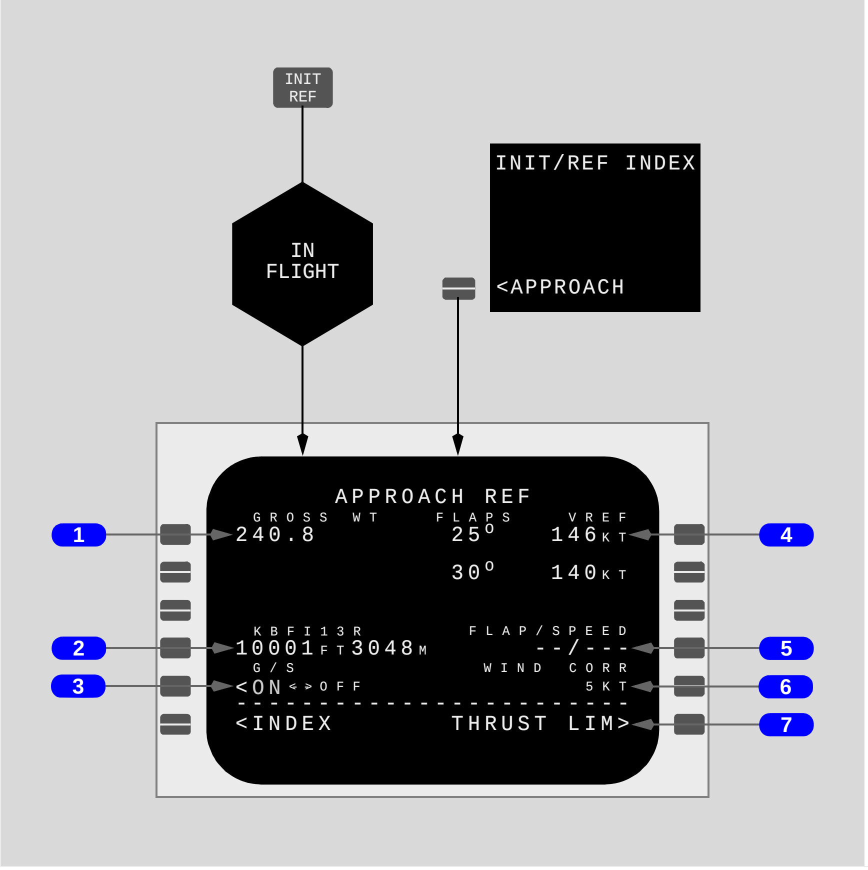
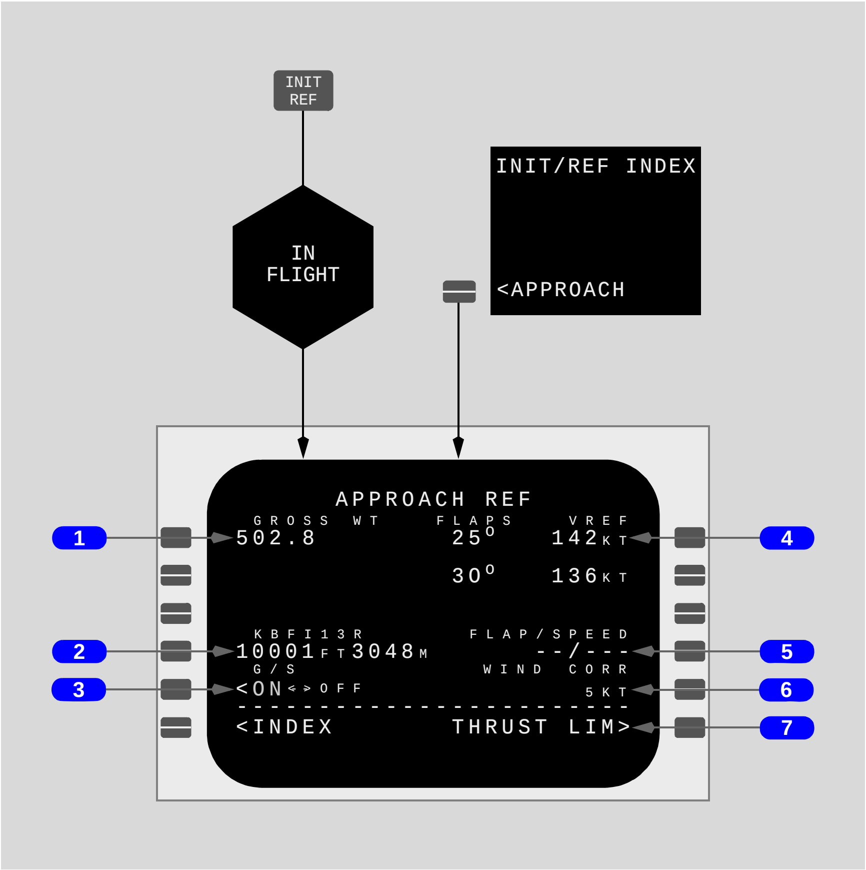


914



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 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 I/GLS glideslope guidance is not available.

Defaults:

- ON (large green font) for ILS or IGS approaches
- OFF (large green font) for LOC, BAC, LDA, or SDF approaches

Push - toggles glideslope on or off.

4 FLAPS VREF

Displays computed VREF for the indicated landing flap settings at displayed gross weight. Blank until gross weight entered.

Push - displays flaps/VREF in scratchpad for entry in 4R.

5 FLAP/SPEED

Valid entries are: XX/YYY, /YYY, or YYY. XX is flap setting, YYY is airspeed.

Entry displays VREF speed on PFD. Entry of an airspeed greater than VREF increases the entire flap speed schedule by the increased amount. If no VREF is selected or an entry is not made, displayed flap speeds are based on flap position increments above VREF 30 for the current gross weight.

Deletion of data removes VREF from PFD.

6 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.

7 Thrust Limit (THRUST LIM)

Push - displays THRUST LIM page.

Alternate Airport Diversions

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~~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.~~

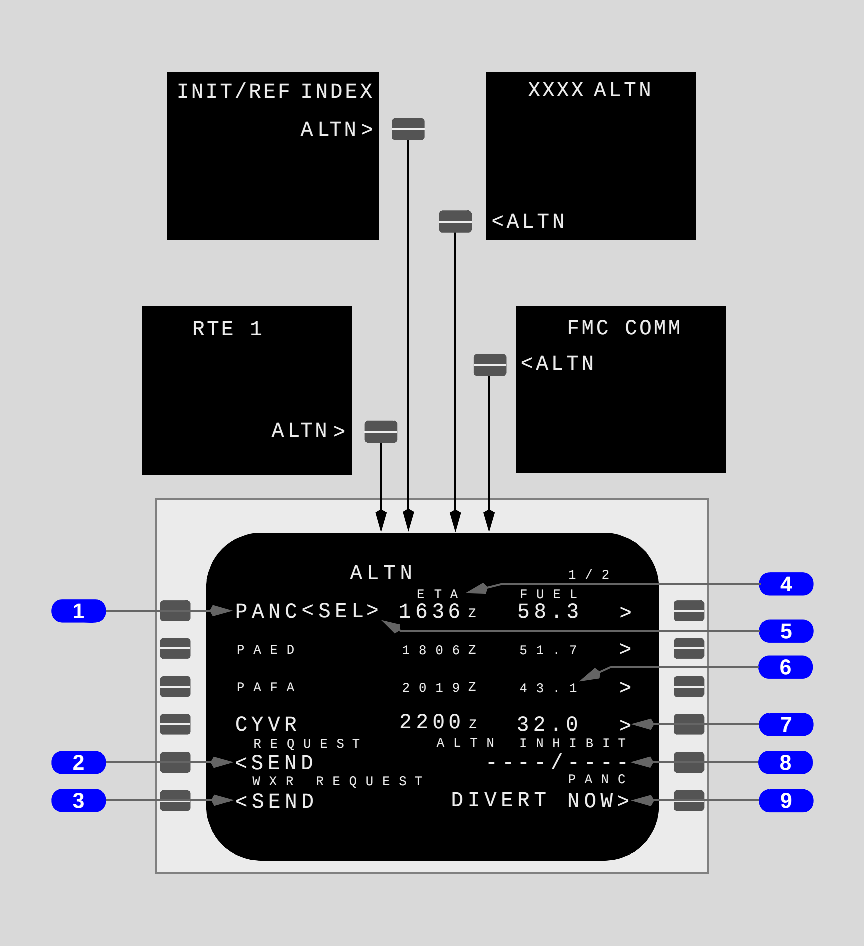
Alternate Page 1/2

~~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.~~

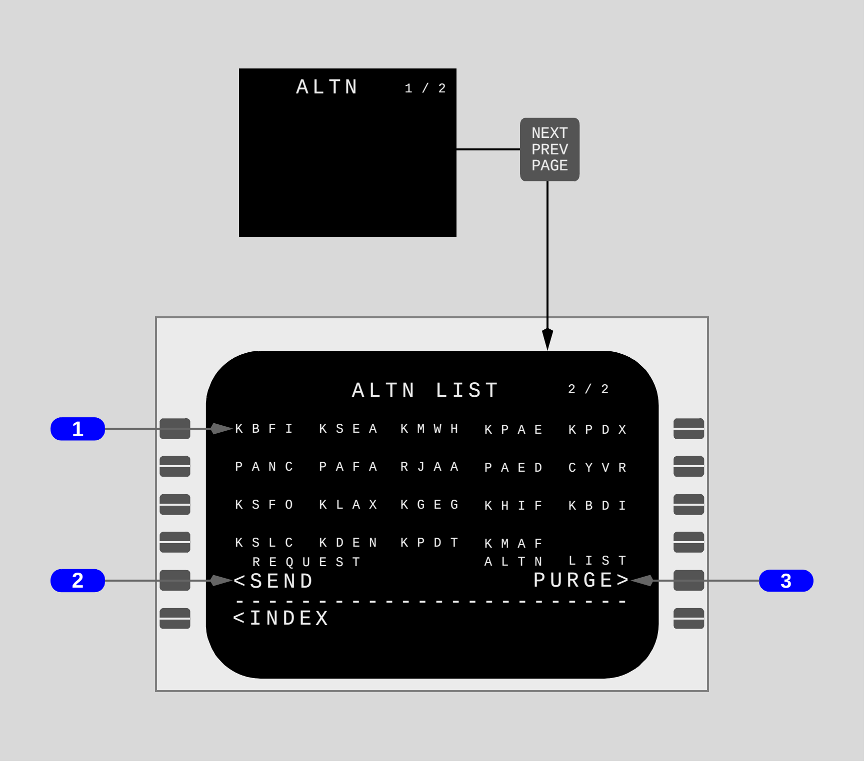
~~Execution of the diversion:~~

- ~~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.~~

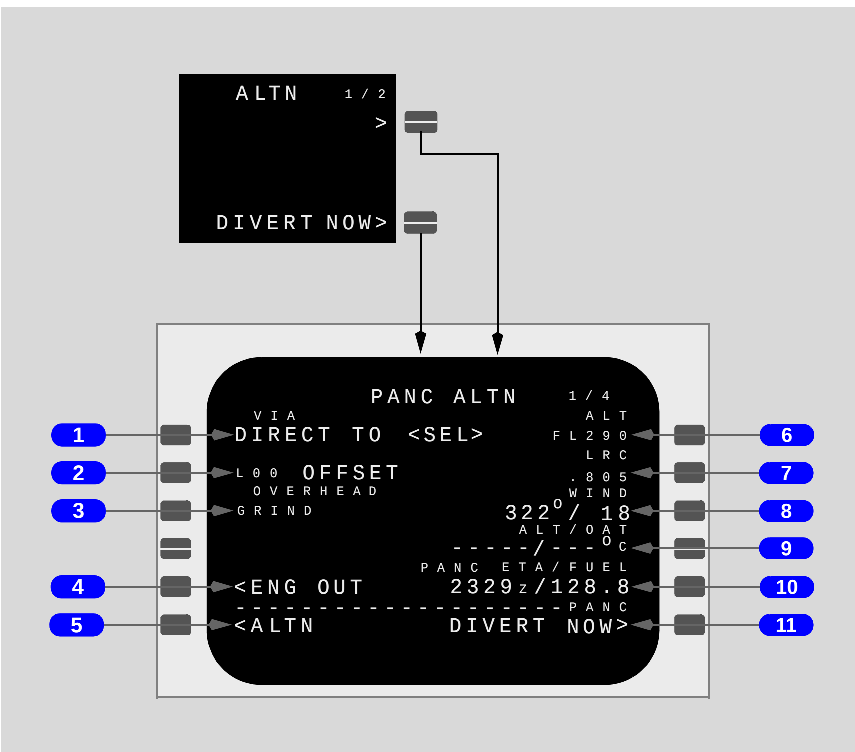
XXXX Alternate Page

~~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.~~

Alternate Airport Diversions

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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.

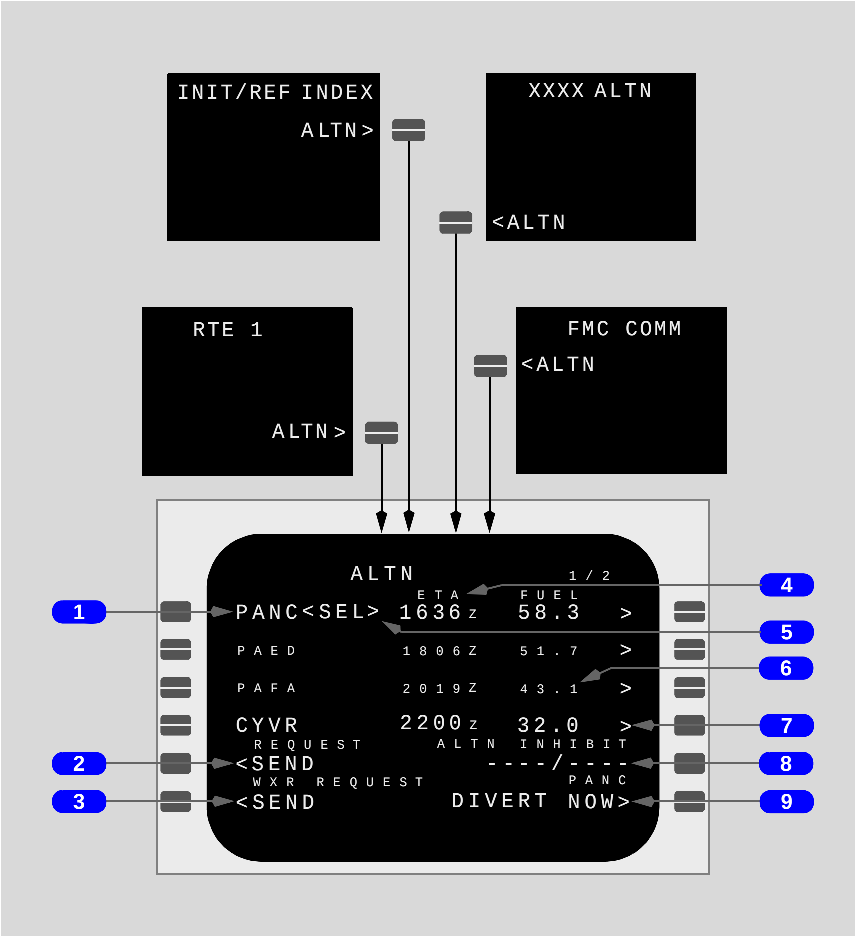
Alternate Page 1/2

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.

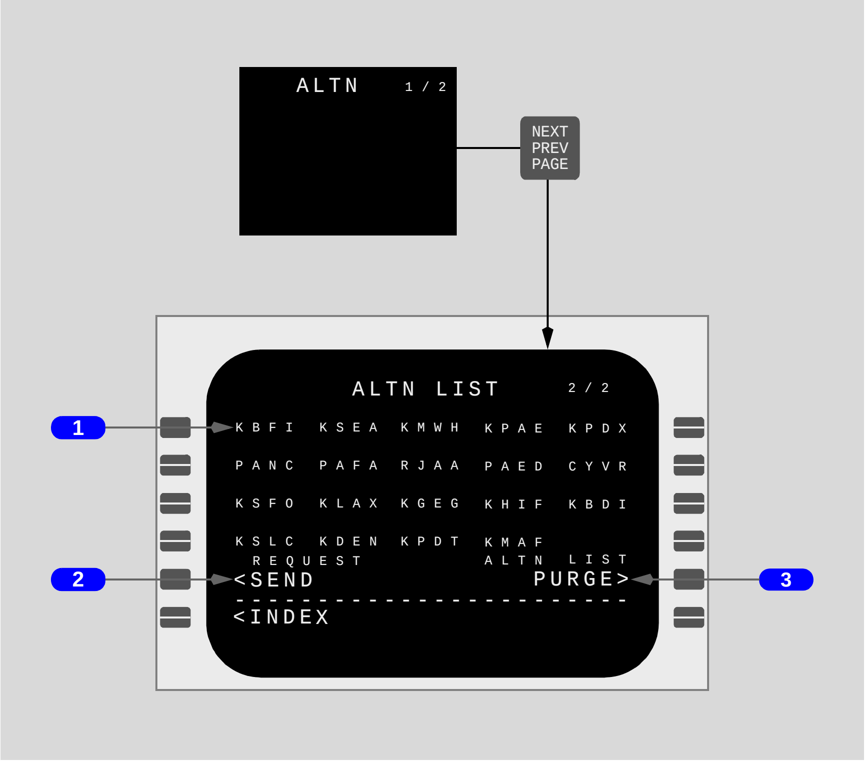
Execution of the diversion:

- 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.

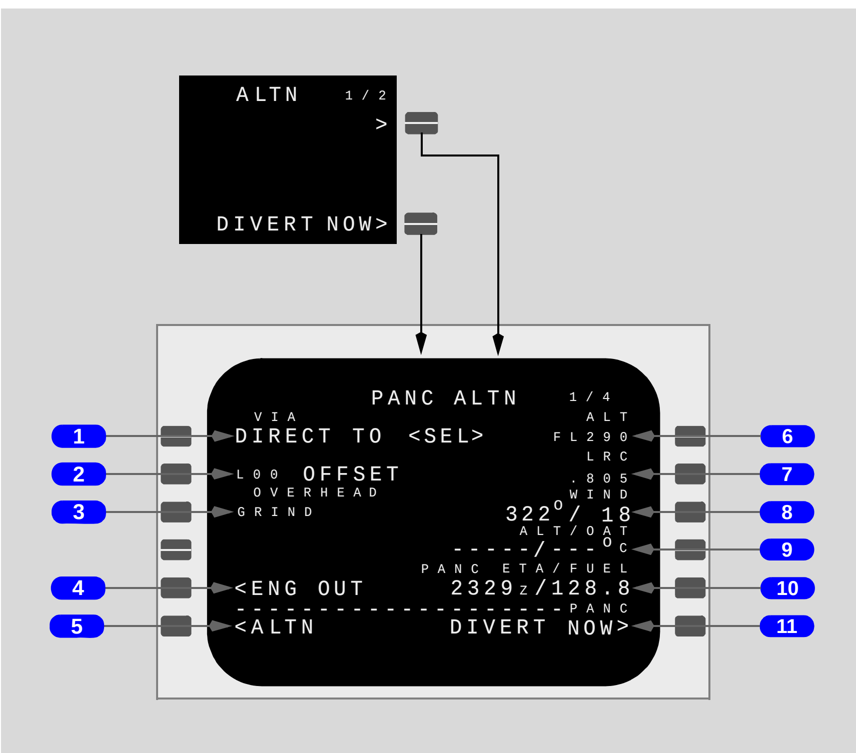
XXXX Alternate Page

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 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.

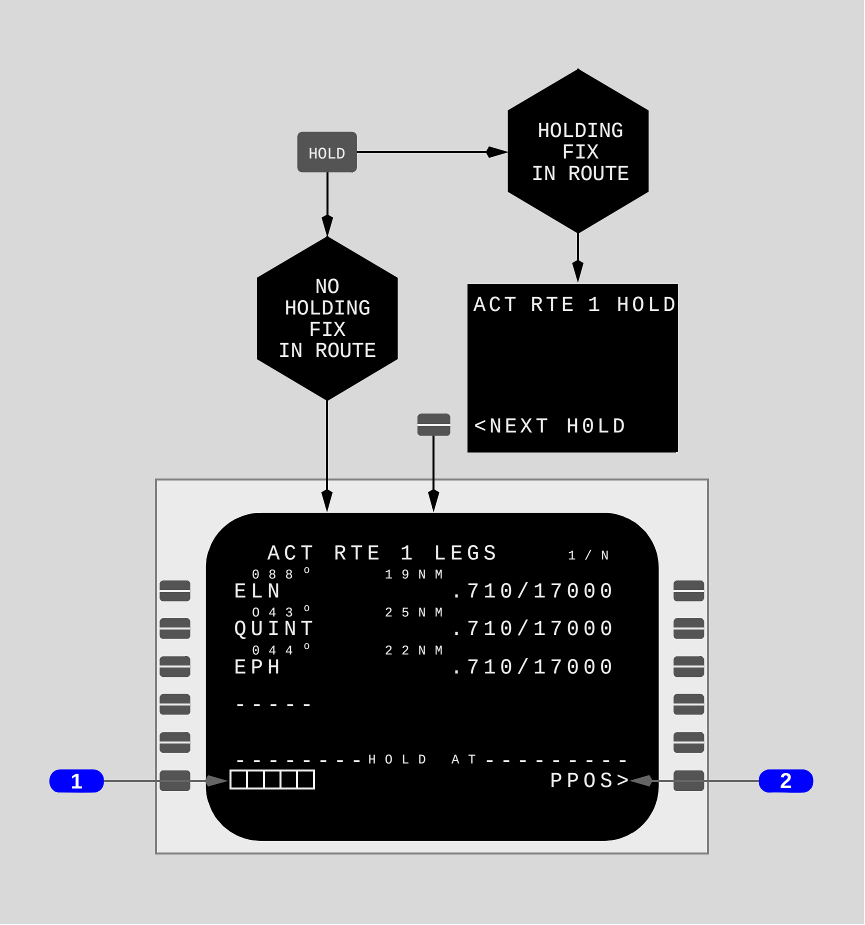
With LNAV active before sequencing the holding fix, holding pattern entries are determined by the following:

- 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
- the initial entry into holding treats the holding fix as a "fly-by" waypoint. Subsequently, the entry path displays and all entry maneuvering is within the displayed holding pattern. Holding exit is also treated as a "fly-by" waypoint

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.

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

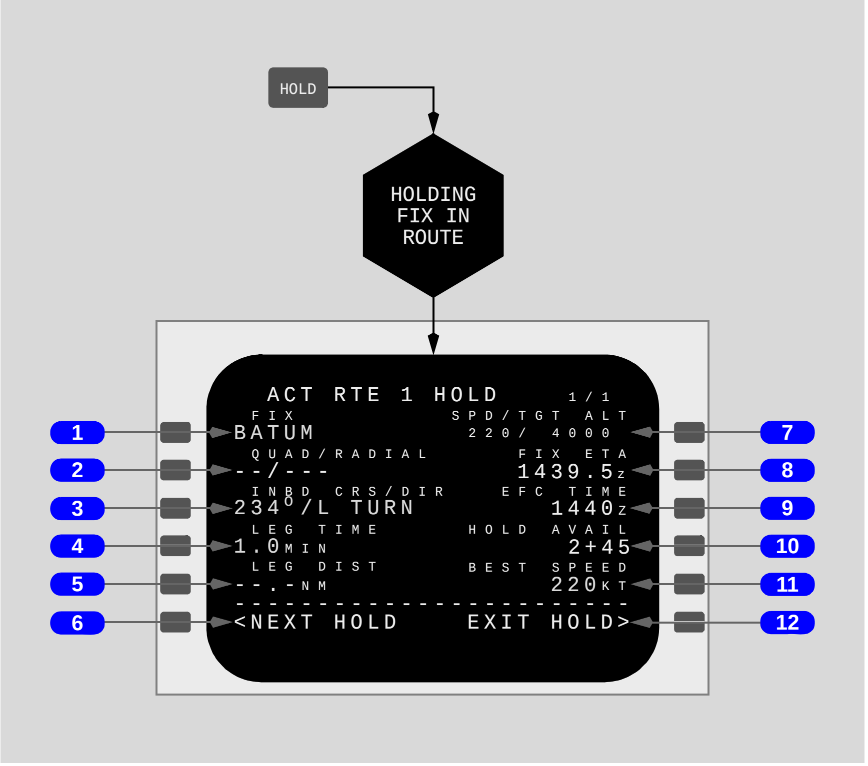
When a hold(s) exists in the route, hold page 1/X displays first existing hold. When more than one hold exists, pushing NEXT PAGE displays succeeding holds.

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.

Flight Management, Navigation — Chapter 11
FMS Alternate Navigation System Description — Section 44

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, and holding patterns. 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

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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.

914
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, ADF, and left ILS. The right CDU tunes the right VOR, DME, ADF, and right ILS. The center CDU tunes the center ILS. Manual tuning is accomplished on the ALTERNATE NAVIGATION RADIO page.

Alternate Navigation CDU Pages

Alternate navigation is accomplished from three CDU pages:

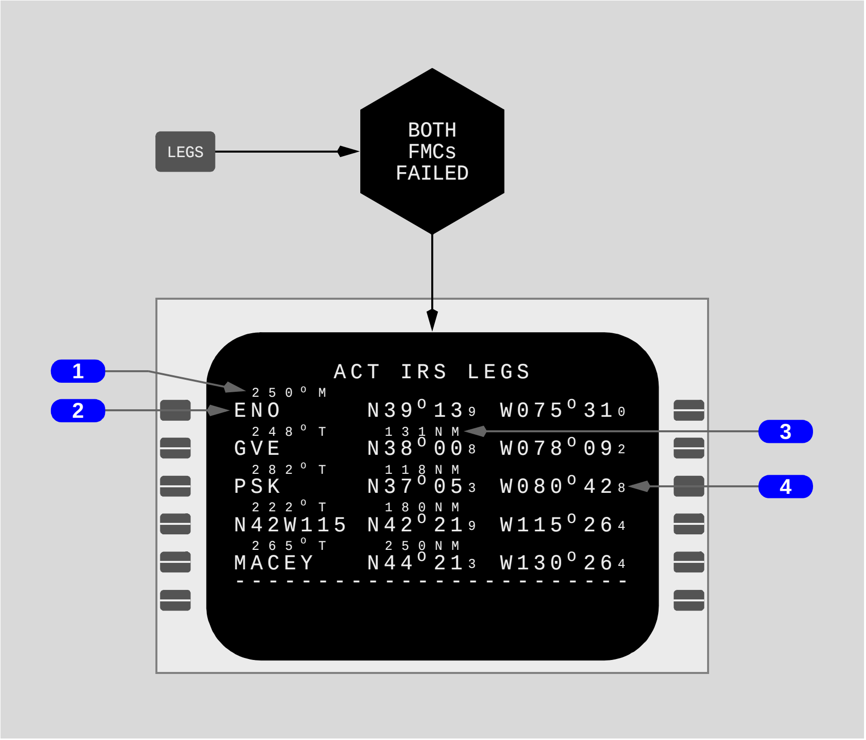
- ALTERNATE NAVIGATION LEGS
- ALTERNATE NAVIGATION PROGRESS
- ALTERNATE NAVIGATION RADIO

Failure of 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. Rotating Navigation Source Selectors to a CDU position restores NDs and the alternate navigation pages.

