787

Flight Crew Operations Manual (FCOM)

TG Revision:	No. 13, dated 03 JAN 20
Boeing Revision:	No. 14, dated 01 SEP 19

Thai Airways International Public Company Limited

Reverse side blank

Preface — Chapter 0

Chapter Table of Contents

Volume 1

Preface 0
V1V2 Model Identification 0.1
Introduction 0.2
Abbreviations 0.3
V1V2 Revision Record 0.4
V1V2 Revision Highlights 0.5
List of Effective Sections 0.6
Bulletin Record 0.7
Limitations L
Normal Procedures . . . . . NP
Supplementary Procedures . . . . . SP
Performance Dispatch . . . . . PD
Performance Inflight . . . . . PI

Volume 2

Airplane General, Emergency Equipment, Doors, Windows 1
Air Systems 2
Anti-ice, Rain 3
Automatic Flight 4
Communications 5
Electrical 6
Engines, APU 7
Fire Protection 8
Flight Controls 9
Flight Instruments, Displays 10
Flight Management, Navigation 11

Fuel 12
Hydraulics 13
Landing Gear 14
Warning Systems 15

General

The table provides a list of airplanes in order of their delivery dates. Model designation, Line, Serial, and Fuselage numbers are supplied by the manufacturer of the airplanes.

No.	Model	Reg.	Name	Line No.	Serial/ Fuselage No.	Delivery Date
1.	787-8	HS-TQA	ONGKHARAK	190	35315/ZA588	16JUL14
2.	787-8	HS-TQB	CHATURAPHAK PHIMAN	209	35316/ZA589	15SEP14
3.	787-8	HS-TQC	PRAN BURI	226	36110/ZA590	29OCT14
4.	787-8	HS-TQD	WAPI PATHUM	244	35320/ZA591	09DEC14
5.	787-8	HS-TQE	KOSUM PHISAI	287	38757/ZA592	17APR15
6.	787-8	HS-TQF	KONG KRAILAT	331	38759/ZA593	07AUG15
7.	787-9	HS-TWA	PHATTHANA NIKHOM	602	38777/ZB219	14SEP17
8.	787-9	HS-TWB	PHROM BURI	623	38780/ZB220	30OCT17

General

The FLIGHT CREW OPERATIONS MANUAL (FCOM) 787 is the property of THAI AIRWAYS INTERNATIONAL PUBLIC COMPANY LIMITED. The manual contents are under the responsibility of THAI Flight Technical Engineering Department (BKKOU). Since the manual includes information regarding THAI policies and methods of operation, it is prohibited to reveal its contents to persons not associated with the Company.

The manual is available at THAISphere and https://vpn.thaiairways.com. It is the duty of all users to access OH web site regularly to ensure that any new revisions that occurred are known and carefully studied. It is also the responsibility of all users to inform BKKOU of any discrepancy found in the manual at 66 2 545 1073.

Purpose and Scope

This manual is specifically prepared for flight personnel and includes information and instructions for operation of the 787. The procedures in this manual cover the regulations issued by the Civil Aviation Authority of Thailand (CAAT) as applicable and specific to this type of aircraft. Although these procedures must be adhered to, nothing should limit personnel from acting on their own best judgment in an emergency.

This manual is structured in a three-volume format, and a Quick Reference Handbook (QRH):

- Volume 1 includes operational limitations, normal and supplementary procedures, and performance data.
- Volume 2 contains systems information.
- QRH contains all checklists necessary for normal and non-normal procedures as well as in-flight performance data.

This manual is written under the assumption that the user has had 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 manual does not contain basic flight information that is considered prerequisite training.

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 sections/pages.

- Limitations and Normal Procedures chapters cover operational limitations and normal procedures. All operating procedures are based on a thorough analysis of crew activity required to operate the airplane, and reflect the latest knowledge and experience available.
- Supplementary Procedures chapter covers those procedures accomplished as required rather than routinely on each flight.
- Performance Dispatch chapter contains performance information necessary for self dispatch.
- Performance In-flight chapter contains performance information necessary for inflight use.

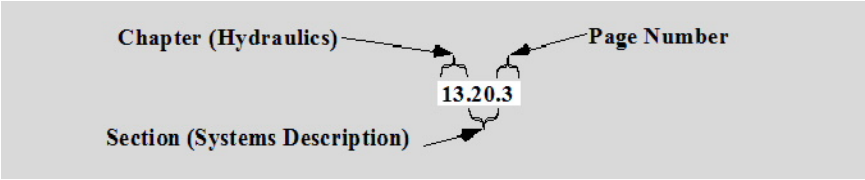
Volume 2—Chapters 1 through 15 contain general airplane and systems information. These chapters are generally subdivided into sections covering controls and indicators and systems descriptions.

Quick Reference Handbook (QRH)—The QRH contains normal checklists, nonnormal checklists, operational information, performance information necessary for inflight use on an expedited basis, and maneuvers.

Page Numbering

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

Example Page Number



Warnings, Cautions, and Notes

The following levels of written advisories are used throughout the FCOM 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.

For additional information on ECL Notes:

- See Operational Notes and Additional Information on page 10.50.7
- See Operational Notes on page 10.60.3

Airplane Effectivities

Differences in airplane configuration are expressed through the use of airplane effectivities which lists airplane registration numbers applicable to particular contents.

Airplane registration numbers are listed in alpha-numeric order. A list of more than four consecutive registration numbers is presented as a range of airplanes. A comma is used in the list to indicate a break in the range, e.g. the list of “TQA to TQC, F” includes the alphabets A through C and F of the "TQ" series.

An airplane list of an entire fleet may, in some cases, be expressed as the fleet itself, e.g. the list of “-8, -9” includes all airplanes in the -8 and -9 fleets.

For PDF format of this document, airplane effectivities are shown adjacent to the applicable contents on the left for even pages and on the right for odd pages. In some rare cases where the effectivity includes several airplane registration numbers or models, the effectivity may extend below its content and slightly cover the area associated with the following content.

For HTML format of this document, airplane effectivities are distinguished by text colors and the airplane lists will be displayed in a pop-up note when the cursor moves over the respective contents.

Example:

Message	Level	Aural	Condition	
HF DATALINK OFF	Memo		The HF datalink is off.	
HF GND OVRD XMIT	Memo		The HF datalink mode is on, on the ground.	TQA,B
HFDL GND XMIT	Memo		The HF datalink mode is on, on the ground.	TQA to TQF

In this example, the effectivity TQA to TQB applies only to the second row (HF GND OVRD XMIT...) while the effectivity TQA to TQF applies only to the third row (HFDL GND XMIT...). The first row applies to all airplanes in the 787 fleet.

The effectivity statements will be updated as the modifications are incorporated. When all affected airplanes have been modified, the effectivity statements are removed.

Bangkok, 12 December 2019
THAI AIRWAYS INTERNATIONAL PUBLIC COMPANY LIMITED

Operations Department (DO)

DELETION



Capt. Soradej Namruangsri
Executive Vice President

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	
A	At or Above
ABS	Absolute
ABV	Above
A/C	Air Conditioning
AC	Alternating Current
ACARS	Aircraft Communications Addressing and Reporting System
ACE	Actuator Control Electronics
ACM	Air Cycle Machines
ACP	Audio Control Panel
ACT	Active
ADF	Automatic Direction Finder
ADJ	Adjust
ADM	Air Data Module
ADRF	Air Data Reference Function
ADRS	Air Data Reference System
ADRU	Air Data Reference Unit
ADS-B	Automatic Dependant Surveillance–Broadcast
AED	Automatic External Defibrillator
AFDS	Autopilot Flight Director System
AFE	Above Field Elevation
AFM	Airplane Flight Manual (FAA approved)
AGCU	APU Generator Control Unit
AGL	Above Ground Level
AHRU	Attitude Heading Reference Unit
AI	Anti–Ice
AIL	Aileron

	A
AIRB	Airborne
ALT	Altitude
ALTN	Alternate
AM	Amplitude Modulation
AMI	Airline Modifiable Information
ANP	Actual Navigation Performance
ANT	Antenna
AOA	Angle of Attack
AOIP	ACARS-over-IP
A/P	Autopilot
APP	Approach
APT	Airport
APU	Auxiliary Power Unit
AR	Authorization Required
ARINC	Aeronautical Radio, Incorporated
ASG	APU Stater Generator
ASO	Airline Selectable Option
ASYM	Asymmetry
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATIS	Automatic Terminal Information Service
ATN	Aeronautical Telecommunications Network
ATP	Alerting and Transponder Control Panel
ATSP	Air Traffic Service Provider
ATT	Attitude
AUTO	Automatic
AUX	Auxiliary
AVAIL	Available
AVS	Alternate Ventilation System
	B
B	At or Below
BA	Bulletin Addendum

	B
BARO	Barometric
BAT	Battery
BCRS or B/CRS	Back Course
BFO	Beat Frequency Oscillator
BITE	Built In Test Equipment
BLW	Below
BRG	Bearing
BRT	Bright
BTL DISCH	Bottle Discharge (fire extinguishers)
	C
C	Captain Celsius Center
CAAT	The Civil Aviation Authority of Thailand
CAB	Cabin
CAC	Cabin Air Compressor
CALC	Calculated
CANC/ RCL	Cancel/Recall
CAPT	Captain
CAS	Calibrated Airspeed
CB	Circuit Breaker
CBIC	Circuit Breaker Indication and Control
CCD	Cursor Control Device
CCR	Common Computing Resource
CCS	Common Core System or Cursor Control Selector
CDN	Common Data Network
CDTI	Cockpit Display of Traffic Information
CDU	Control Display Unit
CG	Center of Gravity
CHKL	Checklist
CHS	Cargo Handling System
CIPS	CAC Ice Protection System

C	
CLB	Climb
CLR	Clear
CMF	Communication Management Function
CMSC	Common Motor Start Controller
CO	Company
COMM	Communication
CON	Continuous
CONFIG	Configuration
CORR	Corrected
CPCS	Cabin Pressure Control System
CRS	Course
CRZ	Cruise
CSOS	Customer Specific Option Selections
CTL	Control
CTR	Center
CTRL	Control
CVR	Cockpit Voice Recorder
D	
DA(H)	Decision Altitude (Height)
DC	Direct Current
D/D	Drift Down
DDG	Dispatch Deviations Guide
DECR	Decrease
DEL	Delete or Deleted
DEP ARR	Departure Arrival
DES	Descent
DEST	Destination
DIR	Directory or Direct or Direction
DISC	Disconnect
DIST	Distance
DLR	Datalink Recorder
DME	Distance Measuring Equipment

D	
DN	Down
DSP	Display Select Panel
DSPL	Display
DTG	Distance To Go
DU	Display Unit
E	
EBA	Electric Brake Actuator
EBAC	Electric Brake Actuator Controller
ECB	Electronic Circuit Breaker
ECL	Electronic Checklist
ECON	Economy
ECS	Environmental Control System
ECV	Economy Cooling Valves
E/D	End of Descent
EDAS	Empennage Door Actuation System
EDP	Engine Driven Pumps
E/E	Electrical and Electronic
EEC	Electronic Engine Control
EFB	Electronic Flight Bag
EFC	Expected Further Clearance
EFIS	Electronic Flight Instrument System
EGT	Exhaust Gas Temperature
EICAS	Engine Indication and Crew Alerting System
ELEC	Electrical
ELEV	Elevator
ELT	Emergency Locator Transmitter
EMA	Elector-Mechanical
EMER	Emergency
EMG	Emergency
EMK	Emergency Medical Kit
EMP	Electric Motor Pump
ENG	Engine

	E
EO	Engine Out
EST	Estimated
ETA	Estimated Time of Arrival
EVAC	Evacuation
EXEC	Execute
EXT	Extend or External
	F
F	Fahrenheit
FA	Final Approach
FAA	Federal Aviation Administration
FAC	Final Approach Course
FAF	Final Approach Fix
FAK	First Aid Kit
FCM	Flight Control Modules
FCOM	Flight Crew Operations Manual
FCTL	Flight Control
F/D	Flight Director
FD	Flight Deck
FDR	Flight Data Recorder
FF	Fuel Flow
FIS	Flight Information Services
FL	Flight Level
FLCH	Flight Level Change
FLPRN	Flaperon
FLT	Flight
FLT DIR	Flight Director
FMA	Flight Mode Annunciation
FMC	Flight Management Computer
FMS	Flight Management System
F/O	First Officer
FPA	Flight Path Angle
FPM	Feet Per Minute

F	
FPV	Flight Path Vector
FQDC	Fuel Quantity Data Concentrator
FR	From
FT	Feet
FWD	Forward
G	
G	Gravity
GA	Go–Around
GATU	Galley Autotransformer Unit
GBAS	Ground–Based Augmentation System
GCB	Generator Control Breaker
GEN	Generator
GLS	GBAS Landing System
GND	Ground
GNSS	Global Navigation Satellite System
GP or G/P	Glidepath
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
GR WT	Gross Weight
G/S	Glideslope
GS	Groundspeed
GTK	Ground Track
H	
HAA	Height Above Airport
HBB	Hot Battery Bus
HCM	Hydraulic Control Module
HDG	Heading
HDG REF	Heading Reference
HDG SEL	Heading Select
HF	High Frequency
HLFC	Hybrid Laminar Flow Control
HPA	Hectopascals

H	
HR	Hour
HT	Height
HUD	Head-Up Display
H/WIND	Head Wind
HXBV	Heat Exchanger Bypass Value
HYD	Hydraulic
I	
IAN	Integrated Approach Navigation
IAS	Indicated Airspeed
ICAO	International Civil Aviation Organization
ICI	Ice Crystal Icing
ICS	Integrated Cooling System
IDENT	Identification
IFE	In-Flight Entertainment System
IFR	Instrument Flight Rules
IGS	Instrument Guidance System
ILS	Instrument Landing System
IN	Inches
INBD	Inboard
INCR	Increase
IND LTS	Indicator Lights
INFO	Information
INIT	Initialize or Initialization
INOP	Inoperative
INR	Integrated Navigation Receiver (Radio)
INT	Interphone
INTC CRS	Intercept Course
IP	Internet Protocol
IRS	Inertial Reference System
IRU	Inertial Reference Unit
ISA	International Standard Atmosphere
ISFD	Integrated Standby Flight Display

I	
ISLN	Isolation
ITP	In Trail Procedure
K	
K	Knots
KG or KGS	Kilograms
KIAS	Knots Indicated Airspeed
KTS	Knots
L	
L	Left
L1	Left #1
L2	Left #2
LAM	Landing Attitude Modifier
LAT	Latitude
LB or LBS	Pounds
LCD	Liquid Crystal Display
LDA	Localizer-Type Directional Aid
LDG	Landing
LDG ALT	Landing Altitude
LED	Light Emitting Diode
LF-ULD	Low Frequency Underwater Locating Device
LIM	Limit
LNAV	Lateral Navigation
LOC	Localizer
LONG	Longitude
LRC	Long Range Cruise
LRU	Line Replaceable Unit
LSK	Line Select Key
LVL	Level
LWR CTR	Lower Center
LWR DSPL	Lower Display
M	
M	Mach

M	
MAC	Mean Aerodynamic Chord
MAG	Magnetic
MAN	Manual
MAX	Maximum
MCG	Minimum Control Ground
MCP	Mode Control Panel
MCS	Miscellaneous Cooling System
MDA(H)	Minimum Descent Altitude (Height)
MEDC	Main Engine Data Concentrator
MEL	Minimum Equipment List
MFD	Multifunction Display
MFK	Multifunction Keypad
MHZ	Megahertz
MIC	Microphone
MIN	Minimum
MISC	Miscellaneous
MKR	Marker Beacon
MM	Millimeters
MMO	Maximum Operating Mach
MOD	Modify
MSA	Modal Suppression Accelerometers
MSG	Message
MSL	Mean Sea Level
MTRS	Meters
N	
N	Normal
N1	Low Pressure Rotor Speed
N2	High Pressure Rotor Speed (General Electric engines) or Intermediate Pressure Rotor Speed (Rolls–Royce engines)
N3	High Pressure Rotor Speed (Rolls-Royce engines)
N/A	Not Applicable
NAV	Navigation
NAV RAD	Navigation Radio

	N
ND	Navigation Display or Nose Down
NEF	Non-Essential Equipment and Furnishings
NGS	Nitrogen Generation System
NM	Nautical Miles
NO	Number
NORM	Normal
NPS	Navigation Performance Scales
NU	Nose Up
	O
OAT	Outside Air Temperature
OBS	Observer
ODS	Overheat Detection System
OFAR	Overhead Flight Attendant Rest
OFCR	Overhead Flight Crew Rest
OMB	Flight Crew Operations Manual Bulletins
OMS	Onboard Maintenance System
OMTS	Onboard Mobile Telephone System
OP	Operational
OPC	Operational Program Configuration
OPT	Optimum Altitude Onboard Performance Tool
OUTBD DSPL	Outboard Display
OVHD	Overhead
OVRD	Override
	P
PA	Passenger Address
PAN	Possible Assistance Needed
PASS	Passenger
PCS	Power Conversion System
PD	Performance Dispatch
PDU	Power Drive Unit
PECS	Power Electronics Cooling System
PED	Personal Electronic Device

P	
PERF	Performance
PERF INIT	Performance Initialization
PF	Pilot Flying
PFC	Primary Flight Computers
PFD	Primary Flight Display
PG	Page
PI	Performance Inflight
PM	Pilot Monitoring
PMA	Permanent Magnet Alternator
PMG	Permanent Magnet Generator
PNL	Panel
POS	Position
POS INIT	Position Initialization
PPDS	Primay Power Distribution System
PRED	Predicted
PREV	Previous
PRI	Primary
PROC	Procedure
PROG	Progress
PRSOV	Pressure Regulating and Shutoff Valves
PRV	Pressure Regulating Valves
PSI	Pounds per Square Inch
PSU	Passenger Service Unit
PTH	Path
PTT	Push-To-Talk
PWS	Predictive Windshear System
Q	
QFE	(altitude above station)
QNH	(altitude above sea level)
QRH	Quick Reference Handbook
QTY	Quantity
QUAD	Quadrant

R	
R	Right
R1	Right #1
R2	Right #2
RA	Radio Altitude or Resolution Advisory
RAD	Radio
RAT	Ram Air Turbine
RCD	Record
RECIRC	Recirculation
RECMD	Recommended
REF	Reference
REL	Relative
RESTR	Restriction
RET	Retract
REV	Reverser
RF	Refill or Radius to Fix
RFMC	Ram Fan Motor Controller
RLS	Remote Light Sensor
RNAV or RNV	Area Navigation
RNP	Required Navigation Performance
RPDU	Remote Power Distribution Unit
RPTG	Reporting
RTA	Required Time of Arrival
RTE	Route
RVSM	Reduced Vertical Separation Minimum
RW or RWY	Runway
S	
SAT	Static Air Temperature or Satellite
SATCOM	Satellite Communication System
S/C	Step Climb
SDF	Simplified Directional Facility
SEL	Select
SELCAL	Selective Calling System

S	
SEP	Separation
SID	Standard Instrument Departure
SL	Sea Level
SLOP	Strategic Lateral Offset Procedure
SPD	Speed
SPU	Start Power Unit
SRM	Structural Repair Manual
STA	Station
STAB	Stabilizer
STAR	Standard Terminal Arrival Route
STAT	Status
STBY	Standby
STD	Standard
SUPP	Supplemental
SURF	Surface Traffic
SVR	Severe
SYS	System
T	
T	True or Turbulence
TA	Traffic Advisory
TAI	Thermal Anti Ice
TAMS	Thrust Asymmetry Minimum Speed
TAP	Thrust Asymmetry Protection
TAS	True Airspeed
TAT	Total Air Temperature
TBC	The Boeing Company
TBD	To Be Determined
TBV	Transient Bleed Valve
T/C	Top of Climb
TCAS	Traffic Alert and Collision Avoidance System
TCB	Thermal Circuit Breaker
TCP	Tuning and Control Panel

T	
T/D	Top of Descent
TEMP	Temperature
TERR	Terrain
TFC	Traffic
TGT	Target
THR	Thrust
TO	Takeoff
TO/GA	Takeoff/Go–Around
TOGW	Takeoff Gross Weight
TOT	Total
TPR	Turbofan Power Ratio
TRANS	Transition
TRK	Track
TRU	True (reference to True North)
TTG	Time To Go
TWIP	Terminal Weather Information for Pilots
U	
UL	Up Link
UNAVAIL	Unavailable
UNLKD	Unlocked
UPR DSPL	Upper Display
USB	Upper Side Band
UTC	Universal Time Coordinated
V	
V1	Takeoff Decision Speed
V1V2	Volume 1, Volume 2
V2	Takeoff Safety Speed
VA	Design Maneuvering Speed
VAR	Variation
V/B	Vertical Bearing
VCTU	Variable Camber Trim Unit
VDL	VHF Digital Link

V	
VERT	Vertical
VFR	Visual Flight Rules
VFSG	Variable Frequency Stater Generator
VHF	Very High Frequency
VMBE	Maximum Brake Energy Speed
VMC	Visual Meteorological Condition
VMO	Maximum Operating Speed
VNAV	Vertical Navigation
VOR	VHF Omnidirectional Range
VR	Rotation Speed
VREF	Reference Speed
V/S	Vertical Speed
VSA	Visual Separation on Approach
VSD	Vertical Situation Display
VTK	Vertical Track
W	
WAP	Wireless Access Point
WGS-84	World Geodetic Survey 1984
WIPS	Wing Ice Protection System
WPT	Waypoint
WT	Weight
WX or WXR	Weather Radar
X	
X	(generic reference to a variable instance)
XFR	Transfer
XPDR	Transponder
XTK	Cross Track
X/WIND	Crosswind
Z	
ZFW	Zero Fuel Weight

Revision Record

No.	Revision date	Date filed & Signature
1	17 JUL 14	Incorporated
3	15 MAY 15	Incorporated
5	15 JUL 16	Incorporated
7	05 MAY 17	Incorporated
9	14 NOV 17	Incorporated
11	13 DEC 18	Incorporated
13	03 JAN 20	
15		
17		
19		
21		
23		
25		
27		
29		
31		
33		
35		
37		
39		
41		
43		
45		
47		
49		
51		
53		

No.	Revision date	Date filed & Signature
2	11 DEC 14	Incorporated
4	14 MAR 16	Incorporated
6	16 DEC 16	Incorporated
8	04 SEP 17	Incorporated
10	12 JUN 18	Incorporated
12	11 JUL 19	Incorporated
14		
16		
18		
20		
22		
24		
26		
28		
30		
32		
34		
36		
38		
40		
42		
44		
46		
48		
50		
52		
54		

No.	Revision date	Date filed & Signature
55		
57		
59		
61		
63		
65		
67		
69		
71		
73		
75		
77		
79		
81		
83		
85		
87		
89		
91		
93		
95		
97		
99		
101		
103		
105		
107		
109		

No.	Revision date	Date filed & Signature
56		
58		
60		
62		
64		
66		
68		
70		
72		
74		
76		
78		
80		
82		
84		
86		
88		
90		
92		
94		
96		
98		
100		
102		
104		
106		
108		
110		

General

FCOM revisions are issued to provide new or revised procedures and information. Formal revisions also incorporate appropriate information from previously issued flight crew operations manual bulletins.

FCOM revisions, include the FCOM Revision Status, FCOM Revision Highlights, and the current FCOM List of Effective Sections.

oOo indicates the end of sections.

Revision Status

TG Revision:	No. 13, dated 03 JAN 20
Boeing Revision:	No. 14, dated 01 SEP 19

Revision Highlights

Revision marks indicate changes to contents. These marks are removed in the digital format of the subsequent revision. Revision marks include:

- Shading (gray for PDF, yellow for HTML) on texts or illustrations indicates changes to or addition of the content for the current revision
- “DELETION” mark appears when a text or illustration from previous revision has been deleted
- Asterisk (*) symbol appearing adjacent to airplane registration numbers indicates changes to airplane effectivity of that content.

Revision highlights provide brief reasons for changes to individual contents. Technical changes are always provided with revision highlights. There are cases where non-technical changes are not accompanied by revision highlights. These include but not limited to:

- Minor grammatical corrections
- Changes to publishing system database configuration; revision marks may appear on contents that appear unchanged.

0 Preface

0.1 V1V2 Model Identification

0.1.1—Editorial correction.

0.3 Abbreviations

0.3.1—Added VHF Digital Link (VDL) abbreviation.

0.7 Bulletin Record

0.7.1—Revised to reflect current bulletin status.

L Limitations

L.10 Limitations and Operational Information

L.10.2—Added RVSM Operations content to AFM Limitations.

L.10.2—Moved RVSM Operations from Non-AFM Operational Information to AFM Limitations.

L.10.2—Deleted duplicate Non-AFM Operational Information title.

L.10.4—Deleted the Flight Deck Communication System (Datalink) section because it is no longer a certification limitation.

NP Normal Procedures

NP.21 Amplified Procedures

NP.21.23—Changed the name of the "nose wheel tiller disconnect switch" to "rudder pedal disconnect switch" to be consistent with other documents.

SP Supplementary Procedures

SP.16 Adverse Weather

SP.16.10—Changed the conditions for which the flaps are left extended after landing. This clarifies the risk of contamination that can cause a slat drive fault.

SP.16.12—Changed location and wording of the note about flap and slat inspection after landing in icing conditions. Added a step to make a logbook entry when the flaps are left extended.

PD Performance Dispatch

PD.10 Takeoff

PD.10.19—Consolidated the two previous fuel jettison limit weight tables into a single table. Removed icing correction footnote to be consistent with the AFM in not requiring the consideration of ice accumulation for dispatch.

PD.12 Landing

PD.12.7—Updated internal structure, no change to data.

PD.13 Gear Down

PD.13.13—Consolidated the two previous fuel jettison limit weight tables into a single table. Removed icing correction footnote to be consistent with the AFM in not requiring the consideration of ice accumulation for dispatch.

PD.14 Text

PD.14.1—Updated wording. The fuel jettison limit weight table is now based on an AFM-DPI lookup and the text was updated accordingly.

PD.14.2—Updated Fuel Jettison Limit Weight text. This table is now based on an AFM-DPI lookup and the text section was updated accordingly.

PD.14.6—Updated wording. The fuel jettison limit weight table is now based on an AFM-DPI lookup and the text was updated accordingly.

PD.20 Takeoff

PD.20.21—Consolidated the two previous fuel jettison limit weight tables into a single table. Removed icing correction footnote to be consistent with the AFM in not requiring the consideration of ice accumulation for dispatch.

PD.23 Gear Down

PD.23.15—Consolidated the two previous fuel jettison limit weight tables into a single table. Removed icing correction footnote to be consistent with the AFM in not requiring the consideration of ice accumulation for dispatch.

PD.24 Text

PD.24.1—Updated wording. The fuel jettison limit weight table is now based on an AFM-DPI lookup and the text was updated accordingly.

PD.24.2—Updated Fuel Jettison Limit Weight text. This table is now based on an AFM-DPI lookup and the text section was updated accordingly.

PD.24.2—Removed negative signs from all values to be consistent with the description of the accompanying text paragraph.

PD.24.2—Updated Fuel Jettison Limit Weight text. This table is now based on an AFM-DPI lookup and the text section was updated accordingly.

PI Performance Inflight

PI.14 Alternate Mode EEC

PI.14.1—Consolidated the two previous fuel jettison limit weight tables into a single table. Removed icing correction footnote to be consistent with the AFM in not requiring the consideration of ice accumulation for dispatch.

PI.18 Text

PI.18.11—Updated Fuel Jettison Limit Weight text. This table is now based on an AFM-DPI lookup and the text section was updated accordingly.

PI.22 Advisory Information

PI.22.57—Updated Recommended Brake Cooling Schedule tables. The throttle chop spindown effects were re-modeled to reduce excess conservatism.

PI.22.58—Updated Recommended Brake Cooling Schedule tables. The throttle chop spindown effects were re-modeled to reduce excess conservatism.

PI.22.59—Updated Recommended Brake Cooling Schedule tables. The throttle chop spindown effects were re-modeled to reduce excess conservatism.

PI.24 Alternate Mode EEC

PI.24.1—Consolidated the two previous fuel jettison limit weight tables into a single table. Removed icing correction footnote to be consistent with the AFM in not requiring the consideration of ice accumulation for dispatch.

PI.28 Text

PI.28.11—Updated Fuel Jettison Limit Weight text. This table is now based on an AFM-DPI lookup and the text section was updated accordingly.

1 Airplane General, Emergency Equipment, Doors, Windows

1.40 Systems Description

1.40.6—Revised "SEAT BELT SIGNS" to "SEAT BELTS", to reflect panel nomenclature.

1.40.6—Revised "SEAT BELT SIGNS" to "SEAT BELTS", to reflect panel nomenclature.

2 Air Systems

2.20 Air Conditioning System Description

2.20.4—Modified cabin temperature zone range adjust.

4 Automatic Flight

4.10 Controls and Indicators

4.10.15—Changed "IAN final approach course" to "final approach course" for standardization.

4.10.15—Changed "disarmed" to "deactivated" for correctness and cross-model standardization.

5 Communications

5.10 Controls and Indicators

5.10.1—Updated Audio Control Panel volume control knob backlit color around the arrows to correct from green to light gray.

5.10.12—Deleted CABIN USE channel status to correctly reflect available status options.

5.10.12—Deleted CALL FAILED channel status to correctly reflect available status options.

5.10.13—Deleted PREEMPTED from SATCOM Call Key callout since it is not a valid key options.

5.10.14—Updated callout that BITE can be OK or FAIL.

5.20 System Description

5.20.6—Removed note regarding SATCOM EICAS message which contained a non-standard cross reference to the Fault Isolation (FIM) . The information contained in the note will be added to the FIM in a future revision.

5.40 MFD Communications Functions

5.40.11—Updated COMM Help Messages table to correctly reflect CMF software functionality.

5.40.42—Updated FANS Select Key callout to FANS Box, and updated description to better define its function.

5.40.73—Separated "VHF Manager Page 2/3" section into "VHF Manager Page 2/3 - VDL Mode A" and "VHF Manager Page 2/3 - VDL Mode 2" sections to match CMF SCD.

5.40.74—Separated "VHF Manager Page 2/3" section into "VHF Manager Page 2/3 - VDL Mode A" and "VHF Manager Page 2/3 - VDL Mode 2" sections to match CMF SCD.

7 Engines, APU

7.20 Engine System Description

7.20.10—Changed the spelling.

7.20.12—Changed the spelling.

7.20.12—Changed the spelling.

7.20.12—Changed the spelling in graphic from "ignitors" to "igniters".

9 Flight Controls

9.20 System Description

9.20.6—Updated description of flight control self-test. The phrase "trim indication blinks" had been removed in a prvious revision. This revision deletes a reference to the same phrase that is no longer applicable.

9.20.13—Description previously stated that "the flight control system reverts to Direct mode" if the trim switch remains jammed or failed. This was removed following Boeing clarification of the operation of the column cutout function.

10 Flight Instruments, Displays

10.10 Controls and Indicators

10.10.7—Removed "ADRS" from the Bank Pointer callout.

10.12 Head-Up Display System—Displays

10.12.5—Removed "ADRS" from the Bank Pointer callout.

10.50 Electronic Checklist Displays

10.50.1—Added Note to clarify the use of checklists to describe ECL functions. The checklist and procedures within this section are for example only.

11 Flight Management, Navigation

11.31 Flight Management System Operation

11.31.36—Removed indentation and replaced "LNAV course" to "LNAV path" for accuracy.

11.40 FMC Preflight

11.40.15—Changed "POS REF 3/4 and 4/4" to "POS REF 2/4 and 4/4" for correctness.

14 Landing Gear

14.10 Controls and Indicators

14.10.3—Modified the Rudder Pedal Disconnect Switch, standardize the name of the switch.

Preface — Chapter 0
List of Effective Sections — Section 6

Section/Page	Date
Volume 1	
Preface	
Title Page	3 Jan 20
0.TOC.1 to 2	3 Jan 20
0.1.1	3 Jan 20
0.2.1 to 4	3 Jan 20
0.3.1 to 16	3 Jan 20
0.4.1 to 2	3 Jan 20
0.5.1 to 6	3 Jan 20
0.6.1 to 3	3 Jan 20
0.7.1 to 2	3 Jan 20
B.TII-2_R3.1	15 Oct 16
B.TII-3_R1.1	15 Oct 16
B.TII-4_R1.1 to 2	18 Jan 19
B.TII-6.1 to 2	22 Apr 14
B.TII-17_R2.1 to 2	14 Dec 18
B.TII-19.1 to 2	1 Feb 16
B.TII-22_R1.1 to 2	15 Apr 16
B.TII-25_R1.1 to 2	2 Mar 19
B.TII-28_R2.1	14 Dec 18
B.TII-30_R3.1	20 Sep 19
B.TII-31_R1.1 to 2	14 Dec 18
B.TII-32_R1.1 to 2	14 Dec 18
B.TII-33_R2.1 to 6	30 Sep 19
B.TII-35_R1.1	14 Dec 18
B.TII-36.1	20 Jun 18
B.TII-37_R2.1 to 4	2 Mar 19
B.TII-38.1 to 2	18 Jan 19
B.TII-39.1	18 Jan 19
B.TII-40_R1.1 to 2	5 Apr 19
B.TII-41.1 to 2	5 Apr 19
B.TII-43.1 to 2	5 Jul 19
B.TII-44_R1.1 to 3	20 Sep 19
B.TII-45.1 to 6	30 Sep 19
B.TII-46.1 to 3	18 Oct 19
Limitations	
L.TOC.1	3 Jan 20
L.10.1 to 6	3 Jan 20

Section/Page	Date
Normal Procedures	
NP.TOC.1 to 2	3 Jan 20
NP.11.1 to 7	16 Dec 16
NP.21.1 to 37	3 Jan 20
Supplementary Procedures	
SP.TOC.1 to 6	3 Jan 20
SP.05.1	17 Jul 14
SP.1.1 to 3	12 Jun 18
SP.2.1 to 2	5 May 17
SP.3.1	17 Jul 14
SP.4.1 to 10	14 Nov 17
SP.5.1 to 2	17 Jul 14
SP.6.1 to 2	5 May 17
SP.7.1	12 Jun 18
SP.10.1 to 2	15 May 15
SP.11.1 to 6	13 Dec 18
SP.12.1 to 2	14 Mar 16
SP.16.1 to 21	3 Jan 20
SP.17.1 to 16	5 May 17
SP.18.1 to 8	13 Dec 18
Performance Dispatch	
PD.TOC.1	3 Jan 20
PD.10.TOC.1 to 2	3 Jan 20
PD.10.1 to 19	3 Jan 20
PD.11.1 to 8	15 Jul 16
PD.12.1 to 7	3 Jan 20
PD.13.1 to 27	3 Jan 20
PD.14.1 to 6	3 Jan 20
PD.20.TOC.1 to 2	3 Jan 20
PD.20.1 to 21	3 Jan 20
PD.21.1 to 10	4 Sep 17
PD.22.1 to 7	4 Sep 17
PD.23.1 to 29	3 Jan 20
PD.24.1 to 6	3 Jan 20
Performance Inflight	
PI.TOC.1	3 Jan 20
PI.10.TOC.1 to 3	3 Jan 20
PI.10.1 to 44	11 Jul 19
PI.11.1 to 7	17 Jul 14

Section/Page	Date
PI.12.1 to 59	11 Jul 19
PI.13.1 to 12	14 Mar 16
PI.14.1 to 6	3 Jan 20
PI.15.1 to 4	17 Jul 14
PI.16.1 to 8	14 Mar 16
PI.17.1 to 6	11 Dec 14
PI.18.1 to 13	3 Jan 20
PI.20.TOC.1 to 3	3 Jan 20
PI.20.1 to 46	11 Jul 19
PI.21.1 to 8	4 Sep 17
PI.22.1 to 59	3 Jan 20
PI.23.1 to 12	4 Sep 17
PI.24.1 to 6	3 Jan 20
PI.25.1 to 4	4 Sep 17
PI.26.1 to 7	4 Sep 17
PI.27.1 to 6	4 Sep 17
PI.28.1 to 13	3 Jan 20
Volume 2	
Airplane General, Emergency Equipment, Doors, Windows	
1.TOC.1 to 5	3 Jan 20
1.10.1 to 4	13 Dec 18
1.20.1	15 May 15
1.21.1 to 2	3 Jan 20
1.22.1 to 5	17 Jul 14
1.23.1 to 6	4 Sep 17
1.30.1 to 35	11 Jul 19
1.40.1 to 35	3 Jan 20
1.45.1 to 13	3 Jan 20
1.46.1 to 30	13 Dec 18
1.47.1 to 29	13 Dec 18
1.60.1 to 2	4 Sep 17
Air Systems	
2.TOC.1 to 2	3 Jan 20
2.10.1 to 15	4 Sep 17
2.20.1 to 12	3 Jan 20
2.30.1 to 3	5 May 17
2.40.1	17 Jul 14
2.50.1 to 2	11 Dec 14
Anti-ice, Rain	
3.TOC.1	14 Mar 16
3.10.1 to 4	17 Jul 14
3.20.1 to 4	14 Mar 16
3.30.1	17 Jul 14
Automatic Flight	
4.TOC.1 to 2	3 Jan 20
4.10.1 to 21	3 Jan 20
4.20.1 to 23	11 Jul 19
4.30.1 to 2	17 Jul 14
Communications	
5.TOC.1 to 5	3 Jan 20
5.10.1 to 28	3 Jan 20
5.20.1 to 7	3 Jan 20
5.30.1 to 7	11 Jul 19
5.40.1 to 91	3 Jan 20
5.50.1 to 3	15 Jul 16
Electrical	
6.TOC.1	13 Dec 18
6.10.1 to 16	11 Dec 14
6.20.1 to 15	13 Dec 18
6.30.1	11 Dec 14
Engines, APU	
7.TOC.1 to 3	3 Jan 20
7.10.1 to 19	11 Jul 19
7.20.1 to 18	3 Jan 20
7.30.1 to 4	17 Jul 14
7.40.1 to 3	15 May 15
Fire Protection	
8.TOC.1 to 2	11 Jul 19
8.10.1 to 6	15 Jul 16
8.20.1 to 8	11 Jul 19
8.30.1 to 2	11 Jul 19
Flight Controls	
9.TOC.1 to 3	3 Jan 20
9.10.1 to 18	14 Nov 17
9.20.1 to 24	3 Jan 20
9.30.1 to 2	17 Jul 14
Flight Instruments, Displays	
10.TOC.1 to 9	3 Jan 20
10.10.1 to 67	3 Jan 20

Section/Page	Date
10.12.1 to 30	3 Jan 20
10.20.1 to 17	13 Dec 18
10.22.1 to 7	15 Jul 16
10.30.1 to 13	17 Jul 14
10.40.1 to 28	11 Jul 19
10.50.1 to 20	3 Jan 20
10.60.1 to 11	15 May 15
10.70.1 to 14	4 Sep 17
10.80.1 to 62	14 Nov 17
10.90.1 to 2	15 Jul 16
Flight Management, Navigation	
11.TOC.1 to 8	3 Jan 20
11.10.1 to 24	13 Dec 18
11.20.1 to 16	15 May 15
11.30.1 to 2	17 Jul 14
11.31.1 to 42	3 Jan 20
11.32.1 to 6	12 Jun 18
11.33.1 to 2	17 Jul 14
11.34.1 to 12	4 Sep 17
11.40.1 to 49	3 Jan 20
11.41.1 to 18	4 Sep 17
11.42.1 to 61	11 Jul 19
11.43.1 to 35	12 Jun 18
11.50.1 to 5	14 Nov 17
11.60.1 to 20	13 Dec 18
Fuel	
12.TOC.1 to 2	13 Dec 18
12.10.1 to 10	13 Dec 18
12.20.1 to 8	13 Dec 18
12.30.1 to 3	17 Jul 14
Hydraulics	
13.TOC.1	11 Jul 19
13.10.1 to 10	11 Jul 19
13.20.1 to 4	17 Jul 14
13.30.1	17 Jul 14
Landing Gear	
14.TOC.1 to 2	3 Jan 20
14.10.1 to 8	3 Jan 20
14.20.1 to 6	11 Jul 19
14.30.1 to 2	5 May 17

Section/Page	Date
Warning Systems	
15.TOC.1 to 3	13 Dec 18
15.10.1 to 31	13 Dec 18
15.20.1 to 36	4 Sep 17
15.30.1 to 2	17 Jul 14

General

Bulletins are issued to provide important information to flight crews. Bulletins are dated and numbered sequentially.

Bulletin contains pertinent information not otherwise covered in the Flight Crew Operations Manuals. The bulletin remains active until the relevant information has been incorporated into the Flight Crew Operations Manual or appropriate actions or airplane modification have been performed to correct for the faults/ anomalites described in the bulletin. When appropriate, the next formal Flight Crew Operations Manual revision will include an updated bulletin record page to reflect current bulletin status. When the information in the bulletin is no longer applicable, the bulletin will be removed.

Each bulletin identifies airplanes affected by the bulletin. The airplane effectivity is defined as follows:

- Effectivity range—effectivities in parentheses indicate the corrective service bulletin is planned to be accomplished and some airplanes may be complete
- All Airplanes—the bulletin applies to all airplanes in the fleet
- Descriptive statement—the bulletin applies to airplanes with specific equipment.

Bulletins that are originated from Boeing are designated “TII-xx”.

Bulletins that are issued by the company are designated “TH-xx”.

Number	Subject	Date
TII-2 R3	Miscellaneous Operational Anomalies	October 15, 2016
TII-3 R1	Weather Radar and Transponder Settings on the TCP	October 15, 2016
TII-4 R1	EICAS Messages That May Show After Short Term Operation On Standby RAT Electrical Power In-flight.	January 18, 2019
TII-6	Anomalous TAT Probe Logic Affecting Manual Operation of Anti-ice Systems	April 22, 2014
TII-17 R2	FMC Reset Anomaly - Procedure Turn	December 14, 2018
TII-19	Nuisance TAIL STRIKE Messages	February 1, 2016
TII-22 R1	Avoidance of abrupt flight control input as a result of a sudden drop in indicated airspeed	April 15, 2016

Number	Subject	Date
TII-25 R1	Uncommanded Engine Shutdown during Landing Roll	March 2, 2019
TII-28 R2	FMC Reset When Exiting a Holding Pattern	December 14, 2018
TII-30 R3	Mode Control Panel (MCP) Uncommanded Altitude Change	September 20, 2019
TII-31 R1	VNAV PATH Not Available On Final Approach	December 14, 2018
TII-32 R1	Flight Management Computer (FMC) Required Time of Arrival (RTA) anomalies	December 14, 2018
TII-33 R2	Rolls-Royce Trent 1000 Package C Engine Operating Restrictions	September 30, 2019
TII-35 R1	Possible LNAV Guidance Error in a Holding Pattern	December 14, 2018
TII-36	Automatic LNAV Activation during Departure	June 20, 2018
TII-37 R2	FMC BP4 Administrative Bulletin	March 2, 2019
TII-38	GLIDESLOPE Alert During Approach	January 18, 2019
TII-39	Premature Climb Thrust Reduction	January 18, 2019
TII-40 R1	Engine Fire Switch Fails Locked or Unlocked	April 5, 2019
TII-41	Additional Guidance for Flap and Slat Anomalies and Overweight Landing	April 5, 2019
TII-43	Nose gear isolation valve (NGIV) fails closed	July 5, 2019
TII-44 R1	Revision to SP.16 - Cold Weather Operations	September 20, 2019
TII-45	Revised Roll-Royce Trent 1000 Package C Engine Operating Restrictions	September 30, 2019
TII-46	Erroneous Autopilot Flight Director System (AFDS) Guidance when Instrument Landing System (ILS) Signal Interference Occurs	October 18, 2019

DELETION

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-2 R3

Issue Date: October 15, 2016

Airplane Effectivity: All Airplanes

Subject: Miscellaneous Operational Anomalies

Reason: To inform flight crews of several minor system anomalies.

Operating Instructions

Air Systems

Blank Cabin Temperatures due to Lav/Galley Vent Fan OFF on the ground [affects all airplanes – to be corrected by a future software update]

This anomaly may occur due to a condition on the ground in which the Cabin Zone temperatures may be blank on the EICAS Air Synoptic display due to the LAV/Galley vent fan not operating.

Communications

HS-TQA–HS-TQF

Lack of standby frequency synchronization with data mode commanded in active [affects all airplanes – to be corrected by a future software update]

This anomaly occurs when using the VHF communication manager page to command the right or center VHF into the DATA mode, or when using the HF communication manager page to command the left or right HF radio into the DATA mode. After the command is received by the radio, changes to the standby frequency on the radio will not synchronize with the other Tuning Control Panels (TCP). The anomaly does not occur if a radio is placed in the DATA mode manually using the TCP. Also, if the VHF or HF communication manager page is used to command radios out of the DATA mode, the standby frequencies will synchronize normally. Manual transfer of the standby frequency into the active frequency window works normally.

Warning Systems

Nuisance EICAS Advisory message GND PROX SYS may show [affects all airplanes – to be corrected by a future software update]

When the airplane is flying faster than 250 knots, selecting FLAP OVRD or GEAR OVRD may cause the EICAS Advisory GND PROX SYS to show. No flight crew action is needed.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-3 R1

Issue Date: October 15, 2016

Airplane Effectivity: HS-TQA–HS-TQF

Subject: Weather Radar and Transponder Settings on the TCP

Reason: To inform flight crews that the settings on the Tuning and Control Panel (TCP) can disagree with the weather radar and transponder indications on the ND.

Background Information

The weather radar (WXR) settings shown on the tuning and control panel (TCP) for tilt, gain, or mode, can disagree with the actual WXR settings. Actual WXR settings are always indicated correctly on the navigation display (ND). This situation can occur on any TCP when the WXR tilt, gain or mode settings were manually selected on the previous flight and the manual selections remained at the end of the flight. It can also occur on the center TCP in flight when using the center TCP to select weather radar settings.

Also, the transponder settings shown on the TCP for TCAS modes ABOVE, NORM, BELOW, and TCAS ALT (ABS/REL selection) can disagree with the actual TCAS settings. Actual TCAS settings are always indicated correctly on the ND. This situation can occur on any TCP when the TCAS modes ABOVE, NORM, BELOW, and TCAS ALT (ABS/REL selection) were manually selected on the previous flight and the manual selections remained at the end of the flight. It can also occur on the center TCP in flight when using the center TCP to select TCAS settings.

Operating Instructions

WXR and TCAS selections made on the TCPs should be verified on the ND. If the setting shown on the TCP disagrees with the actual setting shown on the ND, the flight crew should make an additional change to the affected setting on the TCP to force the TCP to synchronize correctly.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-4 R1

Issue Date: January 18, 2019

Airplane Effectivity: All Airplanes

Subject: Effects of Operation on Standby RAT Electrical Power in Flight.

Reason: Some Critical Systems Will Not Restore After Normal Electrical Power Is Restored.

Background Information

Following restoration of normal electrical power after operation on standby RAT electrical power in flight, some critical systems may not restore.

Air conditioning system CACs may or may not restore, depending on the system's ability to determine the position of the CAC FOD deflector doors. If the CACs do not restore, inflow for cabin pressurization remains lost for the rest of the flight. Descent to a lower altitude may be needed.

TAT data may be lost. This can cause the loss of the functions listed in the Operating Instructions. The autopilot will have limited function.

Airplanes with flight controls electronics (FCE) CPB5 or later will not lose TAT data.

Operating Instructions

After operation on standby power, the air conditioning system may not restore. Cabin pressurization may remain lost. Descent may be needed.

After operation on standby power, the following EICAS messages and Flight Deck Effects can occur:

- FUEL PUMP CENTER R
- AUTOTHROTTLE DISC
- AUTOPILOT
- PACK L+R or PACK L or PACK R
- Loss of TAT data, which can cause:
  - ENG EEC MODE R
  - ICE DETECTORS
  - TCAS RA CAPTAIN
  - TCAS RA F/O
  - THRUST ASYM PROT
  - WEATHER RADAR SYS

- WINDSHEAR SYS
- LNAV inoperative
- VNAV inoperative
- FMC Predictions inoperative
- Autothrottle is inoperative
- FMC thrust limits are inoperative.

oOo

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-6

Issue Date: April 22, 2014

Airplane Effectivity: All Airplanes

Subject: Anomalous TAT Probe Logic Affecting Manual Operation of Anti-ice Systems

Reason: To inform flight crews that the engine and wing anti-ice systems must be operated using a non-standard icing temperature threshold when operated manually.

Background Information

Normally, the two engine TAT probes and the airplane TAT probe are combined to provide a voted TAT solution that is displayed on EICAS. A logic anomaly between engine and airplane TAT probes can affect the accuracy of the displayed TAT. In the remote case that two of the TAT probes provide erroneous data, indicated TAT may be higher or lower than actual TAT. As a result, when operating anti-ice systems manually in flight, icing conditions must be assumed to be possible at or less than 15 °C instead of 10 °C.

On the ground, and when anti-ice is operated in AUTO mode, a different source of TAT is used to command engine anti-ice on. This TAT source is not subject to the TAT anomaly. Anti-ice operation on the ground in manual mode is normal. Anti-ice operation in flight in the AUTO mode is also normal.

Operating Instructions

Ground Operation and Takeoff

Operate anti-ice per normal and supplementary procedures. This anomaly does not affect TAT indications on the ground.

Automatic Anti-Ice Operation—In-Flight

No crew action is required for automatic operation of anti-ice at any temperature.

Manual Anti-Ice Operation—Initial Climb

When TAT is 10 °C or less, wing and engine anti-ice must be ON before entering icing conditions.

When TAT is 15 °C or less, and greater than 10 °C and visible moisture is present, engine and wing anti-ice must be ON. If performance permits, selecting engine and wing anti-ice ON may be delayed to 1,500 feet AGL during climb, but no later than 2,500 feet AGL.

Note: This procedure assumes that AFM performance data using anti-ice OFF shows that the airplane will achieve flaps-up, final climb speed and clear all obstacles at a height of 1,500 feet AGL or less.

Manual Anti-Ice Operation—In-Flight

When TAT is 15 °C or less and visible moisture is present, engine and wing anti-ice must be ON.

WARNING: Do not rely on airframe visual icing cues before turning ON engine and wing 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 engine and wing anti-ice are needed:

CAUTION: Do not use engine or wing anti-ice when TAT is above 15 °C.

ENGINE ANTI-ICE selectors (both).....ON PM
WING ANTI-ICE selector.....ON PM

Note: When the anti-ice system is ON and the displayed TAT is above 10 °C the EICAS advisory message ANTI-ICE ON will show. Disregard this message and override the ANTI-ICE ON checklist in the electronic checklist (ECL).

When engine and wing anti-ice are no longer needed:

ENGINE ANTI-ICE selectors (both).....AUTO or OFF PM
WING ANTI-ICE selector.....AUTO or OFF PM

If ice detection is available, position the selectors to AUTO. If ice detection is inoperative, position the selectors to OFF.

oOo

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-17 R2

Issue Date: December 14, 2018

Airplane Effectivity: All Airplanes

Subject: FMC Reset Anomaly - Procedure Turn

Reason: To advise flight crews of an FMC software anomaly that can cause a reset when a procedure turn is the 28th leg of an active flight plan.

Background Information

In-service reports and testing have identified an anomaly in the flight management function software which can cause an FMC reset if a procedure turn is the 28th leg of an active flight plan. The 28th leg is the third line on the 6th LEGS page.

This anomaly can occur if a procedure turn is loaded (by selection of an approach transition) beyond the 28th leg in the flight plan and then the flight plan progresses normally until the procedure turn becomes the 28th leg. It can also occur if a flight plan is modified in a way that causes a procedure turn to become the 28th leg, either by loading an approach transition or by other modification that causes an existing procedure turn to move into the 28th leg.

If a procedure turn is the 28th leg, the FMC resets. This causes the flight plan to become inactive and a loss of all performance data. Performance data must be reloaded and the flight plan must be activated and executed after removing the procedure turn from the 28th leg. The procedure turn can be removed from the 28th leg by either loading an approach without a procedure turn or by making a modification to the flight plan so the procedure turn is before the 28th leg.

If a procedure turn is the 28th leg, the FMC will not accept selection of the EXEC key. Repeated selection of the EXEC key can cause a complete FMC reset with loss of the flight plan and performance data.

Operating Instructions

Flight crews should not load an approach transition that contains a procedure turn when the procedure turn will be placed on or after the 28th leg of the flight plan.

Note: When loading an approach with a procedure turn, any waypoints in the transition (and any associated STAR) need to be considered when determining if the procedure turn will be on or after the 28th leg.

If a flight plan contains a procedure turn on the 28th leg, as a result of either normal flight sequencing or a flight crew modification, the FMC can reset and may not accept selection of the EXEC key. If this occurs, do the following steps:

- Do not repeatedly select the EXEC key
- Reload the performance data
- Modify the flight plan to prevent a procedure turn on the 28th leg
- Activate and execute the changes.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-19

Issue Date: February 1, 2016

Airplane Effectivity: All Airplanes

Subject: Nuisance TAIL STRIKE Messages

Reason: To advise flight crews a nuisance TAIL STRIKE message can show in flight.

Background Information

Boeing has received reports of the EICAS caution message TAIL STRIKE showing in flight. Completing the TAIL STRIKE checklist results in depressurization of the airplane and landing at the nearest suitable airport.

The tail strike sensor is on the bottom of the fuselage, just forward of the aft pressure bulkhead. The sensor has two independent wire loops. When a tail strike occurs, the wire loops in the tail strike sensor break and the TAIL STRIKE message shows immediately.

Note: Master Caution Light and Aural Alert are inhibited until either 400 feet RA or 800 feet RA per airline selectable option.

Engineering analysis of the events found that no tail strikes occurred. Corrosion in the tail strike sensor caused breaks in the wire loops which caused the message to show. The TAIL STRIKE message did not show during takeoff in any of the reported events; the message first showed later in flight.

A TAIL STRIKE message that first shows during takeoff indicates a tail strike. A TAIL STRIKE message that first shows later in flight does not indicate that a tail strike occurred.

This bulletin does not provide dispatch relief if the TAIL STRIKE message shows on the ground.

Operating Instructions

If the TAIL STRIKE message first shows during takeoff, the crew should consider the message valid and complete the TAIL STRIKE checklist.

Note: Master Caution Light and Aural Alert are inhibited until either 400 feet RA or 800 feet RA per airline selectable option.

If the TAIL STRIKE message does not show during takeoff, but first shows later in flight, the crew may consider it a nuisance message. The crew does not need to do the TAIL STRIKE checklist. The crew may override the non-normal checklist in ECL.

If the crew is not sure if the TAIL STRIKE message first showed during takeoff or after takeoff, the crew should consider the message as valid and the crew should complete the TAIL STRIKE checklist.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-22 R1

Issue Date: April 15, 2016

Airplane Effectivity: All Airplanes

Subject: Avoidance of abrupt flight control input as a result of a sudden and unrealistic drop in indicated airspeed.

Reason: To provide crews a new unannunciated procedure with instructions to avoid rapid or abrupt flight control input as a result of a sudden extreme drop in indicated airspeed, and to disconnect the autopilot prior to making any desired manual flight control inputs.
Revised the Airspeed Drop Condition statement.

Background Information

There have been several events where the indicated airspeed shown to the pilots dropped rapidly (within a few seconds) to below 50kts. These events are suspected to have been caused by temporary blockage of multiple pitot tubes when near weather systems with high moisture content. In all events, the blockage cleared within several seconds. During some events, the FLIGHT CONTROL MODE, AUTOPILOT DISC, and other messages were shown (along with a flight control reversion to secondary mode). In one event, the PFD automatically switched to AOA speed; and in another event, the AIRSPEED UNRELIABLE message was shown. Depending on the duration and nature of the pitot blockage, FLIGHT CONTROL MODE, NAV AIRDATA SYS, NAV AIRSPEED DATA, AIRSPEED UNRELIABLE, AUTOPILOT DISC, AIRSPEED LOW EICAS messages can show during similar events.

While, in all these events, the air data system recovered and the fault detection system provided alert level EICAS messages where expected, a possible flight crew response to an initial sudden drop in indicated airspeed could be to apply pitch inputs which may result in ‘G’ excursions. If the crew applies strong nose down force to the yoke without disconnecting the autopilot, when the autopilot disconnects (as a result of the manual force applied), a sudden nose down command would be applied to the airplane. This nose down input could be amplified by the low column forces being fed back to the pilot as a result of the low airspeed being indicated.

As a result of the above events, Boeing is making improvements to the flight control system and force feedback to mitigate the negative effect of large control inputs in these scenarios, and is also making improvements to the EICAS Alert logic related to air data faults. In addition, Boeing is continuing to investigate the pitot blockage event rate to determine if any design improvements are warranted.

In response to concerns about possible negative crew reaction to an initial sudden drop in airspeed, the FAA intends to issue an Airworthiness Directive to require operators to incorporate a procedure into their AFM which instructs crews to avoid abrupt control inputs in response to sudden unrealistic drops in indicated airspeed. This procedure also reminds pilots that if manual flight is desired, the autopilot should be disconnected prior to any manual flight control inputs.

Operating Instructions

While the procedure provided here does not include specific memory items, crews are expected to be familiar with the possibility of a sudden unrealistic drop in indicated airspeed, and to respond within the guidelines of this procedure.

If crews see a significant drop in indicated airspeed over a short period of time, they should comply with the following:

Airspeed Drop

Condition:	There is a sudden and unrealistic drop in indicated airspeed.
Objective:	To avoid abrupt control inputs and continue flight at normal pitch and power settings and continue until the airspeed indications recover or an EICAS alert message shows.

1 Do **not** apply large, abrupt control column inputs. Fly the airplane at normal pitch and power settings.

2 If manual flight is needed, disconnect the autopilot via the control column switch or MCP switch before making manual flight control inputs.

3 All EICAS alert messages are valid. Accomplish the appropriate checklist(s).

■ ■ ■ ■

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-25 R1

Issue Date: March 2, 2019

Airplane Effectivity: All Airplanes

Subject: Uncommanded Engine Shutdown during Landing Roll

Reason: To advise flight crews of the possibility of the Thrust Control Malfunction Accommodation (TCMA) function shutting down one or both engines on the ground.

Background Information

A 787 with Rolls-Royce engines recently experienced an uncommanded shutdown of both engines during the landing rollout. This event was the result of the unintentional activation of the Thrust Control Malfunction Accommodation (TCMA) function in the Electronic Engine Control (EEC).

TCMA operates only when the airplane is on the ground. TCMA is designed to shut down an engine to prevent loss of control or reverser structural damage if it detects the engine is producing uncommanded high forward or reverse thrust.

In the shutdown event, the airplane floated approximately one third of the length of the runway before it settled onto the main landing gear. While the airplane was at less than 5 feet radio altitude, the crew deployed the thrust reversers and immediately commanded maximum reverse thrust, then within 2 seconds, they rapidly moved the reverse thrust levers back to reverse idle. The thrust reversers were deployed, the engines were accelerating, and the reverse thrust levers were at reverse idle when TCMA became active. TCMA interpreted this as uncommanded high thrust and shut down both engines which also caused a loss of electric and hydraulic power. The crew stopped the airplane with the electric wheel brakes.

Boeing and Rolls-Royce have reproduced the event in a lab environment. This was done by commanding maximum reverse thrust as soon as the interlocks released then rapidly selecting reverse idle within 2 seconds of when the airplane senses weight on wheels. Boeing has determined that this is possible only on 787 airplanes with Rolls-Royce engines.

Rolls-Royce plans to update the EEC software to prevent TCMA from shutting down an engine due to this sequence of events. The EEC update will be available some time in the future.

Operating Instructions

Refer to the FCOM Landing Roll Procedure for correct thrust reverser operation. Note that the thrust reversers are deployed after touchdown. Once the aircraft has touched down, extend the speedbrakes and deploy the thrust reversers without delay. Apply reverse thrust as needed.

oOo

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-28 R2

Issue Date: December 14, 2018

Airplane Effectivity: All Airplanes

Subject: FMC Reset When Exiting a Holding Pattern

Reason: To advise crews of an FMC software anomaly that can cause subsequent resets when a specific set of circumstances exist while exiting a holding pattern.

Background Information

A Boeing Production Test flight found a specific sequence of pilot actions that cause the FMC to reset. This anomaly occurs only on airplanes with FMC BPv3.0/BPv3.0A/BPv3.0B software installed. This anomaly has never been reported in service.

The following sequence of events causes the anomaly:

- The FMC is providing guidance in a holding pattern and the leg after the hold fix has a course within 3 degrees of the inbound holding leg course
- The pilot selects and executes EXIT HOLD
- The pilot selects, but does not execute, direct-to the hold fix
- The airplane sequences the hold fix while the route is in the modified state

If these four events occur in this order, the FMC resets when the airplane sequences the hold fix. The flight plan must be activated again and the performance data must be entered again.

If the active flight plan is modified again to add or change an instrument approach procedure, the FMC resets again. After recovery from the second reset, the FMC will not reset again due to this anomaly.

Operating Instructions

While in a holding pattern, do not select and execute EXIT HOLD then select Direct-To the hold fix then sequence the hold fix with the route in the modified state (MOD showing).

If this anomaly occurs, the flight crew should be aware that certain further modifications to the flight plan can cause another reset. Selecting an instrument approach can cause another FMC reset. If the FMC resets a second time, the route and performance data must be entered again.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-30 R3

Issue Date: September 20, 2019

Airplane Effectivity: All Airplanes

Subject: Mode Control Panel (MCP) Uncommanded Altitude Change

Reason: To advise crews that the altitude setting on the MCP can change without flight crew action.

Background Information

Boeing has received reports of the altitude setting on the MCP changing without any flight crew action. Initial investigation has found a possible hardware issue.

In most cases, the altitude changes by 3000 or 4000 feet. The altitude can change either up or down.

In 2018, the airplane software was modified to add a monitor to detect the altitude changing without flight crew action; the monitor causes the AUTOPILOT message to show. Operators have reported at least three instances on airplanes with the new software where the MCP altitude changed but the AUTOPILOT message did not show. We have revised this Bulletin based on these reports. Boeing and the supplier are continuing to investigate the anomaly.

For 787-8 and 787-9 airplanes that have flight controls function (FCF) software common blockpoint (CBP) 5 or later: If an uncommanded altitude change occurs on the MCP, the AUTOPILOT message shows. If the AUTOPILOT message shows for this condition, the message will clear only when the MCP altitude selector is rotated.

Operating Instructions

Flight crews should be aware that the MCP altitude setting can change without flight crew action.

For 787-8 and 787-9 airplanes that have flight controls function (FCF) software common blockpoint (CBP) 5 or later: If an uncommanded altitude change occurs on the MCP, the AUTOPILOT message can show.

If this occurs, verify the last cleared altitude, set the correct altitude on the MCP, and ensure that the correct pitch mode is selected.

There is no action the crew can take to cause or prevent this anomaly.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-31 R1

Issue Date: December 14, 2018

Airplane Effectivity: All Airplanes

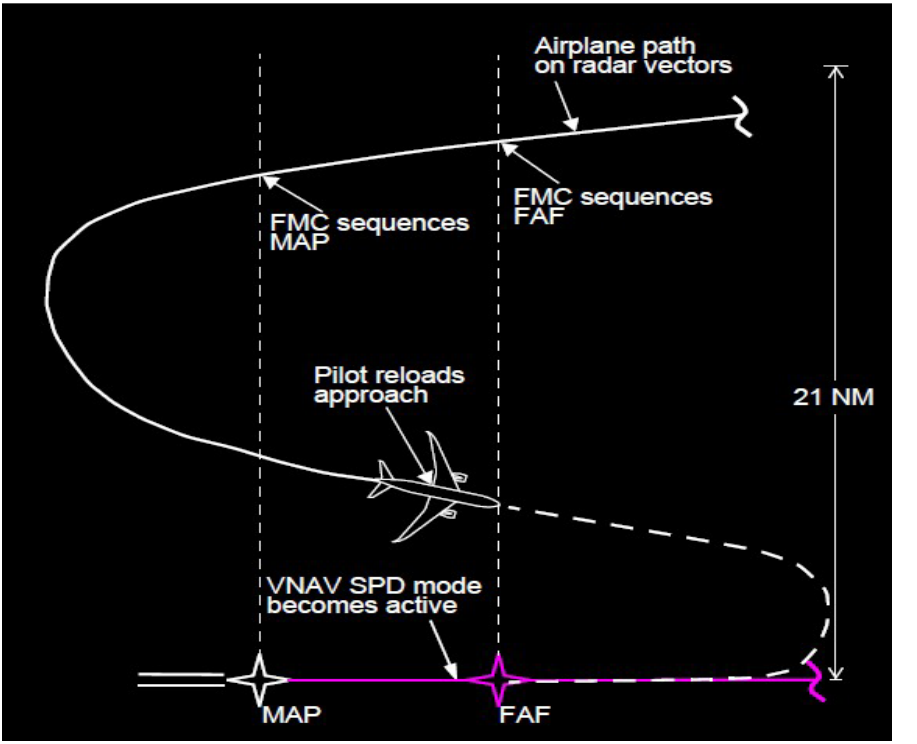
Subject: VNAV PATH Not Available On Final Approach

Reason: To inform flight crews that the VNAV PATH can become unavailable on final approach and how to recover VNAV PATH.

Background Information

Several operators have reported that on final approach, VNAV PATH was unavailable and VNAV SPD was the active mode after the final approach fix. This occurred while the airplane was on radar vectors to an instrument approach that the crew planned to fly in VNAV. The FMC sequenced the missed approach waypoint when the airplane was within 21 miles of the final approach path, abeam the missed approach waypoint, and with the airplane track within 90 degrees of the approach course (see picture below).

After the crews noticed the approach waypoints had been sequenced, they reloaded the same approach, but the FMC provided only VNAV SPD guidance after the final approach fix, when normally the FMC provides VNAV PATH guidance. This occurred because the FMC sequenced the missed approach waypoint and the end-of-descent point. In this case, the FMC does not reset the vertical approach guidance when the same approach is reloaded, so the FMC provides only VNAV SPD guidance for the final approach.



To prevent this condition, when reloading the same approach and planning to fly the approach using VNAV, the crew should also enter a cruise altitude on the VNAV cruise page with an altitude greater than the highest altitude constraint in the flight plan. This resets the vertical guidance function of the FMC for the approach.

This problem does not occur when using vertical guidance provided by IAN, ILS or GLS approaches.

A future revision to the FMC will show a CDU help window for this condition with guidance to restore VNAV PATH.

Operating Instructions

When planning to fly an instrument approach using VNAV and the crew sees that the waypoints for the approach have sequenced past the missed approach waypoint before actually flying the approach, the crew should reload the approach and enter a cruise altitude on the VNAV cruise page. Before the airplane sequences the final approach fix, enter a cruise altitude greater than the highest altitude constraint in the flight plan. This resets the vertical guidance for the approach and allows VNAV PATH to be available for the final approach.

oOo

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-32 R1

Issue Date: December 14, 2018

Airplane Effectivity: All Airplanes

Subject: Flight Management Computer (FMC) Required Time of Arrival (RTA) anomalies

Reason: To inform flight crews of FMC RTA anomalies.

Background Information

The anomaly described in this bulletin occurs on 787-8 and 787-9 airplanes with one or more Rolls-Royce Trent 1000-TEN (RR -TEN) engines. This bulletin is sent to all 787 operators with Rolls-Royce engines because an airplane can have a RR -TEN engine installed before the updated software is installed.

The Aerodynamic/Engine Data Base (AEDB) holds all performance data for all airplane and engine configurations. The AEDB is part of the FMC software. The AEDB was updated with FMC BPv3, however, the data for the RTA function for the RR -TEN was incorrect and causes several issues described below. This error was found before 787-10 certification and was corrected for the 787-10.

There are no other known anomalies with the AEDB at this time.

This anomaly will be corrected in FMC BPv4.

Operating Instructions

The RTA function works correctly in cruise with the exception of the three issues described below.

The RTA function does not sequence correctly from cruise to descent. RTA times must be maintained manually after top of descent.

Operators that use the RTA function should develop procedures to make sure the RTA times after top of descent are met.

EARLY/LATE RTA message:

The RTA distance sensitivity is not correct. When the RTA function works correctly, the farther from an RTA waypoint, the larger the tolerance is for the arrival time. With the current AEDB, the tolerance is the most sensitive value of one second for all distances from the RTA waypoint. This causes EARLY or LATE to show frequently under TIME ERROR on the RTA PROGRESS page.

Crew action: Awareness.

FMC UNABLE RTA message:

The FMC UNABLE RTA message shows when the difference between the actual RTA and desired RTA is 6 seconds or more. The message stays shown when the difference becomes less than 6 seconds. Crews should be aware the RTA function is operating correctly, and set the target speed to comply with the RTA constraint, even though the FMC UNABLE RTA message shows. To blank the FMC UNABLE RTA message, the RTA must be re-computed by changing a value such as altitude, speed, or waypoint. Re-entering the RTA will also blank the FMC UNABLE RTA message.

Crew action: Awareness or re-compute RTA.

RTA Threshold is 6 seconds:

The threshold on the RTA LIMITS page cannot be changed. The threshold is 6 seconds. If a modification is attempted, a Help Window shows and incorrectly suggests a range of 6-0. When the RTA function works correctly, the threshold range is 6-90.

Crew action: Awareness.

oOo

787 Flight Crew Operations Manual Bulletin

Number: TII-33 R2

Issue Date: September 30, 2019

Airplane Effectivity: Airplanes with Trent 1000 Package C Engines

Subject: Rolls-Royce Trent 1000 Package C Engine Operating Restrictions

Reason: To advise flight crews of new restrictions intended to mitigate an intermediate pressure compressor rotor blade vibration that can lead to engine failure under certain conditions.
Revised to add information for Alternate Means of Compliance.

Background Information

The information in this bulletin applies only to model 787-8 and 787-9 airplanes categorized as Group 4 airplanes. Airplane Groups are defined in Boeing Document D021Z002-01: 787 ETOPS Configuration, Maintenance and Procedures, Revision V or later authority-approved revision.

For model 787-8 and 787-9 airplanes categorized as Group 3 airplanes, use the information in the new bulletin titled "Revised Rolls-Royce Trent 1000 Package C Engine Operating Restrictions".

The condition described in this bulletin occurs only on Rolls-Royce Trent 1000 Package C engines that have accumulated 300 or more engine flight cycles on the intermediate pressure compressor rotor 2 blades since new or refurbishment according to applicable RR instructions.

This bulletin is sent to all 787 operators with Rolls-Royce engines.

Rolls-Royce Trent 1000 Package C engines have experienced cracking of the Intermediate Pressure Compressor (IPC) rotor 1 and rotor 2 (R1 and R2) blades. Investigation has determined that the root cause of these IPC R1 and R2 blade cracks is vibration from the wake from the fan blades on the IPC R1 and R2 blades. The cracks occur during specific operating and atmospheric conditions, and can lead to the failure of IPC blades and an in-flight shutdown. The vibration is not indicated or observable in the flight deck. To date, there have been four In-Flight Shutdowns (IFSD) in the worldwide fleet caused by failure of the R1 blade, and one IFSD caused by failure of the R2 blade. An increased engine inspection cycle has been started that will identify cracks early, mitigating the risk of blade failure in normal operations.

Rolls-Royce and Boeing have also developed modified planning and procedures, specifically for Extended Operations (ETOPS), to reduce exposure to IPC blade vibration on:

- The operating engine during an ETOPS enroute engine-out driftdown and diversion.

- The operating engine during an ETOPS diversion at 10,000 feet (e.g. after a decompression).
- Both engines during an ETOPS diversion at 10,000 feet with both engines operating (e.g. after a decompression).

Normal and Non-Normal Operations on non-ETOPS parts of a flight are not affected. ETOPS refers to any operations where the diversion time is in excess of 60 minutes from a landing at a suitable airport.

The FAA has issued airworthiness directive AD 2018-08-03 (updated with AD 2018-09-05), establishing interim limits to ETOPS to a planned maximum of 140 minutes. For this bulletin, the term ETOPS also covers Extended Diversion Time Operations (EDTO). The Operating Instructions below provide a level of safety acceptable to the FAA for the AD.

The AD and Operating Instructions specify speed and Minimum Engine-Out Cruise Altitude limits for the engine-out driftdown and diversion, and speed limits for a diversion at 10,000 feet. In order to maintain the engine-out driftdown diversion altitude, the airplane must be at or below specific planned weights at the ETOPS Entry Points (EEPs) and Equal Time Points (ETPs). These planned weights can restrict the planned Takeoff Weight (TOW).

ETOPS Planning

The tables below specify Minimum Engine-Out Cruise Altitude, planned maximum weight(s) at the EEPs and ETPs according to engine designation, forecast temperatures at the driftdown altitude, and the presence or absence of forecast icing at FL200 for ETOPS planning.

Weight restrictions based on temperature and forecast icing are applied during planning and dispatch only. In flight, the Flight Crew should only use the Minimum Engine-Out Cruise Altitude from the tables. There is no requirement for Flight Crew to verify airplane weight at EEP or ETPs, or apply actual ISA deviation.

The weight restriction for icing is factored into the TOW and EEPs and ETPs weight only for the ETOPS parts of the flight (or "ETOPS circles") where icing exists at FL200 between the ETPs and the planned diversion airport.

ETOPS Enroute Engine-out Driftdown Diversion

If an engine fails on an ETOPS part of a flight, a driftdown and descent to the Minimum Engine-Out Cruise Altitude, or higher, is required. The driftdown and diversion must be flown at Long Range Cruise (LRC).

The Minimum Engine-Out Cruise Altitudes in the tables are higher than the maximum driftdown cruise altitudes computed by the FMC and the driftdown cruise altitudes in the QRH-PI Section. Performance analysis has shown that the airplane can maintain these altitudes which are higher than the conservative FMC altitudes.

In an LRC driftdown, the FMC controls to LRC at Maximum Continuous (CON) Thrust with a gradually decreasing rate of descent. When the rate of descent decreases below 50 fpm, the FMC transitions to VNAV PTH. Once in VNAV PTH, ALT HOLD

should be selected to level off. This maintains the highest possible altitude until final descent. This also prevents the airplane from descending below the Minimum Engine-Out Cruise Altitude in the tables. IAS can be used for final descent.

If the Minimum Engine-Out Cruise Altitude cannot be maintained, LRC should be used at or below the Minimum Engine-Out Cruise Altitude and above 10,000 feet. Cruise below the Minimum Engine-Out Cruise Altitude should be avoided.

FMC fuel predictions are not available above the MAX engine out cruise altitude on the FMC. The diversion (Critical) fuel usage is accounted for in Dispatch Planning. Normal monitoring of fuel-on-board vs flight plan fuel is required.

ETOPS Diversion at 10000ft

After a decompression or any other event that requires descent to 10,000 feet with all engines operating or one engine inoperative, Mach 0.55 must be flown. Do not use IAS. If level-off at an intermediate altitude is required for terrain clearance, use LRC. IAS and normal procedures can be used for final descent.

Non-ETOPS Driftdown and Diversion

If, due to operational considerations (e.g. weather, fuel jettison, holding, etc.), a driftdown and/or diversion, or a return-to-land is expected to take longer than 60 minutes, use the ETOPS driftdown and diversion Operating Instructions below.

Operating Instructions

These Operating Instructions apply to any airplane with a Trent 1000 Package C engine that has ETOPS restricted to 140 minutes at LRC. These instructions do not apply to any operations where a diversion or return-to-land is expected to be completed within 60 minutes.

ETOPS

ETOPS Predeparture and Enroute Phases

Before departure, verify with Dispatch that the planned TOW has accounted for all of the planned weight restrictions specified in the tables below and that the Flight Plan diversion times are restricted to 140 minutes. There is no requirement to check the actual weights at the EEPs or ETPs; the maximum weights in the tables below allow for most operational variations such as unplanned rerouting or favorable winds.

ETOPS Enroute Engine-out Driftdown Diversion:

- For driftdown, on the FMC VNAV page, select EO, then select LRC
- The FMC will command the Selected Speed Bug to target the LRC D/D Mach number during the descent
- Set CRZ ALT no lower than the minimum engine-out cruise altitude specified for the appropriate engine designation and planned enroute temperature in the tables below. This altitude can be higher than the MAX altitude shown by the FMC on the ACT LRC D/D Page 2/3,
- Speedbrakes can be used if required for traffic considerations,

- When the pitch mode changes from VNAV SPD to VNAV PTH, push the altitude HOLD switch to enter ALT mode. Set the CRZ ALT to this altitude. Reselect VNAV
- For engine-out cruise, remain in ACT EO LRC CRZ; do not climb
- FMC fuel predictions are not available above the MAX engine out altitude on the FMC
- If Minimum Engine-Out Cruise Altitude cannot be maintained, Set LRC (ACT EO LRC CRZ) on the FMC cruise page until final descent,
- Do not descend early. Maintain LRC and the cruise altitude for as long as possible to minimize diversion time,
- Use LRC for intermediate level-off above 10,000 feet
- Use Mach 0.55 for intermediate level-off at 10,000 feet
- Use IAS and normal speeds for descent below 10,000 feet.

ETOPS Diversion at 10000ft

ETOPS Enroute Diversion requiring descent to 10,000 feet (e.g. after a decompression):

- Use of speedbrakes is permitted
- Set Mach 0.55 after level-off until final descent
- Use IAS and normal speeds for descent below 10,000 feet.

Non-ETOPS

On a non-ETOPS flight, if the diversion or return-to-land time is expected to exceed 60 minutes, apply the most appropriate ETOPS Operating Instructions above.

Post Flight Action

Standard crew reporting of events to Maintenance apply. Based on the provisions in the FAA AD, it is the responsibility of Maintenance to determine if an out-of-sequence engine inspection is needed after an event.

Alternate Means of Compliance (AMOC)

The information in this bulletin can be considered amended if an alternate means of compliance (AMOC) is published in reference to the AD. Please refer to the AMOC for the latest information. Changes will also be released by Multi-Operator Message (MOM).

HS-TWA, HS-TWB

787-9/Trent 1000-D					
	Maximum Enroute Diversion Temperature*				
	ISA + 0°C and below	ISA + 10°C	ISA + 15°C	ISA + 20°C	ISA + 25°C
Minimum Engine out Cruise Altitude (FT)	19,100	19,100	18,900	18,700	18,500
Without Forecast Icing Maximum Planned Weight at ETOPS Entry Points and Equal Time Points (KG)	231,500	230,640	221,480	211,310	200,390
With Forecast Icing Maximum Planned Weight at ETOPS Entry Points and Equal Time Points (KG)	198,830	194,760	185,240	174,110	162,970
Operation prohibited at enroute temperatures above ISA + 25°C *Interpolation between temperature columns is allowed.					

HS-TQA - HS-TQF

787-8/Trent 1000-AE					
	Maximum Enroute Diversion Temperature*				
	ISA + 0°C and below	ISA + 10°C	ISA + 15°C	ISA + 20°C	ISA + 25°C
Minimum Engine out Cruise Altitude (FT)	19,200	19,200	19,000	18,700	18,400

787-8/Trent 1000-AE					
	Maximum Enroute Diversion Temperature*				
	ISA + 0°C and below	ISA + 10°C	ISA + 15°C	ISA + 20°C	ISA + 25°C
Without Forecast Icing Maximum Planned Weight at ETOPS Entry Points and Equal Time Points (KG)	227,930	227,930	221,780	209,340	195,220
With Forecast Icing Maximum Planned Weight at ETOPS Entry Points and Equal Time Points (KG)	197,910	193,550	184,020	173,910	161,160
Operation prohibited at enroute temperatures above ISA + 25°C *Interpolation between temperature columns is allowed.					

oOo

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-35 R1

Issue Date: December 14, 2018

Airplane Effectivity: All Airplanes

Subject: Possible LNAV Guidance Error in a Holding Pattern

Reason: Inform flight crews of the potential for incorrect LNAV guidance while descending in a holding pattern.

Background Information

FMC software BPv3.0B and earlier can cause the airplane to turn the wrong direction during the first outbound leg in a hold.

When a hold is programmed above 14,000 feet MSL (FL 140) (1.5 minute legs), then the airplane descends through 14,000 feet (FL 140) during the first outbound leg, the FMC resizes the holding pattern to 1 minute legs. When this resizing occurs, a software error can cause the airplane to turn away from the inbound course instead of following the correctly depicted LNAV path. If the error occurs, and the LNAV guidance is followed without intervention, the airplane turns away from the inbound leg, parallels the outbound leg, then back onto the outbound leg and resumes the holding pattern with no further anomalies.

The anomaly can occur only when all of the following conditions are true:

- The default holding pattern inbound course is modified by the pilot.
- The holding pattern entry is direct.
- The airplane has sequenced the holding fix only once (at the entry to the holding maneuver).
- The airplane descends through 14,000 feet MSL (FL 140) while on the first outbound leg.

Operating Instructions

If the airplane descends through 14,000 feet MSL (FL 140) during the first outbound leg of a hold, ensure the airplane stays on the correct path until the first inbound turn.

If the airplane turns away from the correct path, engage HDG SEL or TRK SEL and turn to a heading to intercept the inbound leg. When the airplane is on an intercept heading to the inbound leg, arm LNAV and continue the hold.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-36

Issue Date: June 20, 2018

Airplane Effectivity: All Airplanes

Subject: Automatic LNAV Activation during Departure

Reason: To inform flight crews of the potential for LNAV activation during departure.

Background Information

To reduce pilot workload during a missed approach, when a TO/GA switch is pushed in the air, LNAV automatically arms and activates as the roll mode and the pitch mode goes to TO/GA.

A second push of a TO/GA switch on a missed approach increases thrust to maximum go-around thrust and LNAV stays active. This is used during a windshear escape maneuver or when increased thrust is desired.

Automatic LNAV activation occurs when all of these occur: flaps are not UP, an instrument approach is loaded, and a TO/GA switch is pushed in the air. This can occur on approach or after takeoff. Some operators have reported that this can cause confusion during simulator training when a TO/GA switch is pushed after takeoff with an approach loaded.

On a departure not using LNAV, pushing a TO/GA switch after takeoff causes automatic LNAV activation if a course is available. If no course is available, the flight director roll bar blanks (for airplanes with flight director integrated cue, the flight director blanks), the flight director guidance cue on the HUD blanks, and LNAV shows on the FMA. Select an appropriate roll mode to restore the roll bar.

There have been no reports of unwanted automatic LNAV activation or unexpected roll bar indication on departure in an airplane. However, this has been observed in simulators and several operators have requested clarification about unexpected FMA and flight director indications after takeoff.

A future update to the flight management system will prevent automatic LNAV activation during departure.

Operating Instructions

If an approach is loaded before departure, be alert for unexpected or unwanted autopilot modes and flight director indications if a TO/GA switch is pushed after takeoff.

To prevent unwanted automatic LNAV activation on departure, do not load an instrument approach until after the departure phase of flight.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-37 R2

Issue Date: March 2, 2019

Airplane Effectivity: All Airplanes

Subject: FMC BP4 Administrative Bulletin

Reason: To inform airlines to review The Boeing Company (TBC) FCOM for FMC BP4 added information.

Background Information

This Bulletin provides advance information for FCOM changes for Flight Management Computing (FMC) software update BP4. These changes will be incorporated into the TBC FCOM in the March 2019 revision. These changes will be incorporated into a customer's FCOM when that customer has an airplane that has FMC BP4, either as the delivery configuration or when the operator reports the Service Bulletin is done.

Boeing will start delivering airplanes with FMC BP4 in late December 2018. The Service Bulletin for FMC BP4 is scheduled to be released in first quarter 2019.

The following is a summary of the changes in FMC BP4 that affect the FCOM or airplane operations.

Autothrottle Updates

Autothrottle logic is updated to provide additional protection for low airspeed conditions including additional pitch and thrust modes that were not supported in previous versions.

Improved Thrust Response in Descent

Thrust levers will be slightly forward of the idle position during descent to allow better response when additional thrust is required.

VNAV Step Climb

Improved logic to reduce frequency of unneeded VNAV STEP CLIMB messages. The current VNAV STEP CLIMB checklist can be used with BP4, however, we will publish an improved VNAV STEP CLIMB checklist for BP4 starting with the March 2019 FCOM/QRH/ECL revision.

Notification of Invalid Temperature

When the ADRS cannot provide accurate outside air temperature, the crew is prompted to enter outside air temperature. After engine start, crew is prompted to verify that a manually-entered temperature is still valid.

MagVar Table Updates

Updated to 2015 standard. There is no effect on crew procedures.

Default Climb Derate Washout Schedule

The default setting is to washout a climb derate at a higher altitude than in previous FMC versions. This is set by customer-selectable options. This has no effect on crew procedures.

STEEP DES AFTER XXXXXXX Help Window

This alerts the crew when the active FMC route includes a descent steeper than 6°

ENTER CRZ ALT Help Window

Operations Manual Bulletin "VNAV PATH not available on final approach" described a condition where VNAV PATH is not available after the final approach fix. If this occurs and the crew re-enters the approach in the flight plan, an FMC Help Window will prompt the crew to enter a cruise altitude to restore VNAV PATH.

Descent Page DES NOW Prompt

DES NOW prompt is not available on the ground during preflight.

FMC RUNWAY DISAGREE Change

The FMC RUNWAY DISAGREE message does not show if the GPS positions in the left and right IRS are not aligned.

Strategic Lateral Offset Procedure

SLOP defaults to OFF.

Operations Manual Bulletin Status

The following Operations Manual Bulletins can be cancelled for airplanes that have FMC BP4. These will be cancelled from each operator's manual when the operator notifies Boeing that all of the 787s in their fleet have FMC BP4 installed:

- Possible LNAV Guidance Error in a Holding Pattern
- FMC Reset Anomaly - Procedure Turn
- FMC Reset When Exiting a Holding Pattern
- VNAV PATH Not Available On Final Approach
- FMC Required Time of Arrival Anomalies.

The following Operations Manual Bulletins are cancelled by previous FMC software revisions. Some operators may currently receive these Bulletins if they have not notified Boeing that they have upgraded their FMC software to BP3, BP3A, or BP3B. If an operator does not currently have a Bulletin listed here, it was cancelled by a previous notification. All of these bulletins can be cancelled for airplanes that have FMC BP4:

- FMC Flight Plan Loss (BP2)
- Abeam Points May Cause Route Deactivation (BP2)
- Takeoff Data Uplink Anomalies When Runway Intersections Are Used (BP2)

- G/S OFF when activating inactive route (BP3)
- FMC Reset on Ground with HUD T/O (BP3A)
- FMC Reset in Air Wind Uplink and Waypoint Sequence (BP3A)
- Loss of Magenta Line (BP3A)
- Outdated Flight Plan (BP3B).

Operating Instructions

The Boeing Company FCOM/QRH can be found on MyBoeingFleet, FCOM-QRH, 787, General Airplane Information, FCOM-QRH Sample Volumes.

Please reference the TBC Notice of Change, dated March 1, 2019 for the highlighted FMC BP4 changes listed below.



Chapter 4 - Automatic Flight

Section 20 - System Description

Autothrottle System

4.20.11 - Added paragraph describing autothrottle functionality during a manual landing with FMC BP 4 or later software installed.

4.20.12 - Added automatic activation system description with FMC BP 4 or later software installed.

Chapter 11 - Flight Management, Navigation

Section 31 - Flight Management System Operation

Vertical Navigation (VNAV)

11.31.27 - Added paragraph describing new functionality on the Cruise page with FMC BP 4 or later software installed.

11.31.27 - Added paragraph describing the logic setting for the EICAS advisory message VNAV STEP CLIMB with FMC BP 4 or later software installed.

Section 40 - FMC Preflight

Preflight Pages - Part 2

11.40.42 - Added OAT help window notifications of invalid temperatures with FMC BP 4 or later software installed.

Section 42 - FMC Cruise

LNAV Modifications

11.42.23 - Added Lateral Offset page graphic with FMC BP 4 or later software installed.

11.42.25 - Added SLOP offset callout description with FMC BP 4 or later software installed.

VNAV Modifictions

11.42.36 - Added paragraph describing the logic setting for the EICAS advisory message VNAV STEP CLIMB with FMC BP 4 or later software installed.

11.42.37 - Added paragraph describing the logic setting for the EICAS advisory message VNAV STEP CLIMB with FMC BP 4 or later software installed.

Section 43 - FMC Descent and Approach

Descent

11.43.6 - Added description for when DES NOW prompt is displayed with FMC BP 4 or later software installed.

Section 60 - EICAS Messages

FMC Alerting Messages

11.60.7 - Added CONFIRM OAT help window with FMC BP 4 or later software installed.

11.60.9 - Added ENTER CRZ ALT help window with FMC BP 4 or later software installed.

11.60.10 - Added ENTER OAT help window with FMC BP 4 or later software installed.

11.60.13 - Added STEEP DES AFTER XXXX help window with FMC BP 4 or later software installed.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-38

Issue Date: January 18, 2019

Airplane Effectivity: All Airplanes

Subject: GLIDESLOPE Alert During Approach

Reason: This bulletin informs flight crews of the potential for an unwanted GLIDESLOPE alert on an IAN approach.

Background Information

Several operators have reported occurrences of a GLIDESLOPE alert (voice aural and caution message) when the approach has an FMC-generated IAN glide path. This alert can occur when an approach other than ILS or GLS is selected in the FMC, the active waypoint is the runway or missed approach point, and the airplane is below 1000 feet AGL. The FAC or G/P mode does not need to be armed or engaged for this alert to occur.

Boeing has analyzed these events and has found the alerts can occur due to barometric altimeter indication variations from one or both of these conditions:

- incorrect altimeter setting
- a warmer than standard OAT.

A change in barometric pressure or an OAT that is warmer than standard can cause the IAN glide path to be slightly higher than the visual glide slope indicator (VGSI) path, for example from a PAPI or VASI. In these conditions, if the crew elects to fly below the IAN glide path to follow the VGSI, a GLIDESLOPE alert can occur when the airplane is on a safe and appropriate glide path in visual conditions.

The IAN glide path can be sensitive to small changes in barometric pressure or temperature. For example, a pressure difference of .02 inches Hg can cause a difference of 20 feet between the VGSI and the IAN glide path near the runway. OAT 10 deg.C or more above ISA can cause the GLIDESLOPE alert.

Flight crews should be aware that changes in temperature and barometric pressure are common and that air traffic facilities may not update the ATIS or other information provided to aircraft when small changes occur, especially in VMC. Correct altimeter settings prevent some unwanted GLIDESLOPE alerts, however, crews should be aware that unwanted alerts can occur, especially due to temperatures that are warmer than standard.

Operating Instructions

During approach, make sure the correct altimeter setting is set on each altimeter. At higher temperatures (approximately 10 deg.C or more above ISA), the FMCgenerated IAN glide path can be higher than the guidance provided by the runway VGSI.

At or below applicable weather minima, when suitable visual references are established, transition to use of the VGSI path for the approach.

If a GLIDESLOPE alert occurs in VMC at low altitude, after confirming the aircraft is on a safe VGSI path, the crew can do one or more of these steps:

- silence the GLIDESLOPE aural and continue on the VGSI path
- re-establish the FMC-based barometric IAN glide path and transition to a visual approach and landing in the touchdown zone
- discontinue the approach.

oOo

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-39

Issue Date: January 18, 2019

Airplane Effectivity: HS-TWA, HS-TWB

Subject: Premature Climb Thrust Reduction

Reason: To alert flight crew to premature climb thrust reduction when the thrust reduction point is set to FLAPS 5.

Background Information

The information in this Bulletin applies only to 787-9 and 787-10 airplanes.

Operators have reported a premature climb thrust reduction during a FLAPS 10 takeoff when the thrust reduction (THR REDUCTION) point was set to FLAPS 5. Thrust reduced from the selected takeoff setting to the climb thrust setting when VNAV engaged at 400 feet RA, even though the flaps were still at FLAPS 10. Premature thrust reduction can occur when the Thrust Reduction (THR REDUCTION) point is set to FLAPS 5.

The FMC does not properly recognize takeoff flap settings greater than FLAPS 5 on 787-9 and 787-10 airplanes.

Boeing plans to correct this anomaly in a future revision to the FMC software.

Operating Instructions

To avoid premature climb thrust reduction, when the takeoff flap setting is greater than FLAPS 5, set the thrust reduction (THR REDUCTION) point based on a height, not a flap setting.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-40

Issue Date: March 2, 2019

Airplane Effectivity: All Airplanes

Subject: Engine fire switch fails locked or unlocked

Reason: To alert flight crews that the engine fire switch can fail in a locked or unlocked condition.

Background Information

The engine fire switch can fail in the locked condition (failed locked) or unlocked condition (failed unlocked). This is caused by long term heating of the fire handle locking mechanism in normal operation. Because of the potential failed locked condition, the FAA has issued Airworthiness Directive (AD) 2019-02-03, which requires increased periodic inspections to identify failed engine fire switches.

The engine fire switch is electrically energized to unlock it when an engine fire warning occurs or when there is electric power on the airplane and fuel control switch is in cutoff. At all other times the engine fire switch is de-energized to lock it. Over time, heat can cause fatigue in internal parts and the engine fire switch can fail to an always locked or always unlocked condition.

If the engine fire switch fails locked, the engine fire switch cannot be pulled even by pushing the override switch. If an engine fire switch fails unlocked, the engine fire switch is not protected from being pulled inadvertently when the engine is running. All functions of the engine fire switch other than the locking mechanism operate normally. The APU fire switch is not affected.

The engine fire switch is being redesigned to help prevent an always locked or always unlocked condition. Operators have an enhanced inspection requirement for the engine fire switch until the redesigned component is installed.

Operating Instructions

Engine Fire Switch Fails Locked:

If an engine fire switch fails locked, the engine fire switch stays locked if there is an engine fire warning. The engine fire switch cannot be pulled even if the override switch is pushed. Engine fire extinguisher bottles cannot be discharged.

Do the appropriate non-normal checklist.

Setting the fuel control switch to CUTOFF shuts down the engine and closes the fuel spar valve.

The affected side VFSG goes offline when engine speed decreases below idle.

Do this additional step:

Set the hydraulic ENG PRIMARY pump switch for the affected side to off.

Land as soon as possible if an actual engine fire exists, or is suspected.

Engine Fire Switch Fails Unlocked:

Be aware the engine fire switch can fail in the unlocked condition. The engine fire switch is not protected from being pulled inadvertently. The engine fire bottles can be discharged.