Alternate Navigation Legs Page

This page displays data about each leg of the route. The route can be modified. Waypoint speed and altitude restrictions are not displayed because performance data is not available.



1 Leg Direction

Displays course to the waypoint.

Course reference is M for magnetic, T for true.

Active waypoint leg direction can be magnetic or true. Subsequent waypoint leg directions are true.

2 Waypoint Identifier

Displays the waypoint by name or latitude/longitude.

Valid entries are waypoints currently in the route or latitude/longitude for new waypoints.

3 Distance to Waypoint

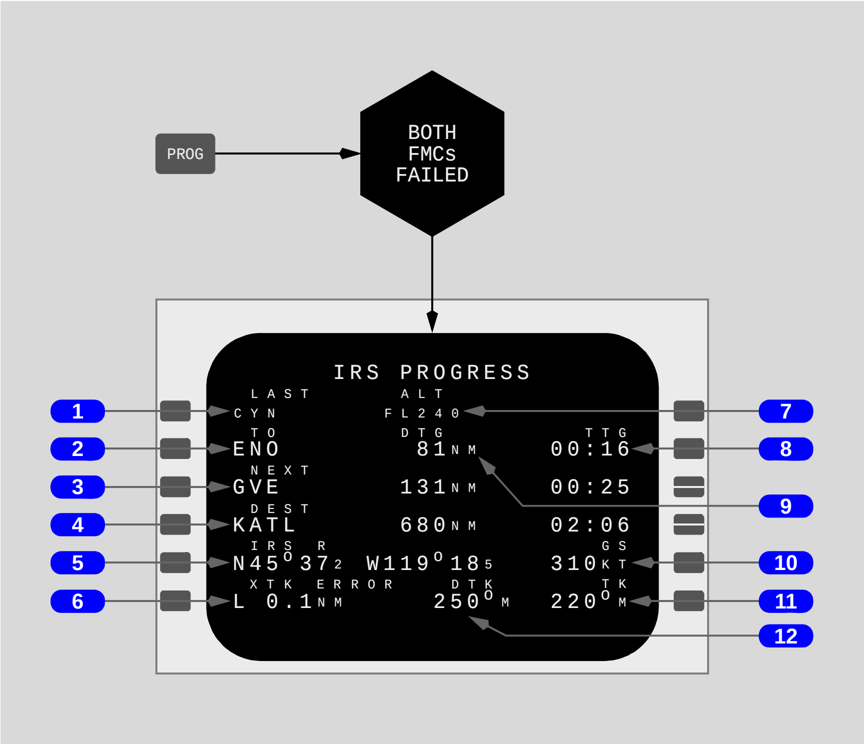
Displays the great circle distance between waypoints.

4 Waypoint Coordinates

Displays the waypoint coordinates.

Alternate Navigation Progress Page

This page displays general data about flight progress.



1 LAST

Displays the identifier of the last waypoint.

2 TO

Displays the active waypoint on the route.

3 NEXT

Displays the waypoint after the TO waypoint.

4 Destination (DEST)

Displays identifier for route destination waypoint or airport. Any waypoint on or off the route can be entered. Time and distance data temporarily displays for that waypoint.

Display options:

- destination airport identifier; distance and time to go along track to the destination airport
- entry of an existing flight plan waypoint (identifier or latitude/longitude) causes the line title to change to ENROUTE WPT. Time and distance to go are from the present position direct to the new waypoint
- entry of a waypoint not in the flight plan causes the line title to change to DIR TO ALTERNATE. Time and distance to go are from the present position direct to the new waypoint

5 Inertial Position (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)

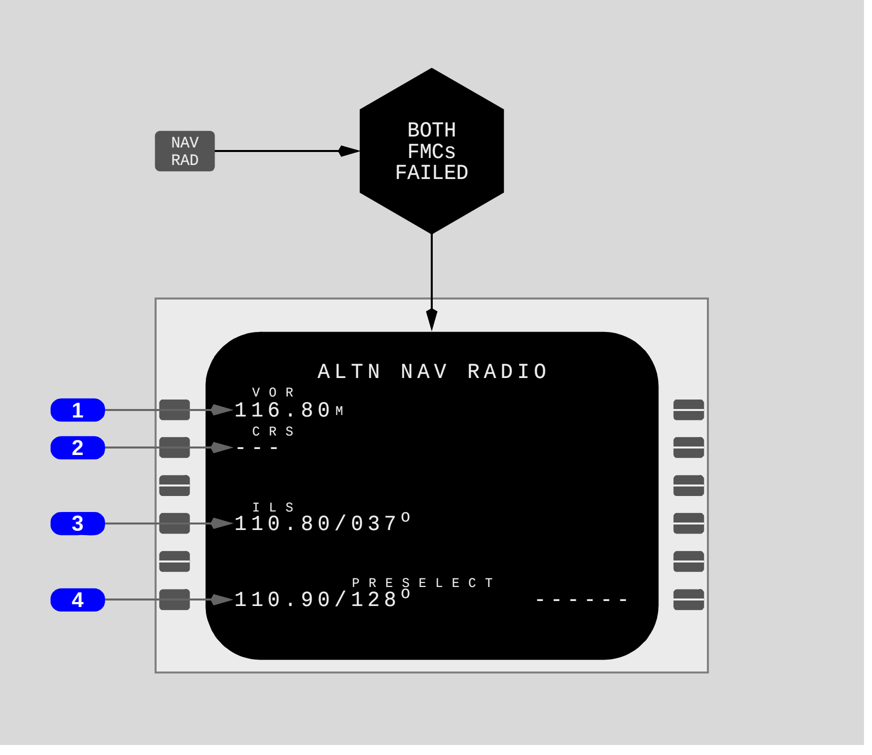
Displays desired track angle relative to the true or magnetic reference selected on the HEADING REFERENCE switch.

Alternate Navigation Radio Page

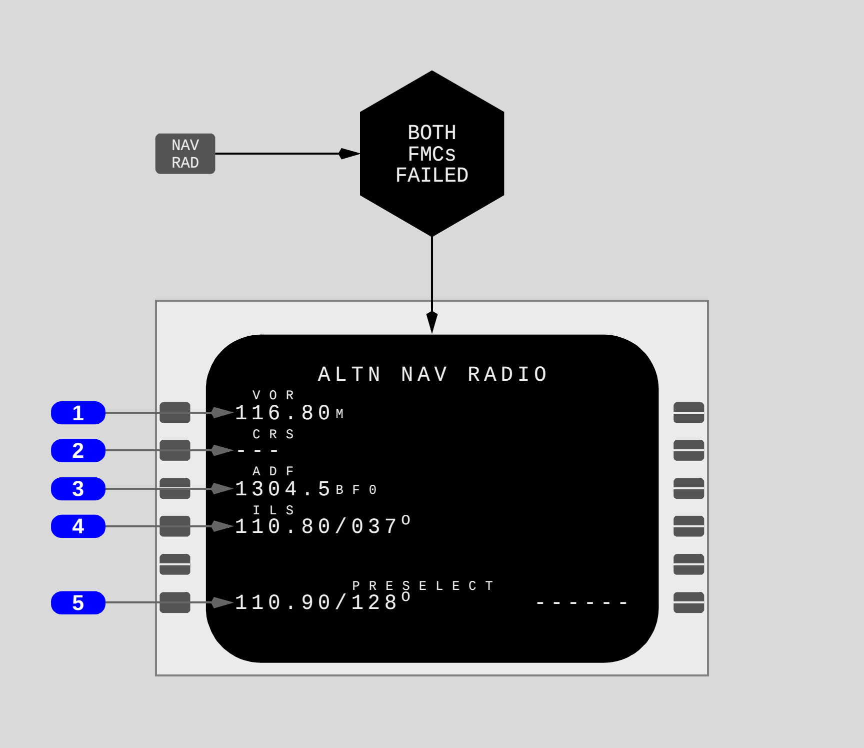
Navigation radios are tuned on this page and related parameters display. Autotune is not available. The CDUs operate independently for navigation radio tuning:

- the left CDU tunes the left radios
- the right CDU tunes the right radios
- the center CDU tunes the center ILS

806



914



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.

914

3 **ADF**

Displays ADF frequency. Tuning status displays as ANT or BFO.

Displays dashes if no ADF frequency entered on NAV RAD or ALTN NAV RAD pages after initial power up.

Valid entry is ADF frequency or ADF frequency suffixed with A or B. Suffix may be changed after entry.

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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: If ILS was in autotune at the time of the FMC failure, the frequency and course are copied to the ALTN NAV RADIO page.

Note: The ILS frequency displays PARK when no frequency is tuned. Deleting the ILS frequency parks a tuned ILS.

Note: ILS course and frequency must be entered on the left, center, and right ALTN NAV RADIO page.

914

4 ILS

Displays last selected ILS frequency, ILS frequency and course, or PARK.

Valid entries are:

- ILS frequency
- ILS frequency/front course
- front course only (a frequency must already be displayed)

Front course defaults to runway course if runway on active route and only frequency entered. Otherwise, front course defaults to 000 or the last entered front course.

Note: If ILS was in autotune at the time of the FMC failure, the frequency and course are copied to the ALTN NAV RADIO page.

Note: The ILS frequency displays PARK when no frequency is tuned. Deleting the ILS frequency parks a tuned ILS.

Note: ILS course and frequency must be entered on the left, center, and right ALTN NAV RADIO page.

806

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.

914

5 PRESELECT

Allows entry of two separate preselected frequencies and/or frequencies/courses.

Valid entries are any of the entries that can be made on the other lines.

Intentionally
Blank

EICAS Alert Messages

Message	Level	Aural	Message Logic
FMC	Advisory		Both FMCs have failed.
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.
INSUFFCNT FUEL	Advisory		When active route is not in a modified state, FMC estimated fuel at destination is less than the entered RESERVES fuel.
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 GLS	Caution		Both pilots’ displays referenced to the same GLS receiver.
SNGL SOURCE ILS	Caution		Both pilots’ displays referenced to the same ILS receiver.

Message	Level	Aural	Message Logic
TRANSPONDER L, R	Advisory		Left or Right ATC transponder fault.
UNABLE RNP	Caution	Beeper	Actual navigation performance does not meet required navigation performance.
VNAV STEP CLIMB	Advisory		The airplane is 5 minutes past a step climb point and a climb has not been started.

EICAS Memo Messages

Message	Condition
IRS ALIGN MODE C, L, R	IRS in align mode. Message no longer displayed when all IRUs enter navigation mode.

FMC Messages

FMC messages indicate degraded system operation, data input errors, or data link status. The messages are categorized as FMC alert, communications, or advisory.

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.

914
~~Q-CLB UNAVAILABLE - FMC calculated Quiet Climb N1 exceeds maximum continuous (CON) N1 thrust.~~

806
Q-CLB UNAVAILABLE - FMC calculated Quiet Climb N1 exceeds maximum continuous (CON) N1 thrust.

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.

914
~~RTA FIX DELETED - RTA fix has been deleted from the modified flight plan.~~

806
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.

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.

914
~~UNABLE FLXXX AT RTA FIX - predicted crossing altitude at RTA fix less than FLXXX, but predicted ETA within tolerance.~~

806
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.

914
~~UNABLE RTA - RTA not achievable within applicable arrival time tolerance.~~

806
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.

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 data 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.

914
~~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.~~

806
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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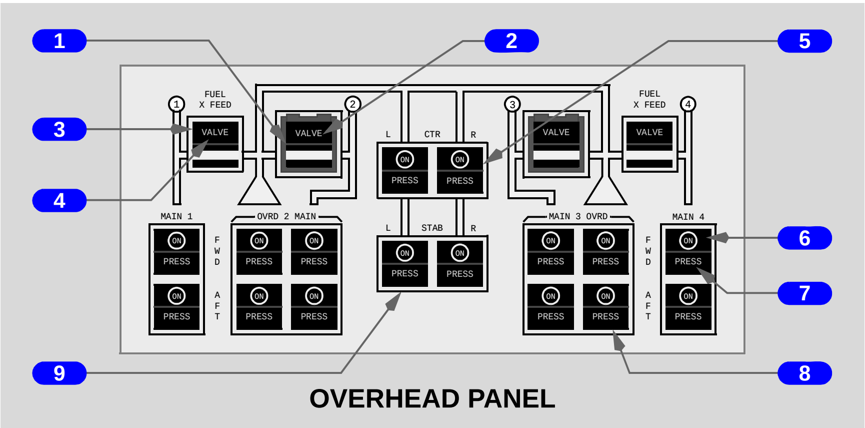
Fuel — Chapter 12
Table of Contents — Section TOC

Fuel System

806



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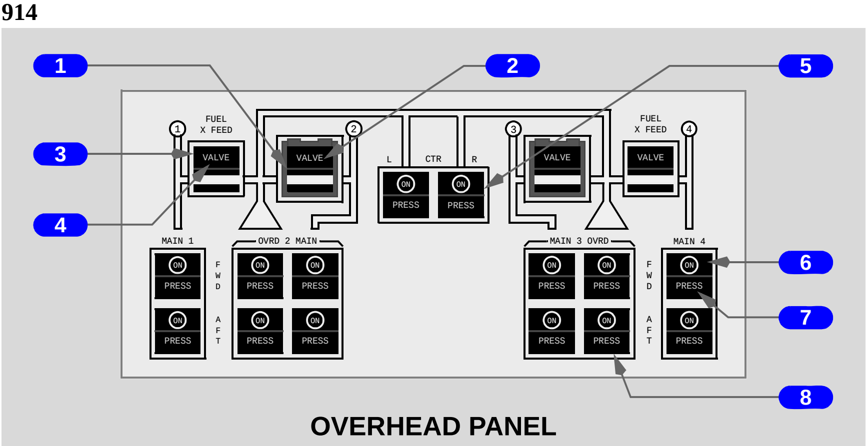


1 Crossfeed (X FEED) Valve Switches 2 and 3

ON (bar visible) - crossfeed valve opens when commanded by system logic.

2 Crossfeed VALVE Lights 2 and 3

Illuminated (amber) - crossfeed valve not in system logic commanded position.

3 Crossfeed (X FEED) Valve Switches 1 and 4

ON (bar visible) - crossfeed valve opens.

4 Crossfeed VALVE Lights 1 and 4

Illuminated (amber) - crossfeed valve position does not agree with switch position.

5 Center (CTR) Wing Tank Pump Switches

ON - fuel pump selected ON.

Off (ON not visible) - fuel pump selected off.

6 MAIN Pump Switches

ON - fuel pump selected ON.

Off (ON not visible) - fuel pump selected off.

7 Fuel Pressure (PRESS) Lights

Illuminated (amber) - fuel output pressure low.

8 Override (OVRD) Fuel Pump Switches

ON - fuel pump operates when commanded by system logic.

Off (ON not visible) - fuel pump selected off.

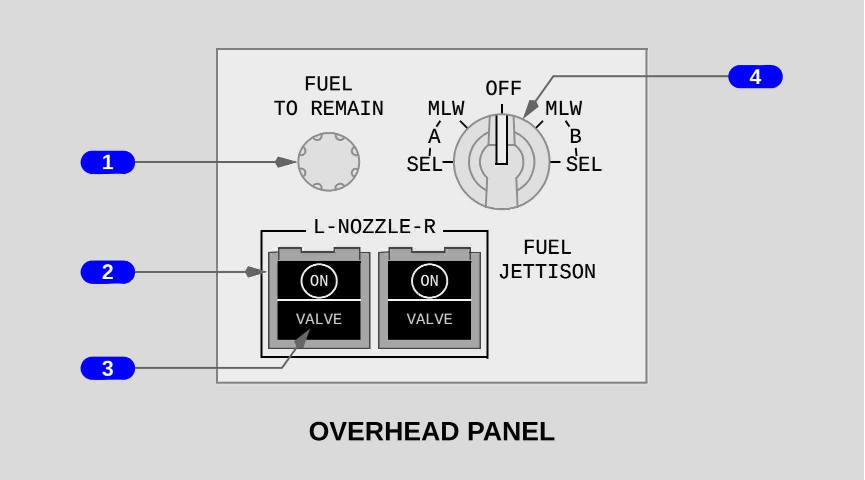
806

9 Stabilizer (STAB) Tank Pump Switches

ON - fuel pump operates when commanded by system logic.

Off (ON not visible) - fuel pump selected off.

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

914

- when jettison system armed, activates override/jettison pumps in tanks containing fuel (pump switches must be ON)

806

- 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

MLW (A or B) -

- arms jettison system

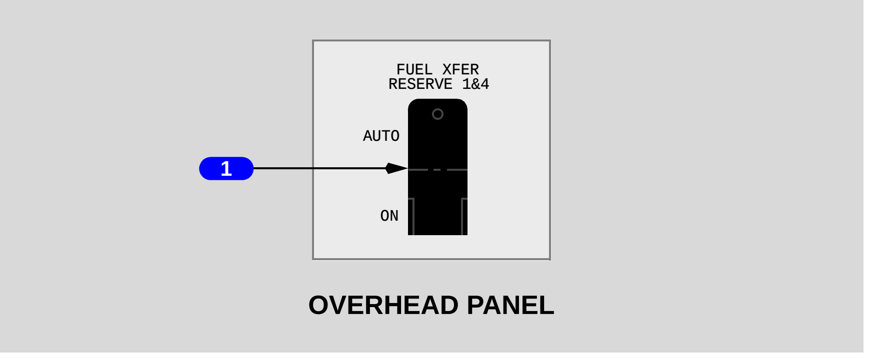
914
- displays fuel to remain for maximum landing weight plus 6,600 pounds on EICAS

806
- displays fuel to remain for maximum landing weight plus 3,000 kilograms on EICAS

SEL (A or B) -

- arms jettison system
- displays preselected fuel to remain on EICAS

Miscellaneous Fuel Control
Flight Deck Transfer Panel



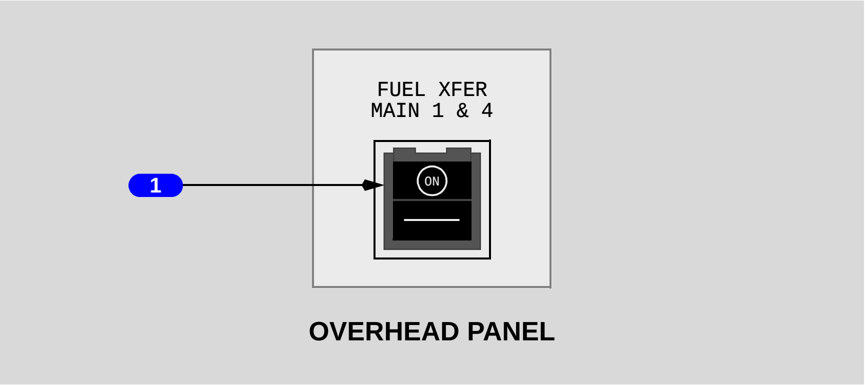
1 FUEL Transfer (XFER) RESERVE 1 & 4 Switch

AUTO -

- reserve 1 and 4 transfer valves closed
- reserve 1 and 4 transfer valves open when commanded by system logic

ON - reserve 1 and 4 transfer valves open.

Fuel Transfer Main 1 & 4 Switch



1 FUEL Transfer (XFER) MAIN 1 & 4 Switch

ON - main 1 and 4 transfer valves open.

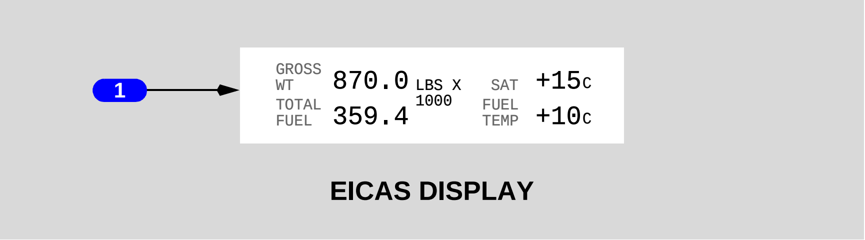
Off -

- main 1 and 4 transfer valves closed
- main 1 and 4 transfer valves open when commanded by system logic

Fuel Indications and Displays

Normal Fuel Indications

914



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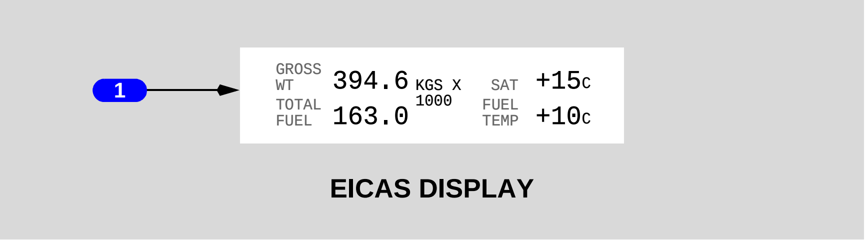


1 **Normal Fuel Indications**

806
GROSS WT (Weight) (kilograms x 1000).

914
GROSS WT (Weight) (pounds x 1000).

806
TOTAL FUEL quantity (kilograms x 1000).

914
TOTAL FUEL quantity (pounds x 1000).

- (white) - FMC estimated fuel at the destination is sufficient.
- (amber) - FMC estimated fuel at the destination is less than the entered reserves fuel.

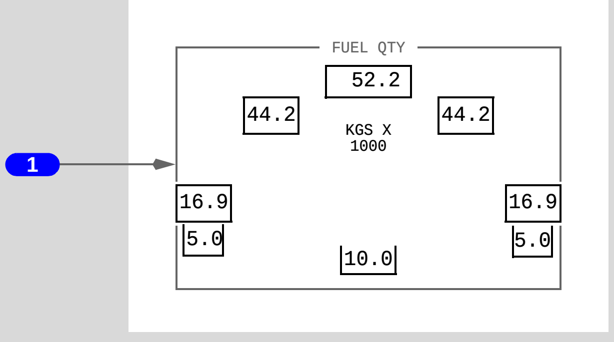
SAT (Static Air Temperature) (degrees Celsius).

FUEL TEMP (Temperature) (degrees Celsius) displayed:

- (white) - normal operating range
- (amber) - at or below the fuel freeze temperature entered on PERF INIT page or -37°C if temperature not entered

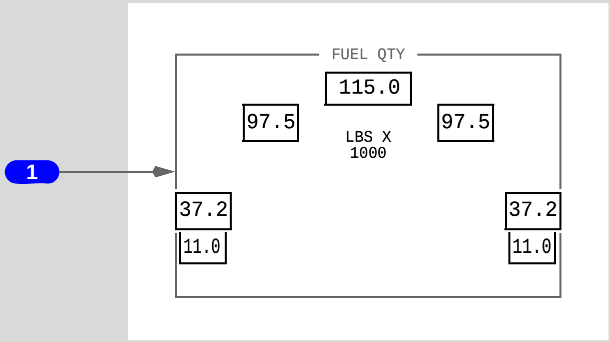
Compacted Fuel Indications

806



EICAS DISPLAY

914



EICAS DISPLAY

1 Compacted Fuel Indications

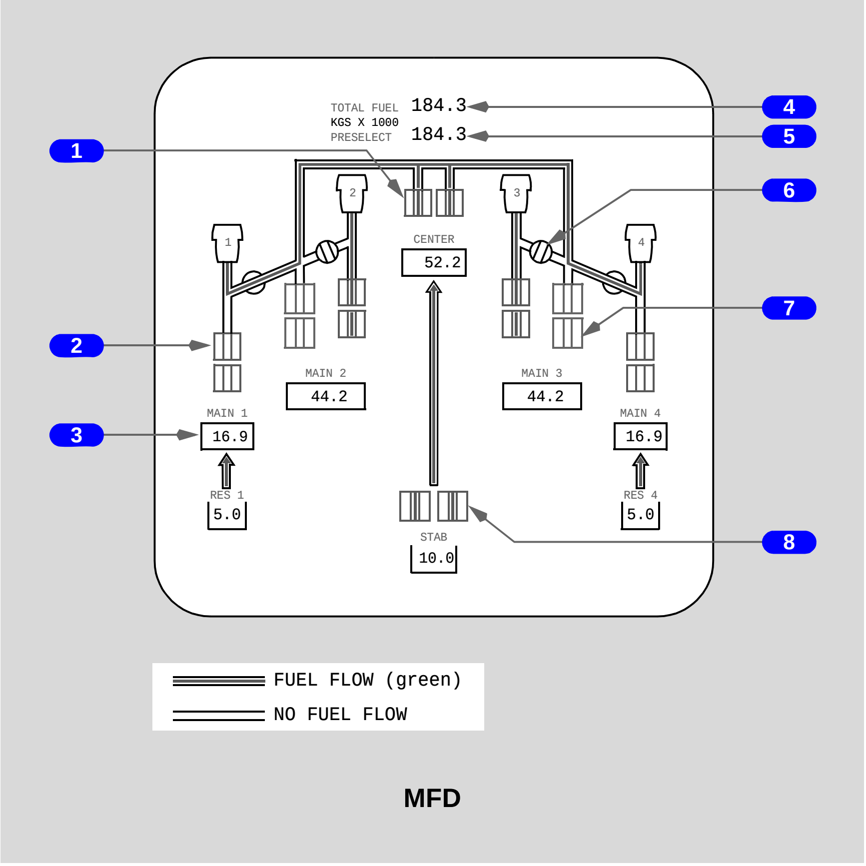
Compacted fuel quantity indications display on primary EICAS if only one display is available for EICAS.

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.

806



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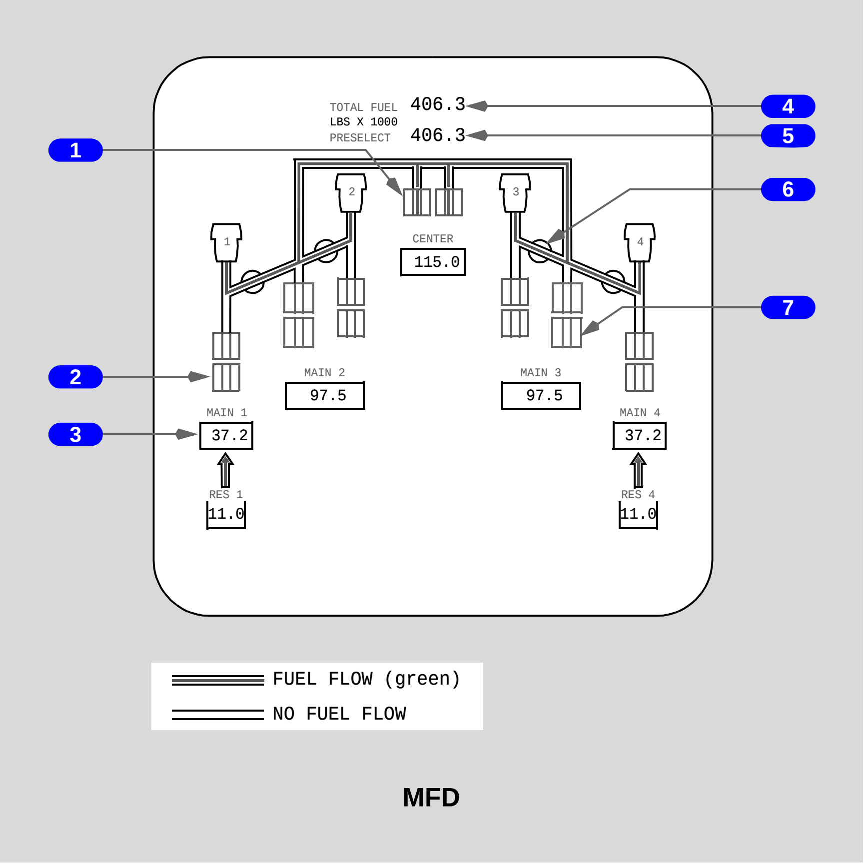


1 Center Wing Tank Pump

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.

806
Amber (main tank only) - imbalance condition or quantity less than 900 kg.

914
Amber (main tank only) - imbalance condition or quantity less than 2,000 pounds.

4 Total Fuel Quantity

White - indicates total fuel quantity.

5 Preselect Fuel Quantity

White - indicates selected total fuel quantity.

Displayed during fueling. No longer displayed when wing fueling panel door closed.

6 Crossfeed Valve

White - indicates open or closed position of crossfeed valve.

Green - indicates open or closed position of crossfeed valve with fuel.

Amber - valve position disagrees with commanded position.

7 Override Pump

White - pump switch off.

Cyan - armed for system logic operation.

Green - pump on.

Amber - pump pressure low.

806
8 Stabilizer Tank Pump

White - pump switch off.

Cyan - armed for system logic operation.

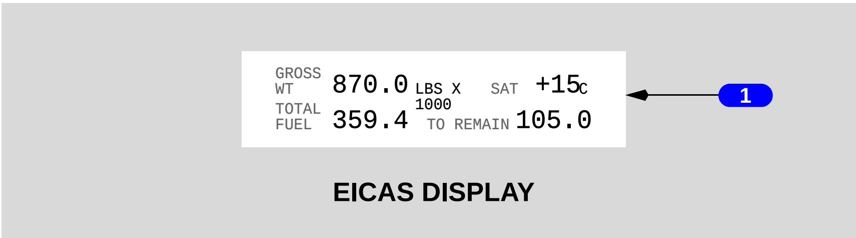
Green - pump on.

Amber - pump pressure low.

Fuel Jettison Indications

Fuel Jettison Indications, Primary EICAS

914



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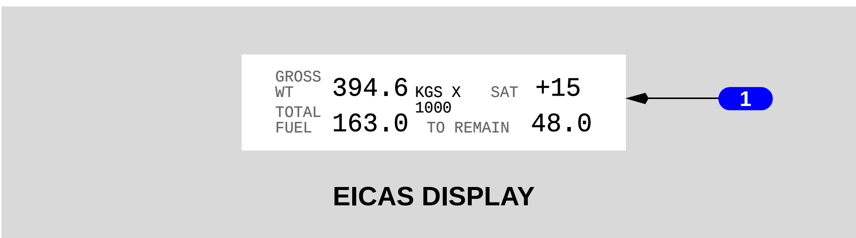


1 Fuel Jettison Indications

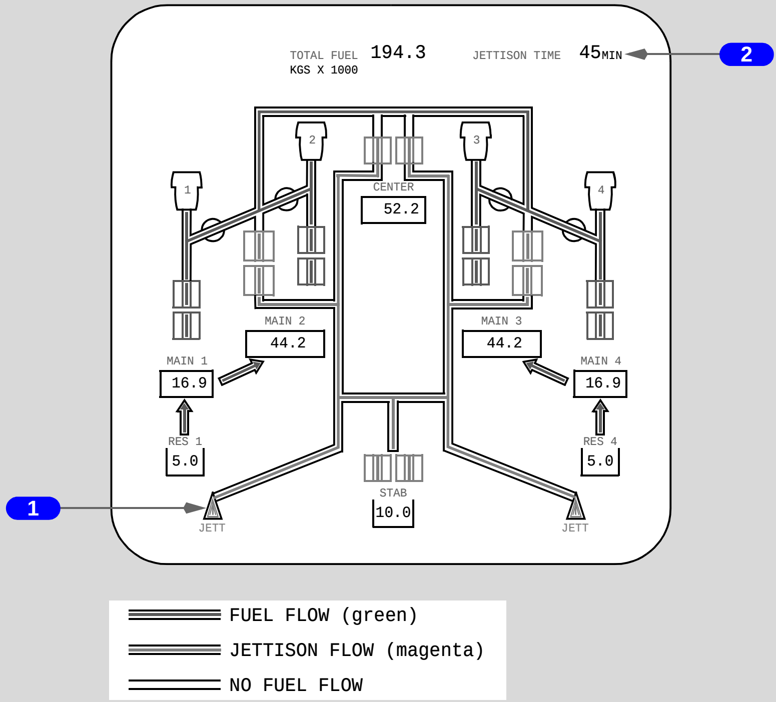
Fuel to remain replaces fuel temperature during jettison operation.

Magenta - indicates fuel to remain at completion of jettison.

White (flashes for five seconds) - indicates jettison has completed.

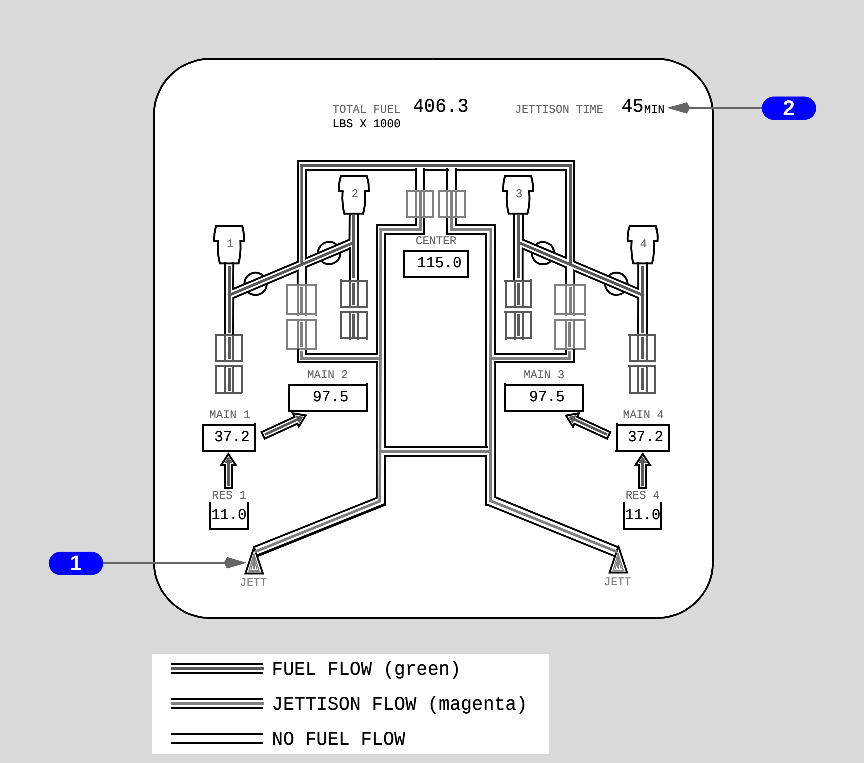
Fuel Jettison Indications, Fuel Synoptic

806



MFD

914



MFD

1 Jettison Nozzle

Magenta - fuel jettison system operating.

2 Time To Complete Jettison

White - time remaining to complete jettison.

Intentionally
Blank

Introduction

914
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 1 and 4. Surge tanks are located in the outer portion of each wing.

806
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 1 and 4, and the horizontal stabilizer tank (HST). Surge tanks are located in the outer portion of each wing and the outer portion of the right horizontal stabilizer.

Refer to Chapter 7, Engines, APU, for a description of the engine and APU fuel systems.

Fuel Quantity

Fuel quantity is measured by sensors in each tank. Total fuel quantity displays on primary EICAS. Tank quantities and total fuel quantity display on the fuel synoptic.

Compacted fuel quantity indications display on primary EICAS if only one 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 the fuel freeze temperature entered on PERF INIT page or -37°C if temperature is not entered. During jettison, the TO REMAIN quantity replaces the EICAS display fuel temperature indication.

Nitrogen Generation System (NGS)

The NGS converts bleed air to nitrogen-enriched air to reduce flammability of center wing tank fuel. To reduce bleed air demand the NGS is shut down:

- during engine out operation, or
- if the Equipment Cooling selector is in OVRD, or
- if the right bleed air duct is isolated, or
- if a Cargo Fire Arm switch is ARMED

After landing:

- with TAT at or above 60°F (16°C), the NGS continues to operate for approximately seven minutes then shuts down, or
- with TAT below 60°F (16°C), the NGS shuts down immediately

Fuel Pumps

806
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 3,450 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.

914
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 7,600 pounds 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.

806
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 and center wing tank quantity is less than or equal to 1,600 kilograms.

914
CWT fuel is scavenged by four jet pumps, two pumping into each main tank 2 and 3. Scavenge begins when main tank 2 or 3 fuel quantity decreases to approximately 60,000 pounds and center wing tank quantity is less than or equal to 3,500 pounds.

806

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

806

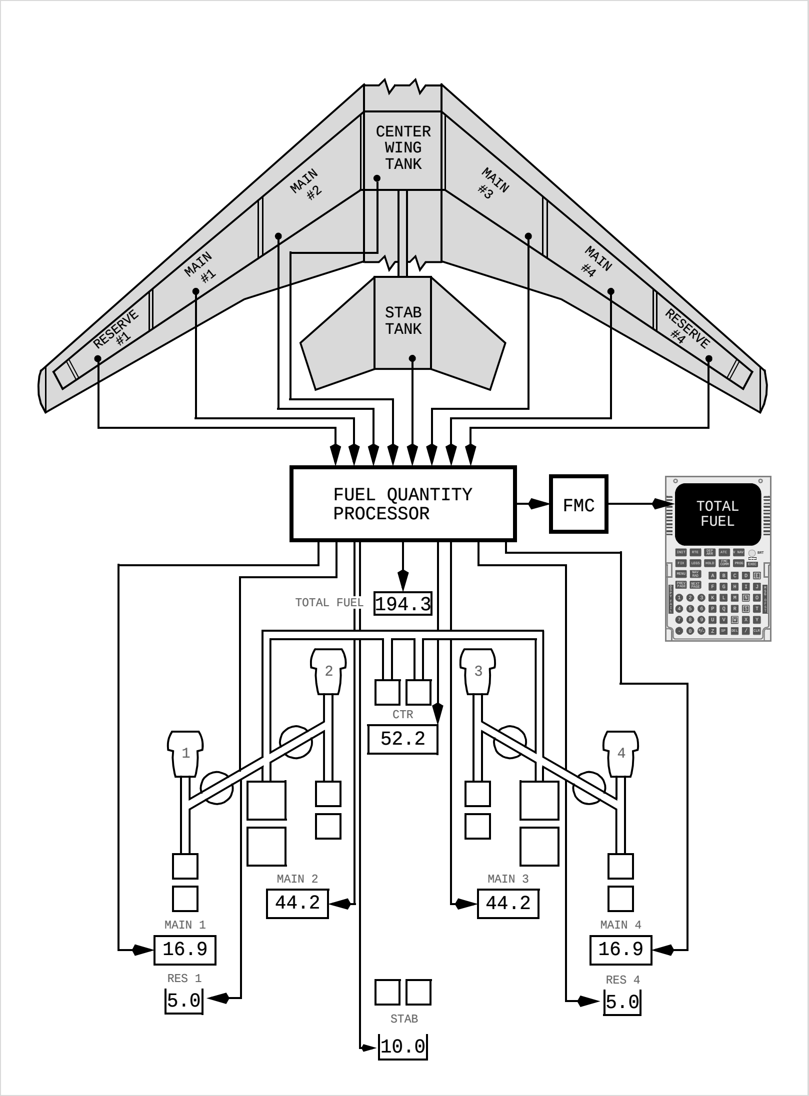
Tank	Liters	Kilograms *
1 and 4 Main	40,276	32,337
2 and 3 Main	109,246	87,713
Center	64,352	51,668
Reserves	11,612	9,323
Stabilizer	12,492	10,030
Total	237,978	191,071
* Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter.		

914

Tank	U.S. Gallons	Pounds*
1 and 4 Main	10,640	71,288
2 and 3 Main	28,860	193,362
Center	17,000	113,900
Reserves	3,068	20,555
Total	59,568	399,105
* Usable fuel at level attitude, fuel density = 6.7 pounds per U.S Gallon.		

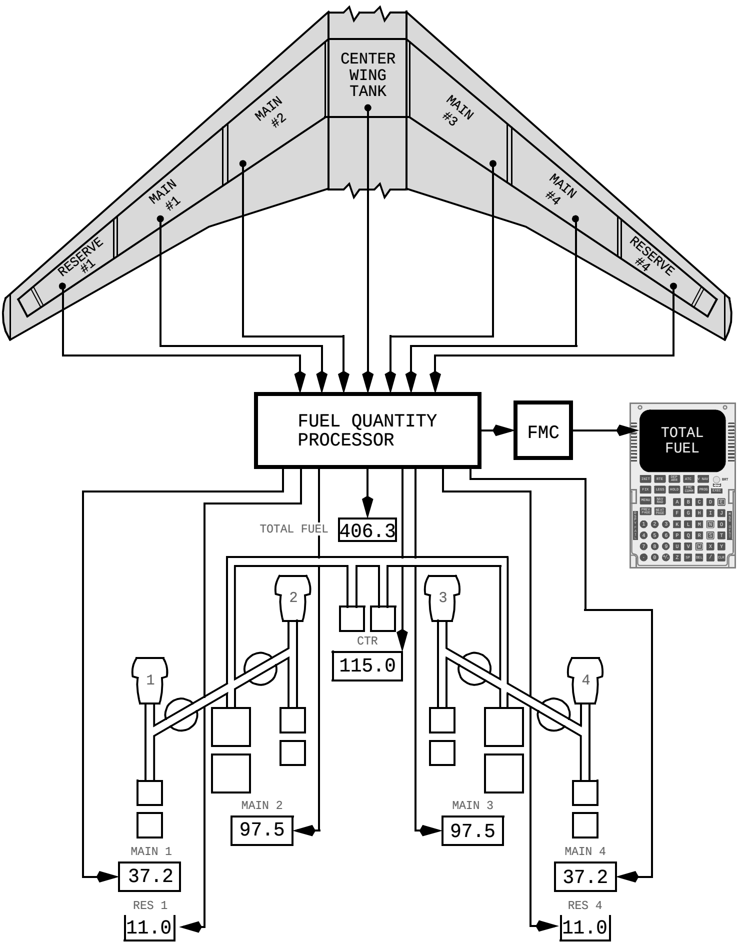
Fuel Quantity Indication

806

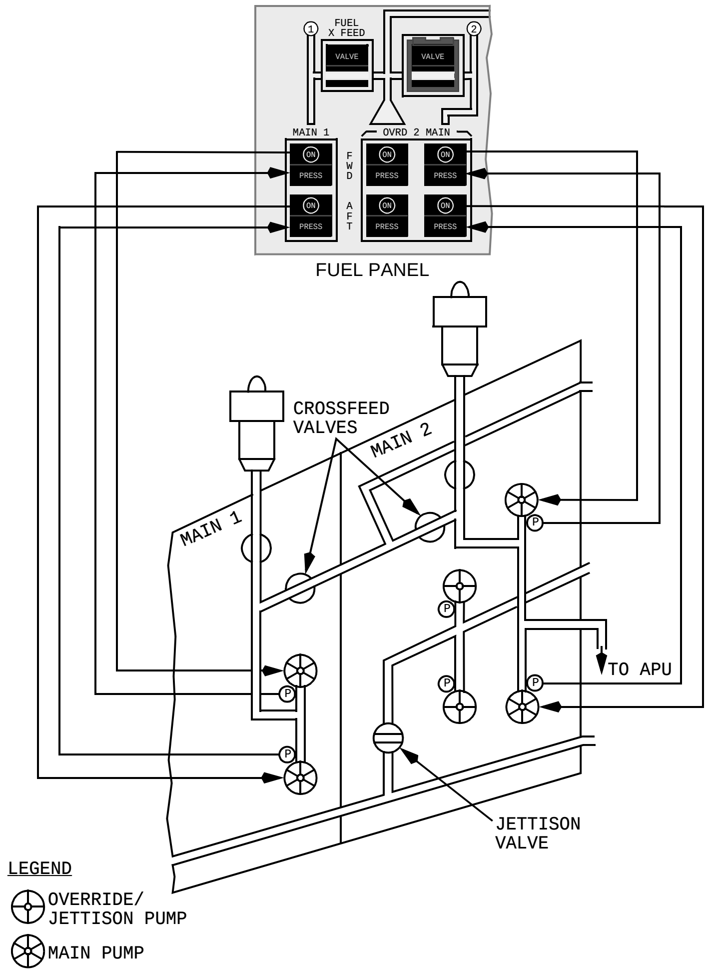


DO NOT USE FOR FLIGHT

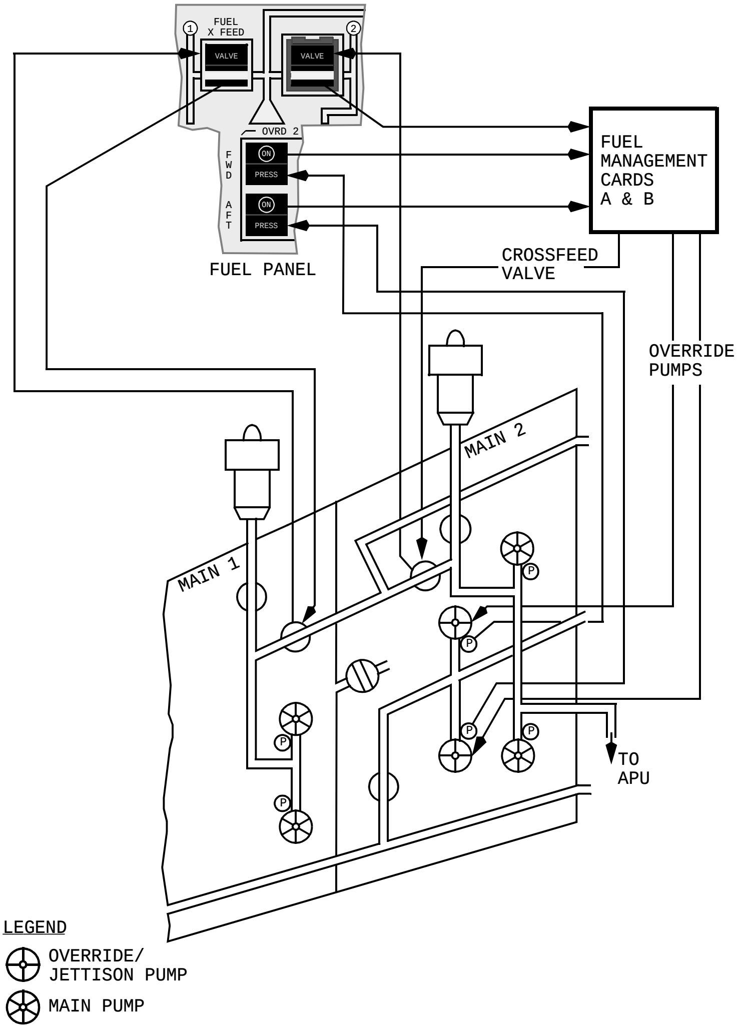
914



Fuel System Schematics
Main Tank Main Pump Schematic



Main Tank Override/Jettison Pump and Fuel Crossfeed Schematic



Center Wing and Horizontal Stabilizer Pump Schematic

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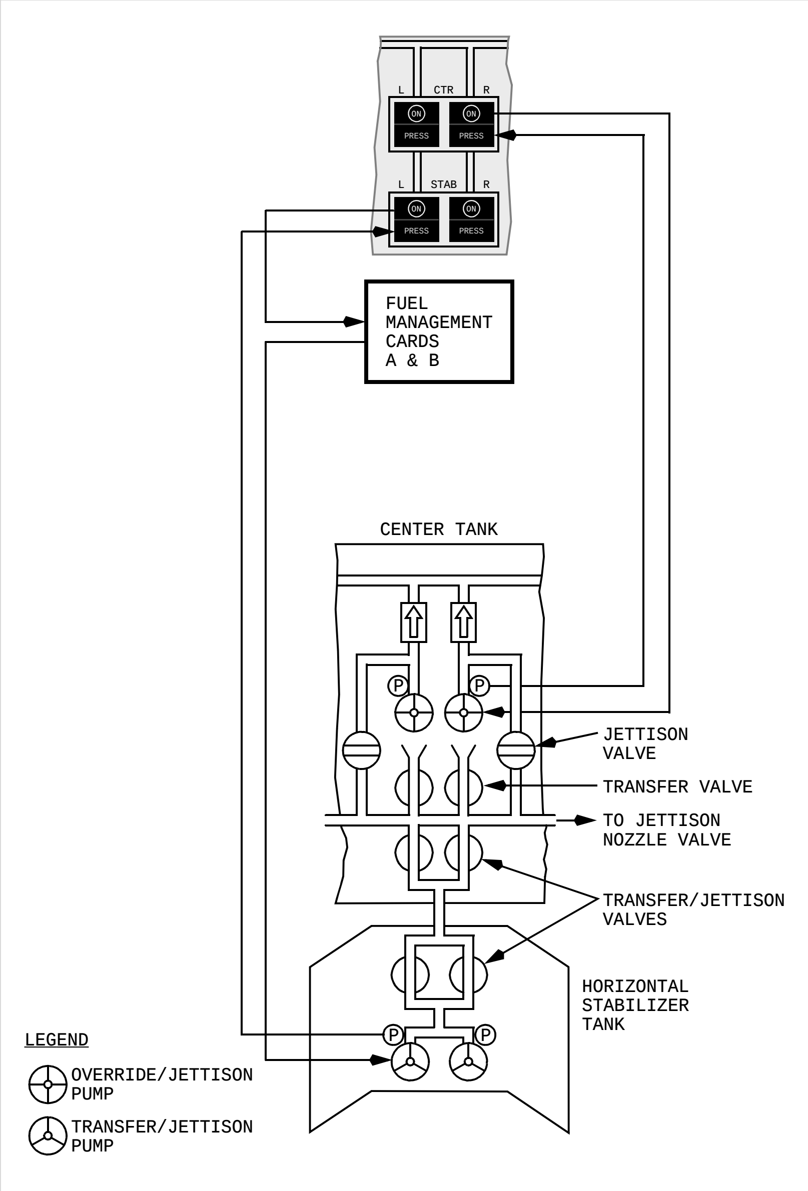
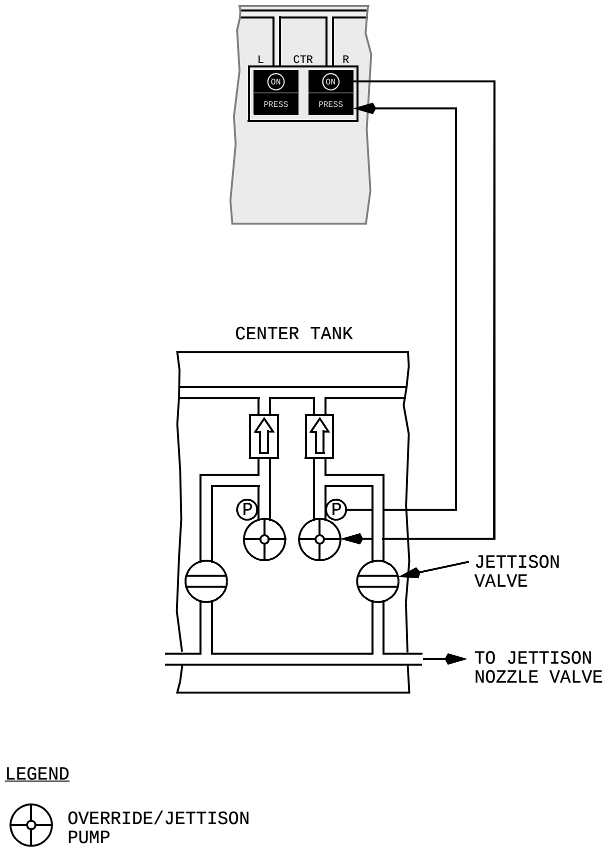


Center Wing Tank Pump Schematic

914



Reserve Tank 1 and 4 Transfer

806
Each reserve tank contains two transfer valves. The valves open and fuel gravity transfers to the outboard main tanks when main tank 1 or 4 fuel quantity decreases to approximately 6,100 kilograms.

914
Each reserve tank contains two transfer valves. The valves open and fuel gravity transfers to the outboard main tanks when main tank 1 or 4 fuel quantity decreases to 13,400 pounds.

Main Tank 1 and 4 Transfer

806
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 3,450 kilograms remaining in each outboard main tank.

914
Main tank 1 and 4 each contain one transfer valve. When the valves open, fuel gravity transfers from the outboard main tanks to the inboard main tanks. Fuel transfers to approximately 7,600 pounds remaining in each outboard main tank.

806
During fuel jettison, the valves open when either main tank 2 or 3 fuel quantity decreases to 21,600 kilograms. The valves may be opened manually using the Fuel Transfer Main 1 & 4 switch on the overhead panel.

914
During fuel jettison, the valves open when either main tank 2 or 3 fuel quantity decreases to 47,600 pounds. The valves may be opened manually using the Fuel Transfer Main 1 & 4 switch on the overhead panel.

APU Fuel Feed

APU fuel is normally supplied from main tank 2. When AC power is available, fuel is supplied by main pump 2 aft; 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

806
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.

914
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

914
With 17,000 pounds or more fuel in the CWT, both CWT pump switches should be ON. The FSMCs close crossfeed valves 2 and 3 when flaps extend to takeoff position on the ground. Override/jettison pumps 2 and 3 are inhibited from operating when pressure is detected from both CWT override/jettison pumps. The CWT override/jettison pumps provide fuel to engines 1 and 4 and main pumps 2 and 3 provide fuel to their respective engine.

806
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 respective engine.

914
With less than 17,000 pounds of fuel in the CWT, both CWT pump switches should be off. The FSMCs close crossfeed valves 2 and 3 when flaps extend to takeoff position on the ground. Override/jettisons pumps 2 provide fuel to engine 1 and override/jettison pumps 3 provide fuel to engine 4. Main pumps 2 and 3 provide fuel to their respective engine.

806
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 respective 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.

806
In flight with flaps retracted out of the range of flaps 10 and flaps 20, stabilizer fuel transfers intermittently as CWT fuel quantity decreases from 29,180 to 1,520 kgs.

914
Note: When CWT quantity drops below approximately 5,000 pounds and total fuel consumption is greater than 15,000 pounds per hour, the CWT override/jettison pumps can no longer provide full override of the outboard main tank pumps. As a result, a shared flow situation between the CWT and outboard main tanks is established. During this shared flow situation, approximately 2,000 pounds of fuel are consumed from each outboard main tank prior to display of the EICAS message FUEL LOW CTR.

806
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.

CWT fuel is scavenged by four jet pumps, two pumping into each main tank 2 and 3.

914
The FSMCs open the reserve transfer valves when main tank 1 or 4 fuel quantity decreases to 13,400 pounds. Fuel transfers from reserve tanks 1 and 4 to the respective main tank.

806
The FSMCs open the reserve transfer valves when main tank 1 or 4 fuel quantity decreases to approximately 6,100 kgs. Fuel transfers from reserve tanks 1 and 4 to the respective main tank.