Maintenance instructions are in place for mandatory enhanced inspections of the engine fire switches. Boeing recommends flight crews do not test engine fire switches for correct operation because this can increase failure rates.

oOo

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-41

Issue Date: April 5, 2019

Airplane Effectivity: All Airplanes

Subject: Additional Guidance for Flap and Slat Anomalies and Overweight Landing

Reason: To provide flight crews additional information for FLAPS PRIMARY FAIL, SLATS PRIMARY FAIL and Overweight Landing conditions.

Background Information

On a 787 diversion for a medical emergency with a planned overweight landing, the airplane had anomalies during the approach that resulted in a landing with flaps and slats up.

After committing to landing overweight, when the crew selected flaps 1, the SLATS DRIVE message showed. When the crew selected flaps 5, the FLAPS PRIMARY FAIL message showed. Due to the airplane weight, and the slower rate of flap extension in secondary mode, when flaps 5 was selected, the upper barber pole and lower amber band converged so it appeared that there was no maneuver margin. In response, the crew moved the flap handle back to the UP position to attempt to recover maneuver margin. The crew then decided to jettison fuel and land with flaps and slats up.

Analysis found the slats drive electric motor unit (EMU) was failed. This unit moves the slats in secondary or alternate mode. This set the SLATS DRIVE message.

The hydraulic nose gear isolation valve (NGIV) was failed-closed which removes center system hydraulic power for slat and flap primary operation, nose gear extension, and nose wheel steering. This set the FLAPS PRIMARY FAIL message.

Boeing has reviewed the checklists for the various conditions involved in this event, and has concluded that some additional guidance in the FLAPS PRIMARY FAIL, SLATS PRIMARY FAIL, and Overweight Landing checklists would be helpful. The SLATS DRIVE checklist does not require any changes. We plan to change the checklists in the September 2019 revision to the FCOM/QRH and ECL. We are providing this Bulletin as an interim measure.

Operating Instructions

If the FLAPS PRIMARY FAIL message or the SLATS PRIMARY FAIL message shows, the flaps or slats (as affected) are operating in secondary mode. The flap lever is used to operate the flaps and slats in secondary mode. In secondary mode the slats take approximately 1.5 minutes to move from UP to 1. In secondary mode, the flaps take approximately 2.5 minutes to move from 1 to 20.

If flaps are extended while accomplishing the Overweight Landing checklist, the upper barber pole and the lower amber band can converge for a short time while the flaps are extending from 1 to 5. Airspeed can be in the lower amber band for as long as 1 minute until the distance between the upper barber pole and the lower amber band increases.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-43

Issue Date: July 5, 2019

Airplane Effectivity: All Airplanes

Subject: Nose gear isolation valve (NGIV) fails closed

Reason: To inform flight crews that an NGIV fault affects configuration for landing.

Background Information

The nose gear isolation valve (NGIV) is part of the center hydraulic system. The NGIV closes to preserve hydraulic power for main gear retraction and primary flight controls if an uncontained engine failure damages hydraulic system tubing forward of the main gear wheel wells. The NGIV isolates primary (hydraulic) flap and slat operation, nose gear actuation, and steering from the center system. The NGIV is open on the ground. The NGIV closes in the air after the landing gear is retracted and the flaps and slats are up. The NGIV opens in the air when the flap lever is moved from UP or the landing gear lever is moved to DN.

Boeing has determined that some NGIVs can fail in the closed position. If this happens during approach, it affects primary mode operation of slats and flaps, nose gear extension, and nose wheel steering.

The following effects can occur:

- When the flap lever is moved from UP to 1: SLATS PRIMARY FAIL (Caution)
- When the flap lever is moved from 1 to 5 or higher: FLAPS PRIMARY FAIL (Caution)
- When the landing gear lever is moved to DN: GEAR DISAGREE (Caution) after 40 seconds
- When alternate gear extension is performed: GEAR DOOR (Advisory)
- When the nose gear is down and locked: NOSE WHEEL STEERING (Advisory)

If the NGIV fails closed, the HYD VLV ISLN NOSE GEAR status message shows approximately 20 seconds after the flap lever is moved from UP or the landing gear lever is moved to DN. On the hydraulic synoptic display, the valve failed symbol (amber valve with an X) shows for the NGIV.

Boeing is working to produce an improved NGIV. Boeing Service Letter 787-SL-29-015 has more information on this issue.

Operating Instructions

During approach, if the SLATS PRIMARY FAIL message shows, when the slats are in the commanded position, move the flap lever to 5. If the FLAPS PRIMARY FAIL message shows, the following messages can also show: GEAR DISAGREE and

NOSE WHEEL STEERING. Do the checklists for all messages that show. Plan additional time for flap and slat operation in secondary mode. Use the Non-Normal Configuration Landing Distance table for FLAPS PRIMARY FAIL. Plan additional time for alternate gear extension. Advise ATC that steering is inoperative and the airplane needs to be towed from the landing runway.

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-44 R1

Issue Date: September 20, 2019

Airplane Effectivity: All Airplanes

Subject: Revision to SP.16 - Cold Weather Operations

Reason: To alert flight crews of requirement to leave flaps and slats extended in icing conditions or after landing on a contaminated runway until inspection is completed
Boeing is re-issuing this bulletin to incorporate changes to the Background Information and SP.16 Procedures.

Background Information

Boeing has found there is a potential for outboard slats to be out of position without indication to the flight crew.

Ice or other contaminants can accumulate around the slats, especially during a prolonged approach in icing conditions, during landing on a contaminated runway, or during ground operations on contaminated surfaces. Ice or other contaminants can cause a shear-out of all of the geared rotary actuators for the outboard slats when the slats are commanded to move. If all of the outboard slats on a wing are not in the commanded position, this is not detected by the position indicating system or the slat skew/loss detection system.

The probability of this occurring is considered to be extremely remote.

Contamination that accumulates during approach or after landing could cause geared rotary actuators to shear-out which can affect slat movement for the next takeoff.

Boeing is revising the guidance in the After Landing Procedure and the Secure Procedure in the Cold Weather Operations section of SP section 16. Changes were published in the September 2019 revision of the 787 FCOM, but based on operator feedback, we are making further changes to these procedures as shown in this Bulletin. These further changes will be published in the March 2020 revision.

The changes more clearly describe the conditions under which the flaps are not to be retracted. They also recommend steps for positive communication between the flight crew and maintenance about the condition of the airplane.

Boeing recommends the inspection and flap and slat retraction is done as soon as practical after the airplane is on the ground. This minimizes additional accumulation of ice, snow, or other contaminants.

Operating Instructions

Use the following procedures for Cold Weather Operations:

After Landing Procedure

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

CAUTION: Precautions must be taken for jet blast up to 600 feet (200 meters) behind the aircraft, snow and ice at the edge of the taxiway that can be ingested by the engines, slippery taxi surfaces, and airport noise restrictions.

Do the normal After Landing Procedure with the following modifications:

Do not retract the flaps and slats if any of the following conditions occur:

- flight with flaps or slats extended was prolonged (for example, due to extended maneuvering, holding, or missed approach) in icing conditions before landing
- an accumulation of airframe ice is suspected (for example, indicated by wing anti-ice active during the approach)
- operation in icing conditions on a runway, or taxiway

If the captain decides that leaving the flaps and slats extended after landing increases the safety risk to ground maneuvering or ground handling, the flaps can be retracted.

Post-flight inspection by qualified personnel is needed to ensure the flap and slat areas are free of ice and contaminants before retracting the flaps and slats.

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 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.

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

When engine anti-ice is needed:

ENGINE ANTI-ICE selectors ..... ON F/O

Confirm that “EAI” is shown on the primary engine display for both engines.

When engine anti-ice is no longer needed:

ENGINE ANTI-ICE selectors ..... AUTO F/O

In icing conditions with visible moisture (fog with visibility of one statute mile (1600m) or less, rain, snow, sleet, ice crystals, and so on), and OAT is 3°C or below, do the following procedure:

Check that the area behind the airplane is clear C

Run-up to a minimum of 20 TPR (42% N1) for at least 30 seconds at intervals no greater than 60 minutes.

If the run-up procedure is not done (either it cannot be done, or time to gate is less than 60 minutes) do one of the following:

Record the taxi-in time without an engine run-up in the airplane logbook or other approved document

Do the run-up procedure less than 5 minutes before the arrival at the gate and record this in the airplane logbook or other approved document

Secure Procedure

Do the normal Secure Procedure with the following modifications:

If the flaps are left extended, or were retracted for safety reasons, in the conditions in the After Landing Procedure above, make an entry in the airplane logbook or other approved document: "Flaps and slats operated in specified icing conditions."

Note: Cold weather maintenance procedures for securing the airplane, including post-inspection flap and slat retraction, are needed in icing conditions. These procedures are found in the approved AMM.

If the airplane will be attended:

PACK switches ..... AUTO F/O

Use normal air conditioning procedures, with all packs, trim air, and recirculation fans on, to provide cabin heating.

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 switches ..... MAN F/O
OUTFLOW VALVE MANUAL switches ..... CLOSE F/O

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

Wheel chocks ..... Verify in place C or F/O
Parking Brake ..... Released C

Reduces the possibility of frozen brakes.

787 Flight Crew Operations Manual Bulletin

Number: TII-45

Issue Date: September 30, 2019

Airplane Effectivity: Airplanes with Trent 1000 Package C Engines

Subject: Revised Rolls-Royce Trent 1000 Package C Engine Operating Restrictions

Reason: To advise flight crews of new operating instructions to comply with a new AMOC to AD 2018-09-05.

Background Information

The information in this bulletin applies only to model 787-8 and 787-9 airplanes categorized as Group 3 airplanes. Airplane Groups are defined in Boeing Document D021Z002-01: 787 ETOPS Configuration, Maintenance and Procedures, Revision V or later authority-approved revision. Use the Operating Instructions in this bulletin to comply with the Alternative Method of Compliance (AMOC) to Airworthiness Directive (AD) 2018-09-05 approved in FAA letter 74-19-10510 dated 09-24, 2019

For model 787-8 and 787-9 airplanes categorized as Group 4 airplanes, use the information in the current bulletin titled "Rolls-Royce Trent 1000 Package C Engine Operating Restrictions".

This bulletin is sent to all 787 operators with Rolls-Royce engines.

Rolls-Royce Trent 1000 Package C engines have experienced cracking of the intermediate pressure compressor (IPC) rotor stage 1 (R1) and stage 2 (R2) blades. An engineering investigation has determined that the root cause of these cracks is rotor blade vibration that is excited by wakes from the fan. This vibration occurs during specific operating and atmospheric conditions and can lead to the failure of IPC blades and an in-flight shutdown (IFSD). The vibration is not indicated or observable in the flight deck. To date, there have been three IFSDs and one on-ground shutdown (while in reverse thrust during landing) caused by failure of an R1 blade, and one IFSD caused by failure of an R2 blade. Additional engine inspection requirements are in place that will identify cracks early to reduce the risk of blade failure in normal operations.

After additional testing of Trent 1000 engines, Rolls-Royce and Boeing have developed improved procedures for Extended Operations (ETOPS). ETOPS means any operations more than 60 minutes from landing at an ETOPS Adequate Airport. These new procedures enable ETOPS operations up to a 180-minute Area of Operations, and eliminate the weight, altitude and temperature limitations that were included in the original AD. Additionally, the analysis by Boeing to allow a 180-minute ETOPS Area of Operations includes an allowance for headwinds (99% of an annual velocity distribution). This eliminates any requirement to verify that the actual driftdown or decompression diversion time does not exceed 180 minutes.

The Operating Instructions in this bulletin are designed to reduce exposure to IPC blade vibration during any of these operations:

- ETOPS engine-out driftdown and diversion
- ETOPS engine-out decompression diversion at 10,000 feet (for example, after an engine failure and decompression)
- ETOPS diversion at 10,000 feet with both engines operating (for example, after a decompression)

Normal and non-normal operations on non-ETOPS parts of a flight are not affected.

The updated AMOC and Operating Instructions specify Maximum Allowable Diversion Speeds for an engine-out driftdown and diversion, and Maximum Allowable Diversion Speeds for level flight during a diversion after a decompression (all engines operating or engine-out).

ETOPS Planning

Operations are limited to those requiring up to and including 180-minute ETOPS type design approval. 207-minute ETOPS operations are not allowed.

The Maximum Speed tables below show Maximum Allowable Diversion Speeds for Driftdown and Decompression diversions. The speeds are listed by airplane model and engine thrust Rating, for both With Icing and Without Icing.

The ETOPS Area of Operation must be calculated at or below the appropriate (With Icing or Without Icing) Driftdown Maximum Allowable Diversion Speed from the table below.

ETOPS engine-out driftdown diversions must be flown at or below the Driftdown speed identified in the appropriate Maximum Allowable Diversion Speed table below. ETOPS all engines operating and engine-out decompression diversions at 10,000 feet must be flown at or below the Decompression speed identified in the appropriate Maximum Allowable Diversion Speed table below. Segments of ETOPS decompression diversions with intermediate level-off altitudes above 10,000 feet must be flown at or below the Driftdown speed identified in the appropriate Maximum Allowable Diversion Speed table below.

All diversions must be flown at or below the Maximum Allowable Diversion Speed With Icing for the ETOPS segments of the flight where icing is forecast between the route and the planned ETOPS Alternate Airport. Normal accounting for forecast icing in critical fuel calculations applies.

Note that the engine-out decompression critical fuel may have a different Maximum Allowable Diversion Speed than the engine-out driftdown critical fuel. Further, the all engine and engine-out decompression scenarios share the same Maximum Allowable Diversion Speed and the maximum speed for leveloff at intermediate altitudes for terrain clearance is the appropriate driftdown maximum speed, not the decompression maximum speed.

Speed selection for critical fuel calculations needs to ensure that any diversion is protected and flight planning needs to ensure that the flight is flown at a speed at or below the appropriate Maximum Allowable Diversion Speed tables.

ETOPS Enroute Engine-out Driftdown Diversion

If an engine fails on an ETOPS segment of a flight, the driftdown and diversion must be flown at a speed no greater than the appropriate Maximum Allowable Diversion Speed listed in the Maximum Allowable Diversion Speed tables below.

During a driftdown, the FMC controls to the target speed at Maximum Continuous (CON) Thrust with a gradually decreasing rate of descent. When the rate of descent decreases below 50 fpm, the pitch mode changes to VNAV PTH. In VNAV PTH, the pitch mode will command a 300 fpm rate of descent until the airplane levels off at the FMC MAX altitude.

If a potential traffic conflict requires a rapid descent, idle thrust and speedbrakes can be used until the driftdown descent is resumed.

ETOPS Diversion at 10000ft

After a decompression or another event that requires emergency descent to 10,000 feet, with all engines operating or one engine inoperative, the diversion must be flown at a speed no greater than the appropriate (With Icing or Without Icing) Maximum Allowable Diversion Speed for Decompression in the appropriate Maximum Allowable Diversion Speed table below. Segments of ETOPS decompression diversions with intermediate level-off altitudes above 10,000 feet must be flown at a speed no greater than the Driftdown maximum speeds identified in the appropriate Maximum Allowable Diversion Speed table below.

The emergency descent can be flown as shown in the CABIN ALTITUDE checklist. Speedbrakes and airspeed up to VMO/MMO, with engine thrust at idle, can be used until reaching the level-off altitude.

Non-ETOPS Driftdown and Diversion

If operational considerations (for example, weather, fuel jettison, or holding) require a driftdown, a diversion, or a return-to-land that is expected to take longer than 60 minutes, use the applicable Operating Instructions and speed from the appropriate Maximum Allowable Diversion Speed table below.

Operating Instructions

These Operating Instructions apply model 787-8 and 787-9 airplanes categorized at Group 3 airplanes, as defined in Boeing Document D021Z002-01: 787 ETOPS Configuration, Maintenance and Procedures, Revision V or later authority approved revision. Use the Operating Instructions in this bulletin to comply with the Alternative Method of Compliance (AMOC) to Airworthiness Directive (AD) 2018-09-05 approved in FAA letter 74-19-10510 dated 09-24, 2019. For these airplanes operations are limited to those requiring up to and including 180 minute ETOPS type design approval, at a speed no greater than the applicable maximum speed listed in the appropriate Maximum Allowable Diversion Speed table below. 207-minute ETOPS operations are not allowed.

ETOPS

ETOPS Pre-departure and Enroute Phases:

Before departure, the Flight Crew must confirm that the flight plan was developed in accordance with the ETOPS planning requirements for Group 3 airplanes defined in Boeing Document D021Z002-01: 787 ETOPS Configuration, Maintenance and Procedures, Revision V or later authorityapproved revision.

ETOPS Enroute Engine-out Driftdown Diversion:

- Select VNAV, select ENG OUT
- Enter Speed/Mach number (per company policy) in EO SPD field (L2)
- Do not exceed the flight plan Maximum Allowable Diversion Speed for Driftdown
- Select FMC MAX altitude from 4R and enter in CRZ ALT (L1)
- Enter FMC MAX altitude in MCP window, do not push altitude selector
- Execute. VNAV will provide appropriate Speed/Mach guidance for driftdown
- If a rapid descent is required, speedbrakes can be used with FLCH mode
- As the airplane approaches the FMC MAX altitude, the FMA will change from VNAV SPD to VNAV PTH. When this change occurs, confirm the MCP altitude is set to the current FMC MAX altitude, which may have increased during the driftdown.
- For engine-out cruise, remain in ACT EO XXXKT CRZ at no more than the Maximum Allowable Diversion Speed for Driftdown
- If actual icing conditions are encountered (engine anti-ice or wing anti-ice is activated automatically or manually) when icing was not forecast (flight plan is for Driftdown Without Icing speed):
  - Limit the speed to the Maximum Allowable Diversion Speed for Driftdown With Icing, from the Maximum Speed tables below
  - When this speed is entered in the FMC, it will cause an increase in the FMC MAX altitude. Set the MCP altitude to the new FMC MAX altitude.
  - If the current altitude is below the FMC MAX altitude, climb to this altitude using no more than Maximum Continuous (CON) Thrust
  - If the airplane is unable to maintain this target speed, do not allow the speed to drop below the default EO speed (minimum drag speed)
  - If the airplane is unable to maintain the default EO speed (minimum drag speed) at the FMC MAX altitude, select a lower cruise altitude in increments of 1,000 feet, until speed can be maintained
  - After leaving icing conditions, and ice sublimation allows, return to the FMC MAX altitude and target speed using no more than Maximum Continuous (CON) Thrust.
- As fuel is used, the FMC MAX altitude will increase. If desired, a climb can be made to the new FMC MAX altitude using no more than Maximum Continuous (CON) Thrust.
- Do not descend early. Maintain the cruise altitude for as long as possible to minimize diversion time.
- Use normal speeds for descent below 10,000 feet.

ETOPS Decompression Diversion

- The rapid descent can be flown as shown in the CABIN ALTITUDE checklist. Speedbrakes and airspeeds up to VMO/MMO with engine thrust at idle can be used.
- For intermediate altitude level-offs above 10,000 feet, do not exceed the flight plan Maximum Allowable Diversion Speed for Driftdown.
  - If actual icing conditions are encountered during an intermediate level off (engine anti-ice or wing anti-ice is active automatically or manually) when icing was not forecast (flight plan is for Without Icing speed)
  - Do not exceed the Maximum Allowable Diversion Speed for Driftdown With Icing. If the airplane is unable to maintain this new target speed, do not allow the speed to drop below the default EO speed (minimum drag speed).
- After descending to 10,000 feet, do not exceed the flight plan Maximum Allowable Diversion Speed for Decompression.
  - If actual icing conditions are encountered (engine anti-ice or wing antiice is active automatically or manually) when icing was not forecast (flight plan is for Without Icing speed)
  - Do not exceed the Maximum Allowable Diversion Speed for Decompression With Icing. If the airplane is unable to maintain this new target speed, do not let the speed drop below the default EO speed (minimum drag speed).
- Use normal speeds for descent below 10,000 feet.

Non-ETOPS

On a non-ETOPS flight, if the diversion or return-to-land time is expected to exceed 60 minutes, apply the most appropriate ETOPS Operating Instructions above.

Post Flight Action

If the maximum speed in the Maximum Allowable Diversion Speed tables below was exceeded, report the event to Maintenance. It is the responsibility of Maintenance to determine if an engine inspection is needed after an event

Maximum Speed Table

HS-TQA - HS-TQF

			Maximum Allowable Diversion Speed (KIAS)	
Model	**Rating**	**Diversion Type**	**Without Forecast Icing**	**With Forecast Icing**
787-8	AE	Driftdown	325	295
		Decompression	No Maximum	315

HS-TWA, HS-TWB

			Maximum Allowable Diversion Speed (KIAS)	
Model	**Rating**	**Diversion Type**	**Without Forecast Icing**	**With Forecast Icing**
787-9	D	Driftdown	310	275
		Decompression	340	290

THAI

787 Flight Crew Operations Manual Bulletin

Number: TII-46

Issue Date: October 18, 2019

Airplane Effectivity: All 787 Airplanes

Subject: Erroneous Autopilot Flight Director System (AFDS) Guidance when Instrument Landing System (ILS) Signal Interference Occurs

Reason: To inform flight crews about erroneous AFDS guidance during ILS approaches

Background Information

This bulletin is being distributed to operators of 787 airplanes.

Boeing has received several reports of unexpected pitch guidance when capturing or tracking the glideslope during an instrument landing system (ILS) approach. In each event for which data was provided, Boeing has determined that glideslope signal interference occurred at the time of the unexpected pitch guidance and, in most of these events, the unexpected pitch guidance occurred during glideslope capture. ILS signal interference can occur when vehicles, aircraft, or other factors affect the localizer or glideslope signal.

This bulletin describes the autopilot flight director system (AFDS) operation during periods of localizer or glideslope signal degradation or signal instability, and the possible flight deck effects during such an event.

The AFDS can detect the degradation or instability of radio signals that support specific autopilot modes. When the AFDS detects a degraded or unstable signal during an ILS approach with the autopilot engaged, the affected AFDS mode changes to an attitude stabilizing mode based on inertial data at the time of the signal degradation or instability. The purpose of the attitude stabilizing mode is to prevent large and abrupt pitch and roll changes during short periods of localizer or glideslope signal interference. When the localizer or glideslope signal stabilizes and the airplane is within parameters for capture, the AFDS returns to tracking the localizer or glideslope. Alternatively, if the localizer or glideslope signal does not stabilize or the airplane is not within parameters for capture, the attitude stabilizing mode remains active. In this case, the AFDS continues to provide guidance in the attitude stabilizing mode, with possible high rates of descent and significant deviation from the localizer or glideslope.

There is no direct indication to the pilot that the attitude stabilizing mode is active if the airplane is above 200 feet radio altitude and either:

- the localizer attitude stabilizing mode is active for less than 20 seconds or
- the glideslope attitude stabilizing mode is active for less than 15 seconds

If the airplane is above 200 feet radio altitude and the attitude stabilizing mode remains active for 20 seconds or more (for localizer) or 15 seconds or more (for glideslope):

- the AUTOPILOT message shows (if autopilot is engaged) and
- the flight director roll or pitch bar is removed (if flight director is on) and
- an amber line shows through the affected flight mode annunciation (FMA)

Figure 1 shows the indications on a typical airplane model after an extended time in the attitude stabilizing mode.

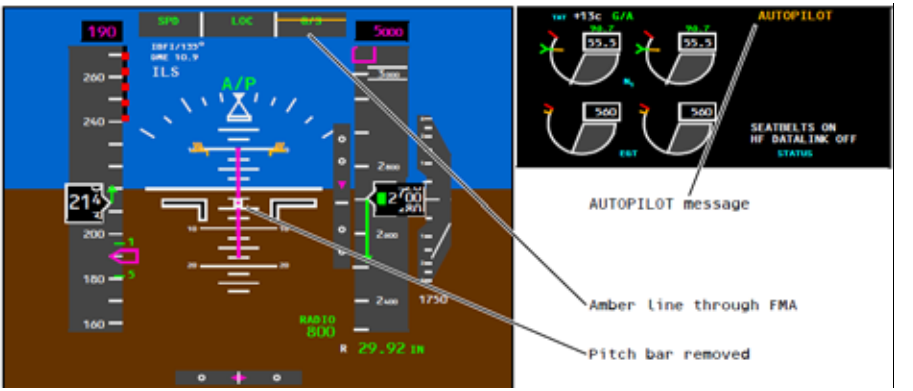


Figure 1- Indications Following Extended Time in Attitude Stabilizing Mode on a Typical Airplane Model

Similarly, there is no indication to the pilot that the attitude stabilizing mode is active if the attitude stabilizing mode remains active for less than 4 seconds while the airplane is at or below 200 feet radio altitude. If the airplane is at or below 200 feet radio altitude and the attitude stabilizing mode remains active for 4 seconds or more, the indications in Figure 1 show.

When these indications show, if the pilot manually disconnects the autopilot, the AUTOPILOT message blanks, the flight director roll and pitch bars show, and the amber line through the affected FMA blanks. However, if G/S is the pitch mode and the airplane is not within the parameters for glideslope capture, the flight director pitch bar continues to provide guidance to the attitude stabilizing mode and not to the glideslope signal. This can lead to high rates of descent and significant deviation from the ILS glideslope. Pilot intervention is needed to return the airplane to the glideslope or to perform a go-around/missed approach. If the AFDS is in the attitude stabilizing mode and the pilot manually disconnects the autopilot before the indications if Figure 1 show, the same condition can occur and the same pilot intervention is needed.

Note that the autoland status annunciation of LAND 2 or LAND 3 is not an indication of proper AFDS localizer and glideslope tracking. LAND 2 and LAND 3 are only indications of the autopilot system level of redundancy.

All of the reports Boeing has received regarding this issue have been for unexpected pitch guidance during glideslope capture or tracking. The AFDS manages localizer capture and tracking differently from glideslope capture and tracking. Boeing has not received similar reports of unexpected guidance during localizer capture and tracking.

Operating Instructions

While on an ILS approach, monitor localizer and glideslope raw data and call out any significant deviations. Perform an immediate go-around if not within the criteria to continue the approach.

Limitations — Chapter L
Table of Contents

Limitations and Operational Information L.10

General L.10.1

Airplane General L.10.1

AFM Limitations L.10.1

AFM Operational Information L.10.2

Non-AFM Operational Information L.10.2

Weight Limitations L.10.3

AFM Limitations L.10.3

Autoflight L.10.3

AFM Limitations L.10.3

Communications L.10.4

AFM Limitations L.10.4

Engines L.10.4

AFM Limitations L.10.4

Flight Controls L.10.5

AFM Limitations L.10.5

Flight Instruments, Displays L.10.5

AFM Limitations L.10.5

Fuel L.10.5

AFM Limitations L.10.5

Warning Systems L.10.6

AFM Limitations L.10.6

General

This chapter contains:

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

Limitations and operational information are included if they are:

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

Limitations and operational information are not included if they are:

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

Limitations and 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 turbulent air penetration speed. 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

AFM Limitations

Runway slope	±2%
# Maximum Takeoff and Landing Tailwind Component	15 knots
Maximum Operating Altitude	43,100 feet pressure altitude
Maximum Takeoff and Landing Altitude	14,000 ft pressure altitude

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

Do not operate HF radios when refueling.

RVSM Operations

Do not fly in RVSM airspace on ISFD alone. The standby altimeter does not meet RVSM altimeter accuracy requirements.

Graphical Exit Signs

All passengers must be informed of the graphical exit signs, by an approved briefing, prior to each takeoff and landing.

Passenger Evacuation

Main door emergency power assists and evacuation slide systems must be armed with the door mode select levers in the automatic position and the electronically dimmable door windows must be in the clear state prior to taxi, takeoff and landing whenever passengers are carried. (See Door Mode Select Panel on page 1.30.17 for additional information.)

Flight Deck Security Door

Verify that an operational check of the Flight Deck Access System has been accomplished according to approved procedures once each flight day. (See Flight Deck Door Access System Test on page SP.1.3 for additional information.)

AFM Operational Information

TQA to TQF The maximum demonstrated crosswind for takeoff is 35 knots and for landing is 33 knots.

TWA,B The maximum demonstrated crosswind for takeoff is 29 knots and for landing is 35 knots.

Severe Turbulent Air Penetration Speed

Severe turbulent air penetration speed (in severe turbulence) is defined as:

- 290 KIAS below 25,000 feet
- 310 KIAS/.84 Mach (whichever is lower) at and above 25,000 feet. (See Severe Turbulence on page SP.16.16 for additional information.)

Non-AFM Operational Information

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

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

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

DELETION

Prior to takeoff the maximum allowable difference between Captain's or First Officer's altitude display and field elevation is 75 feet.

Weight Limitations

AFM Limitations

Maximum Taxi Weight (kg)	Maximum Takeoff Weight (kg)	Maximum Landing Weight (kg)	Maximum Zero Fuel Weight (kg)	
228,383	227,930	172,365	161,025	TQA to TQF
248,115	247,207	192,776	181,436	TWA,B

Autoflight

AFM Limitations

Autopilot/Flight Director System

The autopilot must not be engaged below a minimum engage altitude of 200 feet AGL after takeoff.

Autoland capability may only be used for operations into runways at or below 8,400 feet airport field elevation.

Without LAND 2 or LAND 3 annunciated, the autopilot must be disengaged below 100 feet AGL. TQA to TQF

Without LAND 2 or LAND 3 annunciated, the autopilot must be disengaged below 135 feet AGL. TWA,B

With LAND 2 or LAND 3 annunciated and glideslope angles greater than 3.25°, the autopilot must be disengaged below 100 feet AGL.

If the glidepath angle for approach is greater than 3.77°, the autopilot must be disengaged no later than 50 feet below DH/MDA.

Low Visibility (HUD) Takeoff

Low weather minima takeoff may only be performed using ILS guidance on U.S. Type II or Type III ILS facilities. TQA to TQF

Maximum wind component speeds when takeoff weather minima are predicated on HUD takeoff operations:

# Headwind	25 knots
# Tailwind	15 knots
# Crosswind	20 knots

Automatic Landing

Maximum wind component 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°.

The minimum glideslope angle is 2.5°.

Autoland capability may be used with flaps 20, 25, or 30, with both engines operative or with one engine inoperative.

The autopilot flight director system (AFDS) autoland status annunciation must have LAND 2 or LAND 3 displayed.

Non-AFM Operational Information

Operational approval is required for low visibility operations using HUD TO/GA.

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

Communications

AFM Limitations

Audio Control Panel (ACP)

DELETION

Use of the captains or first officers ACP to establish a SATCOM/cabin conference is prohibited.

Engines

AFM Limitations

Engine Oil System

Oil temperature must be greater than –40 deg. C for engine start.

Reverse Thrust

Intentional selection of reverse thrust in flight is prohibited.

Backing the airplane with use of reverse thrust is prohibited.

Engine Fire Bottle

If the airplane has been parked, un-powered, in an environment below –40 deg. F (–40 deg. C), the temperature of the compartment air surrounding the engine fire extinguishing bottles must be warmed to –10 deg. F (–23 deg. C) or greater

and maintained at this temperature for a minimum of 1.5 hours before engine start.

Verify the appropriate warming procedure was accomplished, prior to engine start.

Tailwind and Crosswind

Ground wind operating envelope:

- with a tailwind component and total wind greater than 42 knots, limit engines to taxi power
- for crosswinds greater than 45 knots, limit engines to taxi power
- for winds greater than 65 knots, do not run engines.

Flight Controls

AFM Limitations

Takeoff is permitted only in the normal flight control mode. (See Flight Control System Normal Mode on page 9.20.5 for additional information.)

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 VA.

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

Flight Instruments, Displays

AFM Limitations

Electronic Flight Bag (EFB)

EFB portable keyboard and attaching cable (if installed) must be stowed during takeoff and landing.

Fuel

AFM Limitations

Fuel Temperature

Maximum tank fuel temperature at takeoff is 49 deg. C (120 deg. F) for Jet A, Jet A-1, JP-5, JP-8 or TS-1.

Inflight fuel temperature is limited to 65 deg. C (150 deg. F) for Jet A, Jet A-1, JP-5 or JP-8.

Inflight fuel temperature for TS-1 is limited to 57 deg. C (135 deg. F) at or above 35,000 feet and 65 deg. C (150 deg. F) below 35,000 feet.

Tank fuel temperature prior to takeoff must not be less than –29 deg. C (–20 deg. F).

In-flight tank fuel temperature must be maintained at least –42 deg. C, as well as 3 deg. C above the freezing point of the fuel being used. The use of Fuel System Icing Inhibitor additives does not change the minimum fuel tank temperature limit. (See Performance Initialization Page on page 11.40.34 for additional information.)

Fuel Loading

Main tanks must be scheduled to be full if center tank fuel is loaded.

Note: The center tank may contain up to 10,000 kilograms of fuel with less than full main tanks provided center tank fuel weight plus actual zero fuel weight does not exceed the maximum zero fuel weight, and center of gravity limits are observed.

Warning Systems

AFM Limitations

GPWS—Look-Ahead Terrain Alerting

Do not use the terrain display for navigation. (See GPWS Look-Ahead Terrain Alerting Display and Annunciations on page 15.10.23 for additional information.)

The use of look-ahead terrain alerting and terrain display functions are prohibited within 15 NM of takeoff, approach or landing at an airport or runway not contained in the GPWS terrain database. Honeywell Document 060-4267-000 for airports and runways contained in the installed GPWS database. (See GPWS Look-Ahead Terrain Alerting Display and Annunciations on page 15.10.23 for additional information.)

TCAS

Pilots are authorized to deviate from their current ATC clearance to the extent necessary to comply with a TCAS resolution advisory. Evasive maneuvers must not be based solely on information from the traffic display or traffic advisory (TA) without visually sighting the traffic. (See TCAS Traffic and Alert Message TRAFFIC Display on page 15.10.15 for additional information.)

Normal Procedures — Chapter NP
Table of Contents

Introduction NP.11

General NP.11.1

Normal Procedures Philosophy and Assumptions NP.11.1

Configuration Check NP.11.1

Crew Duties NP.11.2

Control Display Unit (CDU) Procedures NP.11.3

Autopilot Flight Director System (AFDS) Procedures NP.11.3

Preflight and Postflight Scan Flow NP.11.4

Areas of Responsibility—Captain as Pilot Flying or Taxiing NP.11.6

Areas of Responsibility—First Officer as Pilot Flying or Taxiing NP.11.7

Amplified Procedures NP.21

Preliminary Preflight Procedure—Captain or First Officer NP.21.1

CDU/EFB Preflight Procedure—Captain and First Officer NP.21.1

Exterior Inspection NP.21.4

- Left Forward Fuselage NP.21.5
- Nose NP.21.5
- Nose Wheel Well NP.21.5
- Right Forward Fuselage NP.21.6
- Right Wing Root, Pack, and Lower Fuselage NP.21.6
- Right Engine NP.21.6
- Right Wing and Leading Edge NP.21.6
- Right Wing Tip and Trailing Edge NP.21.7
- Right Main Gear NP.21.7
- Right Main Wheel Well NP.21.7
- Right Aft Fuselage NP.21.7
- Tail NP.21.7
- Left Aft Fuselage NP.21.7
- Left Main Wheel Well NP.21.8

Left Main Gear NP.21.8
Left Wing Tip and Trailing Edge NP.21.8
Left Wing and Leading Edge NP.21.8
Left Engine NP.21.8
Left Wing Root, Pack, and Lower Fuselage NP.21.8
Preflight Procedure—First Officer NP.21.9
Preflight Procedure—Captain NP.21.17
Before Start Procedure NP.21.20
Pushback or Towing Procedure NP.21.22
Engine Start Procedure NP.21.22
Before Taxi Procedure NP.21.23
Before Takeoff Procedure NP.21.24
Takeoff Procedure NP.21.24
Takeoff Flap Retraction Speed Schedule NP.21.26
Climb and Cruise Procedure NP.21.26
Descent Procedure NP.21.27
Approach Procedure NP.21.27
Flap Extension Schedule NP.21.28
Landing Procedure ILS or GLS NP.21.28
Landing Procedure—Instrument Approach Using IAN NP.21.29
Landing Procedure—Instrument Approach Using VNAV NP.21.31
Go-Around and Missed Approach Procedure NP.21.33
Landing Roll Procedure NP.21.34
After Landing Procedure NP.21.34
Shutdown Procedure NP.21.35
Secure Procedure NP.21.37

General

This chapter gives:

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

Normal Procedures Philosophy and Assumptions

Normal procedures verify for each phase of flight that:

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

Normal procedures are done on each flight. Supplementary procedures are done as needed, for example the adverse weather procedures. (See Introduction on page SP.05.1 for additional information.)

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

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

Normal procedures also assume coordination with the ground crew before:

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

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

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

Configuration Check

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

If there is an incorrect configuration or response:

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

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

- check the Minimum Equipment List (MEL) 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 MEL 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:

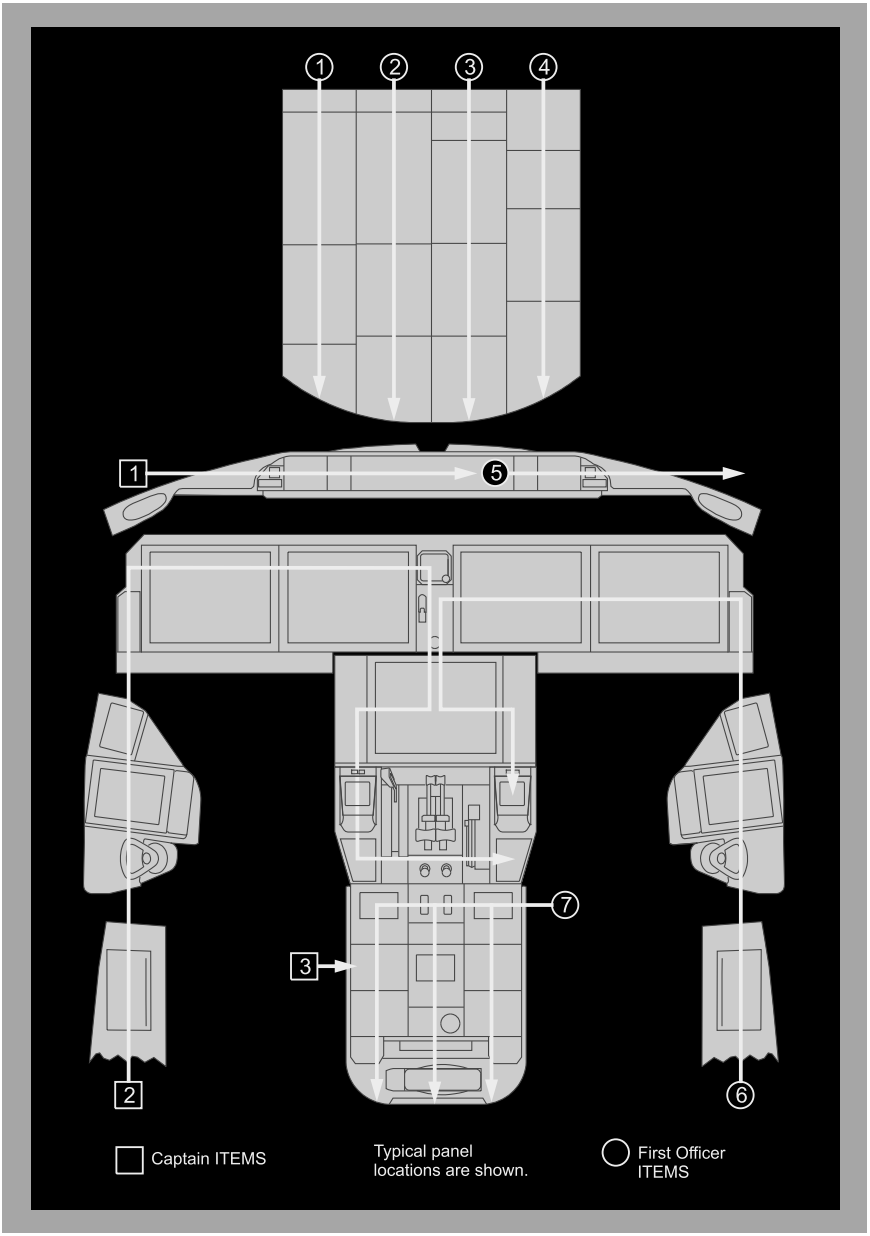
- course
- vertical path
- thrust
- speed.

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

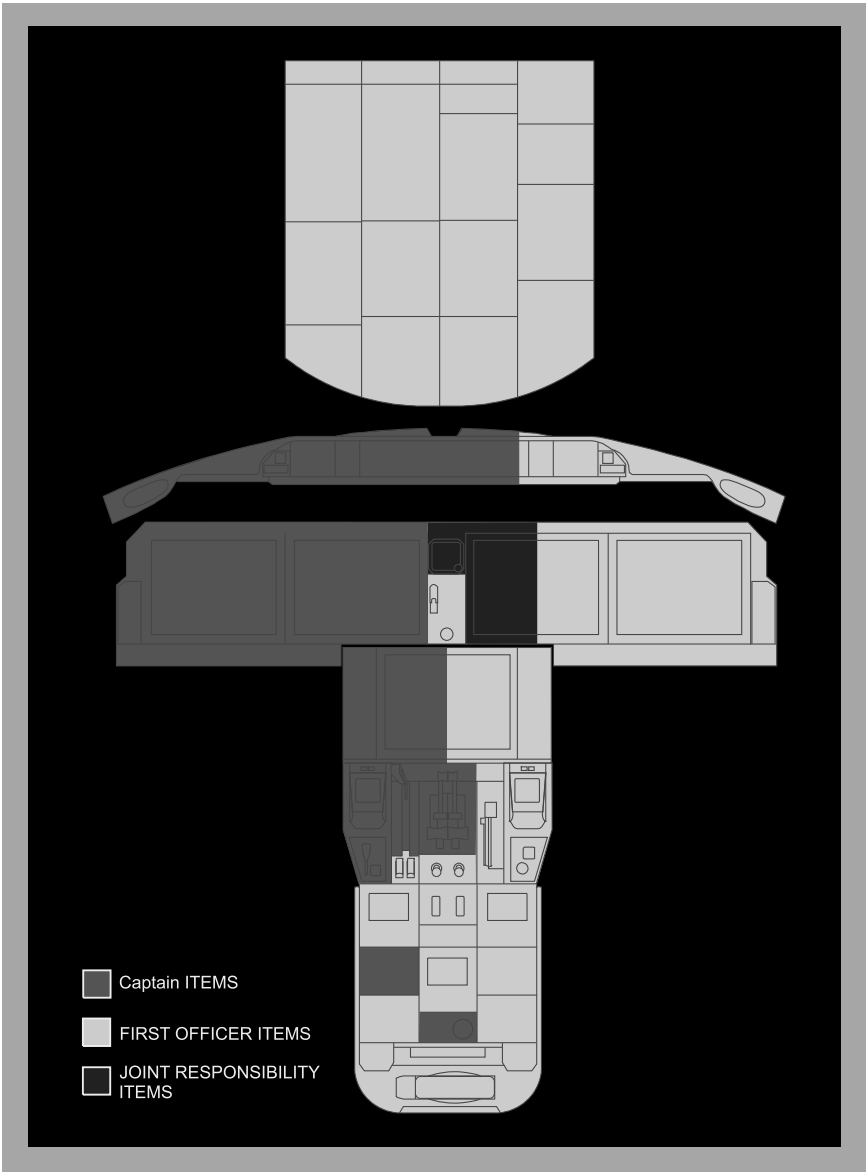
Preflight and Postflight Scan Flow

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

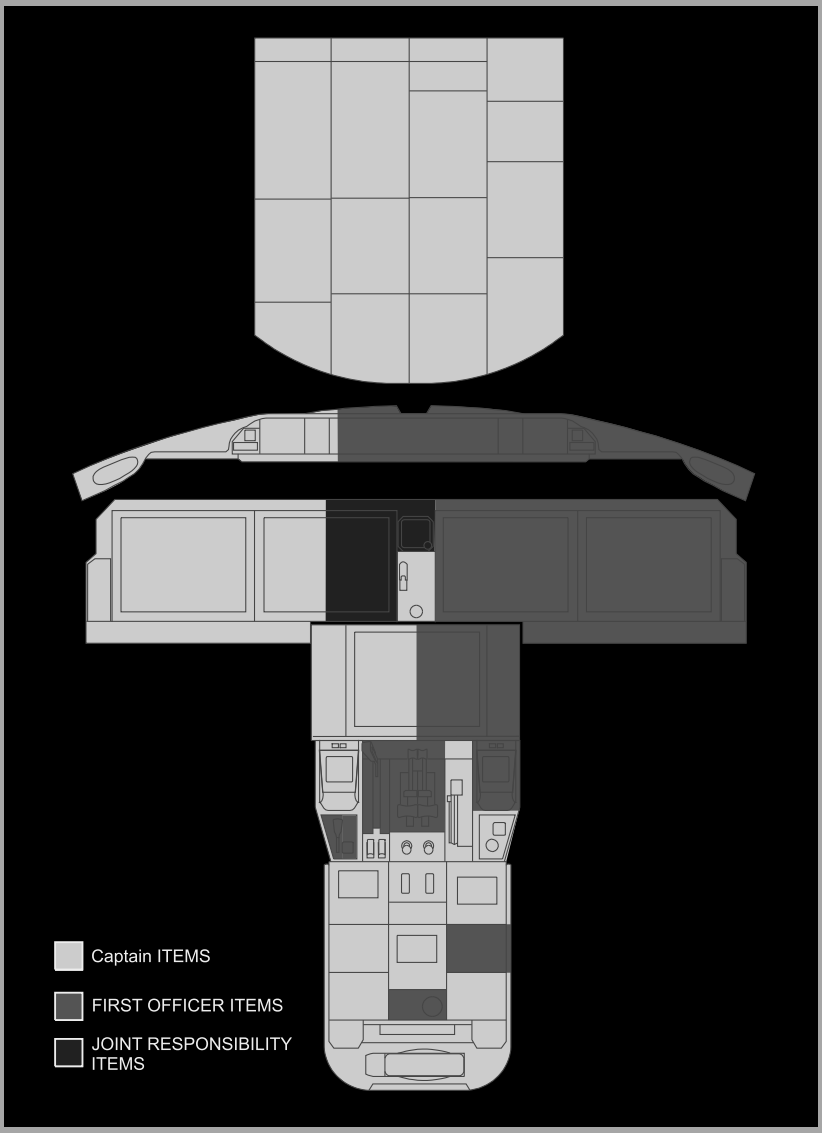
The scan flow diagram provides general guidance on the order each flight crew member should follow when doing the preflight and postflight procedures. Specific guidance on the items to be checked is detailed in the amplified Normal Procedures. For example, preflight procedure details are in the Preflight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


1
2
3
4
1
5
7
3
2
6
Captain ITEMS
Typical panel
locations are shown.
First Officer
ITEMS

Areas of Responsibility—Captain as Pilot Flying or Taxiing



Areas of Responsibility—First Officer as Pilot Flying or Taxiing



Preliminary Preflight Procedure—Captain or First Officer

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

IRS selectors . . . . . OFF 30 seconds, then ON

Verify that the ON BAT light is extinguished.

STATUS display . . . . . Check

Verify that only expected messages are shown.

Verify that the following are sufficient for flight:

- oxygen pressure
- hydraulic quantity
- engine oil quantity.

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

Verify the CREW OXYGEN LOW alert message is blank.

Maintenance documents . . . . . Check

Emergency equipment . . . . . Check

Fire extinguisher—Checked and stowed

Crash axe—Stowed

Flight deck overhead door—Closed and latched

Emergency Descent Devices—Stowed

Other needed equipment—Checked and stowed

Parking brake . . . . . As needed

Set the parking brake to check the brake wear indicators during the exterior inspection.

CDU/EFB Preflight Procedure—Captain and First Officer

Start the CDU/EFB 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/EFB entries. The other pilot must verify the entries.

Enter data in all the boxed items on the following CDU/EFB 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.

Do not load an instrument approach before departure. This prevents unwanted automatic LNAV arming and activation if a TO/GA switch is pushed after takeoff.

Initial Data . . . . . Set

CDU IDENT page:

Verify that the MODEL is correct.

Verify that the ENG RATING is correct.

Verify that the navigation database ACTIVE date range is current.

CDU POS INIT page:

Verify that the time is correct.

Enter the present position on the SET INERTIAL POS line, if needed. Use the most accurate latitude and longitude.

Navigation Data . . . . . Set

CDU RTE page:

Enter the route.

Enter the FLT NO.

ACTIVATE and execute the route.

CDU DEPARTURES page:

Select the runway or HUD TAKEOFF.

Select departure routing.

Execute the runway or HUD TAKEOFF and departure routing.

Note: If a change in HUD TAKEOFF runway is needed, select both flight director switches OFF. After the new runway is executed on the CDU, select the flight director switches back to ON.

POS REF page 2:

Verify the correct RNP for the departure, as needed.

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

Verify or enter the correct RNP for the departure. Enter any changes on POS REF page 2.

NAV RADIO page:

Tune the navigation radios as needed.

Electronic Flight Bag:

Select INITIALIZE FLIGHT.

Verify correct documents are loaded.

Verify databases are current on the EFB IDENT page.

Review FAULTs, MEMOs, and MSGs.

Select TERMINAL CHARTS as needed.

Performance Data . . . . . Set

CDU PERF INIT page:

Enter the ZFW.

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

Verify that the fuel is sufficient for flight.

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

THRUST LIM page:

Verify that the OAT is displayed.

Electronic Flight Bag Onboard Performance Tool (OPT):

Note: Accurate weight, CG, and other performance data must be entered in final EFB performance calculations to ensure accurate data is output to the FMC.

If gross weight CG (%MAC) is at or aft of 25.3, refer to the Aft CG Takeoff in Chapter SP, Section 1 TQA to TQF

If gross weight CG (%MAC) is at or aft of 23.1, refer to the Aft CG Takeoff in Chapter SP, Section 1 TWA,B

Select PERFORMANCE page.

Select COPY FMC DATA and load performance data as needed.

Select CALC to complete the performance calculations.

Review V speeds and engine thrust rating.

Select SEND OUTPUT.

Note: SEND OUTPUT may be accomplished from either EFB. Attempts to SEND OUTPUT simultaneously from both EFBs will be unsuccessful and disable the transfer function.

Select SEND TO FMC to transfer the performance data to the FMC.

Select COMPLETE and verify FMC uplink displays on the FMC TAKEOFF REF page.

CDU TAKEOFF REF pages:

Verify the performance data is correct on the TAKEOFF REF 2/2 and 1/2 pages.

Note: The EO ACCEL HT sent to the FMC is corrected for temperature and barometric setting, and may differ from the value displayed in the EFB Onboard Performance Tool. Use the FMC displayed value.

Select ACCEPT on the TAKEOFF REF 1/2 page.

Exterior Inspection

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

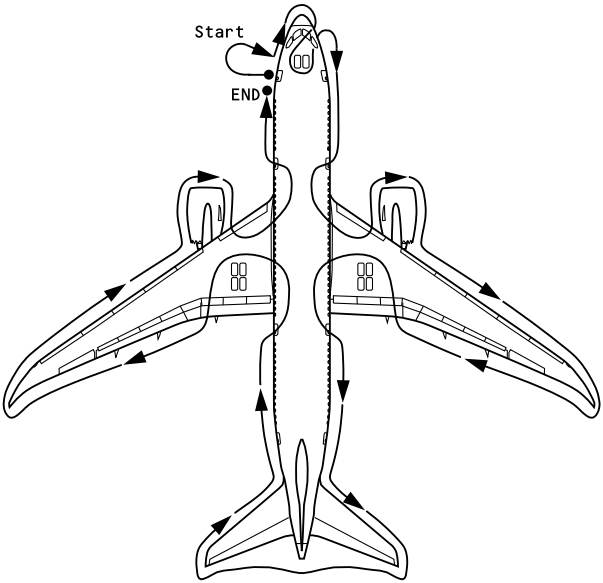
Items at each location may be checked in any sequence.

Use the detailed inspection route below to check that:

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

(See Exterior Inspection on page SP.16.2 for additional information.)

Inspection Route



Left Forward Fuselage

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

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

Forward outflow valve . . . . . Check

Negative pressure relief vents . . . . . Check

Positive pressure relief valves . . . . . Check

Nose

Radome . . . . . Check

Diverter strips—Secure

Forward access door . . . . . Secure

Nose Wheel Well

Tires and wheels . . . . . Check

Gear strut and doors . . . . . Check

Nose wheel steering assembly . . . . . Check

Gear pin . . . . . As needed

Nose gear towing lever . . . . . As needed

Nose gear towing lever pin . . . . . As needed

Exterior lights . . . . . Check

Parking brake light indication . . . . . Check

Wheel well light switch . . . . . As needed

APU remote control panel . . . . . Secure

Right Forward Fuselage

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

Oxygen pressure relief green disc . . . . . In place

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

Negative pressure relief vents . . . . . Check

Right Wing Root, Pack, and Lower Fuselage

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

Exterior lights . . . . . Check

Pack inlet and pneumatic access door . . . . . Secure

CAC inlet and FOD deflector door . . . . . Check

Leading edge slats and flaps . . . . . Check

Right Engine

Access panels . . . . . Latched

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

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

Thrust reverser . . . . . Stowed

Exhaust area and tailcone . . . . . Check

Right Wing and Leading Edge

Access panels . . . . . Latched

Leading edge slats . . . . . Check

Wing Surfaces . . . . . Check

Fuel tank vent . . . . . Check

Right Wing Tip and Trailing Edge

Navigation position and strobe lights . . . . . Check

Static discharge wicks . . . . . Check

Fuel jettison nozzle . . . . . Check

Aileron, flaperon, and trailing edge flaps . . . . . Check

Right Main Gear

Tires, brakes and wheels . . . . . Check

Verify that the wheel chocks are in place as needed.

If the parking brake is set:

The brake wear indicator pins must extend out of the guides.

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

Hydraulic lines and electrical wiring . . . . . Secure

Gear pins . . . . . As needed

Right Main Wheel Well

Wheel well . . . . . Check

Right Aft Fuselage

Ram air turbine door . . . . . Check

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

Aft outflow valve . . . . . Check

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

Tail

Vertical stabilizer and rudder . . . . . Check

Horizontal stabilizer and elevator . . . . . Check

Static discharge wicks . . . . . Check

Navigation position and strobe lights . . . . . Check

APU exhaust outlet . . . . . Check

Access doors . . . . . Latched

Left Aft Fuselage

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

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

Left Main Wheel Well

Wheel well . . . . . Check

Left Main Gear

Tires, brakes and wheels . . . . . Check

Verify that the wheel chocks are in place as needed.

If the parking brake is set:

The brake wear indicator pins must extend out of the guides.

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

Hydraulic lines and electrical wiring . . . . . Secure

Gear pins . . . . . As needed

Left Wing Tip and Trailing Edge

Navigation position and strobe lights . . . . . Check

Static discharge wicks . . . . . Check

Aileron, flaperon, and trailing edge flaps . . . . . Check

Fuel jettison nozzle . . . . . Check

Left Wing and Leading Edge

Wing Surfaces . . . . . Check

Fuel tank vent . . . . . Check

Leading edge slats . . . . . Check

Access panels . . . . . Latched

Left Engine

Exhaust area and tailcone . . . . . Check

Thrust reverser . . . . . Stowed

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

Access panels . . . . . Latched

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

Left Wing Root, Pack, and Lower Fuselage

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

Exterior lights . . . . . Check

Pack inlet and pneumatic access door . . . . . Secure

CAC inlet and FOD deflector door . . . . . Check

Leading edge slats and flaps . . . . . Check

Preflight Procedure—First Officer

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

FLIGHT CONTROL SURFACES panel . . . . . Set

TAIL switch—NORM

WINGS switch—NORM

HEADING REFERENCE switch . . . . . NORM

PRIMARY FLIGHT COMPUTERS DISCONNECT switch . . . . . Guard closed

Verify that the DISC light is extinguished.

ELECTRICAL panel . . . . . Set

BATTERY switch—ON

Verify that the OFF light is extinguished.

IFE/PASS SEATS power switch—ON

Verify that the OFF light is extinguished.

CABIN/UTILITY power switch—ON

Verify that the OFF lights are extinguished.

APU GENERATOR switches—ON

Verify that the OFF light is extinguished.

GENERATOR CONTROL switches—ON

Verify that the OFF lights are illuminated.

Verify that the DRIVE lights are illuminated.

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

Verify that the FAULT light is extinguished.

L HUD BRIGHTNESS control . . . . . In

L WIPER selector . . . . . OFF

TOWING POWER panel lights . . . . . Off

FLIGHT DECK DOOR POWER switch . . . . . ON

CCR RESET switches . . . . . Guards closed

EMERGENCY LIGHTS switch . . . . . Guard closed

SERVICE INTERPHONE switch . . . . . OFF

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

PASSENGER OXYGEN ON light . . . . . Verify extinguished

WINDOW HEAT panel . . . . . Set

BACKUP WINDOW HEAT switches—ON

PRIMARY WINDOW HEAT switches—ON

Verify that the INOP lights are extinguished.

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

RAM AIR TURBINE UNLOCKED light . . . . . Verify extinguished

HYDRAULIC panel . . . . . Set

LEFT and RIGHT ENGINE PRIMARY pump switches—ON

Verify that the FAULT lights are illuminated.

CENTER 1 and CENTER 2 ELECTRIC pump selectors—OFF

Verify that the FAULT lights are illuminated.

LEFT and RIGHT ELECTRIC DEMAND pump selectors—OFF

Verify that the FAULT lights are illuminated.

SEAT BELTS selector . . . . . Set

Lighting panel . . . . . Set

OVERHEAD panel light control—Mid position

MASTER BRIGHTNESS switch—ON

MASTER BRIGHTNESS control—As needed

GLARESHIELD PANEL light control—Mid position

LANDING light switches—OFF

GROUND TEST selector . . . . . NORM

APU fire panel . . . . . Set

Verify that the APU BTL DISCH light is extinguished.

APU fire switch—In

Verify that the APU fire warning light is extinguished.

CARGO FIRE panel . . . . . Set

CARGO FIRE ARM switches—Off

Verify that the FWD and AFT fire warning lights are extinguished.

Verify that the cargo fire DISCH light is extinguished.

ENGINE panel . . . . . Set

EEC MODE switches—NORM

START selectors—NORM

FUEL JETTISON panel . . . . . Set

FUEL JETTISON NOZZLE switches—Off

Verify that the VALVE lights are extinguished.

FUEL TO REMAIN selector—IN

FUEL JETTISON ARM switch—Off

Verify that the FAULT light is extinguished.

FUEL panel . . . . . Set

CROSSFEED switches—OFF

Verify that the VALVE light is extinguished.

FUEL PUMP switches—OFF

Verify that the left aft pump PRESS light is extinguished if the APU is on or is illuminated if the APU is off.

Verify that the other left and right pump PRESS lights are illuminated.

Verify that the center pump PRESS lights are extinguished.

Fuel BALANCE switch—Off

Verify that the ON light and FAULT light are extinguished.

ANTI–ICE panel . . . . . Set

WING anti–ice selector—AUTO

ENGINE anti–ice selectors—AUTO

Lighting panel . . . . . Set

BEACON light switch—OFF

NAVIGATION light switch—As needed

LOGO light switch—As needed

WING light switch—As needed

INDICATOR LIGHTS switch—As needed

RUNWAY TURNOFF light switches—OFF

TAXI light switch—OFF

STROBE light switch—OFF

BROADBAND COMM switch . . . . . As needed

ELT switch . . . . . Guard closed

CARGO TEMPERATURE CONTROL panel . . . . . As needed

FORWARD CARGO TEMPERATURE switch—As needed

If in AUTO, verify that the OFF light is extinguished.

BULK CARGO TEMPERATURE switch—As needed

If in AUTO, verify that the OFF light is extinguished.

AIR CONDITIONING panel . . . . . Set

EQUIPMENT COOLING switches—AUTO

Verify that the OVRD lights are extinguished.

RECIRCULATION FANS switches—ON

FLIGHT DECK TEMPERATURE control—Mid position

CABIN TEMPERATURE control—Mid position

PACK switches—AUTO

Verify that the OFF lights are extinguished if the APU is running.

TRIM AIR switches—ON

Verify that the FAULT lights are extinguished.

VENTILATION switch—NORM

Verify that the ALTN light is extinguished.

PRESSURIZATION panel . . . . . Set

OUTFLOW VALVE switches—AUTO

Verify that the MAN lights are extinguished.

LANDING ALTITUDE selector—IN

R WIPER selector . . . . . OFF

R HUD BRIGHTNESS control . . . . . In

FLIGHT DIRECTOR switch . . . . . ON

Display select panel . . . . . Set

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 selector—IN or HPA

BAROMETRIC selector—Set local altimeter setting

ND mode selector—Select MAP

ND mode select switch—Push

MENU—Select

Map selections—As needed

ND CENTER switch—As needed

ND range selector—0.5, 1, 2 or 5

Displays airport map.

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

ND WXR switch—Off

Verify that the weather radar indications are not shown on the ND or PFD mini-map.

ND TFC and TERR switches—As needed

Oxygen . . . . . Test and set

Oxygen mask . . . . . Stowed and doors closed

RESET/TEST switch . . . . . Push and hold

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

RESET/TEST switch . . . . . Release

TQA to TQF

Normal/100% selector 100%

TWA,B

Emergency/100%/Normal selector 100%

FORWARD PANEL brightness control . . . . . Mid position

INBOARD and OUTBOARD DISPLAY brightness and CONTRAST controls . . . . . Mid position

AIR DATA/ATTITUDE source selector . . . . . AUTO

PFD/MFD selector . . . . . NORM

Do the Initial Data and Navigation Data steps from the CDU/EFB Preflight Procedure and verify that the IRS alignment is complete before checking the flight instruments.

Flight instruments . . . . . Check

Verify that the flight instrument indications are correct.

Verify that only these flags are shown:

- TCAS OFF
- NO VSPD until takeoff V–speeds are selected.

Verify that the flight mode annunciations are correct:

- autothrottle mode is blank
- roll mode is TO/GA or HUD TO/GA
- pitch mode is TO/GA
- AFDS status is FLT DIR.

Select the MAP mode.

Landing gear panel . . . . . Set

Landing gear lever—DN

ALTERNATE GEAR switch—Guard closed

AUTOBRAKE selector—RTO

EICAS display . . . . . Check

Secondary engine indications—Display

Verify that the engine indications show existing conditions.

Verify that no exceedance is shown.

MFD . . . . . Check

Select the status display.

Status messages—Check

CHECKLIST display switch—Push

RESETS—Select

Verify that the AIRLINE DATABASE is correct.

RESET ALL—Select

Left tuning and control panel . . . . . Set

Verify that the OFF light is extinguished.

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

FLIGHT DECK DOOR ACCESS selector . . . . . AUTO

Engine fire panel . . . . . Set

Verify that the ENG BTL 1 DISCH and ENG BTL 2 DISCH lights are extinguished.

Engine fire switches—In

Verify that the LEFT and RIGHT fire warning lights are extinguished.

GLIDESLOPE INHIBIT switch . . . . . BELOW G/S light extinguished

TRANSPONDER MODE selector . . . . . STBY

AURAL CANCEL light . . . . . Extinguished

Center tuning and control panel . . . . . Set

Verify that the OFF light is extinguished.

Flight deck printer . . . . . Set

Verify that the FAIL and PAPER lights are extinguished.

Verify that printer power is ON.

Right tuning and control panel . . . . . Set

Verify that the OFF light is extinguished.

VHF—Select

R VHF—Set

HF—Select

R HF—Set

WEATHER RADAR—Select

GAIN and MODE—As needed

TRANSPONDER—Select

F/O TCAS DISPLAY—As needed

F/O TCAS alt—As needed

VHF—Select

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

FLOOR LIGHTS switch . . . . . As needed

EVACUATION COMMAND switch . . . . . Guard closed

Observer AUDIO selector . . . . . NORM

AISLE STAND PANEL light control . . . . . Mid position

AISLE STAND FLOOD light control . . . . . Mid position

WARNING: Do not put objects between the seat and the aisle stand. Injury can occur when the seat is adjusted.

Seat . . . . . Adjust

Adjust the seat for optimum eye reference.

Rudder pedals . . . . . Adjust

Adjust the rudder pedals to allow full rudder pedal and brake pedal movement. Stow the rudder pedal adjust crank.

WARNING: If the rudder pedal adjust crank is not stowed after use, the rudder pedals may move out of the desired position.

HUD combiner . . . . . Down

HUD BRIGHTNESS control—Adjust

Seat belt and shoulder harness . . . . . Adjust

Do the PREFLIGHT checklist on the captain's command.

Preflight Procedure—Captain

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

EFIS control panel . . . . . Set

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 selector—IN or HPA

BAROMETRIC selector—Set local altimeter setting

ND mode selector—Select MAP

ND mode select switch—Push

MENU—Select

Map selections—As needed

ND CENTER switch—As needed

ND range selector—0.5, 1, 2 or 5

Displays airport map.

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

ND WXR switch—Off

Verify that the weather radar indications are not shown on the ND or PFD mini-map.

ND TFC and TERR switches—As needed

Display select panel . . . . . Set

EICAS TRANSFER switch—As needed

Select EICAS to the desired side.

Mode control panel . . . . . Set

FLIGHT DIRECTOR switch—ON

AUTOTHROTTLE ARM switches—ARM

Autopilot DISENGAGE bar—UP

HEADING/TRACK reference switch—As needed

BANK LIMIT selector—AUTO

VERTICAL SPEED/FLIGHT PATH ANGLE reference switch—As needed

ALTITUDE increment selector—As needed

Oxygen . . . . . Test and set

Oxygen mask . . . . . Stowed and doors closed

RESET/TEST switch . . . . . Push and hold

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

RESET/TEST switch . . . . . Release

TQA to TQF

Normal/100% selector 100%

TWA,B

Emergency/100%/Normal selector 100%

FORWARD PANEL brightness control . . . . . Mid position

INBOARD and OUTBOARD DISPLAY brightness and CONTRAST controls . . . . . Mid position

AIR DATA/ATTITUDE source selector . . . . . AUTO

PFD/MFD selector . . . . . NORM

Do the Initial Data and Navigation Data steps from the CDU/EFB Preflight Procedure and verify that the IRS alignment is complete before checking the flight instruments.

Flight instruments . . . . . Check

Verify that the flight instrument indications are correct.

Verify that only these flags are shown:

- TCAS OFF
- NO VSPD until takeoff V–speeds are selected.

Verify that the flight mode annunciations are correct:

- autothrottle mode is blank
- roll mode is TO/GA or HUD TO/GA
- pitch mode is TO/GA
- AFDS status is FLT DIR.

Select the map mode.

Integrated standby flight display . . . . . Set

Verify that the approach mode display is blank.

Set local altimeter setting.

Verify that the flight instrument indications are correct.

Verify that no flags or messages are shown.

SPEEDBRAKE lever . . . . . DOWN

Reverse thrust levers . . . . . Down

Forward thrust levers . . . . . Closed

Flap lever . . . . . Set

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

Set the flap lever to agree with the flap position.

Parking brake . . . . . Set

Verify that the PARKING BRAKE SET message is shown.

STABILIZER cutout switches . . . . . Guards closed

FUEL CONTROL switches . . . . . CUTOFF

FUEL CONTROL switch fire warning lights . . . . . Verify extinguished

ALTERNATE FLAPS panel . . . . . Set

ALTERNATE FLAPS ARM switch—OFF

ALTERNATE FLAPS selector—OFF

Left tuning and control panel . . . . . Set

WEATHER RADAR—Select

GAIN and MODE—As Needed

TRANSPONDER—Select

CAP TCAS DISPLAY—As needed

CAP TCAS ALT—As needed

VHF—Select

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

WARNING: Do not put objects between the seat and the aisle stand. Injury can occur when the seat is adjusted.

Seat . . . . . Adjust

Adjust the seat for optimum eye reference.

Rudder pedals . . . . . Adjust

Adjust the rudder pedals to allow full rudder pedal and brake pedal movement. Stow the rudder pedal adjust crank.

WARNING: If the rudder pedal adjust crank is not stowed after use, the rudder pedals may move out of the desired position.

HUD combiner . . . . . Down

HUD BRIGHTNESS control—Adjust

Seat belt and shoulder harness . . . . . Adjust

Call “PREFLIGHT CHECKLIST.”

Before Start Procedure

Start the Before Start Procedure after papers are on board.

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

Do the CDU/EFB 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

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

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

Obtain a clearance to pressurize the hydraulic systems.

Obtain a clearance to start the engines.

If pushback is needed:

Nose gear steering . . . . . Verify locked out C

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.

RIGHT ELECTRIC DEMAND pump selector—AUTO

Verify that FAULT light is extinguished.

CENTER 1 and CENTER 2 ELECTRIC pump selectors —AUTO

Verify that the FAULT lights are extinguished.

LEFT ELECTRIC DEMAND pump selector—AUTO

Verify that the FAULT light is extinguished.

Fuel panel . . . . . Set F/O

LEFT and RIGHT FUEL PUMP switches—ON

The PRESS lights are illuminated because of load shedding. If the APU is running, the left aft pump PRESS light is extinguished.

If the FUEL IN CENTER message shows:

CENTER FUEL PUMP switches—ON

Both PRESS lights illuminate until after engine start because of load shedding.

BEACON light switch . . . . . ON F/O

CANCEL/RECALL switch . . . . . Push F/O

Verify that only the expected alert messages are shown.

CANCEL/RECALL switch . . . . . Push F/O

Verify that the messages cancel.

Trim . . . . . Set C

Note: If the target FMC stabilizer takeoff setting is close to the greenband limit, when setting the stabilizer position (STAB), approach the target takeoff STAB setting from the outside of the greenband towards the inside of the greenband. This minimizes nuisance CONFIG STABILIZER messages.

Stabilizer trim—___ UNITS

Set the trim for takeoff.

Verify that the trim is in the greenband.

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.

Ground handling personnel . . . . . Establish communications C

CAUTIONS:
1. **Do not turn the nose wheel tiller during pushback or towing. This can damage the nose gear or the tow bar.**
2. **Do not use airplane brakes to stop the airplane during pushback or towing. This can damage the nose gear or the tow bar.**

Transponder . . . . . XPDR F/O

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

Set or release as directed by ground handling personnel.

When pushback or towing is complete:

Tow bar . . . . . Verify not connected C

Nose gear steering . . . . . Verify not locked out C

Engine Start Procedure

Select the secondary engine indications. F/O

Crew action to correct for abnormal engine indications is not needed.

Respond to any EICAS messages that show.

Note: The engines will not start if external power and the APU are both supplying electric power at the same time. One source must be

selected off. The APU is the preferred electric power source for engine start.

CAUTION: If OAT is above 40 deg. C, do not attempt to start both engines at the same time.

Start sequence . . . . . Announce C

The engines may be started at the same time.

Call “START ____ ENGINE” C

Engine START selector . . . . . START F/O

FUEL CONTROL switch . . . . . RUN C

If the engines were not started at the same time:

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

Before Taxi Procedure

Verify that all engine generator OFF lights are extinguished. . . . . F/O

APU selector . . . . . OFF F/O

ENGINE ANTI–ICE selectors . . . . . As needed F/O

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

Call “FLAPS ___” as needed for takeoff. C

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

Flight controls . . . . . Check C

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

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

- freedom of movement
- that the controls return to center.

Hold the rudder pedal disconnect switch down during the rudder check to prevent 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.

Transponder . . . . . XPDR F/O

Secondary Engine Indications . . . . . Off F/O

Recall . . . . . Check C,F/O

Verify that only expected alert messages are 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:

- run the engines for at least 5 minutes
- use a thrust setting normally used for taxi operations
- engine oil temperature must be above the lower amber band before takeoff.

Pilot Flying	Pilot Monitoring
	Notify the cabin crew to prepare for takeoff. Verify that the cabin is secure.
The pilot who will do the takeoff updates changes to the takeoff briefing as needed.	
Set the weather radar display as needed. Select VSD on 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. Set the transponder mode selector to TA/RA.
Verify that 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 LEFT and RIGHT LANDING light switches to ON.

Pilot Flying	Pilot Monitoring
Advance the thrust levers to approximately 20 TPR. Allow the engines to stabilize.	
Push the TO/GA switch.	
Verify that the correct takeoff thrust is set.	
	Monitor the engine instruments during the 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 thrust, 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 and call out any abnormal indications.
Verify 80 knots and call “CHECK.”	Call “80 KNOTS.”
Verify V1 speed.	Verify the automatic V1 callout or call “V1.”
At VR, rotate toward 15° pitch attitude. After liftoff, follow F/D commands.	At VR call “ROTATE.” Monitor airspeed and vertical speed.
Establish a positive rate of climb.	
	Verify a positive rate of climb on the altimeter and call “POSITIVE RATE.”
Verify a positive rate of climb on the altimeter and call “GEAR UP.”	
	Set the landing gear lever to UP.
Above 400 feet radio altitude, call for a roll mode as needed.	Select or verify the roll mode. Verify VNAV engaged.
Verify that climb thrust is set.	
Verify acceleration at the acceleration height.	

Pilot Flying	Pilot Monitoring
Call “FLAPS___” according to the flap retraction schedule.	
	Set the flap lever as directed.
Engage the autopilot when above the minimum altitude for autopilot engagement.	
	After flap retraction is complete, set the ENGINE ANTI-ICE selectors to AUTO.
Call “AFTER TAKEOFF CHECKLIST.”	
	Do the AFTER TAKEOFF checklist.

Takeoff Flap Retraction Speed Schedule

TQA to TQF

Takeoff Flaps	At “Display”	Select Flaps
20 or 15	"20" or "15"	5
	“5”	1
	“1”	UP
5	"5"	1
	“1”	UP

TWA,B

Takeoff Flaps	At “Display”	Select Flaps
20, 18, 17, 15 or 10	"20", "18", "17", "15", "10"	5
	“5”	1
	“1”	UP
5	"5"	1
	“1”	UP

Climb and Cruise Procedure

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

Pilot Flying	Pilot Monitoring
	During climb or cruise, verify the RNP as needed.
	At or above 10,000 feet MSL, set the LANDING light switches to OFF.
	Set the seatbelt signs as needed.

Pilot Flying	Pilot Monitoring
When climbing above transition altitude, set the altimeters to standard.	
	If the FUEL IN CENTER message shows, set both CENTER FUEL PUMP switches to ON. When the FUEL LOW CENTER message shows, set both CENTER FUEL PUMP switches to OFF.
	Before the top of descent, modify the active route as needed for the arrival and approach.

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
	During the descent, verify the RNP as needed.
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 the approach.	
	Set the NAV RADIO page for the approach.
	Check landing performance.
	Set the AUTOBRAKE selector to the needed brake setting.
Do the approach briefing.	
Call “DESCENT CHECKLIST.”	Do the DESCENT checklist.

Approach Procedure

The Approach Procedure is normally started at transition level.

Complete the Approach Procedure before:

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

- the start of a visual approach.

Do not manually build the approach or add waypoints to the selected FMC procedure. Add cold temperature corrections to waypoint altitude constraints as appropriate. For an instrument approach using IAN, select the G/S prompt OFF if flying an ILS approach where the G/S transmitter is inoperative or when the G/S data is unreliable.

Pilot Flying	Pilot Monitoring
	During arrival and approach, verify the RNP as needed.
	Set the seatbelt signs as needed.
	At or above 10,000 feet MSL, set the LEFT and RIGHT LANDING light switches to ON.
At transition level, set the altimeters.	
Update the arrival and approach, as needed.	
Select VSD on as needed.	
Update the approach briefing as needed.	
Call “APPROACH CHECKLIST.”	Do the APPROACH checklist.

Flap Extension Schedule

Current Flap Position	At Speed Tape “Display”	Select Flaps	Command Speed for Selected Flaps
UP	“UP”	1	“1”
1	“1”	5	“5”
5	“5”	20	“20”
20	20	25 or 30	(VREF 25 or VREF 30) + wind additives

Landing Procedure ILS or GLS

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

Pilot Flying	Pilot Monitoring
	Notify the cabin crew to prepare for landing. Verify that the cabin is secure.
Call “FLAPS___” according to the flap extension schedule.	Set the flap lever as directed.
When on localizer intercept heading: • verify that the navigation radios are tuned and identified • verify that the deviation pointers are shown.	
Arm the APP mode.	
WARNING: When using LNAV to intercept the final approach course, LNAV might parallel the localizer without capturing it. The airplane can then descend on the glideslope with the localizer not captured.	
Use LNAV, HDG SEL/TRK SEL or HDG HOLD/TRK HOLD to intercept the final approach course, as needed.	
Verify that the localizer is captured.	Verify final approach course heading.
	Call “GLIDESLOPE ALIVE.”
At glideslope alive, call: • “GEAR DOWN” • “FLAPS 20.”	
	Set the landing gear lever to DN. Set the flap lever to 20.
Set the speedbrake lever to ARMED.	
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 the final approach fix (LOM, MKR, DME), verify the crossing altitude and crosscheck the altimeters.	
Monitor the approach. Verify the autoland status at 500 feet AGL.	

Landing Procedure—Instrument Approach Using IAN

IAN should be used only for approaches that have one of the following features:

- a published GP angle on the LEGS page for the final approach segment
- a RWxx waypoint at the approach end of the runway

- a missed approach waypoint before the approach end of the runway, (for example, MXxx).

Use of IAN is not recommended when an approach has a visual maneuver segment that is not in the FMC database.

This procedure is not authorized using QFE.

Pilot Flying	Pilot Monitoring
Initially: • If on radar vectors – HDG SEL – Pitch mode (as needed) • If enroute to a fix – LNAV or other roll mode – VNAV or other pitch mode	
	Notify the cabin crew to prepare for landing. Verify that the cabin is secure.
Call “FLAPS___” according to the flap extension schedule.	Set the flap lever as directed.
When on localizer/final approach course intercept heading: • verify that the navigation radios are tuned and identified (as needed) • verify that the deviation pointers are shown.	
Arm the APP mode.	
WARNING: When using LNAV to intercept the final approach course, LNAV might parallel the localizer without capturing it. The airplane can then descend on the glide path with the localizer not captured.	
Use LNAV, HDG SEL, TRK SEL, HDG HOLD, or TRK HOLD to intercept the final approach course as needed.	
Verify that the localizer/final approach course is captured.	
Approximately 2 NM before the final approach fix, call: • “GEAR DOWN” • “FLAPS 20.”	Approximately 2 NM before the final approach fix, call “APPROACHING GLIDE PATH.”
	Set the landing gear lever to DN. Set the flap lever to 20.
Set the speedbrake lever to ARMED.	
At glide path capture, call “FLAPS___” as needed for landing.	Set the flap lever as directed.

Pilot Flying	Pilot Monitoring
Set the missed approach altitude on the MCP.	
Call “LANDING CHECKLIST.”	Do the LANDING checklist.
At the final approach fix, verify the crossing altitude.	
Monitor the approach.	
If suitable visual reference is established at DA(H), MDA(H), or the missed approach point, disengage the autopilot in accordance with regulatory requirements. Maintain the glide path to landing.	

Landing Procedure—Instrument Approach Using VNAV

VNAV should be used only for approaches that have one of the following features:

- a published GP angle on the LEGS page for the final approach segment
- a RWxx waypoint at the approach end of the runway
- a missed approach waypoint before the approach end of the runway, (for example, MXxx)

This procedure is not authorized using QFE.

Pilot Flying	Pilot Monitoring
Initially: • If on radar vectors – HDG SEL – Pitch mode (as needed) • If enroute to a fix – LNAV or other roll mode – VNAV or other pitch mode	
	Notify the cabin crew to prepare for landing. Verify that the cabin is secure.
Call “FLAPS___” according to the flap extension schedule.	Set the flap lever as directed.
The recommended roll modes for the final approach are: • for an RNAV, GPS, VOR or NDB approach use LNAV • for a B/CRS approach use LNAV or B/CRS • for a LOC, SDF, LDA, ILS (G/S off), IGS (G/S off) approach use LNAV or LOC.	

Pilot Flying	Pilot Monitoring
	Verify that the VNAV glide path is shown on the final approach segment of the LEGS page.
When on the final approach course intercept heading for LOC, B/CRS, SDF, or LDA approaches: • verify that the localizer is tuned and identified • verify that the LOC pointer is shown.	
Arm the LNAV or LOC mode.	
WARNING: When using LNAV to intercept the localizer, LNAV might parallel the localizer without capturing it. The airplane can then descend on the VNAV path with the localizer not captured.	
Use LNAV, HDG SEL, TRK SEL, HDG HOLD, or TRK HOLD to intercept the final approach course as needed.	
Verify that LNAV is engaged or that the localizer is captured.	
Approximately 2 NM before the final approach fix and after ALT, VNAV PTH, or VNAV ALT is annunciated. • set DA(H) or MDA(H) on the MCP • select or verify VNAV • select or verify speed intervention.	Approximately 2 NM before the final approach fix, call “APPROACHING GLIDE PATH.”
Call: • “GEAR DOWN” • “FLAPS 20.”	Set the landing gear lever to DN. Set the flap lever to 20.
Set the SPEEDBRAKE lever to ARMED.	
Beginning the final approach descent, call “FLAPS __” as needed for landing.	Set the flap lever as directed.
Call “LANDING CHECKLIST.”	Do the LANDING checklist.
When at least 300 feet below the missed approach altitude, set the missed approach altitude on the MCP.	
At the final approach fix, verify the crossing altitude.	
Monitor the approach.	
If suitable visual reference is established at DA(H), MDA(H), or the missed approach point, disengage the autopilot in accordance with regulatory requirements.	

Pilot Flying	Pilot Monitoring
Maintain the glide path to landing.	

Go-Around and Missed Approach Procedure

Pilot Flying	Pilot Monitoring
At the same time: • push the TO/GA switch • call “FLAPS 20.”	
	Position the flap lever to 20.
Verify: • the rotation to go–around attitude • that the thrust increases.	
	Verify that the thrust is sufficient for the go-around or adjust as needed.
	Verify a positive rate of climb on the altimeter and call “POSITIVE RATE.”
Verify a positive rate of climb on the altimeter and call “GEAR UP.”	
	Set the landing gear lever to UP.
Above 400 feet radio altitude, select or verify a roll mode.	Verify that the missed approach altitude is set.
Verify that the missed approach route is tracked.	
At acceleration height, set speed to the maneuver speed for the planned flap setting.	
Call “FLAPS___” according to the flap retraction schedule.	Set the flap lever as directed.
After flaps are set to the planned flap setting and at or above the flap maneuvering speed, select FLCH or VNAV as needed.	
Verify that climb thrust is set.	
Verify that the missed approach altitude is captured.	
Call “AFTER TAKEOFF CHECKLIST.”	Do the AFTER TAKEOFF checklist.

Landing Roll Procedure

Pilot Flying	Pilot Monitoring
Verify that the thrust levers are closed. Verify that the SPEEDBRAKE lever is UP.	Verify that the 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 raised, a full stop landing must be made. If an engine remains in reverse, safe flight is not possible.	
Without delay, raise the reverse thrust levers to the interlocks and hold light pressure until the interlocks release. Apply reverse thrust as needed.	Verify that the forward thrust levers are closed. When both REV indications are green, call “REVERSERS NORMAL.” If there is no REV indication(s) or the indication(s) stays amber, call “NO REVERSER LEFT ENGINE,” or “NO REVERSER RIGHT ENGINE,” or “NO REVERSERS.”
By 60 KIAS, start movement of the reverse thrust levers to reach the reverse idle detent before taxi speed.	Call “60 KNOTS.”
After the engines are at reverse idle, move the reverse thrust levers to full down.	
Before taxi speed, disarm the autobrake. Use manual braking as needed.	
Before turning off the runway, disconnect the autopilot.	

After Landing Procedure

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

Engine cooldown recommendations:

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

Pilot Flying	Pilot Monitoring
The captain positions or verifies that the SPEEDBRAKE lever is DOWN.	
	Set the APU selector to START, then ON as needed.
	Set the ENGINE ANTI-ICE selectors to ON, if needed.
	Set the exterior lights as needed.
Set the weather radar to off.	
	Set the AUTOBRAKE selector OFF.
	Set the flap lever to UP.
	Set the transponder mode selector to XPDR.

Shutdown Procedure

Start the Shutdown Procedure after taxi is complete.

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

Verify that the PARKING BRAKE SET message is shown.

Electrical power . . . . . Set F/O

If APU power is needed:

Check that the APU RUNNING message is shown.

If external power is needed:

Verify that the FORWARD EXTERNAL POWER L AVAIL light is illuminated.

FORWARD EXTERNAL POWER L switch—Push

Verify that the ON light is illuminated.

If the FORWARD EXTERNAL POWER R AVAIL light is illuminated:

FORWARD EXTERNAL POWER R switch—Push

Verify that the ON light is illuminated.

FUEL CONTROL switches . . . . . CUTOFF C

If towing is needed:

Ground handling personnel . . . . . Establish communications C

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

Nose gear steering . . . . . Verify locked out C

CAUTIONS:
1. **Do not turn the nose wheel tiller during pushback or towing. This can damage the nose gear or the tow bar.**
2. **Do not use airplane brakes to stop the airplane during pushback or towing. This can damage the nose gear or the tow bar.**

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

Set or release as directed by ground handling personnel.

SEAT BELTS selector . . . . . OFF F/O

HYDRAULIC panel . . . . . Set F/O

Left ELECTRIC DEMAND pump selector—OFF

CENTER 1 and CENTER 2 ELECTRIC pump selectors—OFF

RIGHT ELECTRIC DEMAND pump selector—OFF

FUEL PUMP switches . . . . . OFF F/O

BEACON light switch . . . . . OFF F/O

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

TRANSPONDER MODE selector . . . . . STANDBY F/O

EFB CLOSE FLIGHT . . . . . Select C,F/O

Status messages . . . . . Check F/O

Note: Disregard EICAS alert and status messages displayed during the PFC self test after hydraulic shutdown. Wait approximately 3 minutes after HYD PRESS SYS L+C +R message is shown before recording status and alert messages in the maintenance log.

After wheel chocks are in place:

Parking brake . . . . . Release C

APU selector . . . . . As needed F/O

Call “SHUTDOWN CHECKLIST.” C

Do the SHUTDOWN checklist. F/O

Secure Procedure

IRS selectors	OFF	F/O
BATTERY switch	Off	F/O
FLIGHT DECK DOOR POWER switch	OFF	F/O
EMERGENCY LIGHTS switch	OFF	F/O
PACK switches	Off	F/O
EFB PWR switch	Off	C,F/O
HUD combiner	Stow	C,F/O

Note: To prevent the possibility of injury, ensure the combiner is fully raised and securely latched in the stowed position.

CAUTION: **The Power Electronics Cooling System (PECS) requires a cool-down period to prevent damaging the units and degrading the coolant. A wait of up to 22 minutes may be required before removing power. (See Electrical Power Down on page SP.6.1 for additional information.)**

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

Supplementary Procedures — Chapter SP
Table of Contents

Introduction SP.05

General SP.05.1

Airplane General, Emergency Equipment, Doors, Windows SP.1

Aft CG Takeoff SP.1.1

Doors SP.1.2

Entry/Service Door Closing SP.1.2

Entry/Service Door Opening SP.1.2

Emergency Equipment SP.1.2

Emergency Oxygen Use SP.1.2

Flight Deck Door Access System Test SP.1.3

Air Systems SP.2

Air Conditioning Packs SP.2.1

Ground Conditioned Air Use SP.2.1

Automatic Pressurization Control - Departure Airport Elevation At or Above 8,000 Feet SP.2.1

Automatic Pressurization Control - Landing Airport Elevation At or Above 8,000 Feet SP.2.2

Anti-Ice, Rain SP.3

Anti-Ice Operation SP.3.1

Windshield Washer Use SP.3.1

Windshield Wiper Use SP.3.1

Automatic Flight SP.4

AFDS SP.4.1

AFDS Operation SP.4.1

Heading Hold SP.4.1

Heading Select SP.4.1

Track Hold SP.4.1

Track Select SP.4.2
Altitude Hold SP.4.2
Flight Level Change, Climb or Descent SP.4.2
Vertical Speed, Climb or Descent SP.4.2
Flight Path Angle, Climb or Descent SP.4.3
Autothrottle Operation SP.4.3
Instrument Approach Using Vertical Speed (V/S) or Flight Path Angle (FPA) SP.4.4
Circling Approach SP.4.6
Instrument Approach—RNAV (RNP) AR SP.4.6
Preflight Procedure SP.4.7
Pre-approach Requirements SP.4.7
Cruise Procedure SP.4.8
Descent Procedure SP.4.8
Approach Procedure SP.4.8
Landing Procedure SP.4.9
Alternate Go-Around and Missed Approach Procedure SP.4.10

Communications SP.5

Cabin/SATCOM Conferencing SP.5.1
Flight Deck Communications System (Datalink) SP.5.1
Pre-Departure Clearance SP.5.1
Digital-Automatic Terminal Information Service SP.5.1
Oceanic Clearances SP.5.2
Weight and Balance SP.5.2
Takeoff Data SP.5.2

Electrical SP.6

Electrical Power Down SP.6.1
Electrical Power Up SP.6.1

Engines, APU SP.7

Ground Power Engine Start SP.7.1

Flight Instruments, Displays SP.10

Heading Reference Switch Operation SP.10.1

QFE Operation SP.10.1

Flight Management, Navigation SP.11

Alignment/Position Update SP.11.1

Departure or Destination Airport Not in the FMC Navigation Database SP.11.1

Departure Airport Not in the FMC Navigation Database SP.11.2

Destination Airport Not in the FMC Navigation Database . . . SP.11.3

FMS Position Update SP.11.4

Navaid Inhibit SP.11.5

RNP Manual Entry SP.11.6

Fuel SP.12

Fuel Balancing SP.12.1

Adverse Weather SP.16

Introduction SP.16.1

Takeoff—Wet or Contaminated Runway Conditions SP.16.1

Cold Weather Operations SP.16.1

Preliminary Preflight Procedure—Captain or First Officer . . . SP.16.1

Exterior Inspection SP.16.2

Preflight Procedure—First Officer SP.16.3

Engine Start Procedure SP.16.3

Engine Anti-ice Operation—On the Ground SP.16.4

Before Taxi Procedure SP.16.4

Taxi–Out SP.16.5

De-icing/Anti-icing SP.16.5

Before Takeoff Procedure SP.16.6

Takeoff Procedure SP.16.6

Engine Anti-ice Operation—In-flight SP.16.7

Fan Ice Removal SP.16.7

Wing Anti-ice Operation—In-flight SP.16.8
Cold Temperature Altitude Corrections SP.16.8
After Landing Procedure SP.16.10
Secure Procedure SP.16.12
Hot Weather Operation SP.16.12
Moderate to Heavy Rain, Hail or Sleet SP.16.13
Operation in a Sandy or Dusty Environment SP.16.13
Exterior Inspection SP.16.13
Taxi-Out SP.16.14
Takeoff SP.16.15
Landing SP.16.15
Taxi-In SP.16.15
Secure Procedure SP.16.15
Severe Turbulence SP.16.16
Structural Considerations SP.16.16
Climb, Cruise, and Descent Considerations SP.16.16
Manual Flight in Severe Turbulence SP.16.17
Windshear SP.16.17
Avoidance SP.16.17
Precautions SP.16.17
Recovery SP.16.19
Ice Crystal Icing (ICI) SP.16.19
Recognize Ice Crystal Icing SP.16.19
Avoiding Ice Crystal Icing SP.16.20
Ice Crystal Icing Suspected SP.16.21

Emergency SP.17

Introduction SP.17.1
Crew Duties SP.17.1
Takeoff and Landing Preparation SP.17.1
Cabin Ready for Takeoff SP.17.1
Cabin Ready For Landing SP.17.1

Communication—Summary of the Cabin Calls SP.17.2
Normal Calls SP.17.2
Emergency Calls SP.17.3
When Emergency Declared SP.17.4
Preparation—Emergency Landing/Ditching SP.17.5
Briefing Passengers SP.17.5
Demonstrating Life Vest/Brace for Impact SP.17.5
Securing the Passengers and the Cabin SP.17.5
Preparing Survival Equipment SP.17.5
Selecting Able-Bodied Passengers SP.17.5
Crash Protection SP.17.6
Protection of Infants SP.17.6
Brace for Impact—Seating Position SP.17.7
Brace-for-Impact Signals SP.17.7
Evacuation SP.17.8
Evacuation Signal/Order SP.17.8
Initial Evacuation Stage SP.17.8
Redirecting Passengers SP.17.9
Slide/Raft Portability SP.17.9
Unprepared Emergency SP.17.16
Evacuation SP.17.16
On Ground Fires SP.17.16

Loading SP.18

Limitations SP.18.1
Allowable Gross Weights SP.18.1
Mean Aerodynamic Chord and Balance Limits SP.18.1
Cargo Compartments SP.18.2
Crew and Passenger SP.18.3
Configuration SP.18.6
Version Numbering System SP.18.6
Examples of Interior Configuration SP.18.6

Weight & Balance SP.18.6
Weight Calculation SP.18.6
Balance Calculation—General SP.18.7
Examples of Balance Table SP.18.8

General

This chapter contains procedures (adverse weather operation, and so on) that are 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, are usually accomplished by memory. Infrequently used procedures, not normally accomplished are usually accomplished by reference.

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

Aft CG Takeoff

Airplane operations with an aft CG configuration require additional considerations to accommodate the effects of reduced nose gear steering effectiveness. The procedures in this section supplement the normal procedures and should be observed when applicable.

The combination of aft CG, rapid thrust application, and sudden brake release can result in reduced directional control during the initial takeoff phase. Crosswinds and runway contamination can cause further reduction of directional control. If the value of CG (%MAC) is at or greater (more aft) than the value in the table below, the following procedures must be applied to ensure directional control during takeoff roll:

TQA to TQF

787-8	Gross Weight (1000 KG)							
	108	120	140	160	180	200	220	240 or greater
CG (%MAC)	25.3	27.2	30.5	33.6	36.0	37.5	37.5	37.5

TWA,B

787-9	Gross Weight (1000 KG)							
	108	120	140	160	180	200	220	240 or greater
CG (%MAC)	23.1	24.7	27.4	29.8	32.1	34.4	36.8	37.5

- Use reduced thrust whenever possible.
- Release brakes before increasing engine thrust above idle.

CAUTION: If a static engine run-up is needed before brake release, do not exceed 55% N1. Do not release the brakes with N1 greater than 55%. A tip-up can occur and directional control can be reduced.

- Crosswind capability may be reduced if brakes are released above 20 TPR. (Crosswind limits are determined by the operator. If the operator uses Boeing takeoff crosswind guidelines as limits, reduce crosswind limits by 5 knots when brakes are released above 20 TPR).
- Maintain forward pressure on the control column until 80 knots to increase nose wheel steering effectiveness. Above 80 knots, relax the column pressure to the neutral position.

Doors

Entry/Service Door Closing

Gust lock latch . . . . . Release

Door . . . . . Close

Manually position the door aft and inboard to cover the entry.

Door handle . . . . . Rotate

Rotate forward 180° to the closed position. The door lowers into position, latches, and locks.

Verify the door locked indicator is illuminated.

Door mode select lever . . . . . Automatic mode

Observe automatic mode symbolic indicator is illuminated.

Entry/Service Door Opening

Door mode select lever (interior only) . . . . . Manual mode

Observe manual mode symbolic indicator is illuminated.

Note: Escape slide/raft and powered door opening is disarmed automatically when the door is opened from outside.

Door handle . . . . . Rotate

Rotate aft 180° to the open position. The door is lifted clear of the pressure stops.

Door . . . . . Open

Manually position the door outboard and forward to open. The gust lock latch automatically engages and locks door in the open position.

Emergency Equipment

Emergency Oxygen Use

Emergency oxygen should be used when necessary to provide positive pressure in the masks and goggles to prevent or evacuate contaminants. When positive pressure is not required, but contamination of flight deck air exists, 100% oxygen must be used. If prolonged use is required and the situation permits, oxygen availability should be extended by selecting normal flow. When oxygen use is no longer required, close the left hand oxygen compartment door, then push the RESET/TEST switch to restore normal boom microphone operation.

Flight Deck Door Access System Test

Note: (See Flight Deck Security Door on page L.10.2 for additional information.)

Flight deck door . . . . . Open

Flight deck door access selector . . . . . AUTO

Flight deck door power switch . . . . . OFF

At least 20 seconds after the switch is selected to OFF, verify FD DOOR LOCK FAIL EICAS advisory message shows.

Flight deck door power switch . . . . . ON

Verify FD DOOR LOCK FAIL EICAS advisory message blanks.

Emergency access code . . . . . Enter

ENT key . . . . . Push

Verify FD DOOR AUTO UNLOCK EICAS warning message shows, master WARNING lights are on, and aural alert sounds.

Flight deck door access selector . . . . . DENY

Verify FD DOOR AUTO UNLOCK EICAS warning message blanks.

Flight deck door access selector . . . . . UNLKD

Air Conditioning Packs

Ground Conditioned Air Use

Before connecting ground conditioned air:

PACK switches (both) . . . . . OFF

Packs can be damaged if they are operated while ground conditioned air is connected.

LOWER RECIRC FAN switch . . . . . OFF

This step allows conditioned air unit to operate at maximum efficiency.

After disconnecting ground conditioned air:

PACK switches (both) . . . . . AUTO

LOWER RECIRC FAN switch . . . . . ON

Automatic Pressurization Control - Departure Airport Elevation At or Above 8,000 Feet

Note: The HIGH CABIN ALT MODE memo message shows when the departure elevation is at or above 9,650 feet. When this memo is shown, the CABIN ALTITUDE warning limit is raised to as high as 15,600 feet (depending on the departure airport elevation).

If departure elevation is above 10,000 feet or the HIGH CABIN ALT MODE memo message shows:

Oxygen mask and regulator . . . . . ON, Normal

Note: Supplemental oxygen must be used from departure until the cabin altitude is below 10,000 feet and the HIGH CABIN ALT MODE memo message blanks.

Crew communications . . . . . Establish

Once the airplane is airborne, the pressurization system starts lowering the cabin altitude according to the normal pressurization schedule.

Monitor cabin altitude and cabin rate indications during climbout to confirm that the cabin is pressurizing as described above. The EICAS cabin altitude information can be displayed by selecting the AIR synoptic on any MFD.

After the cabin altitude descends below 9,650 feet, the pressurization system automatically changes the CABIN ALTITUDE warning limit to the normal setpoint of 10,000 feet.

Automatic Pressurization Control - Landing Airport Elevation At or Above 8,000 Feet

Note: The HIGH CABIN ALT MODE memo message shows at top of descent when the landing airport elevation is at or above 9,650 feet. When this memo shows, the CABIN ALTITUDE warning limit is raised to as high as 15,600 feet (depending on the landing airport elevation).

Accomplish normal procedures except as modified below:

At top of descent:

If landing elevation is above 10,000 feet or the HIGH CABIN ALT MODE memo message shows:

Oxygen masks and regulators . . . . . ON, Normal

Note: Supplemental oxygen must be used anytime the cabin altitude is above 10,000 feet or the HIGH CABIN ALT MODE memo message shows.

Crew communications . . . . . Establish

Monitor cabin altitude and cabin rate indications during descent to confirm cabin altitude is climbing above 6,000 feet to match the landing airport elevation. The EICAS cabin altitude information can be displayed by selecting the AIR synoptic on any MFD.

Anti-Ice Operation

Note: (See Cold Weather Operations on page SP.16.1 for additional information.)

Windshield Washer Use

Note: Do not use windshield wipers on dry windows.

Windshield Washer switch (as required) . . . . . Push

Windshield Wiper selector . . . . . As required

Windshield Wiper Use

CAUTION: Windshield scratching will occur if the windshield wipers are operated on a dry windshield.

AFDS

AFDS Operation

FLIGHT DIRECTOR switches . . . . . ON

Verify FLT DIR is displayed in the AFDS system status annunciator.

If the autopilot is desired:

AUTOPILOT engage switch . . . . . Push

Verify A/P is displayed in the AFDS system status annunciator.

Heading Hold

If the airplane is operating in polar regions:

HEADING REFERENCE switch . . . . . TRUE

HEADING/TRACK reference switch . . . . . Push

Verify HDG is displayed in the HDG/TRK window.

Heading/track HOLD switch . . . . . Push

Verify HDG HOLD is displayed in the roll mode annunciator.

Heading Select

Maintains the airplane heading the same as the selected heading.

If the airplane is operating in polar regions:

HEADING REFERENCE switch . . . . . TRUE

HEADING/TRACK reference switch . . . . . Push

Verify HDG is displayed in the HDG/TRK window.

Heading/track SELECT switch . . . . . Push

Verify HDG SEL is displayed in the roll mode annunciator.

Heading/track selector . . . . . Rotate

Set desired heading in the HDG/TRK window.

Track Hold

If the airplane is operating in polar regions:

HEADING REFERENCE switch . . . . . TRUE

HEADING/TRACK switch . . . . . Push

Verify TRK is displayed in the HDG/TRK window.

Heading/track HOLD switch . . . . . Push

Verify TRK HOLD is displayed in the roll mode annunciator.

Track Select

Maintains the airplane track the same as the selected track.

If the airplane is operating in polar regions:

HEADING REFERENCE switch . . . . . TRUE

HEADING/TRACK reference switch . . . . . Push

Verify TRK is displayed in the HDG/TRK window.

Heading/track SELECT switch . . . . . Push

Verify TRK SEL is displayed in the roll mode annunciator.

Heading/track selector . . . . . Rotate

Set desired track in the HDG/TRK window.

Altitude Hold

Altitude HOLD switch . . . . . Push

Verify ALT is displayed in the pitch mode annunciator.

Flight Level Change, Climb or Descent

ALTITUDE selector . . . . . Rotate

Set the desired altitude in the MCP ALTITUDE window.

FLCH switch . . . . . Push

Verify FLCH SPD is displayed in the pitch mode annunciator.

IAS/MACH selector . . . . . Rotate

Set the desired speed in the IAS/MACH window.

Vertical Speed, Climb or Descent

ALTITUDE selector . . . . . Rotate

Set the desired altitude in the MCP ALTITUDE window.

VERTICAL SPEED/FLIGHT PATH ANGLE reference switch . . . . . Push

Verify V/S is displayed in the vertical speed/flight path angle window.

VERTICAL SPEED/FLIGHT PATH ANGLE switch . . . . . Push

Verify V/S is displayed in the pitch mode annunciator.

VERTICAL SPEED/FLIGHT PATH ANGLE selector . . . . . Rotate

Set the desired vertical speed in the VERTICAL SPEED/FLIGHT PATH ANGLE window.

If a climb is desired:

Select climb thrust limit on the CDU THRUST LIM page.

Flight Path Angle, Climb or Descent

ALTITUDE selector . . . . . Rotate

Set the desired altitude in the MCP ALTITUDE window.

VERTICAL SPEED/FLIGHT PATH ANGLE Reference switch . . . . . Push

Verify FPA is displayed in the vertical speed/flight path angle window.

VERTICAL SPEED/FLIGHT PATH ANGLE switch . . . . . Push

Verify FPA is displayed in the pitch mode annunciator.

VERTICAL SPEED/FLIGHT PATH ANGLE selector . . . . . Rotate

Set the desired flight path angle in the VERTICAL SPEED/FLIGHT PATH ANGLE window.

If a climb is desired:

Select climb thrust limit on the CDU THRUST LIM page.

Autothrottle Operation

AUTOTHROTTLE ARM switches . . . . . ARM

If the pitch mode is TO/GA:

TO/GA switch . . . . . Push

Verify that THR REF is displayed in the autothrottle mode annunciator. THR REF changes to HOLD at 80 knots.

If the pitch mode is ALT, V/S, FPA, G/S, G/P, or no pitch mode:

AUTOTHROTTLE engage switch . . . . . Push

Verify that SPD is displayed in the autothrottle mode annunciator.

If a constant speed is desired:

IAS/MACH selector . . . . . Rotate

Set the desired speed in the IAS/MACH window.

If climb or continuous thrust is desired:

CLB CON switch . . . . . Push

Verify that THR REF is displayed in the autothrottle mode annunciator.

If FLCH or VNAV is desired:

FLCH or VNAV switch . . . . . Push

Verify that THR REF, THR, SPD, IDLE, or HOLD as appropriate is displayed in the autothrottle mode annunciator.

If TO/GA is desired:

TO/GA switch . . . . . Push

The pitch mode changes to TO/GA. Verify that THR or THR REF is displayed in the autothrottle mode annunciator.

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

AUTOTHROTTLE engage switch . . . . . Push

Verify THR REF, THR, SPD, IDLE, or HOLD as appropriate is displayed in the autothrottle mode annunciator.

Instrument Approach Using Vertical Speed (V/S) or Flight Path Angle (FPA)

Pilot Flying	Pilot Monitoring
Initially: • If on radar vectors – HDG SEL – Pitch mode (as needed) • If enroute to a fix – LNAV or other roll mode – VNAV or other pitch mode.	
Call "FLAPS___" according to the flap extension schedule.	Set the flap lever as directed.

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

Recommended roll modes:

- RNAV, GPS, B/CRS, VOR or NDB approach: LNAV, TRK SEL, or HDG SEL
- B/CRS approach: LNAV, B/CRS, TRK SEL, or HDG SEL
- LOC, SDF, or LDA approach: LOC or LNAV.

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

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

Use LNAV or other roll mode to intercept the final approach course as needed.	
Approximately 2 NM before the final approach fix, set the first intermediate altitude constraint or MDA(H). If constraints or MDA(H) do not end in zero zero (00) for example, 1820, set the MCP ALTITUDE window to the closest 100 foot increment below the constraint or the closest 10 foot increment above the MDA(H). When the current constraint is assured, set the next constraint before ALT is engaged to achieve a continuous descent path.	Approximately 2 NM before the final approach fix, call "APPROACHING GLIDE PATH."
Call: • "GEAR DOWN" • "FLAPS 20"	Set the landing gear lever to DN. Set the flap lever to 20.
Set the speedbrake lever to ARMED.	

At descent point:

Call "FLAPS___" as needed for landing.	Set the flap lever as directed.

V/S or FPA switch . . . . . Push

Verify V/S or FPA mode annunciates.

Desired V/S or FPA . . . . . Set

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

Call "LANDING CHECKLIST."	Do the LANDING checklist.

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:

Disengage the autopilot in accordance with regulatory requirements.

Circling Approach

If a missed approach is needed at any time while circling, make an initial climbing turn toward the landing runway and intercept the missed approach course.

Configuration at MDA(H):

- gear down
- flaps 20 (landing flaps optional)
- speedbrake armed.

MCP Altitude selector . . . . . Set

Accomplish an instrument approach, establish suitable visual reference, and level off at MDA(H).

Verify ALT or VNAV ALT mode annunciates.

Select ALT HOLD as needed.

MCP Altitude selector . . . . . Set Missed Approach Altitude

HDG SEL/HDG HOLD or TRK SEL/TRK HOLD switch . . . . . Push

Verify HDG SEL/HDG HOLD or TRK SEL/TRK HOLD mode annunciates.

Before starting the turn to base:

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

Intercepting the landing profile:

Autopilot disengage switch . . . . . Push

Instrument Approach—RNAV (RNP) AR

Notes: 1. Operators need approval to conduct RNAV (RNP) AR Instrument Approaches.

2. For RNAV (GPS) and RNAV (GNSS) procedures use the Landing Procedure—Instrument Approach using IAN or Landing Procedure—Instrument Approach using VNAV in Normal Procedures.
3. This procedure is not authorized using QFE.

The procedure below supplements normal Preflight, Cruise, Descent and Approach Procedures and replaces the Landing Procedure.

Preflight Procedure

Review RNP availability predictions.

Pre-approach Requirements

Airplane equipment required to begin the approach:

- 2 A/Ps or 2 F/Ds (SINGLE SOURCE F/D alert not shown)
- 2 PFD/MFD Displays (PFD mini-map may be used).

Verify the following EICAS alerts are not shown:

- FMC VERIFY POSITION
- GND PROX SYS
- NAV AIR DATA SYS
- NAV INERTIAL SYS
- NAV IRU
- NAV SINGLE GPS
- NAV UNABLE RNP
- SGL SOURCE RAD ALT
- SINGLE FMC
- TERR POS.

Note: Go-around/missed approach is required if the NAV UNABLE RNP or FMC VERIFY POSITION alert is displayed unless suitable visual reference is established and maintained.

Do the following prior to starting the approach:

- verify that the approach RNP is equal to or greater than 0.10 (F/D or A/P)
- verify that the winds are within limits published for the approach (if applicable)
- verify that the reported airport temperature is within published limits for the approach
- review the maximum IAS for each segment of the approach as determined by aircraft category and applicable regulatory airspeed requirements
- set current local altimeter (remote altimeter settings not allowed).

Cruise Procedure

Pilot Flying	Pilot Monitoring
	When selecting the approach from the navigation database verify ACT RTE LEGS page matches the charted approach. If there is an “at or above” altitude restriction before the FAF, it may be changed to an “at” altitude restriction using the same altitude. Speed modifications are allowed as long as the maximum published speed is not exceeded.

Descent Procedure

Pilot Flying	Pilot Monitoring
In the approach briefing include speed and altitude restrictions, missed approach, engine failure, and unable RNP procedures.	Select or verify VOR/DME NAV OFF on POS REF page 3. Inhibit other navaids as needed per NOTAM.

Approach Procedure

Complete the Approach Procedure before the initial approach fix, or the start of radar vectors to the final approach course.

Notes: 1. When receiving radar vectors from ATC, intercept course modifications may be used to join the LNAV path at any point on initial, intermediate, or missed approach segments.

2. Direct to modifications are not permitted when:
   - the fix is the beginning of an RF leg
   - the fix is the Final Approach Fix (FAF) for the procedure

Pilot Flying	Pilot Monitoring
	On the RNP PROGRESS page verify RNP for the approach.
Select VSD on.	

3. The vertical RNP is set to 125 feet by default. While there are no vertical RNP values published on the approach chart, the use of 125 feet will cause the NPS amber deviation exceedance alert to occur at 75 feet or slightly less deviation, since vertical ANP will be at least 50 feet at all times.

Landing Procedure

Pilot Flying	Pilot Monitoring
Initially • If on radar vectors – HDG SEL – Pitch mode (as needed) • If enroute to a fix – LNAV or other roll mode – VNAV or other pitch mode	
	Notify the cabin crew to prepare for landing. Verify that the cabin is secure.
Select TERR on map. Select ACT RTE LEGS page.	Select TERR or WXR on map.
Use LNAV and VNAV or other pitch mode for initial descent. VNAV is required FAF inbound. Some approach procedures can require use of VNAV from the IAF onward. On intercept heading, arm or verify LNAV.	
Call "FLAPS ___" according to the flap extension schedule or approach speed constraint.	Set the flap lever as directed.
Approximately 2 NM before the final approach fix and after ALT or VNAV PTH or VNAV ALT is annunciated: • set DA(H) on the MCP • select or verify VNAV • select or verify speed intervention.	Call “APPROACHING GLIDE PATH.”
Maximum Lateral Deviation (XTK ERROR): NPS amber indication or 1 × RNP. Maximum Vertical Deviation—FAF to DA: 75 feet. Monitor NPS.	
Approaching glide path, call: • “GEAR DOWN” • “FLAPS 20.”	Set the landing gear lever to DN. Set the flap lever to 20.
Set the SPEEDBRAKE lever to ARM.	
Beginning the final approach descent, call “FLAPS ___” as needed for landing.	Set the flap lever as directed.
Call “LANDING CHECKLIST.”	Do the LANDING checklist.

Pilot Flying	Pilot Monitoring
When at least 300 feet below the missed approach altitude, set the missed approach altitude on the MCP.	
At the final approach fix, verify the crossing altitude matches the charted value within 100 feet.	
Monitor the approach.	
If suitable visual reference is established at DA(H), disengage the autopilot in accordance with regulatory requirements. Maintain the glide path to landing.	

Alternate Go-Around and Missed Approach Procedure

This procedure provides steps to use flaps 5 as an alternate flap setting during a go-around from a flaps 25 approach only.

Notes: 1. This procedure is not authorized from a flaps 30 approach.

2. If a landing at greater than maximum landing weight is needed, do the Overweight Landing checklist and use flap settings from that checklist.

Do the normal Go-Around and Missed Approach Procedure with the following modifications:

Pilot Flying	Pilot Monitoring
At the same time: • push the TO/GA switch • call “FLAPS 5”.	
	Position the FLAP lever to 5.
Above 400 feet radio altitude, select or verify a roll mode.	Verify that the missed approach altitude is set. Verify flaps 5.

Cabin/SATCOM Conferencing

The cabin communications system does not have direct SATCOM calling capability. The following procedure allows the flight crew to facilitate a cabin/SATCOM conference call. (See Satellite Communication (SATCOM) System on page 5.20.5 for additional information.)

Note: The first two procedure steps may be performed in any order.

Establish communication with desired SATCOM ground station.

Establish cabin interphone communication with the cabin crew.

Select both CAB and SAT transmitter select switches on the observer ACP.

Notes:
1. With both CAB and SAT transmitter select switches active on the same ACP, a SATCOM conference is established between the cabin crew and ground station.
2. The conferencing ACP is unusable by the flight crew for other communications while cabin/SATCOM conference is in progress.

Monitor cabin/SATCOM conference on captain or first officer ACP.

When call is completed, terminate SATCOM connection on TCP.

Flight Deck Communications System (Datalink)

The following procedures are one means which may be used to verify Pre-Departure Clearance, Digital-Automatic Terminal Information Service (D-ATIS), Oceanic Clearances, Weight and Balance and Takeoff Data messages transmitted via the COMPANY format.

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 that the D-ATIS altimeter setting numeric value and alpha value are identical. If the D-ATIS altimeter setting numeric value and alpha value are different, or the alpha value is not present, the flight crew must verify the altimeter setting by other means.

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 that the Weight and Balance numeric and alphabetic values are identical. If the Weight and Balance numeric and alphabetic values are different, the flight crew must not accept the Weight and Balance data.

Takeoff Data

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

Electrical Power Down

The following procedure is accomplished to remove all electrical power from the airplane.

IRS selectors . . . . . OFF

BATTERY switch . . . . . OFF

EMER LIGHTS switch . . . . . OFF

PACK switches . . . . . OFF

Verify HYD PRESS SYS L+C+R message is displayed.

CAUTION: The APU or external power must remain ON for the specified cool-down period following pack and hydraulic EMP shutdown. The cool-down period allows the Power Electronics Cooling System (PECS) to remain powered, dissipating residual heat from the liquid-cooled LRUs. With the APU providing power, or with both forward external power receptacles connected and switches selected ON, wait 10 minutes before removing power. With one forward external power receptacle connected and switch selected ON, wait 22 minutes before removing external power.

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

EXTERNAL POWER switches . . . . . OFF

External power sources . . . . . Removed

Verify that all external power AVAIL lights are extinguished.

Electrical Power Up

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

Note: Electrical power initialization is described in Chapter 1, Airplane General. (See Common Core System on page 1.40.1 for additional information.)

BATTERY switch . . . . . ON

C1 and C2 ELEC pump selectors . . . . . OFF

DEMAND pump selectors . . . . . OFF

WIPER selectors . . . . . OFF

Landing gear lever . . . . . DN

ALTN FLAPS selector . . . . . OFF

Electrical power . . . . . Establish

If external power is desired:

EXT PWR AVAIL light(s)—Illuminated

EXT PWR switch(es)—Push

If APU power is desired:

APU GENERATOR switches—ON

Note: Prior to APU start, wait 15 seconds after the left CCR is online (left CCR online is indicated by the captain's inboard and lower display unit showing the default formats).

APU selector—START, then ON

Note: The MAIN BATTERY LOW message can show when power is established. The main battery is charging, and when the battery charge is sufficient for takeoff, the message blanks.

Ground Power Engine Start

This procedure assumes the APU is not available for engine start. Engine starts from ground power require the forward left and right external power sources to be providing power. The aft external power source may also be used, if available. This reduces electrical load shedding during the start of the right engine.

Note: During ground power starts, expect significant equipment reconfigurations and electrical load shedding while the first engine is starting. This includes F/O displays, EFB, right CCR, MCP, and numerous cabin loads. Audio control panel receive and transmit selections may be lost. Reselect if needed after the first engine is running.

If three external power sources are used, start the right engine first to reduce load shedding.

Note: Attempting ground power start with cabin temperatures above 46 deg. C may be unsuccessful due to PECS overheat during start.

External power sources . . . . . Connect

Select FWD EXT PWR L and FWD EXT PWR R switches ON.

Select AFT EXT PWR switch ON, if available.

Note: Advise the cabin to expect the loss of some cabin functions during engine start.

Start the first engine.

After the first engine start is complete:

External power sources . . . . . Disconnect

Verify that all external power AVAIL lights are illuminated.

Disconnect external power sources.

Use normal procedures to start the remaining engine.

Heading Reference Switch Operation

Use TRUE when operating in a region where true referencing is needed.

Use NORM in all other regions.

HEADING REF switch . . . . . NORM or TRUE

Notes:

1. If the HEADING REF switch position is changed for a HUD takeoff, change it before the HUD TAKEOFF runway is selected.
2. If the HEADING REF switch position is changed after the HUD TAKEOFF runway is selected:
   - heading on the ISFD will not change when the HEADING REF switch position is changed
   - HUD TO/GA guidance can be degraded
   - selecting both flight director switches OFF exits the HUD TO/GA mode. This restores normal operation of the HEADING REF switch and the AFDS. The flight directors may be selected ON to restore the HUD TO/GA mode.
3. If using HDG SEL or TRK SEL and the HEADING REF switch position is changed, the AFDS roll mode will change to HDG HOLD or TRK HOLD, respectively. HDG SEL or TRK SEL may be reselected.
4. If the HEADING REF switch position is changed for an approach, change it before the APP mode is armed.
5. If the HEADING REF switch position is changed after the APP mode is armed:
   - the AFDS roll mode will not change from HDG SEL or TRK SEL to HDG HOLD or TRK HOLD respectively
   - the AFDS will not follow the MCP-selected heading
   - LOC capture, and FAC capture, and tracking performance can be degraded
   - exiting the APP mode restores normal operation of the HEADING REF switch and the AFDS. APP mode can be reselected.

QFE Operation

This procedure is accomplished when ATC altitude assignments are referenced to QFE altimeter settings.

Note: Do not use LNAV and/or VNAV below transition altitude/level. Altitudes in the navigation database are not referenced to QFE. Use only raw data for navigation.

CDU APPROACH REF page . . . . . Select

LANDING REF key—Push

Verify QFE selected.

This sets the landing altitude to zero.

Altimeters . . . . . Set

Set altimeters to QFE when below transition altitude/level.

If the QFE altimeter setting is beyond the range of the altimeters:

QNH procedures must be used with QNH set in the altimeters.

Alignment/Position Update

If a position update is desired during an automatic realignment (on ground only):

CDU . . . . . SET

When dash prompts appear on the SET INERTIAL POS line of the POS INIT page:

Enter the most accurate position. Entry may be accomplished by selecting latitude/longitude from LAST POS, REF AIRPORT, GATE, GPS POS, or making a manual entry.

If a manual alignment is desired (on ground only):

IRS selectors . . . . . OFF 30 seconds, then ON

Wait an additional 30 seconds.

CDU . . . . . SET

Enter the present position on the SET INERTIAL POS line, if needed.

If box prompts appear on the SET INERTIAL POS line:

The most accurate latitude and longitude must be entered.

Alignment requires from six to fifteen minutes depending on latitude (six minutes at the equator, ten minutes average).

Departure or Destination Airport Not in the FMC Navigation Database

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

- cabin pressurization schedule
- availability of departure, arrival, and approach procedures in the FMC
- automatic tuning of VOR, DME, and ILS radios for departure, arrival, and approach procedures
- format of altitudes and flight levels on the ND and CDU
- barometric transition altitude alerts (amber display and box) on the PFD
- landing altitude reference bar (white/amber bar) on the PFD altitude tape
- landing altitude indication (amber crosshatched area) on the PFD altitude tape.

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

Departure Airport Not in the FMC Navigation Database

CDU Preflight Procedure—Captain and First Officer

RTE key . . . . . Select

If ORIGIN contains an ICAO identifier:

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

INIT REF key . . . . . Select

INDEX . . . . . Select

IDENT . . . . . Select

Inactive date range . . . . . Select

ACTIVE date range . . . . . Select

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

Clear the NAV DATA OUT OF DATE scratchpad message.

Inactive date range . . . . . Select

ACTIVE date range . . . . . Select

Transfers the inactive navigation database to the ACTIVE line.

Verify the ACTIVE date range is current.

RTE key . . . . . Select

Leave ORIGIN blank.

DEST . . . . . Enter

Route . . . . . Enter

LEGS key . . . . . Select

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

ACTIVATE and execute the route.

VNAV key . . . . . Select

Shows the CLB page.

TRANS ALT . . . . . Enter

NAV RAD key . . . . . Select

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

LDG ALT selector . . . . . Pull

Rotate to set the departure airport altitude manually. This reduces crew workload in the event of a return to the departure airport.

Do **not** accomplish the following checklist:

LANDING ALTITUDE

After engine start, override the LANDING ALTITUDE checklist.

Notes: 1. The LDG ALT flag is shown on the PFD.

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

3. The landing altitude indication (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 selector . . . . . Push

The FMC sets the destination altitude automatically.

VNAV key . . . . . Select

NEXT PAGE key . . . . . Select

FORECAST . . . . . Select

Displays the DESCENT FORECAST page.

TRANS LVL . . . . . Enter

Overwrites the manually entered departure airport transition altitude.

Destination Airport Not in the FMC Navigation Database

CDU/EFB Preflight Procedure—Captain and First Officer

The following steps can also be done in flight.

LEGS key . . . . . Select

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

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

ACTIVATE (if needed) and execute the route.

Before Descent

VNAV key . . . . . Select

NEXT PAGE key . . . . . Select

FORECAST . . . . . Select

Displays the DESCENT FORECAST page.

TRANS LVL . . . . . Enter

LDG ALT selector . . . . . Pull

Rotate to set the destination airport altitude manually.

Do **not** accomplish the following checklist:

LANDING ALTITUDE

Override the LANDING ALTITUDE checklist.

Notes: 1. The LDG ALT flag is shown on the PFD.

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

3. The landing altitude indication (amber crosshatched area) is not shown on the PFD altitude tape during landing.

4. The ARRIVALS page is not available for the destination airport.

Before Approach

NAV RAD key . . . . . Select

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

Note: To create a reference on the ND map, on the FIX INFO page, enter the latitude and longitude of the runway threshold and enter the reciprocal of the final approach course as a bearing. This creates a dashed green line, aligned with the final approach course on the ND map.

FMS Position Update

When the message FMC VERIFY POSITION shows:

The FMC position may require updating.

INIT REF key . . . . . Select

POS . . . . . Select

POS REF page . . . . . Select

POS REF is the second page of POS INIT.

Compare the FMS positions with the displayed GPS, RADIO, and INERTIAL positions.

Select the most appropriate source for FMC position updating.

ARM . . . . . Select

The ARM prompt changes to ARMED and NOW prompts appear to the right of the remaining position sources.

Appropriate source NOW . . . . . Select

Navaid Inhibit

INIT REF key . . . . . Select

INDEX key . . . . . Select

POS . . . . . Select

POS REF page . . . . . Select

POS REF is the third page of POS INIT.

To inhibit GPS updating:

Note: For terminal operations, if the airspace, FMC database, and charts are not referenced to the WGS-84 datum, inhibit GPS updates unless other appropriate procedures are used.

GPS NAV . . . . . Select

Verify GPS NAV OFF selected.

To inhibit DME/DME updating:

DME/DME . . . . . Select

Verify DME/DME OFF selected.

To inhibit VOR/DME updating:

VOR/DME . . . . . Select

Verify VOR/DME OFF selected.

To inhibit localizer updating:

LOC NAV . . . . . Select

Verify LOC NAV OFF selected.

To inhibit data from a specific navaid:

INIT REF key . . . . . Select

INDEX key . . . . . Select

NAV DATA . . . . . Select

Using scratchpad, enter identifiers of specific navaids or VORs to be inhibited on the NAVAID INHIBIT or VOR ONLY INHIBIT lines.

RNP Manual Entry

The FMC automatically supplies appropriate RNP values based on phase of flight. When the airplane is on a procedure or airway that has an RNP requirement, and does not have an RNP value stored in the navigation database, a manual RNP entry may be made.

PROG key . . . . . Select

RNP PROGRESS page . . . . . Select

RNP PROGRESS is the fourth page of PROGRESS.

If the displayed RNP is different from the RNP for the current airway or procedure:

RNP . . . . . Enter

When the manually entered RNP is no longer required:

PROG key . . . . . Select

RNP PROGRESS page . . . . . Select

RNP PROGRESS is the fourth page of PROGRESS.

RNP . . . . . Delete

Fuel Balancing

If a fuel leak is suspected, accomplish the Fuel Leak checklist.

The fuel balance system is inhibited (not available) if any of these occur:

- the fuel balance system is failed
- a center tank pump is on
- on the ground and one or both engines are running
- in flight and the fuel jettison system is active, or the FUEL DISAGREE or FUEL QTY LOW message shows.

If fuel balancing is desired while the airplane is on the ground, and both engines are shutdown:

One fuel pump in the higher quantity tank . . . . . ON

FUEL BALANCE switch . . . . . Push and hold for 1 second

The fuel balance system may take up to 30 seconds to activate.

When fuel balance is complete:

FUEL PUMPS AFT and FWD switches (all) . . . . . Off

If fuel balancing is desired and fuel balance operation is not inhibited:

FUEL BALANCE switch . . . . . Push and hold for 1 second

The fuel balance system may take up to 30 seconds to activate.

If fuel balancing is desired in flight or on the ground, and fuel balance operation is inhibited with 1 or 2 engines running:

FUEL CROSSFEED switch . . . . . On

If the left main tank quantity is low:

L FUEL PUMPS AFT and FWD switches (both) . . . . . Off

This allows fuel from the higher quantity tank to feed both engines.

Do not accomplish the following checklists:

- FUEL PUMP L AFT
- FUEL PUMP L FWD.

If the right main tank quantity is low:

R FUEL PUMPS AFT and FWD switches (both) . . . . . Off

This allows fuel from the higher quantity tank to feed both engines.

Do not accomplish the following checklists:

- FUEL PUMP R AFT
- FUEL PUMP R FWD.

When fuel balancing is complete:

FUEL PUMPS AFT and FWD switches (all) . . . . . ON

FUEL CROSSFEED switch . . . . . Off

Introduction

Airplane operation in adverse weather conditions may require additional considerations due to the 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.

Cold Weather Operations

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 deg. C or below, and any of the following exist:

- visible moisture (clouds, fog with visibility of one statute mile (1,600 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 deg. C. Do not use engine or wing anti-ice when displayed TAT (in-flight) is above 10 deg. 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 (1,600 m) or less, rain, snow, sleet, ice crystals, and so on) in icing conditions and the temperature stayed 3 deg. C or below:

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 Aircraft Maintenance Manual (AMM)
- the engine was run up to a minimum of 20 TPR (42% N1) for at least 30 seconds during taxi-in, less than 5 minutes before engine shutdown.

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 (3 mm) in thickness, on lower wing surfaces due to cold fuel is allowable; however, all leading edge devices, all control surfaces, and upper wing surfaces must be free of snow, ice and frost.

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

Pitot probes and static ports . . . . . Check

Verify that all pitot probes and static ports are free of snow and 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 static ports are clear.

Air conditioning inlets and exits . . . . . Check

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

Engine inlets . . . . . Check

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

Fuel tank vents . . . . . Check

Verify that all traces of ice and 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 must be free of snow and ice before APU start.

Preflight Procedure—First Officer

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

- during the hydraulic panel preflight, if all electric pump selectors are found selected ON and the APU is running, maintenance personnel may have performed a maintenance procedure for cold weather hydraulic system warm-up.
- if maintenance personnel have performed the cold weather hydraulic system warm-up procedure, leave the electric pump selectors ON and the APU running. This ensures all four hydraulic electric pumps remain operating and the hydraulic fluid remains warmed.
- during the Before Start Procedure, select all electric pumps AUTO and resume normal procedures for operation of the hydraulic systems.

Note: If the fuel temperature is less than or equal to −17 deg. C, and if the electric hydraulic pump selectors are in the AUTO or OFF position for more than 10 minutes prior to engine hydraulic pump operation, notify maintenance personnel.

Engine Start Procedure

Do the normal Engine Start Procedure with the following considerations:

- oil pressure may be slow to rise
- initial oil pressure rise may be higher than normal
- additional warm-up time may be needed to allow oil temperature to reach the normal range.
- 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 both engines are started and remain on during all ground operations when icing conditions exist or are anticipated, except when the temperature is below –40 deg. 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 engine damage or failure.

CAUTION: Do not use engine anti-ice when OAT is above 10 deg. C.

When engine anti-ice is needed:

ENGINE ANTI-ICE selectors . . . . . ON F/O

Confirm that “EAI” is shown on the primary engine display for both engines.

Confirm that “EAI” is shown on the primary engine display for both engines. If the EAI indication is blank, confirm the area behind the airplane is clear, then increase thrust until EAI indication shows (no more than 10% above idle). Confirm the EAI indication shows, then resume normal thrust management.

When engine anti-ice is no longer needed:

ENGINE ANTI-ICE selectors . . . . . AUTO or OFF F/O

If ice detection is available:

Position the selectors to AUTO.

If ice detection is inoperative:

Position the selectors to OFF.

Before Taxi Procedure

Do the normal Before Taxi Procedure with the following modifications:

If there is snow or ice accumulation on the wing:

Consider delaying the flight control check until after de-icing/anti-icing is accomplished.

If taxi route is through ice, snow, slush or standing water in low temperatures or if precipitation is falling with temperatures below freezing:

Taxi out with the flaps up. Taxiing with the flaps extended subjects the flaps and flap drives to contamination. Leading edge devices are also susceptible to slush accumulations.

Call “FLAPS ___” as needed. C

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

Taxi–Out

CAUTIONS:

1. **Taxi at a reduced speed. Use smaller tiller and rudder inputs, and apply minimum thrust smoothly. Differential thrust may be used to help maintain airplane momentum during turns. At all other times, apply thurst evenly. Taxiing on slippery taxiways or runways at excessive speed or with high crosswinds may start a skid.**
2. **Precautions must be taken for jet blast up to 600 feet (200 meters) behind the aircraft, snow and ice at the edge of the taxiway that can be ingested by the engines, slippery taxi surfaces, and airport noise restrictions.**

In icing conditions with visible moisture (fog with visibility of one statue mile (1600 m) or less, rain, snow, sleet, ice crystals, and so on), do the following procedure:

If OAT is at or below 3 deg. C and at or above -7 deg. C:

Check that the area behind the airplane is clear C

Run-up to a minimum of 20 TPR (42% N1) for at least 30 seconds at intervals no greater than 60 minutes.

If OAT is below -7 deg. C:

Check that the area behind the airplane is clear C

Run-up to a minimum of 20 TPR (42% N1) for at least 30 seconds within 60 minutes.

If takeoff is not completed within 60 minutes after the first runup, manually de-ice the engines before takeoff.

Note: If the time since the last de-icing procedure or run-up is more than 60 minutes, the engine must be de-iced per the AMM procedure.

De-icing/Anti-icing

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

CAUTION: **Operate the APU during de-icing only if necessary. Ingestion of snow, slush, ice, or de-icing/anti-icing fluid can cause 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 areas.

PACK switches . . . . . OFF F/O

After de-icing/anti-icing is completed:

APU . . . . . As needed F/O

PACK switches . . . . . AUTO F/O

Flight Controls . . . . . Check, as needed C

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 because of slush, standing water, or icing conditions, or because of exterior de-icing/anti-icing.

Engine oil temperature . . . . . Above amber limit PF

Oil temperature must be above the amber limit before takeoff.

Takeoff Procedure

Do the normal Takeoff Procedure with the following modification:

When engine anti-ice is required and the OAT is 3 deg. C or below:

The takeoff must be preceded by a static engine run-up. Use the following procedure:

Run-up to a minimum of 50% N1 and a maximum of 55% N1 for at least 2 seconds to shed any possible ice on the fan.

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 deg. C SAT.

CAUTION: Do not use engine anti-ice when displayed TAT is above 10 deg. 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 selectors . . . . . ON PM

Confirm that “EAI” is shown on the primary engine display for both engines. If not displayed, avoid icing conditions.

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

ENGINE ANTI-ICE selectors . . . . . AUTO or OFF PM

If ice detection is available:

Position the selectors to AUTO.

If ice detection is inoperative:

Position the selectors to OFF.

Fan Ice Removal

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

If moderate to severe icing conditions are encountered:

During flight in moderate to severe icing conditions for prolonged periods, if fan icing is suspected due to high engine vibration, the fan blades must be cleared of any ice. Do the following procedure on both engines, one engine at a time: quickly reduce thrust to idle for 5 seconds then restore the required thrust. If vibration persists, advance thrust lever to Max Climb N1 for at least 2 seconds, then resume normal thrust management.

Wing Anti-ice Operation—In-flight

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

The wing anti-ice system is mainly used to prevent icing in flight. The primary method is to use the automatic ice detection system to control wing anti-ice operation automatically throughout the entire flight envelope. This automatic mode uses a combination of symmetric slat anti-ice and de-icing functions to provide the cleanest airfoil surface, the least possible runback ice formation, and the least thrust and fuel penalty.

The secondary method is to select the WING ANTI-ICE selector ON when wing icing is possible and use for anti-icing.

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

Manual Use of Wing Anti-ice

When manual use of wing anti-ice is needed:

WING ANTI-ICE selector . . . . . ON PM

Confirm that “WAI” is shown on the primary engine display for both engines. If not displayed, avoid icing conditions.

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

WING ANTI-ICE selector . . . . . AUTO or OFF PM

If ice detection is available:

Position the selector to AUTO.

If ice detection is inoperative:

Position the selector to OFF.

The WING ANTI-ICE OFF advisory message is shown when the WING ANTI-ICE selector is in the OFF position.

Cold Temperature Altitude Corrections

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

Apply the altitude correction table when needed:

- apply corrections to all published minimum departure, en route 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
- corrections apply to QNH and QFE operations.

To determine the correction from the Altitude Correction Table:

- subtract the elevation of the altimeter barometric reference setting source (normally the departure or destination airport elevation) from the published minimum altitude to be flown to determine “height above altimeter reference source”
- 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
- enter the table with Airport Temperature and with “height above altimeter reference source.” Read the correction where these two entries intersect. Add the correction to the published minimum altitude to be flown to determine the corrected indicated altitude to be flown. To correct an altitude above the altitude in the last column, use linear extrapolation (e.g., to correct 6000 feet or 1800 meters, use twice the correction for 3000 feet or 900 meters, respectively). The corrected altitude must always be greater than the published minimum altitude
- do not correct altimeter barometric reference settings.

An altitude correction due to cold temperature is not needed for the following conditions:

- while under ATC radar vectors
- when maintaining an ATC assigned flight level (FL)
- when the reported airport temperature is above 0°C or if the airport temperature is at or above the minimum published temperature for the procedure being flown.

Note: Regulatory authorities may have other requirements for cold temperature altitude corrections.

Altitude Correction Table (Heights and Altitudes in Feet)

Airport Temp deg. C	Height Above Altimeter Reference Source											
	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1000 feet	1500 feet	2000 feet	3000 feet
0	20	20	30	30	40	40	50	50	60	90	120	170
–10	20	30	40	50	60	70	80	90	100	150	200	290

Airport Temp deg. C	Height Above Altimeter Reference Source											
	200 feet	300 feet	400 feet	500 feet	600 feet	700 feet	800 feet	900 feet	1000 feet	1500 feet	2000 feet	3000 feet
−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 deg. C	Height Above Altimeter Reference Source											
	60 MTRS	90 MTRS	120 MTRS	150 MTRS	180 MTRS	210 MTRS	240 MTRS	270 MTRS	300 MTRS	450 MTRS	600 MTRS	900 MTRS
0	5	5	10	10	10	15	15	15	20	25	35	50
−10	10	10	15	15	20	20	25	30	30	45	60	90
−20	10	15	20	25	25	30	35	40	45	65	85	130
−30	15	20	25	30	35	40	45	55	60	85	115	170
−40	15	25	30	40	45	50	60	65	75	110	145	220
−50	20	30	40	45	55	65	75	80	90	135	180	270

After Landing Procedure

CAUTIONS:

1. **Taxi at a reduced speed. Use smaller tiller and rudder inputs, and apply minimum thrust smoothly. Differential thrust may be used to help maintain airplane momentum during turns. At all other times, apply thrust evenly. Taxiing on slippery taxiways or runways at excessive speed or with high crosswinds may start a skid.**
2. **Precautions must be taken for jet blast up to 600 feet (200 meters) behind the aircraft, snow and ice at the edge of the taxiway that can be ingested by the engines, slippery taxi surfaces, and airport noise restrictions.**

Do the normal After Landing Procedure with the following modifications:

DELETION

Do not retract the flaps and slats after landing if any of the following conditions occur:

- flight with flaps or slats extended was prolonged (for example, due to extended maneuvering, holding, or missed approach) in icing conditions before landing

- an accumulation of airframe ice is suspected (for example, indicated by wing anti-ice active during the approach)
- engine anti-ice is needed on the ground
- operation in icing conditions on a runway, or taxiway, observed as contaminated.

Post-flight inspection by qualified personnel is needed to ensure the flap and slat areas are free of ice and contaminants before retracting the flaps and slats.

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 deg. 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 engine damage or failure.

CAUTION: Do not use engine anti-ice when OAT is above 10 deg. C.

When engine anti-ice is needed:

ENGINE ANTI-ICE selectors . . . . . ON F/O

Confirm that “EAI” is shown on the primary engine display for both engines.

When engine anti-ice is no longer needed:

ENGINE ANTI-ICE selectors . . . . . AUTO F/O

In icing conditions with visible moisture (fog with visibility of one statute mile (1600m) or less, rain, snow, sleet, ice crystals, and so on), and OAT is 3 deg. C or below, do the following procedure:

Check that the area behind the airplane is clear. C

Run-up to a minimum of 20 TPR (42% N1) for at least 30 seconds at intervals no greater than 60 minutes.

If the run-up procedure is not done (either it cannot be done, or time to gate is less than 60 minutes) do one of the following:

Record the taxi-in time without an engine run-up in the airplane logbook or other approved document.

Do the run-up procedure less than 5 minutes before the arrival at the gate and record this in the airplane logbook or other approved document.

Secure Procedure

Do the normal Secure Procedure with the following modifications:

If the flaps are not retracted, make an entry in the airplane logbook or other approved document: "Flaps and slats left extended because of icing conditions. Inspection is needed by qualified personnel before flap and slat retraction."

Note: Cold weather maintenance procedures for securing the airplane, including post-inspection flap and slat retraction, are needed in icing conditions. These procedures are found in the approved AMM.

If the airplane will be attended:

PACK switches . . . . . AUTO F/O

Use normal air conditioning procedures, with all packs, trim air, and recirculation fans on, to provide cabin heating.

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 switches . . . . . MAN F/O

OUTFLOW VALVE MANUAL switches . . . . . CLOSE F/O

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

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

Parking brake . . . . . Released C

Reduces the possibility of frozen brakes.

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

Hot Weather Operation

During extended ground operations prior to flight deck preparation, consideration should be given to reducing the heat being generated on the flight deck. Window heat, radar, and other electronic components which contribute to a high temperature level on the flight deck may be turned off. All the flight deck air outlets should be open.

Both packs should be used (when possible) for maximum cooling. Recirculation fans should be on for maximum cooling capacity. To maximize the cooling capacity of the air conditioning system, all doors, including cargo doors, should be kept closed as much as possible. All gasper outlets should be open. Passenger cabin windows should be fully dimmed. Flight deck cooling can be

improved by closing the flight deck door and lowering the side trays adjacent to the pilot seats.

CAUTION: Recirculation fans must remain ON unless a non-normal checklist or supplementary procedure directs to select them off.

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 be avoided.

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 rain.

Air conditioning inlets and exits . . . . . Check

Verify that the air inlets and exits are free of sand and dust.

Verify that the cabin pressure outflow valves and both positive pressure relief valves 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 Procedures—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 conditioner, as much as possible. If the packs must be used for air conditioning, maintain a temperature as high as possible while still providing a tolerable flight deck and cabin environment.

Taxi-Out

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

- Use all engines during taxi and taxi at low speed. Limit ground speed to 10 knots and maintain thrust below 40% N1 whenever possible to avoid creating engine vortices 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.
- 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 full fixed derate and/or assumed temperature thrust reduction that meets performance requirements.
- Before 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 allow.

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.
- If performance allows, minimize the use of reverse thrust to prevent ingestion of dust and sand and to prevent reduction of visibility. Reverse thrust is most effective at high speed.

Taxi-In

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

- Use all engines and taxi at low speed. Limit ground speed to 10 knots and maintain thrust below 40% N1 whenever possible.
- Maintain a greater than normal separation from other aircraft while taxiing and avoid the ingestion of another engine's wake.
- Avoid engine overhang of unprepared surfaces.
- 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.

Secure Procedure

Do the normal Secure Procedure with the following modifications:

OUTFLOW VALVE switches . . . . . MAN F/O

OUTFLOW VALVE MANUAL switches . . . . . 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.

Severe Turbulence

The turbulent air penetration speed provides ample protection from stall and high speed buffet, while also providing protection from exceeding the structural limit. (See AFM Limitations on page L.10.1 or additional information.)

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

Passenger signs . . . . . ON

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

Structural Considerations

Flap extension in an area of known turbulence should be delayed as long as possible because the airplane can withstand higher gust loads in the clean configuration. Diversion to another airfield is recommended if severe turbulence persists in the area.

Climb, Cruise, and Descent Considerations

After takeoff, and when established in a clean climb configuration, use of the autoflight system is recommended for flight through turbulence.

During climb and descent, use of VNAV or flight level change may result in excessive pitch changes as the AFDS attempts to fly speed with the elevators. Therefore, vertical speed mode (speed on autothrottles) is recommended for climb and descent in severe turbulence.

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

In severe turbulence during cruise, it may be necessary to disconnect the autothrottles to prevent excessive thrust changes. Thrust setting guidance is available on EICAS when VNAV is engaged. Set TPR at or slightly above the magenta VNAV target TPR indication. Change thrust setting only if required to modify an unacceptable speed trend.

Manual Flight in Severe Turbulence

If manual flight in severe turbulence becomes necessary, trim the airplane for the turbulent air penetration speed. 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 Non-Normal Maneuvers section 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 (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 an approach.

Precautions

If windshear is suspected, be 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. Flaps 15 may be used as a

TQA to TQF

precautionary setting and will provide nearly equivalent performance to Flaps 20.

TWA,B
- For optimum takeoff performance, use flaps 20 for takeoff unless limited by obstacle clearance and/or climb gradient. Flaps 15, 17, or 18 may be used as a precautionary setting and will provide nearly equivalent performance to Flaps 20.
- Use the longest suitable runway provided it is clear of areas of known windshear.
- Use the flight director after takeoff.
- Consider increasing 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 and airspeed build-up. Closely monitor vertical flight path instruments such as vertical speed and altimeters. The pilot monitoring should be especially aware of vertical path instruments and call out any deviations from normal.
- Should airspeed fall below the trim airspeed, unusual control column forces may be required to maintain the desired pitch attitude. If stick shaker is encountered, reduce pitch attitude. Do not exceed the Pitch Limit Indication.

Approach and Landing

- Use either 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 the crosswind or tailwind limitations. Use ILS G/S, VNAV path or VASI/PAPI indications to detect flight path deviations and help with timely detection of windshear.
- If the autothrottle is disengaged, or is planned to be disengaged prior to landing, add an appropriate airspeed correction (correction applied in the same manner as gust), up to a maximum of 15 knots.

- Avoid large thrust reductions or trim changes in response to sudden airspeed increases as these may be followed by airspeed decreases.
- Crosscheck flight director commands using vertical flight path 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 glideslope displacement. The pilot monitoring should call out any deviations from normal. Use of autopilot and autothrottle for the approach may provide more monitoring and recognition time.

Recovery

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

Ice Crystal Icing (ICI)

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.

Ice crystal icing is 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.

Avoid ICI conditions. Flight in clouds containing high concentrations of ice crystals has been associated with engine vibration, engine power loss, engine damage, and airplane Total Air Temperature (TAT) probe icing.

Because these conditions can be difficult to recognize, careful preflight planning is a key component of in-flight situational awareness. When ICI is encountered or suspected, do the Ice Crystal Icing non-normal checklist to mitigate the effect on the flight.

Recognize Ice Crystal Icing

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 deg. C due to TAT probe icing
- areas of light to moderate turbulence
- in IMC with:
  - No significant airframe icing and

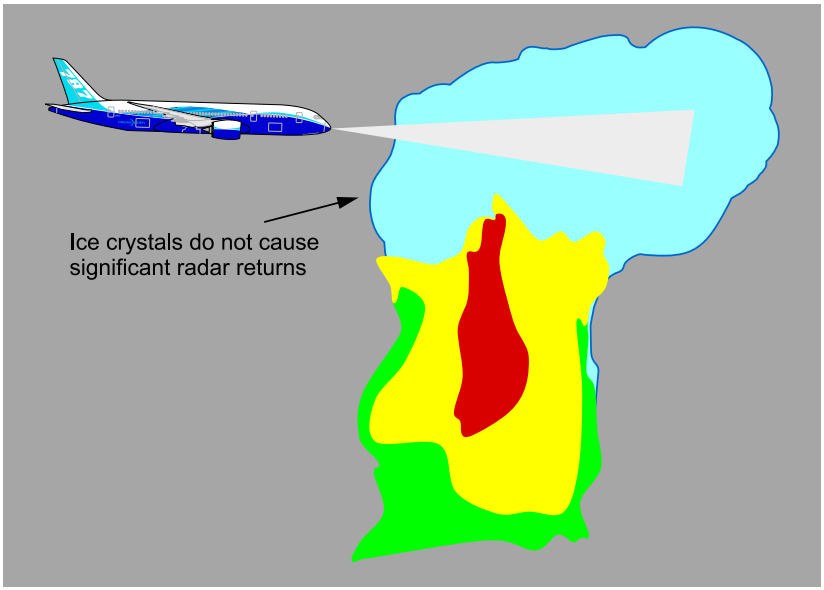
  - no significant radar returns at airplane altitude and
  - heavy precipitation below the airplane, identified by amber and red radar returns on weather radar
- cloud tops above typical cruise levels (above the tropopause).
- smell of ozone or sulfur
- Humidity increase
- Static discharge around the windshield (St. Elmo's fire).

Note: The ice detection system does not detect ice crystal icing. It is designed to detect supercooled water only.

Avoiding Ice Crystal Icing

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.



Areas with a higher risk of High Ice Water Content (HIWC) are identified by some aviation weather vendors. In these areas, ICI should be suspected while operating in IMC. Use of this type of HIWC information is recommended for strategic planning and in-flight adjustments in order to avoid potential ICI conditions.

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.

Introduction

This instruction explains the vital actions which have to be taken in connection with any emergency situation.

Since it is a well-established fact that the unexpected emergencies cause most of the injuries to passengers and crew, and sudden emergency situation requiring immediate evacuation of the airplane may arise in connection with takeoff, landing, taxiing or even while stationary on the tarmac, it is of utmost importance that the crew know the operation of doors, slides, ramps, life rafts and slides/rafts as well as evacuation duties by heart.

The most important duties of the crew will always be to:

- have the occupants well prepared for quick evacuation,
- provide the best crash protection for all occupants,
- supervise the evacuation after landing, and
- help the passengers as necessary after the evacuation.

Crew Duties

The crew duties during emergency are summarized in the Cabin Emergency Checklist.

Extra flight deck and cabin crew are used for assisting disabled or injured passengers, passengers coming down the slide on ground and giving any assistance when required.

Takeoff and Landing Preparation

Cabin Ready for Takeoff

After boarding completed and IM/purser have complied with all items stated in OM-A 8.3.15 Cabin Safety Requirements, he/she, when all passengers seated, cabin safety performed and min CA ready to take their seats, will order CA's through PA systems **"Cabin Crew Arm the doors"**. CA must immediately obey this order. After ensure all door slides armed, IM/AP shall report **"CABIN CLEAR/CABIN READY"** to flight deck crew accordingly.

In case of any malfunctions in the door mode, IM/purser must inform the P-i-C immediately.

Takeoff shall not be commenced, if the emergency demonstration has not been completed.

Cabin Ready For Landing

No reporting is required before landing.

As soon as the FASTEN SEAT BELT sign is ON before landing, the IM/purser shall check the cabin in accordance with CABIN TAKEOFF AND LANDING CHECKLIST.

Communication—Summary of the Cabin Calls

Normal Calls

From	To	Communication method	Remarks
"Cabin crew, arm the doors"			
IM/AP	Cabin	PA system	Then IM/AP shall report **"CABIN CLEAR"/"CABIN READY"** to Flight deck.
"Cabin crew, at your station"			
IM/AP	Cabin	PA system	Given when final cabin safety check is performed during pushback or descent for landing.
"Cabin crew, disarm the door"			
IM/AP	Cabin	PA system	Given when the airplane come to a complete stop and seat belt sign has been switched off.
Takeoff imminent			
Flight deck	Cabin	2 × chimes with SEAT BELTS selector	Given before entering the runway, approx 30–60 sec before takeoff. IM/Purser immediately make an announcement through PA **"CABIN CREW PREPARE FOR TAKEOFF"**. All cabin crew immediately return to assigned seats and fasten seat belt.
Landing imminent			
Flight deck	Cabin	2 × chimes with SEAT BELTS selector **Note:** If passenger oxygen is deployed, use PA system to make an announcement.	Given at approx 2,500 ft/3 min before landing. IM/Purser immediately make an announcement through PA **"CABIN CREW PREPARE FOR LANDING"**. All cabin crew immediately return to

From	To	Communication method	Remarks
			assigned seats and fasten seat belt.

Emergency Calls

From	To	Communication method	Remarks
Urgency call			
Flight deck	Cabin	Service interphone **ALL CALL (TCP)**, press 6 times or more, or PA system **"IM/PURSER, REPORT TO FLIGHT DECK"**, or **6 × FASTEN SEAT BELT**	IM/purser must immediately answer by the nearest interphone. If no reply, he must proceed to flight deck.
Cabin	Flight deck	Interphone, press ****** (Pilot priority)	Any CA can make this call. Flight deck crew must reply. If no reply he/she must proceed to flight deck.
Cabin	Cabin	Interphone, press **54** (ATTN ALL)	
Cabin emergency alert			
Flight deck	Cabin	PA system	Brief announcement, in case of short time for preparation. If given on ground, cabin crew shall immediately go to their stations.
"Emergency stations"			
Flight deck	Cabin	PA system	All CA's must immediately proceed to their emergency stations.
Brace for impact			
Flight deck	Cabin	PA system: **"BRACE, BRACE "** (repeatedly)	Given approx 1 min before landing.

From	To	Communication method	Remarks
		and/or Repeatedly flashing FASTEN SEAT BELT	
Cabin	Passengers	PA system: **“HEAD DOWN”**/ “กัมหัวลง”	Cabin crew shall order passengers after receiving BRACE FOR IMPACT signal.
Evacuation not required			
Flight deck	Cabin	PA system: **“REMAIN SEATED, REMAIN SEATED”**	
Initiating evacuation			
Flight deck	Cabin	Press EVAC SIGNAL or PA system: **“EVACUATE”**	
Cabin	Cabin	Emergency Evacuation Signaling system or PA system: **“EVACUATE.”**	If no order is received from flight deck (pilots might be injured) and the necessity of an immediate evacuation is evident, cabin crew shall initiate the evacuation.
Cabin	Passengers	Order: **“RELEASE SEAT BELT AND GET OUT”**	Cabin crew shall order passengers after receiving evacuation order from flight deck or cabin.

When Emergency Declared

During, and immediately after the declaration of an emergency, the P-i-C or a selected flight deck crew will briefly inform the cabin crew, and when practicable also the passengers, about the impending emergency and the P-i-C’s intentions. The detailed passenger-briefing should then be made by the purser or suitable cabin crew over the PA system in accordance with the EMERGENCY ANNOUNCEMENT.

Strict supervision of all passengers is necessary during an emergency to avoid panic and confusion. Look out for passengers who tend to panic; they are a

danger to the morale of all. Calm them gently at first but forcibly if necessary. Never forget to let them know that the rescue is close at hand if you have any reason to believe it to be so since this will make the emergency more bearable to them.

The cabin crew shall be kept well-informed about the emergency so that they can give further details to the passengers if necessary. As soon as the emergency situation arises, the cabin crew shall be ordered to start preparation according to CABIN EMERGENCY CHECKLIST.

Preparation—Emergency Landing/Ditching

Briefing Passengers

When ordered by the P-i-C, brief passengers according to the EMERGENCY ANNOUNCEMENT form.

Demonstrating Life Vest/Brace for Impact

In case of ditching, on completion of briefing and if time permits, demonstrate wearing of the life vest. The purser shall read the EMERGENCY ANNOUNCEMENT while the other cabin crew demonstrate.

If time permits, demonstrate brace for impact position and explain the signals; otherwise, order **"HEAD DOWN"** when order to brace is given.

Securing the Passengers and the Cabin

While the IM/purser brief the passengers, the other cabin crew shall do the following:

1. Make sure that the seatbacks are in upright position, footrests/legrests folded, tables folded, seat belts fastened.
2. Secure passengers, cabin and galleys.
3. Store hard objects in the stowage and the toilets and secure toilet doors by sliding toilet sign to OCCUPIED.
4. Report to the P-i-C that the cabin is secured. Check with the P-i-C which exits can or cannot be used for evacuation.

Preparing Survival Equipment

Prepare and secure the ELT (emergency locator transmitter) and suitable survival equipment as shown in the CABIN EMERGENCY CHECKLIST.

Selecting Able-Bodied Passengers

In prepared and unprepared emergency, select (reseat and brief if time permits) the suitable passengers to:

- help children and disabled or injured passengers,
- help remove and operate survival equipment,
- guard unsafe exits or damaged evacuation slide,

- help passengers come down the slide.

Crash Protection

Protection of Infants

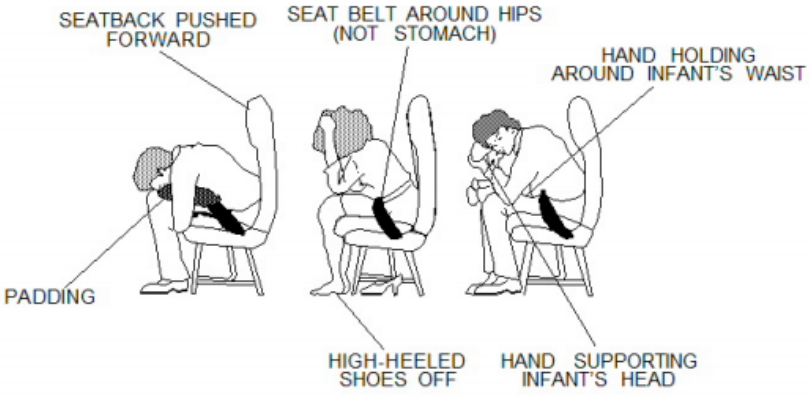
Whenever an emergency landing or ditching is expected, infants must secured as follows:

1. Hold the infant in your lap, or between your legs.
2. Support his head with one hand.
3. Put the other hand around his waist.
4. Push seatback forward.
5. Bend down.

Brace for Impact—Seating Position



Seating Position on CA Seat



Seating Position on Passenger Seat

Brace-for-Impact Signals

One minute before the estimated touchdown, the flight deck crew will order **"BRACE BRACE"** over the PA system and/or repeatedly flash the FASTEN

SEAT BELT sign. Whenever possible the **"BRACE"** order should be repeated immediately before the impact.

Flight deck crew should instruct the passengers to remain in brace position until the airplane has come to a stop and warn that two or more impact shocks may occur before the airplane stops.

Evacuation

Evacuation Signal/Order

In case an evacuation is necessary, the P-i-C shall make an order to start evacuation by switching on the EVAC SIGNAL or using the PA system.

If the P-i-C decides that evacuation is not required, he shall immediately make an appropriate PA announcement and also disarm the evacuation signaling system.

Initial Evacuation Stage

The slides are single lane at doors 1L, 1R, 3L, and 3R. There should be single lane flow at these doors. Use the command: **"FORM ONE LINE"**.

The slides are dual lane at doors 2L, 2R, 4L, and 4R. During an emergency it is very important to establish dual lane flow at these doors to ensure a timely evacuation. Use the command: **"FORM TWO LINES"**.

On Ground

As soon as the airplane comes to a stop, EVAC signal/order is given, IM/purser opens seat belt, stands up and orders: **"RELEASE SEAT BELTS, HIGH-HEELED SHOES OFF, STAND BACK, FORM TWO LINES (or FORM ONE LINE), GET OUT"**. Repeat the order if necessary.

Check through door window, if it is OK outside or if no danger and airplane is stationary, open the door in AUTOMATIC mode. If the door does not open automatically, push the door to fully OPEN position using constant pressure.

Check that the slide and slide/raft are properly inflated and safe for sliding. If the slide, slide/raft or ramps fails to inflate automatically, pull the manual inflation handle.

When the slide or slide/raft are in order, instruct passengers to form double line and start immediate evacuation/boarding by ordering: **"JUMP, JUMP"**.

If a passenger hesitates, order: **"PUSH HIM/HER OUT"**.

- At the exit with the double lane slide/raft, order: **"FORM TWO LINES (or FORM ONE LINE)"**.
- If passengers sit down on the doorsill, order: **"STAY ON YOUR FEET"**.

In Water

As soon as the airplane comes to a stop, EVAC signal/order is given, IM/purser opens seat belt, stands up and orders: **"RELEASE SEAT BELTS, PUT LIFE VESTS ON, HIGH-HEELED SHOES OFF, STAND BACK, FORM TWO LINES (or FORM ONE LINE), GET OUT"**. Repeat the order if necessary.

Check through door window, if it is OK outside or if no danger and airplane is stationary, open the door in AUTOMATIC mode. If the door does not open automatically, push the door to fully OPEN position using constant pressure.

Check that the slide and slide/raft are properly inflated and safe for sliding if the slide, slide/raft or ramps fails to inflate automatically, pull the manual inflation handle.

- Doors 1 2 3 4

  After opening the door in AUTOMATIC/ARMED mode, pull manual inflation handle. Do not wait for automatic inflation.

When the slide/raft are in order, instruct passengers to form double line and start immediate boarding by ordering: **"GET OUT, PUT LIFE VESTS ON (unprepared emergency), GET INTO SLIDE/RAFT, INFLATE LIFE VESTS, HURRY LET'S GO"**.

If a passenger hesitates, order: **"PUSH HIM/HER OUT"**.

- At the exit with the double lane slide/raft, order: **"FORM TWO LINES (or FORM ONE LINE)"**.
- If passengers sit down on the doorsill, order: **"STAY ON YOUR FEET"**.

Redirecting Passengers

If it is impossible to open the door or if slide or slide/raft are damaged or because of any other danger, the IM/purser should redirect passengers to the other doors. Use the able-bodied passengers to guard the unsafe doors. Face passengers, give orders: **"GO THAT WAY—DOOR JAMMED"** or **"FIRE OUTSIDE"** or **"NO SLIDE/NO SLIDE/RAFT"**. Instruct passengers to go to other doors in these priorities:

- the door DIRECTLY ACROSS the cabin,
- the door FWD/AFT on the SAME SIDE of the cabin,
- the door FWD/AFT on the OPPOSITE SIDE of the cabin,
- the OTHER/NEAREST door.

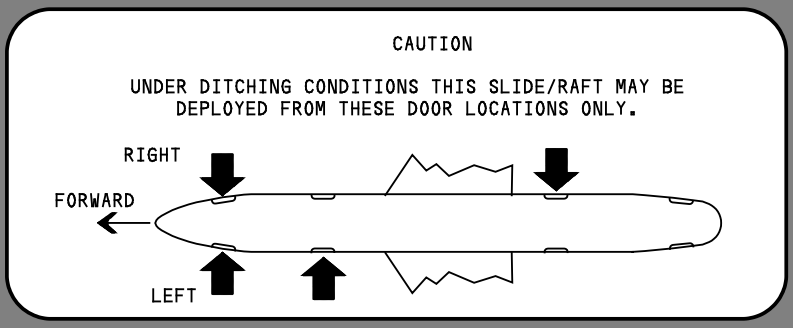
Slide/Raft Portability

Under ditching conditions, the CA must assess outside conditions before opening a door. Sea state conditions may not be suitable for deploying a slide/raft at the door on which it is installed. The slide/raft may be repositioned to an alternate doorway for deployment as indicated below.

Slide/raft alternate deployment positions and instructions are printed on placards on each slide/raft.

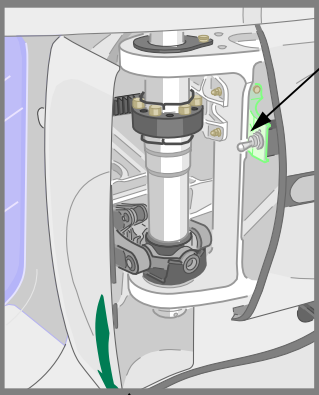
Move from door	Reposition and deploy at door
1L	• 1R • 2L or 2R.
1R	• 1L • 2L or 2R.
2L	• 1L or 1R • 3R.
2R	• 1L or 1R • 3L.
3L	• 1L or 1R • 2R.
3R	• 1L or 1R • 2L.
4L	• 1L or 1R • 2L or 2R • 4R.
4R	• 1L or 1R • 2L or 2R • 4L.

Alternative Exit Identification Placard



Note: Door 2L slide/raft placard shown as typical.

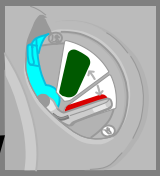
Slide/Raft Portability Procedures

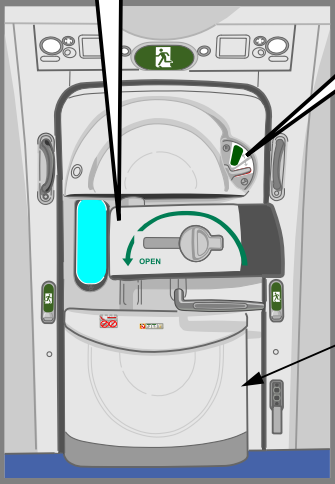


1 **Disable the EPAS**

- Open the hinge door
- Move the switch downward to the SAFE position.

Note: If EPAS is not disabled, the door automatically opens and the slide/raft will deploy.





2 **Mode Select Lever**

- Ensure the lever is in the AUTO position.

3 **Remove slide bustle**

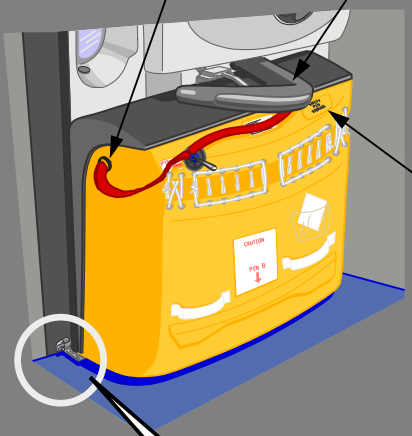
- Push the release buttons near the lower corners of the slide bustle.
- Pick up the slide cover and move it out of the way.

4 **Install Safety Pin "A"**

- Push pin "A" into the valve (push the button on the head of pin "A").

5 **Partially Open the Door**

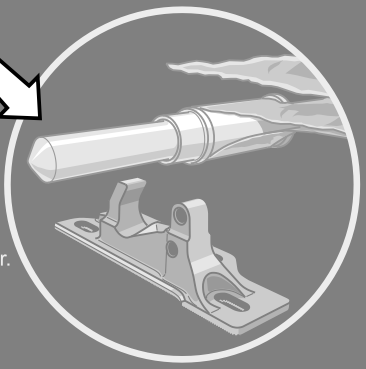
- Rotate door operating handle through full rotation.
- Open door only far enough to access the girt bar in the floor fittings.



Note: Pins "A" and "B" are in the pocket.

6 **Detach the Girt Bar**

- Lift the girt bar from the floor brackets.
- Place the girt bar on the floor inboard of the door.

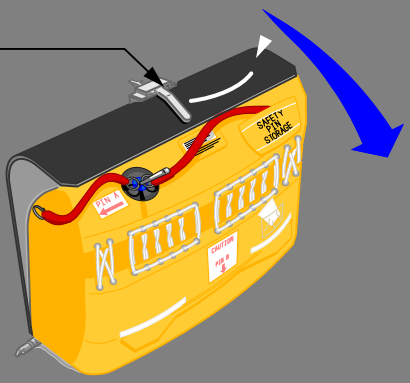


7 **Close the door.**

8 **Remove Slide/Raft from Door**

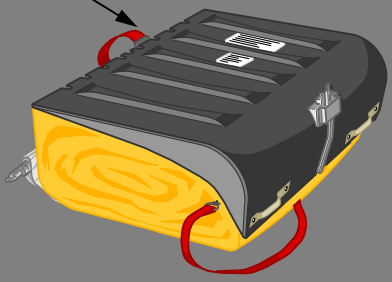
- Push the handle found on top of the pack forward.
- Rotate the pack inboard onto the floor to remove the pack from the door.

(SEE ADDITIONAL INSTRUCTIONS ON PACKBOARD BACK.)



9 **Install safety pin “B” and secure girt bar**

- Route pin “B” strap (both legs) through center slit in girt and install pin “B” into hole in latch.
- Wrap short leg of strap around the girt bar and join snaps together (2 places).

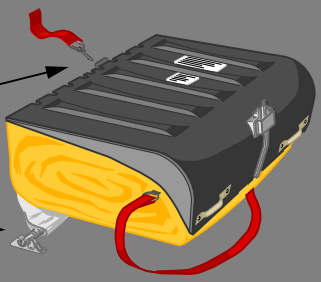


10 **Carry the pack to the alternative door**

- Position 1 person on each side of the pack.
- Use the girt bar to carry the slide/raft.

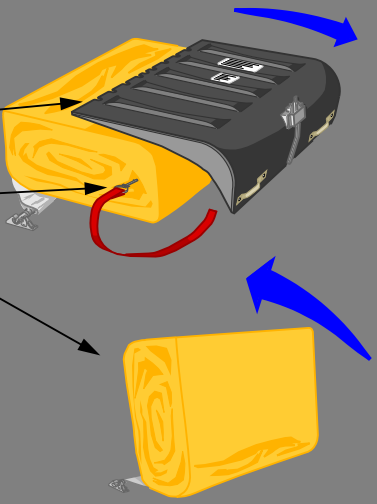
11 **Attach the girt bar to the door sill**

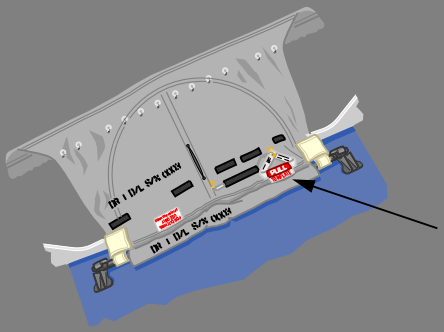
- Put the pack in front of the door with the packboard on top and girt outboard.
- Remove pin “B” from latch; unsnap short leg of strap and pull entire strap through slit in girt.
- Push the ends of the girt bar down into the floor fittings until they latch, keeping the girt outboard (Packboard will release).



12 **Deploy the slide/raft**

- Slide the packboard away from the slide/raft pack.
- Remove pin “A” from the valve.
- Rotate the slide/raft pack out through the door.





– Pull the red manual inflation handle.

Unprepared Emergency

Since it is well-established fact that it is the unexpected emergencies which cause most of the injuries to passengers and crew, it is of the utmost importance that the crew know by heart other operation of the doors slide, slide/rafts and ramps as well as the seating plan and evacuation and boarding duties.

A sudden emergency situation requiring immediate evacuation may arise in connection with takeoff, landing taxiing or even while the airplane is stationary on the tarmac.

Evacuation

Evacuation procedures for the unprepared emergency are the same as those previously explained for the prepared emergency.

On Ground Fires

Since the flight deck crew might not be on board, the CA shall initiate the immediate evacuation as previously stated.

However, if there is a fire during engine starting and taxiing:

1. CA shall wait for instructions from the P-i-C.
2. The evacuation shall start when signaled/ordered by P-i-C.
3. Whenever smoke, fire or other abnormal conditions are observed, the P-i-C must be informed immediately.

Limitations

Allowable Gross Weights

See Weight Limitations on page L.10.3 for allowable gross weights.

For permissible Takeoff and Landing Weight with regard to flap setting, wind, temperature, runway length, airport elevation, etc., see Gross Weight Chart and/or Takeoff or Landing Diagrams.

Mean Aerodynamic Chord and Balance Limits

Mean Aerodynamic Chord (MAC)

The length of MAC is 246.9 inches.

The leading edge of MAC (LEMAC) is located at STA 1174.5.

The nose of the aircraft is located at

- STA 55.8.

Balance Limits

The center-of-gravity limits in % MAC vary linearly between gross weights shown.

Forward limit

Gross Weight (kg)	Center of Gravity (% MAC)
108,998.00	11.50
136,078.00	6.00
211,328.00	6.00
224,664.00	8.90
227,930.00	14.78

Aft Limit

Taxi and takeoff limit (no condition)

Gross Weight (kg)	Center of Gravity (% MAC)
227,930.00	24.07
223,167.00	31.10
197,766.00	37.50
181,618.00	37.50
136,712.00	31.50

Gross Weight (kg)	Center of Gravity (% MAC)
117,934.00	28.70
104,100.00	24.50

Takeoff (rolling condition)

Gross Weight (kg)	Center of Gravity (% MAC)
227,930.00	24.07
223,167.00	31.10
197,766.00	37.50
140,795.00	37.50
104,100.00	29.00

Flight limit

Gross Weight (kg)	Center of Gravity (% MAC)
227,930.00	24.07
223,167.00	31.10
190,962.00	39.50
154,221.00	39.50
140,795.00	37.50
104,100.00	29.00

The loading and consumption of fuel must be taken into consideration to ensure that the certified limits above are never exceeded during any portion of the flight. The effect of fuel density variation on aircraft balance must also be taken into account.

Cargo Compartments

Structural Limitations

Compartment		Max Linear Load (kg/in)	Max Area Load (kg/sq ft)
FWD	BA 340.9–736.6	53.1	90.7
	BA 736.6–832.8	78.9	90.7
AFT	BA 1299.9–1396.1	78.9	90.7
	BA 1396.1–1669.1	53.1	90.7
BULK	BA 1669.1–1773.0	27.2	68.0

Loading Capacity

Maximum weight certified

	FWD COMPT	AFT COMPT	BULK
Station	340.9–832.8	1299.9–1669.1	1669.1–1773.0
Max Weight (kg)	25514	19132	

Crew and Passenger

Crew Member

A maximum of 4 crew members may be carried in the flight deck.

There are 13 jump seats for 787-8 for cabin attendants. The excess cabin crew must be seated in passenger seat. For location of seats, see Examples of Interior Configuration on page SP.18.6.

Maximum Number of Passengers on Board

The actual number of passengers, excluding infants, must not exceed the number of seats with safety belts. For the number of seats available, see Examples of Interior Configuration on page SP.18.6.

An infant can be seated on an adult's knees. The number of infants that can be carried is, however, limited by the number of available oxygen masks and life vests.

Oxygen limitations

Each outboard seat assembly has an extra mask for use by infants and cabin attendants. In every second seat row–except that equipped with baby cradle–these extra masks are reserved for cabin attendants when walking around in the aisles. The remaining extra masks are for infants seated on adults' knees.

This implies that 3 adults and 1 infant can be seated in every second outboard triple seat assembly. In addition, the positions for all baby cradles can be utilized.

Life vest limitations

When two persons, i.e. one adult and one infant, are carried in the same seat, a spare life vest must be placed in the seat pocket adjacent to that seat.

Disabled Passengers

General rules

The general rules for accepting disabled (incapacitated), i.e., sick or invalid passengers and the conditions for such acceptance are found in PHM 5.5. These rules are governed by Company policy and are usually more restrictive than those stated below.

It is important to note that these restrictions only apply to disabled, i.e., immobilized passengers, as defined below. They do not restrict the transportation of other categories of disabled passengers, e.g., SA1, SB1 and SB2.

For all categories of disabled passengers, the cabin crew must have an individual briefing on safety items before takeoff.

Disabled passengers	a person who cannot move himself from his seat to a floor level exit in case of an emergency evacuation. The blind (persons having defective vision) or the deaf (persons having impaired hearing) are not included in the term “disabled passengers”.
Regular flights	scheduled flights or nonscheduled flights (charter flights) where an established max number of disabled passengers may be included in the total number of passengers to be carried.
Special flights	scheduled flights or nonscheduled flights (charter flights) where the number of disabled passengers traveling in groups may exceed the limit stated for regular flights.
Assisting persons	a person trained to help disabled passengers.

Seating

Some seats have been selected as being most suitable for use by disabled passengers. These seats are shown in PHM 7.2.

Before flight, the P-i-C must be informed of the total number of disabled passengers which will be carried and where they and their assisting persons will be seated.

Transportation of disabled passengers on regular flights

The total number of disabled passengers traveling on an individual basis is shown in PHM 7.2. They must be seated in the specific seats mentioned in PHM 7.2.

Transportation of disabled passengers on special flights

Special flights can include:

- flights with a group of disabled passengers together with ordinary passengers. In this case the disabled passengers must be seated as per the applicable version drawing which also shows the maximum number of disabled passengers which can be accepted, or
- flights with passengers including only disabled passengers and person accompanying them, i.e., helpers, nurses, relatives. In this case, the number of disabled passengers carried depends on such factors as length of flight and the disabled passengers’ need for assistance. The seating limitations

will, therefore, be established for each separated flight, considering the factors mentioned above.

The conditions below are applied for all special flights:

- disabled passengers must not be seated in the seat row nearest to an exit.
- there must be at least one assisting person for each group of five disabled passengers which exceeds the max number of disabled passengers on regular flights. Assisting person must be seated in close vicinity of the disabled persons.
- the minimum number of cabin attendants stated for the applicable cabin version must be increased by one cabin attendant for each group of 15 disabled persons above the number stated for regular flights.
- the additional cabin attendant may be replaced by an assisting person as long as this person has been specially trained to help disabled passengers in an emergency evacuation and also has knowledge of the applicable equipment and its operation.

Special flights must be arranged in advance.

Dispatch with One Cabin Door Inoperative

According to MEL 52-11-01, passenger seats must be blocked if the aircraft is to be dispatched with one cabin door inoperative.

The following tables show the blocked seat rows (additional blocked seats), the number of blocked seats and the remaining seat capacity of each aircraft version.

TQA to TQF

787-8 (OFCR and OFAR installed)			
Inoperative Door	**Blocked Row (Additional Blocked Seats)**	**No. of Blocked Seats**	**Remaining Seat Capacity**
1	11–12	12	10C/234Y
2	14–38	82	12C/162Y
3	39–52	114	22C/120Y
4	53–58	48	22C/186Y

TWA,B

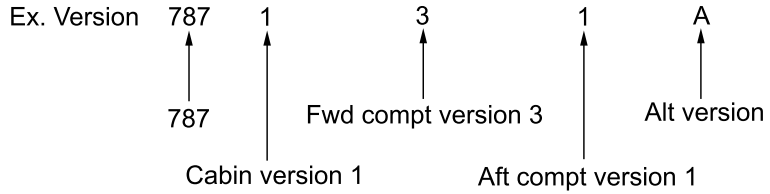
787-9			
Inoperative Door	**Blocked Row (additional Blocked seats)**	**No. of Blocked Seats**	**Remaining Seat Capacity**
1	11–15	16	14C/268Y
2	16–38	86	16C/196Y
3	39–54	132	30C/136Y
4	55–62	64	30C/204Y

Configuration

Version Numbering System

The interior version is identified by 6-digit number.

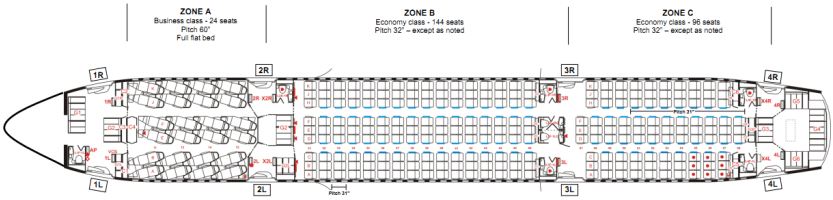
The first three figures in that No. denote aircraft type (787 for 787) the forth figure is cabin version. The forth and the fifth figures are usually show the number of pallets in the compartment where the fifth figure is forward cargo compartment version and the sixth figure is aft cargo compartment version. The last figure is for alternative cargo compartment version.



Note: When identifying interior version on Balance Tables and cabin version plans etc., the cargo compartment version number is usually omitted.

Examples of Interior Configuration

This is an example of Interior Configuration and is not kept up-to-date. The actual Interior Configuration can be found in flight deck, and in PilotDocs OH website.



Weight & Balance

Weight Calculation

Definition of Empty Weight

Basic Empty Weight (BEW)

The basic empty weight and its related center of gravity are obtained through weighing the aircraft. Included in the BEW is the weight of the structure, power plant, fixed furnishings and other items of equipment that are considered integral parts of the aircraft. Also included is the weight of unusable fuel, usable manifold,

lines and engine fuel, usable and unusable oil to engine, IDG and APU, potable water.

Basic Weight (BW)

Basic Empty Weight (BEW) plus Standard Loose Equipment and Version Equipment.

Dry Operating Weight and Index (DOW, DOI)

Basic Weight plus operational items, such as catering equipment, route equipment and crew (refer to Load Control Manual-LCM).

Calculation on Loadsheet

Refer to PLT/LCM.

Balance Calculation—General

Index Formula

The Index Formula used in the balance calculation reads as follows:

$$\text{Index} = \frac{\text{Weight (STA} - 1079.2)}{200{,}000} + 45$$

STA = Center of gravity location expressed in distance (inches) from the reference line (STA = 0).

Balance Aid

The Balance Aid to be used is of a combined graphical-numerical type.

Balance Table

The Balance Table for applicable version is a means for balance control and must be used for all normal calculations of the aircraft balance condition at zero fuel weight. Instruction on how to use the Balance Table is printed on the back of the table.

The Balance Table is carried on board the aircraft in the Load Control Folder together with actual Load sheet in order to make it possible for the flight deck crew to check the balance calculation.

Center of Gravity and Stabilizer Setting Chart

The purpose of this chart is to determine stabilizer setting for takeoff under actual balance conditions.