In flight, the EICAS message FUEL TANK/ENG displays when main tank 2 quantity is equal to or less than the sum of main tank 1 plus reserve tank 1 quantity, or when main tank 3 quantity is equal or less than the sum of main tank 4 plus reserve tank 4 quantity. In the tank-to-engine configuration the main pumps provide fuel to their respective engine until engine shutdown.

914
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 reserve tank plus 1,000 pounds in both wings.

806
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 reserve tank plus 500 kgs in both wings.

Operation With No Fuel in Center Wing Tank

With no fuel in the 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 respective 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.

914
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 reserve tank plus 1,000 pounds in both wings.

914
Note: On the ground with less than approximately 15,000 lbs of fuel in an inboard main tank, the FUEL OVRD 2, 3 AFT, FWD messages may show when the OVRD fuel pump switches are pushed ON before engine start. The messages will blank when the OVRD fuel pump switches are pushed off in response to the FUEL TANK/ENG message.

806
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 reserve tank plus 500 kgs in both wings.

806
Note: On the ground with less than approximately 7,000 kgs of fuel in an inboard main tank, the FUEL OVRD 2, 3 AFT, FWD messages may show when the OVRD fuel pump switches are pushed ON before engine start. The message will blank when the OVRD fuel pump switches are pushed off in response to the FUEL TANK/ENG message.

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.

806
Fuel jettison is initiated by rotating the fuel jettison selector to MLW or SEL on either the A or B side which selects one jettison control system. When a jettison control system is selected, the fuel temperature indication on EICAS is replaced with the fuel to remain quantity indication. Selecting MLW displays the fuel to remain quantity which puts the airplane at maximum landing weight plus 3,000 kilograms when jettison is complete. The jettison manifold and jettison time display on the fuel synoptic.

914
Fuel jettison is initiated by rotating the fuel jettison selector to MLW or SEL on either the A or B side which selects one jettison control system. When a jettison control system is selected, the fuel temperature indication on EICAS is replaced with the fuel to remain quantity indication. Selecting MLW displays the fuel to remain quantity which puts the airplane at maximum landing weight plus 6,600 pounds when jettison is complete. The jettison manifold and jettison time display on the fuel synoptic.

Selecting SEL and rotating the Fuel To Remain selector decreases or increases the fuel to remain quantity.

806
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 respective 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.

914
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 respective 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 display 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.

806
The FSMCs open the reserve transfer valves when main tank 1 or 4 fuel quantity decreases to 6,100 kilograms. Fuel transfers from reserve tanks 1 and 4 to the related main tank.

914
The FSMCs open the reserve transfer valves when main tank 1 or 4 fuel quantity decreases to 13,400 pounds. Fuel transfers from reserve tanks 1 and 4 to the related main tank.

806
When either main tank 2 or 3 fuel quantity decreases to 21,600 kilograms during jettison, both main tank 1 and 4 transfer valves open.

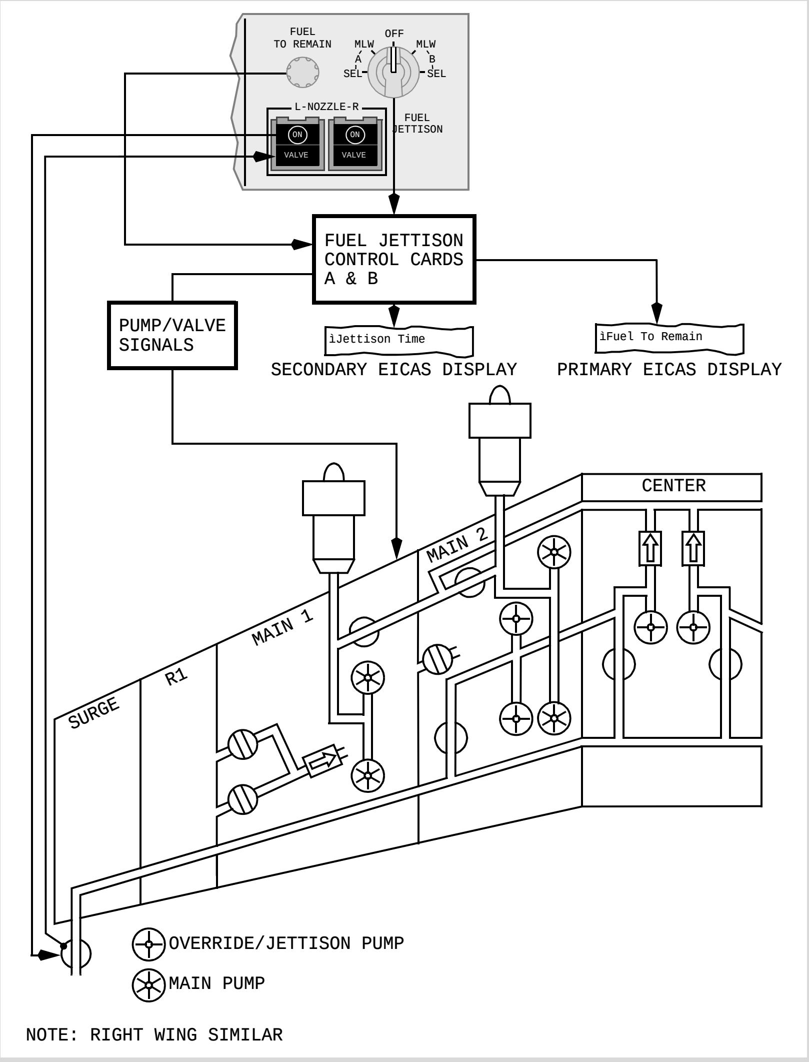
914
When either main tank 2 or 3 fuel quantity decreases to 47,600 pounds during jettison, both main tank 1 and 4 transfer valves open.

806
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 respective FUEL OVRD pump EICAS messages display until the Fuel Jettison selector is OFF.

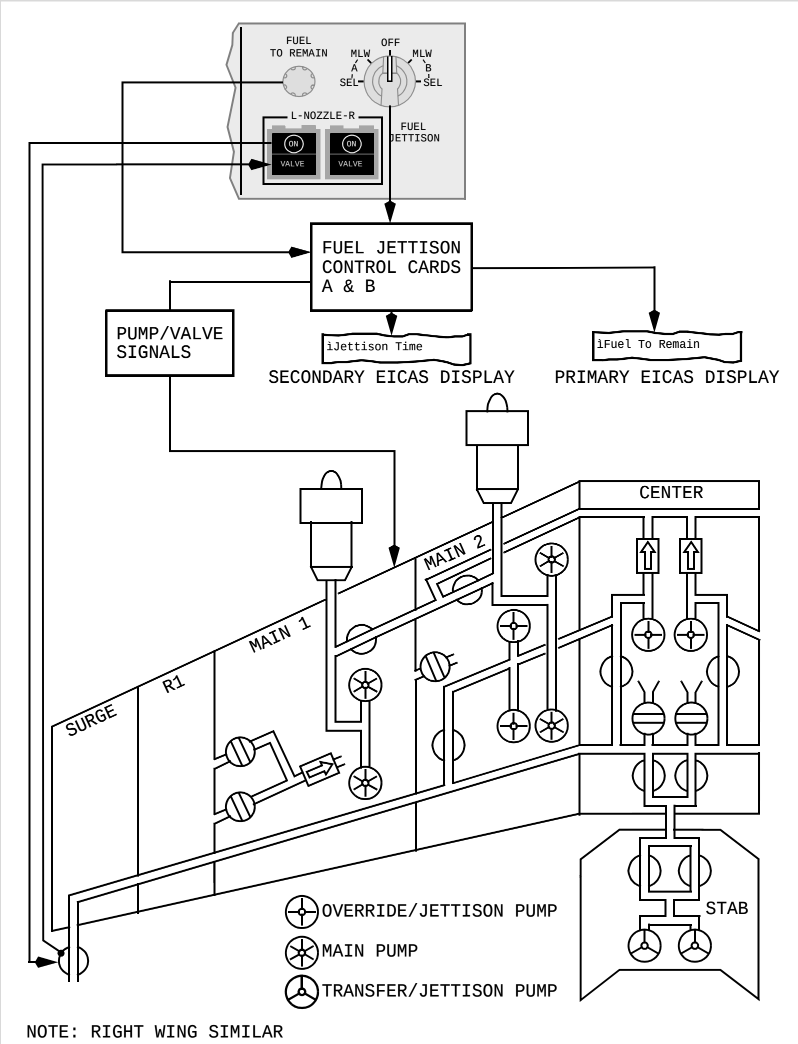
914
Jettison terminates when total fuel quantity decreases to the fuel to remain quantity. The fuel to remain quantity indication changes color from magenta to white and flashes for five seconds. The jettison control system deactivates all operating override/jettison pumps. The respective FUEL OVRD pump EICAS messages display until the Fuel Jettison selector is OFF.

Fuel Jettison Schematic

914



806


FUEL
TO REMAIN
OFF
MLW
A
SEL
MLW
B
SEL
L-NOZZLE-R
ON
VALVE
ON
VALVE
FUEL
JETTISON
FUEL JETTISON
CONTROL CARDS
A & B
PUMP/VALVE
SIGNALS
iJettison Time
SECONDARY EICAS DISPLAY
iFuel To Remain
PRIMARY EICAS DISPLAY
CENTER
MAIN 2
MAIN 1
R1
SURGE
STAB
OVERRIDE/JETTISON PUMP
MAIN PUMP
TRANSFER/JETTISON PUMP
NOTE: RIGHT WING SIMILAR

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EICAS Alert Messages

Message	Level	Aural	Message Logic
FUEL CTR CONFIG	Caution	Beeper	FUEL LOW CTR L or FUEL LOW CTR R message displayed for 60 seconds.
FUEL DISAGREE	Advisory		Totalizer fuel quantity and FMC calculated fuel quantity disagree.
FUEL FLOW ENG 1,2,3,4	Advisory		Fuel flow rate exceeds FMC calculated by 15% for 5 minutes.

914

Message	Level	Aural	Message Logic
FUEL IMBAL 1-4	Advisory		Fuel difference of 3,000 pounds between main tanks 1 and 4. Message no longer displayed when difference less than 1,000 pounds.

806

Message	Level	Aural	Message Logic
FUEL IMBAL 1-4	Advisory		Fuel difference of 1,360 kgs between main tanks 1 and 4. Message no longer displayed when difference less than 450 kgs.

914

Message	Level	Aural	Message Logic
FUEL IMBAL 2-3	Advisory		Fuel difference of 6,000 pounds between main tanks 2 and 3. Message no longer displayed when difference less than 1,000 pounds.

806

Message	Level	Aural	Message Logic
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.

Message	Level	Aural	Message Logic
914			
FUEL IMBALANCE	Advisory		After reaching FUEL TANK/ENG condition, there is a longitudinal fuel imbalance of 6,000 pounds between inboard main tanks and outboard main plus reserve tanks. Message no longer displayed when difference less than 1,000 pounds.
806			
FUEL IMBALANCE	Advisory		After reaching FUEL TANK/ENG condition, there is a longitudinal fuel imbalanceof 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		Selected jettison system has failed.
FUEL JETT SYS	Caution	Beeper	Fuel total less than fuel to remain and one fuel jettison nozzle valve open, or both fuel jettison systems failed.
806			
FUEL LO STAB L, R	Advisory		Stabilizer tank quantity is less than 1,130 kgs with pump switch ON, or with jettison active, stabilizer tank quantity is less than 230 kgs with pump switch ON.

Message	Level	Aural	Message Logic
914			
FUEL LOW CTR L, R	Advisory		Before start, center wing tank quantity less than 17,000 pounds with pump switch ON, or in climb, center wing tank quantity approximately 7,000 pounds with pump switch ON, or in cruise, center wing tank quantity approximately 3,000 pounds with pump switch ON. Message inhibited during jettison or when FUEL CTR CONFIG message displayed.
806			
FUEL LOW CTR L, R	Advisory		Before start, center wing tank quantity less than 7,700 kgs with pump switch ON, or in climb, center wing tank quantity approximately 3,200 kgs with pump switch ON, or in cruise, center wing tank quantity approximately 1,300 kgs with pump switch ON. Message inhibited during jettison or when FUEL CTR CONFIG message displayed.
FUEL M1, M2, M3, M4 FWD+AFT	Advisory		Main forward and aft pump pressures are both low.
914			
FUEL OVD CTR L, R	Advisory		On the ground, center wing tank quantity 17,000 pounds or more with center wing tank pump switch OFF, or in cruise, center wing tank quantity 4,000 pounds or more with center wing tank pump switch OFF.

Message	Level	Aural	Message Logic
806			
FUEL OVD CTR L, R	Advisory		On the ground, center wing tank quantity 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		Fuel override pump pressure is low when pump activated.
FUEL OVRD 2, 3 FWD	Advisory		Fuel override pump pressure is low when pump activated.
FUEL OVRD 2, 3 OFF	Advisory		Override pump switch OFF before tank-to-engine configuration.
806			
FUEL PMP STB L, R	Advisory		Stabilizer tank quantity 500 kgs or more with stabilizer tank pump switch OFF. Message inhibited when FUEL STAB XFR message displayed.
914			
FUEL PRESS CTR L, R	Caution	Beeper	Center tank fuel pump pressure is low when pump switch ON. Message inhibited during jettison until fuel in center wing tank is less than 2,000 pounds.
806			
FUEL PRESS CTR L, R	Caution	Beeper	Center tank fuel pump pressure is low 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	Both main pumps in a tank have low pressure with the respective crossfeed valve closed. Engine on suction feed.

Message	Level	Aural	Message Logic
806			
FUEL PRES STB L, R	Advisory		Stabilizer fuel pump pressure is low when pump activated. Pump activates by system logic with stabilizer tank pump switch ON. Message inhibited during jettison until fuel in stabilizer tank is 1,130 kgs or less.
FUEL PUMP 1, 2, 3, 4 AFT	Advisory		Main pump pressure is low when pump activated. Message inhibited when FUEL M1, M2, M3, M4 FWD+AFT message displayed.
FUEL PUMP 1, 2, 3, 4 FWD	Advisory		Main pump pressure is low when pump activated. Message inhibited when FUEL M1, M2, M3, M4 FWD+AFT message displayed.
914			
FUEL QTY LOW	Caution	Beeper	Fuel quantity 2,000 pounds or less in one or more main tanks.
806			
FUEL QTY LOW	Caution	Beeper	Fuel quantity 900 kgs or less in one or more main tanks.
FUEL RES XFR 1, 4	Advisory		Reserve tank transfer valve not in commanded position.
806			
FUEL STAB XFR	Caution	Beeper	Stabilizer tank fuel transfer function is failed.

Message	Level	Aural	Message Logic
914			
FUEL TANK/ENG	Advisory		On the ground, with crossfeed valve 1 or 4 open, in both wings, inboard tank quantity is less than or equal to the sum of the adjacent outboard tank plus reserve tank plus 1,000 pounds, or in flight, with crossfeed valve 1 or 4 open, in either wing, an inboard tank quantity is less than or equal to the adjacent outboard tank plus reserve tank.
806			
FUEL TANK/ENG	Advisory		On the ground, with crossfeed valve 1 or 4 open, in both wings, inboard tank quantity is less than or equal to the sum of the respective outboard tank plus reserve tank plus 500 kgs, or in flight, with crossfeed valve 1 or 4 open, in either wing, an inboard tank quantity is less than or equal to the respective outboard tank plus reserve tank.
FUEL TEMP LOW	Advisory		Fuel temperature is near the minimum.
FUEL TEMP PRED	Advisory		Fuel temperature predicted to be low after reserve tank transfer.
FUEL TEMP SYS	Advisory		Fuel temperature indication failed.
FUEL X FEED 1, 2, 3, 4	Advisory		Fuel crossfeed valve position disagrees with commanded position.
FUEL XFER MAIN	Advisory		On the ground, Fuel Transfer Main 1 & 4 switch is ON, or in flight, Fuel Transfer Main 1 & 4 switch is ON with inboard main tank quantities greater than outboard main plus reserve tank quantities.

Message	Level	Aural	Message Logic

914

Message	Level	Aural	Message Logic
FUEL XFR RES ON	Advisory		On the ground, Fuel Transfer Reserve 1 & 4 switch is ON, or in flight, Fuel Transfer Reserve 1 & 4 switch is ON and an outboard main tank fuel quantity is more than 13,400 pounds.

806

Message	Level	Aural	Message Logic
FUEL XFR RES ON	Advisory		On the ground, Fuel Transfer Reserve 1 & 4 switch is ON, or in flight, Fuel Transfer Reserve 1 & 4 switch is ON and an outboard main tank fuel quantity is more than 6,000 kgs.
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.
X FEED CONFIG	Advisory		One or more fuel crossfeed valves incorrectly configured. Message displayed when crossfeed valve 1 or 4 closed and main tanks not equal, or crossfeed valve 2 or 3 closed and flaps not in takeoff position.

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Hydraulics — Chapter 13

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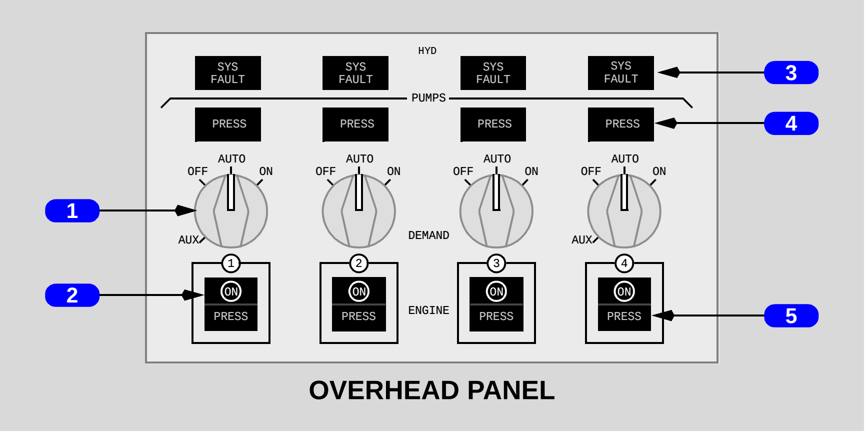
Hydraulics — Chapter 13
Controls and Indicators — Section 10

Hydraulic Panel



1 Hydraulic DEMAND Pump Selector

OFF - demand and auxiliary pumps off.

AUTO -

- demand pump operates when respective engine pump output pressure is low, or when respective fuel control switch is in CUTOFF
- demand pumps 1 and 4 also operate when trailing edge flaps are in transit, or in flight when flaps are extended past 1
- in flight, demand pumps 2 and 3 also operate when flaps are extended past 20

ON - demand pump operates.

AUX (Systems 1 and 4) -

- auxiliary pump operates on the ground when the respective engine driven pump is unpressurized
- respective demand pump off

2 ENGINE Hydraulic Pump Switch

ON - engine hydraulic pump pressurizes system when engine rotates.

3 Hydraulic System (SYS) FAULT Light

Illuminated (amber) -

- low hydraulic system pressure
- low hydraulic reservoir quantity
- excessive hydraulic fluid temperature

4 Demand Pump Low PRESS Light

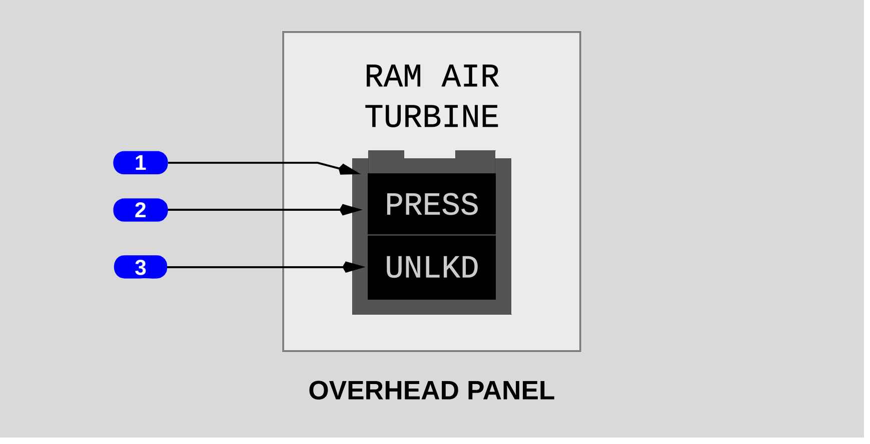
Illuminated (amber) -

- 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.

Ram Air Turbine Switch (RAT)



1 RAM AIR TURBINE Switch

Push - deploys the RAT

2 Ram Air Turbine Pressure (PRESS) Light

Illuminated (green) -

- the RAT is operating
- system 3 primary flight control hydraulic pressure is greater than approximately 1500 psi

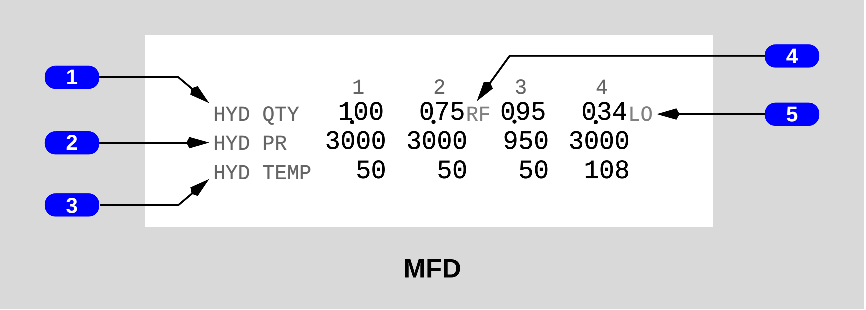
3 Ram Air Turbine Unlocked (UNLKD) Light

Illuminated (amber) - the RAT is not in the stowed position.

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

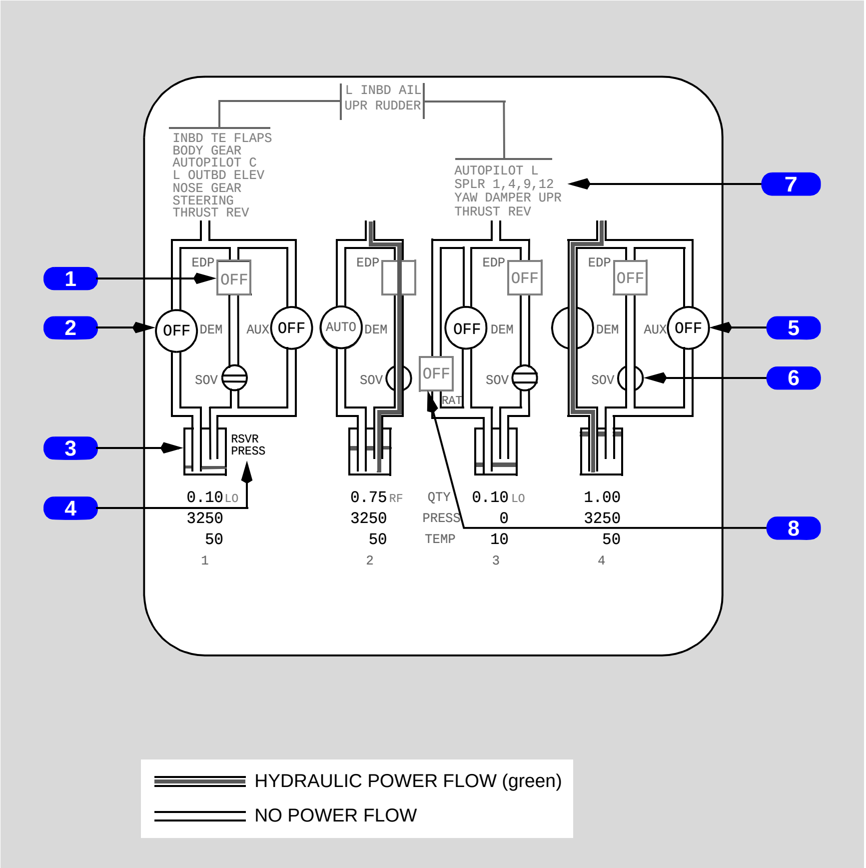
RF (Refill) (magenta) - displays on ground when reservoir requires refill.

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.



MFD

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 **Reservoir (RSVR) Pressure**

RSVR PRESS - displays when reservoir bleed air pressure is low.

5 **Auxiliary Pump**

OFF - auxiliary pump is not operating.

6 **Shutoff Valve**

Indicates open or closed position of shutoff valve.

7 **Inoperative Systems**

Lists inoperative systems due to hydraulic system failures.

8 **Ram Air Turbine**

If the RAT has deployed, the RAT symbology and hydraulic System 3 lines will display green to show RAT functionality.

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Hydraulics — Chapter 13
System Description — Section 20

Introduction

The airplane has four independent hydraulic systems, numbered by the engine which powers it. The hydraulic systems power the:

- primary flight controls
- flaps
- spoilers
- stabilizer trim
- elevator feel
- autopilot servos
- landing gear
- landing gear steering
- brakes
- thrust reversers

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.

Ram Air Turbine

The ram air turbine (RAT) provides emergency hydraulic power to System 3.

The RAT deploys manually when the Ram Air Turbine switch is pushed, or in flight when any three engines drop below 50% N2.

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 by 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 page, HYD synoptic page
- 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 indications may occur for all four hydraulic systems:

- blank hydraulic quantity indications on the EICAS status page and HYD synoptic page

For a single hydraulic system failure, the inoperative items display on the hydraulics synoptic above the affected system graphic. If multiple hydraulic systems are inoperative, additional items common to those systems display above the single system items and are connected by lines to the failed systems.

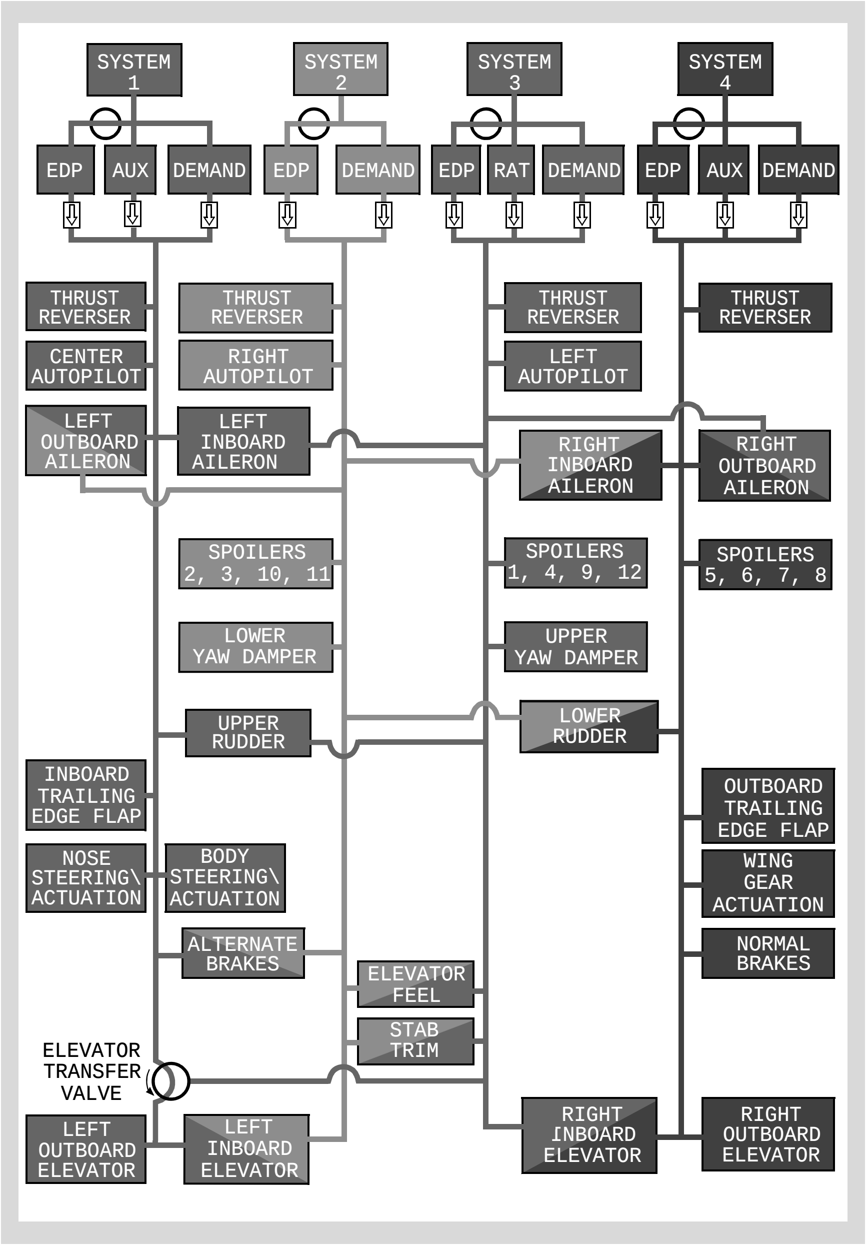
A hydraulic fluid shutoff valve is installed in the fluid supply line to each EDP. If an engine fire switch is pulled, the respective hydraulic fluid shutoff valve closes, the EDP depressurizes, and the respective demand pump operates.