Examples of Balance Table

THAI

787-8
Balance Table Version 7871

STATION	
FLIGHT	
DATE	

ISSUE 1



CABIN A 24 C SEATS | **CABIN B** 144 Y SEATS | **CABIN C** 96 Y SEATS

FWD LOWER COMPT 1	INDEX CORR
1 - 162	- 0
163 - 487	- 1
488 - 811	- 2
812 - 1136	- 3
1137 - 1461	- 4
1462 - 1785	- 5
1786 - 2110	- 6
2111 - 2435	- 7
2436 - 2759	- 8
2760 - 3084	- 9
3085 - 3409	- 10
3410 - 3734	- 11
3735 - 4058	- 12
4059 - 4383	- 13
4384 - 4708	- 14
4709 - 5032	- 15
5033 - 5357	- 16
5358 - 5682	- 17
5683 - 6006	- 18
6007 - 6331	- 19
6332 - 6656	- 20
6657 - 6981	- 21
6982 - 7306	- 22
7306 - 7630	- 23
7631 - 7955	- 24
7956 - 8279	- 25
8280 - 8604	- 26
8605 - 8929	- 27
8930 - 9253	- 28
9254 - 9578	- 29
9579 - 9903	- 30
9904 - 10228	- 31
10229 - 10552	- 32
10553 - 10877	- 33
10878 - 11202	- 34
11203 - 11526	- 35
11527 - 11851	- 36
11852 - 12176	- 37
12177 - 12501	- 38
12502 - 12825	- 39
12826 - 13150	- 40
13151 - 13475	- 41

FWD LOWER COMPT 2	INDEX CORR
1 - 270	- 0
271 - 811	- 1
812 - 1351	- 2
1352 - 1892	- 3
1893 - 2433	- 4
2434 - 2974	- 5
2975 - 3514	- 6
3515 - 4055	- 7
4056 - 4596	- 8
4597 - 5137	- 9
5138 - 5677	- 10
5678 - 6218	- 11
6219 - 6759	- 12
6760 - 7300	- 13
7301 - 7841	- 14
7842 - 8381	- 15
8382 - 8922	- 16
8923 - 9463	- 17
9464 - 10004	- 18
10005 - 10544	- 19
10545 - 11085	- 20
11086 - 11626	- 21
11627 - 12167	- 22
12168 - 12700	- 23

AFT LOWER COMPT 3	INDEX CORR
1 - 319	0
320 - 957	1
958 - 1596	2
1597 - 2234	3
2235 - 2873	4
2874 - 3511	5
3512 - 4150	6
4151 - 4788	7
4789 - 5427	8
5428 - 6065	9
6066 - 6704	10
6705 - 7342	11
7343 - 7981	12
7982 - 8619	13
8620 - 9258	14
9259 - 9896	15
9897 - 10200	16

AFT LOWER COMPT 4	INDEX CORR
1 - 200	0
201 - 602	1
603 - 1003	2
1004 - 1404	3
1405 - 1806	4
1807 - 2207	5
2208 - 2609	6
2610 - 3010	7
3011 - 3412	8
3413 - 3813	9
3814 - 4214	10
4215 - 4616	11
4617 - 5017	12
5018 - 5419	13
5420 - 5820	14
5821 - 6221	15
6222 - 6623	16
6624 - 7024	17
7025 - 7426	18
7427 - 7827	19
7828 - 8229	20
8230 - 8631	21
8632 - 9050	22

BULK COMPT 5	INDEX CORR
1 - 155	0
156 - 466	1
467 - 778	2
779 - 1089	3
1090 - 1400	4
1401 - 1711	5
1712 - 2023	6
2024 - 2334	7
2335 - 2645	8
2646 - 2735	9

FWD ECONOMY CABIN B	INDEX CORR
0 - 16	- 0
17 - 48	- 1
49 - 80	- 2
81 - 112	- 3
113 - 144	- 4

AFT ECONOMY CABIN C	INDEX CORR
0 - 2	0
3 - 8	1
9 - 14	2
15 - 20	3
21 - 26	4
27 - 31	5
32 - 37	6
38 - 43	7
44 - 49	8
50 - 55	9
56 - 60	10
61 - 66	11
67 - 72	12
73 - 78	13
79 - 84	14
85 - 90	15
91 - 95	16
96 -	17

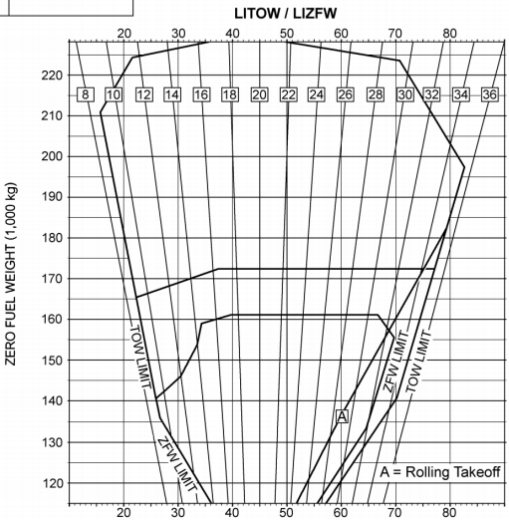
BUSINESS CLASS CABIN A	INDEX CORR
0 - 2	- 0
3 - 6	- 1
7 - 11	- 2
12 - 15	- 3
16 - 20	- 4
21 - 24	- 5

FUEL	INDEX CORR
5001 - 16000	1
16001 - 19800	2
19801 - 23000	3
23001 - 24500	4
24501 - 26700	5
26701 - 28200	6
28201 - 29500	7
29501 - 30500	8
30501 - 31700	9
31701 - 39800	10
39801 - 41600	9
41601 - 44000	8
44001 - 46000	7
46001 - 48100	6
48001 - 50200	5
50201 - 52300	4
52301 - 54500	3
54501 - 56800	2
56801 - 58800	1
58801 - 61100	0
61101 - 63300	- 1
63301 - 65700	- 2
65701 - 68000	- 3
68001 - 70300	- 4
70301 - 72600	- 5
72601 - 75000	- 6
75001 - 77200	- 7
77201 - 79600	- 8
79601 - 82000	- 9
82001 - 84300	- 10
84301 - 86500	- 11
86501 - 88800	- 12
88801 - 91000	- 13
91001 - 93300	- 14
93301 - 95500	- 15
95501 - 97500	- 16
97501 - MAX	- 17

Actual ZFW	
Actual Takeoff Fuel	
Actual TOW	

BALANCE CALCULATION

	−	+	−	+
DOI				
COMPT 1				
COMPT 2				
COMPT 3				
COMPT 4				
COMPT 5				
TOTAL				
DLI				
CABIN A				
CABIN B				
CABIN C				
TOTAL				
LIZFW				
FUEL +/-			+/-	
LITOW				



Performance Dispatch — Chapter PD
Section Table of Contents

787-8 TRENT1000-AE KG M FAA PD.10

787-9 TRENT1000-D KG C M FAA PD.20

Performance Dispatch — Chapter PD
Table of Contents

787-8 TRENT1000-AE KG M FAA

Takeoff PD.10
Takeoff Field Corrections—Dry Runway PD.10.1
Takeoff Field & Climb Limit Weights—Dry Runway PD.10.2
Takeoff Field Corrections—Wet Runway PD.10.10
Takeoff Field & Climb Limit Weights—Wet Runway PD.10.11
Takeoff Obstacle Limit Weight PD.10.17
Fuel Jettison Limit Weight PD.10.19

Enroute PD.11
Long Range Cruise Maximum Operating Altitude PD.11.1
Long Range Cruise Trip Fuel and Time PD.11.2
Long Range Cruise Step Climb PD.11.3
Short Trip Fuel and Time PD.11.4
Holding Planning PD.11.5
Crew Oxygen Requirements PD.11.6
Net Level Off Weight PD.11.8

Landing PD.12
Landing Field Limit Weight—Dry Runway PD.12.1
Landing Field Limit Weight—Wet Runway PD.12.2
Landing Climb Limit Weight PD.12.3
Go-Around Climb Gradient PD.12.4
Quick Turnaround Limit Weight PD.12.7

Gear Down PD.13
Takeoff Field Corrections—Dry Runway PD.13.1
Takeoff Field & Climb Limit Weights—Dry Runway PD.13.2
Takeoff Field Corrections—Wet Runway PD.13.6

Takeoff Field & Climb Limit Weights—Wet Runway PD.13.7
Takeoff Obstacle Limit Weight PD.13.11
Fuel Jettison Limit Weight PD.13.13
Takeoff Speeds—Dry Runway PD.13.14
Takeoff Speeds—Wet Runway PD.13.16
VREF PD.13.18
Landing Field Limit Weight—Dry Runway PD.13.19
Landing Field Limit Weight—Wet Runway PD.13.20
Landing Climb Limit Weight PD.13.21
Long Range Cruise Altitude Capability PD.13.22
Long Range Cruise Trip Fuel and Time PD.13.23
Short Trip Fuel and Time PD.13.25
Holding Planning PD.13.26
Net Level Off Weight PD.13.27

Text PD.14

Introduction PD.14.1
Takeoff PD.14.1
Enroute PD.14.3
Landing PD.14.5
Gear Down PD.14.6

Takeoff Field Corrections—Dry Runway

Table 1 of 3: Slope Correction

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
1600	1570	1580	1590	1590	1600	1570	1530	1500	1470
1800	1800	1800	1800	1800	1800	1750	1710	1660	1610
2000	2030	2020	2010	2010	2000	1940	1880	1810	1750
2200	2260	2240	2230	2210	2200	2120	2050	1970	1900
2400	2480	2460	2440	2420	2400	2310	2220	2130	2040
2600	2710	2680	2660	2630	2600	2500	2390	2290	2180
2800	2940	2910	2870	2840	2800	2680	2560	2440	2330
3000	3170	3130	3080	3040	3000	2870	2730	2600	2470
3200	3400	3350	3300	3250	3200	3050	2910	2760	2610
3400	3630	3570	3510	3460	3400	3240	3080	2920	2760
3600	3850	3790	3730	3660	3600	3420	3250	3070	2900
3800	4080	4010	3940	3870	3800	3610	3420	3230	3040
4000	4310	4230	4150	4080	4000	3800	3590	3390	3180
4200	4540	4450	4370	4280	4200	3980	3760	3550	3330
4400	4770	4670	4580	4490	4400	4170	3940	3700	3470
4600	4990	4900	4800	4700	4600	4350	4110	3860	3610
4800	5220	5120	5010	4910	4800	4540	4280	4020	3760
5000	5450	5340	5230	5110	5000	4730	4450	4180	3900

Table 2 of 3: Wind Correction

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M)							
	WIND COMPONENT (KTS)							
	−15	−10	−5	0	10	20	30	40
1600	830	1090	1340	1600	1700	1790	1890	1990
1800	1020	1280	1540	1800	1900	2000	2100	2200
2000	1210	1470	1740	2000	2100	2210	2310	2420
2200	1400	1660	1930	2200	2310	2410	2520	2630
2400	1580	1860	2130	2400	2510	2620	2730	2850
2600	1770	2050	2320	2600	2710	2830	2940	3060
2800	1960	2240	2520	2800	2910	3030	3150	3280
3000	2150	2430	2720	3000	3120	3240	3360	3490
3200	2340	2620	2910	3200	3320	3440	3570	3710
3400	2530	2820	3110	3400	3520	3650	3780	3920
3600	2710	3010	3300	3600	3730	3860	3990	4140
3800	2900	3200	3500	3800	3930	4060	4200	4350
4000	3090	3390	3700	4000	4130	4270	4410	4570
4200	3280	3590	3890	4200	4330	4480	4620	4780
4400	3470	3780	4090	4400	4540	4680	4830	5000
4600	3650	3970	4280	4600	4740	4890	5040	5210
4800	3840	4160	4480	4800	4940	5090	5250	5430
5000	4030	4350	4680	5000	5150	5300	5470	5640

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1800	200.1	185.9	184.0	182.7	181.4	180.1	177.8	175.9	174.5	164.3	152.7
2000	210.6	195.7	193.7	192.4	191.1	189.7	187.4	185.4	184.0	173.3	161.2
2200	221.1	205.7	203.6	202.2	200.8	199.4	197.0	194.8	193.4	182.3	169.7
2400	231.1	215.2	213.1	211.7	210.2	208.8	206.3	204.1	202.6	191.2	178.3
2600	238.8	223.0	220.9	219.5	218.0	216.6	214.1	211.9	210.4	199.1	186.2
2800	249.2	235.2	233.1	231.7	230.2	228.8	226.2	224.0	222.5	211.0	197.9
3000	249.2	241.2	239.0	237.6	236.1	234.6	232.0	229.8	228.2	216.5	203.2
3200	249.2	247.7	245.5	244.0	242.5	241.0	238.3	236.0	234.4	222.4	208.8
3400	249.2	249.2	249.2	249.2	248.9	247.3	244.6	242.2	240.6	228.3	214.3
3600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	248.2	246.5	234.0	219.7
3800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	239.4	224.8
4000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	244.6	229.7
4200	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	234.4
4400	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	238.9
4600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	243.3
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	247.5
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2
CLIMB LIMIT WT (1000 KG)	217.6	215.9	215.7	215.6	215.4	215.2	215.0	214.7	214.4	198.6	181.1

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1800	189.3	173.9	171.9	170.5	169.2	167.9	166.6	165.3	161.9	151.0	140.0
2000	199.3	183.3	181.2	179.8	178.4	177.0	175.7	174.3	170.8	159.5	148.1
2200	209.4	192.7	190.5	189.0	187.6	186.2	184.8	183.4	179.7	167.9	156.0
2400	219.0	201.9	199.6	198.1	196.6	195.1	193.7	192.3	188.5	176.4	164.2
2600	226.8	209.7	207.4	205.9	204.5	203.0	201.6	200.2	196.4	184.4	172.2
2800	239.1	221.8	219.5	218.0	216.5	215.0	213.5	212.1	208.3	196.1	183.7
3000	245.2	227.5	225.1	223.6	222.1	220.6	219.1	217.6	213.7	201.3	188.7
3200	249.2	233.7	231.3	229.7	228.1	226.6	225.1	223.6	219.6	206.9	194.0
3400	249.2	239.8	237.4	235.7	234.1	232.6	231.0	229.5	225.4	212.3	199.1
3600	249.2	245.7	243.2	241.6	239.9	238.3	236.7	235.1	230.9	217.6	204.1
3800	249.2	249.2	248.9	247.2	245.5	243.8	242.2	240.6	236.3	222.7	208.8
4000	249.2	249.2	249.2	249.2	249.2	249.2	247.5	245.8	241.5	227.5	213.4
4200	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	246.4	232.2	217.8
4400	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	236.7	222.0
4600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	241.1	226.1
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	245.2	230.0
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	233.7
CLIMB LIMIT WT (1000 KG)	208.4	206.9	206.7	206.6	206.4	206.2	206.0	205.7	200.7	183.7	167.4

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1800	177.8	163.3	161.4	160.1	158.9	157.7	156.5	153.3	149.3	138.9	127.3
2000	187.3	172.3	170.3	169.0	167.7	166.4	165.1	161.8	157.6	146.9	134.8
2200	196.9	181.2	179.2	177.8	176.4	175.1	173.8	170.3	166.0	154.8	142.2
2400	206.2	190.1	187.9	186.5	185.1	183.8	182.4	178.9	174.4	162.9	150.0
2600	214.0	198.0	195.9	194.4	193.1	191.7	190.4	186.8	182.4	170.9	158.1
2800	226.2	209.9	207.7	206.3	204.9	203.5	202.2	198.6	194.1	182.4	169.4
3000	231.9	215.4	213.2	211.7	210.3	208.9	207.5	203.8	199.3	187.4	174.1
3200	238.2	221.3	219.0	217.5	216.1	214.7	213.2	209.5	204.8	192.6	179.0
3400	244.5	227.1	224.8	223.3	221.8	220.3	218.9	215.0	210.2	197.8	183.8
3600	249.2	232.7	230.4	228.8	227.3	225.8	224.3	220.3	215.4	202.7	188.4
3800	249.2	238.1	235.7	234.1	232.5	231.0	229.5	225.5	220.4	207.4	192.8
4000	249.2	243.3	240.8	239.2	237.6	236.1	234.5	230.4	225.2	212.0	197.0
4200	249.2	248.3	245.8	244.1	242.5	240.9	239.3	235.1	229.9	216.3	201.1
4400	249.2	249.2	249.2	248.9	247.2	245.6	244.0	239.7	234.3	220.5	205.0
4600	249.2	249.2	249.2	249.2	249.2	249.2	248.4	244.1	238.6	224.6	208.8
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	248.3	242.7	228.5	212.4
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	246.7	232.2	215.9
CLIMB LIMIT WT (1000 KG)	200.0	198.5	198.3	198.1	197.9	197.7	197.5	193.0	186.8	170.6	153.5

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1800	166.1	153.0	151.2	150.0	148.8	147.7	144.8	141.0	137.0	127.3	114.9
2000	175.2	161.5	159.6	158.4	157.2	156.0	153.0	149.1	144.9	134.8	121.9
2200	184.2	170.0	168.1	166.8	165.5	164.3	161.1	157.1	152.7	142.3	128.8
2400	193.2	178.6	176.5	175.2	173.9	172.7	169.4	165.3	160.8	150.0	136.2
2600	201.0	186.5	184.5	183.2	181.9	180.6	177.4	173.3	168.8	158.1	144.3
2800	213.0	198.2	196.2	194.9	193.6	192.3	189.0	184.8	180.3	169.4	155.4
3000	218.5	203.5	201.4	200.1	198.7	197.4	194.1	189.8	185.2	174.2	159.9
3200	224.5	209.1	207.0	205.6	204.2	202.9	199.5	195.1	190.4	179.0	164.5
3400	230.4	214.7	212.5	211.0	209.7	208.3	204.8	200.3	195.5	183.8	168.9
3600	236.1	220.0	217.8	216.3	214.9	213.5	209.9	205.3	200.4	188.4	173.1
3800	241.6	225.1	222.8	221.3	219.9	218.4	214.8	210.1	205.0	192.8	177.2
4000	246.9	230.0	227.7	226.2	224.7	223.2	219.5	214.7	209.5	197.1	181.1
4200	249.2	234.7	232.4	230.8	229.3	227.8	224.0	219.1	213.8	201.1	184.8
4400	249.2	239.3	236.9	235.3	233.7	232.2	228.3	223.3	218.0	205.1	188.4
4600	249.2	243.7	241.2	239.6	238.0	236.5	232.5	227.4	222.0	208.8	191.9
4800	249.2	247.9	245.4	243.7	242.1	240.5	236.5	231.4	225.8	212.4	195.3
5000	249.2	249.2	249.2	247.7	246.0	244.4	240.4	235.1	229.5	215.9	198.5
CLIMB LIMIT WT (1000 KG)	191.2	189.8	189.6	189.5	189.3	189.2	185.0	179.1	172.8	157.6	140.0

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1800	154.9	142.5	140.9	139.7	138.6	135.3	131.6	127.9	124.0	113.2	
2000	163.5	150.6	148.9	147.7	146.6	143.1	139.3	135.4	131.4	120.1	107.0
2200	172.1	158.7	156.9	155.7	154.5	150.8	146.9	142.8	138.7	127.0	113.3
2400	180.7	166.9	165.1	163.8	162.6	158.8	154.8	150.6	146.3	134.3	120.2
2600	188.7	174.9	173.1	171.8	170.6	166.9	162.8	158.7	154.4	142.4	128.4
2800	200.4	186.5	184.6	183.3	182.1	178.3	174.2	170.0	165.7	153.5	139.3
3000	205.7	191.6	189.6	188.4	187.1	183.2	179.0	174.8	170.4	158.0	143.5
3200	211.4	196.9	194.9	193.6	192.3	188.4	184.1	179.7	175.2	162.5	147.7
3400	217.0	202.1	200.1	198.7	197.4	193.4	189.0	184.5	179.8	166.9	151.7
3600	222.4	207.1	205.1	203.7	202.3	198.2	193.7	189.1	184.4	171.1	155.5
3800	227.5	212.0	209.8	208.4	207.0	202.8	198.2	193.5	188.7	175.1	159.2
4000	232.5	216.6	214.4	213.0	211.6	207.2	202.5	197.7	192.8	178.9	162.7
4200	237.3	221.1	218.8	217.4	215.9	211.5	206.7	201.8	196.8	182.6	166.1
4400	241.9	225.4	223.1	221.6	220.1	215.6	210.8	205.8	200.6	186.2	169.3
4600	246.3	229.5	227.2	225.7	224.2	219.6	214.6	209.6	204.3	189.7	172.5
4800	249.2	233.5	231.1	229.6	228.0	223.4	218.3	213.2	207.9	193.0	175.5
5000	249.2	237.2	234.9	233.3	231.8	227.0	221.9	216.7	211.3	196.1	178.4
CLIMB LIMIT WT (1000 KG)	181.5	180.4	180.2	180.1	179.9	174.8	169.0	163.1	156.9	141.0	125.2

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(f) of 3: 10000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1800	145.5	133.7	131.5	129.6	126.0	122.4	118.9	115.1	111.4		
2000	153.7	141.4	139.1	137.2	133.4	129.7	126.0	122.1	118.2		
2200	161.9	149.1	146.8	144.7	140.8	136.9	133.1	129.0	125.0	113.2	
2400	170.2	157.1	154.6	152.6	148.5	144.5	140.6	136.4	132.2	120.1	107.0
2600	178.2	165.1	162.7	160.6	156.6	152.6	148.7	144.5	140.4	128.3	115.2
2800	189.8	176.5	174.1	172.0	167.9	163.9	159.8	155.6	151.4	139.2	125.9
3000	194.9	181.4	178.9	176.8	172.6	168.5	164.4	160.1	155.9	143.5	129.9
3200	200.3	186.5	183.9	181.7	177.4	173.3	169.1	164.7	160.3	147.6	133.7
3400	205.6	191.4	188.8	186.6	182.2	177.9	173.6	169.1	164.6	151.6	137.4
3600	210.7	196.2	193.5	191.3	186.7	182.4	178.0	173.4	168.8	155.4	140.9
3800	215.6	200.8	198.1	195.7	191.1	186.6	182.1	177.4	172.7	159.1	144.2
4000	220.3	205.2	202.4	200.0	195.3	190.7	186.1	181.3	176.5	162.6	147.4
4200	224.9	209.4	206.6	204.1	199.3	194.7	190.0	185.1	180.2	166.0	150.5
4400	229.3	213.5	210.6	208.1	203.2	198.5	193.7	188.7	183.7	169.2	153.4
4600	233.4	217.4	214.5	212.0	207.0	202.1	197.3	192.2	187.1	172.4	156.3
4800	237.5	221.2	218.2	215.6	210.6	205.6	200.7	195.5	190.4	175.4	159.1
5000	241.3	224.8	221.7	219.1	214.0	209.0	204.0	198.7	193.5	178.3	161.7
CLIMB LIMIT WT (1000 KG)	174.2	173.4	172.0	170.1	164.3	158.6	153.0	147.2	141.6	126.8	114.8

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3700
ENGINE & WING ON	–2050	–3800	–4450
ENGINE AUTO	–1500	–3100	0
ENGINE & WING AUTO	–2050	–3800	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1700	–3450	–3850
ENGINE & WING ON	–2350	–4200	–4650
ENGINE AUTO	–1700	–3450	0
ENGINE & WING AUTO	–2350	–4200	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(g) of 3: 12000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1800	134.6	124.0	120.3	117.0	113.4	109.7					
2000	142.4	131.3	127.5	124.1	120.3	116.5	112.8	109.2			
2200	150.2	138.6	134.6	131.1	127.1	123.2	119.3	115.6	111.5		
2400	158.1	146.3	142.1	138.5	134.4	130.4	126.4	122.6	118.4	106.5	
2600	166.2	154.4	150.2	146.6	142.6	138.5	134.6	130.8	126.6	114.8	106.0
2800	177.6	165.6	161.5	157.8	153.7	149.6	145.6	141.7	137.4	125.5	116.6
3000	182.5	170.3	166.1	162.4	158.1	154.0	149.9	145.9	141.6	129.4	120.4
3200	187.6	175.1	170.8	167.0	162.6	158.4	154.2	150.1	145.7	133.2	124.0
3400	192.6	179.8	175.3	171.4	167.0	162.6	158.4	154.2	149.7	136.9	127.4
3600	197.4	184.3	179.7	175.8	171.2	166.8	162.4	158.1	153.5	140.4	130.7
3800	202.0	188.6	183.9	179.9	175.2	170.7	166.2	161.8	157.1	143.7	133.8
4000	206.4	192.8	188.0	183.8	179.1	174.4	169.9	165.4	160.5	146.8	136.7
4200	210.7	196.8	191.9	187.6	182.8	178.0	173.4	168.8	163.9	149.9	139.6
4400	214.8	200.6	195.6	191.3	186.4	181.5	176.8	172.2	167.1	152.9	142.4
4600	218.7	204.3	199.2	194.8	189.8	184.9	180.1	175.4	170.2	155.7	145.1
4800	222.5	207.8	202.7	198.2	193.1	188.1	183.2	178.4	173.2	158.5	147.6
5000	226.1	211.2	206.0	201.5	196.3	191.2	186.2	181.4	176.1	161.1	150.1
CLIMB LIMIT WT (1000 KG)	164.6	164.0	159.2	154.4	148.7	143.2	137.8	132.8	127.4	116.6	110.6

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3700
ENGINE & WING ON	–2050	–3800	–4450
ENGINE AUTO	–1500	–3100	0
ENGINE & WING AUTO	–2050	–3800	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1700	–3450	–3850
ENGINE & WING ON	–2350	–4200	–4650
ENGINE AUTO	–1700	–3450	0
ENGINE & WING AUTO	–2350	–4200	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(h) of 3: 14000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1800	123.4	112.5	108.3								
2000	130.7	119.3	115.0	111.8	108.5						
2200	138.0	126.1	121.6	118.3	114.8	111.4	108.1				P
2400	145.6	133.4	128.8	125.4	121.8	118.2	114.9	111.4	107.2		E
2600	153.7	141.6	136.9	133.6	130.0	126.4	123.1	119.6	115.4		R
2800	164.9	152.7	147.9	144.5	140.9	137.3	133.9	130.4	126.1		F
3000	169.6	157.1	152.3	148.9	145.1	141.5	138.0	134.5	130.1	110.4	
3200	174.4	161.6	156.7	153.1	149.3	145.6	142.0	138.4	133.9	113.7	L
3400	179.1	165.9	160.9	157.3	153.4	149.5	145.9	142.2	137.6	116.9	I
3600	183.6	170.1	165.0	161.2	157.3	153.3	149.6	145.8	141.1	119.9	M
3800	187.8	174.1	168.8	165.0	161.0	156.9	153.1	149.2	144.4	122.8	I
4000	192.0	177.9	172.5	168.7	164.5	160.4	156.5	152.5	147.6	125.5	T
4200	195.9	181.6	176.1	172.2	167.9	163.7	159.8	155.7	150.7	128.2	E
4400	199.8	185.2	179.6	175.5	171.2	167.0	162.9	158.8	153.7	130.7	D
4600	203.5	188.6	182.9	178.8	174.4	170.1	166.0	161.7	156.6	133.2	
4800	207.0	191.9	186.1	181.9	177.5	173.1	168.9	164.6	159.3	135.6	
5000	210.4	195.1	189.2	184.9	180.4	175.9	171.7	167.3	162.0	137.9	
CLIMB LIMIT WT (1000 KG)	153.2	150.4	144.5	140.1	135.2	130.5	126.5	123.3	119.5	107.9	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3700
ENGINE & WING ON	–2050	–3800	–4450
ENGINE AUTO	–1500	–3100	0
ENGINE & WING AUTO	–2050	–3800	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1700	–3450	–3850
ENGINE & WING ON	–2350	–4200	–4650
ENGINE AUTO	–1700	–3450	0
ENGINE & WING AUTO	–2350	–4200	0

Takeoff Field Corrections—Wet Runway

Table 1 of 3: Slope Correction

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	1850	1820	1800	1770	1750	1720	1700
2000	2120	2090	2060	2030	2000	1960	1930	1890	1860
2200	2340	2300	2270	2230	2200	2150	2110	2060	2020
2400	2560	2520	2480	2440	2400	2350	2290	2240	2180
2600	2780	2740	2690	2650	2600	2540	2470	2410	2340
2800	3000	2950	2900	2850	2800	2730	2650	2580	2500
3000	3230	3170	3110	3060	3000	2920	2830	2750	2660
3200	3450	3390	3320	3260	3200	3110	3010	2920	2820
3400	3670	3600	3530	3470	3400	3300	3190	3090	2980
3600	3890	3820	3750	3670	3600	3490	3370	3260	3150
3800	4110	4030	3960	3880	3800	3680	3550	3430	3310
4000	4330	4250	4170	4080	4000	3870	3730	3600	3470
4200	4560	4470	4380	4290	4200	4060	3910	3770	3630
4400	4780	4680	4590	4490	4400	4250	4090	3940	3790
4600	5000	4900	4800	4700	4600	4440	4280	4110	3950
4800	5220	5120	5010	4910	4800	4630	4460	4280	4110
5000	5440	5330	5220	5110	5000	4820	4640	4450	4270

Table 2 of 3: Wind Correction

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M)							
	WIND COMPONENT (KTS)							
	–15	–10	–5	0	10	20	30	40
1800	470	910	1360	1800	1930	2060	2200	2340
2000	700	1130	1570	2000	2130	2260	2400	2550
2200	930	1350	1780	2200	2330	2470	2610	2750
2400	1150	1570	1980	2400	2530	2670	2810	2960
2600	1380	1790	2190	2600	2730	2870	3020	3170
2800	1610	2000	2400	2800	2940	3080	3220	3370
3000	1830	2220	2610	3000	3140	3280	3430	3580
3200	2060	2440	2820	3200	3340	3480	3630	3790
3400	2290	2660	3030	3400	3540	3680	3830	3990
3600	2520	2880	3240	3600	3740	3890	4040	4200
3800	2740	3090	3450	3800	3940	4090	4240	4400
4000	2970	3310	3660	4000	4140	4290	4450	4610
4200	3200	3530	3870	4200	4340	4490	4650	4820
4400	3420	3750	4070	4400	4540	4700	4860	5020
4600	3650	3970	4280	4600	4750	4900	5060	5230
4800	3880	4180	4490	4800	4950	5100	5270	5440
5000	4100	4400	4700	5000	5150	5310	5470	5640

Takeoff Field & Climb Limit Weights—Wet Runway

Flaps 15

Based on anti-ice off

Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2300	226.0	209.2	207.0	205.4	203.8	200.8	198.8	197.3	195.7	183.7	171.2
2400	231.0	214.0	211.7	210.1	208.4	205.3	203.4	201.8	200.2	188.0	175.4
2600	238.9	222.1	219.8	218.3	216.6	213.6	211.6	210.0	208.5	196.5	184.0
2800	249.2	234.0	231.7	230.1	228.4	225.3	223.3	221.7	220.1	207.8	195.0
3000	249.2	239.9	237.5	235.9	234.2	231.0	229.0	227.4	225.7	213.2	200.2
3200	249.2	246.6	244.2	242.6	240.8	237.5	235.5	233.8	232.1	219.2	205.8
3400	249.2	249.2	249.2	249.2	247.7	244.3	242.2	240.4	238.7	225.4	211.6
3600	249.2	249.2	249.2	249.2	249.2	249.2	248.6	246.7	244.9	231.3	217.1
3800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	236.8	222.3
4000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	242.1	227.2
4200	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	247.1	231.9
4400	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	236.4
4600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	240.7
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	244.9
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	248.8
CLIMB LIMIT WT (1000 KG)	217.6	215.9	215.7	215.6	215.4	215.2	215.0	214.7	214.4	198.6	181.1

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–3000
ENGINE & WING ON	–300	–3600
ENGINE AUTO	–300	0
ENGINE & WING AUTO	–300	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2300	213.2	194.7	192.3	190.7	189.1	187.6	186.2	184.7	180.9	169.0	157.2
2400	217.9	199.2	196.7	195.1	193.5	192.0	190.5	189.1	185.1	173.0	161.1
2600	226.0	207.5	205.1	203.5	201.9	200.4	198.9	197.5	193.6	181.7	169.9
2800	238.0	219.1	216.6	215.0	213.4	211.8	210.3	208.9	204.9	192.7	180.6
3000	244.0	224.7	222.2	220.5	218.9	217.3	215.8	214.3	210.2	197.8	185.5
3200	249.2	231.0	228.4	226.7	225.0	223.4	221.8	220.3	216.1	203.3	190.7
3400	249.2	237.6	234.9	233.2	231.4	229.7	228.1	226.5	222.3	209.0	196.0
3600	249.2	243.9	241.1	239.3	237.5	235.7	234.1	232.5	228.1	214.5	201.1
3800	249.2	249.2	246.9	245.0	243.2	241.4	239.7	238.0	233.5	219.6	205.9
4000	249.2	249.2	249.2	249.2	248.5	246.7	245.0	243.3	238.7	224.5	210.5
4200	249.2	249.2	249.2	249.2	249.2	249.2	249.2	248.3	243.6	229.1	214.8
4400	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	248.3	233.5	219.0
4600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	237.8	223.0
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	241.9	226.9
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	245.8	230.6
CLIMB LIMIT WT (1000 KG)	208.4	206.9	206.7	206.6	206.4	206.2	206.0	205.7	200.7	183.7	167.4

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(b) of 3: 2000 FT Pressure Altitude
Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	**OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–300	–3000
ENGINE & WING ON	–300	–3600
ENGINE AUTO	–300	0
ENGINE & WING AUTO	–300	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	**OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	**0**	**6**	**10**	**14**	**18**	**22**	**26**	**30**	**40**	**50**
2300	198.8	182.4	180.3	178.9	177.5	176.1	174.8	171.2	166.8	155.5	143.5
2400	203.3	186.7	184.5	183.1	181.7	180.3	178.9	175.3	170.9	159.4	147.1
2600	211.5	195.2	193.0	191.6	190.2	188.8	187.5	183.9	179.5	168.2	156.1
2800	223.2	206.5	204.3	202.8	201.4	200.0	198.6	195.0	190.5	178.8	166.5
3000	228.9	211.9	209.6	208.1	206.7	205.3	203.8	200.1	195.5	183.7	171.1
3200	235.4	217.8	215.5	214.0	212.5	211.0	209.6	205.8	201.0	188.9	175.9
3400	242.1	224.0	221.6	220.0	218.5	217.0	215.5	211.5	206.7	194.1	180.8
3600	248.4	229.9	227.4	225.8	224.2	222.6	221.1	217.1	212.1	199.1	185.4
3800	249.2	235.3	232.8	231.2	229.5	227.9	226.4	222.2	217.1	203.9	189.9
4000	249.2	240.5	238.0	236.3	234.6	233.0	231.4	227.1	221.9	208.4	194.1
4200	249.2	245.5	242.9	241.1	239.4	237.8	236.1	231.8	226.5	212.7	198.1
4400	249.2	249.2	247.6	245.8	244.1	242.4	240.7	236.3	230.9	216.9	201.9
4600	249.2	249.2	249.2	249.2	248.6	246.8	245.1	240.7	235.1	220.8	205.7
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	244.8	239.2	224.7	209.3
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	248.8	243.1	228.3	212.7
CLIMB LIMIT WT (1000 KG)	200.0	198.5	198.3	198.1	197.9	197.7	197.5	193.0	186.8	170.6	153.5

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	**OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–300	–3000
ENGINE & WING ON	–300	–3600
ENGINE AUTO	–300	0
ENGINE & WING AUTO	–300	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	**OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2300	185.8	170.9	168.8	167.5	166.2	164.9	161.7	157.6	153.2	142.7	130.2
2400	190.2	175.0	172.9	171.5	170.2	168.9	165.7	161.5	157.1	146.4	133.7
2600	198.6	183.6	181.5	180.2	178.9	177.6	174.4	170.3	165.9	155.3	142.8
2800	210.0	194.6	192.5	191.2	189.8	188.5	185.2	181.0	176.5	165.7	152.9
3000	215.4	199.8	197.6	196.2	194.9	193.6	190.2	185.9	181.3	170.3	157.3
3200	221.5	205.4	203.2	201.8	200.4	199.0	195.5	191.1	186.4	175.1	161.7
3400	227.7	211.2	208.9	207.4	206.0	204.6	201.0	196.5	191.6	179.9	166.1
3600	233.7	216.7	214.3	212.8	211.3	209.9	206.2	201.6	196.6	184.6	170.3
3800	239.3	221.8	219.5	217.9	216.4	214.9	211.1	206.4	201.2	188.9	174.4
4000	244.6	226.7	224.3	222.7	221.2	219.6	215.8	210.9	205.7	193.1	178.2
4200	249.2	231.4	228.9	227.3	225.7	224.2	220.3	215.3	209.9	197.1	181.9
4400	249.2	235.9	233.4	231.7	230.1	228.5	224.6	219.5	214.0	201.0	185.5
4600	249.2	240.2	237.7	236.0	234.3	232.7	228.7	223.5	218.0	204.7	189.0
4800	249.2	244.4	241.8	240.0	238.4	236.7	232.6	227.4	221.8	208.3	192.3
5000	249.2	248.3	245.7	243.9	242.2	240.6	236.4	231.1	225.4	211.7	195.5
CLIMB LIMIT WT (1000 KG)	191.2	189.8	189.6	189.5	189.3	189.2	185.0	179.1	172.8	157.6	140.0

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–3000
ENGINE & WING ON	–300	–3600
ENGINE AUTO	–300	0
ENGINE & WING AUTO	–300	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2300	173.4	159.2	157.3	156.1	154.8	151.1	147.1	143.0	138.9	127.9	115.1
2400	177.6	163.1	161.2	159.9	158.7	154.9	150.9	146.7	142.5	131.3	118.4
2600	186.2	171.9	170.0	168.7	167.5	163.8	159.8	155.7	151.5	140.5	127.7
2800	197.3	182.7	180.7	179.4	178.1	174.4	170.3	166.1	161.8	150.5	137.5
3000	202.5	187.6	185.6	184.3	183.0	179.1	175.0	170.7	166.3	154.8	141.5
3200	208.1	192.9	190.8	189.5	188.1	184.2	179.9	175.5	171.0	159.2	145.5
3400	214.0	198.3	196.1	194.8	193.4	189.3	184.8	180.3	175.7	163.5	149.4
3600	219.6	203.4	201.2	199.8	198.4	194.2	189.6	185.0	180.2	167.7	153.2
3800	224.8	208.2	206.0	204.6	203.1	198.8	194.1	189.4	184.5	171.7	156.8
4000	229.8	212.8	210.6	209.1	207.6	203.2	198.4	193.6	188.6	175.5	160.3
4200	234.5	217.2	214.9	213.4	211.9	207.4	202.5	197.6	192.5	179.1	163.6
4400	239.1	221.5	219.1	217.6	216.0	211.5	206.5	201.4	196.2	182.6	166.9
4600	243.5	225.5	223.2	221.6	220.0	215.3	210.3	205.2	199.9	186.0	170.0
4800	247.7	229.5	227.0	225.4	223.8	219.1	214.0	208.7	203.4	189.3	173.0
5000	249.2	233.2	230.7	229.1	227.5	222.7	217.5	212.2	206.7	192.5	175.9
CLIMB LIMIT WT (1000 KG)	181.5	180.4	180.2	180.1	179.9	174.8	169.0	163.1	156.9	141.0	125.2

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(e) of 3: 8000 FT Pressure Altitude
Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	**OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–300	–3000
ENGINE & WING ON	–300	–3600
ENGINE AUTO	–300	0
ENGINE & WING AUTO	–300	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	**OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–350	–4900
ENGINE & WING ON	–350	–5800
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Table 3(f) of 3: 10000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	**0**	**6**	**10**	**14**	**18**	**22**	**26**	**30**	**40**	**50**
2300	162.5	149.3	146.8	144.8	140.8	136.9	133.1	129.1	125.2	114.5	
2400	166.5	153.1	150.6	148.5	144.5	140.5	136.6	132.6	128.6	117.7	105.7
2600	175.2	162.0	159.5	157.4	153.4	149.6	145.7	141.7	137.8	127.1	115.1
2800	186.1	172.5	170.0	167.9	163.8	159.8	155.9	151.8	147.8	136.8	124.6
3000	191.1	177.2	174.7	172.5	168.4	164.3	160.3	156.1	152.1	140.8	128.4
3200	196.4	182.2	179.6	177.4	173.1	168.9	164.8	160.5	156.3	144.8	132.0
3400	201.9	187.3	184.5	182.3	177.8	173.5	169.3	164.9	160.6	148.7	135.5
3600	207.2	192.1	189.3	187.0	182.4	178.0	173.6	169.1	164.7	152.4	138.9
3800	212.1	196.7	193.8	191.4	186.8	182.2	177.7	173.1	168.6	156.1	142.2
4000	216.8	201.0	198.1	195.6	190.9	186.3	181.7	177.0	172.3	159.5	145.3
4200	221.3	205.2	202.2	199.7	194.9	190.1	185.5	180.6	175.9	162.8	148.4
4400	225.6	209.2	206.2	203.6	198.7	193.9	189.1	184.2	179.3	166.0	151.3
4600	229.7	213.0	210.0	207.4	202.3	197.5	192.6	187.6	182.7	169.2	154.2
4800	233.7	216.7	213.6	211.0	205.9	200.9	196.0	190.9	185.9	172.2	156.9
5000	237.5	220.3	217.1	214.5	209.3	204.2	199.2	194.1	189.0	175.1	159.6
CLIMB LIMIT WT (1000 KG)	174.2	173.4	172.0	170.1	164.3	158.6	153.0	147.2	141.6	126.8	114.8

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	**OAT≤5 deg. C**	**5 deg. C<OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–1500	–2900	–3800
ENGINE & WING ON	–2050	–3500	–4600
ENGINE AUTO	–1500	–2900	0
ENGINE & WING AUTO	–2050	–3500	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	**OAT≤5 deg. C**	**5 deg. C<OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–1700	–3450	–3850
ENGINE & WING ON	–2350	–4200	–4650
ENGINE AUTO	–1700	–3450	0
ENGINE & WING AUTO	–2350	–4200	0

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(g) of 3: 12000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2300	150.5	138.5	134.5	131.0	127.1	123.3	119.6	115.9	112.2		
2400	154.3	142.1	138.0	134.5	130.6	126.7	122.9	119.2	115.4		
2600	163.2	151.1	147.1	143.6	139.7	135.9	132.2	128.5	124.8	112.3	
2800	173.7	161.4	157.3	153.7	149.8	145.9	142.0	138.3	134.5	121.8	110.5
3000	178.5	165.9	161.7	158.1	154.1	150.1	146.2	142.4	138.5	125.5	114.0
3200	183.5	170.6	166.3	162.6	158.4	154.3	150.3	146.4	142.4	129.0	117.2
3400	188.6	175.3	170.8	167.0	162.7	158.5	154.3	150.3	146.2	132.4	120.2
3600	193.5	179.8	175.2	171.3	166.8	162.5	158.2	154.1	149.9	135.7	123.2
3800	198.1	184.1	179.4	175.3	170.8	166.4	162.0	157.7	153.4	138.9	126.1
4000	202.4	188.1	183.3	179.2	174.6	170.0	165.6	161.2	156.8	142.0	128.9
4200	206.6	192.0	187.1	182.9	178.2	173.6	169.0	164.6	160.1	145.0	131.6
4400	210.7	195.8	190.8	186.5	181.7	177.0	172.4	167.8	163.2	147.9	134.2
4600	214.6	199.4	194.3	190.0	185.1	180.3	175.6	171.0	166.3	150.7	136.8
4800	218.3	202.9	197.7	193.3	188.4	183.5	178.7	174.0	169.3	153.4	139.3
5000	221.9	206.3	201.0	196.5	191.5	186.6	181.7	177.0	172.1	156.0	141.7
CLIMB LIMIT WT (1000 KG)	164.6	164.0	159.2	154.4	148.7	143.2	137.8	132.8	127.4	116.6	110.6

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–2900	–3800
ENGINE & WING ON	–2050	–3500	–4600
ENGINE AUTO	–1500	–2900	0
ENGINE & WING AUTO	–2050	–3500	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1700	–3450	–3850
ENGINE & WING ON	–2350	–4200	–4650
ENGINE AUTO	–1700	–3450	0
ENGINE & WING AUTO	–2350	–4200	0

Table 3(h) of 3: 14000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2300	138.0	126.0	121.6	118.4	115.0	111.7					
2400	141.6	129.5	125.0	121.8	118.3	114.9	111.8	108.5			P
2600	150.6	138.6	134.2	131.0	127.6	124.3	121.2	117.9	111.2		E
2800	160.9	148.6	144.1	140.9	137.4	134.0	130.8	127.4	120.6		R
3000	165.4	152.9	148.3	145.0	141.4	138.0	134.7	131.3	124.3		F
3200	170.1	157.2	152.5	149.1	145.4	141.8	138.5	135.0	127.8		
3400	174.7	161.5	156.6	153.1	149.3	145.6	142.1	138.5	131.1		L
3600	179.2	165.6	160.6	156.9	153.1	149.3	145.7	142.0	134.4	111.6	I
3800	183.5	169.5	164.4	160.7	156.7	152.8	149.2	145.4	137.6	114.2	M
4000	187.6	173.3	168.0	164.2	160.2	156.2	152.5	148.6	140.6	116.8	I
4200	191.4	176.9	171.5	167.6	163.5	159.5	155.7	151.7	143.6	119.2	T
4400	195.2	180.4	174.9	171.0	166.7	162.6	158.8	154.7	146.4	121.6	E
4600	198.8	183.7	178.2	174.2	169.9	165.7	161.7	157.6	149.2	124.0	D
4800	202.3	187.0	181.3	177.2	172.9	168.7	164.6	160.5	151.9	126.3	
5000	205.6	190.1	184.4	180.2	175.8	171.5	167.4	163.2	154.5	128.5	
CLIMB LIMIT WT (1000 KG)	153.2	150.4	144.5	140.1	135.2	130.5	126.5	123.3	119.5	107.9	

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(h) of 3: 14000 FT Pressure Altitude
Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	**OAT≤5 deg. C**	**5 deg. C<OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–1500	–2900	–3800
ENGINE & WING ON	–2050	–3500	–4600
ENGINE AUTO	–1500	–2900	0
ENGINE & WING AUTO	–2050	–3500	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	**OAT≤5 deg. C**	**5 deg. C<OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–1700	–3450	–3850
ENGINE & WING ON	–2350	–4200	–4650
ENGINE AUTO	–1700	–3450	0
ENGINE & WING AUTO	–2350	–4200	0

Takeoff Obstacle Limit Weight

Flaps 15

Based on anti-ice off, ten minute takeoff thrust time limit

Table 1 of 4: Sea Level, 30 deg. 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	202.3	217.7	229.2	236.1								
20	183.8	197.5	208.2	216.7	222.7	229.0	232.6	235.6	238.1			
40	168.1	181.3	192.2	200.9	207.8	213.3	217.9	221.6	224.8	228.7	230.9	232.9
60	156.3	170.0	180.6	189.4	196.7	202.6	207.5	211.6	215.3	218.3	221.0	223.3
80	146.1	160.7	171.6	180.2	187.6	193.8	199.0	203.5	207.3	210.5	213.4	216.1
100	136.8	152.9	163.8	172.7	161.8	186.2	191.7	196.4	200.4	204.0	207.0	209.8
120	129.0	145.2	157.0	166.0	173.4	179.5	185.1	190.0	194.3	198.0	201.3	204.2
140		138.1	150.9	160.0	167.6	173.9	179.2	184.3	188.7	192.6	196.1	199.2
160		131.7	144.7	154.5	162.2	168.8	174.3	179.0	183.5	187.6	191.2	194.4
180		126.1	138.9	149.4	157.2	163.9	169.8	174.6	178.8	182.9	186.6	190.0
200			133.5	144.2	152.8	159.4	165.3	170.5	174.8	178.6	182.4	185.8
220			128.6	139.3	148.2	155.2	161.2	166.4	171.0	174.9	178.4	181.9
240				134.7	143.8	151.4	157.3	162.6	167.3	171.5	175.0	178.3
260				130.5	139.6	147.3	153.7	159.0	163.8	168.1	171.8	175.1
280				126.5	135.5	143.5	150.2	155.6	160.4	164.8	168.7	172.1
300					131.8	139.8	146.6	152.4	157.2	161.6	165.6	169.2
Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.												

Table 2 of 4: OAT Adjustment

OAT (deg. C)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)						
	120	140	160	180	200	220	240
30 & BELOW	0	0	0	0	0	0	0
32	–1.7	–2.1	–2.4	–2.8	–3.2	–3.5	–3.9
34	–3.4	–4.1	–4.8	–5.6	–6.3	–7.0	–7.8
36	–5.1	–6.2	–7.3	–8.4	–9.5	–10.6	–11.7
38	–6.8	–8.2	–9.7	–11.1	–12.6	–14.1	–15.5
40	–8.4	–10.3	–12.1	–13.9	–15.8	–17.6	–19.4
42	–10.0	–12.2	–14.5	–16.7	–18.9	–21.1	–23.3
44	–11.6	–14.2	–16.8	–19.4	–22.0	–24.6	–27.2
46	–13.2	–16.2	–19.2	–22.1	–25.1	–28.1	–31.1
48	–14.8	–18.2	–21.5	–24.9	–28.3	–31.6	–35.0
50	–16.4	–20.1	–23.9	–27.6	–31.4	–35.1	–38.9

Table 3 of 4: Pressure Altitude Adjustment

PRESS ALT (FT)	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)						
	120	140	160	180	200	220	240
S.L. & BELOW	0	0	0	0	0	0	0
1000	–4.4	–5.2	–6.0	–6.7	–7.5	–8.3	–9.1
2000	–8.8	–10.3	–11.9	–13.5	–15.1	–16.7	–18.2
3000	–12.6	–14.8	–17.1	–19.3	–21.6	–23.8	–26.1
4000	–16.4	–19.3	–22.2	–25.2	–28.1	–31.0	–33.9
5000	–20.2	–23.8	–27.3	–30.9	–34.4	–38.0	–41.6
6000	–24.0	–28.2	–32.4	–36.6	–40.8	–45.0	–49.2
7000	–28.0	–33.0	–37.9	–42.9	–47.9	–52.9	–57.9
8000	–31.9	–37.7	–43.5	–49.2	–55.0	–60.8	–66.6
9000	–36.4	–42.9	–49.4	–55.9	–62.5	–69.0	–75.5
10000	–40.8	–48.1	–55.4	–62.7	–69.9	–77.2	–84.5
11000	–44.4	–52.4	–60.4	–68.3	–76.3	–84.3	–92.3
12000	–48.0	–56.7	–65.3	–74.0	–82.7	–91.3	–100.0
13000	–48.1	–57.8	–67.6	–77.3	–87.0	–96.8	–106.5
14000	–48.2	–59.0	–69.8	–80.6	–91.4	–102.2	–113.0

Takeoff Obstacle Limit Weight

Flaps 15

Based on anti-ice off, ten minute takeoff thrust time limit

Table 4 of 4: Wind Adjustment

WIND (KTS)	OAT & ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)						
	120	140	160	180	200	220	240
15 TW	–24.0	–23.3	–22.6	–22.0	–21.3	–20.6	–19.9
10 TW	–16.0	–15.6	–15.1	–14.6	–14.2	–13.7	–13.3
5 TW	–8.0	–7.8	–7.5	–7.3	–7.1	–6.9	–6.6
0	0	0	0	0	0	0	0
10 HW	2.8	2.5	2.2	1.9	1.6	1.3	1.0
20 HW	5.6	5.0	4.4	3.8	3.2	2.6	2.0
30 HW	8.7	7.8	6.9	6.0	5.0	4.1	3.2
40 HW	11.9	10.6	9.4	8.1	6.9	5.6	4.4

Anti-Ice Adjustments

Pressure Altitude < 9000 FT

	OBSTACLE LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Pressure Altitude ≥ 9000 FT

	OBSTACLE LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1950	–3950	–4450
ENGINE & WING ON	–2700	–4800	–5350
ENGINE AUTO	–1950	–3950	0
ENGINE & WING AUTO	–2700	–4800	0

Fuel Jettison Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	FUEL JETTISON LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	188.9	185.2							
52	192.3	188.6							
50	195.6	192.0	169.4						
48	203.2	195.4	181.7						
46	215.8	200.5	184.9	163.3					
44	219.4	214.4	188.1	166.5					
42	223.3	218.9	191.3	169.6	157.1				
40	227.0	222.6	194.7	181.7	160.1				
38	230.2	226.4	198.2	184.8	163.2	146.7			
36	232.8	230.1	212.8	188.0	166.2	149.9			
34	235.3	233.3	218.3	191.3	169.1	153.1	138.5		
32	235.5	235.9	221.8	194.6	181.1	156.2	141.3		
30	235.7	238.8	224.8	197.9	184.1	159.1	144.1		
28	235.9	239.0	227.4	211.1	187.2	162.2	146.8		
26	236.0	239.2	229.8	217.0	190.4	165.2	149.5		
24	236.1	239.3	229.9	219.4	193.5	168.2	152.3	137.8	
22	236.3	239.5	230.1	221.6	196.1	180.2	155.2	140.5	
20	236.4	239.6	230.2	221.7	198.2	183.0	158.0	143.2	130.5
18	236.5	239.7	230.3	221.8	207.4	185.9	160.8	146.0	132.7
16	236.6	239.8	230.4	221.9	207.7	188.6	163.5	148.7	135.1
14	236.7	239.9	230.5	222.0	207.9	191.1	166.5	151.6	137.5
12	236.8	240.0	230.6	222.1	208.2	191.2	169.5	154.4	140.0
10	236.8	240.1	230.7	222.2	208.4	191.2	181.4	157.2	142.4
0	237.3	240.5	231.1	222.6	209.7	191.6	184.6	166.8	153.1
–10	237.7	240.9	231.4	222.9	211.0	191.9	184.9	167.0	155.4
–20	238.1	241.3	231.8	223.3	212.3	192.2	185.1	167.1	
–30	238.7	241.7	232.1	223.7	213.5	192.5	185.3		
–40	239.5	242.4	232.6	224.1	214.7	192.8			

Table valid for Zero Fuel Weight up to 161025 kg.

Anti-Ice Adjustments

Pressure Altitude ≤ 9000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900	–6400
ENGINE & WING ON	–350	–5850	–7350

Pressure Altitude > 9000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–2950	–5750	–6150
ENGINE & WING ON	–4150	–6450	–6850

DELETION

Long Range Cruise Maximum Operating Altitude
Max Climb Thrust
ISA + 10 deg. C and Below

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
250	32600	–6	33800*	33800*
240	33500	–8	34800*	34800*
230	34400	–10	35800*	35800*
220	35300	–12	36700*	36700*
210	36300	–14	38200*	38200*
200	37300	–14	39200*	39200*
190	38400	–14	40200*	40200*
180	39500	–14	41200*	41200*
170	40700	–14	42300*	42300*
160	42000	–14	43100	43100
150	43100	–14	43100	43100
140	43100	–14	43100	43100
130	43100	–14	43100	43100
120	43100	–14	43100	43100

*Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.

ISA + 15 deg. C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
250	32600	0	33000*	33000*
240	33500	–2	34200*	34200*
230	34400	–4	35200*	35200*
220	35300	–6	36100*	36100*
210	36300	–8	37500*	37500*
200	37300	–8	38700*	38700*
190	38400	–8	39700*	39700*
180	39500	–8	40600*	40600*
170	40700	–8	41600*	41600*
160	42000	–8	42700*	42700*
150	43100	–8	43100	43100
140	43100	–8	43100	43100
130	43100	–8	43100	43100
120	43100	–8	43100	43100

*Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.

ISA + 20 deg. C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
250	32600	6	28500*	28500*
240	33500	4	30600*	30600*
230	34400	2	32400*	32400*
220	35300	0	34800*	34800*
210	36300	–2	36200*	36200*
200	37300	–2	37400*	37400*
190	38400	–2	38400*	38400*
180	39500	–2	39400*	39400*
170	40700	–2	40300*	40300*
160	42000	–2	41100*	41100*
150	43100	–2	41800*	41800*
140	43100	–2	42900*	42900*
130	43100	–2	43100	43100
120	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) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
1070	1004	944	890	843	800	766	734	705	678	654
1602	1503	1413	1335	1264	1200	1150	1103	1059	1019	982
2131	2001	1883	1778	1685	1600	1533	1471	1413	1360	1312
2659	2497	2351	2221	2106	2000	1917	1840	1768	1702	1642
3185	2992	2818	2664	2526	2400	2301	2209	2123	2045	1973
3709	3486	3284	3106	2946	2800	2685	2578	2479	2388	2304
4231	3979	3749	3547	3366	3200	3069	2948	2835	2731	2636
4752	4470	4214	3988	3786	3600	3454	3318	3191	3075	2968
5271	4961	4679	4429	4205	4000	3838	3687	3547	3418	3300
5789	5451	5142	4869	4624	4400	4223	4058	3904	3762	3632
6305	5939	5605	5309	5044	4800	4608	4428	4260	4106	3964
6820	6426	6067	5749	5463	5200	4992	4798	4617	4450	4296
7333	6912	6529	6188	5881	5600	5376	5167	4973	4793	4628
7845	7398	6989	6626	6300	6000	5761	5537	5329	5137	4960
8356	7882	7449	7064	6718	6400	6145	5906	5685	5480	5292
8865	8365	7908	7502	7136	6800	6529	6276	6040	5823	5624
9373	8847	8367	7939	7554	7200	6913	6645	6396	6166	5956
9879	9328	8824	8376	7972	7600	7297	7015	6752	6510	6287
10384	9808	9282	8812	8389	8000	7682	7385	7108	6853	6618

Table 2 of 3: Reference Fuel and Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	31		33		35		37		39	
	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)
800	8.4	2.:05	8.3	2:02	8.1	1:59	8.1	1:56	8.0	1:52
1200	12.2	3:03	12.0	2:59	11.7	2:54	11.6	2:49	11.5	2:43
1600	16.0	4:01	15.7	3:55	15.3	3:49	15.1	3:42	15.0	3:34
2000	19.9	4:59	19.4	4:51	19.0	4:43	18.7	4:34	18.5	4:24
2400	23.8	5:56	23.3	5:46	22.7	5:36	22.4	5:26	22.2	5:14
2800	27.8	6:52	27.1	6:41	26.5	6:30	26.1	6:17	25.9	6:03
3200	31.8	7:48	31.1	7:35	30.3	7:22	29.9	7:08	29.6	6:53
3600	36.0	8:43	35.1	8:28	34.3	8:14	33.8	7:58	33.5	7:42
4000	40.1	9:38	39.1	9:22	38.2	9:06	37.7	8:48	37.3	8:31
4400	44.4	10:32	43.3	10:14	42.3	9:57	41.7	9:37	41.3	9:20
4800	48.7	11:25	47.5	11:06	46.4	10:47	45.8	10:27	45.2	10:09
5200	53.1	12:18	51.7	11:58	50.6	11:38	49.9	11:16	49.3	10:58
5600	57.5	13:11	56.1	12:49	54.9	12:27	54.1	12:05	53.5	11:47
6000	62.0	14:03	60.5	13:40	59.1	13:17	58.3	12:54	57.7	12:37
6400	66.7	14:54	65.1	14:30	63.6	14:06	62.7	13:43	62.1	13:26
6800	71.5	15:45	69.7	15:19	68.2	14:55	67.1	14:32	66.5	14:16
7200	76.3	16:36	74.4	16:09	72.8	15:44	71.7	15:22		
7600	81.4	17:26	79.3	16:57	77.5	16:32	76.4	16:11		
8000	86.4	18:16	84.2	17:46	82.2	17:21	81.1	17:00		

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	LANDING WEIGHT (1000 KG)				
	100	120	140	160	180
10	–1.5	–0.8	0.0	0.9	1.9
20	–2.9	–1.5	0.0	1.9	4.0
30	–4.5	–2.3	0.0	3.0	6.5
40	–6.1	–3.1	0.0	4.1	9.2
50	–7.7	–4.0	0.0	5.4	12.2
60	–9.5	–5.0	0.0	6.8	15.4
70	–11.3	–6.0	0.0	8.3	18.9
80	–13.2	–7.0	0.0	9.9	22.7
90	–15.1	–8.2	0.0	11.5	26.8

Based on 310/.85 climb, Long Range Cruise speed and .85/310/250 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
1043	984	930	882	839	800	764	732	702	674	649
1551	1465	1388	1319	1257	1200	1148	1100	1057	1016	979
2058	1946	1846	1756	1674	1600	1532	1469	1412	1358	1309
2564	2427	2304	2193	2092	2000	1916	1838	1767	1701	1639
3070	2908	2762	2630	2510	2400	2300	2207	2122	2043	1970
3576	3388	3219	3066	2927	2800	2684	2576	2478	2386	2301
4081	3868	3676	3502	3344	3200	3068	2946	2833	2729	2632
4586	4348	4133	3939	3762	3600	3452	3315	3189	3072	2963
5090	4827	4590	4375	4179	4000	3836	3684	3545	3415	3294
5594	5306	5046	4811	4596	4400	4220	4054	3900	3758	3626
6098	5785	5503	5247	5013	4800	4604	4423	4256	4102	3958
6601	6264	5959	5683	5431	5200	4988	4793	4612	4445	4289
7105	6742	6415	6118	5848	5600	5372	5163	4969	4789	4621
7608	7221	6871	6554	6265	6000	5757	5532	5325	5132	4953
8111	7699	7327	6990	6682	6400	6141	5902	5681	5476	5285
8613	8177	7783	7425	7099	6800	6525	6272	6037	5820	5617
9116	8655	8239	7861	7516	7200	6910	6642	6394	6164	5950
9618	9133	8695	8296	7933	7600	7294	7012	6750	6508	6282
10121	9611	9150	8732	8350	8000	7678	7381	7107	6852	6614

Table 2 of 2: Trip Fuel and Time Required

AIR DIST (NM)	TRIP FUEL (1000 KG) LANDING WEIGHT (1000 KG)					TIME (HRS:MIN)
	100	120	140	160	180	
800	6.5	7.2	8.0	8.7	9.6	1:52
1200	9.2	10.3	11.4	12.5	13.8	2:44
1600	11.9	13.4	14.8	16.3	18.0	3:35
2000	14.7	16.5	18.4	20.2	22.3	4:26
2400	17.6	19.7	21.9	24.2	26.8	5:16
2800	20.5	23.0	25.6	28.3	31.3	6:07
3200	23.4	26.3	29.3	32.5	35.9	6:57
3600	26.4	29.7	33.1	36.7	40.7	7:47
4000	29.4	33.2	36.9	41.0	45.7	8:37
4400	32.5	36.7	40.8	45.4	50.8	9:26
4800	35.7	40.2	44.9	49.9	56.1	10:16
5200	38.9	43.8	49.0	54.5	61.4	11:05
5600	42.1	47.5	53.1	59.2	66.8	11:55
6000	45.4	51.2	57.4	64.2	72.3	12:44
6400	48.8	55.0	61.7	69.3	77.9	13:33
6800	52.2	58.9	66.1	74.5	83.7	14:22
7200	55.7	62.9	70.6	79.8	89.5	15:11
7600	59.2	67.0	75.2	85.1	95.6	16:00
8000	62.8	71.1	80.0	90.6	101.7	16:49

Based on 310/.85 climb, Long Range Cruise speed and .85/310/250 descent.
Valid for all pressure altitudes with 4,000 ft step climb to 2,000 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
94	80	70	62	55	50	46	42	39	36	34
160	143	129	118	108	100	93	87	82	77	73
224	204	187	173	161	150	141	132	125	119	113
287	264	244	228	213	200	189	178	169	161	153
348	323	301	282	265	250	237	225	214	204	195
409	381	357	336	317	300	285	271	259	247	237
470	440	413	390	369	350	333	318	303	291	279
532	499	470	444	421	400	381	364	348	334	321
594	558	527	498	473	450	429	410	393	377	362
659	619	584	553	525	500	477	456	437	419	403

Table 2 of 2: Trip Fuel and Time Required

AIR DISTANCE (NM)		LANDING WEIGHT (1000 KG) 100	120	140	160	180	TIME (HRS:MIN)
50	FUEL (1000 KG) ALT (FT)	1.0 13000	1.1 11000	1.1 11000	1.3 9000	1.4 9000	0:14
100	FUEL (1000 KG) ALT (FT)	1.5 15000	1.6 15000	1.8 15000	1.9 15000	2.0 13000	0:23
150	FUEL (1000 KG) ALT (FT)	2.0 23000	2.2 23000	2.3 21000	2.5 21000	2.7 19000	0:30
200	FUEL (1000 KG) ALT (FT)	2.4 27000	2.7 27000	2.9 27000	3.1 27000	3.3 25000	0:37
250	FUEL (1000 KG) ALT (FT)	2.8 39000	3.1 35000	3.3 31000	3.6 29000	3.8 27000	0:43
300	FUEL (1000 KG) ALT (FT)	3.1 43000	3.5 39000	3.8 35000	4.1 35000	4.4 31000	0:49
350	FUEL (1000 KG) ALT (FT)	3.5 43000	3.9 41000	4.2 37000	4.5 35000	4.9 35000	0:54
400	FUEL (1000 KG) ALT (FT)	3.8 43000	4.2 43000	4.6 43000	5.0 39000	5.4 37000	1:00
450	FUEL (1000 KG) ALT (FT)	4.1 43000	4.6 43000	5.0 43000	5.5 41000	5.9 39000	1:06
500	FUEL (1000 KG) ALT (FT)	4.4 43000	5.0 43000	5.4 43000	5.9 41000	6.4 39000	1:12

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
260	6090	6070	6290	6390	6380	6610	6980			
240	5660	5610	5680	5860	5830	5990	6310	6660		
220	5240	5170	5200	5270	5330	5330	5620	5930		
200	4830	4750	4710	4610	4840	4720	4880	5110	5550	
180	4440	4350	4260	4190	4270	4200	4280	4470	4860	
160	4070	3970	3860	3750	3740	3720	3750	3880	4200	4440
140	4030	3810	3480	3360	3340	3280	3290	3320	3560	3760
120	3640	3540	3310	3000	2960	2890	2880	2870	3000	3120
100	3310	3220	3100	2710	2660	2580	2560	2550	2600	2670
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
260	6680	6650	6660	6630	6710
240	6170	6120	6090	6050	6170
220	5660	5610	5560	5490	5640
200	5170	5100	5040	4960	5110
180	4690	4610	4530	4430	4530
160	4250	4150	4050	3970	3990
140	3820	3720	3600	3510	3490
120	3730	3520	3200	3080	3030
100	3360	3250	3040	2730	2660
Includes 5% additional fuel for holding in a race track pattern.					

Crew Oxygen Requirements

Table 1 of 5

NUMBER OF CREW	OXYGEN REQUIRED (LITERS)
2	660
3	990
4	1320

Table 2 of 5

NUMBER OF CREW	OXYGEN REQUIRED FOR LEVEL OFF AT 14000 FT (LITERS)			
	TOTAL POST DECOMPRESSION TIME (HR)			
	2	3	4	5
2	660	960	1270	1570
3	980	1440	1900	2360
4	1310	1920	2530	3140

Table 3 of 5

NUMBER OF CREW	ADDITIONAL LITERS REQUIRED FOR EACH MINUTE HELD AT INTERMEDIATE ALTITUDE OTHER THAN 14000 FT				
	INTERMEDIATE PRESSURE ALTITUDE (FT)				
	UP TO 13999	14000	14001 TO 17999	18000 TO 21999	22000 TO 29000
	REGULATOR ON "NORMAL" OR (100%)				
2	0 (22)	0 (17)	1 (16)	3 (12)	6 (10)
3	0 (33)	0 (25)	2 (24)	5 (18)	8 (15)
4	0 (44)	0 (34)	2 (32)	6 (24)	11 (20)

For more extensive than normal crew usage, add 2.05 liters/person/minute for each crew member at 6,000 ft cabin altitude when regulator setting is NORMAL or 13 liters/person/minute when regulator setting is 100%.

Instructions:

1. Determine protective breathing requirements from Table 1.
2. Determine supplemental requirements for level off at 14,000 ft from Table 2 and correct for level off altitudes other than 14,000 ft using Table 3.
3. Flight crew system oxygen requirement is the larger of protective breathing (Table 1) and supplemental breathing (Tables 2 and 3) requirements.

Crew Oxygen Requirements

Cylinder Volume to Pressure Conversion

Table 4(a) of 5: One 115 Cubic Ft. Cylinder

OXYGEN VOLUME (1000 LITERS)	CYLINDER PRESSURE AT 21 deg. C (PSI)
0.1	200
0.3	300
0.5	400
0.7	500
0.8	600
1.0	700
1.2	800
1.4	900
1.5	1000
1.7	1100
1.9	1200
2.1	1300
2.2	1400
2.4	1500
2.6	1600
2.7	1700
2.9	1800
3.1	1900
3.3	2000
Check maximum pressure in shaded area. Maximum cylinder pressure = 1,850 PSI at 21 deg. C. Adjust maximum cylinder pressure by +32 PSI/–32 PSI for every 5 deg. C above/below 21 deg. C.	

Table 5 of 5: Temperature Corrections

CYLINDER PRESSURE AT 21 deg. C (PSI)	PRESSURE CORRECTION FOR EACH 5 deg. C ABOVE/BELOW 21 deg. C (PSI)
400	7/–7
600	11/–11
800	14/–14
1000	17/–17
1200	21/–21
1400	24/–24
1600	28/–28
1800	31/–31
2000	34/–34

ENGINE INOP

MAX CONTINUOUS THRUST

Net Level Off Weight

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 KG)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
32	112.1	110.1	106.0
30	122.7	120.3	115.8
28	133.0	129.9	124.8
26	143.9	140.1	134.3
24	154.9	151.0	144.6
22	166.5	162.5	155.4
20	181.4	177.7	169.7
18	191.3	183.2	173.9
16	202.8	194.5	184.5
14	214.2	205.2	194.9
12	226.1	215.6	205.1
10	231.3	219.9	209.0
9	233.8	222.6	211.6
8	235.8	225.0	213.9
6	244.9	234.0	222.4
4	249.2	242.6	230.7
2	249.2	249.2	238.3

Anti-Ice Adjustment

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 KG)														
	PRESSURE ALTITUDE (1000 FT)														
	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
ENGINE ON	0.0	0.0	0.0	–2.7	–2.8	–3.0	–3.1	–3.0	–3.0	–2.7	–0.3	–0.3	–0.3	–0.3	–0.3
ENGINE & WING ON	0.0	0.0	0.0	–3.7	–3.9	–4.2	–4.3	–4.3	–4.3	–4.1	–0.4	–0.3	–0.3	–0.3	–0.3

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 KG)														
	PRESSURE ALTITUDE (1000 FT)														
	4	6	8	10	12	14	16	18	20	22	24	26	28	30	32
ENGINE ON	0.0	–3.1	–3.4	–3.3	–3.1	–3.2	–3.3	–3.2	–3.0	–2.7	–0.3	–0.3	–0.3	–0.3	–0.3
ENGINE & WING ON	0.0	–4.4	–4.6	–4.5	–4.3	–4.5	–4.6	–4.6	–4.3	–4.1	–0.4	–0.3	–0.3	–0.3	–0.3

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
1200				1200	1260	1320	1390	1460
1400		1160	1280	1400	1460	1540	1620	1710
1600	1210	1330	1460	1600	1670	1760	1860	1950
1800	1360	1490	1650	1800	1880	1980	2090	2200
2000	1510	1660	1830	2000	2090	2200	2320	2440
2200	1670	1820	2010	2200	2300	2420	2550	2680
2400	1820	1990	2190	2400	2510	2640	2780	2930
2600	1970	2150	2380	2600	2720	2860	3020	3170
2800	2120	2320	2560	2800	2930	3080	3250	3420
3000	2270	2490	2740	3000	3140	3300	3480	3660
3200	2420	2650	2930	3200	3350	3520	3710	3900
3400	2570	2820	3110	3400	3560	3740	3940	4150
3600	2730	2980	3290	3600	3770	3960	4180	4390
3800	2880	3150	3470	3800	3980	4180	4410	4640
4000	3030	3310	3660	4000	4180	4400	4640	4880
4200	3180	3480	3840	4200	4390	4620	4870	5120
4400	3330	3650	4020	4400	4600	4840	5100	5370
4600	3480	3810	4210	4600	4810	5060	5340	5610
4800	3630	3980	4390	4800	5020	5280	5570	5860
5000	3790	4140	4570	5000	5230	5500	5800	6100

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE							
	0	2000	4000	6000	8000	10000	12000	14000
1200	112.9	104.5	96.3					
1400	143.4	135.0	126.0	116.5	107.2			
1600	169.2	160.2	151.0	141.7	132.7	124.1	109.4	105.7
1800	190.7	182.1	173.4	163.4	154.0	144.4	135.2	126.8
2000	210.7	201.1	191.8	182.8	173.9	163.5	154.1	144.3
2200	225.8	218.1	209.6	199.8	190.3	181.1	172.2	161.8
2400	237.0	229.0	221.2	213.4	205.6	196.2	186.6	177.5
2600	247.4	239.1	230.9	222.9	214.9	207.2	199.6	190.8
2800	249.2	248.5	240.0	231.7	223.4	215.4	207.5	199.9
3000		249.2	248.6	239.9	231.4	223.0	214.9	207.1
3200			249.2	247.7	238.9	230.3	221.9	213.7
3400				249.2	245.9	237.0	228.4	220.0
3600					249.2	243.5	234.6	226.0
3800						249.2	240.4	231.6
4000							246.0	236.9
4200							249.2	242.0
4400								246.8
4600								249.2

With manual speedbrakes, decrease weight by 14,900 kg.
With 1 brake deactivated, decrease weight by 19,700 kg.
With 2 brakes deactivated, decrease weight by 41,550 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
1200				1200	1260	1320	1390	1460
1400		1160	1280	1400	1460	1540	1620	1710
1600	1210	1330	1460	1600	1670	1760	1860	1950
1800	1360	1490	1650	1800	1880	1980	2090	2200
2000	1510	1660	1830	2000	2090	2200	2320	2440
2200	1670	1820	2010	2200	2300	2420	2550	2680
2400	1820	1990	2190	2400	2510	2640	2780	2930
2600	1970	2150	2380	2600	2720	2860	3020	3170
2800	2120	2320	2560	2800	2930	3080	3250	3420
3000	2270	2490	2740	3000	3140	3300	3480	3660
3200	2420	2650	2930	3200	3350	3520	3710	3900
3400	2570	2820	3110	3400	3560	3740	3940	4150
3600	2730	2980	3290	3600	3770	3960	4180	4390
3800	2880	3150	3470	3800	3980	4180	4410	4640
4000	3030	3310	3660	4000	4180	4400	4640	4880
4200	3180	3480	3840	4200	4390	4620	4870	5120
4400	3330	3650	4020	4400	4600	4840	5100	5370
4600	3480	3810	4210	4600	4810	5060	5340	5610
4800	3630	3980	4390	4800	5020	5280	5570	5860
5000	3790	4140	4570	5000	5230	5500	5800	6100

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE							
	0	2000	4000	6000	8000	10000	12000	14000
1400	115.8	107.2						
1600	142.3	133.7	124.7	115.2	106.0			
1800	164.6	156.1	146.8	137.7	128.9	119.8	111.5	101.9
2000	184.6	176.3	166.0	157.3	147.6	138.3	129.6	120.8
2200	202.0	192.8	184.0	175.4	164.7	155.7	145.9	136.6
2400	217.7	209.2	199.6	190.2	181.2	172.2	162.0	152.1
2600	229.3	221.6	214.0	204.9	195.2	185.7	176.7	166.0
2800	238.9	230.8	222.9	215.1	207.4	198.8	189.1	179.8
3000	247.8	239.5	231.3	223.3	215.3	207.6	200.0	191.4
3200	249.2	247.7	239.2	230.9	222.7	214.7	206.9	199.3
3400		249.2	246.7	238.1	229.7	221.4	213.4	205.6
3600			249.2	245.0	236.3	227.8	219.5	211.5
3800				249.2	242.6	233.8	225.3	217.1
4000					248.6	239.6	230.9	222.4
4200					249.2	245.1	236.1	227.5
4400						249.2	241.2	232.3
4600							246.0	236.9
4800							249.2	241.4
5000								245.7
5200								249.2

With manual speedbrakes, decrease weight by 14,900 kg.
With 1 brake deactivated, decrease weight by 19,700 kg.
With 2 brakes deactivated, decrease weight by 41,550 kg.

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	LANDING CLIMB LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	181.1	177.3							
52	184.5	180.8							
50	187.9	184.2	169.2						
48	191.4	187.6	173.6						
46	195.1	191.0	177.0	161.4					
44	198.8	194.5	180.2	164.6					
42	202.7	198.3	183.5	169.5	155.2				
40	206.5	202.0	186.9	173.7	158.3				
38	209.7	205.8	190.5	176.9	161.3	144.9			
36	212.3	209.6	194.0	180.2	164.3	148.0			
34	214.9	212.8	197.6	183.5	168.7	151.2	136.6		
32	215.1	215.4	201.1	186.7	173.1	154.3	139.4		
30	215.3	218.0	204.1	190.1	176.1	157.3	142.2		
28	215.4	218.1	206.7	193.5	179.2	160.3	145.0		
26	215.5	218.3	209.2	196.3	182.5	163.3	147.6		
24	215.6	218.4	209.3	198.6	185.7	166.9	150.5	135.9	
22	215.8	218.5	209.5	200.9	188.2	171.9	153.3	138.6	
20	215.9	218.6	209.6	201.0	190.4	175.0	156.2	141.4	129.0
18	216.0	218.8	209.7	201.1	192.4	177.9	158.9	144.1	131.1
16	216.0	218.9	209.8	201.2	192.4	180.7	161.6	146.8	133.4
14	216.1	219.0	209.9	201.3	192.5	183.2	164.6	149.7	135.7
12	216.2	219.0	210.0	201.3	192.6	183.3	169.3	152.5	138.1
10	216.3	219.1	210.1	201.4	192.7	183.4	173.3	155.3	140.6
0	216.7	219.5	210.4	201.9	193.1	183.7	176.7	164.9	151.3
–10	217.0	219.8	210.8	202.2	193.4	184.1	177.0	165.0	153.5
–20	217.4	220.2	211.2	202.6	193.8	184.4	177.2	165.2	
–30	218.0	220.6	211.5	203.0	194.2	184.7	177.4		
–40	218.6	221.2	212.0	203.4	194.5	185.0			

When operating in icing conditions during any part of the flight with forecast landing temperatures at or below 10 deg. C, decrease weight by 22,000 kg.

Anti-Ice Adjustments

Pressure Altitude ≤ 9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900	–6400
ENGINE & WING ON	–350	–5850	–7350

Pressure Altitude > 9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–2950	–5750	–6150
ENGINE & WING ON	–4150	–6450	–6850

ENGINE INOP

Go-Around Climb Gradient
Flaps 20, Gear Up
Based on anti-ice off

Table 1 of 3: Reference Go-Around Gradient (%)

AIRPORT OAT (deg. C)	REFERENCE GO-AROUND GRADIENT (%) PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	2.65	2.40	1.42						
52	2.87	2.62	1.69						
50	3.10	2.85	1.94	1.04					
48	3.33	3.08	2.16	1.29					
46	3.57	3.31	2.37	1.54	0.65				
44	3.82	3.54	2.59	1.75	0.89				
42	4.08	3.78	2.81	1.95	1.13				
40	4.30	4.03	3.03	2.16	1.33	0.22			
38	4.53	4.28	3.26	2.37	1.52	0.44			
36	4.71	4.51	3.49	2.57	1.72	0.65			
34	4.88	4.73	3.73	2.79	1.92	0.85			
32	4.89	4.92	3.94	3.01	2.11	1.05	0.07		
30	4.90	5.09	4.16	3.23	2.31	1.25	0.25		
28	4.91	5.10	4.34	3.43	2.52	1.45	0.43		
26	4.92	5.11	4.51	3.64	2.73	1.65	0.61		
24	4.92	5.11	4.52	3.81	2.92	1.85	0.80		
22	4.93	5.12	4.52	3.95	3.10	2.05	0.99	0.11	
20	4.94	5.13	4.53	3.96	3.26	2.24	1.18	0.28	
18	4.94	5.13	4.53	3.97	3.39	2.43	1.36	0.45	
16	4.95	5.14	4.54	3.97	3.40	2.61	1.56	0.63	
14	4.96	5.15	4.55	3.98	3.40	2.77	1.75	0.81	
12	4.96	5.15	4.55	3.99	3.41	2.78	1.94	0.98	
10	4.97	5.16	4.56	3.99	3.41	2.78	2.13	1.16	0.16
8	4.98	5.17	4.57	4.00	3.42	2.79	2.17	1.33	0.32
6	4.98	5.18	4.57	4.00	3.42	2.79	2.22	1.49	0.48
4	4.99	5.18	4.58	4.01	3.43	2.79	2.26	1.61	0.63
2	5.00	5.19	4.59	4.02	3.43	2.80	2.30	1.72	0.77
0	5.00	5.20	4.59	4.02	3.44	2.80	2.35	1.77	0.89

Table 2 of 3: Weight Adjustment

WEIGHT (1000 KG)	REFERENCE GO-AROUND GRADIENT (%)						
	0	1	2	3	4	5	6
220	–2.00	–2.24	–2.47	–2.69	–2.92	–3.15	–3.37
210	–1.74	–1.93	–2.12	–2.31	–2.50	–2.69	–2.89
200	–1.40	–1.55	–1.70	–1.85	–2.01	–2.16	–2.32
190	–0.99	–1.10	–1.21	–1.32	–1.43	–1.54	–1.66
180	–0.53	–0.59	–0.65	–0.71	–0.77	–0.83	–0.89
170	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	0.51	0.58	0.66	0.74	0.81	0.90	0.98
150	1.11	1.28	1.45	1.62	1.78	1.94	2.10
140	1.81	2.10	2.37	2.64	2.89	3.14	3.37
130	2.67	3.09	3.49	3.87	4.24	4.59	4.92
120	3.78	4.33	4.86	5.38	5.89	6.39	6.88

ENGINE INOP

Go-Around Climb Gradient
Flaps 20, Gear Up
Based on anti-ice off
Table 3 of 3: Speed Adjustment

SPEED (KIAS)	WEIGHT ADJUSTED GO-AROUND GRADIENT (%)										
	0	1	2	3	4	5	6	7	8	9	10
VREF30	–0.15	–0.15	–0.15	–0.14	–0.13	–0.13	–0.14	–0.15	–0.19	–0.24	–0.31
VREF30+5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VREF30+10	–0.01	–0.02	–0.03	–0.05	–0.06	–0.08	–0.09	–0.11	–0.12	–0.13	–0.13
VREF30+15	–0.06	–0.08	–0.11	–0.13	–0.16	–0.19	–0.21	–0.23	–0.25	–0.26	–0.26
VREF30+20	–0.15	–0.19	–0.23	–0.27	–0.31	–0.35	–0.38	–0.40	–0.42	–0.42	–0.42
VREF30+25	–0.28	–0.35	–0.41	–0.47	–0.53	–0.57	–0.61	–0.63	–0.65	–0.65	–0.63
VREF30+30	–0.44	–0.55	–0.65	–0.73	–0.81	–0.87	–0.92	–0.95	–0.96	–0.95	–0.91

With engine anti-ice on and landing temperatures above 8 deg. C, decrease gradient by 0.3%.
With engine and wing anti-ice on and landing temperatures above 8 deg. C, decrease gradient by 0.4%.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10 deg. C, decrease gradient by 1.8%

Flaps 5, Gear Up
Based on anti-ice off
Table 1 of 3: Reference Go-Around Gradient (%)

AIRPORT OAT (deg. C)	REFERENCE GO-AROUND GRADIENT (%) PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	3.82	3.56	2.58						
50	4.27	4.01	3.10	2.19					
46	4.74	4.47	3.53	2.69	1.79				
42	5.24	4.94	3.96	3.11	2.28	1.13			
38	5.69	5.44	4.41	3.52	2.68	1.59	0.62		
34	6.05	5.89	4.88	3.94	3.07	2.00	1.04		
30	6.07	6.26	5.31	4.38	3.47	2.40	1.40		
26	6.08	6.27	5.67	4.79	3.88	2.81	1.77		
22	6.10	6.29	5.68	5.11	4.25	3.20	2.14	1.28	
18	6.11	6.30	5.69	5.12	4.54	3.58	2.52	1.62	0.68
14	6.13	6.31	5.71	5.14	4.55	3.93	2.91	1.97	0.99
10	6.14	6.33	5.72	5.15	4.56	3.94	3.29	2.32	1.33
8	6.15	6.33	5.73	5.15	4.57	3.94	3.33	2.50	1.48
6	6.15	6.34	5.73	5.16	4.57	3.95	3.38	2.66	1.64
4	6.16	6.35	5.74	5.17	4.58	3.95	3.42	2.77	1.80
2	6.17	6.36	5.75	5.17	4.58	3.96	3.47	2.89	1.94
0	6.17	6.36	5.75	5.18	4.59	3.96	3.51	2.94	2.06

Table 2 of 3: Weight Adjustment

WEIGHT (1000 KG)	REFERENCE GO-AROUND GRADIENT (%)							
	0	1	2	3	4	5	6	7
220	–1.83	–2.06	–2.29	–2.53	–2.76	–2.99	–3.22	–3.45
210	–1.56	–1.74	–1.93	–2.12	–2.31	–2.50	–2.70	–2.91
200	–1.25	–1.38	–1.52	–1.67	–1.82	–1.98	–2.15	–2.32
190	–0.88	–0.97	–1.07	–1.18	–1.29	–1.40	–1.52	–1.65
180	–0.47	–0.51	–0.57	–0.62	–0.68	–0.74	–0.81	–0.88
170	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
160	0.36	0.44	0.52	0.59	0.67	0.74	0.81	0.88
150	0.84	1.01	1.18	1.35	1.51	1.67	1.83	1.98
140	1.42	1.70	1.99	2.26	2.53	2.79	3.05	3.29
130	2.14	2.56	2.97	3.37	3.76	4.14	4.51	4.88
120	3.03	3.60	4.17	4.72	5.25	5.78	6.29	6.79

ENGINE INOP

Go-Around Climb Gradient
Flaps 5, Gear Up
Based on anti-ice off
Table 3 of 3: Speed Adjustment

SPEED (KIAS)	WEIGHT ADJUSTED GO-AROUND GRADIENT (%)								
	0	1	2	3	4	5	6	7	8
VREF25	–0.48	–0.51	–0.53	–0.53	–0.52	–0.51	–0.49	–0.48	–0.47
VREF25+5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VREF25+10	0.11	0.10	0.09	0.09	0.09	0.10	0.10	0.10	0.09
VREF25+15	0.19	0.17	0.16	0.16	0.16	0.16	0.16	0.16	0.14
VREF25+20	0.25	0.22	0.20	0.19	0.19	0.19	0.18	0.18	0.16
VREF25+25	0.29	0.24	0.21	0.19	0.18	0.17	0.16	0.15	0.14
VREF25+30	0.29	0.24	0.19	0.16	0.14	0.12	0.10	0.09	0.07

With engine anti-ice on and landing temperatures above 8 deg. C, decrease gradient by 0.1%.
With engine anti-ice on and landing temperatures above 8°C, decrease gradient by 0.4% .
With engine and wing anti-ice on and landing temperatures below 8°C, decrease gradient by 0.1%.
With engine and wing anti-ice on and landing temperatures above 8 deg. C, decrease gradient by 0.4%.
When operating in icing conditions during any part of the flight with forecast landing temperatures below 10 deg. C, decrease gradient by 2.3%

Quick Turnaround Limit Weight

Flaps 30 Limit Weight (1000 KG)

AIRPORT OAT (deg. C)	AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	177.0	170.1							
50	178.2	171.5	163.7						
45	179.6	173.0	165.0	158.8					
40	181.1	174.5	166.6	160.1	154.0				
35	182.6	175.9	168.4	161.4	155.3	149.2			
30	184.1	177.4	170.3	162.7	156.5	150.5	144.6		
25	185.7	178.9	172.1	164.1	157.9	151.7	145.7	140.0	
20	187.3	180.4	173.7	165.5	159.1	153.0	147.0	141.2	135.5
15	188.9	182.0	175.2	167.4	160.5	154.3	148.2	142.4	136.7
10	190.6	183.6	176.8	169.3	161.9	155.7	149.6	143.7	137.9
5	192.3	185.2	178.4	171.4	163.3	157.0	150.9	144.9	139.1
0	194.0	186.9	180.0	173.2	164.8	158.4	152.3	146.2	140.4
–5	195.9	188.7	181.7	174.8	166.7	159.9	153.7	147.6	141.7
–10	197.8	190.5	183.4	176.4	168.8	161.4	155.1	149.0	143.0
–15	199.7	192.3	185.2	178.2	171.0	162.9	156.6	150.4	144.4
–20	201.7	194.2	187.0	179.9	173.0	164.6	158.2	151.9	
–25	203.7	196.2	188.9	181.8	174.7	166.5	159.7	153.4	
–30	205.8	198.2	190.9	183.6	176.5	168.7	161.3		
–35	208.0	200.3	192.9	185.6	178.4	171.1	163.0		
–40	210.2	202.5	195.0	187.6	180.3	173.3			
–45	212.5	204.7	197.1	189.6	182.3	175.2			
–50	215.0	207.0	199.3	191.7	184.3				
–54	217.0	208.9	201.1	193.5	186.1				

Increase weight by 1,450 kg per 1% uphill slope. Decrease weight by 2,750 kg per 1% downhill slope. Increase weight by 4,000 kg per 10 knots headwind. Decrease weight by 22,650 kg per 10 knots tailwind. Decrease weight by 13,000 kg with one brake deactivated. Decrease weight by 26,850 kg with two brakes deactivated.

Use one of the following methods:

1. **After landing at weights exceeding those shown above, adjusted for slope, wind, and deactivated brakes, wait at least 101 minutes after landing and check that wheel thermal plugs have not melted before making a subsequent takeoff.**
2. **No sooner than 10 minutes after parking, check for the BRAKE TEMP advisory message on EICAS. If the message is not displayed or is no longer displayed, no waiting period is required. If it is displayed, do not dispatch until the BRAKE TEMP message is no longer displayed. Check that wheel thermal plugs have not melted before making a subsequent takeoff.**

If any brake temperature display digit is blank or the BRAKE TEMP SYS status message is displayed, the Maximum Quick Turnaround Weight method, Method 1, must be used.

Reverse side blank

GEAR DOWN

Takeoff Field Corrections—Dry Runway

Table 1 of 3: Slope Correction

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
1400	1460	1440	1430	1410	1400	1380	1370	1350	1340
1600	1680	1660	1640	1620	1600	1570	1540	1510	1480
1800	1900	1880	1850	1830	1800	1760	1710	1670	1620
2000	2120	2090	2060	2030	2000	1940	1880	1820	1760
2200	2340	2310	2270	2240	2200	2130	2050	1980	1910
2400	2560	2520	2480	2440	2400	2310	2220	2140	2050
2600	2790	2740	2690	2650	2600	2500	2400	2290	2190
2800	3010	2950	2900	2850	2800	2680	2570	2450	2330
3000	3230	3170	3110	3060	3000	2870	2740	2610	2480
3200	3450	3390	3320	3260	3200	3050	2910	2760	2620
3400	3670	3600	3540	3470	3400	3240	3080	2920	2760
3600	3890	3820	3750	3670	3600	3430	3250	3080	2900
3800	4110	4030	3960	3880	3800	3610	3420	3230	3050
4000	4330	4250	4170	4080	4000	3800	3590	3390	3190
4200	4560	4470	4380	4290	4200	3980	3770	3550	3330
4400	4780	4680	4590	4490	4400	4170	3940	3700	3470
4600	5000	4900	4800	4700	4600	4350	4110	3860	3620
4800	5220	5110	5010	4900	4800	4540	4280	4020	3760
5000	5440	5330	5220	5110	5000	4730	4450	4180	3900

Table 2 of 3: Wind Correction

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M)							
	WIND COMPONENT (KTS)							
	–15	–10	–5	0	10	20	30	40
1400	620	880	1140	1400	1480	1570	1670	1770
1600	810	1070	1340	1600	1690	1780	1880	1980
1800	1000	1270	1530	1800	1890	1990	2090	2200
2000	1190	1460	1730	2000	2100	2200	2310	2420
2200	1380	1650	1930	2200	2300	2410	2520	2640
2400	1570	1840	2120	2400	2500	2610	2730	2850
2600	1760	2040	2320	2600	2710	2820	2940	3070
2800	1940	2230	2510	2800	2910	3030	3160	3290
3000	2130	2420	2710	3000	3120	3240	3370	3510
3200	2320	2610	2910	3200	3320	3450	3580	3720
3400	2510	2810	3100	3400	3520	3660	3790	3940
3600	2700	3000	3300	3600	3730	3860	4010	4160
3800	2890	3190	3500	3800	3930	4070	4220	4380
4000	3080	3380	3690	4000	4140	4280	4430	4590
4200	3270	3580	3890	4200	4340	4490	4640	4810
4400	3450	3770	4080	4400	4540	4700	4860	5030
4600	3640	3960	4280	4600	4750	4900	5070	5250
4800	3830	4150	4480	4800	4950	5110	5280	5460
5000	4020	4350	4670	5000	5160	5320	5500	5680

GEAR DOWN

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1700	190.0	176.6	174.8	173.6	172.4	171.0	169.0	167.2	165.9	156.3	145.3
1800	196.8	183.1	181.3	180.1	178.9	177.6	175.5	173.6	172.3	162.5	151.4
2000	209.5	195.5	193.7	192.5	191.2	189.9	187.7	185.8	184.5	174.6	163.2
2200	220.6	206.3	204.4	203.2	201.9	200.5	198.3	196.3	195.0	184.8	173.2
2400	230.5	215.8	213.8	212.5	211.2	209.8	207.5	205.5	204.1	193.5	181.5
2600	239.7	224.4	222.3	221.0	219.6	218.2	215.8	213.7	212.3	201.3	188.9
2800	249.2	235.2	233.1	231.7	230.2	228.8	226.2	224.0	222.5	211.0	197.9
3000	249.2	242.1	239.9	238.4	237.0	235.5	232.9	230.6	229.1	217.3	204.0
3200	249.2	248.6	246.4	244.9	243.4	241.8	239.1	236.8	235.2	223.1	209.4
3400	249.2	249.2	249.2	249.2	249.2	248.5	246.0	243.6	242.0	229.5	215.2
3600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	236.2	221.5
3800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	242.0	226.9
4000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	248.8	244.2	247.5	232.0
4200	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	236.9
4400	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	241.6
4600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	246.1
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2
CLIMB LIMIT WT (1000 KG)	169.8	168.7	168.6	168.5	168.4	168.2	168.0	165.6	157.8	136.3	109.7

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2900
ENGINE & WING ON	–200	–3450
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–450	–3500	–3550
ENGINE & WING ON	–450	–4800	–4900
ENGINE AUTO	–450	–450	–450
ENGINE & WING AUTO	–450	–450	–450

GEAR DOWN

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1700	179.8	165.3	163.4	162.1	160.8	159.6	158.4	157.2	154.0	143.7	
1800	186.5	171.7	169.7	168.4	167.2	165.9	164.7	163.4	160.2	149.8	
2000	198.9	183.9	181.9	180.6	179.3	178.0	176.8	175.5	172.2	161.6	P
2200	209.8	194.4	192.3	191.0	189.6	188.3	187.0	185.8	182.3	171.5	E
2400	219.4	203.4	201.3	199.9	198.5	197.2	195.9	194.5	191.0	179.8	R
2600	228.1	211.6	209.4	207.9	206.5	205.1	203.7	202.3	198.7	187.1	F
2800	239.1	221.8	219.5	218.0	216.5	215.0	213.5	212.1	208.3	196.1	
3000	246.1	228.3	226.0	224.4	222.9	221.4	219.9	218.4	214.5	202.1	L
3200	249.2	234.4	232.0	230.4	228.9	227.3	225.8	224.3	220.2	207.4	I
3400	249.2	241.2	238.7	237.1	235.4	233.8	232.2	230.7	226.5	213.2	M
3600	249.2	248.4	245.8	244.1	242.4	240.7	239.1	237.5	233.1	219.4	I
3800	249.2	249.2	249.2	249.2	248.4	246.7	245.0	243.3	238.8	224.7	T
4000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	248.8	244.2	229.8	E
4200	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	234.6	D
4400	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	239.3	
4600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	243.8	
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	248.1	
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	
CLIMB LIMIT WT (1000 KG)	162.0	161.3	161.1	161.0	160.9	160.8	158.9	151.6	144.2	119.9	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2900
ENGINE & WING ON	–200	–3450
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–450	–3500	–3550
ENGINE & WING ON	–450	–4800	–4900
ENGINE AUTO	–450	–450	–450
ENGINE & WING AUTO	–450	–450	–450

GEAR DOWN

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1700	168.9	155.3	153.5	152.3	151.1	150.0	148.9	145.8	142.1	132.3	
1800	175.4	161.6	159.7	158.5	157.3	156.1	155.0	151.9	148.1	138.1	
2000	187.7	173.6	171.7	170.5	169.3	168.1	166.9	163.8	159.9	149.8	P
2200	198.2	183.3	181.9	180.6	179.4	178.1	176.9	173.7	169.7	159.4	E
2400	207.4	192.5	190.5	189.2	187.9	186.7	185.4	182.1	178.0	167.3	R
2600	215.7	200.2	198.2	196.8	195.5	194.2	192.9	189.4	185.2	174.0	F
2800	226.2	209.9	207.7	206.3	204.9	203.5	202.2	198.6	194.1	182.4	
3000	232.8	216.2	214.0	215.5	211.1	209.7	208.3	204.6	200.0	188.1	L
3200	239.1	221.9	219.6	218.1	216.7	215.2	213.8	210.0	205.3	193.0	I
3400	246.0	228.2	255.9	224.3	222.8	221.3	219.9	215.9	211.0	198.3	M
3600	249.2	235.0	232.5	230.9	229.3	227.8	226.3	222.2	217.1	204.0	I
3800	249.2	240.7	238.2	236.6	235.0	233.4	231.8	227.6	222.4	208.9	T
4000	249.2	246.1	243.6	241.9	240.2	238.6	237.0	232.7	227.4	213.5	E
4200	249.2	249.2	248.7	247.0	245.3	243.6	242.0	237.6	232.2	218.0	D
4400	249.2	249.2	249.2	249.2	249.2	248.5	246.8	242.3	236.8	222.4	
4600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	246.9	241.3	226.7	
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	245.6	230.8	
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	234.8	
CLIMB LIMIT WT (1000 KG)	154.5	153.8	153.6	153.5	153.4	151.6	144.7	137.6	128.4	97.9	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2900
ENGINE & WING ON	–200	–3450
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–450	–3500	–3550
ENGINE & WING ON	–450	–4800	–4900
ENGINE AUTO	–450	–450	–450
ENGINE & WING AUTO	–450	–450	–450

GEAR DOWN

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1700	157.9	145.6	143.9	142.7	141.6	140.6	137.8	134.3	130.5		
1800	164.2	151.6	149.9	148.8	147.6	146.6	143.8	140.2	136.4		
2000	176.3	163.5	161.7	160.6	159.5	158.3	155.5	151.9	148.0		P
2200	186.5	173.4	171.6	170.4	169.3	168.1	165.2	161.5	157.5		E
2400	195.4	181.8	179.9	178.7	177.5	176.3	173.3	169.5	165.3		R
2600	203.2	189.1	187.2	185.9	184.7	183.5	180.3	176.3	172.0		F
2800	213.0	198.2	196.2	194.9	193.6	192.3	189.0	184.8	180.3		
3000	219.4	204.3	202.2	200.8	199.5	198.2	194.9	190.6	186.0		L
3200	225.2	209.7	207.5	206.1	204.7	203.4	199.9	195.5	190.8		I
3400	231.6	215.6	213.3	211.9	210.5	209.1	205.5	200.9	196.0		M
3600	238.5	221.8	219.5	218.0	216.6	215.1	211.4	206.7	201.6		I
3800	244.3	227.2	224.9	223.3	221.8	220.3	216.5	211.7	206.5		T
4000	249.2	232.3	229.9	228.3	226.8	225.3	221.4	216.4	211.0		E
4200	249.2	237.2	234.8	233.1	231.6	230.0	226.0	221.0	215.5		D
4400	249.2	241.9	239.4	237.8	236.2	234.6	230.6	225.4	219.8		
4600	249.2	246.5	243.9	242.3	240.6	239.0	234.9	229.7	224.0		
4800	249.2	249.2	248.3	246.6	244.9	243.3	239.1	233.8	228.1		
5000	249.2	249.2	249.2	249.2	249.0	247.4	243.2	237.9	232.1		
CLIMB LIMIT WT (1000 KG)	146.3	145.8	145.7	145.6	144.0	137.7	130.1	121.1	108.5		

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2900
ENGINE & WING ON	–200	–3450
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–450	–3500	–3550
ENGINE & WING ON	–450	–4800	–4900
ENGINE AUTO	–450	–450	–450
ENGINE & WING AUTO	–450	–450	–450

GEAR DOWN

Takeoff Field Corrections—Wet Runway

Table 1 of 3: Slope Correction

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	1880	1850	1830	1800	1770	1730	1700	1660
2000	2130	2100	2060	2030	2000	1960	1910	1870	1820
2200	2350	2320	2280	2240	2200	2150	2090	2040	1980
2400	2580	2540	2490	2450	2400	2330	2270	2200	2140
2600	2810	2750	2700	2650	2600	2520	2450	2370	2300
2800	3030	2970	2920	2860	2800	2710	2630	2540	2460
3000	3260	3190	3130	3060	3000	2900	2810	2710	2610
3200	3480	3410	3340	3270	3200	3090	2990	2880	2770
3400	3710	3630	3560	3480	3400	3280	3170	3050	2930
3600	3940	3850	3770	3680	3600	3470	3350	3220	3090
3800	4160	4070	3980	3890	3800	3660	3520	3390	3250
4000	4390	4290	4190	4100	4000	3850	3700	3560	3410
4200	4620	4510	4410	4300	4200	4040	3880	3720	3570
4400	4840	4730	4620	4510	4400	4230	4060	3890	3720
4600	5070	4950	4830	4720	4600	4420	4240	4060	3880
4800	5290	5170	5050	4920	4800	4610	4420	4230	4040
5000	5520	5390	5260	5130	5000	4800	4600	4400	4200

Table 2 of 3: Wind Correction

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M)							
	WIND COMPONENT (KTS)							
	–15	–10	–5	0	10	20	30	40
1800	830	1150	1480	1800	1920	2040	2170	2290
2000	1030	1350	1680	2000	2130	2250	2380	2510
2200	1220	1550	1870	2200	2330	2460	2590	2720
2400	1420	1750	2070	2400	2540	2670	2810	2940
2600	1620	1950	2270	2600	2740	2880	3020	3160
2800	1820	2150	2470	2800	2950	3090	3230	3370
3000	2020	2340	2670	3000	3150	3300	3450	3590
3200	2220	2540	2870	3200	3360	3510	3660	3800
3400	2410	2740	3070	3400	3560	3720	3870	4020
3600	2610	2940	3270	3600	3770	3930	4080	4240
3800	2810	3140	3470	3800	3970	4140	4300	4450
4000	3010	3340	3670	4000	4180	4350	4510	4670
4200	3210	3540	3870	4200	4380	4550	4720	4890
4400	3410	3740	4070	4400	4590	4760	4940	5100
4600	3600	3940	4270	4600	4790	4970	5150	5320
4800	3800	4130	4470	4800	4990	5180	5360	5530
5000	4000	4330	4670	5000	5200	5390	5570	5750

GEAR DOWN

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2200	220.0	204.3	202.2	200.7	199.2	196.4	194.6	193.1	191.6	180.5	168.8
2400	229.4	213.7	211.5	210.1	208.5	205.7	203.9	202.4	200.9	189.7	177.9
2600	239.0	222.7	220.5	219.0	217.4	214.5	212.6	211.1	209.5	197.9	185.8
2800	249.2	234.0	231.7	230.1	228.4	225.3	223.3	221.7	220.1	207.8	195.0
3000	249.2	241.3	238.9	237.2	235.5	232.3	230.2	228.5	226.9	214.2	200.9
3200	249.2	247.9	245.3	243.7	241.8	238.5	236.4	234.6	232.9	219.7	205.9
3400	249.2	249.2	249.2	249.2	249.2	245.7	243.5	241.7	239.8	226.0	211.6
3600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	247.5	233.1	218.1
3800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	239.2	223.6
4000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	244.9	228.9
4200	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	234.0
4400	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	238.8
4600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	243.5
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	247.9
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2
CLIMB LIMIT WT (1000 KG)	169.8	168.7	168.6	168.5	168.4	168.2	168.0	165.6	157.8	136.3	109.7

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–3200
ENGINE & WING ON	–300	–3800
ENGINE AUTO	–300	0
ENGINE & WING AUTO	–300	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–450	–3450	–3550
ENGINE & WING ON	–450	–4800	–4900
ENGINE AUTO	–450	–450	–450
ENGINE & WING AUTO	–450	–450	–450

GEAR DOWN

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2200	208.0	190.7	188.5	187.0	185.5	184.1	182.7	181.4	177.8	166.7	
2400	217.4	200.0	197.7	196.2	194.8	193.3	191.9	190.6	187.0	175.8	
2600	226.5	208.6	206.3	204.7	203.2	201.7	200.3	198.9	195.2	183.6	P
2800	238.0	219.1	216.6	215.0	213.4	211.8	210.3	208.9	204.9	192.7	E
3000	245.4	225.8	223.3	221.6	219.9	218.3	216.7	215.2	211.1	198.5	R
3200	249.2	231.8	229.1	227.4	225.7	224.0	222.3	220.8	216.5	203.4	F
3400	249.2	238.7	235.9	234.1	232.2	230.5	228.8	227.2	222.8	209.0	
3600	249.2	246.4	243.5	241.5	239.7	237.8	236.0	234.3	229.7	215.3	L
3800	249.2	249.2	249.2	247.9	246.0	244.0	242.2	240.5	235.6	220.8	I
4000	249.2	249.2	249.2	249.2	249.2	249.2	248.0	246.2	241.2	226.0	M
4200	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	246.6	231.0	I
4400	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	235.8	T
4600	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	240.4	E
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	244.8	D
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.0	
CLIMB LIMIT WT (1000 KG)	162.0	161.3	161.1	161.0	160.9	160.8	158.9	151.6	144.2	119.9	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–3200
ENGINE & WING ON	–300	–3800
ENGINE AUTO	–300	0
ENGINE & WING AUTO	–300	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–450	–3450	–3550
ENGINE & WING ON	–450	–4800	–4900
ENGINE AUTO	–450	–450	–450
ENGINE & WING AUTO	–450	–450	–450

GEAR DOWN

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2200	194.5	179.3	177.2	175.9	174.6	173.3	172.1	168.8	164.7	154.1	
2400	203.8	188.4	186.4	185.1	183.8	182.5	181.2	177.9	173.8	163.1	
2600	212.5	196.7	194.6	193.2	191.9	190.6	189.2	185.8	181.5	170.5	P
2800	223.2	206.5	204.3	202.8	201.4	200.0	198.6	195.0	190.5	178.8	E
3000	230.1	212.8	210.5	209.0	207.5	206.1	204.6	200.9	196.2	184.2	R
3200	236.3	218.2	215.9	214.3	212.8	211.3	209.8	205.9	201.0	188.4	F
3400	243.4	224.6	222.1	220.4	218.8	217.3	215.7	211.6	206.5	193.4	
3600	249.2	231.6	229.0	227.2	225.6	223.9	222.3	218.0	212.7	199.0	L
3800	249.2	237.6	234.9	233.1	231.4	229.7	228.0	223.6	218.1	204.0	I
4000	249.2	243.3	240.5	238.7	236.9	235.1	233.4	228.9	223.2	208.7	M
4200	249.2	248.7	245.8	244.0	242.1	240.4	238.6	233.9	228.2	213.2	I
4400	249.2	249.2	249.2	249.0	247.2	245.3	243.5	238.8	232.9	217.7	T
4600	249.2	249.2	249.2	249.2	249.2	249.2	248.3	243.4	237.5	222.0	E
4800	249.2	249.2	249.2	249.2	249.2	249.2	249.2	247.9	241.8	226.1	D
5000	249.2	249.2	249.2	249.2	249.2	249.2	249.2	249.2	246.0	230.2	
CLIMB LIMIT WT (1000 KG)	154.5	153.8	153.6	153.5	153.4	151.6	144.7	137.6	128.4	97.9	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–3200
ENGINE & WING ON	–300	–3800
ENGINE AUTO	–300	0
ENGINE & WING AUTO	–300	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–450	–3450	–3550
ENGINE & WING ON	–450	–4800	–4900
ENGINE AUTO	–450	–450	–450
ENGINE & WING AUTO	–450	–450	–450

GEAR DOWN

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2200	182.4	168.4	166.5	165.3	164.1	162.9	159.9	156.1	152.0		
2400	191.6	177.6	175.6	174.4	173.2	172.0	168.9	165.1	161.0		
2600	200.0	185.5	183.5	182.2	180.9	179.7	176.6	172.6	168.4		P
2800	210.0	194.6	192.5	191.2	189.8	188.5	185.2	181.0	176.5		E
3000	216.4	200.5	198.4	196.9	195.6	194.2	190.8	186.4	181.8		R
3200	222.0	205.5	203.2	201.7	200.3	198.9	195.3	190.8	186.0		F
3400	228.5	211.2	208.9	207.3	205.8	204.3	200.6	195.9	190.9		
3600	235.6	217.6	215.2	213.5	212.0	210.4	206.6	201.6	196.3		L
3800	241.8	223.2	220.6	219.0	217.3	215.8	211.8	206.7	201.2		I
4000	247.6	228.4	225.8	224.1	222.4	220.8	216.7	211.4	205.8		M
4200	249.2	233.5	230.8	229.0	227.3	225.7	221.4	216.1	210.3		I
4400	249.2	238.3	235.6	233.8	232.1	230.3	226.0	220.5	214.7		T
4600	249.2	243.0	240.2	238.4	236.6	234.9	230.5	224.9	218.9		E
4800	249.2	247.4	244.6	242.8	241.0	239.2	234.8	229.1	223.1		D
5000	249.2	249.2	248.8	247.0	245.2	243.4	238.9	233.2	227.1		
CLIMB LIMIT WT (1000 KG)	146.3	145.8	145.7	145.6	144.0	137.7	130.1	121.1	108.5		

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–3200
ENGINE & WING ON	–300	–3800
ENGINE AUTO	–300	0
ENGINE & WING AUTO	–300	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–450	–3450	–3550
ENGINE & WING ON	–450	–4800	–4900
ENGINE AUTO	–450	–450	–450
ENGINE & WING AUTO	–450	–450	–450

GEAR DOWN

Takeoff Obstacle Limit Weight
Flaps 15
Based on anti-ice off, ten minute takeoff thrust time limit
Table 1 of 4: Sea Level, 30 deg. 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
40	162.2											
60	152.7	162.2										
80	142.8	155.4	162.2									
100	133.8	147.6	157.2	162.1	161.8	162.1	162.1	162.1	162.1	162.1	162.1	162.1
120	126.2	140.0	150.6	158.4	161.8	161.8	161.8	161.8	161.8	161.8	161.8	161.8
140		133.0	144.2	152.7	159.3	161.5	161.5	161.5	161.5	161.5	161.5	161.5
160		127.0	138.1	147.2	154.2	159.9	161.1	161.1	161.1	161.1	161.1	161.1
180			132.5	141.9	149.4	155.5	160.4	160.8	160.8	160.8	160.8	160.8
200			127.5	136.8	144.7	151.1	156.4	160.5	160.5	160.5	160.5	160.5
120				132.1	140.2	146.8	152.4	157.1	160.2	160.2	160.2	160.2
240				127.7	135.7	142.8	148.6	153.5	157.7	159.8	159.8	159.8
260					131.7	138.8	144.8	149.9	154.4	158.2	159.5	159.5
280					127.9	134.9	141.3	146.5	151.1	155.1	158.6	159.2
300						131.4	137.6	143.2	147.9	152.0	155.7	158.9
Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.												

Table 2 of 4: OAT Adjustment

OAT (deg. C)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)						
	120	130	140	150	160	170	180
30 & BELOW	0	0	0	0	0	0	0
32	–1.6	–1.8	–2.0	–2.2	–2.5	–2.7	–2.9
34	–3.2	–3.6	–4.0	–4.5	–4.9	–5.4	–5.8
36	–4.7	–5.4	–6.1	–6.7	–7.4	–8.0	–8.7
38	–6.3	–7.2	–8.1	–9.0	–9.8	–10.7	–11.6
40	–7.9	–9.0	–10.1	–11.2	–12.3	–13.4	–14.5
42	9.8	–10.9	–12.0	–13.1	–14.1	–15.2	–16.3
44	–11.7	–12.8	–13.9	–14.9	–16.0	–17.0	–18.1
46	–13.7	–14.7	–15.7	–16.8	–17.8	–18.9	–19.9
48	–15.6	–16.6	–17.6	–18.6	–19.7	–20.7	–21.7
50	–17.5	–18.5	–19.5	–20.5	–21.5	–22.5	–23.5

Table 3 of 4: Pressure Altitude Adjustment

ALT (FT)	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)						
	120	130	140	150	160	170	180
S.L. & BELOW	0	0	0	0	0	0	0
1000	–4.2	–4.7	–5.2	–5.7	–6.3	–6.8	–7.3
2000	–7.5	–8.5	–9.5	–10.5	–11.5	–12.5	–13.5
3000	–11.4	–12.8	–14.1	–15.5	–16.9	–18.2	–19.5
4000	–15.6	–17.2	–18.8	–20.3	–21.9	–23.4	–25.0
5000	–19.0	–21.0	–23.0	–25.0	–27.0	–29.0	–31.0

GEAR DOWN

Takeoff Obstacle Limit Weight
Flaps 15
Based on anti-ice off, ten minute takeoff thrust time limit
Table 4 of 4: Wind Adjustment

WIND (KTS)	OAT & ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)						
	120	130	140	150	160	170	180
15 TW	–19.0	–17.8	–16.5	–15.2	–14.0	–12.8	–11.5
10 TW	–12.7	–11.8	–11.0	–10.2	–9.3	–8.5	–7.7
5 TW	–6.3	–5.9	–5.5	–5.1	–4.7	–4.2	–3.8
0	0	0	0	0	0	0	0
10 HW	3.1	2.8	2.4	2.1	1.8	1.5	1.1
20 HW	6.1	5.5	4.9	4.2	3.6	2.9	2.3
30 HW	9.4	8.4	7.4	6.5	5.5	4.5	3.5
40 HW	12.7	11.4	10.0	8.7	7.4	6.0	4.7

Anti-Ice Adjustments
Pressure Altitude ≤ 5000 FT

	OBSTACLE LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–450	–3600	–3600
ENGINE & WING ON	–450	–4900	–4900
ENGINE AUTO	–450	–450	0
ENGINE & WING AUTO	–450	–450	0

GEAR DOWN

Fuel Jettison Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg C)	FUEL JETTISON LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)				
	–2000	0	2000	4000	6000
54	161.7				
52	164.9				
50	168.0	164.6			
48	180.3	167.7			
46	183.7	170.8			
44	187.1	183.2	160.9		
42	190.5	186.6	163.9		
40	193.9	189.9	167.0		
38	196.7	193.3	170.3	157.7	
36	202.7	196.6	182.7	160.7	
34	211.3	205.0	185.9	163.7	
32	212.0	213.0	189.1	166.8	
30	212.5	217.2	191.8	170.0	157.1
28	213.0	217.3	194.1	182.3	160.0
26	213.3	217.5	196.4	184.9	163.0
24	213.7	217.6	196.5	187.0	166.1
22	214.0	217.7	196.6	189.0	168.5
20	214.4	217.8	196.7	189.1	170.5
18	214.7	217.9	196.8	189.2	181.4
16	214.9	218.0	196.9	189.3	181.5
14	215.1	218.1	197.0	189.4	181.5
12	215.4	218.1	197.1	189.5	181.6
10	215.6	218.2	197.2	189.6	181.7
0	215.9	218.5	197.5	189.9	182.0
–10	216.2	218.8	197.9	190.3	182.4
–20	216.6	219.1	198.2	190.6	182.7
–30	217.1	219.5	199.3	191.0	183.1
–40	217.7	220.1	202.1	191.3	183.4

Table valid for Zero Fuel Weight up to 161025 kg.

Anti-Ice Adjustments

Pressure Altitude ≤ 6000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–5150	–6000
ENGINE & WING ON	–300	–6300	–7000

DELETION

GEAR DOWN

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 15
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 5		
	V1	VR	V2
180	134	138	147
170	131	134	144
160	127	131	141
150	122	126	137
140	116	121	134
130	111	116	129
120	105	110	125
110	102	105	121
100	99	101	117
Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	V1				VR				V2			
	PRESS ALT (1000 FT)				PRESS ALT (1000 FT)				PRESS ALT (1000 FT)			
	0	2	4	6	0	2	4	6	0	2	4	6
60	7	9	9	10	3	4	5	5	–3	–4	–4	–5
50	4	6	6	8	2	3	4	4	–2	–2	–3	–4
40	1	3	5	7	1	2	3	3	–1	–1	–2	–3
30	0	1	3	4	0	1	2	3	0	–1	–1	–2
20	0	1	1	2	0	1	1	2	0	0	–1	–1
10	0	1	1	2	0	1	1	2	0	0	–1	–1
0	0	1	2	2	0	1	1	2	0	0	–1	–1
–60	0	1	2	2	0	1	1	2	0	0	–1	–1
*V1 not to exceed VR												

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
180	–3	–1	0	1	3	–2	–2	–1	0	1	2
160	–3	–1	0	1	3	–2	–2	–1	0	1	2
140	–3	–1	0	1	3	–2	–2	–1	0	1	2
120	–2	–1	0	1	2	–2	–1	–1	0	1	2
100	–2	–1	0	1	2	–2	–1	–1	0	1	2
*V1 not to exceed VR.											

Table 4 of 6: V1(MCG)

TEMP (deg. C)	PRESSURE ALTITUDE (FT)			
	0	2	4	6
60	115	112	110	108
55	115	112	110	108
50	117	112	110	108
45	120	115	111	108
40	123	118	114	109
35	126	121	116	112
30	128	124	119	114
25	128	125	121	117
20	128	126	123	119
15	129	126	123	120
10	129	126	123	120
5	129	126	123	120
0	129	126	123	120
–60	131	127	124	121

GEAR DOWN

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 15
Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
160 & ABV	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132
150	127	127	127	127	127	127	127	127	127	127	127	127	128	128	128	129	130	131
140	122	122	122	122	122	122	122	122	122	123	123	124	125	125	126	127	129	130
130	119	119	119	119	119	119	119	119	119	120	121	122	122	124	125	127	129	130
120	115	115	115	115	115	115	115	116	117	117	119	120	121	123	125	127	129	130
110	114	114	113	113	112	112	113	114	114	116	118	119	121	123	125	127	129	130
100	114	114	113	113	112	111	111	112	114	116	118	119	121	123	125	127	129	130

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
160 & ABV	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	141	142	142
150	136	136	136	136	136	136	136	136	136	136	136	136	136	137	138	139	140	141
140	132	132	132	132	132	132	132	132	132	132	132	133	134	135	136	137	139	140
130	127	127	127	127	127	127	127	127	127	128	129	131	131	133	135	137	138	140
120	123	123	123	123	123	123	123	124	125	126	127	129	131	133	135	137	138	140
110	120	120	120	120	120	120	121	122	123	125	127	128	131	133	135	137	138	140
100	119	119	119	119	119	119	120	121	123	125	126	128	131	133	135	137	138	140

GEAR DOWN

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 15
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 15		
	V1	VR	V2
180	126	138	147
170	122	134	144
160	118	131	141
150	113	126	137
140	107	121	134
130	102	116	129
120	99	110	125
110	96	105	121
100	94	101	117
Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	V1				VR				V2			
	PRESS ALT (1000 FT)				PRESS ALT (1000 FT)				PRESS ALT (1000 FT)			
	0	2	4	6	0	2	4	6	0	2	4	6
60	7	9	9	10	3	4	5	5	–3	–4	–4	–5
50	4	6	6	8	2	3	4	4	–2	–2	–3	–4
40	1	3	5	7	1	2	3	3	–1	–1	–2	–3
30	0	1	3	4	0	1	2	3	0	–1	1	–2
20	0	1	1	2	0	1	1	2	0	0	–1	–1
10	0	1	1	2	0	1	1	2	0	0	–1	–1
0	0	1	2	2	0	1	1	2	0	0	–1	–1
–60	0	1	2	2	0	1	1	2	0	0	–1	–1
*V1 not to exceed VR												

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
180	–4	–2	0	2	4	–4	–3	–1	0	2	3
160	–4	–2	0	2	4	–4	–3	–1	0	2	3
140	–4	–2	0	2	3	–4	–2	–1	0	2	3
120	–4	–2	0	2	3	–3	–2	–1	0	1	3
100	–3	–2	0	2	3	–3	–2	–1	0	1	2
*V1 not to exceed VR.											

Table 4 of 6: V1(MCG)

TEMP (deg. C)	PRESSURE ALTITUDE (1000 FT)			
	0	2	4	6
60	115	112	110	108
55	115	112	110	108
50	117	112	110	108
45	120	115	111	108
40	123	118	114	109
35	126	121	116	112
30	128	124	119	114
25	128	125	121	117
20	128	126	123	119
15	129	126	123	120
10	129	126	123	120
5	129	126	123	120
0	129	126	123	120
–60	131	127	124	121

GEAR DOWN

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 15
Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
160 & ABV	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132
150	127	127	127	127	127	127	127	127	127	127	127	127	128	128	128	129	130	131
140	122	122	122	122	122	122	122	122	122	123	123	124	125	125	126	127	129	130
130	119	119	119	119	119	119	119	119	119	120	121	122	122	124	125	127	129	130
120	115	115	115	115	115	115	115	116	117	117	119	120	121	123	125	127	129	130
110	114	114	113	113	112	112	113	114	114	116	118	119	121	123	125	127	129	130
100	114	114	113	113	112	111	111	112	114	116	118	119	121	123	125	127	129	130

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
160 & ABV	140	140	140	140	140	140	140	140	140	140	140	140	140	140	140	141	142	142
150	136	136	136	136	136	136	136	136	136	136	136	136	136	137	138	139	140	141
140	132	132	132	132	132	132	132	132	132	132	132	133	134	135	136	137	139	140
130	127	127	127	127	127	127	127	127	127	128	129	131	131	133	135	137	138	140
120	123	123	123	123	123	123	123	124	125	126	127	129	131	133	135	137	138	140
110	120	120	120	120	120	120	121	122	123	125	127	128	131	133	135	137	138	140
100	119	119	119	119	119	119	120	121	123	125	126	128	131	133	135	137	138	140

GEAR DOWN

VREF

Based on 10,000 ft pressure altitude

WEIGHT (1000 KG)	VREF (KIAS)		
	FLAPS		
	30	25	20
240	173	177	177
230	169	172	172
220	165	168	168
210	160	164	164
200	156	160	160
190	152	155	155
180	148	151	151
170	144	147	147
160	142	144	144
150	139	140	142
140	135	137	140
130	131	133	136
120	126	129	131
110	122	125	126
100	122	125	126

GEAR DOWN

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
1200		1010	1100	1200	1240	1300	1360	1440
1640	1040	1170	1280	1400	1450	1520	1590	1680
1600	1200	1340	1460	1600	1660	1740	1820	1920
1800	1350	1500	1640	1800	1870	1960	2050	2160
2000	1500	1670	1830	2000	2080	2180	2280	2400
2200	1650	1830	2010	2200	2290	2400	2510	2640
2400	1810	2000	2190	2400	2500	2620	2740	2880
2600	1960	2160	2370	2600	2710	2840	2970	3120
2800	2110	2330	2550	2800	2920	3060	3200	3360
3000	2260	2490	2730	3000	3130	3280	3430	3600
3200	2410	2660	2920	3200	3340	3500	3660	3840
3400	2570	2820	3100	3400	3550	3720	3890	4080
3600	2720	2990	3280	3600	3760	3940	4120	4320
3800	2870	3150	3460	3800	3970	4160	4360	4560
4000	3020	3320	3640	4000	4180	4380	4590	4800
4200	3180	3480	3830	4200	4390	4600	4820	5040
4400	3330	3650	4010	4400	4600	4820	5050	5280
4600	3480	3810	4190	4600	4810	5040	5280	5520
4800	3630	3980	4370	4800	5020	5260	5510	5760
5000	3790	4140	4550	5000	5230	5480	5740	6000

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
1400	133.1	124.5			
1600	167.5	154.0	142.0	132.3	
1800	190.7	182.1	173.3	161.6	146.8
2000	210.7	201.1	191.8	182.8	174.1
2200	225.8	218.1	209.7	199.8	190.3
2400	237.0	229.0	221.2	213.4	205.8
2600	247.4	239.1	230.9	222.9	214.9
2800	257.4	248.5	240.0	231.7	223.4
3000		257.6	248.5	239.9	231.4
3200			257.0	247.7	238.9
3400				255.2	245.9
3600					252.7

With manual speedbrakes, decrease weight by 19,650 kg.
With 1 brake deactivated, decrease weight by 24,900 kg.
With 2 brakes deactivated, decrease weight by 47,250 kg.

GEAR DOWN

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
1200				1200	1240	1300	1360	1440
1400		1180	1280	1400	1450	1520	1590	1680
1600	1190	1340	1460	1600	1660	1740	1820	1920
1800	1340	1510	1650	1800	1870	1960	2050	2160
2000	1500	1670	1830	2000	2080	2180	2280	2400
2200	1650	1840	2010	2200	2290	2400	2510	2640
2400	1800	2000	2190	2400	2500	2620	2740	2880
2600	1950	2170	2370	2600	2710	2840	2970	3120
2800	2110	2330	2550	2800	2920	3060	3200	3360
3000	2260	2500	2740	3000	3130	3280	3430	3600
3200	2410	2660	2920	3200	3340	3500	3660	3840
3400	2560	2830	3100	3400	3550	3720	3890	4080
3600	2720	2990	3280	3600	3760	3940	4120	4320
3800	2870	3160	3460	3800	3970	4160	4350	4560
4000	3020	3320	3640	4000	4180	4380	4580	4800
4200	3170	3490	3830	4200	4390	4600	4810	5040
4400	3320	3650	4010	4400	4600	4820	5040	5280
4600	3480	3820	4190	4600	4810	5040	5270	5520
4800	3630	3980	4370	4800	5020	5260	5500	5760
5000	3780	4150	4550	5000	5230	5480	5730	6000

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
1600	131.9				
1800	162.0	147.4	137.4		
2000	184.6	175.7	165.2	150.2	139.4
2200	202.0	192.8	184.0	175.2	164.2
2400	217.7	209.3	199.6	190.2	181.2
2600	229.3	221.6	214.0	205.0	195.2
2800	238.9	230.8	222.9	215.1	207.5
3000	247.8	239.5	231.3	223.3	215.3
3200	256.5	247.7	239.3	230.9	222.7
3400		255.6	246.7	238.2	229.7
3600			254.1	245.0	236.3
3800				251.6	242.6
4000					248.6
4200					254.5

With manual speedbrakes, decrease weight by 19,650 kg.
With 1 brake deactivated, decrease weight by 24,900 kg.
With 2 brakes deactivated, decrease weight by 47,250 kg.

GEAR DOWN

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	LANDING CLIMB LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)				
	–2000	0	2000	4000	6000
54	159.9	156.4			
52	163.0	159.5			
50	166.5	162.7	149.9		
48	172.0	166.1	153.0		
46	175.5	171.3	156.0	144.2	
44	178.8	174.9	159.0	147.1	
42	182.3	178.3	162.0	150.0	138.6
40	185.7	181.6	165.1	152.9	141.4
38	188.6	185.1	170.5	155.8	144.1
36	190.9	188.5	174.4	158.8	146.8
34	193.2	191.3	177.6	161.9	149.6
32	193.4	193.7	180.8	164.9	152.4
30	193.5	196.0	183.6	169.9	155.3
28	193.7	196.2	185.9	174.0	158.1
26	193.8	196.3	188.2	176.6	161.2
24	193.9	196.5	188.3	178.7	164.2
22	194.0	196.6	188.5	180.8	167.4
20	194.1	196.7	188.6	180.9	170.7
18	194.2	196.8	188.6	181.0	173.1
16	194.3	196.9	188.7	181.1	173.2
14	194.3	196.9	188.8	181.1	173.2
12	194.4	197.0	188.9	181.2	173.3
10	194.5	197.1	189.0	181.3	173.4
0	194.8	197.4	189.4	181.7	173.7
–10	195.1	197.7	189.7	182.0	174.1
–20	195.4	198.0	190.0	182.4	174.4
–30	196.0	198.4	190.3	182.7	174.7
–40	196.6	199.0	190.8	183.1	175.0

When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10 deg. C, decrease weight by 22,650 kg.

Anti-Ice Adjustments

Pressure Altitude ≤ 6000

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–5150	–6000
ENGINE & WING ON	–300	–6300	–7000

GEAR DOWN

Long Range Cruise Altitude Capability
Max Climb Thrust, 300 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
250	16700	15700	12200
240	17800	17000	15100
230	19300	18300	16300
220	20700	19900	17500
210	22100	21300	19000
200	23300	22700	20700
190	24500	24000	22400
180	25800	25300	23700
170	27000	26600	25100
160	28400	27800	26300
150	29900	29200	27800
140	31100	30600	29300
130	32400	31900	30800
120	33700	33300	32100
110	34900	34400	33200
100	36100	35600	34200

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
336	297	264	239	218	200	187	175	165	156	149
504	446	397	358	327	300	281	264	249	235	224
671	595	529	478	436	400	375	352	332	314	299
838	743	662	597	545	500	469	441	416	393	374
1004	890	793	716	654	600	563	529	499	473	449
1169	1037	924	835	763	700	657	618	583	552	525
1334	1184	1056	954	872	800	751	706	666	631	600
1498	1330	1187	1073	981	900	845	795	750	710	675
1662	1476	1318	1192	1089	1000	939	884	834	790	751
1825	1623	1448	1311	1198	1100	1033	972	918	869	827
1989	1768	1579	1429	1307	1200	1127	1061	1001	949	902
2151	1914	1710	1548	1415	1300	1221	1150	1085	1028	978
2313	2059	1840	1666	1524	1400	1315	1238	1169	1108	1054
2475	2204	1970	1785	1633	1500	1409	1327	1253	1187	1130
2636	2348	2100	1903	1741	1600	1503	1416	1337	1267	1206
2797	2492	2230	2021	1850	1700	1598	1505	1421	1347	1282
2958	2636	2359	2139	1958	1800	1692	1594	1505	1427	1358
3117	2780	2489	2257	2066	1900	1786	1682	1589	1506	1434
3277	2923	2618	2375	2175	2000	1880	1771	1673	1586	1510

Table 2 of 3: Reference Fuel and Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		26	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	5.1	0:53	4.9	0:51	4.8	0:49	4.7	0:47	4.6	0:46
300	7.4	1:17	7.1	1:13	6.9	1:10	6.7	1:07	6.6	1:04
400	9.8	1:41	9.3	1:36	9.0	1:31	8.7	1:27	8.5	1:23
500	12.1	2:06	11.5	1:59	11.1	1:53	10.7	1:47	10.4	1:42
600	14.6	2:29	13.7	2:21	13.3	2:13	12.8	2:06	12.4	2:00
700	17.0	2:53	16.0	2:43	15.4	2:34	14.8	2:26	14.4	2:19
800	19.4	3:16	18.2	3:06	17.6	2:55	16.9	2:45	16.4	2:37
900	21.9	3:40	20.5	3:28	19.8	3:16	19.0	3:05	18.3	2:55
1000	24.3	4:04	22.8	3:50	21.9	3:37	21.0	3:25	20.3	3:14
1100	26.8	4:27	25.1	4:12	24.2	3:57	23.2	3:44	22.4	3:32
1200	29.4	4:50	27.5	4:34	26.4	4:18	25.3	4:03	24.5	3:50
1300	31.9	5:13	29.9	4:55	28.7	4:38	27.5	4:22	26.5	4:08
1400	34.4	5:36	32.2	5:17	30.9	4:59	29.6	4:41	28.6	4:26
1500	37.0	5:59	34.6	5:39	33.2	5:19	31.8	5:01	30.7	4:44
1600	39.6	6:22	37.1	6:00	35.5	5:39	34.0	5:20	32.8	5:02
1700	42.2	6:45	39.5	6:22	37.8	6:00	36.3	5:38	34.9	5:20
1800	44.9	7:07	42.0	6:43	40.2	6:20	38.5	5:57	37.1	5:37
1900	47.5	7:30	44.5	7:05	42.5	6:40	40.7	6:16	39.2	5:55
2000	50.2	7:53	46.9	7:26	44.8	7:00	43.0	6:35	41.4	6:13

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)				
	100	120	140	160	180
5	–0.7	–0.4	0.0	0.4	0.9
10	–1.3	–0.7	0.0	0.8	1.7
15	–2.0	–1.1	0.0	1.2	2.5
20	–2.7	–1.5	0.0	1.7	3.4
25	–3.4	–1.8	0.0	2.1	4.3
30	–4.1	–2.2	0.0	2.5	5.2
35	–4.8	–2.6	0.0	2.9	6.1
40	–5.6	–2.9	0.0	3.4	7.0
45	–6.3	–3.3	0.0	3.8	8.0
50	–7.0	–3.7	0.0	4.3	8.9
55	–7.8	–4.0	0.0	4.8	9.9

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
109	88	74	64	56	50	45	41	38	35	32
177	153	135	121	110	100	92	85	79	74	70
248	219	197	178	163	150	139	130	121	114	108
318	285	257	235	216	200	186	174	164	154	146
388	350	318	292	269	250	233	219	206	195	184
458	415	378	348	322	300	281	264	248	235	223
528	479	439	405	375	350	328	308	291	276	262
599	545	499	461	428	400	375	353	334	316	300
670	610	560	518	482	450	422	398	376	356	339
742	677	622	575	535	500	469	442	418	397	377

Table 2 of 2: Trip Fuel and Time

AIR DISTANCE (NM)		LANDING WEIGHT (1000 KG)									TIME (HRS:MIN)
		100	110	120	130	140	150	160	170	180	
50	FUEL (1000 KG)	1.4	1.4	1.5	1.6	1.6	1.7	1.8	1.8	1.9	0:16
	ALT (FT)	11000	11000	11000	11000	9000	7000	7000	7000	7000	
100	FUEL (1000 KG)	2.3	2.4	2.5	2.6	2.7	2.8	2.9	3.1	3.2	0:26
	ALT (FT)	25000	23000	23000	17000	17000	17000	17000	17000	17000	
150	FUEL (1000 KG)	3.1	3.2	3.4	3.5	3.7	3.9	4.0	4.2	4.4	0:36
	ALT (FT)	31000	29000	29000	27000	25000	25000	21000	21000	19000	
200	FUEL (1000 KG)	3.8	4.0	4.2	4.4	4.6	4.8	5.1	5.3	5.5	0:45
	ALT (FT)	31000	31000	31000	31000	29000	27000	27000	25000	25000	
250	FUEL (1000 KG)	4.6	4.8	5.0	5.3	5.5	5.8	6.1	6.4	6.6	0:53
	ALT (FT)	31000	31000	31000	31000	29000	29000	27000	25000	25000	
300	FUEL (1000 KG)	5.4	5.6	5.8	6.1	6.5	6.8	7.1	7.4	7.8	1:02
	ALT (FT)	31000	31000	31000	31000	31000	29000	27000	27000	25000	
350	FUEL (1000 KG)	6.1	6.4	6.7	7.0	7.4	7.8	8.2	8.5	8.9	1:11
	ALT (FT)	31000	31000	31000	31000	31000	29000	29000	27000	25000	
400	FUEL (1000 KG)	6.9	7.2	7.5	7.9	8.3	8.7	9.2	9.6	10.0	1:20
	ALT (FT)	31000	31000	31000	31000	31000	29000	29000	27000	25000	
450	FUEL (1000 KG)	7.7	8.0	8.3	8.8	9.2	9.7	10.2	10.7	11.2	1:29
	ALT (FT)	31000	31000	31000	31000	31000	29000	27000	27000	25000	
550	FUEL (1000 KG)	8.4	8.8	9.2	9.6	10.2	10.7	11.3	11.8	12.3	138
	ALT (FT)	31000	31000	31000	31000	31000	29000	27000	27000	25000	

GEAR DOWN

Holding Planning

Flaps Up

WEIGHT (1000 KG)	TOTAL FUEL FLOW (KG/HR) PRESSURE ALTITUDE (FT)						
	1500	5000	10000	15000	20000	25000	30000
260	9940	10100	10440	10600			
240	9200	9310	9630	9680	10130		
220	8480	8550	8800	8860	9180		
200	7780	7820	7990	8060	8300		
180	7100	7110	7220	7270	7430	7720	
160	6500	6490	6540	6540	6720	6950	
140	5860	5830	5830	5800	6000	6150	6320
120	5280	5230	5200	5130	5320	5390	5500
100	4890	4830	4790	4710	4870	4920	5020
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
260	9900	9930	10050	10130	
240	9120	9150	9220	9250	9500
220	8360	8370	8420	8440	8710
200	7590	7580	7640	7640	7970
180	6810	6760	6780	6720	6970
160	6130	6080	6050	5970	6140
140	5480	5410	5350	5270	5420
120	4900	4810	4730	4630	4700
100	4510	4410	4310	4210	4230
Includes 5% additional fuel for holding in a race track pattern.					

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Net Level Off Weight

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 KG)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
22	109.4	107.5	
20	117.3	114.2	109.3
18	125.1	120.5	114.9
16	132.6	128.5	122.5
14	141.9	137.4	131.0
12	153.7	147.2	140.4
10	157.8	150.7	143.4
8	160.8	154.0	146.6
6	167.7	160.5	152.8
4	174.5	166.9	159.0
2	180.7	172.4	164.3
0	187.0	179.9	171.6

Anti-Ice Adjustment

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 KG)										
	PRESSURE ALTITUDE (1000 FT)										
	0	2	4	6	8	10	12	14	16	18	20
ENGINE ON	0.0	0.0	0.0	0.0	0.0	–1.4	–1.8	–1.9	–1.9	–1.8	–1.6
ENGINE & WING ON	0.0	0.0	0.0	0.0	0.0	–1.9	–2.5	–2.6	–2.7	–2.6	–2.4

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 KG)										
	PRESSURE ALTITUDE (1000 FT)										
	0	2	4	6	8	10	12	14	16	18	20
ENGINE ON	–1.9	–1.9	–2.0	–2.2	–2.2	–2.2	–2.0	–1.9	–1.9	–1.8	–1.6
ENGINE & WING ON	–2.8	–2.8	–2.8	–3.0	–3.0	–3.0	–2.8	–2.7	–2.7	–2.6	–2.4

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. The data provided is for a single takeoff flap at 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 Approved Flight Manual, the Flight Manual shall always take precedence.

Takeoff

The maximum allowable takeoff weight is the least of the Field, Climb, Obstacle and Fuel Jettison Limit Weights as determined from the tables in this chapter. The takeoff weight cannot be less than the flaps 15 Minimum Takeoff Weight as determined from chapter Performance Inflight. Brake Energy and Tire Limit Weights are not shown as they are not limiting for the range of conditions shown in this chapter.

Field Limit Weight—Slope and Wind Corrections

These 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 the 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 the 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. Intermediate altitudes may be interpolated or use next higher altitude. If the "Slope and Wind Corrected Field Length" is less than the minimum field length shown in the table, do not extrapolate the data.

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

Obtain reference obstacle limit weight by entering Table 1 with obstacle height above the runway surface and distance from brake release. Next 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.

Fuel Jettison Limit Weight

The Return to Land Fuel Jettison Limit Weight is defined as the landing climb limit weight plus the fuel burned over 30 minutes and the fuel jettisoned over 15 minutes.

The table presented provides the Fuel Jettison Limit Weight for a given altitude and temperature. Enter the table with airport OAT and pressure altitude to read Fuel Jettison Limit Weight. Apply the noted adjustments for anti-ice as required. Intermediate altitudes or temperatures may be interpolated.

The table presented is based on the entry-into-service maximum zero fuel weight. Analysis from the Airplane Flight Manual - Digital Performance Information software using a lower zero fuel weight may yield less restrictive performance.

DELETION

Brakes Deactivated

When operating with brakes deactivated, the field limit weight and the V1 must be reduced to allow for reduced braking capability. A simplified method which conservatively accounts for the reduced braking capability of one or two brakes deactivated is to reduce the normal runway limited weight and the V1 associated with the reduced weight by the amount in the table below:

	WEIGHT ADJUSTMENT (KG)		V1 ADJUSTMENT (KTS)	
	DRY RUNWAY	WET RUNWAY	DRY RUNWAY	WET RUNWAY
1 BRAKE DEACTIVATED	4,850	3,750	2	2
2 BRAKE DEACTIVATED	8,750	6,800	5	3

If the resulting V1 is less than V1(MCG), takeoff is permitted with V1 set equal to V1(MCG) provided the accelerate stop distance available corrected for wind and slope exceeds the appropriate value in the table below:

	MINIMUM FIELD LENGTH (M)	
	DRY RUNWAY	WET RUNWAY
1 BRAKE DEACTIVATED	1,900	2,400
2 BRAKE DEACTIVATED	2,050	2,550

Note: V1(MCG) can be determined from Chapter Performance Inflight. Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

One Thrust Reverser Inoperative

Wet runway takeoff performance presented for all brakes operating is based on the use of one thrust reverser during deceleration. When operating with a thrust reverser inoperative, the runway/obstacle limited takeoff weight and V1 speed must be reduced to account for the reduced deceleration capability.

A simplified method which conservatively accounts for this is to reduce the normal wet runway/obstacle limited weight by 4,850 kg and the V1 associated with the reduced weight by two knots.

If the resulting V1 is less than V1(MCG), takeoff is permitted with V1 set equal to V1(MCG) provided the accelerate stop distance available corrected for wind and slope exceeds approximately 2,450 m.

Enroute

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. Note that these tables consider both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 300 ft/min residual rate of climb.

Flying above these altitudes with sustained banks in excess of approximately 22° may cause the airplane to lose speed and/or altitude. The altitudes shown in the table are limited to the maximum certified altitude of 43,100 ft.

Long Range Cruise Trip Fuel and Time

These tables are provided to determine trip fuel and time required to destination. Data is 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 4,000 ft step climbs to keep the flight within 2,000 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

These tables are provided to determine trip fuel and time for short distances or alternates. The data are based on the use of the FMC short trip optimum altitude. Obtain air distance from the Ground to Air Miles Conversion table (Table 1) using the ground distance and wind component to the alternate. Enter the Trip Fuel and Time table (Table 2) with air distance and read trip fuel required for the expected landing weight. Continue across the table to read trip time. For distances greater than shown or other altitudes, use the Long Range Cruise Trip Fuel and Time tables.

Holding Planning

These tables provide total fuel flow information necessary for planning Flaps Up and Flaps 1 holding and reserve fuel requirements. Data is based on the FMC holding speed schedule which is the higher of the maximum endurance and flap 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%.

Oxygen Requirements

Flight Crew System

Regulations require that sufficient oxygen be provided to the flight crew to account for the greater of supplemental breathing oxygen in the event of a cabin depressurization or protective breathing in the event of smoke or harmful fumes in the flight deck.

Tables are provided to determine the flight crew oxygen dispatch requirements. Table 1 shows minimum oxygen quantity necessary to ensure that protective breathing requirements are satisfied. Table 2 shows the supplemental oxygen requirement for loss of pressurization, emergency descent and total post decompression flight time above 10,000 ft. Table 3 gives adjustments that must be applied to Table 2 crew member supplemental requirements in situations where the enroute altitude after decompression will exceed 14000 ft. Increments shown in parenthesis are adjustments for "100%" regulator setting that can be used if the operator chooses to schedule oxygen dispatch requirements based on pure oxygen availability. For more extensive than normal crew usage, additional oxygen can be added using the actual oxygen flow rate data provided under Table 3.

An additional quantity of oxygen is required when flight altitudes above 41,000 ft are planned. Regulations require that one active duty pilot must don the oxygen mask and breath diluted oxygen for the duration of the flight above 41,000 ft. The additional quantity of oxygen required is 2.05 liters/person/minute (1.2 psi/person/minute for the single cylinder system and 0.6 psi/person/minute for the dual cylinder system), or 13 liters/person/minute (8 psi/person/minute for the single cylinder system and 4 psi/person/minute for the dual cylinder system) if 100% oxygen is selected during normal usage.

After determining the total volume (liters) required for the flight crew by using the larger value from Table 1 or Table 2, obtain the dispatch pressure required from the Cylinder to Volume Pressure Conversion table (Table 4). Adjust this reading for cylinder 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 in straight and level flight following an engine failure. Regulations require terrain clearance planning based on net performance, which is the gross (or actual) gradient performance degraded by 1.1%. In addition, the net level off pressure altitude must clear the terrain by 1,000 ft.

To determine the 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 the maximum landing weight as limited by field length or climb requirements for Flaps 30.

Maximum landing weight is the lowest of the 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 Adjusted 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 to 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. Adjust the reference gradient for airplane weight and speed using Table 2 and Table 3 to determine the weight and speed adjusted Go-Around Gradient. Note that data is for one engine inoperative.

Quick Turnaround Limit Weight

Enter table with airport pressure altitude and OAT to 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.

Gear Down

This section provides flight planning data for revenue operation with gear down for limited airport pressure altitudes. The gear down tables in this section are identical in format and usage to the corresponding gear up tables previously described.

The maximum allowable takeoff weight is the least of the Field, Climb, Obstacle and Fuel Jettison Limit Weights as determined from the tables in this section. When determining a maximum weight for a wet runway, the dry runway limit weight must also be checked and the lower of the two weights used. The takeoff weight cannot be less than the flaps 15 Minimum Takeoff Weight as determined from Chapter Performance Inflight Brake Energy and Tire Limit Weights are not shown as they are not limiting for the range of conditions shown in this section.

Due to increased takeoff speed schedule for gear down dispatch, takeoff speeds must be determined from the tables provided in this section by using the same manner as described in Chapter Performance Inflight.

Performance Dispatch — Chapter PD
Table of Contents

787-9 TRENT1000-D KG C M FAA

Takeoff PD.20
Takeoff Field Corrections—Dry Runway PD.20.1
Takeoff Field & Climb Limit Weights—Dry Runway PD.20.2
Takeoff Field Corrections—Wet Runway PD.20.10
Takeoff Field & Climb Limit Weights—Wet Runway PD.20.11
Takeoff Obstacle Limit Weight PD.20.19
Fuel Jettison Limit Weight PD.20.21

Enroute PD.21
Long Range Cruise Maximum Operating Altitude PD.21.1
Long Range Cruise Trip Fuel and Time PD.21.3
Long Range Cruise Step Climb PD.21.5
Short Trip Fuel and Time PD.21.6
Holding Planning PD.21.7
Crew Oxygen Requirements PD.21.8
Net Level Off Weight PD.21.10

Landing PD.22
Landing Field Limit Weight—Dry Runway PD.22.1
Landing Field Limit Weight—Wet Runway PD.22.2
Landing Climb Limit Weight PD.22.3
Go-Around Climb Gradient PD.22.4
Quick Turnaround Limit Weight PD.22.7

Gear Down PD.23
Takeoff Field Corrections—Dry Runway PD.23.1
Takeoff Field & Climb Limit Weights—Dry Runway PD.23.2
Takeoff Field Corrections—Wet Runway PD.23.7

Takeoff Field & Climb Limit Weights—Wet Runway PD.23.8
Takeoff Obstacle Limit Weight PD.23.13
Fuel Jettison Limit Weight PD.23.15
Takeoff Speeds—Dry Runway PD.23.16
Takeoff Speeds—Wet Runway PD.23.18
VREF PD.23.20
Landing Field Limit Weight—Dry Runway PD.23.21
Landing Field Limit Weight—Wet Runway PD.23.22
Landing Climb Limit Weight PD.23.23
Long Range Cruise Altitude Capability PD.23.24
Long Range Cruise Trip Fuel and Time PD.23.25
Short Trip Fuel and Time PD.23.27
Holding Planning PD.23.28
Net Level Off Weight PD.23.29

Text PD.24

Introduction PD.24.1
Takeoff PD.24.1
Enroute PD.24.3
Landing PD.24.5
Gear Down PD.24.6

Takeoff Field Corrections—Dry Runway

Table 1 of 3: Slope Correction

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
1400	1470	1450	1430	1420	1400	1360	1320	1280	1250
1600	1680	1660	1640	1620	1600	1550	1500	1450	1400
1800	1900	1880	1850	1830	1800	1740	1670	1610	1550
2000	2120	2090	2060	2030	2000	1920	1850	1770	1700
2200	2340	2300	2270	2230	2200	2110	2030	1940	1850
2400	2550	2520	2480	2440	2400	2300	2200	2100	2000
2600	2770	2730	2690	2640	2600	2480	2380	2260	2150
2800	2990	2940	2890	2850	2800	2680	2550	2430	2300
3000	3200	3150	3100	3050	3000	2860	2730	2590	2450
3200	3420	3370	3310	3260	3200	3050	2900	2750	2610
3400	3640	3580	3520	3460	3400	3240	3080	2920	2760
3600	3860	3790	3730	3660	3600	3430	3250	3080	2910
3800	4310	4230	4150	4080	4000	3800	3590	3390	3060
4000	4540	4450	4370	4280	4200	3980	3760	3550	3210
4200	4770	4670	4580	4490	4400	4170	3940	3700	3360
4400	4720	4640	4560	4480	4400	4180	3960	3730	3510
4600	4940	4860	4770	4690	4600	4370	4130	3900	3660
4800	5160	5070	4980	4890	4800	4550	4310	4060	3810
5000	5380	5280	5190	5090	5000	4740	4480	4220	3960

Table 2 of 3: Wind Correction

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M)							
	WIND COMPONENT (KTS)							
	−15	−10	−5	0	10	20	30	40
1400	290	660	1030	1400	1480	1560	1630	1690
1600	500	870	1230	1600	1680	1760	1840	1910
1800	710	1070	1440	1800	1880	1970	2050	2130
2000	910	1280	1640	2000	2080	2170	2260	2360
2200	1120	1480	1840	2200	2290	2380	2470	2580
2400	1330	1690	2040	2400	2490	2580	2690	2800
2600	1540	1890	2250	2600	2690	2790	2900	3020
2800	1740	2100	2450	2800	2890	2990	3110	3240
3000	1950	2300	2650	3000	3090	3200	3320	3470
3200	2160	2500	2850	3200	3290	3400	3530	3690
3400	2360	2710	3050	3400	3490	3610	3750	3910
3600	2570	2910	3260	3600	3690	3810	3960	4130
3800	2780	3120	3460	3800	3890	4020	4170	4350
4000	2990	3320	3660	4000	4090	4220	4380	4570
4200	3190	3530	3860	4200	4300	4430	4590	4800
4400	3400	3730	4070	4400	4500	4630	4810	5020
4600	3610	3940	4270	4600	4700	4840	5020	5240
4800	3810	4140	4470	4800	4900	5040	5230	5460
5000	4020	4350	4670	5000	5100	5250	5440	5680

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	195.5	179.3	177.5	176.3	175.1	173.9	172.7	171.5	170.3	163.8	152.1
1800	208.9	192.0	190.1	188.9	187.6	186.3	185.1	183.8	182.6	175.7	163.6
2000	220.7	203.1	201.1	199.8	198.5	197.1	195.8	194.6	193.3	186.1	173.4
2200	231.7	213.4	211.3	209.9	208.5	207.2	205.8	204.5	203.1	195.6	182.4
2400	242.5	223.4	221.2	219.8	218.4	216.9	215.5	214.1	212.7	205.0	191.2
2600	254.9	235.3	233.1	231.7	230.2	228.7	227.3	225.8	224.4	216.4	202.3
2800	265.2	245.1	242.8	241.3	239.7	238.2	236.8	235.3	233.8	225.6	211.1
3000	269.8	252.3	249.9	248.4	246.8	245.3	243.7	242.2	240.7	232.3	217.3
3200	269.8	259.5	257.1	255.4	253.8	252.2	250.7	249.1	247.5	238.8	223.5
3400	269.8	266.4	264.0	262.3	260.7	259.0	257.4	255.8	254.2	245.2	229.4
3600	269.8	269.8	269.8	268.9	267.2	265.5	263.9	262.2	260.6	251.4	235.1
3800	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.3	266.6	257.2	240.6
4000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	262.9	245.9
4200	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.4	251.0
4400	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	256.0
4600	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	260.8
4800	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	265.5
5000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8
CLIMB LIMIT WT (1000 KG)	240.5	238.9	238.8	238.6	238.5	238.3	238.1	237.9	237.6	227.7	206.0

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	**OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	**OAT≤10 deg. C**	**10 deg. C<OAT≤20 deg. C**
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	182.5	169.1	167.3	166.1	164.9	163.7	162.5	161.3	160.2	151.3	139.0
1800	195.4	181.3	179.4	178.2	176.9	175.7	174.4	173.2	172.0	162.7	149.8
2000	206.6	191.9	190.0	188.7	187.3	186.0	184.7	183.4	182.2	172.5	159.0
2200	217.0	201.7	199.7	198.3	196.9	195.6	194.2	192.9	191.5	181.5	167.4
2400	227.2	211.3	209.1	207.7	206.3	204.9	203.5	202.1	200.7	190.3	175.6
2600	239.3	222.9	220.7	219.3	217.8	216.3	214.9	213.5	212.1	201.3	186.3
2800	249.1	232.3	230.0	228.5	227.0	225.5	224.0	222.6	221.1	210.1	194.6
3000	256.4	239.1	236.8	235.3	233.7	232.2	230.6	229.1	227.6	216.3	200.4
3200	263.7	245.9	243.5	241.9	240.3	238.8	237.2	235.6	234.1	222.4	206.0
3400	269.8	252.5	250.0	248.4	246.8	245.1	243.5	241.9	240.3	228.3	211.5
3600	269.8	258.9	256.3	254.7	253.0	251.3	249.6	248.0	246.4	234.0	216.7
3800	269.8	264.9	262.3	260.6	258.9	257.1	255.5	253.8	252.1	239.4	221.7
4000	269.8	269.8	268.1	266.3	264.6	262.8	261.1	259.3	257.6	244.7	226.6
4200	269.8	269.8	269.8	269.8	269.8	268.3	266.5	264.8	263.0	249.8	231.3
4400	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.3	254.7	235.9
4600	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	259.6	240.3
4800	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	264.2	244.6
5000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.8	248.7
CLIMB LIMIT WT (1000 KG)	229.7	228.3	228.1	228.0	227.8	227.6	227.5	227.2	226.9	211.2	188.5

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	171.4	158.8	157.0	155.8	154.7	153.6	152.4	151.3	148.3	138.6	126.4
1800	183.7	170.5	168.7	167.4	166.2	165.1	163.9	162.7	159.6	149.4	136.6
2000	194.4	180.7	178.7	177.5	176.2	175.0	173.8	172.5	169.2	158.7	145.3
2200	204.3	190.0	188.0	186.6	185.3	184.0	182.8	181.5	178.0	167.0	153.1
2400	214.0	199.1	197.0	195.6	194.2	192.9	191.6	190.2	186.7	175.2	160.7
2600	225.7	210.4	208.2	206.8	205.4	204.0	202.7	201.3	197.7	185.9	171.0
2800	235.1	219.4	217.2	215.7	214.3	212.9	211.5	210.0	206.3	194.2	178.9
3000	242.0	225.9	223.6	222.1	220.6	219.2	217.7	216.2	212.4	200.0	184.2
3200	248.9	232.3	229.9	228.4	226.8	225.3	223.9	222.4	218.4	205.6	189.3
3400	255.6	238.5	236.0	234.4	232.9	231.4	229.8	228.3	224.2	211.0	194.3
3600	262.0	244.5	242.0	240.3	238.7	237.1	235.6	234.0	229.8	216.3	199.1
3800	268.1	250.1	247.6	245.9	244.3	242.6	241.0	239.4	235.1	221.3	203.7
4000	269.8	255.7	253.0	251.3	249.6	248.0	246.3	244.7	240.3	226.1	208.1
4200	269.8	261.0	258.3	256.6	254.8	253.2	251.5	249.8	245.3	230.8	212.4
4400	269.8	266.2	263.5	261.7	259.9	258.2	256.5	254.7	250.1	235.3	216.6
4600	269.8	269.8	268.4	266.6	264.8	263.1	261.3	259.5	254.9	239.8	220.6
4800	269.8	269.8	269.8	269.8	269.6	267.8	266.0	264.2	259.4	244.0	224.5
5000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.7	263.9	248.2	228.3
CLIMB LIMIT WT (1000 KG)	219.2	217.9	217.7	217.5	217.4	217.2	217.1	216.8	211.9	194.2	171.7

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	160.5	148.4	146.7	145.6	144.5	143.4	142.3	139.8	136.6	126.4	114.7
1800	172.3	159.7	157.9	156.7	155.6	154.4	153.3	150.7	147.3	136.6	124.4
2000	182.5	169.3	167.5	166.3	165.1	163.9	162.7	160.0	156.5	145.3	132.6
2200	191.9	178.2	176.2	174.9	173.7	172.5	171.2	168.4	164.7	153.1	139.8
2400	201.1	186.8	184.8	183.5	182.2	180.9	179.6	176.7	172.8	160.8	146.9
2600	212.4	197.8	195.7	194.3	193.0	191.7	190.4	187.3	183.4	171.0	156.8
2800	221.5	206.4	204.3	202.9	201.5	200.2	198.8	195.7	191.7	178.9	164.3
3000	228.0	212.5	210.3	208.9	207.5	206.1	204.7	201.5	197.4	184.2	169.2
3200	234.5	218.5	216.2	214.8	213.3	211.9	210.5	207.2	202.9	189.4	173.9
3400	240.8	224.3	222.0	220.5	219.0	217.5	216.0	212.6	208.3	194.3	178.4
3600	246.8	229.9	227.5	226.0	224.5	222.9	221.4	217.9	213.4	199.1	182.8
3800	252.6	235.3	232.8	231.2	229.6	228.1	226.5	223.0	218.4	203.7	187.0
4000	258.1	240.4	237.9	236.3	234.7	233.1	231.5	227.8	223.1	208.1	191.0
4200	263.5	245.4	242.9	241.2	239.6	238.0	236.3	232.6	227.7	212.4	194.9
4400	268.8	250.3	247.7	246.0	244.3	242.7	241.0	237.2	232.2	216.6	198.7
4600	269.8	255.0	252.3	250.6	248.9	247.2	245.5	241.6	236.6	220.6	202.4
4800	269.8	259.6	256.9	255.1	253.4	251.7	249.9	245.9	240.8	224.5	206.0
5000	269.8	264.0	261.3	259.5	257.7	255.9	254.2	250.1	244.9	228.3	209.4
CLIMB LIMIT WT (1000 KG)	208.0	207.1	206.9	206.8	206.6	206.5	206.3	202.2	196.5	177.4	156.3

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	149.7	138.2	136.6	135.6	134.6	133.3	131.0	128.2	124.9	114.4	
1800	161.0	149.0	147.3	146.2	145.2	143.8	141.5	138.5	135.1	124.1	112.3
2000	170.7	158.2	156.5	155.4	154.2	152.9	150.4	147.2	143.7	132.2	120.0
2200	179.6	166.5	164.7	163.6	162.4	161.0	158.4	155.1	151.4	139.5	126.7
2400	188.3	174.7	172.9	171.6	170.4	168.9	166.3	162.9	159.0	146.6	133.4
2600	199.3	185.4	183.5	182.2	180.9	179.4	176.7	173.2	169.2	156.5	142.9
2800	208.0	193.7	191.7	190.4	189.1	187.6	184.7	181.1	177.1	164.0	150.0
3000	214.1	199.4	197.4	196.0	194.7	193.1	190.2	186.5	182.3	168.8	154.4
3200	220.2	205.0	202.9	201.5	200.2	198.5	195.5	191.7	187.4	173.5	158.7
3400	226.1	210.4	208.3	206.9	205.5	203.8	200.7	196.8	192.3	178.0	162.8
3600	231.7	215.7	213.4	212.0	210.6	208.8	205.6	201.6	197.1	182.4	166.7
3800	237.1	220.6	218.4	216.9	215.4	213.6	210.4	206.3	201.6	186.6	170.5
4000	242.3	225.5	223.1	221.6	220.1	218.3	215.0	210.7	206.0	190.6	174.2
4200	247.3	230.1	227.8	226.2	224.7	222.8	219.4	215.1	210.2	194.5	177.7
4400	252.2	234.7	232.3	230.7	229.1	227.2	223.7	219.3	214.3	198.3	181.2
4600	257.0	239.1	236.6	235.0	233.4	231.4	227.9	223.4	218.3	201.9	184.5
4800	261.6	243.4	240.8	239.2	237.6	235.6	232.0	227.4	222.2	205.5	187.7
5000	266.1	247.5	244.9	243.2	241.6	239.5	235.9	231.2	225.9	208.9	190.8
CLIMB LIMIT WT (1000 KG)	196.5	195.9	195.8	195.7	195.6	194.9	191.5	186.6	180.9	160.6	140.9

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2600
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(f) of 3: 10000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	138.2	127.7	126.3	125.3	124.1	122.1	119.5	116.5	112.7		
1800	149.0	138.0	136.5	135.5	134.2	132.1	129.4	126.3	122.3	111.8	
2000	158.2	146.8	145.2	144.1	142.8	140.6	137.8	134.5	130.4	119.4	
2200	166.6	154.6	152.9	151.8	150.5	148.2	145.2	141.9	137.5	126.1	113.6
2400	174.8	162.3	160.6	159.5	158.0	155.6	152.6	149.1	144.6	132.7	119.8
2600	185.4	172.6	170.9	169.7	168.2	165.7	162.6	159.0	154.4	142.2	128.9
2800	193.7	180.6	178.8	177.6	176.1	173.5	170.3	166.6	161.9	149.3	135.6
3000	199.4	185.9	184.1	182.8	181.3	178.6	175.3	171.5	166.7	153.7	139.7
3200	205.1	191.1	189.2	187.9	186.3	183.6	180.2	176.3	171.3	158.0	143.5
3400	210.5	196.2	194.2	192.8	191.2	188.4	184.9	180.9	175.7	162.0	147.1
3600	215.7	201.0	199.0	197.6	195.9	193.1	189.5	185.3	180.0	166.0	150.7
3800	220.7	205.6	203.5	202.1	200.4	197.5	193.8	189.6	184.2	169.7	154.1
4000	225.5	210.1	208.0	206.5	204.8	201.8	198.0	193.7	188.1	173.4	157.3
4200	230.2	214.4	212.2	210.8	209.0	205.9	202.1	197.7	192.0	176.9	160.5
4400	234.7	218.7	216.4	214.9	213.1	210.0	206.0	201.5	195.7	180.3	163.6
4600	239.1	222.7	220.4	218.9	217.1	213.9	209.8	205.2	199.3	183.6	166.5
4800	243.4	226.7	224.3	222.8	220.9	217.7	213.5	208.9	202.8	186.8	169.4
5000	247.5	230.5	228.1	226.6	224.6	221.3	217.1	212.3	206.2	189.9	172.1
CLIMB LIMIT WT (1000 KG)	183.8	183.4	183.3	183.2	182.5	179.7	175.3	169.9	162.8	144.2	126.5

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1150	–2400	–2900
ENGINE & WING ON	–1600	–2900	–3450
ENGINE AUTO	–1150	–2400	0
ENGINE & WING AUTO	–1600	–2900	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3500
ENGINE & WING ON	–2100	–3750	–4300
ENGINE AUTO	–1500	–3100	0
ENGINE & WING AUTO	–2100	–3750	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(g) of 3: 12000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	127.6	117.8	116.4	115.3	113.4	111.1					
1800	137.9	127.6	126.1	124.9	123.0	120.6	117.8	114.1	110.2		
2000	146.6	135.9	134.4	133.2	131.1	128.6	125.7	121.9	117.8		
2200	154.5	143.3	141.7	140.4	138.3	135.7	132.6	128.6	124.4	113.2	
2400	162.2	150.6	148.9	147.6	145.4	142.7	139.5	135.4	131.0	119.3	113.0
2600	172.5	160.5	158.9	157.5	155.2	152.4	149.2	144.9	140.4	128.5	122.0
2800	180.5	168.1	166.4	165.0	162.7	159.8	156.5	152.1	147.4	135.2	128.5
3000	185.8	173.1	171.4	169.9	167.5	164.6	161.1	156.6	151.8	139.2	132.4
3200	191.0	177.9	176.1	174.6	172.1	169.1	165.6	160.9	156.0	143.0	136.0
3400	196.0	182.6	180.7	179.2	176.6	173.5	169.9	165.1	160.0	146.6	139.4
3600	200.8	187.1	185.1	183.6	181.0	177.7	174.0	169.1	163.9	150.2	142.7
3800	205.5	191.4	189.4	187.8	185.1	181.8	178.0	173.0	167.6	153.5	145.9
4000	209.9	195.5	193.5	191.8	189.1	185.7	181.8	176.7	171.2	156.8	149.0
4200	214.3	199.5	197.5	195.8	193.0	189.5	185.5	180.3	174.7	160.0	152.0
4400	218.5	203.4	201.3	199.6	196.7	193.2	189.1	183.8	178.1	163.0	154.9
4600	222.6	207.2	205.0	203.3	200.3	196.8	192.6	187.1	181.3	166.0	157.7
4800	226.5	210.8	208.6	206.8	203.9	200.2	196.0	190.4	184.4	168.8	160.3
5000	230.3	214.3	212.1	210.3	207.2	203.5	199.2	193.5	187.5	171.5	162.9
CLIMB LIMIT WT (1000 KG)	171.6	171.2	171.1	170.5	168.0	164.3	159.7	153.0	145.8	128.9	121.3

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1150	–2400	–2900
ENGINE & WING ON	–1600	–2900	–3450
ENGINE AUTO	–1150	–2400	0
ENGINE & WING AUTO	–1600	–2900	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3500
ENGINE & WING ON	–2100	–3750	–4300
ENGINE AUTO	–1500	–3100	0
ENGINE & WING AUTO	–2100	–3750	0

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(h) of 3: 14000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	116.6										
1800	126.3	117.0	115.4	113.5	111.2						
2000	134.6	124.8	123.2	121.2	118.9	116.2	112.5				
2200	141.9	131.7	130.0	128.0	125.5	122.7	118.9	114.9	110.8		
2400	149.1	138.6	136.8	134.7	132.1	129.2	125.2	121.1	116.8		
2600	159.1	148.2	146.4	144.2	141.6	138.6	134.5	130.3	125.8	111.4	
2800	166.6	155.5	153.6	151.4	148.7	145.6	141.4	137.0	132.5	117.6	115.3
3000	171.6	160.1	158.2	155.9	153.1	149.9	145.6	141.1	136.4	121.2	118.8
3200	176.3	164.5	162.5	160.2	157.3	154.0	149.6	145.0	140.2	124.4	122.0
3400	181.0	168.8	166.7	164.3	161.3	158.0	153.4	148.7	143.7	127.5	125.0
3600	185.4	172.9	170.8	168.3	165.3	161.8	157.1	152.2	147.2	130.5	128.0
3800	189.6	176.9	174.7	172.1	169.0	165.5	160.7	155.7	150.5	133.4	130.8
4000	193.7	180.7	178.4	175.8	172.6	169.0	164.1	159.0	153.7	136.2	133.5
4200	197.7	184.4	182.1	179.4	176.1	172.4	167.4	162.2	156.8	139.0	136.2
4400	201.6	187.9	185.6	182.9	179.5	175.8	170.6	165.3	159.7	141.6	138.7
4600	205.3	191.4	189.0	186.2	182.8	179.0	173.7	168.3	162.6	144.1	141.2
4800	208.9	194.7	192.3	189.5	186.0	182.0	176.7	171.2	165.4	146.5	143.5
5000	212.4	197.9	195.4	192.6	189.0	185.0	179.6	173.9	168.1	148.8	145.8
CLIMB LIMIT WT (1000 KG)	159.1	158.3	157.5	155.1	151.7	147.5	141.4	134.8	128.3	115.4	114.0

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1150	–2400	–2900
ENGINE & WING ON	–1600	–2900	–3450
ENGINE AUTO	–1150	–2400	0
ENGINE & WING AUTO	–1600	–2900	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3500
ENGINE & WING ON	–2100	–3750	–4300
ENGINE AUTO	–1500	–3100	0
ENGINE & WING AUTO	–2100	–3750	0

Takeoff Field Corrections—Wet Runway

Table 1 of 3: Slope Correction

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	1800	1800	1800	1800	1800	1740	1680	1630	1570
2000	2030	2020	2010	2010	2000	1930	1870	1800	1740
2200	2250	2240	2230	2210	2200	2130	2050	1980	1900
2400	2480	2460	2440	2420	2400	2320	2240	2150	2070
2600	2700	2680	2650	2630	2600	2510	2420	2330	2240
2800	2930	2900	2860	2830	2800	2700	2610	2510	2410
3000	3150	3120	3080	3040	3000	2890	2790	2680	2580
3200	3380	3340	3290	3250	3200	3090	2970	2860	2750
3400	3610	3550	3500	3450	3400	3280	3160	3040	2920
3600	3830	3770	3720	3660	3600	3470	3340	3210	3080
3800	4060	3990	3930	3860	3800	3660	3530	3390	3250
4000	4280	4210	4140	4070	4000	3860	3710	3570	3420
4200	4510	4430	4350	4280	4200	4050	3900	3740	3590
4400	4730	4650	4570	4480	4400	4240	4080	3920	3760
4600	4960	4870	4780	4690	4600	4430	4260	4100	3930
4800	5190	5090	4990	4900	4800	4620	4450	4270	4100
5000	5410	5310	5210	5100	5000	4820	4630	4450	4260

Table 2 of 3: Wind Correction

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M)							
	WIND COMPONENT (KTS)							
	–15	–10	–5	0	10	20	30	40
1800	300	800	1300	1800	1910	2010	2100	2190
2000	530	1020	1510	2000	2110	2210	2310	2410
2200	760	1240	1720	2200	2310	2420	2530	2640
2400	1000	1460	1930	2400	2510	2620	2740	2870
2600	1230	1690	2140	2600	2710	2830	2950	3090
2800	1460	1910	2350	2800	2910	3030	3170	3320
3000	1690	2130	2560	3000	3110	3230	3380	3540
3200	1920	2350	2770	3200	3310	3440	3590	3770
3400	2160	2570	2990	3400	3510	3640	3810	4000
3600	2390	2790	3200	3600	3710	3850	4020	4220
3800	2620	3010	3410	3800	3910	4050	4230	4450
4000	2850	3240	3620	4000	4110	4260	4450	4680
4200	3090	3460	3830	4200	4310	4460	4660	4900
4400	3320	3680	4040	4400	4510	4660	4870	5130
4600	3550	3900	4250	4600	4710	4870	5080	5360
4800	3780	4120	4460	4800	4910	5070	5300	5580
5000	4010	4340	4670	5000	5110	5280	5510	5810

Takeoff Field & Climb Limit Weights—Wet Runway

Flaps 15

Based on anti-ice off

Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	219.8	200.9	198.6	197.2	195.8	194.3	192.9	191.6	190.2	182.7	170.2
2200	229.9	210.2	207.9	206.4	204.9	203.4	202.0	200.5	199.1	191.3	178.3
2400	239.6	219.2	216.8	215.2	213.7	212.1	210.6	209.1	207.6	199.5	186.1
2600	252.9	231.9	229.4	227.8	226.2	224.7	223.1	221.6	220.0	211.7	197.8
2800	263.8	242.0	239.5	237.8	236.2	234.6	233.0	231.4	229.8	221.2	206.9
3000	269.8	249.3	246.7	245.0	243.3	241.6	240.0	238.3	236.6	227.8	213.0
3200	269.8	256.6	253.9	252.1	250.4	248.7	246.9	245.2	243.5	234.4	219.1
3400	269.8	263.7	260.9	259.1	257.3	255.5	253.7	252.0	250.2	240.7	225.0
3600	269.8	269.8	267.6	265.8	263.9	262.1	260.3	258.5	256.6	246.9	230.7
3800	269.8	269.8	269.8	269.8	269.8	268.3	266.5	264.6	262.7	252.8	236.1
4000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.6	258.4	241.4
4200	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	263.9	246.5
4400	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.3	251.5
4600	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	256.4
4800	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	261.0
5000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	265.6
CLIMB LIMIT WT (1000 KG)	240.5	238.9	238.8	238.6	238.5	238.3	238.1	237.9	237.6	227.7	206.0

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	203.9	188.7	186.6	185.2	183.9	182.5	181.2	179.8	178.5	169.0	156.1
2200	213.4	197.6	195.4	193.9	192.5	191.1	189.7	188.3	187.0	177.0	163.7
2400	222.5	206.1	203.8	202.3	200.8	199.4	197.9	196.5	195.1	184.7	170.9
2600	235.3	218.4	216.1	214.5	213.0	211.5	210.0	208.5	207.1	196.5	182.2
2800	245.5	228.1	225.7	224.1	222.6	221.0	219.5	218.0	216.5	205.5	190.8
3000	252.9	234.9	232.4	230.8	229.2	227.6	226.0	224.4	222.9	211.5	196.3
3200	260.4	241.8	239.2	237.5	235.8	234.2	232.5	230.9	229.3	217.6	201.8
3400	267.6	248.4	245.7	244.0	242.2	240.5	238.8	237.2	235.5	223.4	207.2
3600	269.8	254.8	252.0	250.2	248.4	246.7	245.0	243.2	241.5	229.1	212.4
3800	269.8	260.8	258.0	256.2	254.3	252.5	250.8	249.0	247.2	234.5	217.4
4000	269.8	266.7	263.8	261.9	260.0	258.2	256.4	254.6	252.8	239.7	222.2
4200	269.8	269.8	269.4	267.5	265.6	263.7	261.8	260.0	258.2	244.8	226.9
4400	269.8	269.8	269.8	269.8	269.8	269.1	267.2	265.3	263.4	249.8	231.5
4600	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.5	254.6	235.9
4800	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	259.2	240.1
5000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	263.7	244.3
CLIMB LIMIT WT (1000 KG)	229.7	228.3	228.1	228.0	227.8	227.6	227.5	227.2	226.9	211.2	188.5

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	191.6	177.1	175.1	173.8	172.5	171.2	170.0	168.7	165.5	155.3	142.5
2200	200.6	185.5	183.4	182.1	180.7	179.4	178.1	176.8	173.5	162.8	149.5
2400	209.2	193.6	191.4	190.0	188.6	187.2	185.8	184.5	181.0	170.0	156.2
2600	221.7	205.6	203.3	201.9	200.4	199.0	197.6	196.2	192.7	181.3	167.1
2800	231.5	214.9	212.6	211.1	209.6	208.1	206.7	205.2	201.6	189.8	175.2
3000	238.4	221.2	218.8	217.3	215.7	214.2	212.7	211.3	207.5	195.3	180.2
3200	245.4	227.6	225.1	223.5	221.9	220.3	218.8	217.3	213.4	200.8	185.2
3400	252.1	233.8	231.2	229.6	227.9	226.3	224.7	223.1	219.1	206.2	190.0
3600	258.6	239.7	237.1	235.4	233.7	232.0	230.4	228.8	224.6	211.3	194.7
3800	264.7	245.4	242.7	241.0	239.2	237.5	235.9	234.2	229.9	216.3	199.3
4000	269.8	250.9	248.1	246.3	244.6	242.8	241.1	239.4	235.1	221.1	203.7
4200	269.8	256.2	253.4	251.6	249.8	248.0	246.3	244.5	240.0	225.8	208.0
4400	269.8	261.4	258.6	256.7	254.8	253.0	251.2	249.4	244.9	230.3	212.1
4600	269.8	266.5	263.5	261.6	259.7	257.9	256.1	254.2	249.6	234.7	216.1
4800	269.8	269.8	268.4	266.4	264.5	262.6	260.7	258.9	254.1	239.0	220.0
5000	269.8	269.8	269.8	269.8	269.1	267.2	265.3	263.4	258.5	243.1	223.8
CLIMB LIMIT WT (1000 KG)	219.2	217.9	217.7	217.5	217.4	217.2	217.1	216.8	211.9	194.2	171.7

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	179.4	165.7	163.8	162.6	161.4	160.2	159.0	156.3	152.9	142.1	130.0
2200	187.9	173.6	171.7	170.4	169.1	167.9	166.7	163.9	160.3	149.1	136.5
2400	196.1	181.2	179.2	177.9	176.5	175.3	174.0	171.1	167.4	155.7	142.6
2600	208.1	192.9	190.8	189.4	188.0	186.7	185.4	182.4	178.6	166.6	153.1
2800	217.5	201.8	199.6	198.2	196.8	195.5	194.1	191.0	187.1	174.7	160.8
3000	224.0	207.7	205.4	204.0	202.5	201.1	199.7	196.6	192.5	179.7	165.3
3200	230.4	213.6	211.3	209.7	208.3	206.8	205.3	202.1	197.9	184.7	169.8
3400	236.7	219.3	216.9	215.4	213.8	212.3	210.8	207.5	203.1	189.5	174.1
3600	242.7	224.9	222.4	220.8	219.2	217.7	216.1	212.7	208.2	194.2	178.4
3800	248.5	230.2	227.6	226.0	224.4	222.8	221.2	217.7	213.1	198.7	182.5
4000	254.0	235.3	232.7	231.0	229.4	227.8	226.1	222.5	217.8	203.1	186.5
4200	259.4	240.3	237.6	235.9	234.2	232.6	230.9	227.2	222.4	207.4	190.4
4400	264.7	245.1	242.4	240.7	239.0	237.3	235.6	231.8	226.9	211.5	194.2
4600	269.8	249.8	247.1	245.3	243.5	241.8	240.1	236.2	231.2	215.5	197.9
4800	269.8	254.4	251.6	249.8	248.0	246.2	244.4	240.5	235.4	219.4	201.4
5000	269.8	258.8	255.9	254.1	252.3	250.5	248.7	244.6	239.5	223.1	204.8
CLIMB LIMIT WT (1000 KG)	208.0	207.1	206.9	206.8	206.6	206.5	206.3	202.2	196.5	177.4	156.3

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	167.5	154.6	152.9	151.7	150.6	149.2	146.8	143.8	140.3	129.3	117.6
2200	175.6	162.1	160.3	159.1	157.9	156.5	154.0	150.8	147.2	135.8	123.6
2400	183.2	169.3	167.4	166.1	164.9	163.5	160.8	157.5	153.8	141.9	129.3
2600	194.9	180.6	178.6	177.3	176.1	174.6	171.9	168.5	164.6	152.4	139.4
2800	203.9	189.1	187.1	185.8	184.5	182.9	180.1	176.6	172.7	160.0	146.7
3000	209.8	194.6	192.5	191.1	189.8	188.2	185.3	181.7	177.6	164.5	150.7
3200	215.8	200.0	197.9	196.5	195.1	193.4	190.4	186.7	182.5	168.9	154.6
3400	221.6	205.3	203.1	201.7	200.2	198.5	195.5	191.6	187.2	173.3	158.5
3600	227.2	210.5	208.2	206.7	205.2	203.5	200.3	196.3	191.8	177.5	162.3
3800	232.6	215.4	213.1	211.5	210.0	208.2	205.0	200.9	196.3	181.6	166.1
4000	237.8	220.2	217.8	216.2	214.7	212.8	209.5	205.4	200.7	185.6	169.7
4200	242.8	224.9	222.4	220.8	219.2	217.3	214.0	209.7	204.9	189.5	173.2
4400	247.7	229.4	226.9	225.2	223.6	221.7	218.2	213.9	209.0	193.3	176.6
4600	252.5	233.7	231.2	229.5	227.9	225.9	222.4	217.9	212.9	196.9	179.9
4800	257.1	238.0	235.4	233.7	232.0	230.0	226.4	221.9	216.7	200.4	183.1
5000	261.6	242.1	239.4	237.7	236.0	233.9	230.3	225.6	220.4	203.8	186.1
CLIMB LIMIT WT (1000 KG)	196.5	195.9	195.8	195.7	195.6	194.9	191.5	186.6	180.9	160.6	140.9

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4750
ENGINE & WING ON	–350	–5600
ENGINE AUTO	–350	0
ENGINE & WING AUTO	–350	0

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(f) of 3: 10000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	155.3	143.3	141.7	140.6	139.3	137.1	134.4	131.3	127.3	116.8	
2200	162.9	150.3	148.6	147.5	146.2	143.9	141.1	137.8	133.7	122.8	110.9
2400	170.0	157.0	155.3	154.1	152.7	150.4	147.4	144.0	139.7	128.5	116.1
2600	181.3	168.0	166.2	165.0	163.5	161.1	158.1	154.6	150.2	138.6	125.9
2800	189.9	176.1	174.2	173.0	171.5	169.0	165.9	162.3	157.7	145.8	132.7
3000	195.4	181.1	179.2	177.9	176.4	173.8	170.5	166.9	162.1	149.8	136.2
3200	200.9	186.1	184.1	182.8	181.2	178.6	175.2	171.4	166.5	153.7	139.7
3400	206.2	191.0	188.9	187.6	185.9	183.2	179.7	175.8	170.7	157.5	143.1
3600	211.4	195.7	193.6	192.2	190.5	187.7	184.1	180.1	174.9	161.3	146.5
3800	216.4	200.3	198.1	196.7	195.0	192.1	188.4	184.3	178.9	165.0	149.8
4000	221.2	204.8	202.5	201.1	199.3	196.3	192.6	188.3	182.9	168.6	153.1
4200	225.8	209.1	206.8	205.3	203.5	200.4	196.6	192.3	186.7	172.1	156.2
4400	230.4	213.2	210.9	209.4	207.5	204.4	200.5	196.1	190.4	175.5	159.3
4600	234.8	217.3	214.9	213.3	211.4	208.3	204.3	199.8	194.0	178.8	162.2
4800	239.0	221.2	218.8	217.2	215.2	212.0	207.9	203.3	197.4	181.9	165.0
5000	243.1	225.0	222.5	220.9	218.9	215.6	211.5	206.7	200.7	184.9	167.7
CLIMB LIMIT WT (1000 KG)	183.8	183.4	183.3	183.2	182.5	179.7	175.3	169.9	162.8	144.2	126.5

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1100	–2400	–2700
ENGINE & WING ON	–1600	–2900	–3300
ENGINE AUTO	–1100	–2400	0
ENGINE & WING AUTO	–1600	–2900	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3500
ENGINE & WING ON	–2100	–3750	–4300
ENGINE AUTO	–1500	–3100	0
ENGINE & WING AUTO	–2100	–3750	0

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(g) of 3: 12000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	143.4	132.5	131.0	129.8	127.8	125.3	122.5	118.8	114.9		
2200	150.4	139.2	137.6	136.3	134.2	131.7	128.7	124.9	120.8	110.4	
2400	157.1	145.4	143.8	142.4	140.3	137.6	134.6	130.6	126.4	115.6	
2600	168.1	156.0	154.3	153.0	150.7	148.0	144.9	140.8	136.4	125.3	118.0
2800	176.2	163.8	162.0	160.6	158.3	155.5	152.3	148.1	143.6	132.1	124.6
3000	181.2	168.4	166.6	165.1	162.7	159.8	156.5	152.1	147.5	135.6	127.8
3200	186.2	172.9	171.1	169.6	167.1	164.1	160.7	156.1	151.4	139.1	131.0
3400	191.1	177.4	175.5	173.9	171.4	168.3	164.8	160.1	155.1	142.5	134.1
3600	195.8	181.7	179.8	178.2	175.6	172.4	168.7	163.9	158.8	145.8	137.2
3800	200.4	186.0	183.9	182.3	179.6	176.4	172.6	167.7	162.5	149.1	140.4
4000	204.9	190.1	188.0	186.3	183.6	180.3	176.4	171.4	166.1	152.4	143.4
4200	209.2	194.1	191.9	190.2	187.4	184.0	180.1	174.9	169.5	155.5	146.3
4400	213.4	197.9	195.7	194.0	191.1	187.6	183.6	178.4	172.8	158.5	149.1
4600	217.4	201.6	199.4	197.6	194.7	191.1	187.1	181.7	176.0	161.4	151.9
4800	221.3	205.2	202.9	201.1	198.2	194.5	190.4	184.9	179.1	164.2	154.5
5000	225.1	208.7	206.4	204.5	201.5	197.8	193.6	188.0	182.1	166.9	157.0
CLIMB LIMIT WT (1000 KG)	171.6	171.2	171.1	170.5	168.0	164.3	159.7	153.0	145.8	128.9	121.3

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1100	–2400	–2700
ENGINE & WING ON	–1600	–2900	–3300
ENGINE AUTO	–1100	–2400	0
ENGINE & WING AUTO	–1600	–2900	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3500
ENGINE & WING ON	–2100	–3750	–4300
ENGINE AUTO	–1500	–3100	0
ENGINE & WING AUTO	–2100	–3750	0

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(h) of 3: 14000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	131.6	121.6	120.0	118.1	115.8	113.2					
2200	138.1	127.8	126.1	124.1	121.7	119.0	115.4	111.6			
2400	144.4	133.7	131.8	129.8	127.3	124.5	120.8	116.9	112.9		
2600	154.9	143.9	142.0	139.9	137.4	134.5	130.7	126.6	122.6		P
2800	162.6	151.3	149.4	147.2	144.6	141.6	137.7	133.5	129.3	111.5	E
3000	167.2	155.5	153.5	151.2	148.5	145.5	141.4	137.0	132.7	114.3	R
3200	171.7	159.6	157.5	155.2	152.4	149.2	145.0	140.5	136.1	117.0	F
3400	176.2	163.6	161.5	159.1	156.2	153.0	148.6	144.0	139.4	119.7	
3600	180.5	167.6	165.4	162.9	160.0	156.6	152.1	147.4	142.6	122.4	L
3800	184.7	171.4	169.2	166.7	163.6	160.2	155.6	150.7	145.9	125.1	I
4000	188.7	175.2	172.9	170.3	167.2	163.7	159.0	154.0	149.0	127.8	M
4200	192.7	178.9	176.5	173.9	170.7	167.1	162.3	157.2	152.1	130.4	I
4400	196.5	182.4	180.0	177.3	174.0	170.3	165.4	160.2	155.0	132.9	T
4600	200.2	185.8	183.3	180.6	177.2	173.5	168.5	163.2	157.9	135.2	E
4800	203.8	189.1	186.6	183.8	180.4	176.5	171.4	166.0	160.6	137.5	D
5000	207.2	192.2	189.7	186.8	183.3	179.5	174.2	168.7	163.2	139.7	
CLIMB LIMIT WT (1000 KG)	159.1	158.3	157.5	155.1	151.7	147.5	141.4	134.8	128.3	115.4	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1100	–2400	–2700
ENGINE & WING ON	–1600	–2900	–3300
ENGINE AUTO	–1100	–2400	0
ENGINE & WING AUTO	–1600	–2900	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3500
ENGINE & WING ON	–2100	–3750	–4300
ENGINE AUTO	–1500	–3100	0
ENGINE & WING AUTO	–2100	–3750	0

Takeoff Obstacle Limit Weight

Flaps 15

Based on anti-ice off, five minute takeoff thrust time limit

Table 1 of 4: Sea Level, 35 deg. 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	207.9	226.3	240.4									
20	191.2	207.3	221.0	232.4	240.7	246.7						
40	175.9	190.6	203.9	214.8	223.8	231.1	237.2	241.5	245.3	249.6		
60	162.8	179.5	191.8	202.4	211.3	218.8	225.1	230.4	235.0	238.7	241.7	244.5
80	152.9	169.6	181.9	192.5	201.4	209.0	215.4	221.0	225.8	229.9	233.6	236.8
100	143.5	161.0	174.0	184.0	193.0	200.6	207.2	212.9	217.9	222.3	226.1	229.5
120	135.1	153.3	166.3	177.1	185.6	193.3	200.0	205.9	211.0	215.5	219.6	223.2
140	127.3	146.0	159.8	170.3	179.4	186.7	193.5	199.5	204.8	209.4	213.6	217.3
160	119.7	139.3	153.5	164.1	173.3	180.9	187.6	193.7	199.1	203.8	208.1	212.0
180	113.0	132.9	147.5	158.9	167.7	175.7	182.2	188.3	193.8	198.7	203.0	207.0
200		127.0	141.9	153.6	162.5	170.5	177.5	183.4	188.9	193.8	198.3	202.3
220		121.3	136.7	148.5	158.1	165.8	172.8	179.0	184.3	189.3	193.9	198.0
240		115.9	131.6	143.7	153.5	161.4	168.4	174.7	180.2	185.1	189.7	193.9
260		111.0	126.8	139.2	149.2	157.4	164.2	170.5	176.2	181.1	185.7	190.0
280			122.1	134.8	145.0	153.5	160.5	166.6	172.3	177.5	182.0	186.2
300			117.7	130.5	141.0	149.6	156.9	163.0	168.7	173.8	178.6	182.7

Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.

Table 2 of 4: OAT Adjustment

OAT (deg. C)	OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)							
	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
35 & BELOW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	–1.4	–1.5	–1.7	–1.9	–2.0	–2.2	–2.4	–2.5
38	–4.1	–4.6	–5.1	–5.6	–6.1	–6.6	–7.1	–7.6
40	–6.9	–7.7	–8.6	–9.4	–10.2	–11.1	–11.9	–12.7
42	–9.0	–10.2	–11.4	–12.6	–13.8	–14.9	–16.1	–17.3
44	–11.0	–12.6	–14.2	–15.7	–17.3	–18.8	–20.4	–21.9
46	–13.1	–15.0	–16.9	–18.9	–20.8	–22.7	–24.6	–26.6
48	–15.1	–17.4	–19.7	–22.0	–24.3	–26.6	–28.9	–31.2
50	–17.2	–19.9	–22.5	–25.2	–27.9	–30.5	–33.2	–35.8

Table 3 of 4: Pressure Altitude Adjustment

PRESS ALT (FT)	OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)							
	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
S.L.& BELOW	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	–5.8	–6.5	–7.3	–8.0	–8.7	–9.4	–10.1	–10.8
2000	–11.7	–13.1	–14.5	–15.9	–17.3	–18.7	–20.2	–21.6
3000	–16.3	–18.4	–20.5	–22.6	–24.8	–27.0	–29.2	–31.4
4000	–20.9	–23.8	–26.6	–29.4	–32.3	–35.3	–38.2	–41.2
5000	–24.0	–27.5	–31.0	–34.6	–38.2	–41.8	–45.4	–49.0
6000	–27.0	–31.2	–35.5	–39.7	–44.0	–48.2	–52.5	–56.7
7000	–31.2	–36.1	–41.0	–45.9	–50.9	–55.8	–60.7	–65.6
8000	–35.3	–40.9	–46.5	–52.1	–57.7	–63.3	–68.9	–74.5
9000	–40.1	–46.3	–52.5	–58.7	–64.9	–71.1	–77.3	–83.5
10000	–44.8	–51.6	–58.4	–65.2	–72.0	–78.8	–85.6	–92.5
11000	–47.0	–54.9	–62.8	–70.7	–78.6	–86.5	–94.4	–102.3
12000	–49.2	–58.2	–67.2	–76.2	–85.2	–94.2	–103.2	–112.2
13000	–53.3	–63.0	–72.8	–82.5	–92.2	–101.9	–111.6	–121.4
14000	–57.3	–67.8	–78.3	–88.8	–99.2	–109.6	–120.0	–130.5

Takeoff Obstacle Limit Weight

Flaps 15

Based on anti-ice off, five minute takeoff thrust time limit

Table 4 of 4: Wind Adjustment

WIND (KTS)	OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)							
	OAT AND ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
15 TW	–27.9	–27.2	–26.5	–25.8	–25.1	–24.4	–23.6	–22.9
10 TW	–18.6	–18.1	–17.7	–17.2	–16.7	–16.2	–15.8	–15.3
5 TW	–9.3	–9.1	–8.8	–8.6	–8.4	–8.1	–7.9	–7.6
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 HW	1.9	1.8	1.7	1.7	1.6	1.5	1.4	1.3
20 HW	3.7	3.6	3.5	3.4	3.2	3.0	2.8	2.6
30 HW	5.6	5.4	5.3	5.1	4.9	4.7	4.5	4.3
40 HW	7.4	7.2	7.0	6.9	6.7	6.5	6.3	6.1

Anti-Ice Adjustments

Pressure Altitude < 9000 FT

	OBSTACLE LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–250	–4700
ENGINE & WING ON	–250	–5450
ENGINE AUTO	–250	0
ENGINE & WING AUTO	–250	0

Pressure Altitude ≥ 9000 FT

	OBSTACLE LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1950	–3200	–3750
ENGINE & WING ON	–2550	–3900	–4650
ENGINE AUTO	–1950	–3200	0
ENGINE & WING AUTO	–2550	–3900	0

Fuel Jettison Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	FUEL JETTISON LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	212.4	207.0							
52	217.3	211.9							
50	235.6	216.8	189.8						
48	240.1	235.0	204.0						
46	244.2	239.8	208.6	181.9					
44	248.3	244.2	213.3	186.4					
42	252.4	248.1	217.9	191.0	174.4				
40	256.4	251.9	235.5	205.0	178.7				
38	258.5	255.7	239.1	209.5	183.1	166.2			
36	258.7	259.4	242.6	213.2	187.3	170.4			
34	258.8	261.3	246.1	216.4	200.9	174.4	157.0		
32	259.0	261.5	249.5	227.2	204.5	178.4	160.7		
30	259.2	261.6	251.1	236.3	207.4	182.3	164.4		
28	259.3	261.8	251.3	239.6	210.3	185.5	168.1		
26	259.5	261.9	251.4	241.1	213.3	188.2	171.6		
24	259.6	262.1	251.5	241.3	216.2	191.0	174.6	158.2	
22	259.7	262.2	251.7	241.4	217.6	202.8	177.1	161.5	
20	259.8	262.3	251.8	241.5	217.7	205.1	179.6	164.1	146.4
18	259.9	262.4	251.9	241.6	217.8	206.3	181.6	166.3	149.4
16	260.0	262.5	252.0	241.6	217.9	206.7	183.6	168.3	151.8
14	260.0	262.6	252.0	241.7	218.0	207.0	184.5	170.1	153.7
12	260.1	262.6	252.1	241.8	218.0	207.1	184.9	171.8	155.6
10	260.2	262.7	252.2	241.9	218.1	207.2	185.2	172.6	157.3
0	260.6	263.1	252.6	242.3	218.4	207.4	185.4	173.2	160.5
–10	261.0	263.4	252.9	242.7	221.8	207.6	185.6	173.4	160.9
–20	261.3	263.7	253.3	243.0	224.8	207.8	185.7	173.5	
–30	261.9	264.1	253.6	243.3	226.0	208.0	185.8		
–40	262.6	264.7	254.1	243.7	227.1	208.1			

Table valid for Zero Fuel Weight up to 181437 kg.

Anti-Ice Adjustments

Pressure Altitude ≤ 9000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4650	–4650
ENGINE & WING ON	–350	–5500	–5500

Pressure Altitude > 9000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3500
ENGINE & WING ON	–2100	–3700	–4300

DELETION

Long Range Cruise Maximum Operating Altitude
Max Climb Thrust
ISA + 10 deg. C and Below

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
260	31800	–4	34400*	34400*
250	32600	–6	35300*	35300*
240	33500	–8	36100*	36100*
230	34400	–10	36900*	36900*
220	35300	–12	37800*	37800*
210	36300	–14	38700*	38700*
200	37300	–14	39600*	39600*
190	38400	–14	40600*	40600*
180	39500	–14	41600*	41600*
170	40700	–14	42600*	42600*
160	41900	–14	43100	43100
150	43100	–14	43100	43100
140	43100	–14	43100	43100
130	43100	–14	43100	43100
120	43100	–14	43100	43100
110	43100	–14	43100	43100

*Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.

ISA + 15 deg. C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
260	31800	2	33500*	33500*
250	32600	0	34500*	34500*
240	33500	–2	35300*	35300*
230	34400	–4	36100*	36100*
220	35300	–6	37000*	37000*
210	36300	–8	37900*	37900*
200	37300	–8	38800*	38800*
190	38400	–8	39700*	39700*
180	39500	–8	40600*	40600*
170	40700	–8	41500*	41500*
160	41900	–8	42500*	42500*
150	43100	–8	43100	43100
140	43100	–8	43100	43100
130	43100	–8	43100	43100
120	43100	–8	43100	43100
110	43100	–8	43100	43100

*Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.