Load Assignments

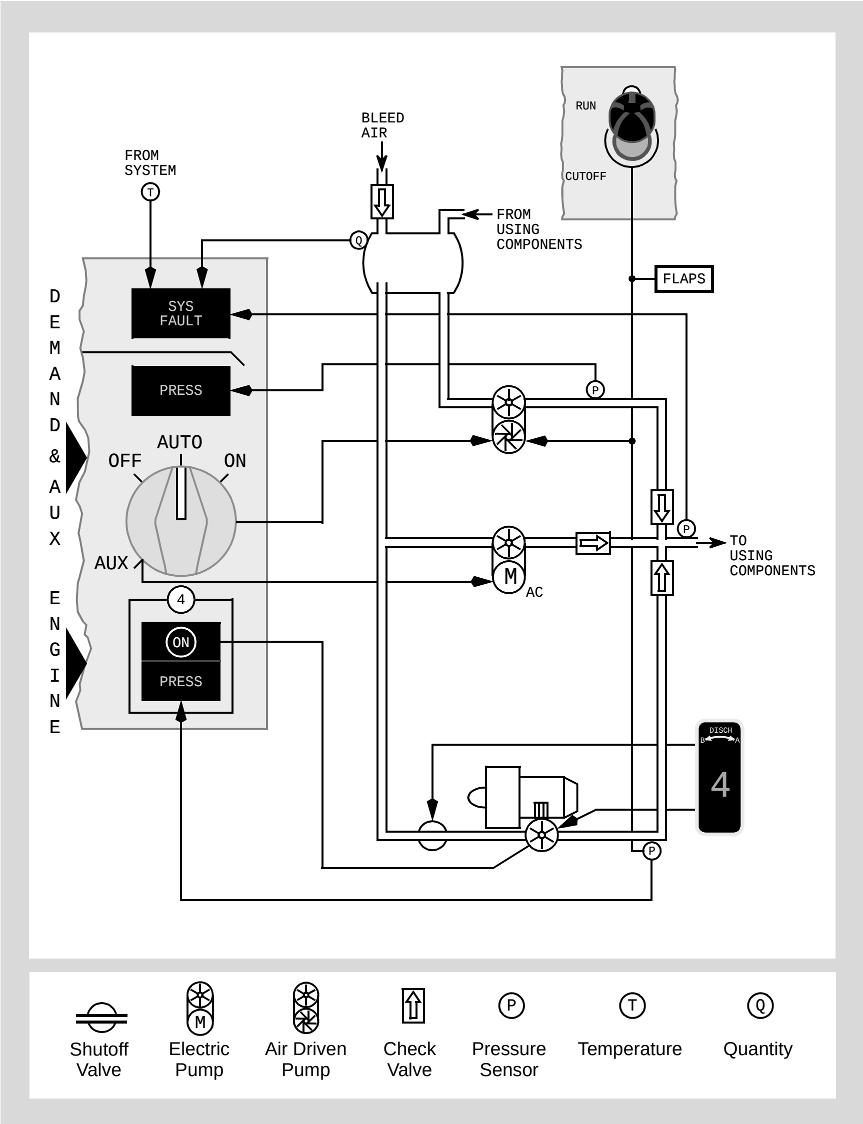
Systems 1 and 4 power the trailing edge flaps, landing gear, normal brakes (SYS 4), alternate brakes (SYS 1), steering, and their respective thrust reversers. Systems 1 and 4 also provide redundant power to the primary flight controls.

Systems 2 and 3 power the primary flight controls, stabilizer trim, elevator feel, and their respective thrust reversers. System 2 also powers the alternate brakes and lower yaw damper. System 3 powers the upper yaw damper.

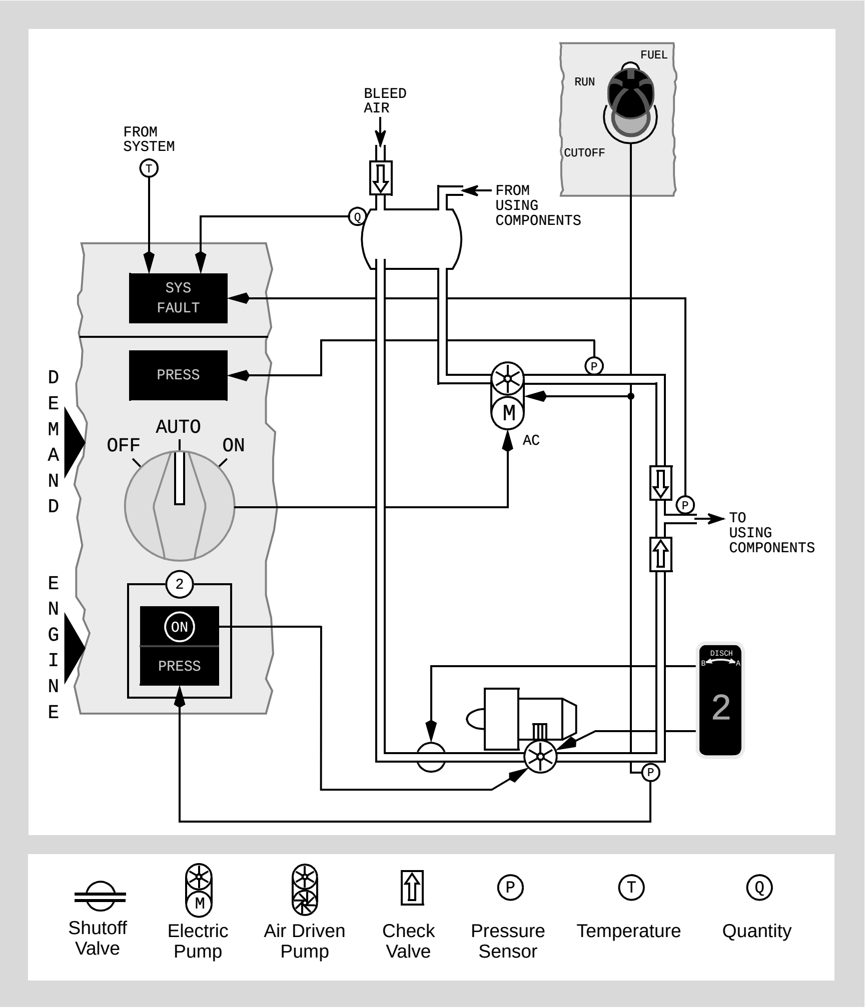
Systems 1, 2, and 3 power the respective center, right, and left autopilot servos. Systems 2, 3, and 4 power the spoilers.


SYSTEM 1
SYSTEM 2
SYSTEM 3
SYSTEM 4
EDP
AUX
DEMAND
EDP
DEMAND
EDP
RAT
DEMAND
EDP
AUX
DEMAND
THRUST REVERSER
CENTER AUTOPILOT
LEFT OUTBOARD AILERON
THRUST REVERSER
RIGHT AUTOPILOT
LEFT INBOARD AILERON
THRUST REVERSER
LEFT AUTOPILOT
RIGHT INBOARD AILERON
THRUST REVERSER
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
ELEVATOR TRANSFER VALVE
LEFT OUTBOARD ELEVATOR
LEFT INBOARD ELEVATOR
RIGHT INBOARD ELEVATOR
RIGHT OUTBOARD ELEVATOR

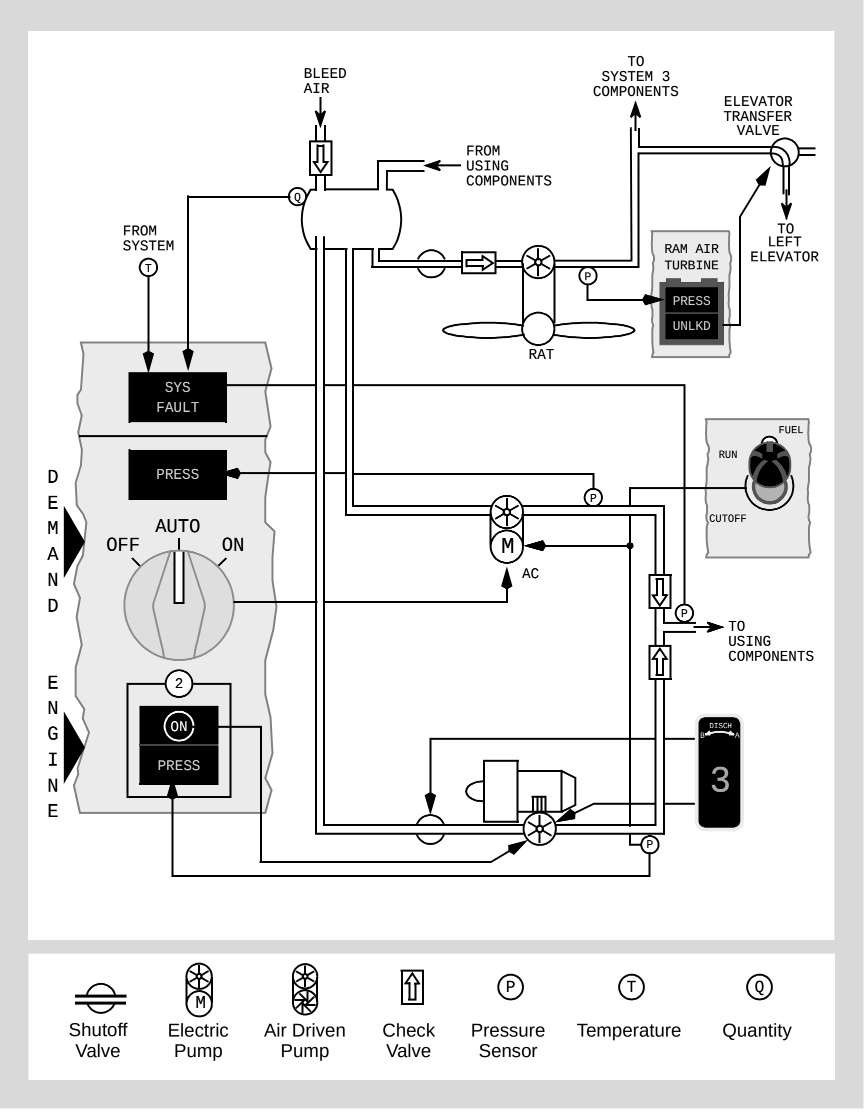
Hydraulic System Schematics
Hydraulic Systems 1 and 4



Hydraulic System 2



Hydraulic System 3



EICAS Messages

Message	Level	Aural	Message Logic
HYD COLD SYS 1, 2, 3, 4	Advisory		Hydraulic system is too cold for takeoff.
HYD CONTROL 1, 4	Advisory		Hydraulic system control is inoperative.
HYD OVHT SYS 1, 2, 3, 4	Advisory		Hydraulic system temperature is high.
HYD OVHT DEM 2, 3	Advisory		The hydraulic system demand pump temperature is high.
HYD PRESS DEM 1, 2, 3, 4	Advisory		Hydraulic demand pump pressure is low.
HYD PRESS ENG 1, 2, 3, 4	Advisory		Hydraulic engine pump pressure is low.
HYD PRES SYS 1+ 4	Caution	Beeper	Hydraulic systems 1 and 4 pressures are low.
HYD PRES SYS 2 + 3	Caution	Beeper	Hydraulic systems 2 and 3 pressures are low.
HYD PRESS SYS 1, 2, 3, 4	Caution	Beeper	Hydraulic system pressure is low.
HYD QTY LOW 2 + 4	Advisory		Hydraulic systems 2 and 4 quantities are low.
HYD QTY LOW 1, 2, 3, 4	Advisory		Hydraulic system quantity is low.
RAT UNLOCKED	Advisory		The ram air turbine is not stowed and locked.

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Landing Gear — Chapter 14

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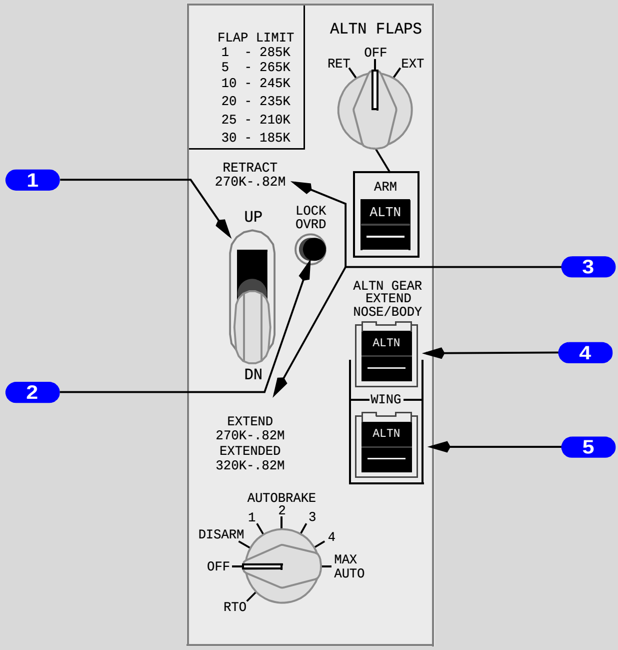
Landing Gear Panel



CENTER FORWARD PANEL

1 Landing Gear Lever

UP - landing gear retracts.

DN - landing gear extends.

2 Landing Gear Lever LOCK Override (OVRD) switch

Push - releases Landing Gear lever lock.

3 Landing Gear Limit Speeds

RETRACT - landing gear in transit to retracted position.

EXTEND - landing gear in transit to extended position.

EXTENDED - landing gear in extended position.

EXTENDED - landing gear down, wheel well doors closed.

Note: Wheel well doors remain open after alternate gear extension.

4 NOSE/BODY Alternate (ALTN) GEAR EXTEND switch

ALTN - nose/body landing gear extends by alternate extension system.

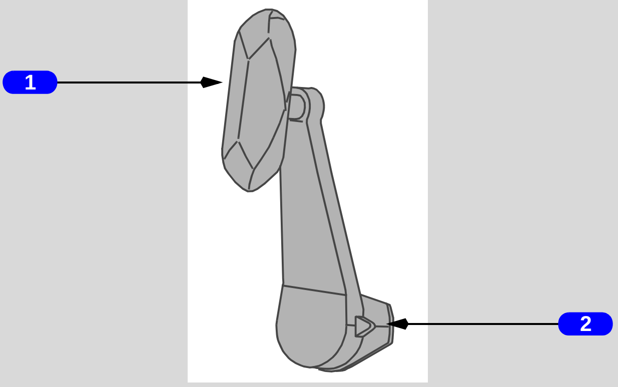
Note: Alternate extension may be selected with the Landing Gear lever in any position.

5 WING Alternate (ALTN) GEAR EXTEND switch

ALTN - wing landing gear extends by alternate extension system.

Note: Alternate extension may be selected with the Landing Gear lever in any position.

Nose Wheel Steering Tiller



LEFT AND RIGHT SIDEWALLS

1 Nose Wheel Steering Tiller

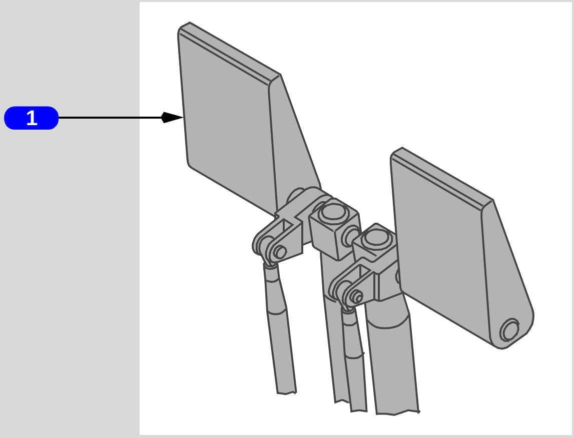
Rotate -

- turns nose wheels up to 70 degrees in either direction
- overrides rudder pedal steering

2 Tiller Position Indicator

Shows tiller displacement from straight-ahead, neutral position.

Brake System
Rudder/Brake Pedals



1 Rudder/Brake Pedals

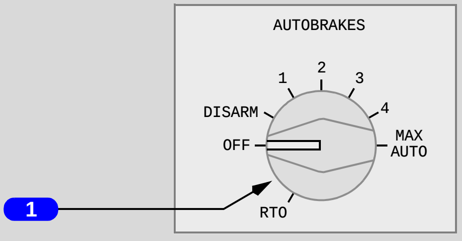
Push full pedal -

- turns nose wheel up to 7 degrees in either direction
- does not activate body gear steering

Push top of pedals - actuates wheel brakes.

Refer to Chapter 9, Flight Controls for the description of rudder operation.

Autobrakes Selector



CENTER FORWARD PANEL

1 AUTOBRAKES Selector

OFF - deactivates and resets system.

DISARM -

- disengages autobrakes
- releases brake pressure

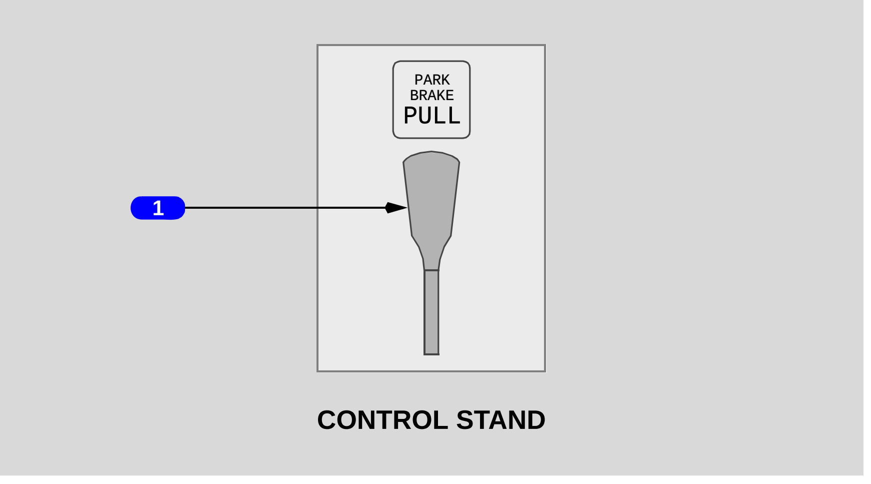
1, 2, 3, 4, MAX AUTO -

- increasing autobrakes deceleration rates
- brakes apply at touchdown

RTO -

- rejected takeoff braking
- applies maximum brake pressure when thrust levers retarded to idle above 85 knots

Parking Brake Lever

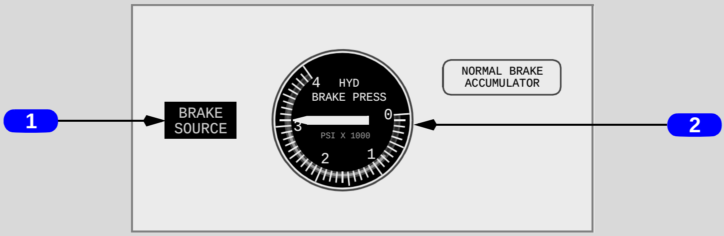


1 Parking Brake Lever

Pull - sets parking brake when both brake pedals simultaneously depressed.

Releases when both brake pedals simultaneously depressed.

Brake Accumulator Pressure Indicator



CAPTAIN'S PANEL

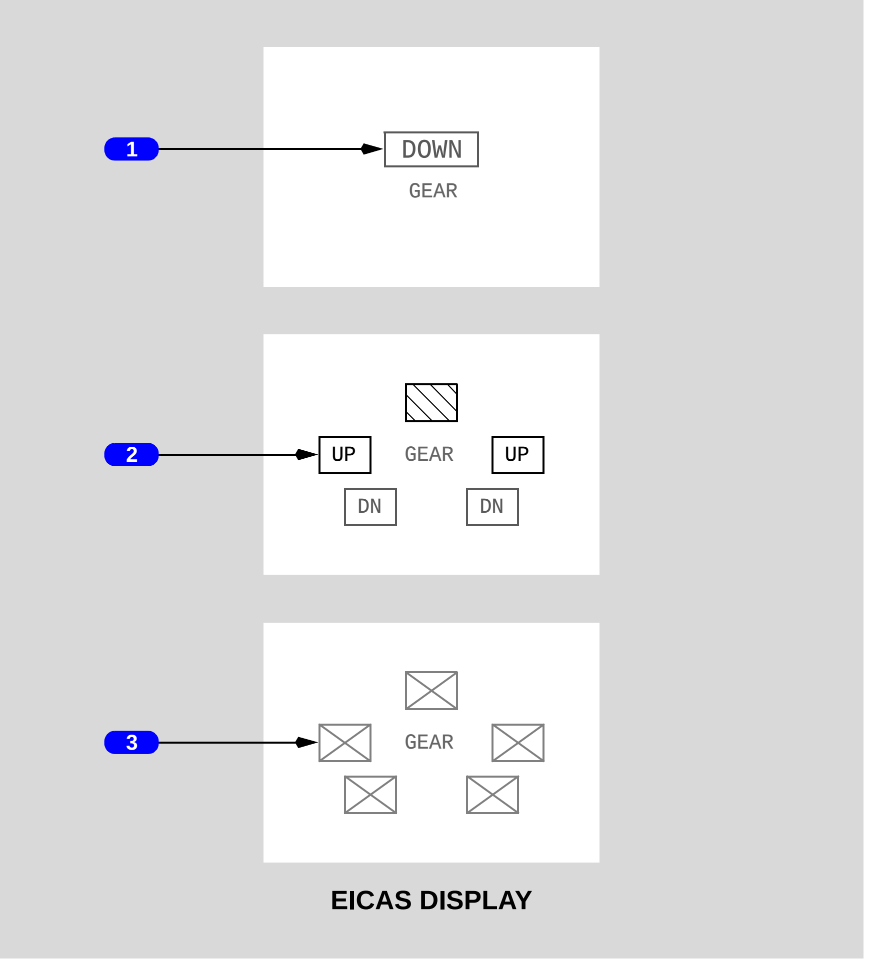
1 BRAKE SOURCE Light

Illuminated (amber) - active brake hydraulic sources (hydraulic systems 4, 1, and 2) have low pressure.

2 Hydraulic (HYD) BRAKE Accumulator Pressure (PRESS) 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.

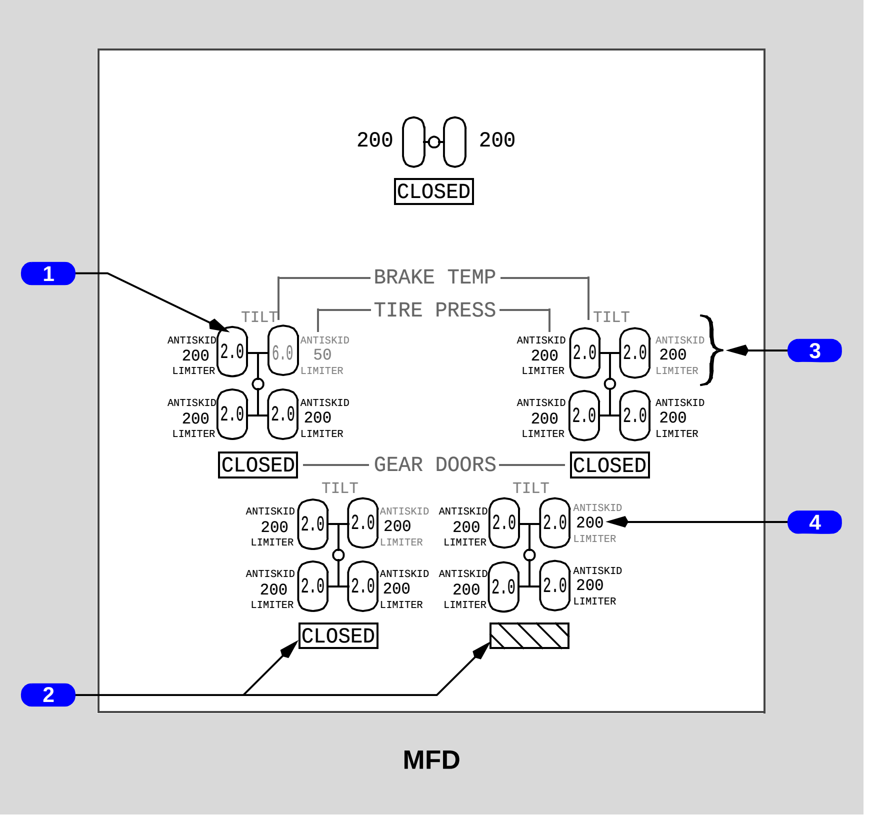
UP (white) - respective landing gear up and locked.

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 (TEMP)**

Indicates a relative value of wheel brake temperature:

- values range from 0.0 to 9.9
- white - normal range
- amber - high range

2 **GEAR DOORS Status**

Crosshatched - door not closed.

CLOSED (white) - door closed.

Empty box(es) (white) - respective landing gear door position indicators inoperative.

3 Disabled System Messages

TILT (amber) - main gear truck not in full tilt positions.

ANTISKID (white or amber) - loss of antiskid protection to respective wheels.

LIMITER (white or amber) - torque limiting control fault detected.

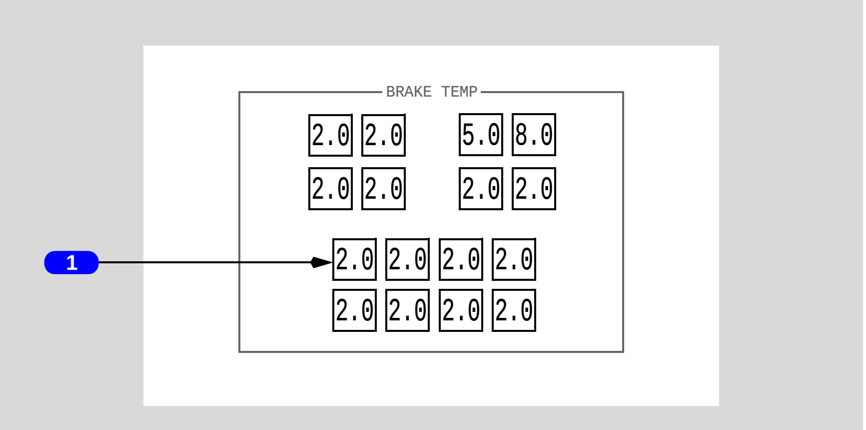
4 TIRE Pressure (PRESS) Indication

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.