Long Range Cruise Maximum Operating Altitude
Max Climb Thrust
ISA + 20 deg. C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33°)	1.30 (39°)
260	31800	8	30600*	30600*
250	32600	6	32400*	32400*
240	33500	4	34100*	34100*
230	34400	2	35300*	35300*
220	35300	0	36100*	36100*
210	36300	–2	36900*	36900*
200	37300	–2	37700*	37700*
190	38400	–2	38600*	38600*
180	39500	–2	39500*	39500*
170	40700	–2	40400*	40400*
160	41900	–2	41300*	41300*
150	43100	–2	42200*	42200*
140	43100	–2	43100	43100
130	43100	–2	43100	43100
120	43100	–2	43100	43100
110	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) HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	AIR DISTANCE (NM) TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
1054	992	935	885	841	800	765	733	704	676	652
1575	1484	1401	1327	1261	1200	1149	1102	1058	1017	981
2095	1974	1865	1767	1680	1600	1533	1470	1412	1359	1310
2612	2463	2328	2208	2099	2000	1916	1839	1767	1700	1640
3128	2951	2790	2647	2518	2400	2301	2208	2122	2043	1970
3642	3438	3252	3086	2937	2800	2685	2578	2478	2386	2301
4154	3923	3713	3525	3356	3200	3069	2947	2833	2729	2633
4665	4408	4173	3963	3774	3600	3453	3316	3189	3072	2965
5174	4891	4632	4401	4192	4000	3837	3686	3545	3416	3297
5682	5373	5091	4839	4610	4400	4222	4056	3902	3759	3629
6188	5855	5549	5276	5028	4800	4607	4426	4258	4103	3961
6693	6335	6006	5712	5445	5200	4991	4796	4615	4447	4293
7197	6814	6462	6148	5863	5600	5376	5166	4971	4791	4626
7700	7292	6918	6583	6280	6000	5760	5536	5328	5135	4958
8100	7696	7324	6989	6683	6400	6145	5906	5684	5479	5291
8603	8174	7780	7424	7100	6800	6529	6276	6040	5823	5623
9106	8653	8236	7860	7517	7200	6913	6645	6396	6166	5955
9609	9131	8692	8296	7934	7600	7297	7015	6752	6510	6287
10112	9610	9148	8732	8352	8000	7682	7385	7109	6853	6619
10704	10154	9649	9195	8782	8400	8066	7755	7465	7197	6951

Table 2 of 3: Reference Fuel and Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	31		33		35		37		39	
	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)
800	9.2	2:00	9.1	1:57	9.0	1:54	8.9	1:51	8.8	1:49
1200	13.4	2:56	13.2	2:51	13.0	2:46	12.8	2:41	12.7	2:38
1600	17.7	3:51	17.3	3:44	17.0	3:38	16.8	3:31	16.6	3:27
2000	21.9	4:46	21.5	4:37	21.1	4:29	20.7	4:21	20.5	4:17
2400	26.3	5:39	25.8	5:29	25.3	5:19	24.9	5:10	24.6	5:06
2800	30.7	6:33	30.1	6:21	29.5	6:09	29.0	6:00	28.6	5:55
3200	35.2	7:26	34.5	7:12	33.8	6:59	33.2	6:49	32.8	6:44
3600	39.8	8:18	38.9	8:02	38.2	7:48	37.5	7:38	37.1	7:33
4000	44.4	9:10	43.4	8:53	42.5	8:38	41.8	8:27	41.4	8:23
4400	49.2	10:00	48.0	9:42	47.1	9:27	46.3	9:16	46.0	9:12
4800	53.9	10:51	52.7	10:32	51.6	10:16	50.8	10:05	50.5	10:02
5200	58.8	11:41	57.4	11:21	56.3	11:05	55.4	10:55		
5600	63.8	12:31	62.3	12:09	61.1	11:54	60.2	11:44		
6000	68.8	13:20	67.1	12:58	65.8	12:42	64.9	12:33		
6400	74.0	14:09	72.2	13:47	70.8	13:31	70.1	13:23		
6800	79.2	14:58	77.3	14:35	75.9	14:20	75.2	14:12		
7200	84.6	15:46	82.5	15:24	81.1	15:10				
7600	90.1	16:34	87.9	16:12	86.5	15:59				
8000	95.7	17:22	93.3	17:01	91.8	16:48				
8400	101.2	18:10	98.9	17:49	97.5	17:37				

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)					
	120	140	160	180	200	220
10	–1.5	–0.8	0.0	0.8	1.6	2.5
20	–2.9	–1.5	0.0	1.6	3.3	5.5
30	–4.4	–2.2	0.0	2.4	5.2	8.8
40	–5.9	–3.0	0.0	3.4	7.4	12.5
50	–7.4	–3.8	0.0	4.4	9.8	16.5
60	–9.0	–4.6	0.0	5.6	12.5	20.9
70	–10.6	–5.5	0.0	6.8	15.5	25.6
80	–12.3	–6.4	0.0	8.2	18.8	30.8
90	–14.0	–7.3	0.0	9.7	22.3	36.2
100	–15.8	–8.2	0.0	11.3	26.0	42.1
110	–17.5	–9.2	0.0	12.9	30.1	48.3
Based on 310/.85 climb, Long Range Cruise speed and .85/310/250 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
1042	983	930	882	839	800	764	732	702	675	649
1549	1464	1387	1319	1257	1200	1148	1101	1057	1017	980
2055	1944	1845	1755	1674	1600	1532	1470	1412	1359	1310
2560	2424	2302	2192	2092	2000	1916	1839	1768	1702	1641
3065	2904	2759	2628	2509	2400	2300	2208	2123	2045	1972
3570	3384	3216	3064	2926	2800	2684	2578	2479	2388	2303
4075	3864	3673	3501	3344	3200	3068	2947	2835	2731	2634
4579	4343	4130	3937	3761	3600	3452	3316	3191	3074	2966
5083	4822	4586	4373	4178	4000	3837	3686	3547	3418	3298
5586	5300	5042	4808	4595	4400	4221	4056	3903	3761	3629
6089	5779	5498	5244	5012	4800	4605	4425	4259	4105	3961
6592	6257	5954	5680	5429	5200	4989	4795	4615	4448	4293
7095	6735	6410	6115	5846	5600	5374	5165	4972	4792	4625
7597	7213	6866	6551	6263	6000	5758	5535	5328	5136	4958
8100	7691	7322	6986	6680	6400	6142	5904	5684	5480	5290
8602	8169	7778	7422	7097	6800	6527	6274	6041	5824	5622
9104	8647	8233	7857	7514	7200	6911	6644	6397	6168	5955
9606	9124	8689	8293	7931	7600	7295	7014	6754	6512	6287
10108	9602	9144	8728	8348	8000	7680	7384	7110	6856	6619
10610	10080	9600	9163	8765	8400	8064	7754	7467	7200	6952

Table 2 of 2: Trip Fuel and Time Required

AIR DIST (NM)	TRIP FUEL (1000 KG) LANDING WEIGHT (1000 KG)					TIME (HRS:MIN)
	120	140	160	180	200	
800	7.3	8.0	8.8	9.6	10.4	1:50
1200	10.4	11.5	12.6	13.9	15.0	2:40
1600	13.5	15.0	16.5	18.2	19.8	3:29
2000	16.7	18.5	20.5	22.5	24.6	4:19
2400	20.0	22.1	24.5	27.0	29.6	5:08
2800	23.3	25.8	28.7	31.5	34.6	5:58
3200	26.6	29.5	32.9	36.1	39.8	6:47
3600	30.0	33.4	37.1	40.9	45.1	7:36
4000	33.5	37.3	41.5	45.8	50.5	8:25
4400	37.0	41.2	45.9	50.8	56.0	9:14
4800	40.6	45.3	50.4	55.8	61.7	10:03
5200	44.3	49.5	55.0	61.0	67.4	10:52
5600	48.0	53.7	59.8	66.3	73.3	11:41
6000	51.8	58.0	64.6	71.8	79.3	12:29
6400	55.6	62.3	69.6	77.3	85.5	13:18
6800	59.6	66.8	74.6	83.0	91.8	14:07
7200	63.6	71.3	79.8	88.8	98.3	14:56
7600	67.7	75.9	85.1	94.8	104.8	15:44
8000	71.9	80.7	90.5	100.8	111.5	16:33
8400	76.2	85.6	96.0	107.0	118.4	17:21

Based on 310/.85 climb, Long Range Cruise speed and .85/310/250 descent.
Valid for all pressure altitudes with 4,000 ft step climb to 2,000 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
97	82	71	62	55	50	46	42	39	36	34
161	143	129	118	108	100	93	87	82	77	73
225	204	187	173	161	150	141	132	125	118	113
288	265	245	228	213	200	188	178	169	161	153
350	324	302	282	265	250	237	224	213	204	195
411	383	358	336	317	300	285	271	258	247	236
472	441	414	390	369	350	333	317	303	290	278
533	500	470	444	421	400	381	364	348	333	320
595	559	527	499	473	450	429	410	393	377	362
657	618	584	553	525	500	477	456	437	420	404
721	679	641	608	577	550	525	502	482	462	445
786	740	699	663	630	600	573	548	525	504	485

Table 2 of 2: Trip Fuel and Time Required

AIR DISTANCE (NM)		LANDING WEIGHT (1000 KG) 120	140	160	180	200	TIME (HRS:MIN)
50	FUEL (1000 KG) ALT (FT)	1.0 11000	1.1 11000	1.2 11000	1.4 9000	1.4 9000	0:14
100	FUEL (1000 KG) ALT (FT)	1.6 15000	1.8 15000	1.9 13000	2.0 13000	2.2 13000	0:23
150	FUEL (1000 KG) ALT (FT)	2.2 21000	2.4 21000	2.5 19000	2.7 19000	2.9 19000	0:30
200	FUEL (1000 KG) ALT (FT)	2.7 27000	2.9 25000	3.1 25000	3.3 25000	3.5 23000	0:37
250	FUEL (1000 KG) ALT (FT)	3.1 35000	3.4 31000	3.6 29000	3.9 29000	4.2 27000	0:43
300	FUEL (1000 KG) ALT (FT)	3.5 41000	3.8 37000	4.1 31000	4.4 31000	4.8 29000	0:48
350	FUEL (1000 KG) ALT (FT)	3.9 43000	4.2 41000	4.6 39000	5.0 37000	5.3 33000	0:54
400	FUEL (1000 KG) ALT (FT)	4.2 43000	4.7 43000	5.1 39000	5.5 37000	5.9 35000	0:59
450	FUEL (1000 KG) ALT (FT)	4.6 43000	5.1 43000	5.5 41000	6.0 39000	6.5 35000	1:05
500	FUEL (1000 KG) ALT (FT)	5.0 43000	5.5 43000	6.0 41000	6.5 39000	7.0 37000	1:11
550	FUEL (1000 KG) ALT (FT)	5.3 43000	5.9 43000	6.5 41000	7.0 39000	7.6 37000	1:17
600	FUEL (1000 KG) ALT (FT)	5.7 43000	6.3 43000	6.9 41000	7.5 39000	8.2 37000	1:25

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
260	6330	6260	6190	6130	6180	6540	6820	7370		
240	5920	5840	5750	5680	5710	5830	6140	6530		
220	5470	5380	5280	5210	5240	5260	5460	5760		
200	5020	4910	4810	4730	4750	4710	4860	5090	5600	
180	4590	4470	4360	4280	4280	4220	4270	4470	4840	
160	4180	4060	3940	3860	3840	3770	3790	3900	4180	4440
140	3790	3670	3540	3460	3410	3330	3330	3370	3560	3730
120	3720	3590	3190	3110	3040	2940	2930	2940	3060	3160
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
260	6780	6740	6710	6710	6770
240	6300	6240	6220	6190	6280
220	5790	5700	5680	5640	5750
200	5280	5150	5130	5090	5180
180	4800	4640	4590	4570	4620
160	4330	4170	4070	4060	4080
140	3900	3740	3600	3580	3570
120	3790	3370	3220	3150	3120
Includes 5% additional fuel for holding in a race track pattern.					

Crew Oxygen Requirements

Table 1 of 5

NUMBER OF CREW	OXYGEN REQUIRED (LITERS)
2	660
3	990
4	1320

Table 2 of 5

NUMBER OF CREW	OXYGEN REQUIRED FOR LEVEL OFF AT 14000 FT (LITERS)			
	TOTAL POST DECOMPRESSION TIME (HR)			
	2	3	4	5
2	660	960	1270	1570
3	980	1440	1900	2360
4	1310	1920	2530	3140

Table 3 of 5

NUMBER OF CREW	ADDITIONAL LITERS REQUIRED FOR EACH MINUTE HELD AT INTERMEDIATE ALTITUDE OTHER THAN 14000 FT				
	INTERMEDIATE PRESSURE ALTITUDE (FT)				
	UP TO 13999	14000	14001 TO 17999	18000 TO 21999	22000 TO 29000
	REGULATOR ON "NORMAL" OR (100%)				
2	0 (22)	0 (17)	1 (16)	3 (12)	6 (10)
3	0 (33)	0 (25)	2 (24)	5 (18)	8 (15)
4	0 (44)	0 (34)	2 (32)	6 (24)	11 (20)

For more extensive than normal crew usage, add 2.05 liters/person/minute for each crew member at 6,000 ft cabin altitude when regulator setting is NORMAL or 13 liters/person/minute when regulator setting is 100%.

Instructions:

1. Determine protective breathing requirements from Table 1.
2. Determine supplemental requirements for level off at 14,000 ft from Table 2 and correct for level off altitudes other than 14,000 ft using Table 3.
3. Flight crew system oxygen requirement is the larger of protective breathing (Table 1) and supplemental breathing (Tables 2 and 3) requirements.

Crew Oxygen Requirements

Cylinder Volume to Pressure Conversion

Table 4(a) of 5: One 115 Cubic Ft. Cylinder

OXYGEN VOLUME (1000 LITERS)	CYLINDER PRESSURE AT 21 deg. C (PSI)
0.1	200
0.3	300
0.5	400
0.7	500
0.8	600
1.0	700
1.2	800
1.4	900
1.5	1000
1.7	1100
1.9	1200
2.1	1300
2.2	1400
2.4	1500
2.6	1600
2.7	1700
2.9	1800
3.1	1900
3.3	2000
Check maximum pressure in shaded area. Maximum cylinder pressure = 1,850 PSI at 21 deg. C. Adjust maximum cylinder pressure by +32 PSI/–32 PSI for every 5 deg. C above/below 21 deg. C.	

Table 4(b) of 5: Two 115 Cubic Ft. Cylinders

OXYGEN VOLUME (1000 LITERS)	CYLINDER PRESSURE AT 21 deg. C (PSI)
0.3	200
0.7	300
1.0	400
1.4	500
1.7	600
2.1	700
2.4	800
2.8	900
3.1	1000
3.5	1100
3.8	1200
4.2	1300
4.5	1400
4.9	1500
5.2	1600
5.5	1700
5.9	1800
6.2	1900
6.6	2000
Check maximum pressure in shaded area. Maximum cylinder pressure = 1,850 PSI at 21 deg. C. Adjust maximum cylinder pressure by +32 PSI/–32 PSI for every 5 deg. C above/below 21 deg. C.	

Table 5 of 5: Temperature Corrections

CYLINDER PRESSURE AT 21 deg. C (PSI)	PRESSURE CORRECTION FOR EACH 5 deg. C ABOVE/BELOW 21 deg. C (PSI)
400	7/–7
600	11/–11
800	14/–14
1000	17/–17
1200	21/–21
1400	24/–24
1600	28/–28
1800	31/–31
2000	34/–34

ENGINE INOP

MAX CONTINUOUS THRUST

Net Level Off Weight

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 KG)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
30	126.4	120.3	116.0
28	137.7	130.0	125.2
26	149.8	140.3	134.7
24	159.9	152.2	146.1
22	170.0	164.8	158.1
20	183.2	178.2	170.7
18	194.4	187.9	179.6
16	209.0	199.5	190.4
14	223.8	211.3	201.5
12	238.7	223.2	212.7
10	246.5	235.2	224.4
8	257.7	245.7	234.3
6	268.0	254.2	242.5

Anti-Ice Adjustment

For TAT≤10 deg. C

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 ON	0.0	0.0	–2.1	–2.5	–2.5	–2.6	–2.7	–2.7	–2.7	–0.4	–0.3	–0.3	–0.3
ENGINE & WING ON	0.0	0.0	–3.0	–3.5	–3.5	–3.7	–3.8	–4.0	–3.8	–0.5	–0.3	–0.3	–0.3

For 10 deg. C<TAT≤20 deg. C

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 ON	–2.9	–3.0	–3.0	–3.1	–3.1	–3.0	–2.8	–2.7	–2.7	–0.4	–0.3	–0.3	–0.3
ENGINE & WING ON	–4.0	–4.1	–4.2	–4.3	–4.3	–4.2	–4.0	–4.0	–3.8	–0.5	–0.3	–0.3	–0.3

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
1200		1000	1100	1200	1250	1300	1350	1400
1400	1050	1160	1280	1400	1450	1510	1570	1630
1600	1200	1330	1460	1600	1660	1730	1800	1870
1800	1350	1500	1650	1800	1870	1950	2030	2100
2000	1500	1660	1830	2000	2080	2170	2250	2340
2200	1650	1830	2010	2200	2290	2390	2480	2580
2400	1800	2000	2200	2400	2500	2600	2710	2810
2600	1950	2160	2380	2600	2710	2820	2940	3050
2800	2100	2330	2560	2800	2920	3040	3160	3290
3000	2250	2500	2750	3000	3130	3260	3390	3520
3200	2400	2660	2930	3200	3340	3480	3620	3760
3400	2550	2830	3110	3400	3550	3700	3850	4000
3600	2700	3000	3300	3600	3750	3910	4070	4230
3800	2850	3160	3480	3800	3960	4130	4300	4470
4000	3000	3330	3660	4000	4170	4350	4530	4700
4200	3150	3500	3850	4200	4380	4570	4750	4940
4400	3300	3660	4030	4400	4590	4790	4980	5180
4600	3450	3830	4210	4600	4800	5000	5210	5410
4800	3600	4000	4400	4800	5010	5220	5440	5650
5000	3750	4160	4580	5000	5220	5440	5660	5890

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE (FT)							
	0	2000	4000	6000	8000	10000	12000	14000
1400	145.1	136.7	126.0	115.8				
1600	170.2	161.4	152.9	143.7	134.3	123.3		
1800	194.3	184.1	174.4	165.0	156.0	146.8	137.5	126.6
2000	217.9	207.1	196.0	185.4	175.3	165.6	156.4	147.0
2200	237.2	227.7	217.3	206.0	194.6	183.7	173.4	163.7
2400	252.4	241.4	233.2	224.6	213.9	201.9	190.5	179.7
2600	264.6	255.8	244.3	235.8	227.4	219.2	207.6	195.8
2800	269.8	266.6	257.6	245.9	237.1	228.6	220.4	212.0
3000		269.8	267.5	258.2	246.4	237.5	228.9	220.6
3200			269.8	267.3	257.9	246.0	237.0	228.3
3400				269.8	266.2	256.7	244.6	235.7
3600					269.8	264.3	254.7	242.6
3800						269.8	261.6	251.3
4000							268.3	258.5
4200							269.8	264.6
4400								269.8

With manual speedbrakes, decrease weight by 16,350 kg.
With 1 brake deactivated, decrease weight by 20,750 kg.
With 2 brakes deactivated, decrease weight by 42,850 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
1200		1000	1100	1200	1250	1300	1350	1400
1400	1050	1160	1280	1400	1450	1510	1570	1630
1600	1200	1330	1460	1600	1660	1730	1800	1870
1800	1350	1500	1650	1800	1870	1950	2030	2100
2000	1500	1660	1830	2000	2080	2170	2250	2340
2200	1650	1830	2010	2200	2290	2390	2480	2580
2400	1800	2000	2200	2400	2500	2600	2710	2810
2600	1950	2160	2380	2600	2710	2820	2940	3050
2800	2100	2330	2560	2800	2920	3040	3160	3290
3000	2250	2500	2750	3000	3130	3260	3390	3520
3200	2400	2660	2930	3200	3340	3480	3620	3760
3400	2550	2830	3110	3400	3550	3700	3850	4000
3600	2700	3000	3300	3600	3750	3910	4070	4230
3800	2850	3160	3480	3800	3960	4130	4300	4470
4000	3000	3330	3660	4000	4170	4350	4530	4700
4200	3150	3500	3850	4200	4380	4570	4750	4940
4400	3300	3660	4030	4400	4590	4790	4980	5180
4600	3450	3830	4210	4600	4800	5000	5210	5410
4800	3600	4000	4400	4800	5010	5220	5440	5650
5000	3750	4160	4580	5000	5220	5440	5660	5890

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE (FT)							
	0	2000	4000	6000	8000	10000	12000	14000
1400	115.5							
1600	144.0	135.4	124.6	114.6				
1800	166.0	157.4	148.8	139.7	129.3	118.8		
2000	186.9	177.2	167.9	158.8	149.9	140.5	130.3	119.7
2200	207.9	197.0	186.6	176.5	166.9	157.7	148.5	139.0
2400	226.9	216.7	205.5	194.4	183.7	173.5	163.8	154.7
2600	241.1	233.0	222.9	212.2	200.5	189.3	178.6	168.6
2800	254.9	243.4	235.1	227.0	216.8	205.1	193.5	182.5
3000	265.1	256.3	244.7	236.2	227.8	219.7	208.4	196.5
3200	269.8	265.7	256.7	245.0	236.3	227.8	219.6	210.6
3400		269.8	265.4	256.2	244.4	235.6	227.1	218.8
3600			269.8	264.2	254.9	243.0	234.2	225.7
3800				269.8	262.3	252.8	241.0	232.2
4000					269.3	259.7	248.0	238.4
4200					269.8	266.2	256.5	244.5
4400						269.8	262.5	252.9
4600							268.3	258.5
4800								263.9
5000								269.0

With manual speedbrakes, decrease weight by 16,350 kg.
With 1 brake deactivated, decrease weight by 20,750 kg.
With 2 brakes deactivated, decrease weight by 42,850 kg.

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	LANDING CLIMB LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	200.9	195.6							
52	205.8	200.4							
50	210.7	205.2	187.9						
48	215.2	210.1	192.6						
46	219.2	214.8	197.2	180.0					
44	223.3	219.2	201.8	184.5					
42	227.3	223.0	206.4	189.0	172.5				
40	231.3	226.8	210.5	193.6	176.8				
38	233.4	230.6	214.1	198.0	181.2	164.3			
36	233.6	234.3	217.6	201.8	185.4	168.5			
34	233.7	236.2	221.0	204.9	189.5	172.6	155.1		
32	233.9	236.3	224.4	208.1	193.0	176.5	158.9		
30	234.1	236.5	226.1	211.4	196.0	180.4	162.6		
28	234.2	236.6	226.2	214.6	198.9	183.6	166.2		
26	234.3	236.8	226.3	216.2	201.8	186.3	169.7		
24	234.4	236.9	226.5	216.3	204.7	189.0	172.7	156.3	
22	234.6	237.0	226.6	216.4	206.1	191.4	175.3	159.7	
20	234.7	237.1	226.7	216.5	206.2	193.7	177.7	162.3	144.5
18	234.8	237.2	226.8	216.6	206.3	194.8	179.8	164.4	147.6
16	234.8	237.3	226.9	216.7	206.4	195.2	181.7	166.4	149.9
14	234.9	237.4	227.0	216.7	206.4	195.6	182.6	168.2	151.9
12	235.0	237.5	227.1	216.8	206.5	195.6	183.0	169.9	153.7
10	235.1	237.6	227.2	216.9	206.6	195.7	183.3	170.7	155.4
0	235.5	237.9	227.5	217.3	206.9	195.9	183.5	171.3	158.6
–10	235.8	238.2	227.9	217.7	207.2	196.1	183.6	171.5	159.1
–20	236.2	238.5	228.2	218.0	207.5	196.3	183.8	171.6	
–30	236.8	238.9	228.5	218.4	207.8	196.5	183.9		
–40	237.5	239.5	229.0	218.7	208.1	196.7			

When operating in icing conditions during any part of the flight with forecast landing temperatures at or below 10 deg. C, decrease weight by 17,100 kg.

Anti-Ice Adjustments

Pressure Altitude ≤ 9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4650	–4650
ENGINE & WING ON	–350	–5500	–5500

Pressure Altitude > 9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3500
ENGINE & WING ON	–2100	–3700	–4300

ENGINE INOP

Go-Around Climb Gradient
Flaps 20, Gear Up
Based on anti-ice off

Table 1 of 3: Reference Go-Around Gradient (%)

AIRPORT OAT (deg. C)	REFERENCE GO-AROUND GRADIENT (%) PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	2.74	2.43	1.43						
50	3.29	2.99	1.97	0.98					
46	3.81	3.53	2.52	1.50	0.56				
42	4.29	4.04	3.04	2.04	1.06	0.12			
38	4.60	4.50	3.51	2.53	1.58	0.58			
34	4.67	4.80	3.92	2.97	2.04	1.06	0.05		
30	4.68	4.86	4.19	3.34	2.45	1.50	0.49		
26	4.70	4.87	4.25	3.60	2.78	1.88	0.88		
22	4.71	4.88	4.26	3.65	3.00	2.18	1.24	0.29	
18	4.72	4.90	4.27	3.65	3.04	2.36	1.51	0.60	
14	4.73	4.91	4.28	3.66	3.05	2.42	1.66	0.83	
10	4.75	4.92	4.29	3.67	3.05	2.43	1.71	0.97	0.10
8	4.75	4.93	4.30	3.68	3.06	2.43	1.71	1.00	0.17
6	4.76	4.93	4.30	3.68	3.06	2.43	1.72	1.01	0.23
4	4.77	4.94	4.31	3.69	3.07	2.43	1.72	1.01	0.25
2	4.77	4.94	4.31	3.69	3.07	2.44	1.72	1.01	0.27
0	4.78	4.95	4.32	3.70	3.07	2.44	1.72	1.01	0.29

Table 2 of 3: Weight Adjustment

WEIGHT (1000 KG)	REFERENCE GO-AROUND GRADIENT (%)							
	0	1	2	3	4	5	6	7
240	–1.83	–2.06	–2.29	–2.51	–2.71	–2.90	–3.09	–3.26
230	–1.56	–1.76	–1.95	–2.13	–2.30	–2.46	–2.61	–2.75
220	–1.24	–1.40	–1.54	–1.68	–1.81	–1.94	–2.06	–2.17
210	–0.87	–0.98	–1.08	–1.17	–1.27	–1.36	–1.44	–1.52
200	–0.46	–0.51	–0.56	–0.61	–0.66	–0.71	–0.76	–0.80
190	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180	0.48	0.53	0.59	0.66	0.72	0.80	0.87	0.96
170	1.03	1.15	1.27	1.41	1.55	1.71	1.88	2.05
160	1.65	1.84	2.04	2.26	2.49	2.74	3.00	3.28
150	2.32	2.61	2.90	3.22	3.54	3.89	4.24	4.62
140	3.13	3.53	3.94	4.37	4.81	5.26	5.72	6.20
130	4.14	4.68	5.23	5.79	6.37	6.95	7.55	8.17
120	5.26	5.94	6.64	7.35	8.08	8.83	9.60	10.38

Table 3 of 3: Speed Adjustment

SPEED (KIAS)	WEIGHT ADJUSTED GO-AROUND GRADIENT (%)										
	–2	1	0	1	2	3	4	5	6	7	8
VREF30	–0.11	–0.12	–0.13	–0.13	–0.13	–0.13	–0.13	–0.13	–0.13	–0.12	–0.12
VREF30+5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VREF30+10	0.04	0.04	0.03	0.01	0.00	–0.02	–0.04	–0.06	–0.08	–0.10	–0.12
VREF30+15	0.04	0.01	–0.02	–0.05	–0.08	–0.11	–0.15	–0.18	–0.21	–0.24	–0.27
VREF30+20	–0.01	–0.06	–0.11	–0.16	–0.21	–0.26	–0.31	–0.35	–0.39	–0.43	–0.46
VREF30+25	–0.07	–0.15	–0.23	–0.31	–0.38	–0.45	–0.51	–0.57	–0.63	–0.68	–0.72
VREF30+30	–0.13	–0.24	–0.35	–0.46	–0.56	–0.66	–0.76	–0.85	–0.94	–1.01	–1.08
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10 deg. C, decrease gradient by 0.9%											

ENGINE INOP

Go-Around Climb Gradient
Flaps 20, Gear Up
Based on anti-ice off
Anti-Ice Adjustment

	GO-AROUND CLIMB GRADIENT ADJUSTMENT (%)	
ANTI-ICE CONFIGURATION	OAT≤8 deg. C	8 deg. C<OAT≤20 deg. C
ENGINE ON	–0.2	–0.3
ENGINE & WING ON	–0.2	–0.3

Flaps 5, Gear Up
Based on anti-ice off
Table 1 of 3: Reference Go-Around Gradient (%)

AIRPORT OAT (deg. C)	REFERENCE GO-AROUND GRADIENT (%)								
	PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	3.86	3.54	2.52						
50	4.41	4.11	3.07	2.06					
46	4.93	4.65	3.62	2.58	1.65				
42	5.41	5.15	4.14	3.13	2.14	1.21			
38	5.72	5.61	4.62	3.63	2.66	1.67	0.72		
34	5.79	5.90	5.03	4.07	3.13	2.15	1.15		
30	5.80	5.97	5.30	4.45	3.54	2.58	1.58		
26	5.81	5.98	5.35	4.70	3.89	2.97	1.98		
22	5.83	5.99	5.36	4.75	4.11	3.28	2.33	1.40	
18	5.84	6.00	5.37	4.76	4.15	3.46	2.60	1.71	0.72
14	5.85	6.01	5.38	4.77	4.16	3.52	2.76	1.94	1.01
10	5.86	6.02	5.40	4.78	4.17	3.53	2.81	2.08	1.22
8	5.87	6.03	5.40	4.78	4.17	3.53	2.81	2.10	1.29
6	5.88	6.04	5.41	4.79	4.17	3.54	2.82	2.12	1.35
4	5.88	6.04	5.41	4.79	4.18	3.54	2.82	2.12	1.37
2	5.89	6.05	5.42	4.80	4.18	3.54	2.82	2.12	1.38
0	5.89	6.05	5.42	4.80	4.19	3.55	2.82	2.13	1.41

Table 2 of 3: Weight Adjustment

WEIGHT (1000 KG)	REFERENCE GO-AROUND GRADIENT (%)							
	0	1	2	3	4	5	6	7
240	–1.53	–1.80	–2.06	–2.30	–2.53	–2.74	–2.93	–3.11
230	–1.31	–1.53	–1.74	–1.94	–2.13	–2.30	–2.46	–2.61
220	–1.04	–1.22	–1.38	–1.54	–1.68	–1.81	–1.94	–2.05
210	–0.73	–0.85	–0.97	–1.07	–1.17	–1.27	–1.35	–1.43
200	–0.38	–0.45	–0.51	–0.56	–0.61	–0.66	–0.71	–0.74
190	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
180	0.40	0.46	0.53	0.59	0.65	0.72	0.78	0.85
170	0.89	1.00	1.13	1.26	1.40	1.54	1.69	1.85
160	1.43	1.61	1.81	2.01	2.24	2.47	2.72	2.98
150	2.00	2.28	2.57	2.88	3.19	3.52	3.86	4.21
140	2.68	3.08	3.49	3.91	4.34	4.78	5.23	5.68
130	3.53	4.06	4.61	5.17	5.75	6.33	6.92	7.52
120	4.48	5.16	5.85	6.56	7.29	8.04	8.80	9.58

ENGINE INOP

Go-Around Climb Gradient
Flaps 5, Gear Up
Based on anti-ice off
Table 3 of 3: Speed Adjustment

SPEED (KIAS)	WEIGHT ADJUSTED GO-AROUND GRADIENT (%)										
	–2	1	0	1	2	3	4	5	6	7	8
VREF25	–0.45	–0.46	–0.47	–0.48	–0.49	–0.49	–0.50	–0.50	–0.50	–0.50	–0.50
VREF25+5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VREF25+10	0.09	0.09	0.09	0.09	0.09	0.09	0.08	0.08	0.08	0.08	0.08
VREF25+15	0.17	0.16	0.16	0.15	0.15	0.15	0.14	0.14	0.14	0.14	0.13
VREF25+20	0.24	0.22	0.20	0.19	0.18	0.17	0.17	0.16	0.16	0.15	0.14
VREF25+25	0.28	0.25	0.23	0.21	0.19	0.17	0.16	0.14	0.13	0.12	0.10
VREF25+30	0.31	0.27	0.24	0.21	0.18	0.14	0.11	0.08	0.05	0.02	–0.01
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10 deg. C, decrease gradient by 0.8%											

Anti-Ice Adjustment

	GO-AROUND CLIMB GRADIENT ADJUSTMENT (%)	
ANTI-ICE CONFIGURATION	**OAT≤8 deg. C**	**8 deg. C<OAT≤20 deg. C**
ENGINE ON	–0.2	–0.3
ENGINE & WING ON	–0.3	–0.3

Quick Turnaround Limit Weight

Flaps 30 Limit Weight (1000 KG)

AIRPORT OAT (deg. C)	AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	199.7	192.6							
50	201.0	193.8	186.7						
45	202.6	195.3	188.2	181.2					
40	204.2	196.9	189.7	182.7	175.8				
35	205.9	198.5	191.3	184.2	177.2	170.4			
30	207.6	200.2	192.9	185.7	178.7	171.8	165.1		
25	209.4	201.8	194.5	187.3	180.2	173.2	166.5	159.8	
20	211.2	203.5	196.2	188.9	181.7	174.7	167.9	161.2	154.7
15	213.0	205.3	197.8	190.5	183.3	176.2	169.4	162.6	156.1
10	214.9	207.1	199.6	192.2	184.9	177.7	170.8	164.1	157.5
5	216.9	209.0	201.4	193.9	186.6	179.3	172.4	165.6	158.9
0	218.9	210.9	203.2	195.7	188.3	181.0	173.9	167.1	160.4
–5	220.9	212.9	205.1	197.5	190.0	182.7	175.5	168.7	161.9
–10	223.1	214.9	207.0	199.4	191.8	184.4	177.2	170.3	163.4
–15	225.3	217.0	209.1	201.3	193.7	186.2	178.9	171.9	165.0
–20	227.5	219.2	211.1	203.3	195.6	188.1	180.7	173.6	
–25	229.8	221.4	213.3	205.3	197.5	190.0	182.5	175.3	
–30	232.2	223.7	215.5	207.4	199.6	191.9	184.4		
–35	234.7	226.1	217.8	209.6	201.6	193.9	186.3		
–40	237.3	228.6	220.1	211.9	203.8	196.0			
–45	240.0	231.1	222.6	214.2	206.0	198.1			
–50	242.8	233.7	225.1	216.6	208.3				
–54	245.1	235.9	227.2	218.6	210.3				

Increase weight by 1,700 kg per 1% uphill slope. Decrease weight by 3,200 kg per 1% downhill slope. Increase weight by 4,300 kg per 10 knots headwind. Decrease weight by 24,450 kg per 10 knots tailwind. Decrease weight by 14,950 kg with one brake deactivated. Decrease weight by 30.600 kg with two brakes deactivated.

Use one of the following methods:

1. **After landing at weights exceeding those shown above, adjusted for slope, wind, and deactivated brakes, wait at least 65 minutes after landing and check that wheel thermal plugs have not melted before making a subsequent takeoff.**
2. **No sooner than 10 minutes after parking, check for the BRAKE TEMP advisory message on EICAS. If the message is not displayed, no waiting period is required. If it is displayed, do not dispatch until the BRAKE TEMP message is no longer displayed. Check that wheel thermal plugs have not melted before making a subsequent takeoff.**

If any brake temperature display digit is blank or the BRAKE TEMP SYS status message is displayed, the Maximum Quick Turnaround Weight method, Method 1, must be used.

GEAR DOWN

Takeoff Field Corrections—Dry Runway

Table 1 of 3: Slope Correction

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
1400	1430	1420	1420	1410	1400	1380	1350	1330	1300
1600	1650	1640	1630	1610	1600	1560	1530	1490	1450
1800	1870	1850	1840	1820	1800	1750	1700	1650	1600
2000	2090	2070	2050	2020	2000	1940	1880	1810	1750
2200	2310	2280	2260	2230	2200	2130	2050	1980	1900
2400	2530	2500	2470	2430	2400	2310	2230	2140	2050
2600	2750	2710	2680	2640	2600	2500	2400	2300	2200
2800	2970	2930	2890	2840	2800	2690	2580	2460	2350
3000	3190	3140	3100	3050	3000	2880	2750	2630	2500
3200	3410	3360	3310	3250	3200	3060	2930	2790	2650
3400	3630	3570	3520	3460	3400	3250	3100	2950	2800
3600	3850	3790	3730	3660	3600	3440	3280	3110	2950
3800	4070	4000	3940	3870	3800	3630	3450	3280	3100
4000	4290	4220	4150	4070	4000	3810	3630	3440	3250
4200	4510	4430	4360	4280	4200	4000	3800	3600	3400
4400	4730	4650	4570	4480	4400	4190	3980	3760	3550
4600	4950	4860	4780	4690	4600	4380	4150	3930	3700
4800	5170	5080	4990	4890	4800	4560	4330	4090	3850
5000	5390	5300	5200	5100	5000	4750	4500	4250	4000
5200	5610	5510	5410	5300	5200	4940	4680	4410	4150
5400	5830	5730	5620	5510	5400	5130	4850	4580	4300
5600	6050	5940	5830	5710	5600	5310	5030	4740	4450
5800	6270	6160	6040	5920	5800	5500	5200	4900	4600
6000	6490	6370	6250	6120	6000	5690	5380	5060	4750
6200	6710	6590	6460	6330	6200	5880	5550	5230	4900

Table 2 of 3: Wind Correction

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M) WIND COMPONENT (KTS)							
	–15	–10	–5	0	10	20	30	40
1400	420	750	1070	1400	1460	1530	1600	1670
1600	620	950	1270	1600	1670	1740	1820	1900
1800	830	1150	1480	1800	1870	1950	2040	2130
2000	1030	1350	1680	2000	2080	2170	2260	2360
2200	1230	1550	1880	2200	2280	2380	2480	2590
2400	1430	1750	2080	2400	2490	2590	2700	2820
2600	1630	1950	2280	2600	2690	2800	2920	3050
2800	1830	2150	2480	2800	2900	3010	3140	3280
3000	2030	2350	2680	3000	3100	3220	3360	3520
3200	2230	2550	2880	3200	3310	3440	3580	3750
3400	2430	2760	3080	3400	3510	3650	3800	3980
3600	2630	2960	3280	3600	3720	3860	4020	4210
3800	2830	3160	3480	3800	3920	4070	4240	4440
4000	3040	3360	3680	4000	4130	4280	4460	4670
4200	3240	3560	3880	4200	4330	4500	4680	4900
4400	3440	3760	4080	4400	4540	4710	4900	5130
4600	3640	3960	4280	4600	4740	4920	5120	5360
4800	3840	4160	4480	4800	4950	5130	5350	5590
5000	4040	4360	4680	5000	5150	5340	5570	5820
5200	4240	4560	4880	5200	5360	5550	5790	6050
5400	4440	4760	5080	5400	5560	5770	6010	6280
5600	4640	4960	5280	5600	5770	5980	6230	6520
5800	4840	5160	5480	5800	5970	6190	6450	6750

GEAR DOWN

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	192.7	176.4	174.6	173.3	172.1	170.9	169.7	168.5	167.3	160.7	149.0
1800	207.8	190.3	188.3	187.0	185.7	184.4	183.1	181.8	180.5	173.4	160.8
2000	220.7	202.8	200.8	199.5	198.1	196.8	195.5	194.2	192.8	185.6	172.7
2200	232.3	214.0	211.9	210.6	209.2	207.8	206.5	205.1	203.8	196.3	183.2
2400	243.2	224.4	222.3	220.8	219.4	218.0	216.6	215.3	213.9	206.2	192.7
2600	255.5	236.0	233.8	232.3	230.9	229.4	228.0	226.6	225.1	217.2	203.2
2800	265.2	245.1	242.8	241.3	239.7	238.2	236.8	235.3	233.8	225.6	211.1
3000	269.8	251.2	248.9	247.3	245.7	244.2	242.6	241.1	239.6	231.1	216.1
3200	269.8	257.5	255.2	253.6	252.0	250.4	248.9	247.3	245.8	237.2	222.1
3400	269.8	263.8	261.5	259.8	258.3	256.7	255.1	253.5	252.0	243.4	228.1
3600	269.8	269.8	267.7	266.1	264.5	262.8	261.3	259.7	258.1	249.3	233.8
3800	269.8	269.8	269.8	269.8	269.8	269.0	267.3	265.7	264.1	255.1	239.3
4000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	260.8	244.5
4200	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	266.4	249.6
4400	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	254.5
4600	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	259.2
4800	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	263.7
5000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.1
CLIMB LIMIT WT (1000 KG)	183.4	182.6	182.5	182.4	182.4	182.2	182.0	178.9	167.1	147.7	123.7

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2650
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–100

GEAR DOWN

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	179.7	166.1	164.3	163.1	161.8	160.6	159.4	158.2	157.1	148.1	
1800	193.8	179.2	177.2	175.9	174.6	173.3	172.0	170.7	169.5	159.9	
2000	206.4	191.5	189.5	188.2	186.8	185.5	184.2	182.9	181.6	171.8	
2200	217.7	202.4	200.4	199.0	197.6	196.3	194.9	193.6	192.3	182.3	P
2400	228.1	212.5	210.4	209.0	207.5	206.2	204.8	203.4	202.0	191.7	E
2600	239.9	223.7	221.5	220.0	218.6	217.1	215.7	214.3	212.9	202.2	R
2800	249.1	232.3	230.0	228.5	227.0	225.5	224.0	222.6	221.1	210.1	F
3000	255.4	238.0	235.7	234.1	232.6	231.0	229.5	228.0	226.5	215.0	
3200	261.7	244.2	241.8	240.3	238.7	237.1	235.6	234.0	232.5	221.0	L
3400	268.1	250.4	248.0	246.4	244.8	243.3	241.7	240.2	238.6	227.0	I
3600	269.8	256.5	254.1	252.5	250.8	249.2	247.7	246.1	244.5	232.7	M
3800	269.8	262.4	260.0	258.3	256.7	255.1	253.4	251.8	250.2	238.2	I
4000	269.8	268.3	265.8	264.1	262.4	260.7	259.1	257.4	255.8	243.4	T
4200	269.8	269.8	269.8	269.8	268.0	266.3	264.6	262.9	261.2	248.4	E
4400	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.2	266.5	253.3	D
4600	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	258.0	
4800	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	262.4	
5000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	266.7	
CLIMB LIMIT WT (1000 KG)	175.9	175.3	175.1	175.1	174.9	174.8	172.3	162.5	155.1	135.9	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2650
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–100

GEAR DOWN

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	168.4	155.7	153.9	152.7	151.5	150.4	149.3	148.1	145.1	135.3	
1800	181.6	168.0	166.1	164.8	163.5	162.3	161.1	159.9	156.6	146.1	
2000	194.0	180.1	178.1	176.8	175.5	174.3	173.0	171.8	168.4	157.7	
2200	205.0	190.7	188.7	187.4	186.1	184.8	183.5	182.2	178.8	167.9	P
2400	215.1	200.5	198.4	197.0	195.7	194.3	193.0	191.7	188.2	176.9	E
2600	226.4	211.2	209.1	207.6	206.3	204.9	203.5	202.2	198.5	186.9	R
2800	235.1	219.4	217.2	215.7	214.3	212.9	211.5	210.0	206.3	194.2	F
3000	240.9	224.7	222.4	220.9	219.4	217.9	216.5	215.0	211.1	198.7	
3200	247.1	230.8	228.4	226.9	225.4	223.9	222.5	221.0	217.1	204.5	L
3400	253.4	236.8	234.5	232.9	231.4	229.9	228.5	227.0	223.0	210.3	I
3600	259.5	242.7	240.3	238.8	237.2	235.7	234.2	232.7	228.7	215.8	M
3800	265.5	248.4	245.9	244.3	242.8	241.2	239.7	238.1	234.1	220.9	I
4000	269.8	253.9	251.4	249.7	248.1	246.5	245.0	243.4	239.2	225.6	T
4200	269.8	259.2	256.6	255.0	253.3	251.7	250.1	248.4	244.1	230.1	E
4400	269.8	264.4	261.8	260.0	258.3	256.6	255.0	253.3	248.8	234.4	D
4600	269.8	269.5	266.7	264.9	263.2	261.4	259.7	257.9	253.3	238.4	
4800	269.8	269.8	269.8	269.7	267.8	266.0	264.2	262.4	257.6	242.1	
5000	269.8	269.8	269.8	269.8	269.8	269.8	268.6	266.7	261.7	245.6	
CLIMB LIMIT WT (1000 KG)	166.8	166.4	166.3	166.3	166.2	164.2	156.1	148.6	141.2	118.8	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2650
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–100

GEAR DOWN

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	157.4	145.2	143.5	142.3	141.2	140.2	139.1	136.5	133.3		
1800	169.8	156.7	154.9	153.6	152.5	151.3	150.1	147.4	143.9		
2000	181.9	168.6	166.7	165.4	164.2	163.0	161.8	159.0	155.5		
2200	192.6	178.9	177.0	175.7	174.5	173.3	172.1	169.2	165.6	P	
2400	202.4	188.3	186.3	185.0	183.8	182.5	181.2	178.3	174.6	E	
2600	213.3	198.7	196.6	195.3	193.9	192.6	191.3	188.3	184.4	R	
2800	221.5	206.4	204.3	202.9	201.5	200.2	198.8	195.7	191.7	F	
3000	226.9	211.3	209.1	207.6	206.2	204.8	203.4	200.2	196.0		
3200	233.0	217.2	215.0	213.5	212.1	210.7	209.3	206.0	201.8	L	
3400	239.0	223.1	220.9	219.4	218.0	216.6	215.1	211.9	207.6	I	
3600	245.0	228.8	226.5	225.1	223.6	222.2	220.7	217.4	213.1	M	
3800	250.7	234.2	231.9	230.3	228.8	227.4	225.9	222.5	218.1	I	
4000	256.2	239.3	236.9	235.4	233.8	232.3	230.8	227.3	222.8	T	
4200	261.7	244.2	241.8	240.2	238.6	237.0	235.5	231.9	227.2	E	
4400	266.9	249.0	246.4	244.7	243.1	241.5	239.9	236.2	231.4	D	
4600	269.8	253.5	250.8	249.1	247.4	245.8	244.1	240.2	235.3		
4800	269.8	257.8	255.0	253.3	251.5	249.8	248.0	244.0	238.9		
5000	269.8	261.9	259.0	257.2	255.4	253.6	251.8	247.6	242.2		
CLIMB LIMIT WT (1000 KG)	157.6	157.4	157.3	157.3	155.5	148.6	141.5	133.9	125.5		

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2650
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–100

GEAR DOWN

Takeoff Field & Climb Limit Weights—Dry Runway
Flaps 15
Based on anti-ice off
Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
1600	146.5	134.9	133.3	132.3	131.2	130.0	127.7	124.8			
1800	158.1	145.6	143.9	142.8	141.7	140.3	137.9	134.7			
2000	170.0	157.2	155.5	154.3	153.2	151.8	149.3	146.1			
2200	180.4	167.4	165.6	164.4	163.2	161.8	159.3	156.0	P		
2400	189.8	176.4	174.6	173.4	172.2	170.7	168.1	164.7	E		
2600	200.2	186.3	184.4	183.2	181.9	180.4	177.7	174.2	R		
2800	208.0	193.7	191.7	190.4	189.1	187.6	184.7	181.1	F		
3000	212.9	198.1	196.1	194.7	193.4	191.8	188.8	185.1			
3200	218.9	203.9	201.8	200.5	199.1	197.5	194.6	190.8	L		
3400	224.8	209.7	207.6	206.3	204.9	203.3	200.3	196.5	I		
3600	230.5	215.2	213.1	211.7	210.3	208.7	205.6	201.8	M		
3800	235.9	220.3	218.1	216.7	215.3	213.6	210.5	206.6	I		
4000	241.1	225.0	222.8	221.4	219.9	218.2	215.0	211.0	T		
4200	246.1	229.5	227.2	225.8	224.3	222.5	219.2	215.0	E		
4400	250.8	233.8	231.4	229.9	228.3	226.5	223.1	218.8	D		
4600	255.4	237.7	235.3	233.7	232.1	230.2	226.7	222.3			
4800	259.8	241.4	238.9	237.3	235.6	233.6	230.0	225.4			
5000	264.0	244.9	242.3	240.6	238.8	236.7	233.0	228.2			
CLIMB LIMIT WT (1000 KG)	148.6	148.5	148.5	147.1	140.7	133.7	125.7	117.6			

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2650
ENGINE & WING ON	–200	–3100
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–100

GEAR DOWN

Takeoff Field Corrections—Wet Runway

Table 1 of 3: Slope Correction

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	1800	1800	1800	1800	1800	1760	1720	1680	1640
2000	2030	2020	2010	2010	2000	1950	1900	1860	1810
2200	2260	2250	2230	2220	2200	2140	2090	2030	1970
2400	2490	2470	2450	2420	2400	2340	2270	2210	2140
2600	2730	2700	2660	2630	2600	2530	2450	2380	2310
2800	2960	2920	2880	2840	2800	2720	2640	2560	2470
3000	3190	3140	3100	3050	3000	2910	2820	2730	2640
3200	3430	3370	3310	3260	3200	3100	3000	2910	2810
3400	3660	3590	3530	3460	3400	3290	3190	3080	2970
3600	3890	3820	3750	3670	3600	3490	3370	3260	3140
3800	4130	4040	3960	3880	3800	3680	3550	3430	3310
4000	4360	4270	4180	4090	4000	3870	3740	3610	3470
4200	4590	4490	4400	4300	4200	4060	3920	3780	3640
4400	4820	4720	4610	4510	4400	4250	4100	3960	3810
4600	5060	4940	4830	4710	4600	4440	4290	4130	3980
4800	5290	5170	5050	4920	4800	4640	4470	4310	4140
5000	5520	5390	5260	5130	5000	4830	4650	4480	4310
5200	5760	5620	5480	5340	5200	5020	4840	4660	4480
5400	5990	5840	5690	5550	5400	5210	5020	4830	4640
5600	6220	6070	5910	5760	5600	5400	5200	5010	4810
5800	6460	6290	6130	5960	5800	5590	5390	5180	4980

Table 2 of 3: Wind Correction

SLOPE CORR'D FIELD LENGTH (M)	SLOPE & WIND CORRECTED FIELD LENGTH (M)							
	WIND COMPONENT (KTS)							
	–15	–10	–5	0	10	20	30	40
1800	440	890	1350	1800	1890	1980	2070	2160
2000	660	1110	1550	2000	2100	2190	2290	2380
2200	890	1320	1760	2200	2300	2400	2500	2600
2400	1110	1540	1970	2400	2510	2610	2720	2820
2600	1330	1760	2180	2600	2710	2820	2930	3040
2800	1560	1970	2390	2800	2920	3030	3150	3260
3000	1780	2190	2590	3000	3120	3240	3360	3480
3200	2010	2400	2800	3200	3330	3450	3580	3700
3400	2230	2620	3010	3400	3530	3660	3790	3920
3600	2450	2840	3220	3600	3740	3870	4010	4140
3800	2680	3050	3430	3800	3940	4080	4220	4360
4000	2900	3270	3630	4000	4150	4290	4440	4580
4200	3130	3480	3840	4200	4350	4500	4650	4800
4400	3350	3700	4050	4400	4560	4710	4870	5020
4600	3580	3920	4260	4600	4760	4920	5080	5240
4800	3800	4130	4470	4800	4970	5130	5300	5460
5000	4020	4350	4670	5000	5170	5340	5510	5680
5200	4250	4570	4880	5200	5380	5550	5730	5900
5400	4470	4780	5090	5400	5580	5760	5940	6120
5600	4700	5000	5300	5600	5790	5970	6160	6340
5800	4920	5210	5510	5800	5990	6180	6370	6560

GEAR DOWN

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(a) of 3: Sea Level Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	221.1	201.7	199.5	198.0	196.6	195.2	193.8	192.3	190.9	183.4	170.8
2200	231.9	212.2	209.9	208.4	206.9	205.4	204.0	202.5	201.1	193.4	180.5
2400	242.4	222.0	219.6	218.1	216.6	215.1	213.6	212.1	210.6	202.6	189.4
2600	253.9	232.7	230.2	228.6	227.1	225.5	223.9	222.4	220.8	212.5	198.8
2800	263.8	241.8	239.2	237.6	235.9	234.3	232.7	231.1	229.5	220.9	206.6
3000	269.8	249.0	246.4	244.7	243.0	241.3	239.6	238.0	236.3	227.5	212.8
3200	269.8	256.4	253.7	251.9	250.2	248.4	246.7	245.0	243.3	234.1	218.9
3400	269.8	263.6	260.8	259.0	257.2	255.4	253.6	251.8	250.1	240.6	224.9
3600	269.8	269.8	267.6	265.7	263.9	262.0	260.2	258.4	256.6	246.8	230.6
3800	269.8	269.8	269.8	269.8	269.8	268.0	266.1	264.3	262.4	252.4	235.8
4000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	268.2	258.0	241.0
4200	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	263.6	246.2
4400	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.5	251.4
4600	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	256.7
4800	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	262.1
5000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	267.5
CLIMB LIMIT WT (1000 KG)	183.4	182.6	182.5	182.4	182.4	182.2	182.0	178.9	167.1	147.7	123.7

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–350

GEAR DOWN

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(b) of 3: 2000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	204.9	189.5	187.4	186.0	184.6	183.2	181.9	180.5	179.2	169.6	
2200	215.4	199.6	197.5	196.0	194.6	193.2	191.8	190.4	189.1	179.3	
2400	225.4	209.1	206.8	205.4	203.9	202.4	201.0	199.6	198.2	188.0	
2600	236.2	219.3	216.9	215.4	213.9	212.4	210.9	209.4	208.0	197.4	P
2800	245.4	227.9	225.4	223.8	222.3	220.7	219.2	217.6	216.1	205.2	E
3000	252.8	234.7	232.1	230.5	228.9	227.3	225.7	224.1	222.6	211.3	R
3200	260.3	241.6	239.0	237.3	235.6	233.9	232.3	230.7	229.1	217.4	F
3400	267.6	248.3	245.6	243.8	242.1	240.4	238.7	237.0	235.4	223.3	
3600	269.8	254.7	252.0	250.2	248.4	246.6	244.8	243.1	241.4	229.0	L
3800	269.8	260.5	257.7	255.8	254.0	252.2	250.4	248.6	246.9	234.2	I
4000	269.8	266.2	263.4	261.5	259.6	257.7	255.9	254.1	252.3	239.3	M
4200	269.8	269.8	269.2	267.3	265.3	263.4	261.5	259.7	257.8	244.4	I
4400	269.8	269.8	269.8	269.8	269.8	269.2	267.3	265.4	263.5	249.6	T
4600	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.2	254.9	E
4800	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	260.1	D
5000	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	269.8	265.5	
CLIMB LIMIT WT (1000 KG)	175.9	175.3	175.1	175.1	174.9	174.8	172.3	162.5	155.1	135.9	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–350

GEAR DOWN

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(c) of 3: 4000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	192.6	177.8	175.8	174.4	173.1	171.8	170.6	169.3	166.1	155.8	
2200	202.8	187.7	185.6	184.2	182.9	181.6	180.3	179.0	175.7	165.2	
2400	212.4	196.8	194.6	193.2	191.8	190.4	189.1	187.8	184.4	173.5	
2600	222.7	206.5	204.2	202.7	201.3	199.9	198.5	197.1	193.6	182.3	P
2800	231.4	214.6	212.3	210.7	209.2	207.8	206.3	204.9	201.2	189.5	E
3000	238.3	221.0	218.6	217.0	215.5	214.0	212.5	211.0	207.2	195.1	R
3200	245.4	227.4	224.9	223.3	221.7	220.1	218.6	217.1	213.2	200.7	F
3400	252.2	233.6	231.1	229.4	227.8	226.1	224.6	223.0	218.9	206.0	
3600	258.8	239.6	237.0	235.3	233.6	231.9	230.3	228.6	224.5	211.1	L
3800	264.6	245.1	242.4	240.6	238.9	237.2	235.5	233.8	229.6	216.0	I
4000	269.8	250.4	247.7	245.9	244.1	242.4	240.6	238.9	234.6	220.6	M
4200	269.8	255.9	253.1	251.2	249.4	247.6	245.8	244.1	239.6	225.3	I
4400	269.8	261.5	258.6	256.6	254.8	252.9	251.1	249.3	244.6	229.8	T
4600	269.8	267.2	264.1	262.1	260.2	258.3	256.4	254.5	249.7	234.3	E
4800	269.8	269.8	269.8	267.7	265.7	263.7	261.7	259.8	254.8	238.8	D
5000	269.8	269.8	269.8	269.8	269.8	269.2	267.1	265.1	259.8	243.2	
CLIMB LIMIT WT (1000 KG)	166.8	166.4	166.3	166.3	166.2	164.2	156.1	148.6	141.2	118.8	

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–350

GEAR DOWN

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(d) of 3: 6000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	180.3	166.3	164.3	163.1	161.9	160.7	159.5	156.8	153.4		
2200	190.2	175.9	173.9	172.7	171.4	170.2	169.0	166.2	162.7		
2400	199.4	184.6	182.5	181.2	179.9	178.7	177.4	174.6	170.9		
2600	209.2	193.8	191.7	190.3	189.0	187.7	186.3	183.4	179.6	P	
2800	217.4	201.5	199.3	197.9	196.5	195.1	193.7	190.7	186.8	E	
3000	223.9	207.4	205.2	203.7	202.3	200.9	199.5	196.3	192.3	R	
3200	230.4	213.4	211.1	209.5	208.1	206.6	205.2	201.9	197.7	F	
3400	236.7	219.2	216.8	215.2	213.7	212.2	210.7	207.3	203.0		
3600	242.8	224.7	222.2	220.6	219.0	217.5	215.9	212.5	208.0	L	
3800	248.3	229.8	227.3	225.6	224.0	222.4	220.9	217.3	212.8	I	
4000	253.8	234.8	232.2	230.6	228.9	227.3	225.7	222.0	217.4	M	
4200	259.4	239.9	237.2	235.5	233.8	232.1	230.4	226.7	221.9	I	
4400	265.1	244.9	242.1	240.4	238.6	236.9	235.2	231.3	226.3	T	
4600	269.8	250.0	247.1	245.3	243.4	241.7	239.9	235.9	230.7	E	
4800	269.8	255.0	252.1	250.2	248.3	246.4	244.5	240.4	235.0	D	
5000	269.8	260.1	257.0	255.0	253.1	251.1	249.2	244.8	239.3		
CLIMB LIMIT WT (1000 KG)	157.6	157.4	157.3	157.3	155.5	148.6	141.5	133.9	125.5		

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–350

GEAR DOWN

Takeoff Field & Climb Limit Weights—Wet Runway
Flaps 15
Based on anti-ice off
Table 3(e) of 3: 8000 FT Pressure Altitude

CORR'D FIELD LENGTH (M)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (deg. C)										
	–40	0	6	10	14	18	22	26	30	40	50
2000	168.3	155.1	153.3	152.2	151.0	149.6	147.2	144.1			
2200	177.9	164.5	162.7	161.5	160.3	158.9	156.4	153.3			
2400	186.7	172.8	170.9	169.7	168.5	167.0	164.5	161.2			
2600	196.0	181.5	179.6	178.3	177.0	175.5	172.9	169.5	P		
2800	203.7	188.8	186.7	185.4	184.1	182.6	179.8	176.3	E		
3000	209.8	194.3	192.3	190.9	189.6	188.0	185.1	181.5	R		
3200	215.8	199.8	197.7	196.3	194.9	193.2	190.3	186.5	F		
3400	221.7	205.1	202.9	201.5	200.0	198.3	195.3	191.4			
3600	227.3	210.3	208.0	206.5	205.0	203.2	200.1	196.1	L		
3800	232.5	215.1	212.7	211.2	209.7	207.9	204.6	200.6	I		
4000	237.5	219.7	217.3	215.7	214.2	212.3	209.1	204.9	M		
4200	242.7	224.3	221.8	220.2	218.6	216.7	213.3	209.1	I		
4400	247.8	228.8	226.3	224.6	223.0	221.0	217.5	213.1	T		
4600	253.0	233.3	230.7	229.0	227.3	225.2	221.6	217.0	E		
4800	258.2	237.7	235.0	233.2	231.4	229.3	225.5	220.7	D		
5000	263.4	242.1	239.2	237.3	235.5	233.3	229.3	224.4			
CLIMB LIMIT WT (1000 KG)	148.6	148.5	148.5	147.1	140.7	133.7	125.7	117.6			

Field Limit Weight Anti-Ice Adjustments

	FIELD LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–200	–2750
ENGINE & WING ON	–200	–3200
ENGINE AUTO	–200	0
ENGINE & WING AUTO	–200	0

Climb Limit Weight Anti-Ice Adjustments

	CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1350	–2700	–2900
ENGINE & WING ON	–1750	–3650	–4000
ENGINE AUTO	–350	–350	–350
ENGINE & WING AUTO	–350	–350	–350

GEAR DOWN

Takeoff Obstacle Limit Weight
Flaps 15
Based on anti-ice off, five minute takeoff thrust time limit
Table 1 of 4: Sea Level, 35 deg. 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
80	152.5											
100	143.7											
120	135.6	150.3	160.0	159.8	159.8	159.8	159.8	159.8	159.8	159.8	159.8	159.8
140	128.0	143.3	154.6	159.9	159.6	159.6	159.6	159.6	159.6	159.6	159.6	159.6
160	120.8	136.8	148.8	157.6	159.4	159.4	159.4	159.4	159.4	159.4	159.4	159.4
180	114.3	130.7	143.0	152.7	159.5	159.2	159.2	159.2	159.2	159.2	159.2	159.2
200		124.9	137.6	147.6	155.5	159.2	159.1	159.1	159.1	159.1	159.1	159.1
220		119.4	132.4	142.8	151.2	157.7	158.9	158.9	158.9	158.9	158.9	158.9
240		114.3	127.5	138.1	146.7	153.9	159.0	158.7	158.7	158.7	158.7	158.7
260			122.8	133.6	142.5	149.9	155.9	158.6	158.5	158.5	158.5	158.5
280			118.3	129.3	138.4	146.0	152.4	157.6	158.4	158.4	158.4	158.4
300			114.1	125.2	134.5	142.2	148.9	154.5	158.2	158.2	158.2	158.2
Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.												

Table 2 of 4: OAT Adjustment

OAT (deg. C)	OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)						
	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)						
	120	130	140	150	160	170	180
35 & BELOW	0.0	0.0	0.0	0.0	0.0	0.0	0.0
36	–0.6	–0.9	–1.2	–1.5	–1.8	–2.1	–2.4
38	–1.8	–2.7	–3.6	–4.5	–5.4	–6.3	–7.2
40	–3.0	–4.5	–6.0	–7.5	–9.0	–10.5	–12.0
42	–5.4	–6.9	–8.4	–9.9	–11.4	–12.9	–14.4
44	–7.8	–9.3	–10.8	–12.3	–13.8	–15.3	–16.8
46	–10.2	–11.7	–13.2	–14.7	–16.2	–17.7	–19.2
48	–12.6	–14.1	–15.6	–17.1	–18.6	–20.1	–21.6
50	–15.0	–16.5	–18.0	–19.5	–21.0	–22.5	–24.0

Table 3 of 4: Pressure Altitude Adjustment

ALT (FT)	OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)						
	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)						
	120	130	140	150	160	170	180
S.L. & BELOW	0.0	0.0	0.0	0.0	0.0	0.0	0.0
1000	–4.8	–5.3	–5.8	–6.4	–6.9	–7.4	–7.9
2000	–9.6	–10.6	–11.7	–12.7	–13.8	–14.8	–15.9
3000	–12.6	–14.5	–16.4	–18.3	–20.1	–22.0	–23.9
4000	–15.7	–18.4	–21.1	–23.8	–26.5	–29.2	–32.0
5000	–17.8	–21.7	–25.5	–29.4	–33.3	–37.1	–41.0
6000	–20.0	–25.0	–30.0	–35.0	–40.0	–45.0	–50.0

GEAR DOWN

Takeoff Obstacle Limit Weight
Flaps 15
Based on anti-ice off, five minute takeoff thrust time limit
Table 4 of 4: Wind Adjustment

WIND (KTS)	OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)						
	OAT & ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)						
	120	130	140	150	160	170	180
15 TW	–21.0	–20.0	–19.0	–18.0	–17.0	–16.0	–15.0
10 TW	–14.0	–13.3	–12.7	–12.0	–11.3	–10.7	–10.0
5 TW	–7.0	–6.7	–6.3	–6.0	–5.7	–5.3	–5.0
0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
10 HW	1.5	1.5	1.5	1.5	1.5	1.5	1.5
20 HW	3.0	3.0	3.0	3.0	3.0	3.0	3.0
30 HW	4.5	4.5	4.5	4.5	4.5	4.5	4.5
40 HW	6.0	6.0	6.0	6.0	6.0	6.0	6.0

Anti-Ice Adjustments
Pressure Altitude ≤ 9000 FT

	OBSTACLE LIMIT WEIGHT ADJUSTMENT (KG)	
ANTI-ICE CONFIGURATION	OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–2650	–3200
ENGINE & WING ON	–3650	–4150
ENGINE AUTO	–350	–150
ENGINE & WING AUTO	–350	–150

GEAR DOWN

Fuel Jettison Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg C)	FUEL JETTISON LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)					
	–2000	0	2000	4000	6000	8000
54	180.8					
52	185.2	180.4				
50	189.5	184.7				
48	203.0	189.0	173.3			
46	206.7	202.8	177.5			
44	210.3	206.7	181.6			
42	213.9	210.1	185.7	170.2		
40	217.5	213.6	189.4	174.2		
38	226.5	217.1	202.1	178.1		
36	227.1	231.1	205.3	181.4		
34	227.6	235.7	208.5	184.3	170.5	
32	228.3	235.8	211.6	187.1	173.7	
30	229.0	235.9	213.1	190.1	176.3	
28	229.6	236.0	213.2	202.6	179.0	165.4
26	230.0	236.2	213.3	204.0	181.5	167.7
24	230.5	236.3	213.5	204.1	184.0	170.0
22	230.9	236.4	213.6	204.2	185.2	172.1
20	231.4	236.5	213.7	204.3	185.3	174.1
18	231.7	236.6	213.7	204.4	185.4	175.1
16	232.0	236.7	213.8	204.4	185.4	175.4
14	232.4	236.8	213.9	204.5	185.5	175.8
12	232.7	236.8	214.0	204.6	185.6	175.8
10	233.0	236.9	214.1	204.7	185.6	175.9
0	234.5	237.2	214.4	205.0	185.9	176.1
–10	235.0	237.5	214.7	205.3	186.2	176.2
–20	235.4	237.8	215.0	205.6	186.4	176.4
–30	235.9	238.1	215.3	205.9	186.7	176.6
–40	236.5	238.6	215.7	206.2	186.9	176.7

Table valid for Zero Fuel Weight up to 181437 kg.

Anti-Ice Adjustments

Pressure Altitude ≤ 8000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–4200	–4200
ENGINE & WING ON	–300	–5000	–5000

DELETION

GEAR DOWN

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 15
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	TAKEOFF SPEEDS (KIAS)		
	V1	VR	V2
190	136	141	149
180	132	138	147
170	129	135	145
160	125	132	141
150	121	127	136
140	116	123	131
130	112	120	127
120	107	116	123
110	102	112	119
Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																								
	V1									VR										V2						
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)										PRESS ALT (1000 FT)						
	0	1	2	3	4	5	6	7	8	0	1	2	3	4	5	6	7	8	0	1	2	3	4	5	6	7	8
60	0	1	2	4	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
50	0	1	2	4	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
40	0	1	2	4	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
30	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
0	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
–60	1	2	3	4	4	4	4	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
*V1 not to exceed VR																											

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
200	–3	–1	0	1	2	–2	–1	–1	0	1	2
180	–3	–1	0	1	2	–2	–1	–1	0	1	2
160	–3	–1	0	1	2	–2	–1	–1	0	1	2
140	–3	–1	0	1	2	–2	–1	–1	0	1	2
120	–2	–1	0	1	2	–2	–1	–1	0	1	2
100	–2	–1	0	1	2	–2	–1	–1	0	1	2
*V1 not to exceed VR.											

GEAR DOWN

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 15
Table 4 of 6: V1(MCG)

TEMP (deg. C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	0	1000	2000	3000	4000	5000	6000	7000	8000
60	114	112	111	110	109	107	106	105	103
55	114	112	111	110	109	107	106	105	103
50	117	114	111	110	109	107	106	105	103
45	120	118	115	112	110	107	106	105	103
40	123	121	118	116	113	110	108	105	103
35	126	123	121	118	116	114	111	108	106
30	126	124	123	121	118	116	114	111	109
25	126	124	123	121	120	118	116	113	111
20	126	124	123	121	120	118	116	115	113
15	126	125	123	121	120	118	117	115	113
10	126	125	123	121	120	118	117	115	113
5	126	125	123	121	120	119	117	115	113
0	126	125	123	122	120	119	117	115	113
–60	128	126	124	123	121	120	118	116	114

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	MINIMUM VR (KIAS)													
	V1(MCG) (KIAS)													
	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	138	138	138	138	138	138	138	138	138	138	138	138	138	138
170	136	136	136	136	136	136	136	136	136	138	138	136	135	134
160	133	133	133	133	133	133	133	133	133	134	135	133	132	131
150	128	128	128	128	128	128	128	129	130	130	131	130	130	131
140	125	125	125	125	125	125	125	126	127	127	127	128	129	131
130	122	122	122	122	122	122	122	122	123	124	126	128	129	131
120	118	118	118	118	118	118	119	120	122	124	126	128	129	131
110	115	115	115	115	115	117	118	120	122	124	126	128	129	130

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	MINIMUM V2 (KIAS)													
	V1(MCG) (KIAS)													
	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	147	147	147	147	147	147	147	147	147	147	147	147	147	147
170	146	146	146	146	146	146	146	146	146	146	146	145	145	145
160	141	141	141	141	141	141	141	141	141	142	143	143	143	143
150	136	136	136	136	136	136	136	137	139	140	141	140	141	142
140	133	133	133	133	133	133	134	135	136	137	138	139	141	142
130	130	130	130	130	130	130	131	132	133	134	136	139	140	142
120	125	125	125	125	126	127	129	130	132	134	136	138	140	141
110	122	122	122	123	124	126	128	130	132	134	136	138	140	141

GEAR DOWN

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 15
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	TAKEOFF SPEEDS (KIAS)		
	V1	VR	V2
190	128	141	149
180	124	138	147
170	120	135	145
160	116	132	141
150	112	127	136
140	108	123	131
130	104	120	127
120	100	116	123
110	96	112	119
Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																								
	V1									VR										V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)										PRESS ALT (1000 FT)								
	0	1	2	3	4	5	6	7	8	0	1	2	3	4	5	6	7	8		0	1	2	3	4	5	6	7	8
60	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
50	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
40	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
30	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
20	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
10	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
0	0	1	2	3	3	3	3	3	3	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
–60	1	2	3	4	4	4	4	4	4	0	0	0	0	0	0	0	0	0		0	0	0	0	0	0	0	0	0
*V1 not to exceed VR																												

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
200	–4	–2	0	2	4	–4	–3	–1	0	2	3
180	–4	–2	0	2	4	–4	–3	–1	0	2	3
160	–4	–2	0	2	4	–4	–3	–1	0	2	3
140	–4	–2	0	2	3	–4	–3	–1	0	2	3
120	–4	–2	0	2	3	–3	–2	–1	0	1	3
100	–4	–2	0	2	3	–3	–2	–1	0	1	3
*V1 not to exceed VR.											

GEAR DOWN

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 15
Table 4 of 6: V1(MCG)

TEMP (deg. C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	0	1000	2000	3000	4000	5000	6000	7000	8000
60	114	112	111	110	109	107	106	105	103
55	114	112	111	110	109	107	106	105	103
50	117	114	111	110	109	107	106	105	103
45	120	118	115	112	110	107	106	105	103
40	123	121	118	116	113	110	108	105	103
35	126	123	121	118	116	114	111	108	106
30	126	124	123	121	118	116	114	111	109
25	126	124	123	121	120	118	116	113	111
20	126	124	123	121	120	118	116	115	113
15	126	125	123	121	120	118	117	115	113
10	126	125	123	121	120	118	117	115	113
5	126	125	123	121	120	119	117	115	113
0	126	125	123	122	120	119	117	115	113
–60	128	126	124	123	121	120	118	116	114

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	MINIMUM VR (KIAS)													
	V1(MCG) (KIAS)													
	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	138	138	138	138	138	138	138	138	138	138	138	138	138	138
170	136	136	136	136	136	136	136	136	136	138	138	136	135	134
160	133	133	133	133	133	133	133	133	133	134	135	133	132	131
150	128	128	128	128	128	128	128	129	130	130	131	130	130	131
140	125	125	125	125	125	125	125	126	127	127	127	128	129	131
130	122	122	122	122	122	122	122	122	123	124	126	128	129	131
120	118	118	118	118	118	118	119	120	122	124	126	128	129	131
110	115	115	115	115	115	117	118	120	122	124	126	128	129	130

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	MINIMUM V2 (KIAS)													
	V1(MCG) (KIAS)													
	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	147	147	147	147	147	147	147	147	147	147	147	147	147	147
170	146	146	146	146	146	146	146	146	146	146	146	145	145	145
160	141	141	141	141	141	141	141	141	141	142	143	143	143	143
150	136	136	136	136	136	136	136	137	139	140	141	140	141	142
140	133	133	133	133	133	133	134	135	136	137	138	139	141	142
130	130	130	130	130	130	130	131	132	133	134	136	139	140	142
120	125	125	125	125	126	127	129	130	132	134	136	138	140	141
110	122	122	122	123	124	126	128	130	132	134	136	138	140	141

GEAR DOWN

VREF

Based on 10,000 ft pressure altitude

WEIGHT (1000 KG)	VREF (KIAS)		
	FLAPS		
	30	25	20
250	175	181	182
240	172	179	179
230	168	175	175
220	164	170	171
210	160	166	166
200	156	162	162
190	152	157	158
180	148	153	153
170	144	148	148
160	139	144	144
150	135	139	139
140	131	134	134
130	128	130	130
120	125	125	125

GEAR DOWN

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
1200		1000	1100	1200	1260	1320	1380	1450
1400	1050	1170	1280	1400	1470	1540	1610	1690
1600	1200	1330	1470	1600	1680	1760	1840	1920
1800	1350	1500	1650	1800	1890	1980	2060	2160
2000	1500	1670	1830	2000	2100	2200	2290	2400
2200	1650	1830	2020	2200	2310	2420	2520	2640
2400	1800	2000	2200	2400	2510	2630	2750	2870
2600	1950	2170	2380	2600	2720	2850	2980	3110
2800	2100	2330	2570	2800	2930	3070	3210	3350
3000	2250	2500	2750	3000	3140	3290	3430	3590
3200	2400	2670	2930	3200	3350	3510	3660	3820
3400	2550	2830	3120	3400	3560	3730	3890	4060
3600	2700	3000	3300	3600	3770	3950	4120	4300
3800	2850	3170	3480	3800	3980	4170	4350	4530
4000	3000	3330	3670	4000	4190	4390	4570	4770
4200	3150	3500	3850	4200	4400	4610		
4400	3300	3670	4030	4400	4610			
4600	3450	3830	4220	4600				
4800	3600	4000	4400	4800				
5000	3750	4170	4580					

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
1400	142.8	131.4	119.3		
1600	170.2	161.4	152.6	141.2	129.0
1800	194.3	184.1	174.4	165.0	156.0
2000	217.9	207.1	196.0	185.4	175.3
2200	237.2	227.7	217.3	206.0	194.6
2400	252.4	241.4	233.2	224.6	213.9
2600	264.6	255.8	244.3	235.8	227.4
2800	269.8	266.6	257.6	245.9	237.1
3000		269.8	267.5	258.2	246.4
3200			269.8	267.3	257.9
3400				269.8	266.2
3600					269.8

With manual speedbrakes, decrease weight by 18,800 kg.
With 1 brake deactivated, decrease weight by 23,350 kg.
With 2 brakes deactivated, decrease weight by 46,550 kg.

GEAR DOWN

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
1200		1000	1100	1200	1260	1320	1380	1450
1400	1050	1170	1280	1400	1470	1540	1610	1690
1600	1200	1330	1470	1600	1680	1760	1840	1920
1800	1350	1500	1650	1800	1890	1980	2060	2160
2000	1500	1670	1830	2000	2100	2200	2290	2400
2200	1650	1830	2020	2200	2310	2420	2520	2640
2400	1800	2000	2200	2400	2510	2630	2750	2870
2600	1950	2170	2380	2600	2720	2850	2980	3110
2800	2100	2330	2570	2800	2930	3070	3210	3350
3000	2250	2500	2750	3000	3140	3290	3430	3590
3200	2400	2670	2930	3200	3350	3510	3660	3820
3400	2550	2830	3120	3400	3560	3730	3890	4060
3600	2700	3000	3300	3600	3770	3950	4120	4300
3800	2850	3170	3480	3800	3980	4170	4350	4530
4000	3000	3330	3670	4000	4190	4390	4570	4770
4200	3150	3500	3850	4200	4400	4610		
4400	3300	3670	4030	4400	4610			
4600	3450	3830	4220	4600				
4800	3600	4000	4400	4800				
5000	3750	4170	4580					

Table 2 of 2: Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (M)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
1600	141.3	129.7	117.7		
1800	166.0	157.4	147.4	136.4	123.3
2000	186.9	177.2	167.9	158.8	149.0
2200	207.9	197.0	186.6	176.5	166.9
2400	226.9	216.7	205.5	194.4	183.7
2600	241.1	233.0	222.9	212.2	200.5
2800	254.9	243.4	235.1	227.0	216.8
3000	265.1	256.3	244.7	236.2	227.8
3200	269.8	265.7	256.7	245.0	236.3
3400		269.8	265.4	256.2	244.4
3600			269.8	264.2	254.9
3800				269.8	262.3
4000					269.3
4200					269.8

With manual speedbrakes, decrease weight by 16,350 kg.
With 1 brake deactivated, decrease weight by 20,750 kg.
With 2 brakes deactivated, decrease weight by 42,850 kg.

GEAR DOWN

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	LANDING CLIMB LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)					
	–2000	0	2000	4000	6000	8000
54	178.9	174.2				
52	183.3	178.5				
50	187.6	182.8	167.3			
48	191.6	187.1	171.5			
46	195.2	191.4	175.6	160.2		
44	198.8	195.2	179.7	164.3		
42	202.4	198.7	183.8	168.3	153.5	
40	206.0	202.1	187.5	172.4	157.4	
38	207.9	205.6	190.7	176.3	161.3	146.2
36	208.1	209.0	193.9	179.6	165.0	150.0
34	208.2	210.7	197.0	182.4	168.6	153.6
32	208.3	210.8	200.1	185.2	171.8	157.2
30	208.5	211.0	201.6	188.2	174.5	160.7
28	208.6	210.7	197.0	182.4	168.6	163.5
26	208.7	211.3	201.8	192.6	179.6	165.8
24	208.8	211.4	202.0	192.7	182.1	168.2
22	208.9	211.5	202.1	192.8	183.3	170.2
20	209.0	211.6	202.2	192.9	183.4	172.2
18	209.1	211.7	202.3	192.9	183.5	173.2
16	209.2	211.7	202.3	193.0	183.5	173.6
14	209.3	211.8	202.4	193.1	183.6	173.9
12	209.3	211.9	202.5	193.2	183.7	173.9
10	209.4	211.9	202.6	193.2	183.7	174.0
0	209.8	212.2	202.9	193.6	184.0	174.2
–10	210.1	212.5	203.2	193.9	184.3	174.4
–20	210.4	212.8	203.5	194.2	184.5	174.5
–30	211.0	213.2	203.8	194.5	184.8	174.7
–40	211.6	213.7	204.2	194.8	185.0	174.8

When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10 deg. C, decrease weight by 22,650 kg.

Anti-Ice Adjustments

Pressure Altitude ≤ 8000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–300	–4200	–4200
ENGINE & WING ON	–300	–5000	–5000

GEAR DOWN

Long Range Cruise Altitude Capability
Max Climb Thrust, 300 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
260	15200	13200	10700
250	16300	14300	11700
240	17200	15300	12600
230	18200	16300	13900
220	19200	17700	15500
210	20600	19300	17400
200	21900	21000	19000
190	23500	22700	20800
180	25200	24200	22700
170	26500	25500	24100
160	27800	26800	25500
150	29100	28200	27000
140	30500	29600	28400
130	32000	31100	29800
120	33500	32500	31300
110	34600	33700	32600

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
328	292	261	237	217	200	187	175	165	156	148
492	438	392	356	326	300	281	263	248	234	223
655	584	523	474	435	400	374	351	331	313	297
818	729	653	593	543	500	468	439	414	391	372
980	874	784	711	652	600	562	527	497	470	447
1142	1019	914	830	760	700	656	615	580	548	521
1303	1163	1043	948	869	800	749	704	663	627	596
1463	1307	1173	1066	977	900	843	792	746	706	671
1623	1451	1302	1184	1086	1000	937	880	829	785	746
1782	1594	1431	1301	1194	1100	1031	969	913	864	821
1941	1737	1560	1419	1302	1200	1125	1057	996	943	896
2100	1879	1689	1536	1410	1300	1219	1146	1080	1022	972
2257	2021	1818	1654	1519	1400	1313	1234	1164	1101	1047
2414	2163	1946	1771	1627	1500	1407	1323	1247	1181	1123
2570	2304	2074	1888	1735	1600	1501	1412	1331	1260	1199
2726	2444	2201	2005	1843	1700	1595	1500	1415	1340	1275
2881	2585	2328	2122	1950	1800	1689	1589	1499	1420	1351
3035	2724	2456	2238	2058	1900	1784	1678	1583	1500	1427
3189	2864	2582	2355	2166	2000	1878	1767	1668	1580	1503
3342	3003	2709	2471	2274	2100	1972	1856	1752	1660	1579
3495	3141	2835	2587	2381	2200	2066	1945	1836	1740	1656
3646	3279	2961	2703	2489	2300	2161	2035	1921	1820	1732
3797	3417	3087	2819	2596	2400	2255	2124	2006	1901	1809
3948	3554	3212	2935	2704	2500	2350	2213	2090	1981	1886

Table 2 of 3: Reference Fuel and Time Required

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		26	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	5.8	0:51	5.5	0:49	5.4	0:47	5.3	0:46	5.3	0:45
300	8.4	1:15	8.1	1:11	7.8	1:08	7.6	1:05	7.5	1:03
400	11.1	1:38	10.6	1:33	10.2	1:28	9.8	1:24	9.7	1:21
500	13.7	2:01	13.1	1:55	12.6	1:49	12.1	1:44	11.8	1:39
600	16.5	2:24	15.7	2:16	15.1	2:09	14.5	2:02	14.1	1:57
700	19.3	2:47	18.3	2:38	17.5	2:29	16.8	2:21	16.4	2:15
800	22.0	3:10	20.9	2:59	20.0	2:49	19.1	2:40	18.7	2:32
900	24.8	3:32	23.5	3:21	22.5	3:10	21.5	2:59	21.0	2:50
1000	27.5	3:55	26.1	3:42	24.9	3:30	23.8	3:18	23.3	3:08
1100	30.4	4:17	28.8	4:03	27.5	3:49	26.3	3:37		
1200	33.3	4:39	31.5	4:24	30.1	4:09	28.8	3:55		
1300	36.2	5:02	34.2	4:45	32.7	4:29	31.2	4:13		
1400	39.1	5:24	36.9	5:05	35.3	4:48	33.7	4:32		
1500	41.9	5:46	39.7	5:26	37.8	5:08	36.2	4:50		
1600	45.0	6:07	42.5	5:46	40.5	5:27	38.8	5:08		
1700	48.0	6:28	45.4	6:07	43.2	5:46	41.4	5:26		
1800	51.0	6:50	48.2	6:27	45.9	6:04	44.0	5:44		
1900	54.0	7:11	51.1	6:47	48.7	6:23	46.6	6:02		
2000	57.0	7:32	53.9	7:07	51.4	6:42	49.2	6:19		
2100	60.2	7:53	56.9	7:26	54.2	7:01				
2200	63.4	8:14	59.9	7:46	57.0	7:19				
2300	66.5	8:34	62.9	8:05	59.9	7:37				
2400	69.7	8:55	65.9	8:25	62.7	7:55				
2500	72.9	9:15	68.9	8:44	65.6	8:14				

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)					
	120	140	160	180	200	220
5	−0.7	−0.4	0.0	0.4	0.8	1.3
10	−1.4	−0.7	0.0	0.7	1.6	2.5
15	−2.0	−1.0	0.0	1.1	2.4	3.7
20	−2.7	−1.4	0.0	1.5	3.2	4.9
25	−3.4	−1.7	0.0	1.9	4.0	6.1
30	−4.1	−2.0	0.0	2.3	4.9	7.3
35	−4.7	−2.4	0.0	2.7	5.7	8.5
40	−5.4	−2.7	0.0	3.2	6.6	9.6
45	−6.1	−3.1	0.0	3.6	7.5	10.8
50	−6.8	−3.4	0.0	4.0	8.3	11.9
55	−7.5	−3.8	0.0	4.4	9.2	13.1
60	−8.2	−4.1	0.0	4.8	10.2	14.2
65	−8.9	−4.5	0.0	5.3	11.1	15.3
70	−9.6	−4.9	0.0	5.7	12.0	16.5
75	−10.3	−5.2	0.0	6.1	13.0	17.6

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
108	88	74	64	56	50	45	41	38	35	33
176	153	135	121	109	100	92	85	79	74	70
247	219	196	178	163	150	139	130	121	114	108
318	284	257	235	216	200	186	174	164	154	146
389	350	318	292	269	250	233	219	206	194	184
460	415	379	348	322	300	281	263	248	235	223
530	481	440	405	376	350	328	308	291	275	261
601	546	500	462	429	400	375	353	333	316	300
672	612	561	519	482	450	422	397	376	356	338
743	677	622	575	535	500	469	442	418	396	377
815	743	683	632	588	550	516	487	460	436	415
887	810	745	689	642	600	563	531	502	477	453

Table 2 of 2: Trip Fuel and Time

AIR DISTANCE (NM)		LANDING WEIGHT (1000 KG) 120	130	140	150	160	170	180	190	200	TIME (HR:MIN)
50	FUEL (1000 KG)	1.5	1.6	1.7	1.8	1.8	1.9	2.0	2.0	2.1	0:16
	ALT (FT)	11000	11000	11000	11000	11000	9000	9000	9000	9000	
100	FUEL (1000 KG)	2.6	2.7	2.8	2.9	3.1	3.2	3.3	3.4	3.6	0:26
	ALT (FT)	23000	21000	21000	19000	19000	17000	17000	17000	15000	
150	FUEL (1000 KG)	3.5	3.6	3.8	4.0	4.2	4.4	4.5	4.7	4.9	0:35
	ALT (FT)	27000	27000	25000	25000	23000	23000	21000	19000	19000	
200	FUEL (1000 KG)	4.4	4.6	4.8	5.0	5.3	5.5	5.7	6.0	6.3	0:44
	ALT (FT)	31000	29000	27000	25000	25000	23000	23000	21000	21000	
250	FUEL (1000 KG)	5.2	5.5	5.8	6.1	6.4	6.6	6.9	7.3	7.6	0:53
	ALT (FT)	31000	29000	29000	27000	25000	25000	23000	23000	21000	
300	FUEL (1000 KG)	6.1	6.4	6.8	7.1	7.4	7.8	8.1	8.5	8.9	1:02
	ALT (FT)	31000	31000	29000	27000	27000	25000	25000	23000	21000	
350	FUEL (1000 KG)	7.0	7.3	7.7	8.1	8.5	8.9	9.4	9.8	10.3	1:11
	ALT (FT)	31000	31000	29000	27000	27000	25000	25000	23000	21000	
400	FUEL (1000 KG)	7.8	8.3	8.7	9.2	9.6	10.1	10.6	11.1	11.6	1:20
	ALT (FT)	31000	31000	29000	27000	27000	25000	25000	23000	21000	
450	FUEL (1000 KG)	8.7	9.2	9.7	10.2	10.7	11.3	11.8	12.4	13.0	1:29
	ALT (FT)	31000	31000	29000	27000	27000	25000	25000	23000	21000	
500	FUEL (1000 KG)	9.6	10.1	10.7	11.3	11.8	12.4	13.1	13.7	14.4	1:38
	ALT (FT)	31000	31000	29000	27000	27000	25000	23000	23000	21000	
550	FUEL (1000 KG)	10.5	11.1	11.7	12.3	13.0	13.6	14.3	15.1	15.8	1:47
	ALT (FT)	31000	31000	29000	27000	27000	25000	23000	21000	21000	
600	FUEL (1000 KG)	11.4	12.0	12.7	13.4	14.1	14.8	15.6	16.4	17.1	1:56
	ALT (FT)	31000	31000	29000	27000	27000	25000	23000	21000	21000	

GEAR DOWN

Holding Planning

Flaps Up

WEIGHT (1000 KG)	TOTAL FUEL FLOW (KG/HR) PRESSURE ALTITUDE (FT)						
	1500	5000	10000	15000	20000	25000	30000
260	10600	10640	10740	10990			
240	10180	10210	10300	10470			
220	9400	9430	9480	9710	10240		
200	8450	8470	8480	8650	8950		
180	7580	7590	7610	7690	7830	8130	
160	6870	6850	6860	6890	7030	7180	
140	6180	6110	6120	6130	6250	6330	6620
120	5610	5490	5500	5500	5650	5640	5780
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
260	10290	10310	10360	10470	
240	9780	9780	9840	9930	
220	8940	8940	8970	9060	9330
200	8080	8060	8050	8110	8270
180	7240	7190	7150	7180	7310
160	6420	6330	6280	6280	6410
140	5710	5570	5510	5510	5640
120	5160	4960	4900	4890	4980
Includes 5% additional fuel for holding in a race track pattern.					

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Net Level Off Weight

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 KG)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
18	127.8	122.9	118.0
16	137.0	130.8	125.2
14	147.0	138.8	132.9
12	157.9	147.2	140.8
10	163.4	157.1	150.2
8	171.3	164.2	156.5
6	179.4	171.0	163.0
4	187.4	177.5	169.4
2	193.9	181.8	173.6
0	198.7	186.5	178.1

Anti-Ice Adjustment

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 KG) PRESSURE ALTITUDE (1000 FT)									
	0	2	4	6	8	10	12	14	16	18
ENGINE ON	0.0	0.0	0.0	0.0	0.0	–1.5	–1.6	–1.7	–1.7	–1.6
ENGINE & WING ON	0.0	0.0	0.0	0.0	0.0	–2.1	–2.2	–2.4	–2.5	–2.3

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	LEVEL OFF WEIGHT ADJUSTMENT (1000 KG) PRESSURE ALTITUDE (1000 FT)									
	0	2	4	6	8	10	12	14	16	18
When operating in icing conditions during any part of the flight, decrease net level off wight by 23,400 kg.										
ENGINE ON	–1.7	–1.8	–2.0	–2.1	–2.0	–2.0	–2.0	–1.9	–1.8	–1.6
ENGINE & WING ON	–2.5	–2.6	–2.7	–2.8	–2.7	–2.7	–2.7	–2.6	–2.5	–2.3

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. The data provided is for a single takeoff flap at 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 Approved Flight Manual, the Flight Manual shall always take precedence.

Takeoff

The maximum allowable takeoff weight is the least of the Field, Climb, Obstacle and Fuel Jettison Limit Weights as determined from the tables in this chapter. The takeoff weight cannot be less than the flaps 15 Minimum Takeoff Weight as determined from chapter Performance Inflight. Brake Energy and Tire Limit Weights are not shown as they are not limiting for the range of conditions shown in this chapter.

Field Limit Weight—Slope and Wind Corrections

These 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 the 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 the 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. Intermediate altitudes may be interpolated or use next higher altitude. If the "Slope and Wind Corrected Field Length" is less than the minimum field length shown in the table, do not extrapolate the data.

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

Obtain reference obstacle limit weight by entering Table 1 with obstacle height above the runway surface and distance from brake release. Next 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.

Fuel Jettison Limit Weight

The Return to Land Fuel Jettison Limit Weight is defined as the landing climb limit weight plus the fuel burned over 30 minutes and the fuel jettisoned over 15 minutes.

The table presented provides the Fuel Jettison Limit Weight for a given altitude and temperature. Enter the table with airport OAT and pressure altitude to read Fuel Jettison Limit Weight. Apply the noted adjustments for anti-ice as required. Intermediate altitudes or temperatures may be interpolated.

The table presented is based on the entry-into-service maximum zero fuel weight. Analysis from the Airplane Flight Manual - Digital Performance Information software using a lower zero fuel weight may yield less restrictive performance.

DELETION

Brakes Deactivated

When operating with brakes deactivated, the field limit weight and the V1 must be reduced to allow for reduced braking capability. A simplified method which conservatively accounts for the reduced braking capability of one or two brakes deactivated is to reduce the normal runway limited weight and the V1 associated with the reduced weight by the amount in the table below:

	WEIGHT ADJUSTMENT (KG)		V1 ADJUSTMENT (KTS)	
	DRY RUNWAY	WET RUNWAY	DRY RUNWAY	WET RUNWAY
1 BRAKE DEACTIVATED	3,350	2,450	3	2
2 BRAKES DEACTIVATED	7,450	5,200	5	4

If the resulting V1 is less than V1(MCG), takeoff is permitted with V1 set equal to V1(MCG) provided the accelerate stop distance available corrected for wind and slope exceeds the appropriate value in the table below:

	MINIMUM FIELD LENGTH (M)	
	DRY RUNWAY	WET RUNWAY
1 BRAKE DEACTIVATED	1,600	2,000
2 BRAKES DEACTIVATED	1,750	2,150

Note: V1(MCG) can be determined from Chapter Performance Inflight. Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

One Thrust Reverser Inoperative

Wet runway takeoff performance presented for all brakes operating is based on the use of one thrust reverser during deceleration. When operating with a thrust reverser inoperative, the runway/obstacle limited takeoff weight and V1 speed must be reduced to account for the reduced deceleration capability.

A simplified method which conservatively accounts for this is to reduce the normal wet runway/obstacle limited weight by 3,650 kg and the V1 associated with the reduced weight by two knots.

If the resulting V1 is less than V1(MCG), takeoff is permitted with V1 set equal to V1(MCG) provided the accelerate stop distance available corrected for wind and slope exceeds approximately 2,000 m.

Enroute

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. Note that these tables consider both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 300 ft/min residual rate of climb.

Flying above these altitudes with sustained banks in excess of approximately 21° may cause the airplane to lose speed and/or altitude. The altitudes shown in the table are limited to the maximum certified altitude of 43,100 ft.

Long Range Cruise Trip Fuel and Time

These tables are provided to determine trip fuel and time required to destination. Data is 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 4,000 ft step climbs to keep the flight within 2,000 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

These tables are provided to determine trip fuel and time for short distances or alternates. The data are based on the use of the FMC short trip optimum altitude. Obtain air distance from the Ground to Air Miles Conversion table (Table 1) using the ground distance and wind component to the alternate. Enter the Trip Fuel and Time table (Table 2) with air distance and read trip fuel required for the expected landing weight. Continue across the table to read trip time. For distances greater than shown or other altitudes, use the Long Range Cruise Trip Fuel and Time tables.

Holding Planning

These tables provide total fuel flow information necessary for planning Flaps Up and Flaps 1 holding and reserve fuel requirements. Data is based on the FMC holding speed schedule which is the higher of the maximum endurance and flap 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%.

Oxygen Requirements

Flight Crew System

Regulations require that sufficient oxygen be provided to the flight crew to account for the greater of supplemental breathing oxygen in the event of a cabin depressurization or protective breathing in the event of smoke or harmful fumes in the flight deck.

Tables are provided to determine the flight crew oxygen dispatch requirements. Table 1 shows minimum oxygen quantity necessary to ensure that protective breathing requirements are satisfied. Table 2 shows the supplemental oxygen requirement for loss of pressurization, emergency descent and total post decompression flight time above 10,000 ft. Table 3 gives adjustments that must be applied to Table 2 crew member supplemental requirements in situations where the enroute altitude after decompression will exceed 14000 ft. Increments shown in parenthesis are adjustments for "100%" regulator setting that can be used if the operator chooses to schedule oxygen dispatch requirements based on pure oxygen availability. For more extensive than normal crew usage, additional oxygen can be added using the actual oxygen flow rate data provided under Table 3.

An additional quantity of oxygen is required when flight altitudes above 41,000 ft are planned. Regulations require that one active duty pilot must don the oxygen mask and breath diluted oxygen for the duration of the flight above 41,000 ft. The additional quantity of oxygen required is 2.05 liters/person/minute (1.2 psi/person/minute for the single cylinder system and 0.6 psi/person/minute for the dual cylinder system), or 13 liters/person/minute (8 psi/person/minute for the single cylinder system and 4 psi/person/minute for the dual cylinder system) if 100% oxygen is selected during normal usage.

After determining the total volume (liters) required for the flight crew by using the larger value from Table 1 or Table 2, obtain the dispatch pressure required from the Cylinder to Volume Pressure Conversion table (Table 4). Adjust this reading for cylinder 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 in straight and level flight following an engine failure. Regulations require terrain clearance planning based on net performance, which is the gross (or actual) gradient performance degraded by 1.1%. In addition, the net level off pressure altitude must clear the terrain by 1,000 ft.

To determine the 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 the maximum landing weight as limited by field length or climb requirements for Flaps 30.

Maximum landing weight is the lowest of the 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 Adjusted 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 to 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. Adjust the reference gradient for airplane weight and speed using Table 2 and Table 3 to determine the weight and speed adjusted Go-Around Gradient. Note that data is for one engine inoperative.

Quick Turnaround Limit Weight

Enter table with airport pressure altitude and OAT to 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.

As an alternate procedure, no sooner than 10 minutes after parking, check for the BRAKE TEMP advisory message on EICAS. If the message is not displayed, no waiting period is required. If it is displayed, do not dispatch until the BRAKE TEMP message is no longer displayed. Check that the wheel thermal plugs have not melted before executing a takeoff.

If brake system control unit software P/N CRZ32-B787-2881 is installed:

- use the alternate procedure for outside air temperature (OAT) at or below 102 deg. F (39 deg. C)
- for outside air temperature above 102 deg. F (39 deg. C), no sooner than 10 minutes after parking, check for the BRAKE TEMP advisory message on EICAS. If the message is not displayed, no waiting period is required. If the message is displayed, do not dispatch until Brake Temperature Monitoring System (BTMS) readings on the Landing Gear Synoptic Display are all below 2.2. Check that wheel thermal plugs have not melted before making a subsequent takeoff.

If the BRAKE TEMP SYS status message is displayed, wait the specified time and check that the wheel thermal plugs have not melted before executing a takeoff.

Gear Down

This section provides flight planning data for revenue operation with gear down for limited airport pressure altitudes. The gear down tables in this section are identical in format and usage to the corresponding gear up tables previously described.

The maximum allowable takeoff weight is the least of the Field, Climb, Obstacle and Fuel Jettison Limit Weights as determined from the tables in this section. When determining a maximum weight for a wet runway, the dry runway limit weight must also be checked and the lower of the two weights used. The takeoff weight cannot be less than the flaps 15 Minimum Takeoff Weight as determined from Chapter Performance Inflight Brake Energy and Tire Limit Weights are not shown as they are not limiting for the range of conditions shown in this section.

DELETION

Due to increased takeoff speed schedule for gear down dispatch, takeoff speeds must be determined from the tables provided in this section by using the same manner as described in Chapter Performance Inflight.

Performance Inflight — Chapter PI
Section Table of Contents

787-8 TRENT1000-AE KG M FAA PI.10

787-9 TRENT1000-D KG C M FAA PI.20

Performance Inflight — Chapter PI

Table of Contents

787-8 TRENT1000-AE KG M FAA

General PI.10

Minimum Takeoff Weight PI.10.1
Takeoff Speeds—Dry Runway PI.10.2
Takeoff Speeds—Wet Runway PI.10.8
Stabilizer Trim Setting PI.10.14
VREF PI.10.15
Flap Maneuver Speed PI.10.16
Slush/Standing Water Takeoff PI.10.18
Dry Snow Takeoff PI.10.21
Wet Snow Takeoff PI.10.24
Slippery Runway Takeoff PI.10.27
Takeoff TPR PI.10.30
Go-Around TPR PI.10.32
Max Climb TPR PI.10.33
Flight With Unreliable Airspeed PI.10.34
ISFD Airspeed and Altitude Correction PI.10.38
ISFD Airspeed and Altitude Correction PI.10.41

All Engine PI.11

Long Range Cruise Maximum Operating Altitude PI.11.1
Long Range Cruise Control PI.11.2
Long Range Cruise Enroute Fuel and Time—Low Altitude PI.11.3
Long Range Cruise Enroute Fuel and Time—High Altitude PI.11.4
Long Range Cruise Wind-Altitude Trade PI.11.6
Holding PI.11.7

Advisory Information PI.12

Runway Surface Condition Correlation PI.12.1

Normal Configuration Operational Landing Distance PI.12.2
Non-Normal Configuration Landing Distance PI.12.5
Landing Climb Limit Weight PI.12.53
Tire Speed Landing Limit Weight PI.12.55
Recommended Brake Cooling Schedule PI.12.57

Engine Inoperative PI.13
Initial Max Continuous TPR PI.13.1
Max Continuous TPR PI.13.2
Driftdown Speed/Level Off Altitude PI.13.6
Driftdown/LRC Cruise Range Capability PI.13.7
Long Range Cruise Altitude Capability PI.13.8
Long Range Cruise Control PI.13.9
Long Range Cruise Diversion Fuel and Time PI.13.10
Holding PI.13.11
Gear Down Landing Rate of Climb Available PI.13.12

Alternate Mode EEC PI.14
Fuel Jettison Limit Weight PI.14.1
Limit Weight PI.14.2
Max Takeoff %N1 . . . . . PI.14.3
Max Climb %N1 . . . . . PI.14.4
Max Cruise %N1 . . . . . PI.14.5
Go-Around %N1 . . . . . PI.14.6

Alternate Mode EEC, Engine Inoperative PI.15
Initial Max Continuous %N1 . . . . . PI.15.1
Max Continuous %N1 . . . . . PI.15.2

Gear Down PI.16
220 KIAS Max Climb TPR PI.16.1
Long Range Cruise Altitude Capability PI.16.2

Long Range Cruise Control PI.16.3
Long Range Cruise Enroute Fuel and Time PI.16.4
Descent at 220 KIAS PI.16.6
Holding PI.16.7

Gear Down, Engine INOP PI.17

Driftdown Speed/Level Off Altitude PI.17.1
Long Range Cruise Altitude Capability PI.17.2
Long Range Cruise Control PI.17.3
Long Range Cruise Diversion Fuel and Time PI.17.4
Holding PI.17.6

Text PI.18

Introduction PI.18.1
General PI.18.1
All Engines PI.18.5
Advisory Information PI.18.6
Engine Inoperative PI.18.9
Alternate Mode EEC PI.18.11
Alternate Mode EEC, Engine Inoperative PI.18.12
Gear Down PI.18.12

Minimum Takeoff Weight
Maximum Takeoff Thrust
Based on anti-ice off
Weight Limit (1000 KG)

Flaps 5

OAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)														
	S.L & BLW	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50	104.1	104.1	104.1												
45	104.1	104.1	104.1	104.1	104.1										
40	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1							
35	105.0	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1					
30	108.2	104.7	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1				
25	108.4	106.0	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1		
20	108.5	106.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1
15	108.6	106.3	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1
10	108.7	106.4	104.2	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1
0 & BLW	108.9	106.6	104.4	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1	104.1

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability during takeoff. For takeoff at weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

Flaps 15

OAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)														
	S.L & BLW	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50	106.6	104.1	104.1												
45	111.3	107.3	104.1	104.1	104.1										
40	116.3	112.1	108.0	104.1	104.1	104.1	104.1	104.1							
35	121.4	117.1	112.8	108.9	104.8	104.1	104.1	104.1	104.1	104.1					
30	124.9	121.1	117.4	113.6	109.6	105.5	104.1	104.1	104.1	104.1	104.1				
25	125.1	122.6	120.2	117.2	113.7	110.2	106.2	104.1	104.1	104.1	104.1	104.1	104.1		
20	125.3	122.7	120.4	118.0	115.6	113.3	109.8	105.3	104.1	104.1	104.1	104.1	104.1	104.1	104.1
15	125.4	122.9	120.5	118.1	115.7	113.4	110.9	108.2	104.8	104.1	104.1	104.1	104.1	104.1	104.1
10	125.5	123.0	120.6	118.2	115.9	113.5	111.0	108.3	105.5	104.1	104.1	104.1	104.1	104.1	104.1
0 & BLW	125.7	123.2	120.8	118.4	116.1	113.7	111.2	108.5	105.7	104.1	104.1	104.1	104.1	104.1	104.1

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability during takeoff. For takeoff at weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

Flaps 20

OAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)														
	S.L & BLW	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50	130.3	125.6	120.9												
45	136.0	131.2	126.4	122.0	117.6										
40	142.5	137.1	132.0	127.4	122.9	118.5	115.9	116.6							
35	149.1	143.5	138.0	133.0	128.3	123.7	119.3	116.0	116.5	116.9					
30	153.6	148.7	143.9	139.0	134.0	129.1	124.5	118.5	116.0	116.5	116.9				
25	153.9	150.6	147.5	143.7	139.1	134.7	129.9	123.7	118.7	115.9	116.6	116.9	117.1		
20	154.1	150.8	147.7	144.7	141.6	138.5	134.1	128.8	123.7	118.8	116.0	116.6	117.0	117.1	117.1
15	154.3	150.9	147.9	144.8	141.8	138.7	135.5	132.3	128.3	123.4	117.4	116.1	116.7	116.9	117.1
10	154.4	151.1	148.1	145.0	141.9	138.8	135.7	132.4	129.1	125.9	122.4	117.0	116.1	116.7	117.0
0 & BLW	154.7	151.4	148.3	145.2	142.2	139.1	135.9	132.6	129.4	126.1	124.7	121.5	118.4	115.9	116.4

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability during takeoff. For takeoff at 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 5
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 5		
	V1	VR	V2
240	161	164	171
230	158	161	167
220	154	157	164
210	151	153	161
200	147	149	157
190	143	145	153
180	138	141	150
170	133	136	145
160	129	131	142
150	123	126	139
140	118	121	135
130	112	116	131
120	106	111	127
110	102	106	123
100	98	101	119

Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	6	7	9	9	10	11	13	13	13	3	3	4	5	5	5	6	6	6	–3	–3	–4	–5	–5	–6	–7	–7	–7
50	4	4	6	6	8	11	13	13	13	2	2	3	4	4	5	6	6	6	–2	–2	–3	–4	–5	–6	–7	–7	–7
40	1	1	3	5	6	9	11	12	13	1	1	2	3	3	4	5	6	6	–1	–1	–2	–3	–4	–5	–6	–7	–7
30	0	0	1	3	4	6	8	10	11	0	0	1	2	3	3	4	5	5	0	0	–1	–2	–2	–4	–5	–6	–6
20	0	0	1	1	2	4	6	8	10	0	0	1	1	2	2	4	4	4	0	0	0	–1	–1	–3	–4	–5	–6
10	0	0	1	1	2	3	3	5	7	0	0	1	1	2	2	3	4	4	0	0	0	–1	–1	–2	–4	–5	–6
0	0	0	1	2	2	3	3	4	6	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–4	–4	–5
–60	0	0	1	2	2	4	4	4	4	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–2	–2	–3

***V1 not to exceed VR.**

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
240	–3	–1	0	1	2	–3	–1	–1	0	1	1
220	–3	–1	0	1	3	–2	–1	–1	0	1	1
200	–3	–1	0	1	3	–2	–1	–1	0	1	2
180	–3	–1	0	1	3	–2	–1	–1	0	1	2
160	–3	–1	0	1	3	–2	–1	–1	0	1	2
140	–3	–1	0	1	2	–2	–1	–1	0	1	2
120	–2	–1	0	1	2	–2	–1	–1	0	1	2
100	–2	–1	0	1	2	–2	–1	–1	0	1	1

***V1 not to exceed VR.**

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 5
Table 4 of 6: V1(MCG)

TEMP (deg. C)	PRESSURE ALTITUDE (1000 FT)								
	−2	0	2	4	6	8	10	12	14
60	117	115	113	111	108	104	101	100	98
55	117	115	113	111	108	104	101	100	98
50	119	118	113	111	108	104	101	100	98
45	122	121	116	111	108	104	101	100	98
40	125	124	119	114	110	104	101	100	98
35	128	127	122	117	112	106	101	100	98
30	128	129	124	120	115	109	104	100	98
25	128	129	126	122	118	112	106	100	98
20	128	129	126	123	120	114	109	103	98
15	129	129	126	123	120	117	111	106	101
10	129	129	126	124	121	117	114	108	103
5	129	130	127	124	121	117	115	111	105
0	129	130	127	124	121	117	115	112	107
−60	131	131	128	125	122	119	116	113	111

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	V1(MCG)																		
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	132
170 & ABV	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135
160	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132
150	128	128	128	128	128	128	128	128	128	128	128	128	128	128	129	129	130	130	131
140	124	124	124	124	124	124	124	124	124	124	124	125	125	125	126	127	128	129	131
130	119	119	119	119	119	119	119	119	120	120	121	121	122	123	125	127	128	129	131
120	115	115	114	115	114	114	115	116	116	117	118	120	122	123	125	127	128	129	131
110	114	113	113	113	112	112	112	113	113	116	118	120	121	123	125	127	128	129	131
100	114	113	113	113	112	111	110	112	113	116	118	120	121	123	125	127	128	129	131

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	V1(MCG)																		
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	132
180 & ABV	148	148	148	148	148	148	148	148	148	148	148	148	148	148	149	149	149	149	149
170	144	144	144	144	144	144	144	144	144	144	144	144	145	145	145	145	145	146	146
160	140	140	140	140	140	140	140	140	140	140	140	140	141	141	141	142	142	143	143
150	135	135	135	135	135	135	135	135	136	136	136	136	137	137	138	139	140	142	143
140	130	130	130	130	130	131	131	131	132	132	132	133	134	135	136	138	140	142	143
130	125	125	126	126	126	126	127	127	128	129	130	131	132	134	136	138	140	142	143
120	120	120	120	120	121	122	123	124	125	126	128	130	132	134	136	138	140	142	143
110	119	119	119	119	119	119	120	122	123	125	128	130	132	134	136	138	140	142	143
100	119	119	119	119	119	119	120	122	123	125	128	130	132	134	136	138	140	142	143

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 15
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 15		
	V1	VR	V2
220	149	151	157
210	146	147	154
200	141	143	151
190	137	139	147
180	133	134	144
170	129	129	140
160	123	125	137
150	119	120	133
140	113	116	130
130	108	111	125
120	102	105	121
110	99	100	117
100	96	96	113
Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	6	7	9	9	10	11	13	13	13	3	3	4	5	5	5	6	6	6	–2	–3	–4	–4	–5	–6	–7	–7	–7
50	4	4	6	6	8	11	13	13	13	2	2	3	4	4	5	6	6	6	–2	–2	–2	–3	–4	–6	–7	–7	–7
40	1	1	3	5	7	9	11	12	13	1	1	2	3	3	4	5	6	6	–1	–1	–1	–2	–3	–5	–6	–7	–7
30	0	0	1	3	4	6	8	10	11	0	0	1	2	3	3	4	5	5	0	0	–1	–1	–2	–3	–5	–6	–6
20	0	0	1	1	2	4	6	8	10	0	0	1	1	2	2	4	4	4	0	0	0	–1	–1	–2	–4	–5	–6
10	0	0	1	1	2	3	3	5	7	0	0	1	1	2	2	3	4	4	0	0	0	–1	–1	–2	–4	–5	–6
0	0	0	1	2	2	3	3	4	6	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–4	–4	–5
–60	0	0	1	2	2	4	4	4	4	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–1	–2	–2	–3
***V1 not to exceed VR.**																											

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
240	–3	–1	0	1	2	–3	–1	–1	0	1	1
220	–3	–1	0	1	3	–2	–1	–1	0	1	1
200	–3	–1	0	1	3	–2	–1	–1	0	1	2
180	–3	–1	0	1	3	–2	–1	–1	0	1	2
160	–3	–1	0	1	3	–2	–1	–1	0	1	2
140	–3	–1	0	1	2	–2	–1	–1	0	1	2
120	–2	–1	0	1	2	–2	–1	–1	0	1	2
100	–2	–1	0	1	2	–2	–1	–1	0	1	1
***V1 not to exceed VR.**											

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 15
Table 4 of 6: V1 (MCG)

TEMP (deg. C)	PRESSURE ALTITUDE (1000 FT)								
	−2	0	2	4	6	8	10	12	14
60	116	115	112	110	108	104	100	100	97
55	116	115	112	110	108	104	100	100	97
50	119	117	112	110	108	104	100	100	97
45	122	120	115	111	108	104	100	100	97
40	125	123	118	114	109	104	100	100	97
35	127	126	121	116	112	106	100	100	97
30	127	128	124	119	114	109	103	100	97
25	128	128	125	121	117	111	106	100	97
20	128	128	126	123	119	114	108	102	98
15	128	129	126	123	120	116	111	105	100
10	128	129	126	123	120	117	113	107	102
5	128	129	126	123	120	117	114	110	104
0	128	129	126	123	120	117	114	111	106
−60	130	131	127	124	121	118	115	113	110

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
180 & ABV	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135
170	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	132	132	133
160	127	127	127	127	127	127	127	127	127	127	127	127	128	128	129	129	130	131
150	123	123	123	123	123	123	123	123	123	123	124	125	125	126	127	128	129	130
140	119	119	119	119	119	119	119	120	120	121	122	122	123	124	125	127	129	130
130	115	115	114	115	115	116	116	117	118	119	119	120	121	123	125	127	129	130
120	114	114	113	113	113	113	114	114	115	116	118	119	121	123	125	127	129	130
110	114	114	113	113	112	111	111	112	114	116	118	119	121	123	125	127	129	130
100	114	114	113	113	112	111	111	112	114	116	118	119	121	123	125	127	129	130

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
180 & ABV	142	142	142	142	142	142	142	142	142	142	142	143	143	143	143	143	144	144
170	138	138	138	138	138	138	138	138	138	139	139	139	139	139	140	141	142	142
160	134	134	134	134	134	134	134	134	134	135	135	136	136	137	138	139	140	141
150	130	130	130	130	130	130	130	130	131	131	132	133	134	135	136	137	139	140
140	126	126	126	126	126	126	126	127	128	129	130	131	132	133	135	137	138	140
130	121	121	121	121	122	122	123	124	126	127	128	129	131	133	135	137	138	140
120	119	119	119	119	120	120	121	122	123	125	127	128	131	133	135	137	138	140
110	119	119	119	119	119	119	120	121	123	125	126	128	131	133	135	137	138	140
100	119	119	119	119	119	119	119	121	123	125	126	128	131	133	135	137	138	140

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 20
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 20		
	V1	VR	V2
210	138	139	147
200	135	137	145
190	132	132	143
180	129	129	140
170	124	124	137
160	120	120	134
150	115	115	131
140	110	110	127
130	105	105	123
120	101	101	119
110	96	96	115
100	93	93	111

Check V1 (MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	7	7	9	9	10	11	13	13	13	3	3	4	5	5	5	6	6	6	–3	–3	–4	–5	–5	–6	–7	–7	–7
50	4	4	6	6	8	11	13	13	13	2	2	3	4	4	5	6	6	6	–2	–2	–3	–4	–5	–6	–7	–7	–7
40	2	2	4	5	6	9	11	12	13	1	1	2	3	3	4	5	6	6	–1	–1	–2	–3	–4	–5	–6	–7	–7
30	1	0	1	3	4	6	7	10	11	0	0	1	2	3	3	4	5	5	0	0	–1	–2	–2	–4	–5	–6	–6
20	1	0	1	1	2	3	6	8	10	0	0	1	1	2	2	4	4	4	0	0	0	–1	–1	–3	–4	–5	–6
10	1	0	1	1	2	2	3	5	7	0	0	1	1	2	2	3	4	4	0	0	0	–1	–1	–2	–4	–5	–6
0	1	0	1	1	2	3	3	4	6	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–4	–4	–5
–60	1	0	2	2	2	4	4	4	4	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–2	–2	–3

***V1 not to exceed VR.**

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
240	–3	–1	0	1	2	–3	–1	–1	0	1	1
220	–3	–1	0	1	3	–2	–1	–1	0	1	1
200	–3	–1	0	1	3	–2	–1	–1	0	1	2
180	–3	–1	0	1	3	–2	–1	–1	0	1	2
160	–3	–1	0	1	3	–2	–1	–1	0	1	2
140	–3	–1	0	1	2	–2	–1	–1	0	1	2
120	–2	–1	0	1	2	–2	–1	–1	0	1	2
100	–2	–1	0	1	2	–2	–1	–1	0	1	1

***V1 not to exceed VR.**

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 20
Table 4 of 6: V1 (MCG)

TEMP (deg. C)	PRESSURE ALTITUDE (1000 FT)								
	−2	0	2	4	6	8	10	12	14
60	115	114	111	109	106	102	99	99	96
55	115	114	111	109	106	102	99	99	96
50	117	116	111	109	106	102	99	99	96
45	120	119	114	110	106	102	99	99	96
40	123	122	117	112	108	102	99	99	96
35	126	125	120	115	110	105	99	99	96
30	126	127	122	118	113	108	102	99	96
25	126	127	124	120	116	110	104	99	96
20	126	127	124	121	118	113	107	101	97
15	127	127	124	122	119	115	109	104	99
10	127	127	124	122	119	115	112	106	101
5	127	127	125	122	119	116	113	109	103
0	127	128	125	122	119	116	113	110	105
−60	129	129	126	123	120	117	114	112	109

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
200 & ABV	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137
190	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	135	135
180	130	130	130	130	130	130	130	130	130	130	130	130	130	130	132	132	133	133
170	126	126	126	126	126	126	126	126	126	126	126	127	127	129	129	130	130	131
160	123	123	123	123	123	123	123	123	123	124	124	125	125	126	127	128	129	129
150	119	119	119	119	119	119	119	120	120	121	122	122	123	124	125	127	129	129
140	115	115	115	115	115	116	116	117	118	119	119	120	121	123	125	127	129	129
130	114	113	113	112	112	113	114	115	115	116	118	120	121	123	125	127	129	129
120	114	113	113	112	112	112	111	112	114	116	118	120	121	123	125	127	129	129
110	114	113	113	112	112	111	111	112	114	116	118	120	121	123	125	127	129	129
100	114	113	113	112	112	111	111	112	114	116	118	120	121	123	125	127	129	129

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
200 & ABV	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146
190	142	142	142	142	142	142	142	142	142	142	142	142	142	142	142	143	144	145
180	138	138	138	138	138	138	138	138	138	138	138	138	138	139	140	141	142	143
170	134	134	134	134	134	134	134	134	134	134	135	135	136	138	138	139	140	141
160	131	131	131	131	131	131	131	131	131	131	132	133	134	135	136	138	139	139
150	126	126	126	126	126	126	127	127	128	129	130	131	132	134	135	137	139	139
140	122	122	122	122	122	123	124	125	126	127	128	130	131	133	135	137	139	139
130	120	120	120	120	120	121	122	123	124	125	127	129	131	133	135	137	139	139
120	120	120	120	120	120	120	120	121	123	125	127	129	131	133	135	137	139	139
110	120	120	120	120	120	120	120	121	123	125	127	129	131	133	135	137	139	139
100	120	120	120	120	120	120	120	121	123	125	127	129	131	133	135	137	139	139

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 5
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 5		
	V1	VR	V2
240	156	164	171
230	152	161	167
220	148	157	164
210	143	153	161
200	139	149	157
190	135	145	153
180	130	141	150
170	125	136	145
160	120	131	142
150	114	126	139
140	109	121	135
130	103	116	131
120	97	111	127
110	94	106	123
100	92	101	119

Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	6	7	9	9	10	11	13	13	13	3	3	4	5	5	5	6	6	6	–3	–3	–4	–5	–5	–6	–7	–7	–7
50	4	4	6	6	8	11	13	13	13	2	2	3	4	4	5	6	6	6	–2	–2	–3	–4	–5	–6	–7	–7	–7
40	1	1	3	5	6	9	11	12	13	1	1	2	3	3	4	5	6	6	–1	–1	–2	–3	–4	–5	–6	–7	–7
30	0	0	1	3	4	6	8	10	11	0	0	1	2	3	3	4	5	5	0	0	–1	–2	–2	–4	–5	–6	–6
20	0	0	1	1	2	4	6	8	10	0	0	1	1	2	2	4	4	4	0	0	0	–1	–1	–3	–4	–5	–6
10	0	0	1	1	2	3	3	5	7	0	0	1	1	2	2	3	4	4	0	0	0	–1	–1	–2	–4	–5	–6
0	0	0	1	2	2	3	3	4	6	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–4	–4	–5
–60	0	0	1	2	2	4	4	4	4	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–2	–2	–3

***V1 not to exceed VR.**

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
240	–5	–2	0	2	4	–4	–3	–1	0	1	3
220	–4	–2	0	2	4	–4	–3	–1	0	2	3
200	–4	–2	0	2	4	–4	–3	–1	0	2	3
180	–4	–2	0	2	4	–4	–3	–1	0	2	3
160	–4	–2	0	2	4	–4	–3	–1	0	2	3
140	–4	–2	0	2	3	–4	–2	–1	0	2	3
120	–4	–2	0	2	3	–3	–2	–1	0	1	3
100	–3	–2	0	2	3	–3	–2	–1	0	1	2

***V1 not to exceed VR.**

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 5
Table 4 of 6: V1(MCG)

TEMP (deg. C)	PRESSURE ALTITUDE (1000 FT)								
	−2	0	2	4	6	8	10	12	14
60	117	115	113	111	108	104	101	100	98
55	117	115	113	111	108	104	101	100	98
50	119	118	113	111	108	104	101	100	98
45	122	121	116	111	108	104	101	100	98
40	125	124	119	114	110	104	101	100	98
35	128	127	122	117	112	106	101	100	98
30	128	129	124	120	115	109	104	100	98
25	128	129	126	122	118	112	106	100	98
20	128	129	126	123	120	114	109	103	98
15	129	129	126	123	120	117	111	106	101
10	129	129	126	124	121	117	114	108	103
5	129	130	127	124	121	117	115	111	105
0	129	130	127	124	121	117	115	112	107
−60	131	131	128	125	122	119	116	113	111

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	V1 (MCG)																		
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	132
170 & ABV	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135
160	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132	132
150	128	128	128	128	128	128	128	128	128	128	128	128	128	128	129	129	130	130	131
140	124	124	124	124	124	124	124	124	124	124	124	125	125	125	126	127	128	129	131
130	119	119	119	119	119	119	119	119	120	120	121	121	122	123	125	127	128	129	131
120	115	115	114	115	114	114	115	116	116	117	118	120	122	123	125	127	128	129	131
110	114	113	113	113	112	112	112	113	113	116	118	120	121	123	125	127	128	129	131
100	114	113	113	113	112	111	110	112	113	116	118	120	121	123	125	127	128	129	131

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	V1 (MCG)																		
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130	132
180 & ABV	148	148	148	148	148	148	148	148	148	148	148	148	148	148	149	149	149	149	149
170	144	144	144	144	144	144	144	144	144	144	144	144	145	145	145	145	145	146	146
160	140	140	140	140	140	140	140	140	140	140	140	140	141	141	141	142	142	143	143
150	135	135	135	135	135	135	135	135	136	136	136	136	137	137	138	139	140	142	143
140	130	130	130	130	130	131	131	131	132	132	132	133	134	135	136	138	140	142	143
130	125	125	126	126	126	126	127	127	128	129	130	131	132	134	136	138	140	142	143
120	120	120	120	120	121	122	123	124	125	126	128	130	132	134	136	138	140	142	143
110	119	119	119	119	119	119	120	122	123	125	128	130	132	134	136	138	140	142	143
100	119	119	119	119	119	119	120	122	123	125	128	130	132	134	136	138	140	142	143

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 15
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 15		
	V1	VR	V2
220	141	151	157
210	138	147	154
200	133	143	151
190	129	139	147
180	124	134	144
170	119	129	140
160	115	125	137
150	110	120	133
140	104	116	130
130	99	111	125
120	96	105	121
110	93	100	117
100	91	96	113
Check V1 (MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	6	7	9	9	10	11	13	13	13	3	3	4	5	5	5	6	6	6	–2	–3	–4	–4	–5	–6	–7	–7	–7
50	4	4	6	6	8	11	13	13	13	2	2	3	4	4	5	6	6	6	–2	–2	–2	–3	–4	–6	–7	–7	–7
40	1	1	3	5	7	9	11	12	13	1	1	2	3	3	4	5	6	6	–1	–1	–1	–2	–3	–5	–6	–7	–7
30	0	0	1	3	4	6	8	10	11	0	0	1	2	3	3	4	5	5	0	0	–1	–1	–2	–3	–5	–6	–6
20	0	0	1	1	2	4	6	8	10	0	0	1	1	2	2	4	4	4	0	0	0	–1	–1	–2	–4	–5	–6
10	0	0	1	1	2	3	3	5	7	0	0	1	1	2	2	3	4	4	0	0	0	–1	–1	–2	–4	–5	–6
0	0	0	1	2	2	3	3	4	6	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–4	–4	–5
–60	0	0	1	2	2	4	4	4	4	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–1	–2	–2	–3
*V1 not to exceed VR.																											

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
240	–5	–2	0	2	4	–4	–3	–1	0	1	3
220	–4	–2	0	2	4	–4	–3	–1	0	2	3
200	–4	–2	0	2	4	–4	–3	–1	0	2	3
180	–4	–2	0	2	4	–4	–3	–1	0	2	3
160	–4	–2	0	2	4	–4	–3	–1	0	2	3
140	–4	–2	0	2	3	–4	–2	–1	0	2	3
120	–4	–2	0	2	3	–3	–2	–1	0	1	3
100	–3	–2	0	2	3	–3	–2	–1	0	1	2
*V1 not to exceed VR.											

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 15
Table 4 of 6: V1 (MCG)

TEMP (deg. C)	PRESSURE ALTITUDE (1000 FT)								
	−2	0	2	4	6	8	10	12	14
60	116	115	112	110	108	104	100	100	97
55	116	115	112	110	108	104	100	100	97
50	119	117	112	110	108	104	100	100	97
45	122	120	115	111	108	104	100	100	97
40	125	123	118	114	109	104	100	100	97
35	127	126	121	116	112	106	100	100	97
30	127	128	124	119	114	109	103	100	97
25	128	128	125	121	117	111	106	100	97
20	128	128	126	123	119	114	108	102	98
15	128	129	126	123	120	116	111	105	100
10	128	129	126	123	120	117	113	107	102
5	128	129	126	123	120	117	114	110	104
0	128	129	126	123	120	117	114	111	106
−60	130	131	127	124	121	118	115	113	110

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
180 & ABV	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135	135
170	131	131	131	131	131	131	131	131	131	131	131	131	131	131	131	132	132	133
160	127	127	127	127	127	127	127	127	127	127	127	127	128	128	129	129	130	131
150	123	123	123	123	123	123	123	123	123	123	124	125	125	126	127	128	129	130
140	119	119	119	119	119	119	119	120	120	121	122	122	123	124	125	127	129	130
130	115	115	114	115	115	116	116	117	118	119	119	120	121	123	125	127	129	130
120	114	114	113	113	113	113	114	114	115	116	118	119	121	123	125	127	129	130
110	114	114	113	113	112	111	111	112	114	116	118	119	121	123	125	127	129	130
100	114	114	113	113	112	111	111	112	114	116	118	119	121	123	125	127	129	130

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	V1(MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
180 & ABV	142	142	142	142	142	142	142	142	142	142	142	143	143	143	143	144	144	144
170	138	138	138	138	138	138	138	138	138	139	139	139	139	139	140	141	142	142
160	134	134	134	134	134	134	134	134	134	135	135	136	136	137	138	139	140	141
150	130	130	130	130	130	130	130	130	131	131	132	133	134	135	136	137	139	140
140	126	126	126	126	126	126	126	127	128	129	130	131	132	133	135	137	138	140
130	121	121	121	121	122	122	123	124	126	127	128	129	131	133	135	137	138	140
120	119	119	119	119	120	120	121	122	123	125	127	128	131	133	135	137	138	140
110	119	119	119	119	119	119	120	121	123	125	126	128	131	133	135	137	138	140
100	119	119	119	119	119	119	119	121	123	125	126	128	131	133	135	137	138	140

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 20
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	FLAPS 20		
	V1	VR	V2
210	131	139	147
200	128	137	145
190	124	132	143
180	120	129	140
170	116	124	137
160	111	120	134
150	106	115	131
140	101	110	127
130	97	105	123
120	95	101	119
110	90	96	115
100	87	93	111

Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	V1									VR									V2								
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)								
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	7	7	9	9	10	11	13	13	13	3	3	4	5	5	5	6	6	6	–3	–3	–4	–5	–5	–6	–7	–7	–7
50	4	4	6	6	8	11	13	13	13	2	2	3	4	4	5	6	6	6	–2	–2	–3	–4	–5	–6	–7	–7	–7
40	2	2	4	5	6	9	11	12	13	1	1	2	3	3	4	5	6	6	–1	–1	–2	–3	–4	–5	–6	–7	–7
30	1	0	1	3	4	6	7	10	11	0	0	1	2	3	3	4	5	5	0	0	–1	–2	–2	–4	–5	–6	–6
20	1	0	1	1	2	3	6	8	10	0	0	1	1	2	2	4	4	4	0	0	0	–1	–1	–3	–4	–5	–6
10	1	0	1	1	2	2	3	5	7	0	0	1	1	2	2	3	4	4	0	0	0	–1	–1	–2	–4	–5	–6
0	1	0	1	1	2	3	3	4	6	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–4	–4	–5
–60	1	0	2	2	2	4	4	4	4	0	0	1	1	2	2	3	3	4	0	0	0	–1	–1	–2	–2	–2	–3

*V1 not to exceed VR.

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
240	–5	–2	0	2	4	–4	–3	–1	0	1	3
220	–4	–2	0	2	4	–4	–3	–1	0	2	3
200	–4	–2	0	2	4	–4	–3	–1	0	2	3
180	–4	–2	0	2	4	–4	–3	–1	0	2	3
160	–4	–2	0	2	4	–4	–3	–1	0	2	3
140	–4	–2	0	2	3	–4	–2	–1	0	2	3
120	–4	–2	0	2	3	–3	–2	–1	0	1	3
100	–3	–2	0	2	3	–3	–2	–1	0	1	2

*V1 not to exceed VR.

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 20
Table 4 of 6: V1 (MCG)

TEMP (deg. C)	PRESSURE ALTITUDE (1000 FT)								
	−2	0	2	4	6	8	10	12	14
60	115	114	111	109	106	102	99	99	96
55	115	114	111	109	106	102	99	99	96
50	117	116	111	109	106	102	99	99	96
45	120	119	114	110	106	102	99	99	96
40	123	122	117	112	108	102	99	99	96
35	126	125	120	115	110	105	99	99	96
30	126	127	122	118	113	108	102	99	96
25	126	127	124	120	116	110	104	99	96
20	126	127	124	121	118	113	107	101	97
15	127	127	124	122	119	115	109	104	99
10	127	127	124	122	119	115	112	106	101
5	127	127	125	122	119	116	113	109	103
0	127	128	125	122	119	116	113	110	105
−60	129	129	126	123	120	117	114	112	109

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	V1 (MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
200 & ABV	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137	137
190	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	134	135	135
180	130	130	130	130	130	130	130	130	130	130	130	130	130	130	132	132	133	133
170	126	126	126	126	126	126	126	126	126	126	126	127	127	129	129	130	130	131
160	123	123	123	123	123	123	123	123	123	124	124	125	125	126	127	128	129	129
150	119	119	119	119	119	119	119	120	120	121	122	122	123	124	125	127	129	129
140	115	115	115	115	115	116	116	117	118	119	119	120	121	123	125	127	129	129
130	114	113	113	112	112	113	114	115	115	116	118	120	121	123	125	127	129	129
120	114	113	113	112	112	112	111	112	114	116	118	120	121	123	125	127	129	129
110	114	113	113	112	112	111	111	112	114	116	118	120	121	123	125	127	129	129
100	114	113	113	112	112	111	111	112	114	116	118	120	121	123	125	127	129	129

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	V1 (MCG)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	130
200 & ABV	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146	146
190	142	142	142	142	142	142	142	142	142	142	142	142	142	142	142	143	144	145
180	138	138	138	138	138	138	138	138	138	138	138	138	138	139	140	141	142	143
170	134	134	134	134	134	134	134	134	134	134	135	135	136	138	138	139	140	141
160	131	131	131	131	131	131	131	131	131	131	132	133	134	135	136	138	139	139
150	126	126	126	126	126	126	127	127	128	129	130	131	132	134	135	137	139	139
140	122	122	122	122	122	123	124	125	126	127	128	130	131	133	135	137	139	139
130	120	120	120	120	120	121	122	123	124	125	127	129	131	133	135	137	139	139
120	120	120	120	120	120	120	120	121	123	125	127	129	131	133	135	137	139	139
110	120	120	120	120	120	120	120	121	123	125	127	129	131	133	135	137	139	139
100	120	120	120	120	120	120	120	121	123	125	127	129	131	133	135	137	139	139

Stabilizer Trim Setting

Max Takeoff Thrust

Flaps 5

WEIGHT (1000 KG)	C.G. (%MAC)										
	6	10	14	18	22	26	30	32	36	38	40
240	10.5	9.3	8.1	6.9	5.7	4.5	3.3	2.7	1.5	1.1	1.1
230	10.2	9.0	7.8	6.7	5.5	4.3	3.1	2.5	1.3	0.8	0.8
220	10.0	8.8	7.6	6.4	5.2	4.0	2.8	2.2	1.0	0.6	0.6
210	9.7	8.5	7.3	6.1	4.9	3.8	2.6	2.0	0.8	0.4	0.4
200	9.4	8.2	7.0	5.9	4.7	3.5	2.4	1.8	0.6	0.3	0.3
190	9.0	7.9	6.7	5.6	4.4	3.3	2.1	1.6	0.4	0.3	0.3
180	8.7	7.6	6.5	5.3	4.2	3.1	1.9	1.4	0.3	0.3	0.3
170	8.4	7.3	6.2	5.1	4.0	3.0	1.9	1.3	0.3	0.3	0.3
160	8.0	7.7	6.0	4.9	3.9	2.8	1.8	1.3	0.3	0.3	0.3
150	7.4	6.4	5.4	4.4	3.5	2.5	1.5	1.0	0.3	0.3	0.3
140	6.8	5.8	4.9	3.9	3.0	2.0	1.1	0.6	0.3	0.3	0.3
130	6.2	5.3	4.4	3.5	2.6	1.7	0.8	0.4	0.3	0.3	0.3
120	5.6	4.8	3.9	3.0	2.2	1.3	0.5	0.3	0.3	0.3	0.3
110	5.3	4.4	3.6	2.8	1.9	1.1	0.3	0.3	0.3	0.3	0.3
100	5.3	4.4	3.6	2.8	1.9	1.1	0.3	0.3	0.3	0.3	0.3

Flaps 15

WEIGHT (1000 KG)	C.G. (%MAC)										
	6	10	14	18	22	26	30	32	36	38	40
240	11.9	10.6	9.3	8.1	6.8	5.5	4.2	3.6	2.3	1.8	1.8
230	11.6	10.4	9.1	7.8	6.5	5.2	4.0	3.3	2.0	1.6	1.6
220	11.4	10.1	8.8	7.5	6.2	5.0	3.7	3.0	1.8	1.3	1.3
210	11.1	9.9	8.6	7.3	6.0	4.7	3.4	2.8	1.5	1.0	1.0
200	10.9	9.6	8.3	7.0	5.7	4.4	3.2	2.5	1.2	0.7	0.7
190	10.5	9.3	8.0	6.7	5.5	4.2	3.0	2.3	1.1	0.6	0.6
180	10.2	8.9	7.7	6.5	5.2	4.0	2.7	2.1	0.9	0.4	0.4
170	9.7	8.5	7.3	6.1	4.9	3.6	2.4	1.8	0.6	0.4	0.4
160	9.3	8.1	6.9	5.7	4.5	3.3	2.1	1.5	0.3	0.3	0.3
150	8.6	7.5	6.4	5.2	4.1	3.0	1.9	1.4	0.3	0.3	0.3
140	7.8	6.8	5.8	4.8	3.8	2.8	1.8	1.3	0.3	0.3	0.3
130	7.1	5.2	5.2	4.3	3.4	2.4	1.5	1.0	0.3	0.3	0.3
120	6.4	5.6	4.7	3.8	2.9	2.0	1.1	0.7	0.3	0.3	0.3
110	6.0	5.1	4.3	3.4	2.6	1.7	0.9	0.5	0.3	0.3	0.3
100	6.0	5.1	4.3	3.4	2.6	1.7	0.9	0.5	0.3	0.3	0.3

Flaps 20

WEIGHT (1000 KG)	C.G. (%MAC)										
	6	10	14	18	22	26	30	32	36	38	40
240	13.7	12.2	10.8	9.4	8.0	6.6	5.2	4.5	3.1	2.5	2.5
230	13.5	12.0	10.5	9.0	7.5	6.0	4.5	3.8	2.2	1.7	1.7
220	13.1	11.6	10.1	8.6	7.1	5.6	4.0	3.3	1.8	1.2	1.2
210	12.6	11.1	9.6	8.1	6.6	5.2	3.7	2.9	1.4	0.9	0.9
200	12.1	10.6	9.2	7.7	6.3	4.8	3.4	2.6	1.2	0.6	0.6
190	11.6	10.2	8.8	7.4	6.0	4.5	3.1	2.4	1.0	0.5	0.5
180	11.2	9.8	8.4	7.0	5.7	4.3	2.9	2.2	0.8	0.3	0.3
170	10.6	9.3	8.0	6.7	5.4	4.1	2.7	2.1	0.8	0.3	0.3
160	10.1	8.8	7.6	6.3	5.1	3.8	2.6	2.0	0.7	0.3	0.3
150	9.3	8.2	7.0	5.8	4.6	3.5	2.3	1.7	0.5	0.3	0.3
140	8.6	7.5	6.4	5.3	4.2	3.1	2.0	1.4	0.3	0.3	0.3
130	8.0	6.9	5.9	4.8	3.7	2.7	1.6	1.1	0.3	0.3	0.3
120	7.5	6.5	5.4	4.4	3.4	2.3	1.3	0.7	0.3	0.3	0.3
110	7.3	6.2	5.2	4.1	3.1	2.1	1.0	0.5	0.3	0.3	0.3
100	7.3	6.2	5.2	4.1	3.1	2.1	1.0	0.5	0.3	0.3	0.3

VREF

Based on 10,000 ft pressure altitude

WEIGHT (1000 KG)	VREF (KIAS)		
	FLAPS		
	30	25	20
240	172	177	177
230	168	172	172
220	164	168	168
210	160	164	164
200	156	160	160
190	152	155	155
180	148	151	151
170	144	147	147
160	140	143	144
150	135	138	140
140	131	133	135
130	126	128	131
120	121	123	126
110	119	119	122
100	119	119	121

Flap Maneuver Speed

Sea Level Pressure Altitude

WEIGHT (1000 KG)	MANEUVER SPEED (KIAS)						
	FLAPS						
	UP	1	5	15	20	25	30
240	250	231	210	182	182	174	171
230	247	227	207	179	179	170	167
220	243	223	203	177	177	166	163
210	239	219	199	176	176	162	159
200	235	214	195	175	175	158	155
190	231	209	191	171	171	154	150
180	227	203	187	167	167	149	146
170	223	198	183	163	163	146	142
160	220	195	180	160	160	142	139
150	215	190	175	155	155	137	134
140	211	186	171	151	151	133	130
130	206	181	166	146	146	128	125
120	202	177	162	142	142	123	121
110	200	175	160	140	140	119	119
100	198	173	158	138	138	119	119

Flaps 25 maneuver speed based on VREF25.
Flaps 30 maneuver speed based on VREF30.

10,000 FT Pressure Altitude

WEIGHT (1000 KG)	MANEUVER SPEED (KIAS)						
	FLAPS						
	UP	1	5	15	20	25	30
240	252	232	212	183	183	174	171
230	248	228	208	179	179	170	167
220	245	225	205	178	178	166	163
210	241	221	201	177	177	162	159
200	237	216	197	176	176	158	155
190	232	210	192	172	172	154	150
180	228	204	188	168	168	149	146
170	224	199	184	164	164	146	142
160	221	196	181	161	161	142	139
150	216	191	176	156	156	137	134
140	211	186	171	151	151	133	130
130	207	182	167	147	147	128	125
120	202	177	162	142	142	123	121
110	200	175	160	140	140	119	119
100	198	173	158	138	138	119	119

Flaps 25 maneuver speed based on VREF25.
Flaps 30 maneuver speed based on VREF30.

Flap Maneuver Speed

20,000 FT Pressure Altitude and Above

WEIGHT (1000 KG)	MANEUVER SPEED (KIAS)						
	FLAPS						
	UP	1	5	15	20	25	30
240	253	233	213	183	183	174	171
230	250	230	210	180	180	170	167
220	246	228	206	180	180	166	163
210	243	227	203	179	179	162	159
200	239	223	199	179	179	158	155
190	235	216	195	175	175	154	150
180	230	208	190	170	170	149	146
170	226	202	186	166	166	146	142
160	223	198	183	163	163	142	139
150	218	193	178	158	158	137	134
140	213	188	173	153	153	133	130
130	208	183	168	148	148	128	125
120	203	178	163	143	143	123	121
110	200	175	160	140	140	119	119
100	198	173	158	138	138	119	119

Flaps 25 maneuver speed based on VREF25.
Flaps 30 maneuver speed based on VREF30.

ADVISORY INFORMATION

Slush/Standing Water Takeoff

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–15.2	–18.6	–22.0	–24.8	–22.4	–25.8	–29.2	–31.9	–38.4	–41.8	–45.2	–47.9
240	–14.5	–17.9	–21.3	–24.0	–20.8	–24.2	–27.6	–30.3	–35.1	–38.5	–41.9	–44.6
230	–13.7	–17.1	–20.5	23.2	–19.3	–22.7	–26.1	–28.8	–31.8	–35.2	–38.6	–41.4
220	–12.8	–16.2	–19.6	–22.3	–17.7	–21.1	–24.5	–27.3	–28.8	–32.2	–35.6	–38.3
210	–11.9	–15.3	–18.7	–21.5	–16.3	–19.7	–23.1	–25.8	–25.9	–29.3	–32.7	–35.4
200	–11.1	–14.5	–17.9	–20.6	–14.8	–18.2	–21.6	–24.4	–23.1	–26.5	–29.9	–32.6
190	–10.2	–13.6	–17.0	–19.7	–13.4	–16.8	–20.2	–23.0	–20.5	–23.9	–27.3	–30.0
180	–9.2	–12.6	–16.0	–18.7	–12.0	–15.4	–18.8	–21.5	–18.1	–21.5	–24.9	–27.6
170	–8.3	–11.7	–15.1	–17.8	–10.7	–14.1	–17.5	–20.2	–15.8	–19.2	–22.6	–25.4
160	–7.3	–10.7	–14.1	–16.8	–9.4	–12.8	–16.2	–18.9	–13.7	–17.1	–20.5	–23.2
150	–6.3	–9.7	–13.1	–15.8	–8.1	–11.5	–14.9	–17.6	–11.7	–15.1	–18.6	–21.3
140	–5.3	–8.7	–12.1	–14.8	–6.8	–10.3	–13.7	–16.4	–10.0	–13.4	–16.8	–19.5
130	–4.2	–7.6	–11.0	–13.7	–5.6	–9.0	–12.4	–15.1	–8.3	–11.7	–15.1	–17.9
120	–3.2	–6.6	–10.0	–12.7	–4.4	–7.8	–11.2	–14.0	–6.9	–10.3	–13.7	–16.4
110	–2.1	–5.5	–8.9	–11.6	–3.3	–6.7	–10.1	–12.8	–5.6	–9.0	–12.4	–15.1
100	–1.0	–4.4	–7.8	–10.5	–2.1	–5.5	–8.9	–11.7	–4.4	–7.8	–11.2	–14.0

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1400					71.4				77.8			
1600	98.3				102.4				107.0			
1800	130.2	73.8			133.4	77.7			136.2	85.2		
2000	162.2	103.8			164.4	107.3			165.4	112.4		
2200	194.5	134.1	77.0		195.6	136.9	81.0		194.8	139.9	88.1	
2400	227.9	165.3	106.7		227.8	167.3	110.1		225.1	168.2	115.1	74.2
2600	262.4	197.6	137.0	91.1	261.0	198.6	139.7	94.9	256.7	197.5	142.5	101.0
2800		231.1	168.3	121.0		231.0	170.3	124.1		228.1	170.9	128.0
3000		265.8	200.7	151.7		264.3	201.7	154.2		259.8	200.4	155.9
3200			234.3	183.6			234.1	185.1			231.0	184.9
3400			269.0	216.6			267.4	217.0			262.7	214.8
3600				250.8				249.9				246.0
3800								283.3				278.0

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 –65 m/+65 m for every 10 deg. C above/below 0 deg. 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

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–10	–7	–5	–3	–6	–3	–1	0	0	0	0	0
240	–11	–8	–6	–4	–7	–4	–2	0	0	0	0	0
230	–11	–9	–6	–4	–7	–5	–2	0	0	0	0	0
220	–12	–9	–7	–5	–8	–6	–3	–1	0	0	0	0
210	–12	–10	–7	–5	–9	–6	–4	–2	–1	0	0	0
200	–13	–10	–8	–6	–10	–7	–5	–3	–2	0	0	0
190	–13	–11	–8	–6	–11	–8	–6	–4	–3	–1	0	0
180	–14	–12	–9	–7	–11	–9	–6	–4	–5	–2	0	0
170	–15	–12	–10	–8	–12	–9	–7	–5	–6	–4	–1	0
160	–15	–12	–10	–8	–13	–10	–8	–6	–7	–5	–2	0
150	–15	–13	–10	–8	–13	–10	–8	–6	–8	–6	–3	–1
140	–15	–13	–10	–8	–13	–11	–8	–6	–9	–6	–4	–2
130	–15	–13	–10	–8	–13	–11	–8	–6	–9	–7	–4	–2
120	–15	–12	–10	–8	–13	–11	–8	–6	–9	–7	–4	–2
110	–14	–12	–9	–7	–13	–10	–8	–6	–9	–7	–4	–2
100	–14	–11	–9	–7	–12	–10	–7	–5	–9	–7	–4	–2

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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–23.4	–27.5	–31.6	–34.8	–30.7	–34.7	–38.8	–42.1	–46.9	–51.0	–55.1	–58.3
240	–22.3	–26.4	–30.4	–33.7	–28.7	–32.8	–36.9	–40.1	–43.1	–47.2	–51.3	–54.5
230	–21.1	–25.2	–29.3	–32.5	–26.8	–30.9	–35.0	–38.2	–39.5	–43.5	–47.6	–50.9
220	–19.9	–24.0	–28.1	–31.3	–24.9	–29.0	–33.1	–36.4	–36.1	–40.1	–44.2	–47.5
210	–18.7	22.8	–26.9	–30.2	–23.1	–27.2	–31.3	–34.6	32.8	–36.9	–41.0	–44.2
200	–17.5	–21.6	–25.7	–28.9	–21.4	–25.4	–29.5	–32.8	–29.8	–33.8	–37.9	–41.2
190	–16.3	–20.4	–24.5	–27.8	–19.7	–23.8	–27.9	–31.1	–26.9	–31.0	–35.1	–38.3
180	–15.1	–19.2	–23.3	–26.5	–18.1	–22.1	–26.2	–29.5	–24.2	–28.3	–32.4	–35.7
170	–13.9	–18.0	–22.0	–25.3	–16.5	–20.5	–24.6	–27.9	–21.8	–25.9	–29.9	–33.2
160	–12.7	–16.7	–20.8	–24.1	–14.9	–19.0	–23.1	–26.4	–19.5	–23.6	–27.7	–30.9
150	–11.4	–15.5	–19.5	–22.8	–13.5	–17.6	–21.6	–24.9	–17.4	–21.5	–25.5	–28.8
140	–10.2	–14.2	–18.3	–21.6	–12.0	–16.1	–20.2	–23.5	–15.5	–19.5	–23.6	–26.9
130	–8.9	–13.0	–17.1	–20.3	–10.7	–14.7	–18.8	–22.1	–13.8	–17.9	–22.0	–25.2
120	–7.6	–11.7	–15.8	–19.1	–9.3	–13.4	–17.5	–20.8	–12.2	–16.3	–20.4	–23.7
110	–6.4	–10.4	–14.5	–17.8	–8.1	–12.2	–16.2	–19.5	–10.9	–15.0	–19.1	–22.4
100	–5.1	–9.2	–13.2	–16.5	–6.8	–10.9	–15.0	–18.3	–9.8	–13.9	–18.0	–21.2

ADVISORY INFORMATION

Slush/Standing Water Takeoff

No Reverse Thrust

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1800									84.9			
2000	79.7				96.5				116.7			
2200	118.9				132.6				148.6	86.0		
2400	158.1	77.2			168.7	94.9			180.4	116.1		
2600	197.2	116.6			205.0	130.6			213.1	146.9	84.2	
2800	236.2	155.8	75.0		241.7	166.6	92.8		246.7	178.6	114.4	
3000	275.2	195.0	114.4		278.6	202.9	128.5	69.8	280.8	211.2	145.1	94.8
3200		234.0	153.6	88.9		239.5	164.5	105.4		244.8	176.8	125.2
3400		273.0	192.7	128.3		276.4	200.8	141.2		278.9	209.3	156.2
3600			231.8	167.5			237.4	177.3			242.8	188.1
3800			270.8	206.6			274.3	213.8			276.9	221.1
4000				245.5				250.5				254.8
4200				284.6								

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 –80 m/+80 m for every 10 deg. C above/below 0 deg. 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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–15	–10	–5	–1	–10	–5	0	0	0	0	0	0
240	–16	–11	–6	–2	–11	–6	–1	0	0	0	0	0
230	–16	–11	–6	–2	–11	–6	–1	0	0	0	0	0
220	–17	–12	–7	–3	–12	–7	–2	0	0	0	0	0
210	–18	–13	–8	–4	–13	–8	–3	0	–2	0	0	0
200	–19	–14	–9	–5	–14	–9	–4	0	–4	0	0	0
190	–20	–15	–10	–6	–16	–11	–6	–2	–6	–1	0	0
180	–21	–16	–11	–7	–17	–12	–7	–3	–8	–3	0	0
170	–22	–17	–12	–8	–18	–13	–8	–4	–10	–5	0	0
160	–23	–18	–13	–9	–20	–15	–10	–6	–12	–7	–2	0
150	–24	–19	–14	–10	–21	–16	–11	–7	–14	–19	–4	0
140	–25	–20	–15	–11	–22	–17	–12	–8	–16	–11	–6	–2
130	–25	–20	–15	–11	–23	–18	–13	–9	–17	–12	–7	–3
120	–25	–20	–15	–11	–23	–18	–13	–9	–18	–13	–8	–4
110	–25	–20	–15	–11	–24	–19	–14	–10	–19	–14	–9	–5
100	–25	–20	–15	–11	–24	–19	–14	–10	–20	–15	–10	–6

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

Maximum 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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–7.8	–9.9	–11.9	–13.6	–11.2	–13.3	–15.3	–17.0	–17.3	–19.4	–21.4	–23.0
240	–8.2	–10.2	–12.2	–13.9	–11.2	–13.2	–15.3	–16.9	–16.6	–18.7	–20.7	–22.4
230	–8.3	–10.3	–12.4	–14.0	–11.1	–13.1	–15.1	–16.8	–16.0	–18.0	–20.0	–21.7
220	–8.4	–10.4	–12.5	–14.1	–10.8	–12.9	–14.9	–16.6	–15.2	–17.2	–19.3	–20.9
210	–8.3	–10.4	–12.4	–14.1	–10.5	–12.6	–14.6	–16.2	–14.4	–16.4	–18.5	–20.1
200	–8.2	–10.3	–12.3	–13.9	–10.1	–12.2	–14.2	–15.8	–13.6	–15.6	–17.6	–19.3
190	–7.9	–10.0	–12.0	–13.7	–9.6	–11.7	–13.7	–15.3	–12.7	–14.7	–16.7	–18.4
180	–7.6	–9.6	–11.7	–13.3	–9.1	–11.1	–13.2	–14.8	–11.7	–13.7	–15.8	–17.4
170	–7.1	–9.1	–11.2	–12.8	–8.4	–10.4	–12.5	–14.1	–10.8	–12.8	–14.8	–16.5
160	–6.5	–8.6	–10.6	–12.2	–7.7	–9.7	–11.7	–13.4	–9.7	–11.7	–13.8	–15.4
150	–5.9	–7.9	–9.9	–11.6	–6.8	–8.9	–10.9	–12.6	–8.7	–10.7	–12.7	–14.4
140	–5.0	–7.1	–9.1	–10.8	–5.9	–8.0	–10.0	–11.7	–7.5	–9.6	–11.6	–13.2
130	–4.1	–6.2	–8.2	–9.8	–4.9	–7.0	–9.0	–10.7	–6.4	–8.4	–10.5	–12.1
120	–3.1	–5.2	–7.2	–8.8	–3.9	–5.9	–8.0	–9.6	–5.2	–7.2	–9.3	–10.9
110	–2.0	–4.1	–6.1	–7.8	–2.7	–4.8	–6.8	–8.4	–3.9	–6.0	–8.0	–9.7
100	–0.8	–2.9	–4.9	–6.5	–1.5	–3.5	–5.6	–7.2	–2.6	–4.7	–6.7	–8.3

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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1400	76.9				80.1				84.9			
1600	108.9				111.3				114.4			
1800	141.3	87.3			143.0	90.2			144.7	94.4		
2000	174.9	119.2			175.9	121.4	69.3		176.1	124.1	74.5	
2200	209.9	152.1	97.6		209.9	153.5	100.3		208.8	154.7	103.9	
2400	246.2	186.1	129.7	86.8	245.2	186.7	131.7	89.7	242.7	186.5	133.9	93.9
2600	283.4	221.5	162.9	118.7	281.3	221.1	164.1	120.9	277.6	219.5	164.9	123.5
2800		258.3	197.4	151.5		256.9	197.7	153.0		254.0	197.0	154.2
3000			233.2	185.5			232.5	186.1			230.5	185.9
3200			270.2	220.9			268.4	220.5			265.3	218.9
3400				257.6				256.2				253.4

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 –60 m/+60 m for every 10 deg. C above/below 0 deg. 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

Maximum 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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–7	–4	–2	0	–5	–3	0	0	–2	0	0	0
240	–8	–5	–3	–1	–6	–4	–1	0	–4	–1	0	0
230	–9	–7	–4	–2	–8	–5	–3	–1	–5	–2	0	0
220	–10	–8	–5	–3	–9	–6	–4	–2	–6	–4	–1	0
210	–11	–9	–6	–4	–10	–7	–5	–3	–7	–5	–2	0
200	–12	–10	–7	–5	–11	–8	–6	–4	–8	–6	–3	–1
190	–13	–10	–8	–6	–11	–9	–6	–4	–9	–6	–4	–2
180	–14	–11	–9	–7	–12	–10	–7	–5	–10	–7	–5	–3
170	–14	–12	–9	–7	–13	–10	–8	–6	–10	–8	–5	–3
160	–15	–12	–10	–8	–13	–11	–8	–6	–11	–8	–6	–4
150	–15	–13	–10	–8	–14	–11	–9	–7	–11	–9	–6	–4
140	–15	–13	–10	–8	–14	–11	–9	–7	–11	–9	–6	–4
130	–15	–13	–10	–8	–14	–12	–9	–7	–12	–9	–7	–5
120	–15	–13	–10	–8	–14	–12	–9	–7	–12	–9	–7	–5
110	–15	–13	–10	–8	–14	–11	–9	–7	–11	–9	–6	–4
100	–15	–13	–10	–8	–14	–11	–9	–7	–11	–9	–6	–4

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.

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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–13.7	–15.2	–16.8	–18.1	–17.3	–18.9	–20.5	–21.8	–23.6	–25.2	–26.8	–28.0
240	–14.0	–15.6	–17.2	–18.5	–17.3	–18.9	–20.5	–21.7	–22.9	–24.4	–26.0	–27.3
230	–14.2	–15.8	–17.4	–18.7	–17.1	–18.7	–20.3	–21.5	–22.0	–23.6	–25.2	–26.5
220	–14.3	–15.9	–17.5	–18.7	–16.8	–18.4	–20.0	–21.3	–21.2	–22.8	–24.4	–25.6
210	–14.2	–15.8	–17.4	–18.6	–16.4	–18.0	–19.6	–20.9	–20.3	–21.9	–23.5	–24.7
200	–14.0	–15.6	–17.1	–18.4	–15.9	–17.5	–19.1	–20.4	–19.3	–20.9	–22.5	–23.8
190	–13.6	–15.2	–16.8	–18.1	–15.3	–16.9	–18.5	–19.8	–18.3	–19.9	–21.5	–22.8
180	–13.1	–14.7	–16.3	–17.6	–14.6	–16.2	–17.8	–19.1	–17.2	–18.8	–20.4	–21.7
170	–12.4	–14.0	–15.6	–16.9	–13.8	–15.4	–17.0	–18.2	–16.1	–17.7	–19.3	–20.6
160	–11.6	–13.2	–14.8	–16.1	–12.8	–14.4	–16.0	–17.3	–15.0	–16.6	–18.1	–19.4
150	–10.7	–12.2	–13.8	–15.1	–11.8	–13.4	–15.0	–16.2	–13.7	–15.3	–16.9	–18.2
140	–9.6	–11.2	–12.7	–14.0	–10.7	–12.2	–13.8	–15.1	–12.4	–14.0	–15.6	–16.9
130	–8.3	–9.9	–11.5	–12.7	–9.4	–11.0	–12.6	–13.8	–11.1	–12.7	–14.3	–15.6
120	–6.9	–8.5	–10.1	–11.4	–8.0	–9.6	–11.2	–12.4	–9.7	–11.3	–12.9	–14.2
110	–5.4	–7.0	–8.6	–9.8	–6.5	–8.1	–9.7	–11.0	–8.3	–9.8	–11.4	–12.7
100	–3.7	–5.3	–6.9	–8.2	–4.9	–6.5	–8.1	–9.3	–6.8	–8.3	–9.9	–11.2

ADVISORY INFORMATION

Dry Snow Takeoff

No Reverse Thrust

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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1800	72.4				82.2				94.3			
2000	113.0				120.4				129.1	71.0		
2200	153.9	85.5			159.2	94.5			164.8	105.5		
2400	195.2	126.2			198.5	132.9	68.7		201.4	140.5	82.1	
2600	237.1	167.2	98.7		238.5	171.8	106.9		239.3	176.5	116.7	70.3
2800	279.4	208.8	139.4	84.8	279.1	211.4	145.4	93.9	277.9	213.6	152.1	104.9
3000		250.7	180.6	125.4		251.6	184.6	132.2		251.8	188.4	139.9
3200			222.3	166.4			224.3	171.1			225.8	175.9
3400			264.4	208.0			264.7	210.7			264.2	212.9
3600				250.0				250.9				251.1

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 –65 m/+65 m for every 10 deg. C above/below 0 deg. 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.

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–10	–8	–5	–3	–8	–5	–3	–1	–4	–2	0	0
240	–11	–9	–6	–4	–9	–7	–4	–2	–6	–3	–1	0
230	–13	–10	–8	–6	–11	–8	–6	–4	–7	–5	–2	0
220	–14	–12	–9	–7	–12	–10	–7	–5	–9	–6	–4	–2
210	–16	–13	–11	–9	–14	–11	–9	–7	–10	–8	–5	–3
200	–17	–14	–12	–10	–15	–12	–10	–8	–11	–9	–6	–4
190	–18	–16	–13	–11	–16	–14	–11	–9	–13	–10	–8	–6
180	–19	–17	–14	–12	–17	–15	–12	–10	–14	–11	–9	–7
170	–21	–18	–16	–14	–19	–16	–14	–12	–15	–13	–10	–8
160	–22	–19	–17	–15	–20	–17	–15	–13	–16	–14	–11	–9
150	–23	–20	–18	–16	–21	–18	–16	–14	–18	–15	–13	–11
140	–24	–22	–19	–17	–22	–20	–17	–15	–19	–16	–14	–12
130	–25	–23	–20	–18	–23	–21	–18	–16	–20	–17	–15	–13
120	–26	–24	–21	–19	–24	–22	–19	–17	–20	–18	–15	–13
110	–27	–24	–22	–20	–25	–22	–20	–18	–21	–19	–16	–14
100	–28	–25	–23	–21	–26	–23	–21	–19	–22	–20	–17	–15

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

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–9.4	–12.6	–15.7	–18.3	–15.7	–18.9	–22.0	–24.6	–32.9	–36.1	–39.3	–41.8
240	–9.6	–12.7	–15.9	–18.5	–15.3	–18.5	–21.6	–24.2	–30.7	–33.9	–37.1	–39.6
230	–9.6	–12.8	–16.0	–18.5	–14.8	–18.0	–21.1	–23.7	–28.5	–31.7	–34.9	–37.4
220	–9.6	–12.7	–15.9	–18.5	–14.2	–17.4	–20.5	–23.1	–26.4	–29.5	–32.7	–35.2
210	–9.4	–12.6	–15.8	–18.3	–13.6	–16.7	–19.9	–22.5	–24.2	–27.4	–30.6	–33.1
200	–9.2	–12.3	–15.5	–18.1	–12.8	–16.0	–19.2	–21.7	–22.1	–25.3	–28.5	–31.0
190	–8.8	–12.0	–15.1	–17.7	–12.0	–15.2	–18.4	–20.9	–20.1	–23.3	–26.4	–29.0
180	–8.3	–11.5	–14.7	–17.2	–11.1	–14.3	–17.5	–20.0	–18.1	–21.3	–24.4	–27.0
170	–7.8	–10.9	–14.1	–16.6	–10.1	–13.3	–16.5	–19.0	–16.1	–19.3	–22.5	–25.0
160	–7.0	–10.2	–13.4	–15.9	–9.1	–12.2	–15.4	–18.0	–14.2	–17.3	–20.5	–23.0
150	–6.2	–9.4	–12.6	–15.1	–7.9	–11.1	–14.2	–16.8	–12.2	–15.4	–18.6	–21.1
140	–5.3	–8.5	–11.7	–14.2	–6.7	–9.8	–13.0	–15.6	–10.4	–13.6	–16.7	–19.3
130	–4.3	–7.4	–10.6	–13.2	–5.4	–8.5	–11.7	–14.2	–8.5	–11.7	–14.9	–17.4
120	–3.1	–6.3	–9.5	–12.0	–3.9	–7.1	–10.3	–12.8	–6.7	–9.9	–13.1	–15.6
110	–1.9	–5.1	–8.3	–10.8	–2.5	–5.7	–8.8	–11.4	–4.9	–8.1	–11.3	–13.8
100	–0.5	–3.7	–6.9	–9.4	–0.9	–4.1	–7.3	–9.8	–3.2	–6.4	–9.6	–12.1

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1400	72.5				76.2				81.5			
1600	106.5				109.0				111.7			
1800	140.5	84.2			141.8	87.0			141.9	93.6		
2000	174.4	116.2			174.6	118.2			172.0	121.0	73.6	
2200	209.3	149.1	92.2		208.3	150.0	94.7		203.7	149.6	100.5	
2400	245.6	182.9	124.3	79.3	243.0	182.9	126.0	82.3	237.6	179.7	128.0	89.7
2600	282.7	218.1	157.3	111.3	278.6	216.8	158.0	113.3	273.2	211.8	156.8	116.8
2800		254.7	191.5	143.9		251.8	191.2	145.0		246.4	187.5	145.0
3000			227.1	177.6			225.3	177.7		282.3	220.1	174.9
3200			263.9	212.6			260.6	211.4			255.3	206.7
3400				248.9				246.3				240.9
3600				286.0				281.9				276.5

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 –60 m/+60 m for every 10 deg. C above/below 0 deg. 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

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–6	–4	–1	0	–4	–1	0	0	0	0	0	0
240	–7	–5	–2	0	–5	–2	0	0	0	0	0	0
230	–8	–6	–3	–1	–6	–3	–1	0	0	0	0	0
220	–9	–7	–4	–2	–7	–4	–2	0	0	0	0	0
210	–10	–8	–5	–3	–8	–5	–3	–1	–1	0	0	0
200	–11	–9	–6	–4	–9	–6	–4	–2	–1	0	0	0
190	–12	–10	–7	–5	–10	–7	–5	–3	–3	0	0	0
180	–13	–11	–8	–6	–11	–8	–6	–4	–4	–1	0	0
170	–14	–11	–9	–7	–11	–9	–6	–4	–5	–3	0	0
160	–14	–12	–9	–7	–12	–10	–7	–5	–6	–4	–1	0
150	–15	–12	–10	–8	–13	–10	–8	–6	–8	–5	–3	–1
140	–15	–13	–10	–8	–13	–11	–8	–6	–8	–6	–3	–1
130	–16	–13	–11	–9	–14	–11	–9	–7	–9	–7	–4	–2
120	–16	–13	–11	–9	–14	–12	–9	–7	–10	–7	–5	–3
110	–16	–13	–11	–9	–14	–12	–9	–7	–11	–8	–6	–4
100	–16	–13	–11	–9	–14	–12	–9	–7	–11	–8	–6	–4

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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–15.6	–18.3	–21.0	–23.2	–22.5	–25.2	–27.9	–30.1	–39.7	–42.4	–45.1	–47.3
240	–15.7	–18.5	–21.2	–23.4	–21.9	–24.6	–27.4	–29.5	–37.3	–40.1	–42.8	–45.0
230	–15.8	–18.5	–21.2	–23.4	–21.3	–24.0	–26.7	–28.9	–35.0	–37.7	–40.5	–42.6
220	–15.7	–18.4	–21.1	–23.3	–20.5	–23.3	–26.0	–28.2	–32.7	–35.4	–38.1	–40.3
210	–15.5	–18.2	–20.9	–23.1	–19.7	–22.5	–25.2	–27.4	–30.4	–33.2	–35.9	–38.1
200	–15.1	–17.8	–20.5	–22.7	–18.8	–21.5	–24.3	–26.4	–28.2	–30.9	–33.7	–35.8
190	–14.6	–17.3	–20.0	–22.2	–17.8	–20.5	–23.3	–25.4	–26.0	–28.7	–31.4	–33.6
180	–13.9	–16.6	–19.4	–21.5	–16.7	–19.5	–22.2	–24.4	–23.8	–26.5	–29.3	–31.4
170	–13.2	–15.9	–18.6	–20.8	–15.6	–18.3	–21.0	–23.2	–21.6	–24.4	–27.1	–29.3
160	–12.2	–14.9	–17.6	–19.8	–14.3	–17.0	–19.7	–21.9	–19.5	–22.2	–24.9	–27.1
150	–11.1	–13.8	–16.6	–18.7	–12.9	–15.6	–18.4	–20.5	–17.4	–20.1	–22.8	–25.0
140	–9.9	–12.6	–15.3	–17.5	–11.5	–14.2	–16.9	–19.1	–15.3	–18.0	–20.7	–22.9
130	–8.5	–11.2	–14.0	–16.1	–9.9	–12.6	–15.3	–17.5	–13.2	–15.9	–18.6	–20.8
120	–7.0	–9.8	–12.5	–14.7	–8.3	–11.0	–13.7	–15.9	–11.2	–13.9	–16.6	–18.8
110	–5.4	–8.1	–10.8	–13.0	–6.5	–9.3	–12.0	–14.2	–9.1	–11.8	–14.6	–16.7
100	–3.6	–6.3	–9.0	–11.2	–4.7	–7.4	–10.1	–12.3	–7.1	–9.8	–12.6	–14.7

ADVISORY INFORMATION

Wet Snow Takeoff
No Reverse Thrust
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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1800	70.8				81.1				95.3			
2000	112.2				120.1				130.4	76.4		
2200	153.5	81.8			159.2	91.6			165.6	108.6		
2400	194.9	122.6			198.2	130.1	62.7		200.8	140.8	85.5	
2600	236.7	163.7	91.9		237.6	168.8	101.1		237.8	174.4	116.7	72.9
2800	278.9	205.2	132.7	75.6	277.1	207.9	139.6	85.7	276.4	209.7	149.0	104.1
3000		247.1	174.0	116.3		247.4	178.4	124.1		247.2	182.9	135.7
3200		289.3	215.6	157.3		286.9	217.6	162.8		286.1	218.9	169.1
3400			257.5	198.8			257.2	201.9			256.8	204.2
3600				240.6				241.3				241.3
3800				282.8				280.8				280.0

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 –65 m/+65 m for every 10 deg. C above/below 0 deg. 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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–9	–4	0	0	–6	–1	0	0	0	0	0	0
240	–11	–6	–1	0	–7	–2	0	0	0	0	0	0
230	–12	–7	–2	0	–8	–3	0	0	0	0	0	0
220	–13	–8	–3	0	–9	–4	0	0	0	0	0	0
210	–15	–10	–5	–1	–11	–6	–1	0	–1	0	0	0
200	–16	–11	–6	–2	–12	–7	–2	0	–2	0	0	0
190	–17	–12	–7	–3	–14	–9	–4	0	–4	0	0	0
180	–19	–14	–9	–5	–15	–10	–5	–1	–6	–1	0	0
170	–20	–15	–10	–6	–17	–12	–7	–3	–8	–3	0	0
160	–22	–17	–12	–8	–19	–14	–9	–5	–10	–5	0	0
150	–23	–18	–13	–9	–20	–15	–10	–6	–13	–8	–3	0
140	–24	–19	–14	–10	–22	–17	–12	–8	–15	–10	–5	–1
130	–25	–20	–15	–11	–23	–18	–13	–9	–17	–12	–7	–3
120	–26	–21	–16	–12	–24	–19	–14	–10	–19	–14	–9	–5
110	–28	–23	–18	–14	–26	–21	–16	–12	–21	–16	–11	–7
100	–29	–24	–19	–15	–27	–22	–17	–13	–23	–18	–13	–9

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

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–0.1	–1.0	–2.0	–2.7	–4.7	–5.6	–6.5	–7.2	–27.0	–27.9	–28.8	–29.6
240	–0.7	–1.6	–2.5	–3.3	–5.7	–6.6	–7.5	–8.3	–26.7	–27.6	–28.5	–29.3
230	–1.1	–2.0	–2.9	–3.6	–6.5	–7.4	–8.3	–9.0	–26.2	–27.1	–28.0	–28.7
220	–1.3	–2.2	–3.1	–3.9	–7.0	–7.9	–8.8	–9.6	–25.4	–26.3	–27.2	–27.9
210	–1.3	–2.2	–3.1	–3.9	–7.3	–8.2	–9.1	–9.8	–24.4	–25.3	–26.2	–26.9
200	–1.2	–2.1	–3.0	–3.7	–7.2	–8.1	–9.0	–9.8	–23.2	–24.1	–25.0	–25.8
190	–0.8	–1.7	–2.6	–3.4	–6.8	–7.8	–8.7	–9.4	–21.8	–22.7	–23.6	–24.3
180	–0.4	–1.3	–2.2	–2.9	–6.4	–7.3	–8.2	–8.9	–20.1	–21.0	–22.0	–22.7
170	0.0	–1.0	–1.9	–2.6	–5.9	–6.8	–7.7	–8.4	–18.6	–19.5	–20.4	–21.1
160	0.0	–0.9	–1.8	–2.5	–5.4	–6.3	–7.2	–7.9	–17.1	–18.1	–19.0	–19.7
150	0.0	–0.9	–1.8	–2.5	–4.9	–5.9	–6.8	–7.5	–15.7	–16.6	–17.5	–18.2
140	0.0	–0.9	–1.8	–2.5	–4.6	–5.5	–6.4	–7.1	–14.4	–15.3	–16.2	–16.9
130	0.0	–0.9	–1.8	–2.5	–4.2	–5.1	–6.0	–6.8	–13.1	–14.0	–14.9	–15.6
120	0.0	–0.9	–1.8	–2.5	–3.9	–4.8	–5.7	–6.4	–11.9	–12.8	–13.7	–14.4
110	–0.1	–1.0	–1.9	–2.6	–3.6	–4.5	–5.4	–6.2	–10.7	–11.6	–12.5	–13.2
100	–0.5	–1.4	–2.3	–3.0	–3.4	–4.3	–5.2	–5.9	–9.6	–10.5	–11.4	–12.2

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1200	68.9											
1400	107.6				72.0							
1600	146.3	84.9			105.8							
1800	185.0	123.3	62.0		139.6	82.2						
2000	223.9	161.7	100.3		173.9	114.7						
2200	263.1	200.5	138.6	89.6	209.6	148.0	90.1		92.9			
2400		239.6	177.3	127.8	246.8	182.6	122.8	77.2	112.0			
2600		278.8	216.1	166.4	284.9	218.6	156.5	109.6	131.6			
2800			255.3	205.2		256.2	191.4	142.8	151.8	94.9		
3000				244.3			227.7	177.1	172.7	114.0		
3200				283.6			265.6	213.0	194.4	133.6		
3400								250.3	217.1	154.0	96.9	
3600									240.6	175.0	116.0	
3800									265.1	196.7	135.7	90.8
4000										219.5	156.1	109.9
4200										243.2	177.1	129.4
4400										267.6	199.1	149.6
4600											221.9	170.4
4800											245.7	192.1
5000											270.1	214.3

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 –50 m/+50 m for every 10 deg. C above/below 0 deg. C.
Adjust "Medium" field length available by –60 m/+60 m for every 10 deg. C above/below 0 deg. C.
Adjust "Poor" field length available by –90 m/+90 m for every 10 deg. C above/below 0 deg. 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
Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–5	–3	0	0	–8	–5	–3	–1	–25	–22	–20	–18
240	–6	–4	–1	0	–9	–7	–4	–2	–26	–24	–21	–19
230	–7	–4	–2	0	–10	–8	–5	–3	–28	–26	–23	–21
220	–8	–5	–3	–1	–11	–9	–6	–4	–30	–27	–25	–23
210	–8	–6	–3	–1	–12	–10	–7	–5	–31	–29	–26	–24
200	–8	–6	–3	–1	–13	–11	–8	–6	–33	–30	–28	–26
190	–9	–6	–4	–2	–14	–11	–9	–7	–34	–32	–29	–27
180	–9	–6	–4	–2	–15	–12	–10	–8	–36	–33	–31	–29
170	–9	–6	–4	–2	–15	–13	–10	–8	–37	–34	–32	–30
160	–9	–6	–4	–2	–16	–13	–11	–9	–38	–35	–33	–31
150	–9	–6	–4	–2	–16	–14	–11	–9	–39	–36	–34	–32
140	–8	–6	–3	–1	–16	–14	–11	–9	–40	–37	–35	–33
130	–8	–5	–3	–1	–17	–14	–12	–10	–41	–38	–36	–34
120	–8	–5	–3	–1	–17	–14	–12	–10	–41	–39	–36	–34
110	–7	–4	–2	0	–17	–14	–12	–10	–42	–40	–37	–35
100	–6	–4	–1	0	–17	–14	–12	–10	–43	–40	–38	–36

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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–4.9	–5.4	–5.9	–6.2	–10.6	–11.1	–11.5	–11.9	–39.7	–40.2	–40.6	–41.0
240	–5.4	–5.9	–6.4	–6.7	–11.7	–12.2	–12.6	–13.0	–38.9	–39.4	–39.8	–40.2
230	–5.8	–6.2	–6.7	–7.0	–12.5	–13.0	–13.4	–13.8	–37.8	–38.2	–38.7	–39.1
220	–5.9	–6.4	–6.8	–7.2	–13.0	–13.4	–13.9	–14.2	–36.3	–36.7	–37.2	–37.6
210	–5.8	–6.3	–6.7	–7.1	–13.2	–13.6	–14.1	–14.4	–34.5	–35.0	–35.4	–35.8
200	–5.5	–6.0	–6.4	–6.8	–13.1	–13.5	–14.0	–14.3	–32.4	–32.8	–33.3	–33.7
190	–5.1	–5.5	–6.0	–6.4	–12.6	–13.1	–13.5	–13.9	–29.9	–30.4	–30.8	–31.2
180	–4.5	–4.9	–5.4	–5.8	–11.9	–12.4	–12.8	–13.2	–27.3	–27.7	–28.2	–28.5
170	–3.9	–4.4	–4.9	–5.2	–11.2	–11.7	–12.2	–12.5	–24.7	–25.1	–25.6	–25.9
160	–3.5	–3.9	–4.4	–4.8	–10.6	–11.1	–11.5	–11.9	–22.2	–22.6	–23.1	–23.5
150	–3.1	–3.5	–4.0	–4.4	–9.9	–10.4	–10.8	–11.2	–19.8	–20.2	–20.7	–21.0
140	–2.8	–3.2	–3.7	–4.0	–9.3	–9.8	–10.2	–10.6	–17.5	–17.9	–18.4	–18.7
130	–2.5	–2.9	–3.4	–3.8	–8.7	–9.1	–9.6	–9.9	–15.2	–15.7	–16.1	–16.5
120	–2.3	–2.8	–3.2	–3.6	–8.0	–8.5	–8.9	–9.3	–13.1	–13.6	–14.0	–14.4
110	–2.2	–2.6	–3.1	–3.4	–7.4	–7.8	–8.3	–8.7	–11.1	–11.6	–12.0	–12.4
100	–2.1	–2.6	–3.0	–3.4	–6.8	–7.2	–7.7	–8.0	–9.2	–9.6	–10.1	–10.4

ADVISORY INFORMATION

Slippery Runway Takeoff

No Reverse Thrust

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1600	95.4											
1800	140.3	58.9			63.5							
2000	185.3	106.6			106.1							
2200	230.0	154.0	73.6		148.8	74.2						
2400	273.6	199.9	122.1	57.1	191.9	116.7						
2600		244.1	169.1	105.6	235.4	159.4	84.8					
2800		287.6	214.3	153.2	279.3	202.6	127.2	67.7				
3000			258.2	199.1		246.2	170.1	110.2				
3200				243.4		290.0	213.4	152.8				
3400				287.0			257.1	195.9				
3600								239.4				
3800								283.4	82.1			
4000									107.4			
4200									133.2			
4400									159.9	84.8		
4600									187.6	110.0		
4800									216.4	135.9		
5000									246.3	162.6		

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 –50 m/+50 m for every 10 deg. C above/below 0 deg. C.
   Adjust "Medium" field length available by –60 m/+60 m for every 10 deg. C above/below 0 deg. C.
   Adjust "Poor" field length available by –90 m/+90 m for every 10 deg. C above/below 0 deg. 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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
250	–8	–3	0	0	–12	–7	–2	0	–42	–37	–32	–28
240	–9	–4	0	0	–13	–8	–3	0	–45	–40	–35	–31
230	–10	–5	0	0	–14	–9	–4	0	–47	–42	–37	–33
220	–11	–6	–1	0	–16	–11	–6	–2	–49	–44	–39	–35
210	–11	–6	–1	0	–17	–12	–7	–3	–52	–47	–42	–38
200	–12	–7	–2	0	–18	–13	–8	–4	–54	–49	–44	–40
190	–12	–7	–2	0	–20	–15	–10	–6	–57	–52	–47	–43
180	–13	–8	–3	0	–21	–16	–11	–7	–59	–54	–49	–45
170	–13	–8	–3	0	–22	–17	–12	–8	–61	–56	–51	–47
160	–13	–8	–3	0	–23	–18	–13	–9	–63	–58	–53	–49
150	–13	–8	–3	0	–24	–19	–14	–10	–65	–60	–55	–51
140	–13	–8	–3	0	–26	–21	–16	–12	–68	–63	–58	–54
130	–13	–8	–3	0	–27	–22	–17	–13	–70	–65	–60	–56
120	–13	–8	–3	0	–28	–23	–18	–14	–72	–67	–62	–58
110	–13	–8	–3	0	–29	–24	–19	–15	–74	–69	–64	–60
100	–12	–7	–2	0	–30	–25	–20	–16	–76	–71	–66	–62

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

Takeoff TPR

Max Takeoff Thrust

Based on anti-ice off

AIRPORT OAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
75	44.6	45.2	45.7	44.9	44.1	43.3	42.4	41.5	40.6	38.8	37.4	36.3	34.8	33.3	31.8	30.6	29.3
70	48.0	48.8	49.4	48.7	47.9	47.2	46.4	45.6	44.8	42.9	41.6	40.5	39.0	37.6	36.1	35.0	33.8
65	51.3	52.3	53.1	52.4	51.7	51.1	50.4	49.6	48.9	47.0	45.7	44.7	43.2	41.8	40.4	39.4	38.3
60	54.7	55.8	56.8	56.2	55.5	55.0	54.4	53.7	53.0	51.1	49.9	48.9	47.5	46.1	44.7	43.7	42.7
55	57.5	59.1	60.5	60.0	59.4	58.9	58.3	57.7	57.2	55.2	54.0	53.1	51.7	50.4	49.0	48.1	47.2
50	60.3	61.9	63.5	63.3	63.1	62.8	62.3	61.8	61.3	59.3	58.1	57.3	55.9	54.6	53.3	52.5	51.7
45	63.1	64.9	66.4	66.3	66.2	66.1	66.0	65.8	65.4	63.4	62.3	61.5	60.2	58.9	57.5	56.9	56.1
40	66.2	68.0	69.7	69.5	69.3	69.3	69.3	69.1	69.1	67.4	66.4	65.7	64.4	63.1	61.8	61.2	60.6
35	68.7	70.9	73.1	72.9	72.7	72.7	72.6	72.5	72.5	71.1	70.4	69.8	68.6	67.4	66.1	65.6	65.0
30	69.3	72.4	75.4	75.7	76.0	76.2	76.1	76.0	76.0	74.8	74.4	73.9	72.4	71.4	70.3	70.0	69.5
25	69.5	72.5	75.6	76.8	78.1	79.0	79.4	79.8	79.8	78.6	78.1	77.8	76.3	75.2	74.1	73.8	73.6
20	69.7	72.7	75.8	77.0	78.3	79.7	81.0	82.4	82.8	82.3	81.9	81.6	80.2	79.1	77.9	77.5	77.3
15	69.9	72.9	76.0	77.2	78.5	79.9	81.2	82.6	83.8	84.9	85.5	85.2	84.0	83.2	82.1	81.6	81.1
10	70.0	73.1	76.2	77.4	78.7	80.1	81.4	82.8	84.1	85.1	86.3	87.4	88.2	87.5	86.5	85.8	85.2
5	70.2	73.3	76.4	77.6	78.9	80.3	81.7	83.0	84.3	85.4	86.5	87.6	90.3	90.8	90.7	89.9	89.1
0	70.4	73.5	76.6	77.8	79.1	80.5	81.9	83.2	84.5	85.6	86.7	87.9	90.6	91.9	93.2	93.3	92.7
–10	70.8	73.9	77.0	78.2	79.5	80.9	82.3	83.7	85.0	86.0	87.2	88.3	91.0	92.4	93.7	94.3	94.9
–20	71.1	74.3	77.4	78.6	79.9	81.3	82.7	84.1	85.4	86.5	87.6	88.8	91.5	92.9	94.2	94.8	95.4
–30	71.5	74.7	77.8	79.0	80.4	81.8	83.2	84.5	85.8	86.9	88.1	89.2	92.0	93.3	94.7	95.3	95.9
–40	71.9	75.0	78.2	79.4	80.8	82.2	83.6	85.0	86.3	87.4	88.5	89.7	92.5	93.8	95.2	95.8	96.4
–50	72.2	75.4	78.6	79.8	81.2	82.6	84.0	85.4	86.7	87.8	89.0	90.2	93.0	94.3	95.7	96.3	96.9

TPR Adjustment for Anti-ice

For OAT≤10 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)							
	–2	0	9	10	11	12	13	14
ENGINE ON	0.0	0.0	0.0	–1.0	–1.0	–1.0	–1.1	–1.1
ENGINE & WING ON	0.0	0.0	0.0	–1.4	–1.4	–1.5	–1.5	–1.5
ENGINE AUTO	0.0	0.0	0.0	–1.0	–1.0	–1.0	–1.1	–1.1
ENGINE & WING AUTO	0.0	0.0	0.0	–1.4	–1.4	–1.5	–1.5	–1.5

For 10 deg. C<OAT≤20 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ENGINE ON	–1.5	–1.5	–1.5	–1.5	–1.5	–1.6	–1.6	–1.7	–1.7	–1.8	–1.8	–1.9	–1.9	–2.0	–2.1	–2.1	–2.2
ENGINE & WING ON	–1.7	–1.7	–1.8	–1.8	–1.9	–1.9	–2.0	–2.0	–2.1	–2.1	–2.2	–2.3	–2.3	–2.4	–2.5	–2.6	–2.7
With engine anti-ice auto or engine and wing anti-ice auto, no adjustment is necessary.																	

ADVISORY INFORMATION

Takeoff TPR
Max Takeoff Thrust
Based on anti-ice off
Minimum Allowable TPR for Reduced Thrust
Based on 25% thrust reduction

MAX TAKEOFF TPR FOR ACTUAL OAT	MIN TAKEOFF TPR ALLOWED
45.0	45.0
50.0	45.0
55.0	45.0
60.0	47.2
65.0	51.0
70.0	54.6
75.0	58.3
80.0	61.8
85.0	65.1
90.0	68.3
95.0	71.0
100.0	73.5
105.0	75.6
110.0	77.8

Go-Around TPR

Based on anti-ice off

REPORTED OAT (deg. C)	TAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
		–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
56	60	55.8	57.2	58.4	57.9	57.4	56.9	56.4	55.8	55.3	53.6	52.4	51.5	50.1	48.8	47.4	46.5	45.6
51	55	58.4	59.9	61.4	61.2	61.0	60.7	60.2	59.8	59.3	57.6	56.4	55.5	54.2	52.9	51.6	50.8	49.9
46	50	61.1	62.7	64.2	64.1	64.0	64.0	63.9	63.7	63.2	61.5	60.5	59.6	58.3	57.1	55.7	55.0	54.2
41	45	64.1	65.7	67.3	67.1	67.0	67.1	67.1	67.0	67.0	65.5	64.5	63.7	62.4	61.2	59.9	59.2	58.5
36	40	66.5	68.7	70.6	70.4	70.3	70.3	70.3	70.3	70.3	69.0	68.3	67.7	66.5	65.3	64.1	63.5	62.8
31	35	67.6	70.6	73.2	73.4	73.7	73.7	73.7	73.7	73.6	72.5	72.0	71.5	70.2	69.3	68.2	67.7	67.1
26	30	67.7	70.8	73.9	75.1	76.2	76.6	77.1	77.2	77.2	76.2	75.7	75.4	73.8	72.9	71.9	71.6	71.3
21	25	67.9	71.0	74.1	75.3	76.5	77.9	79.3	80.1	80.5	80.0	79.5	79.2	77.7	76.7	75.6	75.2	74.8
16	20	68.1	71.2	74.3	75.5	76.7	78.1	79.5	80.9	82.3	83.4	83.2	82.9	81.6	80.7	79.6	79.0	78.5
11	15	68.3	71.4	74.5	75.6	76.9	78.3	79.7	81.1	82.5	83.8	84.9	86.1	85.9	84.9	83.9	83.2	82.5
7	10	68.4	71.6	74.7	75.8	77.1	78.5	79.9	81.3	82.7	84.0	85.2	86.3	88.6	88.8	88.6	87.4	86.6
2	5	68.6	71.7	74.9	76.0	77.3	78.7	80.1	81.5	82.9	84.2	85.4	86.6	89.3	90.7	91.9	91.1	90.3
–3	0	68.8	71.9	75.1	76.2	77.5	78.9	80.3	81.7	83.1	84.4	85.6	86.8	89.5	90.9	92.3	92.8	93.2
–13	–10	69.1	72.3	75.4	76.6	77.9	79.3	80.7	82.1	83.5	84.8	86.0	87.2	90.0	91.4	92.8	93.3	93.7
–23	–20	69.5	72.7	75.8	77.0	78.3	79.7	81.1	82.6	84.0	85.3	86.5	87.7	90.5	91.9	93.3	93.7	94.2
–33	–30	69.9	73.0	76.2	77.4	78.7	80.1	81.6	83.0	84.4	85.7	86.9	88.1	90.9	92.4	93.8	94.2	94.7
–43	–40	70.2	73.4	76.6	77.8	79.1	80.5	82.0	83.4	84.8	86.2	87.4	88.6	91.4	92.8	94.2	94.7	95.2
–53	–50	70.6	73.8	77.0	78.2	79.5	80.9	82.4	83.8	85.3	86.6	87.8	89.0	91.9	93.3	94.7	95.2	95.6

TPR Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)							
	–2	0	9	10	11	12	13	14
ENGINE ON	0.0	0.0	0.0	–1.0	–1.0	–1.0	–1.1	–1.1
ENGINE & WING ON	0.0	0.0	0.0	–1.4	–1.4	–1.5	–1.5	–1.5
ENGINE AUTO	0.0	0.0	0.0	–1.0	–1.0	–1.0	–1.1	–1.1
ENGINE & WING AUTO	0.0	0.0	0.0	–1.4	–1.4	–1.5	–1.5	–1.5

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ENGINE ON	–1.5	–1.5	–1.5	–1.5	–1.6	–1.6	–1.6	–1.7	–1.7	–1.8	–1.8	–1.9	–1.9	–2.0	–2.1	–2.1	–2.2
ENGINE & WING ON	–1.7	–1.8	–1.8	–1.8	–1.9	–1.9	–2.0	–2.0	–2.1	–2.1	–2.2	–2.3	–2.3	–2.4	–2.5	–2.6	–2.7
With engine anti-ice auto or engine and wing anti-ice auto, no adjustment is necessary.																	