PRIMARY EICAS DISPLAY

1 BRAKE Temperature (TEMP)

Indicates a relative value of wheel brake temperature:

- values range from 0.0 to 9.9
- white - normal range
- amber - high range

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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 tire and brake monitor 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 send an air/ground signal to relays controlling 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 to UP. The lever lock can be manually overridden by pushing and holding the landing gear lever LOCK OVRD switch. In flight, the lever lock is released when the main gear are tilted and the body gear are 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.

If any main gear is not tilted in flight, the disabled system TILT message displays on the gear synoptic adjacent to the affected gear.

Each wing gear has one hydraulically-actuated and one mechanically-actuated gear door. Each body gear has one hydraulically-actuated and two mechanically-actuated gear doors. The nose gear has two hydraulically-actuated and two mechanically-actuated gear doors.

Landing Gear Retraction

When the Landing Gear lever is moved to UP, the landing gear doors open, automatic braking occurs, and the landing gear begin to retract. The EICAS landing gear position indication display changes from a green DOWN indication to a white crosshatch in-transit indication as the landing gear retract into the wheel wells.

After retraction, the main gear are held in the up position by uplocks. The nose gear is mechanically locked in the up position. The EICAS landing gear position indication changes to UP for 10 seconds and then blanks. With the landing gear retracted and all doors closed, the landing gear system is automatically depressurized.

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 main landing gear free-fall to the down and locked position. The nose gear is hydraulically powered to the down and locked position. The downlocks are powered to the locked position, and all hydraulically-actuated gear doors close. 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 door latches and gear uplocks 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 from the landing gear selector valve 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 cause 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.

If antiskid power is off on all wheels, or the parking brake valve is not fully open, or a brake system control unit power loss occurs, the disabled system message ANTISKID displays on the gear synoptic adjacent to the affected wheels.

Brake Torque Limiter

A brake torque sensor is provided at each wheel. The sensors detect excessive torque during braking to prevent damage to landing gear. When excessive torque is detected, a signal is sent to the antiskid valve to release brake pressure to that wheel. If the alternate brake system is used, brake torque is sensed on an individual wheel basis, however the signal is sent to the alternate antiskid valve and brake pressure is released on a laterally paired wheel basis.

If a brake torque limiter failure occurs on more than one wheel per truck, or the parking brake lever is released and the parking brake valve is not fully open, or a brake system control unit power loss occurs, the disabled system message LIMITER displays on the gear synoptic adjacent to the affected wheels.

Autobrake System

The autobrake system provides braking at preselected deceleration rates for landing and full pressure for rejected takeoff. The system operates only when the normal brake 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 Autobrake selector
- autobrake fault
- normal antiskid system fault
- loss of normal brake hydraulic pressure

When the autobrake system disarms after landing, the Autobrake selector moves to DISARM position. Rotating the Autobrakes selector to OFF removes power from the autobrake system.

When the autobrake system disarms during takeoff, the Autobrake selector remains in RTO position, but moves to OFF after takeoff.

Parking Brake

The parking brake can be set with the normal or alternate brake hydraulic system pressurized. If the normal and alternate brake systems are not pressurized, parking brake pressure is maintained by the brake accumulator. The brake accumulator is pressurized by hydraulic system 4. Accumulator pressure is shown on the brake accumulator pressure indicator.

Sufficient pressure is stored in the accumulator to set and hold the parking brake, but the accumulator is not designed to stop the aircraft.

The parking brake is set by fully depressing both brake pedals, pulling the Parking Brake lever up, then releasing the pedals. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

When the parking brake is set, the first hydraulic system pressurized may supply a small amount of fluid to the brake lines. When brakes are released, that small amount of fluid returns to system 4. Pressurizing hydraulic system 4 before pressurizing the other systems precludes the transfer of hydraulic fluid from hydraulic system 1 or 2 into hydraulic system 4.

The parking brake is released by depressing the pedals until the Parking Brake lever releases.

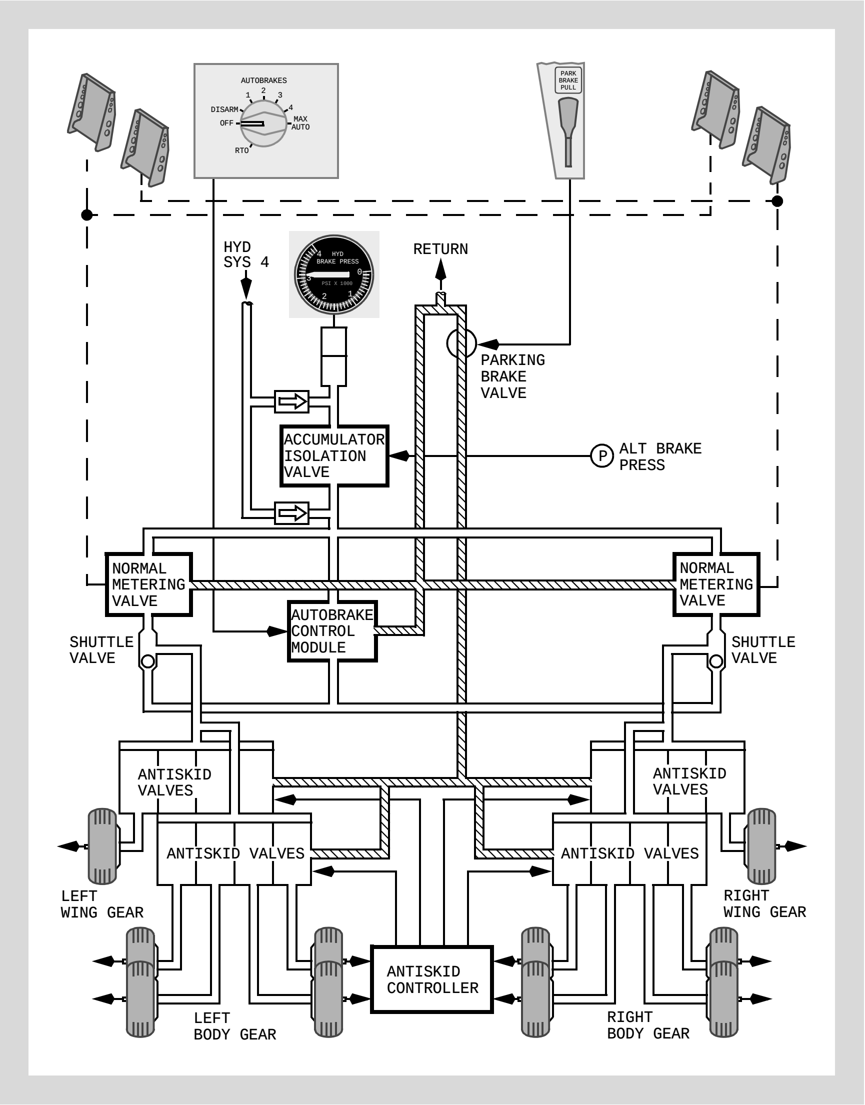
Brake Temperature Indication

Wheel brake temperatures display on the GEAR synoptic display. Numerical values related to wheel brake temperature display inside each wheel/brake symbol.

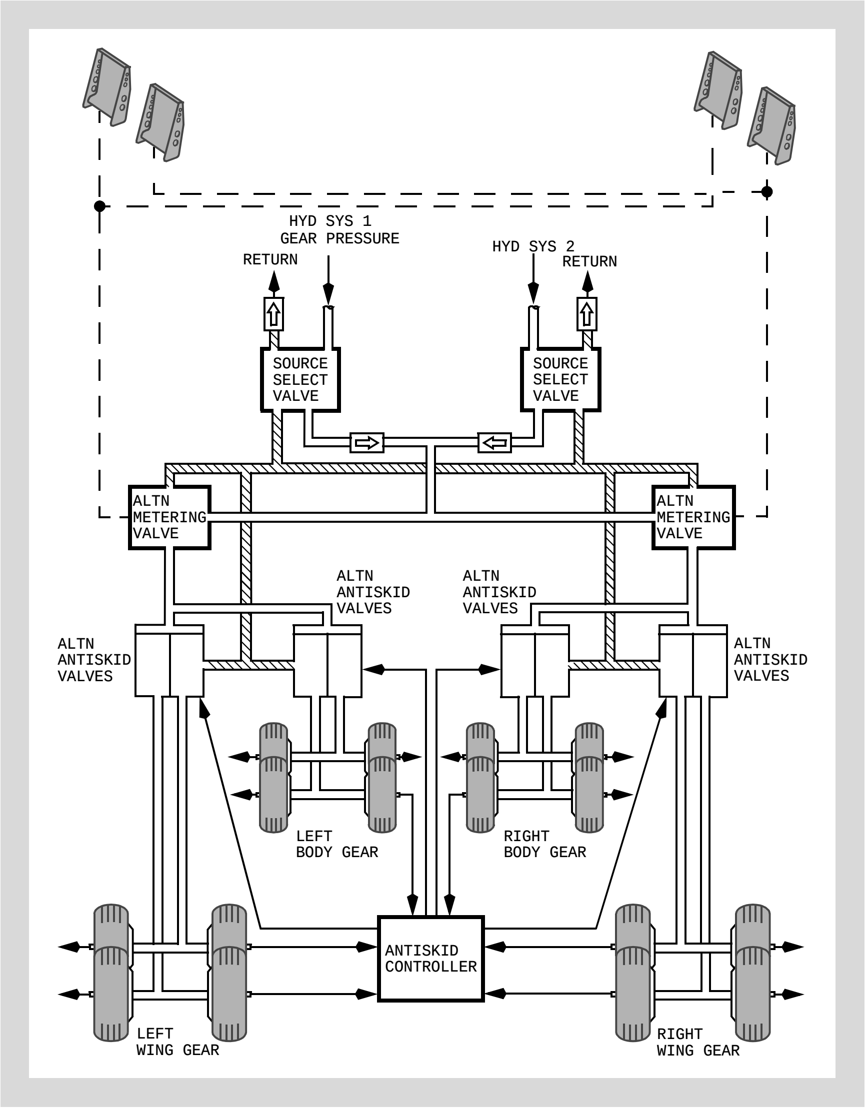
Tire Pressure Indication

Tire pressures, from 0 to 400 PSI, display beside the individual wheel symbols on the GEAR synoptic display.

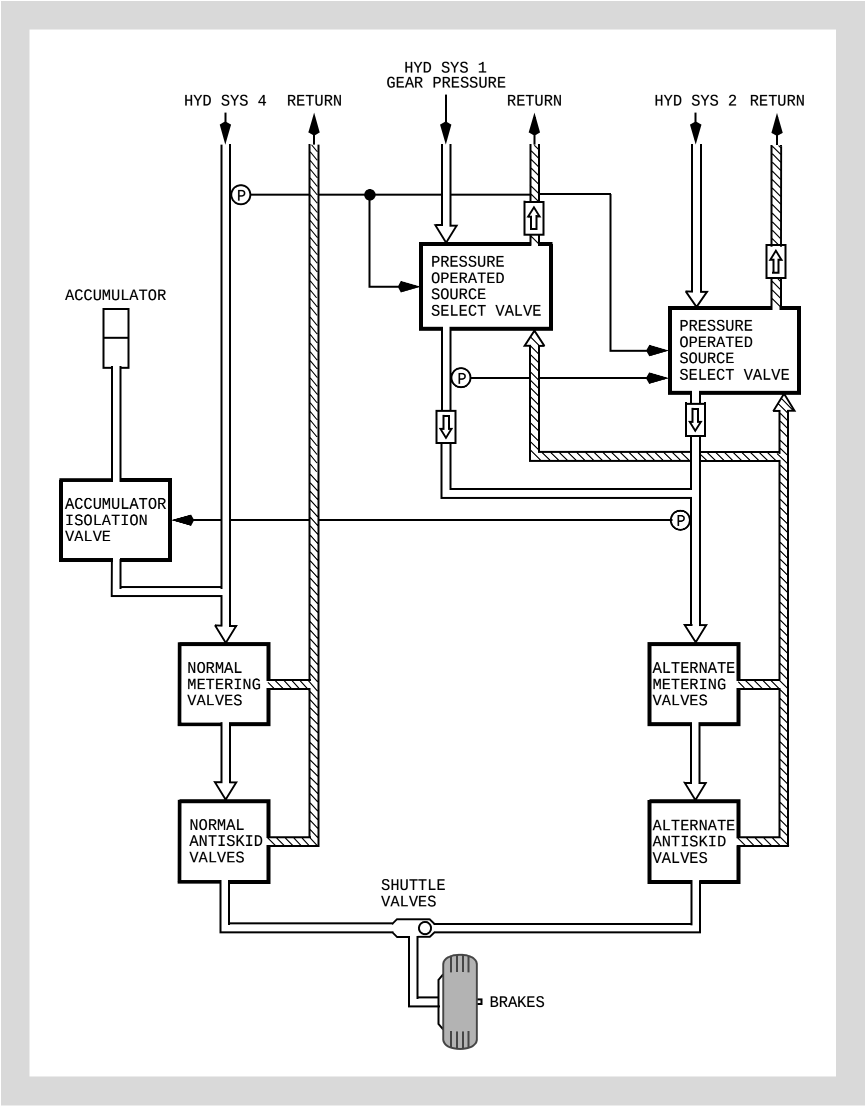
Normal Brake System Diagram



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 is failed in the air mode.
ANTISKID	Advisory		An antiskid system fault occurs.
ANTISKID OFF	Advisory		One or more of these occur: • The parking brake valve is not fully open • The antiskid system power is off
AUTOBRAKES	Advisory		One of these occurs: • The autobrake system is failed or disarmed • The autobrake selector is OFF but the system is armed • RTO is initiated above 85 knots and the autobrake has not been applied
BODY GEAR STRG	Advisory		One or more of these occur: • Body gear steering does not lock • Body gear steering pressure is on when commanded off
BRAKE LIMITER	Advisory		One or more of these occur: • More than one brake torque limiter is failed on a single gear • The parking brake valve is not fully open
BRAKE SOURCE	Caution	Beeper	Normal and alternate brake system pressures are low.

Message	Level	Aural	Message Logic
BRAKE TEMP	Advisory		One or more brake temperatures are high.
GEAR DISAGREE	Caution	Beeper	The gear position disagrees with the landing gear lever position.
GEAR DOOR	Advisory		One or more gear doors are not closed.
GEAR TILT	Caution	Beeper	The main gear trucks are not in the fully tilted position.
TIRE PRESSURE	Advisory		One or more tire pressures are not normal.

EICAS Memo Messages

Message	Level	Aural	Message Logic
AUTOBRAKES 1, 2, 3, 4	Memo		Autobrake level selected.
AUTOBRAKES MAX	Memo		Autobrakes MAX selected.
AUTOBRAKES RTO	Memo		Autobrakes RTO selected.
PARK BRAKE SET	Memo		Parking brake valve closed.

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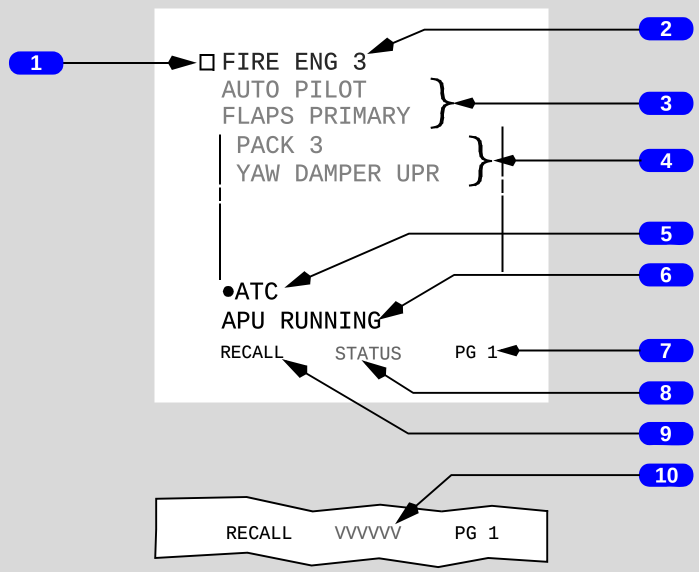
Engine Indication and Crew Alerting System (EICAS)

EICAS Messages



EICAS DISPLAY

1 Checklist Icon

Displayed (white) -

- when checklist with procedural steps, notes, or other information of which the crew must be made aware exists for respective message
- no longer displayed when checklist complete
- no longer displayed when inhibited by checklist of another message

2 Warning Messages

Displayed (red) -

- highest priority alert messages
- red alert messages remain displayed and cannot be canceled by pushing the Cancel/Recall switch.

3 Caution Messages

Displayed (amber) -

- next highest priority alert messages after warning messages
- amber alert messages can be canceled or recalled by pushing the Cancel/Recall switch

4 Advisory Messages

Displayed (amber) -

- lowest priority alert messages; indented one space
- amber alert messages can be canceled or recalled by pushing the Cancel/Recall switch

5 Communication Messages

Displayed (white) -

- prefaced with white dot
- COMM low messages indented one space
- cannot be canceled by pushing the Cancel/Recall switch

6 Memo Messages

Displayed (white) -

- reminder of selected state of controls or systems
- cannot be canceled by pushing the Cancel/Recall switch
- EICAS alert messages have display priority over memo messages; some or all memo messages not displayed on current EICAS message page if insufficient message lines are available below alert messages

7 Page (PG) Number

Displayed (white) -

- more than one page of alert or memo messages exists
- indicates number of page selected

8 STATUS Cue

Displayed (cyan) -

- new status message exists
- no longer displayed when status display selected
- inhibited from beginning of first engine start until 30 minutes after lift-off
- inhibited if Secondary Engine Exceedance cue is displayed

9 RECALL Indication

Displayed (white) -

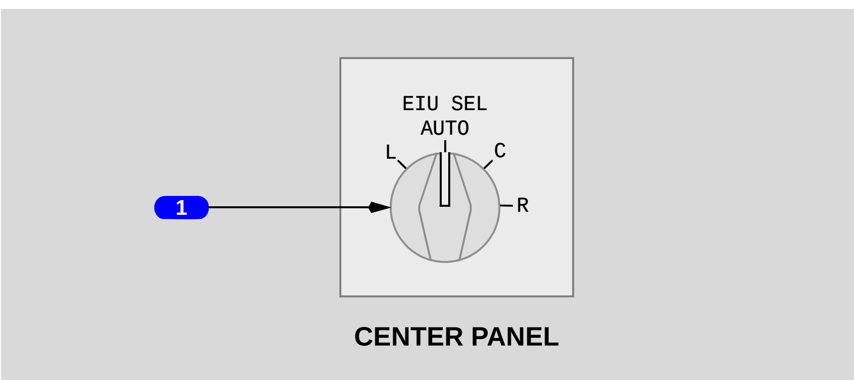
- when Cancel/Recall switch pushed
- remains displayed for one second after switch released

10 ENGINE Exceedence Cue

Displayed (cyan) -

- engine parameter on Secondary Engine display is exceeded
- displayed until parameter xceeded 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, and
    - if airplane is on standby power, all EFIS and EICAS displays fail

AUTO -

- selects an operable EIU to provide data to EFIS and EICAS
- selects left, then center, then right

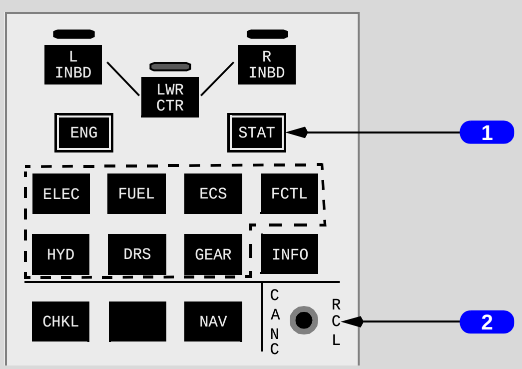
C -

- center EIU provides data to EFIS and EICAS
- if center EIU fails, automatic switching to an operable EIU is inhibited

R -

- right EIU provides data to EFIS and EICAS
- if right EIU fails, automatic switching to an operable EIU is inhibited

Display Select Panel



GLARESHIELD PANEL

1 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

2 Cancel/Recall (CANC/RCL) Switch

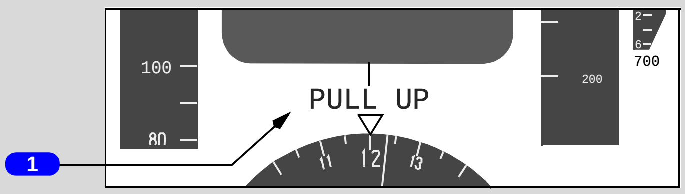
Push (when EICAS caution or advisory messages displayed)-

- 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

Push (when no EICAS caution or advisory messages displayed) -

- redisplays all caution and advisory EICAS messages when non-normal condition exists
- displays first page of messages when multiple pages exist
- redisplays red box for parameters previously exceeded

GPWS, PWS, and Speedbrake Alerts on PFD



PFD

1 Alert on PFD

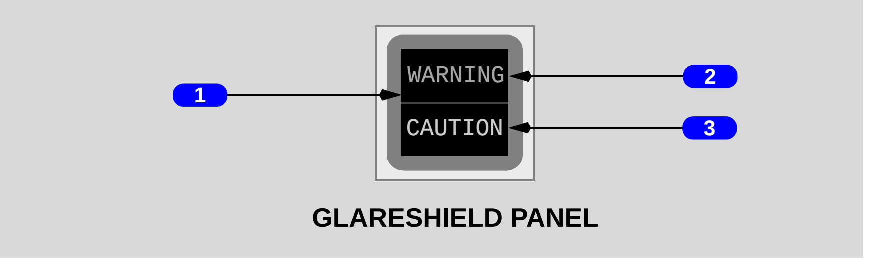
PULL UP (red) - PULL UP alert is occurring.

SPEEDBRAKE (red) - SPEEDBRAKE 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 accompanies the EICAS warning messages:
  - CABIN ALTITUDE
  - CONFIG GEAR, if displayed because landing gear not down and locked, any thrust lever at idle, and radio altitude less than 800 feet
  - FIRE

  914
  - OVERSPEED
  - PILOT RESPONSE

2 Master WARNING Light

Illuminated (red) -

- new EICAS warning message displayed, or
- PULL UP, SPEEDBRAKE, or WINDSHEAR alert displayed on PFD

3 Master CAUTION Light

Illuminated (amber) - new EICAS caution message displayed

Overspeed Aural Reset Switch

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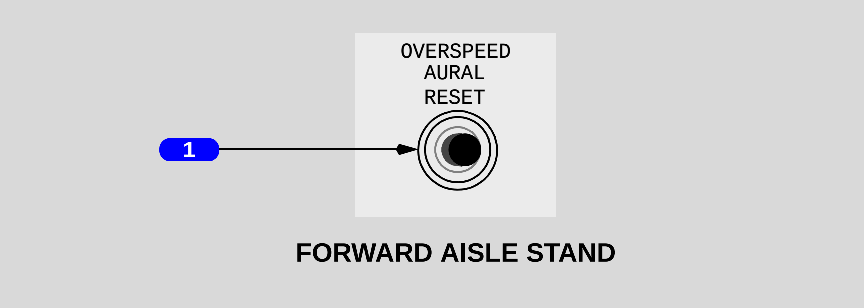


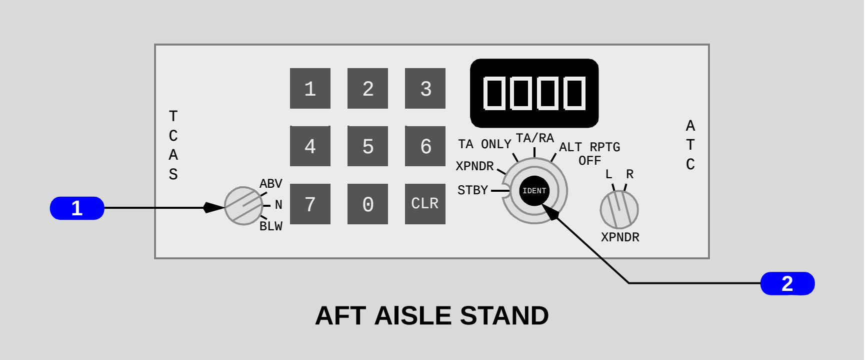
1 OVERSPEED AURAL RESET Switch

Push -

- extinguishes Master Warning lights
- silences the aural that accompanies the EICAS warning message OVERSPEED

Traffic Alert and Collision Avoidance System (TCAS)

TCAS Controls (Transponder Panel)



1 TCAS Airspace Selector

ABV (above) - altitude reporting traffic from 2,700 feet below to 7,000 feet above current altitude displayed.

N (normal) l- altitude reporting traffic from 2,700 feet below to 2,700 feet above current altitude displayed.

BLW (below) - altitude reporting traffic 7,000 feet below to 2,700 feet above current altitude displayed.

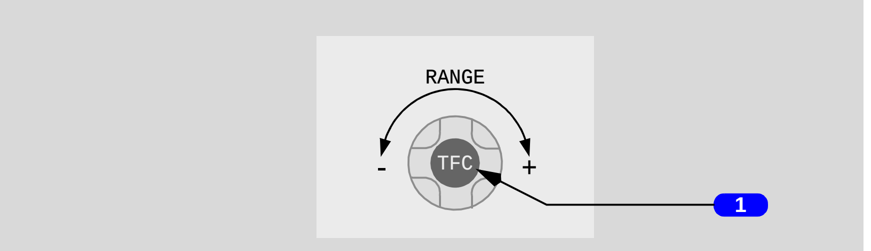
2 **Transponder Mode Selector**

TA ONLY (traffic advisory) -

- transponder and TCAS TA modes enabled
- all aircraft that would have been predicted as a RA are predicted as a TA

TA/RA (traffic advisory/resolution advisory) - transponder and TCAS TA and RA modes enabled.

TCAS Controls (EFIS Control Panel)



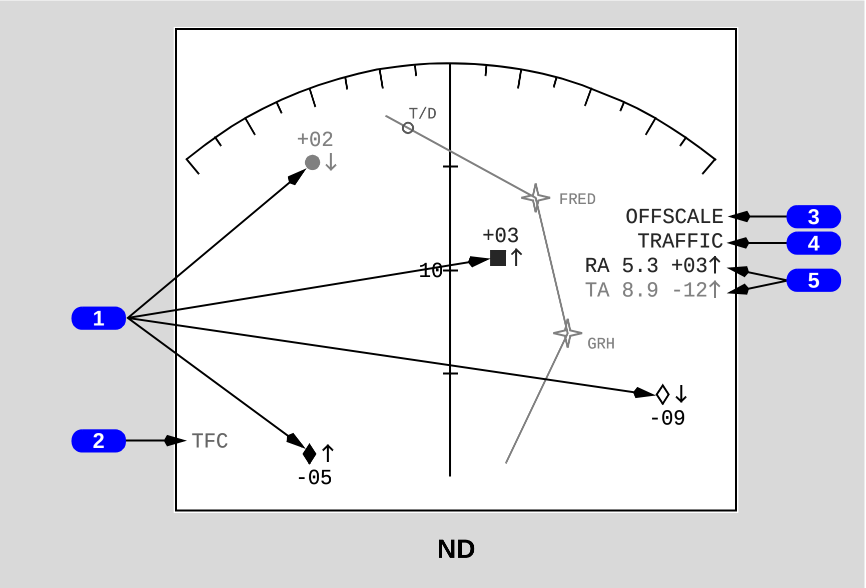
EFIS CONTROL PANEL

1 **ND Traffic (TFC) Switch (inner)**

Push – in VOR, APP, MAP, and MAP CTR modes:

- TCAS traffic dsiplayed 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

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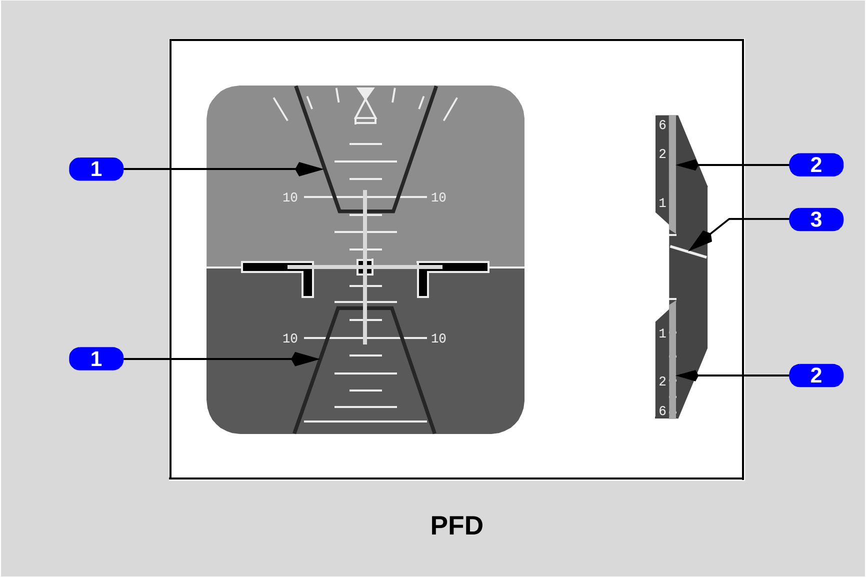

PFD

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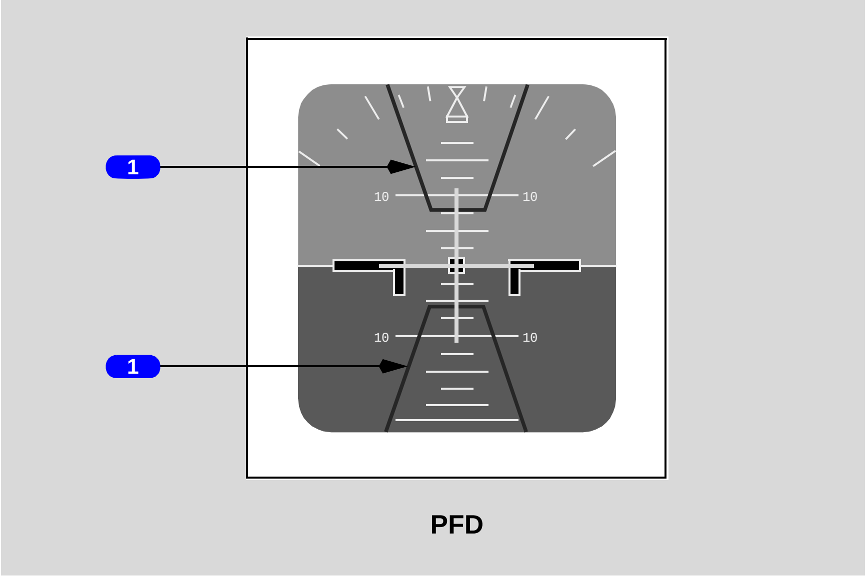

PFD

1 **RA Pitch Region To Avoid Traffic (red outlined)**

Note: For a single RA, only one red outlined RA pitch region, either above or below, is displayed at a time. For two or more RAs, two red outlined RA pitch regions may be displayed.

To ensure vertical separation, the center of the airplane symbol must be outside the red outlined RA pitch regions to avoid traffic.

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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.

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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

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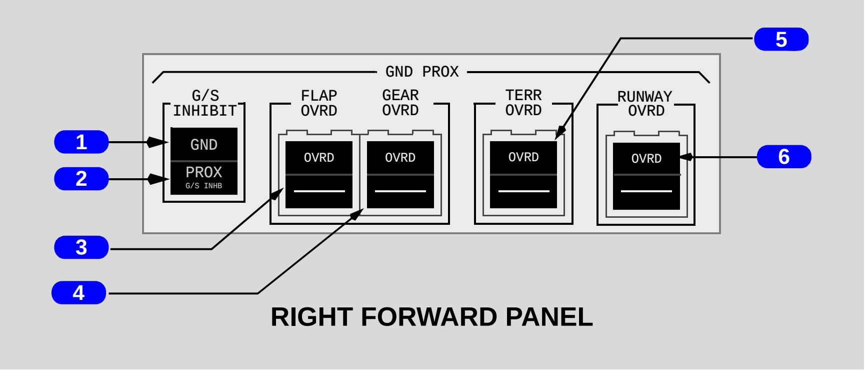

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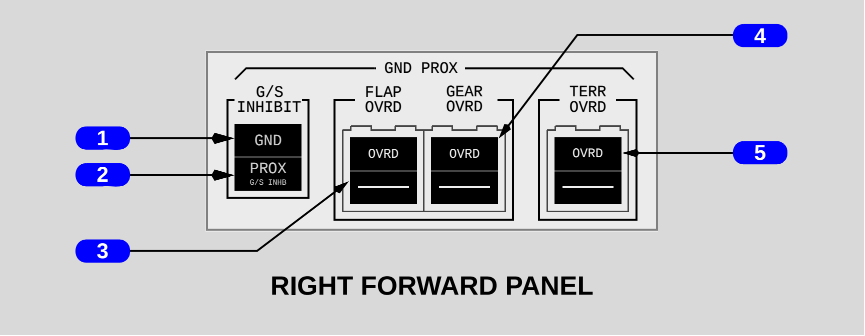

1 Ground Proximity (GND PROX) Glideslope (G/S) Inhibit Switch

Push - inhibits GLIDESLOPE alert when pushed below 1,000 feet radio altitude.

2 Ground Proximity (GND PROX) Light

Illuminated (amber) -

- GPWS GLIDE SLOPE, SINKRATE, TERRAIN, TOO LOW FLAPS, TOO LOW GEAR, or TOO LOW TERRAIN immediate alert is occurring
- Inhibited for GLIDESLOPE, or TOO LOW FLAPS, or TOO LOW GEAR alerts when respective inhibit or override switch is pushed

3 Ground Proximity (GND PROX) Flap Override (OVRD) Switch

Push (OVRD illuminated) -

- inhibits TOO LOW FLAPS alert
- EICAS advisory message GND PROX SYS will be displayed when airspeed greater than 250 knots for more than 60 seconds

4 Ground Proximity (GND PROX) Configuration (CONFIG) Gear (GEAR) Override (OVRD) Switch

Push (OVRD illuminated) -

- inhibits TOO LOW GEAR alert
- inhibits CONFIG GEAR alert
- EICAS advisory message GND PROX SYS will be displayed when airspeed greater than 290 knots for more than 60 seconds

5 Ground Proximity (GND PROX) Terrain (TERR) Override (OVRD) Switch

Push (OVRD illuminated) - inhibits look-ahead terrain alerts and terrain display.

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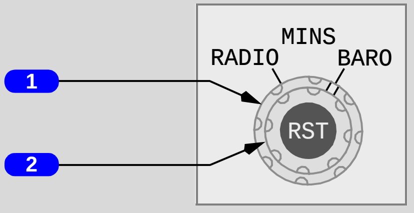
6 RUNWAY Awarness System Override (OVRD) Switch

Push (OVRD illuminated) - inhibits RAAS

Radio Altitude/Barometric Altitude Control

806



EFIS CONTROL PANEL

1 Minimums (MINS) Selector (outer)

RADIO - Radio Altimeter/Barometric Altitude control sets RADIO minimums display on PFD. The left Radio Altimeter/Barometric Altitude control sets RADIO reference for GPWS minimums voice annunciation.

BARO - Radio Altimeter/Barometric Altitude control sets BARO minimums pointer and BARO minimums display on PFD. The left Radio Altimeter/Barometric Altitude control sets BARO reference for GPWS minimums voice annunciation.

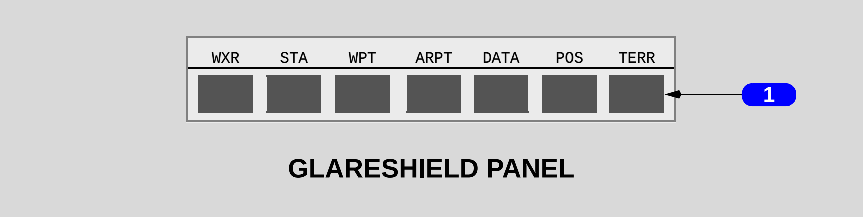
2 **RADIO Altitude/Barometric (BARO) Altitude Control (middle)**

Rotate -

- when RADIO selected on the Minimums selector, sets RADIO altitude minimums displayed on PFD
- When BARO selected on the Minimums selector, sets BARO minimums pointer and BARO minimums display on PFD
- the left Radio Altitude/Barometric Altitude control sets RADIO or BARO reference for GPWS minimums voice annunciation

GPWS Look-Ahead Terrain Alerting Display and Annunciations

EFIS Control Panels



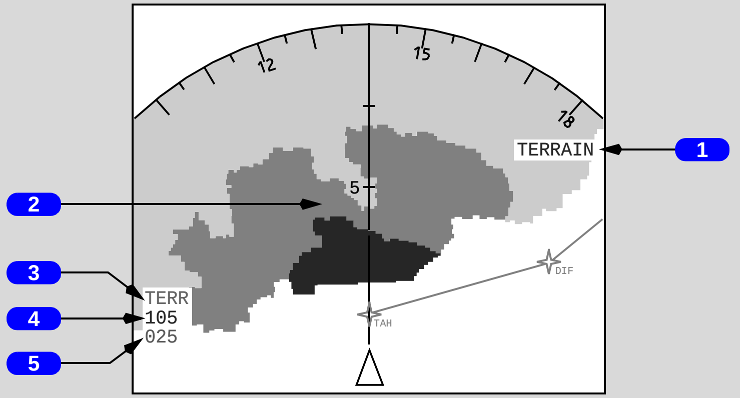
1 **Terrain (TERR) Switch**

Push –

- terrain data is displayed in MAP, MAP CTR, VOR, and APP modes
- deselects weather radar display regardless of switch position

Second push – deselects terrain data display.

Terrain Display



NAVIGATION DISPLAY

1 OBSTACLE and TERRAIN Annunciation

OBSTACLE (amber) – obstacle caution alert is occurring.

OBSTACLE (red) – obstacle warning alert is occurring.

TERRAIN (amber) – look–ahead terrain caution alert is occurring.

TERRAIN (red) – look–ahead terrain warning alert is occurring.

Displayed in all ND display modes.

2 Obstacle and Terrain Display

When airplane is higher than 2,000 feet above terrain, density based on obstacle height, peaks height, and airplane altitude:

- solid green – highest obstacles or peaks displayed
- high density green – intermediate height obstacles or terrain peaks displayed
- low density green – lowest obstacles or terrain peaks displayed

When airplane is lower than 2,000 feet above terrain, color and density based on obstacle height, terrain height, and airplane altitude:

- dotted green – obstacles or terrain from 2,000 feet below to 500 feet (250 feet with gear down) below airplane altitude
- dotted amber – obstacles or terrain 500 feet (250 feet with gear down) below to 2,000 feet above airplane altitude

- dotted red – obstacles or terrain more than 2,000 feet above airplane altitude
- dotted magenta – no terrain data available
- solid amber – look–ahead terrain caution alert is occurring
- solid red – look–ahead terrain warning alert is occurring

Note: In areas without obstacle or terrain data, look–ahead terrain alerting and display functions not available. GPWS immediate alerts function normally.

Note: Terrain within 200 feet of the nearest airport runway elevation is not displayed.

Displayed automatically when:

- a look–ahead obstacle or terrain alert occurs, and
- TERR not selected on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode

Display updates with a display sweep similar to weather radar display.

3 Terrain Mode Annunciation

TERR (cyan) – terrain display enabled.

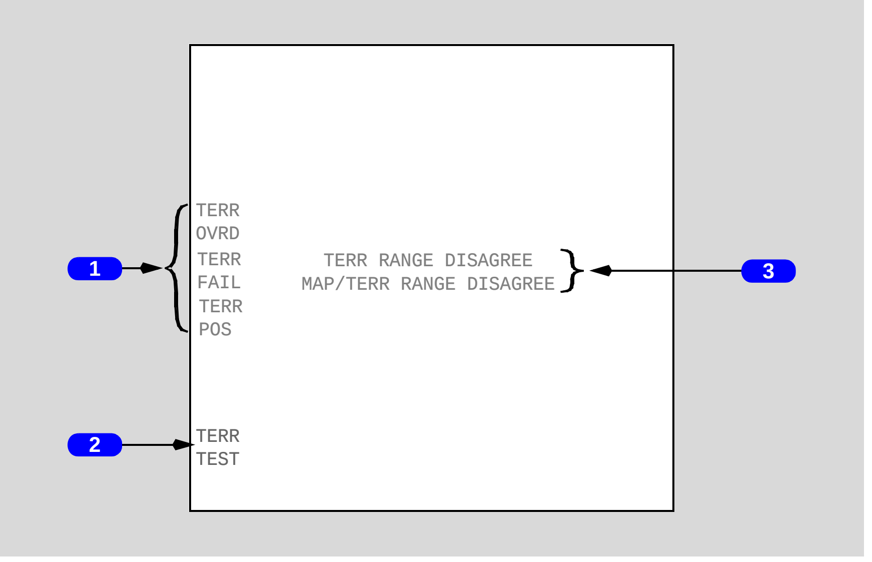
4 Highest Elevation of Obstacle or Terrain Displayed

Color (amber, green, or red) same as color of corresponding obstacle or terrain displayed.

5 Lowest Elevation of Obstacle or Terrain Displayed

Color (amber, green, or red) same as color of corresponding obstacle or terrain displayed.

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 position failure and display of TERR POS message, IRS provides position for look-ahead alerting and display.

2 Terrain Test Annunciation

TERR TEST (cyan) - GPWS operating in self-test mode.

3 Terrain Range Annunciation

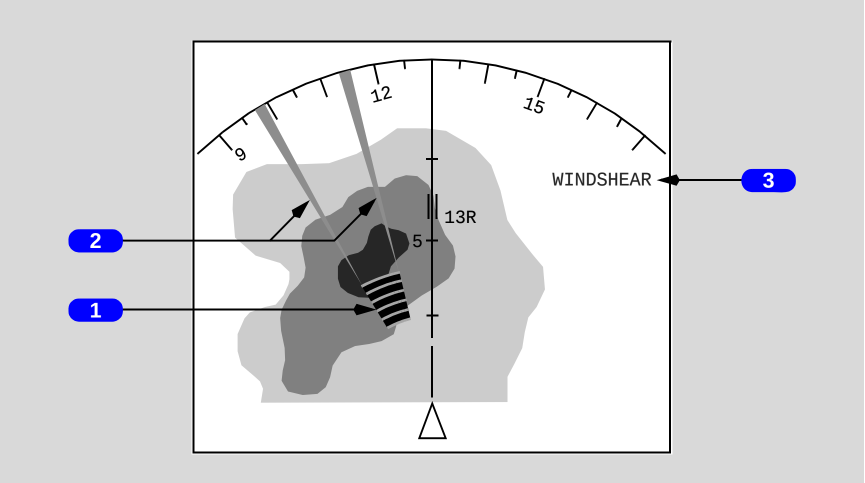
TERR RANGE DISAGREE (amber) -

- terrain display enabled, and
- terrain output range disagrees with range selected by EFIS control panel

MAP/TERR RANGE DISAGREE (amber) -

- terrain display enabled, and
- terrain output range disagrees with range selected by EFIS control panel, and
- map display output range disagrees with range selected by EFIS control panel

Predictive Windshear (PWS) Display and Annunciations



NAVIGATION DISPLAY

1 PWS Symbol

Displayed (red and black) -

- PWS alert is occurring
- displays windshear location and approximate geometric size (width and depth)

Symbol, radials, and weather radar returns displayed automatically when:

- PWS alert occurs, and
- WXR is not selected on either ND, and
- respective ND is in MAP, MAP CTR, VOR, or APP mode

When terrain display is selected and PWS alert occurs, weather radar display replaces terrain display.

2 PWS Radials

Displayed (amber) -

- PWS alert is occurring
- Extend from PWS symbol to help locate windshear event

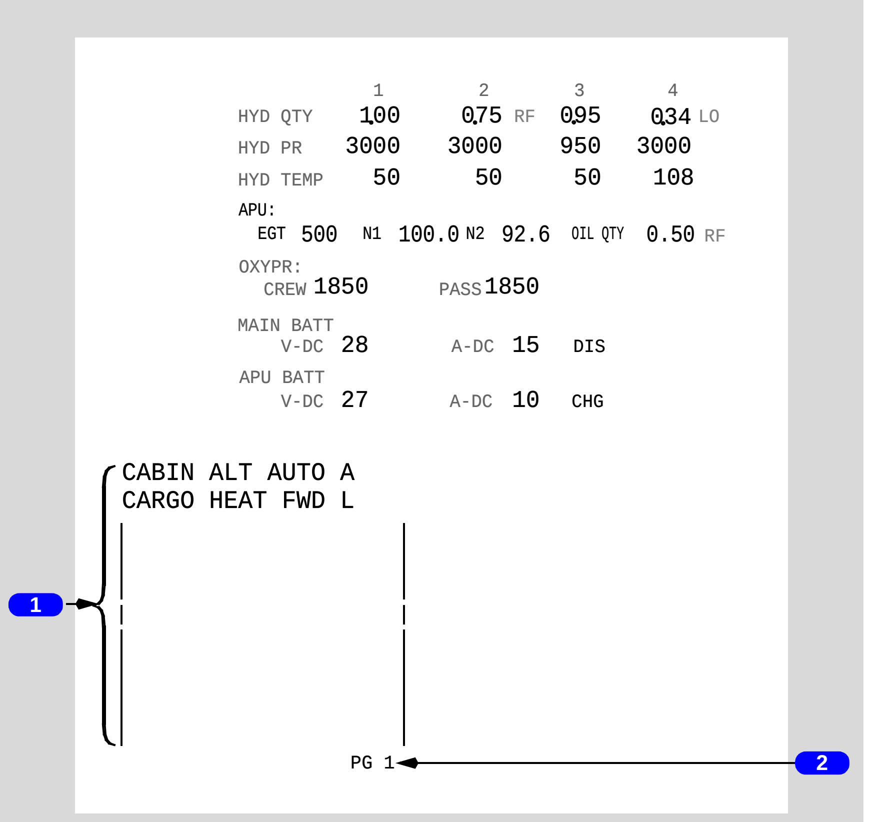
3 WINDSHEAR Annunciation

WINDSHEAR (amber) - PWS caution is occurring.

WINDSHEAR (red) - PWS warning is occurring.

Displayed in all navigation display modes.

Status Display



SECONDARY EICAS

1 Status Messages

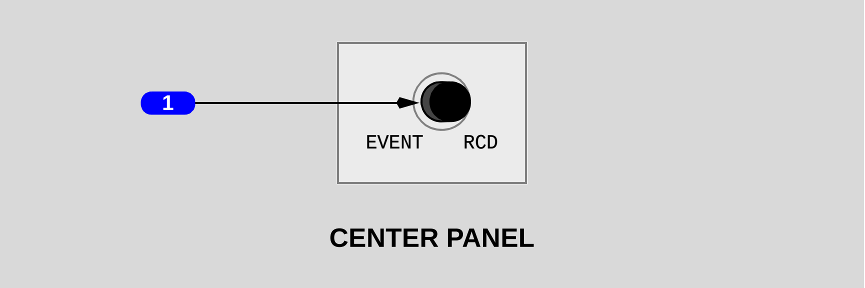
Status messages indicate equipment faults requiring MEL reference for dispatch.

2 Page (PG) Number

Displayed -

- additional pages of status messages exist
- displays number of page selected

EICAS Event Record Switch



1 EICAS Event Record (EVENT RCD) Switch

Push - records up to five EICAS events.

Intentionally
Blank

Introduction

Warning systems consist of:

- engine indication and crew alerting system (EICAS)

806
- aurals, Master Warning/Caution lights and switches, Overspeed Aural Reset switch, and Ground Proximity light

914
- aurals, Master Warning/Caution lights and switches, and Ground Proximity light
- airspeed alerts
- takeoff and landing configuration warning system
- MCP selected altitude alerts
- crew alertness monitor
- traffic collision avoidance system (TCAS)
- 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 EICAS which is normally displayed on the upper center display.

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 four types of EICAS messages:

- EICAS alert messages are the primary method to alert the crew to non-normal conditions
- EICAS communication messages direct the crew to normal communication conditions and messages

- EICAS memo messages are crew reminders of certain flight crew selected normal conditions
- EICAS status messages indicate equipment faults which affect airplane dispatch capability

An EICAS alert, communications, or memo message is no longer displayed when the respective condition no longer exists.

EICAS Alert Messages

From after engine start until engine shut down, EICAS alert messages are the primary means to alert the crew to non-normal conditions which may impact other operations during the flight.

There is a non-normal procedure for each EICAS alert message. The procedure for every EICAS alert message is included as a checklist in the QRH. Procedures for some EICAS alert messages have steps to reconfigure airplane systems. A rectangular symbol [] prefaces an alert message that has procedural steps. The rectangular symbol [] also prefaces EICAS alert messages for checklists that have notes or information of which the crew must be made aware.

EICAS alert messages are grouped into three priority levels: warning, caution, and advisory. Prioritization is an aid to flight crew decision making when more than one EICAS alert message is displayed.

EICAS warning messages are displayed red and EICAS caution and advisory messages are displayed amber. Red EICAS alert messages remain displayed and cannot be canceled by pushing the Cancel/Recall switch. Amber EICAS alert messages can be canceled and recalled by pushing the Cancel/Recall switch.

EICAS Communication Messages

EICAS communication messages direct crew attention to normal communication conditions which may require crew attention. There is a crew action for each EICAS communications message.

EICAS communications messages are grouped into three priority levels: high, medium, and low. Prioritization is an aid to flight crew decision making when more than one message is displayed.

EICAS communications messages are displayed in white below EICAS alert messages. Communication messages can not be cancelled by pushing the Cancel/Recall switch.

EICAS Memo Messages

EICAS memo messages are crew reminders of certain flight crew selected normal conditions. They are displayed in white at the bottom of the last page of EICAS alert messages on the primary EICAS display.

Pushing the Cancel/Recall switch when the last page of EICAS alert messages is displayed ensures all current memo messages have been displayed.

EICAS Status Messages

All EICAS status messages are listed in the Dispatch Deviation Guide (DDG) or airline equivalent and provide a cross reference to the Minimum Equipment List (MEL) for dispatch capability.

Display and Manipulation of EICAS Messages

If more than one EICAS alert message is displayed, the messages are displayed in a list which is grouped by priority level. EICAS warning messages are displayed in red at the top of the message list.

EICAS caution messages are displayed in amber below the lowest warning message. EICAS advisory messages are displayed in amber below the lowest caution message and are indented one character so they may be distinguished from EICAS caution messages.

The most recent EICAS alert message is displayed at the top of its priority group and all messages move down one display line. If a message is no longer displayed because the respective system non-normal condition no longer exists, all messages previously displayed move up one display line.

If there are more messages in the list than can be displayed on one page, multiple pages are created and numbered sequentially. The page number is normally displayed at the bottom of each list. Multiple pages of EICAS caution and advisory messages can be displayed one page at a time by pushing the Cancel/Recall 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/Recall 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/Recall 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 Cancel/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 Cancel/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 communication message is displayed at the top of its priority group and all messages move down one display line. If a message is no longer displayed because the respective communication condition no longer exists, all messages previously displayed move up one display line.

The most recent EICAS memo message is displayed at the bottom of the memo messages.

The Status cue is displayed on primary EICAS when a new EICAS status message is displayed. When the 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/Recall switch controls the display of EICAS alert messages.

Aurals, Master Warning/Caution Switches and Lights, Overspeed Aural Reset Switch, 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, parentheses () indicate crew action to silence the aural alert or extinguish the light while the alert is occurring.

Aural	Light	Calls Attention To:
806		
Bell (Silence by pushing Master Warning/Caution Reset switch.)	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	EICAS warning message: APU FIRE FIRE CARGO AFT, FWD FIRE ENG FIRE WHEEL WELL

Aural	Light	Calls Attention To:

914

Bell (Silence by pushing Master Warning/Caution Reset switch.)	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	EICAS warning message: APU FIRE FIRE CARGO AFT, FWD FIRE ENG FIRE MAIN DECK FIRE MN DK AFT, FWD, MID FIRE WHEEL WELL

806

Wailer	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	EICAS warning message AUTO PILOT DISC

806

Siren (Silence by pushing Overspeed Aural Reset switch.)	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	EICAS warning message OVERSPEED

914

Siren (Silence by pushing Master Warning/Caution Reset switch.)	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	EICAS warning message OVERSPEED

Aural	Light	Calls Attention To:
806		
Siren	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	On the ground, EICAS warning message: CONFIG FLAPS CONFIG GEAR CONFIG PARK BRK CONFIG STAB
914		
Siren	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	On the ground, EICAS warning message: AUTOPILOT DISC CONFIG FLAPS CONFIG GEAR CONFIG PARK BRK CONFIG STAB
Siren (Silence by pushing Master Warning/Caution Reset switch.)	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	In flight, EICAS warning message CONFIG SPOILERS
806		
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

Aural	Light	Calls Attention To:

914

Aural	Light	Calls Attention To:
Siren (Silence by pushing Master Warning/Caution Reset switch.)	Master Warning lights (Extinguish by pushing Master Warning/Caution Reset switch.)	EICAS warning message: CABIN ALTITUDE OVERSPEED PILOT RESPONSE

Aural	Light	Calls Attention To:
Beeper	Master Caution lights (Extinguish by pushing Master Warning/Caution Reset switch.)	New EICAS caution message, except: ENG SHUTDOWN
Voice annunciation: DON'T SINK, DON'T SINK TOO LOW, TERRAIN	Ground Proximity 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 LEVEL OFF, LEVEL OFF MAINTAIN VERTICAL SPEED, MAINTAIN MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN MONITOR VERTICAL SPEED	None	Red regions to avoid on PFD Red TRAFFIC message and TCAS RA traffic display on ND
Voice annunciation CLEAR OF CONFLICT	None	Red regions to avoid on PFD, Red TRAFFIC message, and TCAS RA traffic display on ND are no longer displayed.

Aural	Light	Calls Attention To:
Voice annunciation: OBSTACLE, OBSTACLE, PULL UP TERRAIN, TERRAIN, PULL UP	Master Warning lights (Extinguish by pushing Master Warning/Caution switch.)	Red PULL UP on both PFDs Red OBSTACLE or TERRAIN message and obstacle or terrain display on ND
Voice annunciation: CAUTION OBSTACLE CAUTION TERRAIN	Ground Proximity light	Amber OBSTACLE or TERRAIN message and obstacle or 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 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 if 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.

Spare Engine Carriage Message

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 calculation 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.

Speedbrakes Not Deployed During Rejected Takeoff or Landing Roll

On the ground, the red PFD message SPEEDBRAKE alerts the crew if speedbrakes are not deployed and:

- the Speedbrake lever is DN or at ARM, and
- airspeed is greater than 80 knots, and
- the main gear tilt sensors indicate gear are not tilted for more than three seconds, and
- all thrust levers are set below climb thrust for more than three seconds

Speedbrake Lever Extended Beyond ARM During Climb

In flight, the EICAS warning message CONFIG SPOILERS is displayed if:

- the Speedbrake lever is extended beyond ARM, and
- climb or higher thrust is set on any two thrust levers

The message remains displayed until:

- the Speedbrake lever is DN or at ARM, or
- at least three thrust levers are set below climb thrust

Configuration Warning System Non-normal Operation

If the takeoff warning system fails or if the takeoff warning system input to the EIU fails, the EICAS alert message CONFIG WARN SY will be displayed. If the takeoff and landing configuration system fails, CONFIG messages may or may not be displayed. If the messages are displayed with the CONFIG WARN SY message, the CONFIG messages may not be correct.

MCP Selected Altitude Alerts

Altitude alerts are 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 200 feet of the selected altitude.

Departing MCP Selected Altitude

When departing the selected altitude by 200 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 200 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

The FMC continuously monitors switch action on the MCP, EFIS control panel, display select panel, CDUs, and radio transmitter microphone switches. When a predefined time elapses after the last switch action was detected the EICAS 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 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 outside the red outlined RA pitch region.

If the traffic aircraft also has TCAS and a mode S transponder, TCAS vertical guidance is coordinated with the traffic aircraft TCAS.

TCAS ND Messages

ND Message	Color	Description
TFC	Cyan	TCAS traffic display enabled. Inhibited if following TCAS messages are displayed: TCAS FAIL, TCAS OFF, TCAS TEST
TRAFFIC	Amber	TA is occurring.
OFFSCALE	Amber	TA is occurring at range greater than current ND range. Replaced by red OFFSCALE when RA is also occurring at range greater than current ND range.
TRAFFIC	Red	RA is occurring.
OFFSCALE	Red	RA is occurring at range greater than current ND range.
TA ONLY	Cyan	TCAS can not provide RAs. All traffic that would have been RAs are predicted as TAs.
TCAS FAIL	Amber	TCAS failed, or TCAS information cannot be displayed on ND.
TCAS OFF	Amber	ND Traffic 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

806

Voice Annunciation	Condition	Response
TRAFFIC, TRAFFIC	New TA, initial voice annunciation.	Attempt to visually locate the traffic.
MONITOR VERTICAL SPEED	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA region.	Continue to keep pitch attitude and vertical speed outside the red RA region.
MAINTAIN VERTICAL SPEED, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA region.	
MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA region. Airplane will pass through the altitude of the traffic.	
CLIMB, CLIMB	New RA, initial voice annunciation. Present pitch attitude and vertical speed re within the red RA region.	Increase pitch attitude and vertical speed to remain outside the red RA region.
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA region. Airplane will climb through the altitude of the traffic.	

Voice Annunciation	Condition	Response
DESCEND, DESCEND	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA region.	Decrease pitch attitude and vertical speed to remain outside the red RA region.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the red RA region. Airplane will descend through the altitude of the traffic.	
LEVEL OFF, LEVEL OFF	Present pitch attitude and vertical speed are within the red RA region.	Reduce vertical speed to zero. Adjust pitch attitude and vertical speed to remain outside the red RA region.
INCREASE CLIMB, INCREASE CLIMB	Existing RA, TCAS requires change in vertical rate. Present pitch attitude and vertical speed are within the red RA region.	Adjust pitch attitude and vertical speed to remain outside the red RA region.
INCREASE DESCENT, INCREASE DESCENT		
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 region.	Decrease pitch attitude and vertical speed to remain outside the red RA region.

Voice Annunciation	Condition	Response
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 region.	Increase pitch attitude and vertical speed to remain outside the red RA region.
CLEAR OF CONFLICT	TCAS PFD vertical guidance is no longer displayed and traffic changes to a TA symbol. Separation is increasing and the RA will not occur. However, the voice annunciation will not sound if TCAS can no longer predict the track of the RA aircraft.	Attempt to visually locate the traffic.

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Voice Annunciation	Condition	Response
TRAFFIC, TRAFFIC	New TA, initial voice annunciation.	Attempt to visually locate the traffic.
MONITOR VERTICAL SPEED	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA region.	Continue to keep pitch attitude and vertical speed outside the red RA region.
MAINTAIN VERTICAL SPEED, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the red RA region.	
MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude is outside the red RA region. Airplane will pass through the altitude of the traffic.	
CLIMB, CLIMB	New RA, initial voice annunciation. Present pitch attitude is within the red RA region.	Increase pitch attitude to remain outside the red RA region.
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	New RA, initial voice annunciation. Present pitch attitude is within the red RA region. Airplane will climb through the altitude of the traffic.	

Voice Annunciation	Condition	Response
DESCEND, DESCEND	New RA, initial voice annunciation. Present pitch attitude is within the red R region	Decrease pitch attitude to remain outside the red RA region.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	New RA, initial voice annunciation. Present pitch attitude is within the red RA region. Airplane will descend through the altitude of the traffic.	
LEVEL OFF, LEVEL OFF	Present pitch attitude is within the red RA region.	Reduce vertical speed to zero. Adjust pitch attitude to remain outside the red RA region.
INCREASE CLIMB, INCREASE CLIMB	Existing RA, TCAS requires change in vertical rate. Present pitch attitude is within the red RA region.	Adjust pitch attitude to remain outside the red RA region.
INCREASE DESCENT, INCREASE DESCENT		
DESCEND, DESCEND NOW, DESCEND, DESCEND NOW	Existing RA, previous TCAS vertical guidance was to climb. Present pitch attitude is within the red RA region.	Decrease pitch attitude to remain outside the red RA region.
CLIMB, CLIMB NOW, CLIMB, CLIMB NOW	Existing RA, previous TCAS vertical guidance was to descend. Present pitch attitude is within the red RA region.	Increase pitch attitude to remain outside the red RA region.

Voice Annunciation	Condition	Response
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. TA/RA is normally selected, however, it is sometimes necessary to select TA ONLY to prevent nuisance RAs.

TA ONLY is selected during engine out operations to prevent RAs when adequate thrust is not available to follow the RA commands. Also, TA ONLY can be selected when intentionally operating near other traffic that may cause RAs, such as during parallel approaches and VFR operations.

TCAS Non-Normal Operation

The EICAS alert message TCAS OFF is displayed if TCAS is not operating. No TCAS RA guidance is displayed on the PFDs, no TCAS traffic symbols are displayed on the NDs, and no TCAS voice alerts sound. An amber TCAS OFF message is displayed on both NDs.

The EICAS alert message TCAS RA is displayed if TCAS cannot display RA guidance on the respective 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)

Introduction

GPWS provides:

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- runway awareness and advisory system annunciations on the ground and in flight
- look-ahead obstacle and terrain alerts for potentially hazardous flight conditions involving impact with the obstacles and the ground
- predictive windshear alerts
- immediate windshear alerts
- bank angle voice alerts
- immediate alerts for potentially hazardous flight conditions involving impact with the ground
- altitude voice annunciations during approach

Runway Awareness and Advisory System (RAAS)

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Note: RAAS voice annunciations are based upon RAAS database runway details. RAAS voice annunciations are not based upon the runway intended or planned. RAAS voice annunciations do not take into account airplane performance factors such as airplane weight, wind, runway condition, slope, air temperature, or airport altitude. The absence of RAAS voice annunciations does not ensure that a runway is appropriate for takeoff or landing. RAAS voice annunciations do not ensure that a runway is inappropriate for takeoff or landing. Flight crew is responsible to use other means available to ensure correct runway selection and the performance calculations are accurate for the conditions.

The RAAS provides voice annunciations to assist flight crew awareness of airplane position during ground operations, approach to landing, and go-around. The airports in the RAAS airport database include details for every runway on the airport.

In flight RAAS voice annuciations are enabled or inhibited based on an algorithm that numerically subtracts the landing runway touchdown zone elevation in the GPWS database from the pressure altitude of the airplane. The term "above field elevation" is used in the system description for these altitudes.

Voice Annunciations During Taxi and Takeoff on RAAS Airports

Voice Annunciation	Description
ON RUNWAY (RUNWAY IDENTIFIER)	Sounds once when the airplane:: • enters a runway, and • heading is within 20 degrees of the runway heading
ON RUNWAY (RUNWAY IDENTIFIER) (LENGTH) REMAINING	Sounds once when the airplane:: • enters a runway with available runway length for takeoff less than the defined length required, and • heading is within 20 degrees of the runway heading

Voice Annunciation	Description
ON RUNWAY (RUNWAY IDENTIFIER)	Sounds when the airplane: • remains on runway, and • moves less than 30 meters after entering runway, and • heading is within 20 degrees of the runway heading

Voice Annunciations During Approach, Landing, Go-Around, and RTO on RAAS Airports

Voice Annunciation	Description
APPROACHING (RUNWAY IDENTIFIER)	Sounds once each time the airplane: • approaches within three nautical miles of a runway threshold, and • is within 20 degrees of the runway heading, and • is within approximately 200 feet plus one runway width of the runway extended center line, and • is between 750 feet and 300 feet field elevation The voice annunciation is delayed and sounds at 450 feet altitude if the voice annunciation would have sounded when the airplane was between 550 feet and 450 feet above field elevation.
APPROACHING RUNWAYS	Sounds once each time the description is met while approaching two runways.

Voice Annunciation	Description
APPROACHING (RUNWAY IDENTIFIER) (METERS) AVAILABLE	Sounds once each time the airplane: • approaches within three nautical miles of a runway threshold with available runway length for landing less than the defined length required, and • is within 20 degrees of the runway heading, and • is within approximately 200 feet plus one runway width of the runway extended center line, and • is between 750 feet and 300 feet above field elevation The voice annunciation is delayed and sounds at 450 feet altitude if the voice annunciation would have sounded when the airplane was between 550 feet and 450 feet above field elevation.
(METERS) REMAINING	Sounds once each time the airplane is on the ground:: • with ground speed greater than 40 knots, and • is on a defined minimum length from the runway end • during rejected takeoff, when ground speed during takeoff decreases by seven knots from the maximum ground speed achieved

	Sounds once each time the airplane is in the air:
	• less than 100 feet above the runway, and
	• is over a defined minimum length from the runway end
	• during go-around after the voice annunciation REMAINING sounds, the voice annunciations continue to sound until the airplane is:
	  • higher than 100 feet above the runway, or
	  • rate of climb is greater than 450 feet per minute

Voice Annunciation	Description
THIRTY REMAINING	Sounds once each time the airplane: • is within 20 degrees of the runway heading, and • is within 30 meters of the end of a runway, and • ground speed is less than 40 knots

Look-ahead Obstacle and Peaks Terrain Alerting System

Look-ahead obstacle and peaks terrain alerts are provided by monitoring obstacle and terrain proximity using a world-wide terrain data base and an obstacle data base. The obstacle data base is not yet world wide. Terrain data is not designed to be an independent navigation aid.

Proximate obstacle and terrain data may be displayed on the ND. If there is a potential obstacle or terrain hazard, 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 path is not considered in the estimated time to impact.

Altitude used for look-ahead terrain mode alerts are a weighted combination of radio altitude, barometric altitude, GPS, and previous flight path. Weighting is reduced for an altitude source which becomes less reliable.

Note: Obstacle or terrain ahead of the airplane may exceed available climb performance. A GPWS caution or warning alert does not guarantee obstacle or terrain clearance.

When the GPWS Terrain switch is pushed on, the TERR symbol is displayed on the ND and obstacle and terrain contours may be displayed. When obstacle and terrain contours are displayed, the altitudes of the highest and lowest displayed obstacle or terrain are displayed below the TERR symbol. The color of each altitude corresponds to the altitude of the respective contour.

When the airplane is higher than 2,000 feet above the terrain, obstacles and terrain peaks are displayed using solid, high density, and low density contours of green. The highest obstacles or terrain are represented by solid green, and the lowest obstacles or terrain displayed are represented by low density green.

When the airplane is lower than 2,000 feet above the terrain, all obstacles and terrain within 2,000 feet of airplane altitude are displayed on the navigation display.

When an obstacle or terrain alert occurs, the respective message is displayed on the ND. When an OBSTACLE alert occurs while a TERRAIN alert message is displayed, the OBSTACLE alert message replaces the TERRAIN alert message. Both messages will not be displayed at the same time.

The terrain display is correlated to GPS position, or to IRU position if GPS position is intermittently unavailable.

Terrain and weather radar cannot be simultaneously displayed on an ND. When one pilot selects terrain and the other pilot selects weather radar, each display updates on alternating sweeps.

Look-Ahead Obstacle and Terrain Alerts

Voice Annunciation	PFD and ND Display and Light	Description
OBSTACLE, OBSTACLE, PULL UP	Red PULL UP on both PFDs Master WARNING lights Red OBSTACLE message on both NDs Solid red obstacle on ND	20 to 30 seconds from projected impact with obstacle. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
TERRAIN, TERRAIN, PULL UP	Red PULL UP on both PFDs Master WARNING lights Red TERRAIN message on both NDs Solid red terrain on ND	20 to 30 seconds from projected impact with terrain. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
CAUTION OBSTACLE	Amber OBSTACLE message on both NDs Solid amber obstacle on ND GND PROX light	40 to 60 seconds from projected impact with obstacle. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.

Voice Annunciation	PFD and ND Display and Light	Description
CAUTION TERRAIN	Amber TERRAIN message on both NDs Solid amber terrain on ND GND PROX light	40 to 60 seconds from projected impact with terrain. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.
TOO LOW, TERRAIN	Amber TERRAIN message on both NDs GND PROX light	Descent below unsafe altitude while too far from any airport in the terrain database. Pushing the GND PROX TERR OVRD switch to OVRD inhibits the alert.

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.

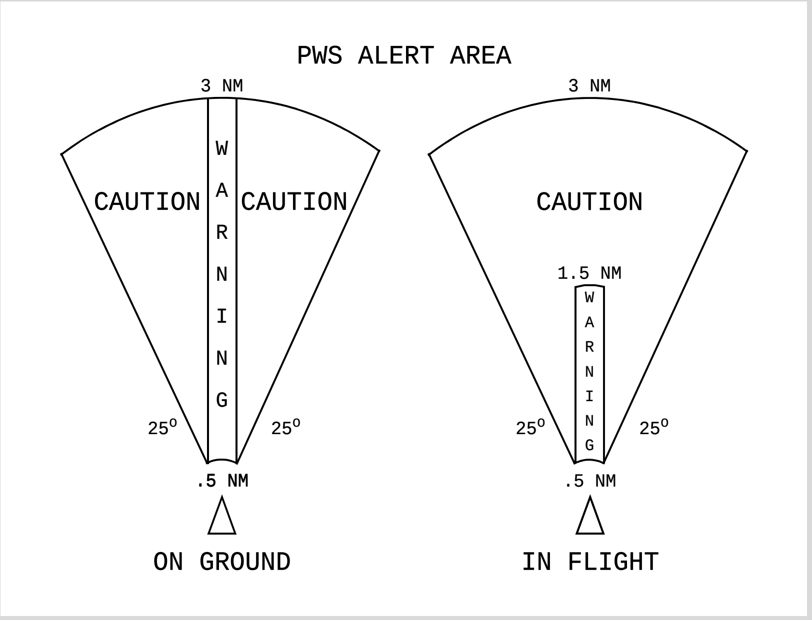
Weather radar uses radar imaging to detect disturbed air ahead of the airplane. PWS alerts are enabled approximately 12 seconds after weather radar begins scanning for windshear.

When PWS is enabled, radar antenna scan sweep is reduced.

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 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.

Voice Annunciation	PFD and ND Display and Light	Description
GO AROUND, WINDSHEAR AHEAD	Red WINDSHEAR on both PFDs Master WARNING lights Red WINDSHEAR message on both NDs RED windshear symbol on ND	Windshear predicted within 1.5 miles and directly ahead of the airplane. Enabled during approach, below 1,200 feet radio altitude. WIndshear position displayed by PWS symbol on the ND in MAP, MAP CTR, VOR, or APP modes only.
MONITOR RADAR DISPLAY	Amber WINDSHEAR message on both NDs RED windshear symbol on ND	Windshear predicted within 3 miles and ahead of the airplane. Enabled during takeoff and approach, below 1,200 feet radio altitude. Windshear position displayed on PWS on ND in MAP, MAP CTR, VOR, or APP modes only.

Note: Weather radar provides windshear alerts for windshear events containing some level of moisture or particulate matter.

Note: Weather radar detects microbursts and other windshears with similar characteristics. Weather radar does not provide alerting for all types of windshear. The flight crew must continue to rely on traditional windshear avoidance methods.

Immediate Windshear 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.

Bank Angle Alerting System

The voice alert BANK ANGLE sounds if bank angle exceeds 35°, 40°, and 45°.

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 Ground Proximity Glideslope Inhibit switch inhibits the alert when pushed below 1,000 feet radio altitude.
PULL UP	Red PULL UP on both PFDs Master Warning lights	Follows SINK RATE alert when descent rate becomes severe, or follows TERRAIN alert with flaps and/or gear not in landing configuration when excessive terrain closing rate continues.
SINK RATE	Ground Proximity light	Excessive descent rate.
TERRAIN	Ground Proximity light	Excessive terrain closing rate.

Voice Annunciation	PFD and ND Display and Light	Description
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 Gear Override switch to OVRD inhibits the alert.
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 not in landing position. Pushing the Ground Proximity Gear Override switch to OVRD inhibits the alert, when the alert is because gear 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:

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- 500 feet - FIVE HUNDRED, when glideslope or localizer not received, or glideslope or localizer deviation greater than two dots
- 100 feet - ONE HUNDRED

- 50 feet - FIFTY
- 30 feet - THIRTY
- 20 feet - TWENTY
- 10 feet - TEN

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- 2,500 feet - TWENTY-FIVE HUNDRED
- 1,000 feet - ONE THOUSAND
- 500 feet - FIVE HUNDRED, when glideslope or localizer not received, or glideslope or localizer deviation greater than two dots
- 400 feet - FOUR HUNDRED
- 300 feet - THREE HUNDRED
- 200 feet - TWO HUNDRED
- 100 feet - ONE HUNDRED
- 50 feet - FIFTY
- 40 feet - FORTY
- 30 feet - THIRTY
- 20 feet - TWENTY
- 10 feet - TEN

Minimums Voice Annunciation

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Minimums voice annunciation APPROACHING MINIMUMS at 80 feet above the altitude set by the left Radio Altimeter/Barometric Altitude control on the EFIS control panel, and MINIMUMS sounds at the altitude set.

GPWS Non-Normal Operation

Altitude Voice Annunciations During Approach Non-Normal Operation

If there is a fault in the altitude voice anunciations during approach system, the EICAS advisory message ALT CALLOUTS is displayed and GPWS voice annunciations during the approach are inhibited.

RAAS Non-Normal Operation

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If the RAAS Runway Override switch is OFF, the EICAS advisory message RUNWAY OVRD is displayed and RAAS voice annunciations and ND messages are inhibited.

If GPS position is uncertain, the EICAS advisory message RUNWAY POS is displayed and RAAS voice annunciations and ND messages are inhibited.

If there is a fault in RAAS or the airport is not in the GPWS RAAS database, the EICAS advisory message RUNWAY SYS is displayed and RAAS voice annunciations ND messages are inhibited.

Look-Ahead Alert Non-Normal Operation

If there is a fault in the look-ahead terrain alerting system, 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 TA/RA 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 or PWS warning alerts are no longer occurring, TCAS returns to TA/RA mode and provides RAs for all appropriate TAs.

EICAS 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.

EICAS Alert Messages Inhibited During Normal System Operation

Certain alert messages are time delayed, even though related flight deck panel annunciation lights are illuminated. Time delay inhibits prevent normal in-transit indications from being displayed as EICAS system alert messages. For example, valves are generally only sensed open and/or closed, not in-transit. When a valve is in-transit, the alert message indicating the valve has failed to open or close is inhibited to allow the valve time to move to the commanded position. If the valve is not in the commanded position at the end of the inhibit period, the respective EICAS alert message is displayed.

Voice Annunciation Inhibits

Voice annunciations for warning alerts inhibit new voice annunciations for caution alerts.

All voice annunciations are prioritized to aid flight crew decision making when more than one alert occurs.

ND Display Alert Inhibits and Automatic Display

Alert displays on the NDs are prioritized to aid flight crew decision making when more than one alert occurs. The displays are also prioritized when neither ND is in MAP, MAP CTR, VOR, or APP mode.

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 right ND. 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 automatically 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 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 for that ND. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for TERR display and TERR will be selected 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 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 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 for that ND. The ND not in MAP, MAP CTR, VOR, or APP mode is armed for WXR display and WXR will be selected 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 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 EAI 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 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	TCAS TAs		Approximately 500 feet radio altitude
All TCAS RAs	TCAS RAs 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
TCAS DESCEND RAs	Alerts are inhibited		Approximately 1,100 feet radio altitude
STATUS cue	All EICAS new status messages	Engine start	30 minutes after lift-off
Hi Chime	Attendant call	Any engine in takeoff thrust range	400 feet radio altitude

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
914			
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		400 feet radio altitude or 20 seconds after rotation, whichever occurs first. If rejected takeoff initiated above 80 knots, inhibit continues until airspeed is less than 75 knots.

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
806			
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

<table>
<tr><th>Alert Inhibited</th><th>For Message</th><th>Inhibit Begins</th><th>Inhibit Ends</th></tr>
<tr><td colspan="4">914</td></tr>
<tr><td>Master Warning lights
Bell
If the Master Warning lights illuminate and fire bell sounds before reaching V1, they continue to be illuminated and sound when V1 is exceeded.
If new FIRE messages are displayed during the inhibit, the bell will sound when the inhibit ends.</td><td>New EICAS warning messages FIRE</td><td rowspan="2">V1</td><td rowspan="2">400 feet radio altitude or 25 seconds after V1, whichever occurs first.</td></tr>
<tr><td rowspan="2">Master Warning lights
Siren
If the Master Warning lights illuminate and siren sounds before reaching V1, they continue to be illuminated and sound when V1 is exceeded
If new EICAS warning messages are displayed during the inhibit, the siren will sound when the inhibit ends.</td><td>New EICAS warning messages except:
CONFIG GEAR
FIRE</td></tr>
<tr><td>EICAS warning message CONFIG GEAR</td><td rowspan="2">Lift-off</td><td>800 feet radio altitude or 140 seconds after nose gear strut lift-off, whichever occurs first</td></tr>
<tr><td>EICAS advisory message FUEL TANK/ENG if tank to engine condition occurs after lift-off.</td><td>Message is inhibited</td><td>Ten minutes after lift-off</td></tr>
<tr><td>All PWS alerts</td><td>Messages are inhibited</td><td>1,200 feet radio altitude</td><td>Approach</td></tr>
</table>

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	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
TCAS voice alerts	TCAS TAs	Approximately 500 feet radio altitude	Go-around at approximately 500 feet radio altitude
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.

Intentionally
Blank

EICAS Alert Messages

Message	Level	Aural	Message Logic
AIRSPEED LOW	Caution	Beeper	Airspeed is less than minimum maneuvering speed.
ALT ALERT SYS	Advisory		The altitude alerting system has failed.

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ALT CALLOUTS	Advisory		Altitude and minimums voice annunciations during approach are no longer provided.

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ALT CALLOUTS	Advisory		Altitude voice annunciations during approach are no longer provided.

ALTITUDE ALERT	Caution	Beeper	Airplane has deviated more than 200 feet from the MCP selected altitude.
CHKL INCOMP NORM	Caution	Beeper	A checklist line item is not completed before the respective Before Takeoff, Approach, or Landing phase of flight.
CHKL NON-NORMAL	Advisory		A hidden non-normal check list is not complete, and the ECL is not displayed, and the respective EICAS message is not displayed.
CONFIG FLAPS	Warning	Siren	Flaps not in a takeoff position when the airplane is on the ground, airspeed is less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in the takeoff range.
CONFIG GEAR	Warning	Siren	Any landing gear is not down and locked when any Thrust lever closed below 800 feet radio altitude, or when the flaps are in a landing position.

Message	Level	Aural	Message Logic
CONFIG GEAR CTR	Warning	Siren	Body gear steering is unlocked when the airplane is on the ground, airspeed less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in the takeoff range.
CONFIG PARK BRK	Warning	Siren	Parking brake is set when airplane is on the ground, airspeed is less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in the takeoff range.
CONFIG SPOILERS	Warning	Siren	Speedbrake lever is not DOWN when the airplane is on the ground, airspeed is less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in the takeoff range; or, Speedbrake lever is extended beyond ARM in flight, and climb thrust or greater is set on any two Thrust levers.
CONFIG STAB	Warning	Siren	Stabilizer is not within the greenband when the airplane is on the ground, airspeed is less than V1, three or more Fuel Control switches are in RUN, and engine 2 or 3 thrust is in the takeoff range.
CONFIG WARN SY	Advisory		Configuration warning system fault is occuring.
GND PROX SYS	Advisory		Some or all GPWS alerts may not be provided. GPWS alerts that occur are valid.
OVERSPEED	Warning	Siren	Airspeed exceeds Vmo/Mmo.
PILOT RESPONSE	Warning	Siren	Pilot action is not detected during a specified time.
PILOT RESPONSE	Caution	Beeper	Pilot action is not detected during a specified time.

Message	Level	Aural	Message Logic
PILOT RESPONSE	Advisory		Pilot action is not detected during a specified time.

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Message	Level	Aural	Message Logic
RUNWAY OVRD	Advisory		Runway Override switch is in OVRD.

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Message	Level	Aural	Message Logic
RUNWAY POS	Advisory		RAAS not operating because GPS position accuracy is inadequate.

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Message	Level	Aural	Message Logic
RUNWAY SYS	Advisory		RAAS unavailable because airport is not in the database, or. RAAS failed

Message	Level	Aural	Message Logic
TCAS OFF	Advisory		TCAS mode TA ONLY or TA/RA is not selected.
TCAS RA CAPTAIN, F/O	Advisory		TCAS cannot display RA guidance on the PFD.
TCAS SYSTEM	Advisory		TCAS is failed.
TERR OVRD	Advisory		Ground Proximity Override switch is in OVRD. Look-ahead terrain alerts will not be provided.
TERR POS	Advisory		Terrain position data is 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		Some or all windshear alerts may not be provided. Windshear alerts that occur are valid.

EICAS Memo Messages

Message	Level	Aural	Message Logic
VMO GEAR DOWN	Memo		Gear down dispatch has been selected in the electronics bay.