Max Climb TPR

Based on anti-ice off

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)									
	0	5	10	15	20	25	30	35	40	43
	310	310	310	310	310	310	310	0.85	0.85	0.85
60	47.9	47.4	49.1	53.1	57.0	59.4	61.7	64.8	65.6	65.3
50	54.4	53.5	52.1	53.1	57.0	59.4	61.7	64.8	65.6	65.3
40	60.8	61.0	59.3	58.9	58.2	59.4	61.7	64.8	65.6	65.3
30	62.3	66.7	67.1	67.4	66.6	65.2	63.2	64.8	65.6	65.3
20	62.7	67.1	72.1	75.5	76.2	74.9	74.7	68.4	66.3	66.0
15	62.8	67.3	72.3	77.7	80.7	79.7	78.8	74.5	72.2	71.8
10	63.0	67.4	72.4	77.9	83.2	84.5	82.9	79.9	78.2	77.7
5	63.1	67.6	72.6	78.1	83.9	87.3	87.5	84.2	82.9	82.4
0	63.3	67.8	72.8	78.3	84.1	88.3	90.4	88.4	87.3	86.9
–5	63.4	67.9	73.0	78.5	84.3	88.5	91.3	93.2	92.1	91.9
–10	63.6	68.1	73.2	78.7	84.5	88.7	91.5	95.6	96.0	96.0
–15	63.8	68.3	73.3	78.9	84.7	88.9	91.7	96.3	97.6	97.7
–20	63.9	68.4	73.5	79.0	84.9	89.1	92.0	96.5	97.9	97.9
–25	64.1	68.6	73.7	79.2	85.1	89.3	92.2	96.8	98.1	98.1
–30	64.2	68.8	73.9	79.4	85.3	89.5	92.4	97.0	98.3	98.3
–35	64.4	68.9	74.1	79.6	85.5	89.7	92.6	97.2	98.5	98.6
–40	64.5	69.1	74.2	79.8	85.7	89.9	92.8	97.4	98.8	98.8

TPR Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	43
ENGINE ON	0.0	0.0	0.0	–1.1	–1.4	–1.7	–2.1	–2.6	–3.7	–4.8
ENGINE & WING ON	0.0	0.0	0.0	–1.6	–2.0	–2.6	–3.3	–4.2	–6.0	–7.9

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	43
ENGINE ON	–0.8	–0.8	–1.0	–1.1	–1.4	–1.7	–2.0	–2.5	–3.6	–4.8
ENGINE & WING ON	–1.1	–1.2	–1.4	–1.6	–2.1	–2.6	–3.3	–4.2	–5.9	–7.8

Flight With Unreliable Airspeed

Altitude and/or vertical speed indications may also be unreliable.

Climb

Flaps Up, Set Max Climb Thrust

Based on 270 KIAS/260 KIAS

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)						
		110	130	150	170	190	210	230
40000 (260 KIAS)	PITCH ATT	3.0	2.5	2.5				
	V/S (FT/MIN)	1200	900	700				
38000 (270 KIAS)	PITCH ATT	3.0	3.0	3.0	3.0			
	V/S (FT/MIN)	1500	1200	900	600			
35000 (270 KIAS)	PITCH ATT	4.0	3.5	3.5	3.5	3.5	3.5	
	V/S (FT/MIN)	2100	1700	1300	1000	800	500	
30000 (270 KIAS)	PITCH ATT	5.0	5.0	4.5	4.5	4.5	4.5	4.5
	V/S (FT/MIN)	2800	2300	1900	1600	1300	1000	800
25000 (270 KIAS)	PITCH ATT	6.5	6.0	5.5	5.5	5.5	5.5	5.5
	V/S (FT/MIN)	3500	2900	2400	2100	1700	1500	1200
20000 (270 KIAS)	PITCH ATT	8.0	7.5	7.0	6.5	6.5	6.5	6.5
	V/S (FT/MIN)	4300	3600	3000	2600	2200	1900	1600
10000 (270 KIAS)	PITCH ATT	11.5	10.0	9.0	8.5	8.0	8.0	8.0
	V/S (FT/MIN)	5600	4600	3900	3400	2900	2600	2300
SEA LEVEL (270 KIAS)	PITCH ATT	15.0	13.5	12.0	11.0	10.5	10.0	9.5
	V/S (FT/MIN)	6600	5500	4700	4100	3600	3200	2800

Cruise

Flaps Up, Set Thrust for Level Flight

Based on 270 KIAS/260 KIAS

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		110	130	150	170	190	210	230
40000 (260 KIAS)	PITCH ATT	1.5	1.5	2.0	2.5	3.0		
	TPR	64.8	68.3	72.8	78.6	88.4		
	(Alt Mode %N1)	(79.6)	(81.1)	(82.8)	(84.9)	(88.1)		
38000 (270 KIAS)	PITCH ATT	1.0	1.5	2.0	2.0	2.5	3.0	
	TPR	62.0	65.0	68.4	73.1	78.4	86.3	
	(Alt Mode %N1)	(78.3)	(79.6)	(81.0)	(82.8)	(84.7)	(87.3)	
35000 (270 KIAS)	PITCH ATT	1.5	1.5	2.0	2.5	2.5	3.0	3.5
	TPR	55.8	58.2	61.4	65.1	69.8	75.4	82.5
	(Alt Mode %N1)	(74.8)	(76.0)	(77.5)	(79.2)	(81.1)	(83.3)	(85.8)
30000 (270 KIAS)	PITCH ATT	1.5	2.0	2.0	2.5	3.0	3.5	3.5
	TPR	48.1	49.5	51.9	54.5	57.7	61.8	67.5
	(Alt Mode %N1)	(71.1)	(71.9)	(73.1)	(74.6)	(76.2)	(78.3)	(80.8)
25000 (270 KIAS)	PITCH ATT	1.5	2.0	2.0	2.5	3.0	3.5	4.0
	TPR	41.7	42.8	44.4	46.5	48.8	51.6	55.1
	(Alt Mode %N1)	(67.3)	(68.0)	(69.1)	(70.5)	(72.0)	(73.6)	(75.6)
20000 (270 KIAS)	PITCH ATT	1.5	1.5	2.0	2.5	3.0	3.5	4.0
	TPR	36.4	37.2	38.5	40.1	42.0	44.1	46.7
	(Alt Mode %N1)	(63.3)	(64.1)	(65.2)	(66.5)	(67.9)	(69.4)	(71.2)
15000 (270 KIAS)	PITCH ATT	1.5	1.5	2.0	2.5	3.0	3.5	4.0
	TPR	31.7	32.4	33.5	34.8	36.3	38.0	40.1
	(Alt Mode %N1)	(59.5)	(60.3)	(61.4)	(62.5)	(63.8)	(65.3)	(67.0)

Flight With Unreliable Airspeed

Altitude and/or vertical speed indications may also be unreliable.

Descent

Flaps Up, Set Idle Thrust

Based on 270 KIAS/260 KIAS

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)						
		110	130	150	170	190	210	230
40000	PITCH ATT	–1.5	–1.0	–0.5	0.0	0.5	1.0	1.0
(260 KIAS)	V/S (FT/MIN)	–2300	–2100	–2000	–1900	–1900	–2000	–2200
38000	PITCH ATT	–1.5	–1.0	–0.5	0.0	0.5	0.5	1.0
(270 KIAS)	V/S (FT/MIN)	–2400	–2200	–2000	–1900	–1800	–1800	–1900
35000	PITCH ATT	–2.0	–1.0	–0.5	0.0	0.5	0.5	1.0
(270 KIAS)	V/S (FT/MIN)	–2500	–2200	–2100	–2000	–1900	–1900	–1900
30000	PITCH ATT	–2.0	–1.0	–0.5	0.0	0.5	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–2500	–2200	–2000	–1900	–1800	–1800	–1800
25000	PITCH ATT	–2.0	–1.5	–0.5	0.0	0.5	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–2500	–2100	–1900	–1800	–1700	–1700	–1600
20000	PITCH ATT	–2.5	–1.5	–1.0	–0.5	0.5	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–2400	–2100	–1900	–1800	–1700	–1600	–1600
10000	PITCH ATT	–2.5	–2.0	–1.0	–0.5	0.0	0.5	1.0
(270 KIAS)	V/S (FT/MIN)	–2100	–1900	–1700	–1600	–1500	–1500	–1400
SEA LEVEL	PITCH ATT	–3.0	–2.0	–1.5	–0.5	0.0	0.5	1.0
(270 KIAS)	V/S (FT/MIN)	–1900	–1700	–1500	–1400	–1400	–1300	–1300

Holding

Flaps Up, Set Thrust for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		110	130	150	170	190	210	230
10000	PITCH ATT	3.0	3.5	4.0	4.0	4.5	4.5	5.0
	TPR	22.0	24.0	26.2	28.3	30.4	32.5	34.6
	(Alt Mode %N1)	(47.8)	(50.4)	(53.0)	(55.4)	(57.7)	(60.1)	(62.2)
	KIAS	200	207	216	224	232	241	248
5000	PITCH ATT	3.0	3.5	4.0	4.5	4.5	4.5	5.0
	TPR	19.2	20.9	22.8	24.6	26.4	28.3	30.0
	(Alt Mode %N1)	(44.8)	(47.1)	(49.7)	(52.0)	(54.1)	(56.2)	(58.3)
	KIAS	200	206	216	224	232	240	248

Flight With Unreliable Airspeed

Altitude and/or vertical speed indications may also be unreliable.

Terminal Area (5000 FT)

Set Thrust for Level Flight

FLAPS POSITION		WEIGHT (1000 KG)						
		110	130	150	170	190	210	230
FLAPS UP GEAR UP	PITCH ATT	3.5	4.0	4.0	4.5	4.5	5.0	5.0
	TPR	19.9	21.8	23.7	25.7	27.6	29.7	31.7
	(Alt Mode %N1)	(46.2)	(48.8)	(51.6)	(54.1)	(56.4)	(58.9)	(61.2)
	KIAS	199	207	216	224	232	240	248
FLAPS 1 GEAR UP	PITCH ATT	5.0	5.5	5.5	6.0	6.0	6.0	6.0
	TPR	19.9	21.9	24.0	26.1	28.3	30.6	32.8
	(Alt Mode %N1)	(46.2)	(48.9)	(51.8)	(54.4)	(57.1)	(59.7)	(62.0)
	KIAS	174	182	191	199	209	219	228
FLAPS 5 GEAR UP	PITCH ATT	2.5	3.0	3.0	3.5	3.5	4.0	4.0
	TPR	20.5	22.5	24.6	26.9	29.3	31.6	33.9
	(Alt Mode %N1)	(46.4)	(49.5)	(52.4)	(55.2)	(58.0)	(60.4)	(62.8)
	KIAS	159	167	176	184	192	200	207
FLAPS 15 GEAR UP	PITCH ATT	3.0	3.5	4.0	4.0	4.5	5.0	5.5
	TPR	20.6	23.0	25.5	28.1	30.7	33.4	36.4
	(Alt Mode %N1)	(46.3)	(49.8)	(53.0)	(56.3)	(59.1)	(62.0)	(64.8)
	KIAS	138	146	156	164	172	177	179
FLAPS 20 GEAR DOWN	PITCH ATT	2.5	3.0	3.0	3.0	3.0	3.5	4.0
	TPR	27.5	30.8	34.3	37.7	41.1	44.1	46.7
	(Alt Mode %N1)	(55.4)	(58.8)	(62.5)	(65.1)	(68.7)	(71.0)	(72.9)
	KIAS	138	146	156	164	172	177	179

Final Approach (1500 FT)

Gear Down, Set Thrust for 3° Glideslope

FLAPS POSITION		WEIGHT (1000 KG)						
		110	130	150	170	190	210	230
FLAPS 20	PITCH ATT	0.0	0.0	0.5	0.5	0.5	0.5	0.5
	TPR	15.3	16.6	17.9	18.9	20.3	21.6	22.8
	(Alt Mode %N1)	(38.5)	(40.4)	(42.5)	(44.0)	(46.0)	(48.1)	(50.0)
	KIAS	133	142	150	156	164	172	180
Pitch and power from the above table will result in a speed of approximately VREF 20+10 KIAS.								

Go-Around

Flaps 20, Gear Up, Set Go-Around Thrust

Table 1(a): Normal Mode

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		110	130	150	170	190	210	230
10000	PITCH ATT	16.0	13.5	11.0	9.5	8.5	7.5	7.5
	VS (FT/MIN)	4100	3500	3000	2500	2200	1800	1500
	KIAS	140	147	157	165	173	178	179
5000	PITCH ATT	19.0	16.0	13.0	11.5	10.0	9.0	8.5
	VS (FT/MIN)	4500	3900	3300	2900	2500	2100	1800
	KIAS	140	147	156	164	172	177	179
SEA LEVEL	PITCH ATT	21.5	18.0	15.5	13.0	11.5	10.5	10.0
	VS (FT/MIN)	4800	4200	3600	3200	2800	2400	2100
	KIAS	140	147	156	163	171	176	179

Flight With Unreliable Airspeed

Altitude and/or vertical speed indications may also be unreliable.

Go-Around

Flaps 20, Gear Up, Set Go-Around Thrust

Table 1(b): Alternate Mode EEC

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		110	130	150	170	190	210	230
10000	PITCH ATT	14.5	12.0	10.0	8.5	7.5	6.5	6.5
	VS (FT/MIN)	3700	3100	2600	2100	1800	1500	1200
	KIAS	140	147	157	165	173	178	179
5000	PITCH ATT	16.5	13.5	11.5	10.0	8.5	8.0	7.5
	VS (FT/MIN)	4000	3300	2800	2400	2000	1700	1500
	KIAS	140	147	156	164	172	177	179
SEA LEVEL	PITCH ATT	18.5	15.5	13.0	11.5	10.0	9.0	8.5
	VS (FT/MIN)	4300	3600	3100	2600	2300	2000	1700
	KIAS	140	147	156	163	171	176	179

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps Up and 1

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
196	194	194	195	196	197	198	200	202
200	198	198	199	200	201	202	203	205
204	202	202	203	203	204	205	207	208
208	206	206	206	207	208	209	210	212
212	210	210	210	211	211	212	214	215
216	214	214	214	215	215	216	217	218
220	218	218	218	218	219	220	221	222
230	228	228	228	228	228	229	230	231
240	238	238	238	238	238	238	239	240
260	258	258	257	257	258	258	258	258
280	278	278	277	277	277	277	277	278
300	299	298	298	297	297	297	297	297
320	320	319	318	317	317	317	317	317
340	341	339	338	338	337	337	337	337
360		360	359	358	358	357	357	357

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
196	40	30	20	0	–20	–50	–80	–120
200	40	40	30	10	–10	–40	–70	–110
204	40	40	30	20	0	–30	–60	–90
208	50	40	40	20	0	–20	–50	–80
212	50	50	40	30	10	–10	–40	–70
216	50	50	40	30	20	0	–30	–60
220	50	50	50	40	30	10	–20	–40
230	60	60	60	50	40	30	10	–20
240	60	60	60	60	50	40	30	10
260	60	70	70	80	70	70	60	40
280	50	70	80	90	90	90	80	70
300	30	60	80	100	100	100	100	100
320	10	50	80	100	110	120	120	120
340	–40	30	60	90	110	120	130	130
360		–10	40	80	100	120	140	150
Actual altitude = ISFD altitude + pressure altitude adjustment.								

Flaps 5

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
156	153	154	155	156	158	161	165	171
160	157	158	158	160	161	164	167	171
164	161	161	162	163	165	167	169	173
168	165	165	166	167	168	170	172	175
172	169	169	170	170	171	173	175	177
176	173	173	173	174	175	176	178	180
180	177	177	177	178	178	180	181	183
190	187	187	187	187	188	188	189	191
200	197	196	196	197	197	197	198	199
210	207	206	206	206	206	207	207	208
220	217	217	216	216	216	216	217	217
230	227	227	226	226	226	226	226	226
240	237	237	236	236	236	236	236	236

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 5

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
156	40	30	20	–10	–40	–80	–140	–220
160	50	40	30	0	–20	–60	–110	–180
164	50	50	30	10	–10	–50	–90	–150
168	60	50	40	20	0	–30	–70	–120
172	60	60	50	30	10	–20	–50	–90
176	60	60	50	40	20	0	–30	–70
180	60	60	60	50	30	10	–20	–50
190	70	70	70	60	50	30	10	–10
200	70	80	80	80	70	60	40	20
210	70	80	90	90	80	80	60	50
220	70	80	90	100	100	90	80	70
230	70	90	100	100	110	110	100	90
240	70	90	100	110	110	120	110	110
Actual altitude = ISFD altitude + pressure altitude adjustment.								

Flaps 15

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
136	134	135	137	140	145	154		
140	138	138	140	142	146	152		
144	141	142	143	145	148	153	160	
148	145	146	147	148	151	154	159	171
152	149	149	150	152	154	156	160	167
156	153	153	154	155	157	159	162	167
160	157	157	158	158	160	162	164	168
170	167	167	167	167	168	170	171	173
180	177	177	177	177	177	178	179	181
190	187	187	186	186	187	187	188	189
200	197	197	196	196	196	196	197	198
210		207	206	206	206	206	206	207
220		217	216	216	216	216	216	216

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
136	30	20	–10	–50	–110	–220		
140	40	20	0	–30	–90	–160		
144	40	30	10	–20	–60	–120	–220	
148	40	40	20	–10	–40	–90	–160	–300
152	50	40	30	10	–20	–70	–130	–210
156	50	50	40	20	–10	–50	–100	–160
160	50	50	40	30	0	–30	–70	–130
170	60	60	60	50	30	10	–20	–60
180	60	70	70	60	50	40	20	–10
190	60	70	80	80	70	60	40	20
200	60	70	80	90	80	80	70	50
210		70	90	90	90	90	90	80
220		70	90	100	100	100	100	100
Actual altitude = ISFD altitude + pressure altitude adjustment.								

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 20

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
136	133	134	135	136	140	150		
140	137	138	138	139	142	146		
144	141	141	142	143	144	147	154	
148	145	145	146	146	147	150	154	169
152	149	149	149	150	151	152	155	160
156	153	153	153	154	154	155	157	161
160	157	157	157	157	158	159	160	163
170		167	167	167	167	168	168	169
180		177	176	177	177	177	177	178
190			186	186	186	186	187	187
200				196	196	196	196	196
210				206	206	206	206	206
220					216	216	216	216

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
136	40	30	20	0	–50	–180		
140	40	40	30	10	–20	–90		
144	40	40	30	20	0	–50	–140	
148	50	40	40	30	10	–20	–80	–280
152	50	50	40	40	20	0	–50	–120
156	50	50	50	40	30	10	–20	–80
160	50	50	50	50	40	20	0	–40
170		60	60	60	50	40	30	10
180		70	70	70	70	60	50	40
190			80	80	80	70	70	60
200				90	90	90	80	80
210				90	100	100	90	90
220					100	110	110	100

Actual altitude = ISFD altitude + pressure altitude adjustment.

GEAR DOWN

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
190	188	188	189	189	191	192	194	197
200	198	198	198	199	200	201	202	204
210	208	208	208	208	209	210	211	212
220	218	217	217	218	218	219	220	221
230	228	227	227	227	228	228	229	230
240	238	237	237	237	237	238	238	239
260	258	258	257	257	257	257	257	258
280		278	277	277	277	277	277	277

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
190	50	40	30	10	–10	–40	–80	–130
200	50	50	40	30	10	–20	–50	–80
210	50	60	50	40	30	10	–20	–50
220	60	60	60	60	50	30	10	–20
230	60	60	70	70	60	50	30	10
240	60	70	70	70	70	60	50	30
260	50	70	80	90	90	90	80	70
280		70	80	90	100	100	100	100
Actual altitude = ISFD altitude + pressure altitude adjustment.								

Flaps 5

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
156	153	154	155	156	158	161	165	171
160	157	158	158	160	161	164	167	171
164	161	161	162	163	165	167	169	173
168	165	165	166	167	168	170	172	175
172	169	169	170	170	171	173	175	177
176	173	173	173	174	175	176	178	180
180	177	177	177	178	178	180	181	183
190	187	187	187	187	188	188	189	191
200	197	196	196	197	197	197	198	199
210	207	206	206	206	206	207	207	208
220	217	217	216	216	216	216	217	217
230	227	227	226	226	226	226	226	226
240	237	237	236	236	236	236	236	236

GEAR DOWN

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 5

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
156	40	30	20	–10	–40	–80	–140	–220
160	50	40	30	0	–20	–60	–110	–180
164	50	50	30	10	–10	–50	–90	–150
168	60	50	40	20	0	–30	–70	–120
172	60	60	50	30	10	–20	–50	–90
176	60	60	50	40	20	0	–30	–70
180	60	60	60	50	30	10	–20	–50
190	70	70	70	60	50	30	10	–10
200	70	80	80	80	70	60	40	20
210	70	80	90	90	80	80	60	50
220	70	80	90	100	100	90	80	70
230	70	90	100	100	110	110	100	90
240	70	90	100	110	110	120	110	110
Actual altitude = ISFD altitude + pressure altitude adjustment.								

Flaps 20

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
136	133	134	135	136	140	150		
140	137	138	138	139	142	146		
144	141	141	142	143	144	147	154	
148	145	145	146	146	147	150	154	169
152	149	149	149	150	151	152	155	160
156	153	153	153	154	154	155	157	161
160	157	157	157	157	158	159	160	163
170		167	167	167	167	168	168	169
180		177	176	177	177	177	177	178
190			186	186	186	186	187	187
200				196	196	196	196	196
210				206	206	206	206	206
220					216	216	216	216

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
136	40	30	20	0	–50	–180		
140	40	40	30	10	–20	–90		
144	40	40	30	20	0	–50	–140	
148	50	40	40	30	10	–20	–80	–280
152	50	50	40	40	20	0	–50	–120
156	50	50	50	40	30	10	–20	–80
160	50	50	50	50	40	20	0	–40
170		60	60	60	50	40	30	10
180		70	70	70	70	60	50	40
190			80	80	80	70	70	60
200				90	90	90	80	80
210				90	100	100	90	90
220					100	110	110	100
Actual altitude = ISFD altitude + pressure altitude adjustment.								

GEAR DOWN

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 25

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
116	115	117	122					
120	118	120	123	132				
124	122	123	125	130				
128	126	126	128	132	139			
132	129	130	131	134	138			
136	133	134	135	136	140	146		
140	137	137	138	140	142	146	156	
144	141	141	142	143	145	148	153	
148	145	145	145	146	148	150	153	160
152	149	149	149	150	151	153	155	160
156	153	153	153	153	154	156	158	161
160	157	157	157	157	158	159	160	163
170		166	166	167	167	167	168	170
180		176	176	176	176	177	177	178
190			186	186	186	186	187	187

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
116	20	–10	–70					
120	20	0	–40	–130				
124	30	10	–20	–80				
128	30	20	0	–50	–130			
132	40	30	10	–20	–80			
136	40	30	20	–10	–50	–130		
140	40	40	30	10	–30	–80	–210	
144	50	40	30	20	–10	–50	–120	
148	50	50	40	30	10	–30	–80	–170
152	50	50	50	40	20	–10	–50	–120
156	60	50	50	40	30	10	–30	–80
160	60	60	50	50	40	20	–10	–50
170		70	60	60	60	50	30	10
180		70	70	70	70	60	50	40
190			80	80	80	80	70	60
Actual altitude = ISFD altitude + pressure altitude adjustment.								

GEAR DOWN

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 30

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
116	114	116	121					
120	118	119	122	130				
124	122	123	124	129				
128	125	126	127	130	137			
132	129	130	131	133	137			
136	133	133	134	136	138	144		
140	137	137	138	139	141	145	154	
144	141	141	141	142	144	146	151	
148		145	145	146	147	149	152	158
152		149	149	149	150	151	154	158
156		153	153	153	154	155	156	159
160			157	157	157	158	159	161
170			166	166	167	167	168	169
180				176	176	176	177	177

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	100	120	140	160	180	200	220	240
116	20	0	−50					
120	30	10	−30	−120				
124	30	20	−10	−60				
128	40	30	10	−30	−120			
132	40	30	20	−10	−70			
136	40	40	30	10	−30	−110		
140	40	40	30	20	−10	−70	−180	
144	50	50	40	30	10	−30	−100	
148		50	50	40	20	−10	−60	−150
152		50	50	40	30	10	−30	−90
156		60	50	50	40	20	−10	−50
160			60	50	50	30	10	−20
170			70	70	60	50	40	20
180				80	70	70	60	50

Actual altitude = ISFD altitude + pressure altitude adjustment.

Long Range Cruise Maximum Operating Altitude
Max Climb Thrust
ISA + 10 deg. C and Below

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33º)	1.30 (39º)
250	32600	–6	33800*	33800*
240	33500	–8	34800*	34800*
230	34400	–10	35800*	35800*
220	35300	–12	36700*	36700*
210	36300	–14	38200*	38200*
200	37300	–14	39200*	39200*
190	38400	–14	40200*	40200*
180	39500	–14	41200*	41200*
170	40700	–14	42300*	42300*
160	42000	–14	43100	43100
150	43100	–14	43100	43100
140	43100	–14	43100	43100
130	43100	–14	43100	43100
120	43100	–14	43100	43100

*Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.

ISA + 15 deg. C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33º)	1.30 (39º)
250	32600	0	33000*	33000*
240	33500	–2	34200*	34200*
230	34400	–4	35200*	35200*
220	35300	–6	36100*	36100*
210	36300	–8	37500*	37500*
200	37300	–8	38700*	38700*
190	38400	–8	39700*	39700*
180	39500	–8	40600*	40600*
170	40700	–8	41600*	41600*
160	42000	–8	42700*	42700*
150	43100	–8	43100	43100
140	43100	–8	43100	43100
130	43100	–8	43100	43100
120	43100	–8	43100	43100

*Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.

ISA + 20 deg. C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33º)	1.30 (39º)
250	32600	6	28500*	28500*
240	33500	4	30600*	30600*
230	34400	2	32400*	32400*
220	35300	0	34800*	34800*
210	36300	–2	36200*	36200*
200	37300	–2	37400*	37400*
190	38400	–2	38400*	38400*
180	39500	–2	39400*	39400*
170	40700	–2	40300*	40300*
160	42000	–2	41100*	41100*
150	43100	–2	41800*	41800*
140	43100	–2	42900*	42900*
130	43100	–2	43100	43100
120	43100	–2	43100	43100

*Denotes altitude thrust limited in level flight, 300 fpm 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
260	TPR	64.0	68.7	73.7	**79.1**	**86.2**					
	MACH	.791	.823	.850	**.855**	**.847**					
	KIAS	334	334	332	**320**	**303**					
	FF/ENG	3574	3646	3673	**3598**	**3533**					
240	TPR	60.5	64.2	69.6	74.8	**80.4**	**87.9**				
	MACH	.764	.794	.826	.851	**.854**	**.846**				
	KIAS	321	321	322	318	**306**	**289**				
	FF/ENG	3257	3266	3367	3376	**3300**	**3254**				
220	TPR	56.6	60.1	64.1	69.9	75.5	**81.1**	**89.2**			
	MACH	.736	.765	.795	.828	.852	**.853**	**.845**			
	KIAS	309	308	308	309	305	**292**	**276**			
	FF/ENG	2930	2938	2957	3058	.852	**3000**	**2994**			
200	TPR	52.4	56.0	59.3	63.7	68.4	73.9	**79.3**	**86.5**		
	MACH	.707	.734	.763	.793	.827	.852	**.853**	**.845**		
	KIAS	296	295	295	295	295	292	**279**	**264**		
	FF/ENG	2594	2624	2621	2648	2690	2709	**2651**	**2634**		
180	TPR	48.6	52.0	55.2	58.7	63.1	68.0	73.4	**79.1**	**86.4**	
	MACH	.678	.702	.729	.758	.789	.823	.850	**.854**	**.846**	
	KIAS	283	281	281	280	280	280	278	**267**	**252**	
	FF/ENG	2313	2320	2328	2331	2351	2392	2429	**2409**	**2404**	
160	TPR	45.5	48.2	51.2	54.5	58.3	62.6	67.6	73.0	**78.6**	**85.5**
	MACH	.652	.672	.694	.721	.750	.781	.814	.847	**.855**	**.848**
	KIAS	271	268	266	265	265	265	265	264	**255**	**241**
	FF/ENG	2088	2064	2053	2057	2066	2080	2135	2195	**2190**	**2173**
140	TPR	42.2	44.7	47.4	50.3	53.7	57.3	61.6	66.5	71.7	**77.2**
	MACH	.616	.640	.662	.682	.709	.738	.768	.801	.837	**.854**
	KIAS	255	255	253	250	249	249	248	248	249	**243**
	FF/ENG	1846	1840	1821	1799	1800	1804	1832	1882	1944	**1961**
120	TPR	38.6	40.9	43.4	46.2	49.0	52.2	55.9	59.9	64.4	69.6
	MACH	.577	.598	.622	.647	.669	.691	.720	.750	.781	.815
	KIAS	238	237	237	236	234	232	231	231	230	231
	FF/ENG	1605	1595	1592	1581	1560	1546	1558	1587	1623	1673
100	TPR	34.9	36.9	39.1	41.5	44.2	47.1	50.2	53.6	57.3	61.4
	MACH	.536	.555	.576	.598	.623	.648	.670	.694	.723	.753
	KIAS	221	219	218	217	217	216	214	212	211	211
	FF/ENG	1376	1360	1350	1341	1337	1325	1312	1318	1337	1361

Boldface area approximates optimum altitude.

Long Range Cruise Enroute Fuel and Time—Low Altitude

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
287	264	244	227	213	200	190	181	173	166	160
572	527	488	455	426	400	381	364	348	334	321
858	792	733	683	639	600	572	547	524	502	483
1144	1055	977	910	852	800	764	730	699	670	644
1431	1320	1222	1138	1065	1000	954	912	873	838	806
1719	1585	1467	1366	1278	1200	1145	1095	1048	1006	967
2008	1852	1713	1595	1492	1400	1336	1277	1222	1173	1128
2298	2118	1958	1823	1705	1600	1527	1459	1397	1340	1289
2588	2385	2205	2052	1919	1800	1718	1642	1572	1507	1449
2880	2653	2451	2280	2133	2000	1909	1824	1746	1675	1610

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		20		24		28	
	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	2.7	0:40	2.3	0:38	1.9	0:36	1.7	0:35	1.5	0:34
400	5.6	1:15	5.0	1:12	4.4	1:08	4.0	1:05	3.7	1:03
600	8.5	1:51	7.7	1:47	6.9	1:39	6.3	1:35	5.8	1:31
800	11.4	2:28	10.4	2:21	9.3	2:11	8.6	2:05	8.0	2:00
1000	14.3	3:04	13.0	2:56	11.7	2:43	10.8	2:35	10.1	2:28
1200	17.1	3:41	15.6	3:31	14.0	3:15	13.1	3:06	12.2	2:57
1400	19.9	4:18	18.2	4:06	16.4	3:48	15.3	3:36	14.3	3:27
1600	22.7	4:55	20.8	4:41	18.7	4:20	17.5	4:07	16.4	3:56
1800	25.5	5:32	23.4	5:17	21.1	4:53	19.7	4:38	18.4	4:25
2000	28.3	6:10	25.9	5:53	23.4	5:26	21.9	5:09	20.5	4:55

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)								
	100	120	140	160	180	200	220	240	260
2	–0.2	–0.2	–0.1	–0.1	0.0	0.1	0.2	0.3	0.4
4	–0.7	–0.5	–0.4	–0.2	0.0	0.3	0.5	0.8	1.1
6	–1.0	–0.8	–0.6	–0.3	0.0	0.4	0.8	1.3	1.8
8	–1.3	–1.1	–0.8	–0.4	0.0	0.6	1.1	1.8	2.5
10	–1.7	–1.4	–1.0	–0.5	0.0	0.7	1.5	2.3	3.2
12	–2.0	–1.7	–1.2	–0.6	0.0	0.9	1.8	2.7	3.9
14	–2.3	–2.0	–1.4	–0.7	0.0	1.0	2.1	3.2	4.5
16	–2.6	–2.3	–1.6	–0.8	0.0	1.2	2.4	3.7	5.2
18	–2.9	–2.6	–1.8	–0.9	0.0	1.3	2.7	4.2	5.9
20	–3.2	–2.9	–2.0	–1.0	0.0	1.5	3.0	4.6	6.5
22	–3.5	–3.2	–2.2	–1.1	0.0	1.6	3.3	5.1	7.1
24	–3.8	–3.5	–2.4	–1.2	0.0	1.7	3.6	5.6	7.8
26	–4.1	–3.8	–2.5	–1.3	0.0	1.9	3.9	6.0	8.4
28	–4.3	–4.1	–2.7	–1.4	0.0	2.0	4.2	6.5	9.0
30	–4.6	–4.4	–2.9	–1.5	0.0	2.2	4.5	6.9	9.6

Long Range Cruise Enroute Fuel and Time—High Altitude

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
526	495	467	442	420	400	383	367	353	340	328
1044	984	930	882	839	800	768	738	710	684	660
1563	1475	1394	1323	1259	1200	1152	1107	1066	1028	993
2084	1967	1860	1764	1679	1600	1536	1477	1422	1371	1325
2606	2459	2325	2206	2099	2000	1921	1847	1778	1714	1656
3130	2953	2792	2648	2519	2400	2305	2216	2134	2058	1988
3656	3448	3259	3091	2939	2800	2689	2586	2490	2401	2320
4184	3945	3727	3534	3360	3200	3073	2955	2845	2744	2651
4713	4443	4196	3977	3780	3600	3457	3324	3201	3086	2981
5244	4941	4666	4421	4202	4000	3841	3693	3555	3428	3311
5777	5442	5137	4866	4623	4400	4225	4061	3909	3769	3640
6312	5944	5608	5311	5044	4800	4608	4429	4263	4109	3968
6848	6446	6080	5757	5466	5200	4992	4797	4616	4449	4296
7385	6949	6553	6202	5888	5600	5375	5165	4969	4789	4624
7924	7454	7027	6649	6310	6000	5758	5532	5322	5128	4950
8465	7960	7501	7096	6732	6400	6141	5899	5674	5466	5276
9008	8468	7976	7543	7155	6800	6523	6265	6025	5804	5602
9554	8977	8453	7991	7578	7200	6905	6631	6376	6141	5926
10102	9488	8931	8440	8001	7600	7288	6997	6727	6478	6250
10652	10001	9410	8889	8425	8000	7670	7362	7077	6814	6573

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	31		33		35		37		39	
	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	3.5	1:01	3.3	0.59	3.2	0:58	3.2	0:57	3.1	0:57
800	7.6	1:55	7.3	1:52	7.2	1:49	7.1	1:46	6.9	1:46
1200	11.6	2:50	11.3	2:46	11.1	2:41	10.9	2:36	10.7	2:35
1600	15.6	3:46	15.2	3:40	14.9	3:33	14.7	3:26	14.5	3:24
2000	19.6	4:42	19.1	4:34	18.7	4:26	18.4	4:17	18.2	4:13
2400	23.4	5:39	22.9	5:29	22.4	5:19	22.1	5:09	21.8	5:02
2800	27.3	6:37	26.6	6:25	26.0	6:13	25.7	6:00	25.4	5:52
3200	31.0	7:35	30.3	7:21	29.6	7:08	29.3	6:53	28.9	6:42
3600	34.8	8:34	33.9	8:18	33.2	8:03	32.8	7:46	32.4	7:32
4000	38.4	9:33	37.5	9:15	36.7	8:58	36.2	8:39	35.8	8:24
4400	42.0	10:33	41.0	10:13	40.1	9:54	39.6	9:33	39.1	9:15
4800	45.6	11:33	44.5	11:12	43.5	10:51	42.9	10:28	42.4	10.08
5200	49.1	12.34	47.9	12:11	46.8	11:48	46.2	11:23	45.6	11:00
5600	52.6	13:36	51.2	13:11	50.1	12:46	49.4	12:19	48.8	11:54
6000	56.0	14:38	54.6	14:12	53.3	13:45	52.6	13:15	51.9	12:48
6400	59.4	15:40	57.9	15:13	56.5	14:44	55.7	14:12	55.0	13:42
6800	62.7	16:44	61.1	16:14	59.7	15:43	58.8	15:09	58.0	14:37
7200	66.0	17:48	64.3	17:16	62.8	16:44	61.8	16:07	61.0	15:33
7600	69.2	18:53	67.4	18:19	65.8	17:45	64.8	17:06	63.9	16:29
8000	72.5	19:58	70.5	19:22	68.9	18:46	67.7	18:05	66.8	17:26

Long Range Cruise Enroute Fuel and Time—High Altitude

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)								
	100	120	140	160	180	200	220	240	260
5	−1.0	−0.8	−0.6	−0.3	0.0	0.4	1.5	3.7	5.6
10	−2.4	−1.8	−1.2	−0.6	0.0	0.8	2.5	5.8	9.2
15	−3.8	−2.8	−1.9	−1.0	0.0	1.3	3.5	7.7	12.5
20	−5.1	−3.8	−2.6	−1.3	0.0	1.7	4.4	9.5	15.5
25	−6.5	−4.8	−3.2	−1.7	0.0	2.1	5.3	11.2	18.3
30	−7.8	−5.8	−3.9	−2.0	0.0	2.5	6.2	12.8	20.8
35	−9.1	−6.8	−4.6	−2.4	0.0	2.9	7.1	14.2	23.0
40	−10.4	−7.8	−5.2	−2.7	0.0	3.4	7.9	15.6	24.9
45	−11.7	−8.8	−5.9	−3.0	0.0	3.8	8.7	16.8	26.6
50	−13.0	−9.8	−6.5	−3.3	0.0	4.2	9.5	17.9	28.1
55	−14.3	−10.8	−7.2	−3.7	0.0	4.6	10.3	18.9	29.2
60	−15.6	−11.8	−7.9	−4.0	0.0	5.0	11.1	19.7	30.1
65	−16.8	−12.8	−8.5	−4.3	0.0	5.5	11.8	20.5	30.7
70	−18.0	−13.8	−9.2	−4.6	0.0	5.9	12.5	21.1	31.1
75	−19.3	−14.8	−9.8	−4.9	0.0	6.3	13.2	21.6	31.2

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 KG)								
	260	240	220	200	180	160	140	120	100
43						0	3	15	34
41				5	0	2	10	25	46
39			5	0	1	7	19	36	58
37		4	0	0	5	15	29	47	70
35	3	0	0	5	13	25	40	59	82
33	0	1	5	12	22	35	52	71	93
31	1	5	12	21	32	47	63	82	104
29	6	12	20	31	43	58	74	93	114
27	13	21	30	41	54	69	85	103	123
25	21	30	40	52	65	80	96	113	132

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 .85/310/250 KIAS

PRESSURE ALT (1000 FT)	25	27	29	31	33	35	37	39	41	43
DISTANCE (NM)	86	92	99	106	111	116	122	128	134	140
TIME (MINUTES)	18	19	20	21	21	22	23	23	24	25

Holding

Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)									
		1500	5000	10000	15000	20000	25000	30000	35000	40000	43000
260	TPR	29.7	32.9	38.4	45.4	52.8	62.6	75.7			
	KIAS	258	259	284	285	288	291	295			
	FF/ENG	3050	3040	3140	3200	3190	3300	3490			
240	TPR	28.1	31.0	36.5	42.8	49.7	58.7	71.0	87.3		
	KIAS	251	251	252	274	276	279	283	283		
	FF/ENG	2830	2810	2840	2930	2910	3000	3150	3330		
220	TPR	26.5	29.2	34.1	39.9	46.8	54.3	66.0	80.7		
	KIAS	243	244	245	262	264	266	270	274		
	FF/ENG	2620	2580	2600	2640	2660	2660	2810	2970		
200	TPR	24.8	27.3	31.7	36.8	43.8	50.1	60.1	73.0	91.7	
	KIAS	235	236	237	238	251	253	256	260	252	
	FF/ENG	2420	2370	2360	2310	2420	2360	2440	2550	2780	
180	TPR	23.2	25.5	29.4	34.3	40.2	46.3	55.0	67.1	82.0	
	KIAS	227	227	228	229	238	239	242	245	249	
	FF/ENG	2220	2170	2130	2090	2140	2100	2140	2240	2430	
160	TPR	21.6	23.7	27.3	31.5	36.7	42.8	50.7	61.3	75.2	84.7
	KIAS	220	220	221	222	223	225	227	230	233	235
	FF/ENG	2030	1990	1930	1880	1870	1860	1880	1940	2100	2220
140	TPR	19.9	21.8	25.1	29.1	33.8	39.3	46.3	55.4	68.0	76.7
	KIAS	211	211	211	212	213	213	213	214	217	219
	FF/ENG	2010	1910	1740	1680	1670	1640	1640	1660	1780	1880
120	TPR	18.3	20.0	22.9	26.6	30.8	35.8	42.0	50.0	60.5	68.3
	KIAS	202	202	202	203	203	203	203	203	203	203
	FF/ENG	1820	1770	1650	1500	1480	1440	1440	1430	1500	1560
100	TPR	16.9	18.5	21.1	24.4	28.3	32.9	38.3	45.4	54.0	60.3
	KIAS	198	198	198	198	198	199	199	199	199	199
	FF/ENG	1660	1610	1550	1360	1330	1290	1280	1280	1300	1340

This table includes 5% additional fuel for holding in a racetrack pattern.

Flaps 1

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
260	TPR	32.5	36.2	42.3	49.9	59.5
	KIAS	239	239	240	241	241
	FF/ENG	3340	3320	3330	3320	3360
240	TPR	30.6	33.9	39.6	46.6	55.6
	KIAS	231	232	232	233	233
	FF/ENG	3080	3060	3050	3030	3090
220	TPR	28.6	31.7	36.9	43.4	51.6
	KIAS	223	224	225	226	228
	FF/ENG	2830	2800	2780	2750	2820
200	TPR	26.6	29.4	34.3	40.2	47.8
	KIAS	214	215	216	218	223
	FF/ENG	2580	2550	2520	2480	2560
180	TPR	24.6	27.2	31.6	37.0	43.9
	KIAS	203	204	204	206	208
	FF/ENG	2340	2300	2270	2220	2270
160	TPR	22.6	25.0	28.9	33.9	40.0
	KIAS	195	195	196	197	198
	FF/ENG	2120	2070	2030	1980	2000
140	TPR	20.7	22.7	26.2	30.7	36.2
	KIAS	186	186	186	187	188
	FF/ENG	1910	1860	1800	1750	1750
120	TPR	18.8	20.6	23.6	27.6	32.4
	KIAS	177	177	177	178	178
	FF/ENG	1870	1760	1600	1540	1520
100	TPR	17.2	18.7	21.4	24.8	29.1
	KIAS	173	173	173	173	173
	FF/ENG	1680	1620	1520	1370	1330

This table includes 5% additional fuel for holding in a racetrack pattern.

Runway Surface Condition Correlation

RUNWAY CONDITION CODE	RUNWAY SURFACE CONDITION DESCRIPTION	REPORTED BRAKING ACTION
6	Dry	Dry
5	Wet (Smooth, Grooved or PFC) or Frost 3 mm (0.12 inches) or less of: Water, Slush, Dry Snow or Wet Snow	Good
4	Compacted Snow at or below –15 deg. C OAT	Good to Medium
3	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 3 mm (0.12 inches) of : Dry Snow or Wet Snow Compacted Snow at OAT warmer than –15 deg. C	Medium
2	Greater than 3 mm (0.12 inches) of: Water or Slush	Medium to Poor
1	Ice	Poor
0	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice	Nil

ADVISORY INFORMATION

Normal Configuration Operational Landing Distance
Flaps 30

	OPERATIONAL LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF30	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1340	35/–25	40	–65/220	15/–15	35/–35	60	25	60
MAX AUTO	1630	40/–30	50	–80/265	5/–5	45/–45	95	0	0
AUTOBRAKE 4	1970	50/–40	65	–105/345	0/0	55/–55	115	0	0
AUTOBRAKE 3	2240	60/–50	75	–120/405	0/–15	65/–65	120	5	5
AUTOBRAKE 2	2425	70/–60	90	–135/455	30/–40	70/–70	115	95	95
AUTOBRAKE 1	2565	75/–65	105	–145/505	60/–60	75/–75	115	265	295
Good Reported Braking Action									
MAX MANUAL	1610	45/–35	65	–95/340	25/–25	50/–50	80	80	185
MAX AUTO	1670	45/–30	60	–85/310	10/–5	45/–45	90	50	155
AUTOBRAKE 4	2005	50/–40	65	–105/355	5/–5	60/–60	120	0	0
AUTOBRAKE 3	2260	60/–50	80	–120/410	10/–25	65/–65	125	5	5
AUTOBRAKE 2	2445	70/–60	95	–135/460	35/–50	70/–75	115	100	100
AUTOBRAKE 1	2565	75/–65	105	–150/505	65/–60	75/–75	115	265	300
Good to Medium Reported Braking Action									
MAX MANUAL	1745	40/–35	60	–95/335	40/–35	45/–45	75	105	260
MAX AUTO	1795	45/–35	60	–100/340	35/–25	45/–50	90	105	260
AUTOBRAKE 4	2030	50/–40	65	–110/375	20/–15	60/–60	120	15	90
AUTOBRAKE 3	2260	60/–50	80	–120/410	10/–25	65/–65	125	5	5
AUTOBRAKE 2	2445	70/–60	95	–135/460	35/–50	70/–75	115	100	100
AUTOBRAKE 1	2565	75/–65	105	–150/505	65/–60	75/–75	115	265	300
Medium Reported Braking Action									
MAX MANUAL	1885	45/–40	65	–110/380	50/–45	50/–50	80	145	370
MAX AUTO	1905	50/–40	65	–110/385	45/–40	50/–50	90	140	360
AUTOBRAKE 4	2085	50/–40	70	–115/405	30/–20	60/–60	115	50	240
AUTOBRAKE 3	2295	60/–50	80	–125/440	30/–35	65/–65	120	25	110
AUTOBRAKE 2	2450	70/–60	95	–135/465	50/–50	70/–70	115	110	135
AUTOBRAKE 1	2565	75/–65	105	–150/505	65/–60	75/–75	115	265	300
Medium to Poor Reported Braking Action									
MAX MANUAL	2090	65/–50	90	–135/485	65/–55	65/–65	95	225	615
MAX AUTO	2100	65/–50	90	–135/485	70/–60	65/–65	95	230	620
AUTOBRAKE 4	2175	60/–45	85	–130/440	50/–35	60/–60	105	160	550
AUTOBRAKE 3	2355	60/–55	80	–135/445	45/–45	65/–70	115	60	390
AUTOBRAKE 2	2485	70/–60	95	–140/470	60/–60	70/–75	105	125	255
AUTOBRAKE 1	2585	75/–65	105	–150/505	75/–65	75/–75	115	275	330
Poor Reported Braking Action									
MAX MANUAL	2690	75/–65	100	–190/730	225/–135	75/–75	95	505	1570
MAX AUTO	2700	75/–65	100	–190/730	230/–140	75/–75	95	505	1580
AUTOBRAKE 4	2700	75/–60	100	–190/730	230/–135	75/–75	100	505	1580
AUTOBRAKE 3	2780	75/–65	100	–195/740	215/–130	80/–80	115	440	1520
AUTOBRAKE 2	2855	80/–70	100	–195/750	215/–140	80/–85	105	410	1445
AUTOBRAKE 1	2900	85/–70	120	–200/760	230/–145	85/–85	115	480	1400

Reference distance is for sea level, standard day, no wind or slope, VREF 30 approach speed and 2 engines at maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
All reference distances and adjustments are increased by 15%.
Includes a 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 30 m.
For autobrake and manual speedbrakes, increase reference landing distance by 25 m.

ADVISORY INFORMATION

Normal Configuration Operational Landing Distance
Flaps 25

	OPERATIONAL LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF25	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1380	35/–25	40	–65/225	15/–15	35/–35	60	30	65
MAX AUTO	1685	40/–35	50	–80/265	5/–5	45/–45	95	0	0
AUTOBRAKE 4	2045	50/–45	65	–105/350	0/0	60/–60	115	0	0
AUTOBRAKE 3	2325	60/–55	80	–125/410	5/–15	70/–70	125	5	5
AUTOBRAKE 2	2515	70/–65	95	–135/460	30/–45	75/–75	120	105	105
AUTOBRAKE 1	2660	80/–70	110	–150/510	60/–65	75/–80	115	290	320
Good Reported Braking Action									
MAX MANUAL	1665	45/–40	65	–95/345	30/–25	50/–50	80	85	205
MAX AUTO	1730	45/–35	65	–85/315	10/–5	45/–50	90	60	175
AUTOBRAKE 4	2085	50/–45	70	–105/360	10/–5	60/–60	120	0	0
AUTOBRAKE 3	2345	60/–55	80	–125/415	10/–25	70/–70	125	5	5
AUTOBRAKE 2	2535	70/–65	95	–140/470	40/–50	75/–75	120	115	115
AUTOBRAKE 1	2660	80/–70	110	–150/515	70/–65	80/–80	115	290	325
Good to Medium Reported Braking Action									
MAX MANUAL	1795	45/–40	60	–100/340	40/–35	45/–50	75	115	280
MAX AUTO	1855	45/–40	65	–100/345	35/–25	50/–50	90	115	285
AUTOBRAKE 4	2105	50/–45	70	–110/380	20/–15	60/–60	120	15	95
AUTOBRAKE 3	2345	60/–55	80	–125/415	10/–25	70/–70	125	5	5
AUTOBRAKE 2	2535	70/–65	95	–140/470	40/–50	75/–75	120	115	115
AUTOBRAKE 1	2660	80/–70	110	–150/515	70/–65	80/–80	115	290	325
Medium Reported Braking Action									
MAX MANUAL	1940	50/–45	70	–110/385	55/–45	50/–50	80	155	395
MAX AUTO	1970	50/–45	70	–110/390	50/–40	55/–55	90	150	390
AUTOBRAKE 4	2160	50/–45	70	–120/415	30/–20	60/–60	120	50	255
AUTOBRAKE 3	2380	60/–55	80	–130/445	30/–35	70/–70	125	30	115
AUTOBRAKE 2	2540	70/–65	95	–140/475	55/–55	75/–75	120	120	150
AUTOBRAKE 1	2660	80/–70	110	–150/515	70/–65	80/–80	115	290	325
Medium to Poor Reported Braking Action									
MAX MANUAL	2165	65/–55	95	–140/490	70/–60	65/–70	95	250	685
MAX AUTO	2185	65/–55	95	–135/490	75/–65	70/–70	100	255	700
AUTOBRAKE 4	2255	60/–50	90	–130/450	50/–40	60/–65	105	185	635
AUTOBRAKE 3	2445	60/–60	85	–135/455	45/–45	70/–70	115	70	460
AUTOBRAKE 2	2580	70/–70	95	–140/480	65/–60	75/–75	110	140	320
AUTOBRAKE 1	2680	80/–70	110	–150/515	80/–70	80/–80	115	300	370
Poor Reported Braking Action									
MAX MANUAL	2770	75/–70	100	–190/735	230/–140	80/–80	95	535	1700
MAX AUTO	2790	80/–70	100	–190/740	235/–145	80/–80	95	540	1710
AUTOBRAKE 4	2790	80/–65	100	–190/740	235/–135	80/–80	105	540	1710
AUTOBRAKE 3	2875	80/–70	100	–195/750	220/–130	80/–85	115	470	1645
AUTOBRAKE 2	2950	80/–75	105	–200/760	220/–140	85/–85	110	440	1565
AUTOBRAKE 1	2995	85/–80	125	–205/770	235/–150	85/–90	115	515	1520

Reference distance is for sea level, standard day, no wind or slope, VREF 25 approach speed and 2 engines at maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
All reference distances and adjustments are increased by 15%.
Includes a 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 30 m.
For autobrake and manual speedbrakes, increase reference landing distance by 25 m.

ADVISORY INFORMATION

Normal Configuration Operational Landing Distance
Flaps 20

	OPERATIONAL LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	VREF ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF20	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1390	35/–25	40	–70/225	15/–15	35/–35	60	30	65
MAX AUTO	1690	40/–30	50	–80/270	5/–5	45/–45	95	0	0
AUTOBRAKE 4	2050	50/–40	65	–105/350	0/0	60/–60	120	0	0
AUTOBRAKE 3	2335	60/–50	80	–125/410	0/–15	70/–70	125	0	0
AUTOBRAKE 2	2540	70/–60	95	–140/465	30/–40	75/–75	120	85	85
AUTOBRAKE 1	2695	80/–70	110	–150/515	60/–65	80/–80	120	270	290
Good Reported Braking Action									
MAX MANUAL	1685	45/–35	65	–95/350	30/–25	50/–50	85	90	210
MAX AUTO	1735	45/–35	65	–85/330	20/–5	50/–50	90	70	190
AUTOBRAKE 4	2090	50/–40	70	–105/360	10/–5	60/–60	120	0	0
AUTOBRAKE 3	2355	60/–55	80	–125/415	10/–20	70/–70	130	0	0
AUTOBRAKE 2	2560	70/–60	95	–140/470	35/–45	75/–75	125	95	95
AUTOBRAKE 1	2700	80/–70	110	–155/520	65/–70	80/–80	120	275	295
Good to Medium Reported Braking Action									
MAX MANUAL	1815	45/–35	60	–100/340	40/–35	50/–50	75	115	285
MAX AUTO	1870	45/–35	65	–100/350	35/–30	50/–50	90	115	285
AUTOBRAKE 4	2115	50/–40	70	–110/380	20/–15	60/–60	120	20	105
AUTOBRAKE 3	2355	60/–55	80	–125/415	10/–20	70/–70	130	0	0
AUTOBRAKE 2	2560	70/–60	95	–140/470	35/–45	75/–75	125	95	95
AUTOBRAKE 1	2700	80/–70	110	–155/520	65/–70	80/–80	120	275	295
Medium Reported Braking Action									
MAX MANUAL	1960	50/–40	70	–110/390	55/–45	50/–55	80	160	405
MAX AUTO	1985	50/–40	70	–110/390	50/–40	55/–55	90	155	395
AUTOBRAKE 4	2170	50/–45	70	–120/415	30/–25	60/–60	120	55	275
AUTOBRAKE 3	2395	60/–55	80	–130/445	25/–30	70/–70	130	25	120
AUTOBRAKE 2	2565	70/–60	95	–140/475	50/–50	75/–75	125	105	135
AUTOBRAKE 1	2700	80/–70	110	–155/520	65/–70	80/–80	120	275	295
Medium to Poor Reported Braking Action									
MAX MANUAL	2195	65/–55	95	–140/500	70/–60	70/–70	100	255	705
MAX AUTO	2215	65/–55	95	–140/500	80/–65	70/–70	100	260	725
AUTOBRAKE 4	2275	65/–50	95	–130/465	55/–40	65/–65	105	210	670
AUTOBRAKE 3	2465	60/–55	85	–135/455	45/–45	70/–70	120	70	490
AUTOBRAKE 2	2610	70/–65	95	–145/480	65/–60	75/–75	115	120	340
AUTOBRAKE 1	2720	80/–70	110	–155/520	80/–75	80/–80	115	280	360
Poor Reported Braking Action									
MAX MANUAL	2815	80/–65	100	–195/745	240/–145	80/–80	100	550	1740
MAX AUTO	2835	80/–65	105	–195/745	245/–150	80/–80	100	555	1755
AUTOBRAKE 4	2835	80/–65	105	–195/745	245/–145	80/–80	105	555	1755
AUTOBRAKE 3	2915	80/–65	100	–200/755	225/–135	85/–85	120	490	1695
AUTOBRAKE 2	2990	80/–70	105	–200/770	230/–140	85/–85	115	445	1615
AUTOBRAKE 1	3045	85/–75	125	–205/780	245/–155	90/–90	115	515	1555

Reference distance is for sea level, standard day, no wind or slope, VREF 20 approach speed and 2 engines at maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.
All reference distances and adjustments are increased by 15%.
Includes a 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 30 m.
For autobrake and manual speedbrakes, increase reference landing distance by 25 m.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
AIRSPEED UNRELIABLE (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1250	30/–20	35	–60/200	15/–10	30/–30	55	25	60
AUTOBRAKE MAX	1535	35/–30	45	–75/240	5/–5	40/–40	90	0	0
AUTOBRAKE 2	2320	65/–55	85	–125/415	25/–35	70/–70	115	75	75
Good Reported Braking Action									
MAX MANUAL	1510	40/–35	60	–85/310	25/–25	45/–45	75	80	195
AUTOBRAKE MAX	1590	45/–30	65	–80/310	25/–10	45/–45	85	75	200
AUTOBRAKE 2	2345	65/–55	90	–125/420	35/–45	70/–70	115	85	85
Good to Medium Reported Braking Action									
MAX MANUAL	1625	40/–35	55	–90/305	35/–30	45/–45	70	105	260
AUTOBRAKE MAX	1710	40/–35	60	–90/310	35/–30	45/–45	80	115	280
AUTOBRAKE 2	2335	65/–55	90	–125/420	35/–45	70/–70	115	85	85
Medium Reported Braking Action									
MAX MANUAL	1755	45/–35	60	–100/345	50/–40	45/–45	75	145	370
AUTOBRAKE MAX	1820	45/–40	65	–100/350	50/–40	50/–50	85	150	390
AUTOBRAKE 3	2185	55/–50	75	–115/400	25/–30	65/–65	120	20	120
Medium to Poor Reported Braking Action									
MAX MANUAL	1960	60/–50	85	–125/440	65/–55	60/–60	90	235	660
AUTOBRAKE MAX	2050	65/–50	90	–125/450	75/–60	65/–65	95	260	730
AUTOBRAKE 3	2265	55/–50	80	–120/410	45/–45	65/–65	105	75	530
Poor Reported Braking Action									
MAX MANUAL	2510	70/–60	90	–170/655	215/–130	70/–70	90	500	1615
AUTOBRAKE MAX	2600	75/–60	95	–175/665	220/–135	75/–75	95	525	1685
AUTOBRAKE 3	2665	70/–60	95	–175/670	205/–125	75/–80	105	465	1630

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTI-ICE LEAK ENG L, R (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1235	35/–20	35	–60/205	15/–15	30/–30	55	0	30
AUTOBRAKE MAX	1530	35/–30	45	–75/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2400	60/–50	85	–125/425	0/–5	75/–75	145	0	0
Good Reported Braking Action									
MAX MANUAL	1545	45/–35	65	–95/340	35/–30	50/–50	80	0	110
AUTOBRAKE MAX	1640	45/–35	65	–90/340	30/–25	50/–50	90	0	120
AUTOBRAKE 2	2425	65/–50	85	–130/430	10/–10	75/–75	150	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1690	40/–35	55	–95/325	45/–40	45/–45	75	0	150
AUTOBRAKE MAX	1805	45/–35	60	–95/335	45/–35	50/–50	85	0	165
AUTOBRAKE 2	2415	65/–50	85	–130/430	10/–10	75/–75	150	0	0
Medium Reported Braking Action									
MAX MANUAL	1865	45/–40	65	–105/375	65/–55	50/–50	80	0	225
AUTOBRAKE MAX	1950	50/–40	70	–110/385	65/–50	55/–55	95	0	230
AUTOBRAKE 3	2210	55/–45	75	–120/415	35/–25	65/–65	130	0	100
Medium to Poor Reported Braking Action									
MAX MANUAL	2155	70/–55	100	–145/535	95/–75	75/–75	105	0	410
AUTOBRAKE MAX	2260	70/–55	105	–150/545	105/–85	80/–80	110	0	455
AUTOBRAKE 3	2305	70/–50	105	–130/525	90/–50	70/–70	110	0	435
Poor Reported Braking Action									
MAX MANUAL	3045	80/–65	110	–220/865	445/–220	90/–90	105	0	1165
AUTOBRAKE MAX	3150	80/–70	115	–225/870	455/–230	95/–95	110	0	1210
AUTOBRAKE 3	3165	80/–65	115	–225/875	450/–225	95/–95	110	0	1215

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTI-ICE LEAK ENG L, R (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1190	30/–25	35	–60/200	15/–10	30/–30	55	0	30
AUTOBRAKE MAX	1475	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2305	60/–50	80	–125/415	0/–10	70/–70	135	0	0
Good Reported Braking Action									
MAX MANUAL	1470	45/–35	60	–90/330	30/–25	50/–45	80	0	95
AUTOBRAKE MAX	1565	45/–35	60	–85/325	25/–20	50/–50	90	0	105
AUTOBRAKE 2	2325	60/–50	80	–125/420	10/–15	70/–70	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1620	40/–35	55	–90/320	45/–35	45/–45	70	0	140
AUTOBRAKE MAX	1730	40/–35	60	–95/330	40/–35	50/–50	85	0	150
AUTOBRAKE 2	2315	60/–50	80	–125/420	10/–15	70/–70	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1780	45/–40	60	–105/370	60/–50	50/–50	75	0	205
AUTOBRAKE MAX	1865	45/–40	65	–105/375	60/–45	55/–55	90	0	210
AUTOBRAKE 3	2120	55/–45	75	–120/405	35/–25	65/–65	120	0	85
Medium to Poor Reported Braking Action									
MAX MANUAL	2035	65/–55	90	–140/515	90/–70	70/–70	100	0	355
AUTOBRAKE MAX	2125	65/–55	95	–145/520	95/–80	75/–75	100	0	385
AUTOBRAKE 3	2195	65/–50	95	–125/490	70/–45	65/–65	105	0	345
Poor Reported Braking Action									
MAX MANUAL	2890	75/–65	105	–215/840	420/–205	85/–85	100	0	1045
AUTOBRAKE MAX	2975	80/–65	110	–215/850	425/–215	90/–90	100	0	1080
AUTOBRAKE 3	2990	80/–65	110	–215/850	420/–210	90/–90	105	0	1085

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTISKID (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1900	45/–45	65	–110/390	60/–50	50/–50	75	180	475
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	2075	60/–50	90	–130/490	75/–60	60/–60	90	270	785
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	2305	60/–55	90	–150/560	140/–95	65/–65	85	360	1080
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2445	65/–60	100	–165/635	190/–115	65/–70	85	440	1385
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2555	75/–65	115	–180/695	200/–125	75/–75	95	515	1690
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	3220	90/–85	125	–270/1170	685/–290	90/–95	95	1105	5115
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTISKID (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1850	45/–40	65	–110/390	60/–50	50/–50	75	170	440
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	2010	60/–50	85	–125/480	75/–60	60/–60	85	250	715
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	2240	60/–50	85	–150/555	135/–95	60/–60	85	340	1005
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2380	65/–55	95	–165/630	185/–115	65/–65	85	415	1285
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2480	75/–60	110	–180/685	195/–120	70/–75	95	480	1540
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	3135	90/–80	125	–270/1165	670/–285	90/–90	95	1050	4760
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
AUTO SPEEDBRAKE (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1220	30/–25	35	–60/195	10/–10	30/–30	50	25	55
AUTOBRAKE MAX	1465	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2195	60/–55	85	–120/405	25/–35	65/–65	105	85	85
Good Reported Braking Action									
MAX MANUAL	1470	40/–35	60	–85/300	25/–20	45/–45	70	70	175
AUTOBRAKE MAX	1515	40/–30	55	–75/280	10/–5	40/–40	80	50	155
AUTOBRAKE 2	2215	60/–60	85	–120/410	35/–45	65/–65	105	90	90
Good to Medium Reported Braking Action									
MAX MANUAL	1585	35/–35	55	–85/295	35/–30	40/–40	65	95	240
AUTOBRAKE MAX	1625	40/–35	55	–85/300	30/–25	45/–45	80	100	245
AUTOBRAKE 2	2205	60/–60	85	–120/410	35/–45	65/–65	105	90	90
Medium Reported Braking Action									
MAX MANUAL	1705	40/–40	60	–95/335	45/–40	45/–45	70	135	340
AUTOBRAKE MAX	1725	45/–40	60	–95/340	45/–35	45/–45	80	130	335
AUTOBRAKE 3	2075	50/–50	70	–115/390	25/–30	60/–60	110	20	100
Medium to Poor Reported Braking Action									
MAX MANUAL	1900	55/–50	80	–120/430	60/–50	60/–60	85	210	585
AUTOBRAKE MAX	1920	60/–50	85	–120/430	65/–55	60/–60	85	215	600
AUTOBRAKE 3	2145	55/–55	75	–115/395	45/–40	60/–60	100	60	390
Poor Reported Braking Action									
MAX MANUAL	2430	65/–60	85	–165/645	200/–120	70/–70	85	465	1465
AUTOBRAKE MAX	2445	70/–60	90	–170/645	205/–125	70/–70	85	470	1480
AUTOBRAKE 3	2520	70/–60	90	–170/655	190/–115	70/–75	100	405	1420

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
AUTO SPEEDBRAKE (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1190	30/–20	35	–60/195	10/–10	30/–30	50	20	50
AUTOBRAKE MAX	1420	35/–30	45	–70/230	5/–5	40/–40	80	0	0
AUTOBRAKE 2	2115	60/–55	80	–120/395	25/–35	60/–65	100	75	75
Good Reported Braking Action									
MAX MANUAL	1420	40/–30	55	–80/295	25/–20	45/–45	70	65	160
AUTOBRAKE MAX	1465	40/–30	55	–75/275	10/–5	40/–40	80	45	135
AUTOBRAKE 2	2135	60/–55	80	–120/400	35/–40	60/–65	105	80	80
Good to Medium Reported Braking Action									
MAX MANUAL	1540	35/–30	50	–85/295	35/–30	40/–40	65	90	220
AUTOBRAKE MAX	1575	40/–30	55	–85/300	30/–25	40/–40	75	90	225
AUTOBRAKE 2	2125	60/–55	80	–120/400	35/–40	60/–65	105	80	80
Medium Reported Braking Action									
MAX MANUAL	1660	40/–35	55	–95/335	45/–35	45/–45	70	125	315
AUTOBRAKE MAX	1675	40/–35	60	–95/335	40/–35	45/–45	80	125	310
AUTOBRAKE 3	2000	50/–45	70	–110/380	25/–30	60/–60	110	20	90
Medium to Poor Reported Braking Action									
MAX MANUAL	1835	55/–45	80	–120/420	60/–50	55/–55	85	195	520
AUTOBRAKE MAX	1850	55/–45	80	–120/425	65/–55	55/–60	85	195	530
AUTOBRAKE 3	2065	50/–50	70	–120/390	40/–40	60/–60	100	50	330
Poor Reported Braking Action									
MAX MANUAL	2360	65/–55	85	–165/635	195/–120	65/–65	85	435	1355
AUTOBRAKE MAX	2370	65/–55	85	–165/640	200/–125	65/–70	85	440	1365
AUTOBRAKE 3	2435	65/–55	85	–170/645	185/–115	70/–70	100	380	1315

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
BRAKES (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1545	55/–35	50	–85/290	35/–30	40/–40	65	95	230
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	1805	55/–45	80	–110/410	50/–45	55/–55	80	190	520
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	1990	50/–45	75	–120/445	85/–65	55/–55	75	250	695
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2130	55/–50	85	–135/505	115/–80	60/–60	80	315	910
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2270	70/–60	105	–155/575	125/–90	70/–70	90	400	1230
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	2895	85/–75	115	–230/950	665/–220	80/–85	90	830	3100
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
BRAKES (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1505	50/–30	50	–85/285	30/–30	40/–40	65	90	215
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	1745	50/–40	75	–110/400	50/–45	55/–55	80	175	475
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	1930	50/–45	75	–120/440	85/–65	55/–55	75	235	645
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2065	55/–50	80	–135/500	110/–80	55/–60	80	295	845
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2195	65/–55	100	–155/570	125/–90	65/–65	90	370	1115
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	2815	80/–70	110	–225/940	655/–215	80/–80	90	780	2870
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ENG SHUTDOWN L, R (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1225	35/–20	35	–60/200	15/–15	30/–30	55	0	30
AUTOBRAKE MAX	1530	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2400	60/–50	85	–125/425	0/–10	75/–75	140	0	0
Good Reported Braking Action									
MAX MANUAL	1520	45/–35	60	–90/330	30/–30	50/–50	80	0	105
AUTOBRAKE MAX	1620	45/–35	65	–85/325	25/–20	50/–50	90	0	110
AUTOBRAKE 2	2420	65/–55	85	–130/430	10/–20	75/–75	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1655	40/–35	55	–90/315	45/–35	45/–45	70	0	140
AUTOBRAKE MAX	1770	45/–35	60	–95/325	40/–35	50/–50	85	0	150
AUTOBRAKE 2	2410	65/–55	85	–130/430	10/–20	75/–75	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1815	45/–40	60	–105/360	60/–50	50/–50	75	0	205
AUTOBRAKE MAX	1905	50/–40	65	–105/365	55/–45	55/–55	90	0	210
AUTOBRAKE 3	2185	55/–45	75	–115/400	30/–25	65/–65	125	0	70
Medium to Poor Reported Braking Action									
MAX MANUAL	2090	65/–55	95	–140/505	90/–70	70/–70	105	0	370
AUTOBRAKE MAX	2190	70/–55	100	–140/515	100/–80	75/–75	105	0	405
AUTOBRAKE 3	2260	65/–50	95	–125/480	70/–40	70/–70	110	0	360
Poor Reported Braking Action									
MAX MANUAL	2815	80/–70	100	–195/725	295/–175	85/–85	105	0	930
AUTOBRAKE MAX	2915	85/–70	105	–195/735	305/–185	85/–85	105	0	965
AUTOBRAKE 3	2930	85/–70	105	–195/735	300/–175	85/–85	110	0	975

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ENG SHUTDOWN L, R (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1180	30/–25	35	–60/195	15/–10	30/–30	50	0	25
AUTOBRAKE MAX	1475	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2300	60/–55	80	–125/415	0/–15	70/–70	130	0	0
Good Reported Braking Action									
MAX MANUAL	1450	45/–35	60	–85/320	30/–25	45/–45	75	0	90
AUTOBRAKE MAX	1545	45/–35	60	–85/315	25/–20	50/–45	85	0	95
AUTOBRAKE 2	2320	60/–55	80	–125/420	10/–25	70/–70	130	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1590	40/–35	55	–90/305	40/–35	45/–45	70	0	125
AUTOBRAKE MAX	1695	40/–35	55	–90/315	40/–30	45/–45	85	0	140
AUTOBRAKE 2	2310	60/–55	80	–125/420	10/–25	70/–70	130	0	0
Medium Reported Braking Action									
MAX MANUAL	1735	45/–40	60	–100/350	55/–45	50/–50	75	0	185
AUTOBRAKE MAX	1825	45/–40	65	–105/360	50/–45	50/–50	90	0	190
AUTOBRAKE 3	2095	55/–45	70	–115/395	25/–25	60/–60	120	0	60
Medium to Poor Reported Braking Action									
MAX MANUAL	1975	65/–50	90	–135/485	80/–65	65/–65	100	0	315
AUTOBRAKE MAX	2060	65/–55	95	–135/495	90/–70	70/–70	100	0	345
AUTOBRAKE 3	2155	60/–50	90	–120/445	55/–35	65/–65	110	0	280
Poor Reported Braking Action									
MAX MANUAL	2670	75/–65	95	–185/710	275/–165	80/–80	100	0	835
AUTOBRAKE MAX	2755	80/–70	100	–190/715	285/–170	80/–80	100	0	865
AUTOBRAKE 3	2770	80/–70	100	–190/715	280/–165	80/–80	105	0	870

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAP/SLAT CONTROL (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1210	30/–20	35	–60/195	15/–10	30/–30	50	25	55
AUTOBRAKE MAX	1530	35/–30	45	–70/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2295	65/–55	85	–120/410	30/–40	65/–70	105	100	100
Good Reported Braking Action									
MAX MANUAL	1465	40/–30	60	–85/305	25/–25	45/–45	75	75	185
AUTOBRAKE MAX	1570	40/–30	60	–75/290	15/–5	45/–45	85	65	180
AUTOBRAKE 2	2315	65/–55	90	–125/415	35/–45	70/–70	110	110	110
Good to Medium Reported Braking Action									
MAX MANUAL	1580	35/–30	55	–85/300	35/–30	40/–40	65	100	245
AUTOBRAKE MAX	1685	40/–35	55	–90/305	30/–25	45/–45	80	110	265
AUTOBRAKE 2	2305	65/–55	90	–125/415	35/–45	70/–70	110	110	110
Medium Reported Braking Action									
MAX MANUAL	1705	40/–35	60	–95/335	45/–40	45/–45	70	140	350
AUTOBRAKE MAX	1790	45/–35	65	–100/345	45/–35	50/–50	80	145	365
AUTOBRAKE 3	2170	55/–50	75	–115/395	25/–35	65/–65	115	25	110
Medium to Poor Reported Braking Action									
MAX MANUAL	1910	55/–45	85	–120/435	65/–50	60/–60	85	220	615
AUTOBRAKE MAX	1995	60/–50	90	–120/440	70/–60	60/–65	90	245	675
AUTOBRAKE 3	2225	55/–50	80	–120/405	45/–40	65/–65	105	70	465
Poor Reported Braking Action									
MAX MANUAL	2450	70/–55	90	–170/650	205/–125	70/–70	85	480	1510
AUTOBRAKE MAX	2535	70/–60	95	–170/655	215/–130	70/–75	90	500	1575
AUTOBRAKE 3	2615	70/–60	90	–175/665	200/–120	75/–75	105	435	1510

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Flaps + Slats Fail (Flaps and Slats Up)
VREF 30+50

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1710	55/–30	50	–65/220	15/–15	45/–45	N/A	55	120
AUTOBRAKE MAX	2240	40/–35	70	–85/280	0/0	60/–65	N/A	0	5
AUTOBRAKE 2	3255	80/–75	130	–145/475	65/–70	95/–95	N/A	385	450
Good Reported Braking Action									
MAX MANUAL	2195	55/–45	90	–105/360	40/–35	70/–70	N/A	185	475
AUTOBRAKE MAX	2290	50/–35	90	–90/325	10/–5	65/–65	N/A	130	415
AUTOBRAKE 2	3255	80/–75	130	–145/475	70/–70	95/–100	N/A	390	455
Good to Medium Reported Braking Action									
MAX MANUAL	2210	45/–40	75	–95/330	45/–40	60/–60	N/A	175	445
AUTOBRAKE MAX	2385	45/–35	80	–100/345	30/–25	65/–65	N/A	115	385
AUTOBRAKE 2	3255	80/–75	130	–145/475	70/–70	95/–100	N/A	390	455
Medium Reported Braking Action									
MAX MANUAL	2385	50/–45	85	–110/375	60/–50	65/–65	N/A	240	620
AUTOBRAKE MAX	2485	50/–40	85	–110/385	45/–35	70/–70	N/A	210	600
AUTOBRAKE 3	3115	70/–70	115	–135/460	55/–60	90/–95	N/A	185	290
Medium to Poor Reported Braking Action									
MAX MANUAL	2795	75/–60	125	–140/490	85/–75	85/–85	N/A	465	1405
AUTOBRAKE MAX	2810	75/–60	125	–140/490	90/–75	85/–90	N/A	465	1415
AUTOBRAKE 3	3155	70/–70	120	–135/465	70/–70	90/–95	N/A	235	1100
Poor Reported Braking Action									
MAX MANUAL	3345	85/–75	145	–190/705	230/–145	95/–95	N/A	750	2510
AUTOBRAKE MAX	3360	85/–75	145	–190/705	235/–150	95/–100	N/A	755	2515
AUTOBRAKE 3	3550	90/–80	150	–195/725	230/–150	105/–105	N/A	655	2360

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS DRIVE (1 ≤ Flaps ≤5)
VREF 30+40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1585	45/–25	45	–65/215	15/–15	40/–40	55	45	100
AUTOBRAKE MAX	2080	40/–35	65	–85/270	5/–5	55/–60	95	0	0
AUTOBRAKE 2	2985	75/–70	120	–135/455	60/–60	85/–90	100	320	390
Good Reported Braking Action									
MAX MANUAL	2005	50/–40	80	–100/345	35/–30	65/–65	75	145	360
AUTOBRAKE MAX	2125	45/–35	80	–85/310	10/–5	60/–60	95	95	315
AUTOBRAKE 2	3000	75/–70	120	–140/460	65/–70	90/–90	100	325	400
Good to Medium Reported Braking Action									
MAX MANUAL	2050	45/–40	70	–95/320	40/–35	55/–55	65	150	370
AUTOBRAKE MAX	2225	45/–35	75	–100/335	30/–20	60/–60	95	100	330
AUTOBRAKE 2	3000	75/–70	120	–140/460	65/–70	90/–90	100	325	400
Medium Reported Braking Action									
MAX MANUAL	2210	50/–45	80	–105/365	55/–45	60/–60	70	200	515
AUTOBRAKE MAX	2320	50/–40	80	–110/375	45/–35	65/–65	95	185	510
AUTOBRAKE 3	2865	65/–65	105	–130/440	60/–60	85/–85	100	165	250
Medium to Poor Reported Braking Action									
MAX MANUAL	2555	70/–60	110	–135/475	80/–65	80/–80	85	370	1065
AUTOBRAKE MAX	2575	70/–55	115	–135/475	80/–70	80/–80	90	370	1075
AUTOBRAKE 3	2895	65/–65	110	–130/445	65/–65	85/–85	95	190	790
Poor Reported Braking Action									
MAX MANUAL	3095	80/–70	130	–180/685	220/–140	90/–90	85	635	2035
AUTOBRAKE MAX	3120	80/–70	130	–185/690	225/–140	90/–90	90	640	2045
AUTOBRAKE 3	3280	80/–75	135	–190/705	220/–140	95/–95	95	570	1915

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS DRIVE (5 < Flaps < 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1380	35/–25	40	–60/205	15/–15	35/–35	50	35	75
AUTOBRAKE MAX	1805	40/–30	55	–80/255	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2660	70/–65	105	–130/435	45/–55	80/–80	105	220	225
Good Reported Braking Action									
MAX MANUAL	1710	45/–35	70	–90/325	30/–25	55/–55	75	110	275
AUTOBRAKE MAX	1850	45/–35	70	–80/305	15/–5	50/–50	90	95	270
AUTOBRAKE 2	2680	70/–65	105	–130/440	50/–60	80/–80	105	230	240
Good to Medium Reported Braking Action									
MAX MANUAL	1800	40/–35	60	–90/310	40/–35	50/–50	65	125	315
AUTOBRAKE MAX	1955	45/–35	65	–95/325	30/–25	55/–55	90	120	330
AUTOBRAKE 2	2670	70/–65	105	–130/440	50/–60	80/–80	105	230	240
Medium Reported Braking Action									
MAX MANUAL	1940	45/–40	70	–100/350	50/–45	50/–55	70	175	445
AUTOBRAKE MAX	2055	50/–40	75	–105/360	50/–35	55/–55	90	185	470
AUTOBRAKE 3	2545	60/–60	90	–125/425	45/–50	75/–75	110	80	170
Medium to Poor Reported Braking Action									
MAX MANUAL	2210	65/–50	100	–125/455	70/–60	70/–70	85	300	870
AUTOBRAKE MAX	2305	65/–55	105	–130/460	80/–65	70/–70	90	325	940
AUTOBRAKE 3	2585	65/–60	95	–125/430	50/–55	75/–75	100	110	690
Poor Reported Braking Action									
MAX MANUAL	2750	75/–65	100	–175/670	215/–130	80/–80	85	570	1845
AUTOBRAKE MAX	2845	75/–65	105	–180/675	220/–140	80/–80	90	595	1915
AUTOBRAKE 3	2975	80/–70	110	–180/690	205/–135	85/–85	100	495	1815

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS DRIVE (Flaps ≥ 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1210	30/–20	35	–60/195	15/–10	30/–30	50	25	55
AUTOBRAKE MAX	1530	35/–30	45	–70/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2295	65/–55	85	–120/410	30/–40	65/–70	105	100	100
Good Reported Braking Action									
MAX MANUAL	1465	40/–30	60	–85/305	25/–25	45/–45	75	75	185
AUTOBRAKE MAX	1570	40/–30	60	–75/290	15/–5	45/–45	85	65	180
AUTOBRAKE 2	2315	65/–55	90	–125/415	35/–45	70/–70	110	110	110
Good to Medium Reported Braking Action									
MAX MANUAL	1580	35/–30	55	–85/300	35/–30	40/–40	65	100	245
AUTOBRAKE MAX	1685	40/–35	55	–90/305	30/–25	45/–45	80	110	265
AUTOBRAKE 2	2305	65/–55	90	–125/415	35/–45	70/–70	110	110	110
Medium Reported Braking Action									
MAX MANUAL	1705	40/–35	60	–95/335	45/–40	45/–45	70	140	350
AUTOBRAKE MAX	1790	45/–35	65	–100/345	45/–35	50/–50	80	145	365
AUTOBRAKE 3	2170	55/–50	75	–115/395	25/–35	65/–65	115	25	110
Medium to Poor Reported Braking Action									
MAX MANUAL	1910	55/–45	85	–120/435	65/–50	60/–60	85	220	615
AUTOBRAKE MAX	1995	60/–50	90	–120/440	70/–60	60/–65	90	245	675
AUTOBRAKE 3	2225	55/–50	80	–120/405	45/–40	65/–65	105	70	465
Poor Reported Braking Action									
MAX MANUAL	2450	70/–55	90	–170/650	205/–125	70/–70	85	480	1510
AUTOBRAKE MAX	2535	70/–60	95	–170/655	215/–130	70/–75	90	500	1575
AUTOBRAKE 3	2615	70/–60	90	–175/665	200/–120	75/–75	105	435	1510

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS PRIMARY FAIL (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1245	30/–20	35	–60/200	15/–10	30/–30	45	15	50
AUTOBRAKE MAX	1530	35/–30	45	–70/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2315	65/–55	90	–125/415	25/–35	70/–70	110	80	80
Good Reported Braking Action									
MAX MANUAL	1510	45/–35	60	–85/310	25/–25	45/–45	70	70	195
AUTOBRAKE MAX	1580	45/–30	65	–80/310	25/–10	50/–45	85	80	210
AUTOBRAKE 2	2335	65/–55	90	–125/420	35/–45	70/–70	115	85	85
Good to Medium Reported Braking Action									
MAX MANUAL	1625	40/–35	55	–90/305	40/–30	45/–45	60	95	260
AUTOBRAKE MAX	1700	40/–35	60	–90/310	35/–30	45/–45	80	115	285
AUTOBRAKE 2	2325	65/–55	90	–125/420	35/–45	70/–70	115	85	85
Medium Reported Braking Action									
MAX MANUAL	1755	45/–35	60	–100/345	50/–40	45/–50	65	135	370
AUTOBRAKE MAX	1810	45/–40	65	–100/350	55/–40	50/–50	85	155	400
AUTOBRAKE 3	2180	55/–50	75	–115/400	25/–30	65/–65	115	20	130
Medium to Poor Reported Braking Action									
MAX MANUAL	1965	60/–50	85	–125/440	65/–55	60/–60	85	230	675
AUTOBRAKE MAX	2040	65/–50	90	–125/445	75/–60	65/–65	90	265	760
AUTOBRAKE 3	2245	55/–50	80	–120/405	45/–40	65/–65	105	80	560
Poor Reported Braking Action									
MAX MANUAL	2510	70/–60	90	–170/660	215/–130	70/–70	80	500	1640
AUTOBRAKE MAX	2585	75/–60	95	–175/665	220/–135	75/–75	90	535	1725
AUTOBRAKE 3	2650	75/–60	95	–175/670	205/–120	75/–75	105	480	1670

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLIGHT CONTROL MODE (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1250	30/–20	35	–60/200	15/–10	30/–30	55	25	60
AUTOBRAKE MAX	1535	35/–30	45	–75/240	5/–5	40/–40	90	0	0
AUTOBRAKE 2	2320	65/–55	85	–125/415	25/–35	70/–70	115	75	75
Good Reported Braking Action									
MAX MANUAL	1510	40/–35	60	–85/310	25/–25	45/–45	75	80	195
AUTOBRAKE MAX	1590	45/–30	65	–80/310	25/–10	45/–45	85	75	200
AUTOBRAKE 2	2345	65/–55	90	–125/420	35/–45	70/–70	115	85	85
Good to Medium Reported Braking Action									
MAX MANUAL	1625	40/–35	55	–90/305	35/–30	45/–45	70	105	260
AUTOBRAKE MAX	1710	40/–35	60	–90/310	35/–30	45/–45	80	115	280
AUTOBRAKE 2	2335	65/–55	90	–125/420	35/–45	70/–70	115	85	85
Medium Reported Braking Action									
MAX MANUAL	1755	45/–35	60	–100/345	50/–40	45/–45	75	145	370
AUTOBRAKE MAX	1820	45/–40	65	–100/350	50/–40	50/–50	85	150	390
AUTOBRAKE 3	2185	55/–50	75	–115/400	25/–30	65/–65	120	20	120
Medium to Poor Reported Braking Action									
MAX MANUAL	1960	60/–50	85	–125/440	65/–55	60/–60	90	235	660
AUTOBRAKE MAX	2050	65/–50	90	–125/450	75/–60	65/–65	95	260	730
AUTOBRAKE 3	2265	55/–50	80	–120/410	45/–45	65/–65	105	75	530
Poor Reported Braking Action									
MAX MANUAL	2510	70/–60	90	–170/655	215/–130	70/–70	90	500	1615
AUTOBRAKE MAX	2600	75/–60	95	–175/665	220/–135	75/–75	95	525	1685
AUTOBRAKE 3	2665	70/–60	95	–175/670	205/–125	75/–80	105	465	1630

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLIGHT CONTROLS (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1480	35/–25	45	–65/215	20/–15	40/–40	65	50	110
AUTOBRAKE MAX	1825	35/–30	55	–80/255	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2760	70/–65	105	–135/450	40/–50	80/–85	130	125	125
Good Reported Braking Action									
MAX MANUAL	1855	50/–40	80	–100/345	40/–35	60/–60	90	155	400
AUTOBRAKE MAX	1955	55/–40	85	–95/350	45/–35	60/–60	95	165	440
AUTOBRAKE 2	2785	75/–70	110	–135/450	45/–55	85/–85	120	135	135
Good to Medium Reported Braking Action									
MAX MANUAL	1940	45/–40	70	–95/330	50/–40	50/–55	80	170	430
AUTOBRAKE MAX	2030	50/–40	75	–100/335	50/–40	55/–55	90	175	450
AUTOBRAKE 2	2780	75/–70	110	–135/450	45/–55	85/–85	120	135	135
Medium Reported Braking Action									
MAX MANUAL	2095	50/–45	75	–105/370	65/–55	55/–60	85	225	600
AUTOBRAKE MAX	2185	55/–45	80	–110/375	65/–55	60/–60	90	235	635
AUTOBRAKE 3	2605	60/–60	90	–125/430	40/–40	75/–80	125	35	260
Medium to Poor Reported Braking Action									
MAX MANUAL	2375	70/–55	110	–135/480	85/–70	75/–75	100	390	1195
AUTOBRAKE MAX	2485	75/–60	115	–135/485	95/–80	80/–80	100	420	1300
AUTOBRAKE 3	2680	65/–60	105	–130/445	60/–55	80/–80	115	225	1105
Poor Reported Braking Action									
MAX MANUAL	2945	80/–70	115	–185/700	245/–150	85/–85	100	690	2355
AUTOBRAKE MAX	3055	85/–75	120	–190/705	255/–160	90/–90	100	725	2460
AUTOBRAKE 3	3125	85/–75	115	–190/715	245/–145	90/–90	115	650	2390

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Fuel Leak (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1225	35/–20	35	–60/200	15/–15	30/–30	55	0	30
AUTOBRAKE MAX	1530	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2400	60/–50	85	–125/425	0/–10	75/–75	140	0	0
Good Reported Braking Action									
MAX MANUAL	1520	45/–35	60	–90/330	30/–30	50/–50	80	0	105
AUTOBRAKE MAX	1620	45/–35	65	–85/325	25/–20	50/–50	90	0	110
AUTOBRAKE 2	2420	65/–55	85	–130/430	10/–20	75/–75	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1655	40/–35	55	–90/315	45/–35	45/–45	70	0	140
AUTOBRAKE MAX	1770	45/–35	60	–95/325	40/–35	50/–50	85	0	150
AUTOBRAKE 2	2410	65/–55	85	–130/430	10/–20	75/–75	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1815	45/–40	60	–105/360	60/–50	50/–50	75	0	205
AUTOBRAKE MAX	1905	50/–40	65	–105/365	55/–45	55/–55	90	0	210
AUTOBRAKE 3	2185	55/–45	75	–115/400	30/–25	65/–65	125	0	70
Medium to Poor Reported Braking Action									
MAX MANUAL	2090	65/–55	95	–140/505	90/–70	70/–70	105	0	370
AUTOBRAKE MAX	2190	70/–55	100	–140/515	100/–80	75/–75	105	0	405
AUTOBRAKE 3	2260	65/–50	95	–125/480	70/–40	70/–70	110	0	360
Poor Reported Braking Action									
MAX MANUAL	2815	80/–70	100	–195/725	295/–175	85/–85	105	0	930
AUTOBRAKE MAX	2915	85/–70	105	–195/735	305/–185	85/–85	105	0	965
AUTOBRAKE 3	2930	85/–70	105	–195/735	300/–175	85/–85	110	0	975

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Fuel Leak (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1180	30/–25	35	–60/195	15/–10	30/–30	50	0	25
AUTOBRAKE MAX	1475	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2300	60/–55	80	–125/415	0/–15	70/–70	130	0	0
Good Reported Braking Action									
MAX MANUAL	1450	45/–35	60	–85/320	30/–25	45/–45	75	0	90
AUTOBRAKE MAX	1545	45/–35	60	–85/315	25/–20	50/–45	85	0	95
AUTOBRAKE 2	2320	60/–55	80	–125/420	10/–25	70/–70	130	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1590	40/–35	55	–90/305	40/–35	45/–45	70	0	125
AUTOBRAKE MAX	1695	40/–35	55	–90/315	40/–30	45/–45	85	0	140
AUTOBRAKE 2	2310	60/–55	80	–125/420	10/–25	70/–70	130	0	0
Medium Reported Braking Action									
MAX MANUAL	1735	45/–40	60	–100/350	55/–45	50/–50	75	0	185
AUTOBRAKE MAX	1825	45/–40	65	–105/360	50/–45	50/–50	90	0	190
AUTOBRAKE 3	2095	55/–45	70	–115/395	25/–25	60/–60	120	0	60
Medium to Poor Reported Braking Action									
MAX MANUAL	1975	65/–50	90	–135/485	80/–65	65/–65	100	0	315
AUTOBRAKE MAX	2060	65/–55	95	–135/495	90/–70	70/–70	100	0	345
AUTOBRAKE 3	2155	60/–50	90	–120/445	55/–35	65/–65	110	0	280
Poor Reported Braking Action									
MAX MANUAL	2670	75/–65	95	–185/710	275/–165	80/–80	100	0	835
AUTOBRAKE MAX	2755	80/–70	100	–190/715	285/–170	80/–80	100	0	865
AUTOBRAKE 3	2770	80/–70	100	–190/715	280/–165	80/–80	105	0	870

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FUEL QTY LOW (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1210	30/–20	35	–60/195	15/–10	30/–30	50	25	55
AUTOBRAKE MAX	1470	35/–25	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2210	60/–55	85	–120/405	25/–35	65/–65	105	75	75
Good Reported Braking Action									
MAX MANUAL	1465	40/–30	60	–85/305	25/–25	45/–45	75	75	185
AUTOBRAKE MAX	1510	40/–30	55	–75/285	15/–5	40/–40	80	60	165
AUTOBRAKE 2	2225	60/–55	85	–120/410	30/–40	65/–65	105	80	80
Good to Medium Reported Braking Action									
MAX MANUAL	1580	35/–30	55	–85/300	35/–30	40/–40	65	100	245
AUTOBRAKE MAX	1625	40/–30	55	–85/300	30/–25	45/–45	80	100	250
AUTOBRAKE 2	2220	60/–55	85	–120/410	30/–40	65/–65	105	80	80
Medium Reported Braking Action									
MAX MANUAL	1705	40/–35	60	–95/335	45/–40	45/–45	70	140	350
AUTOBRAKE MAX	1730	45/–35	60	–95/340	45/–35	45/–50	80	135	345
AUTOBRAKE 3	2080	50/–45	70	–115/390	25/–30	60/–60	110	20	105
Medium to Poor Reported Braking Action									
MAX MANUAL	1910	55/–45	85	–120/435	65/–50	60/–60	85	220	615
AUTOBRAKE MAX	1925	60/–45	85	–120/435	70/–55	60/–60	85	225	630
AUTOBRAKE 3	2145	55/–50	75	–115/400	40/–40	60/–60	105	60	430
Poor Reported Braking Action									
MAX MANUAL	2450	70/–55	90	–170/650	205/–125	70/–70	85	480	1510
AUTOBRAKE MAX	2465	70/–60	90	–170/650	210/–130	70/–70	85	485	1525
AUTOBRAKE 3	2535	70/–60	90	–170/660	195/–115	75/–75	105	425	1475

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR CONTROL (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1220	30/–25	35	–60/195	10/–10	30/–30	50	25	55
AUTOBRAKE MAX	1465	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2195	60/–55	85	–120/405	25/–35	65/–65	105	85	85
Good Reported Braking Action									
MAX MANUAL	1470	40/–35	60	–85/300	25/–20	45/–45	70	70	175
AUTOBRAKE MAX	1515	40/–30	55	–75/280	10/–5	40/–40	80	50	155
AUTOBRAKE 2	2215	60/–60	85	–120/410	35/–45	65/–65	105	90	90
Good to Medium Reported Braking Action									
MAX MANUAL	1585	35/–35	55	–85/295	35/–30	40/–40	65	95	240
AUTOBRAKE MAX	1625	40/–35	55	–85/300	30/–25	45/–45	80	100	245
AUTOBRAKE 2	2205	60/–60	85	–120/410	35/–45	65/–65	105	90	90
Medium Reported Braking Action									
MAX MANUAL	1705	40/–40	60	–95/335	45/–40	45/–45	70	135	340
AUTOBRAKE MAX	1725	45/–40	60	–95/340	45/–35	45/–45	80	130	335
AUTOBRAKE 3	2075	50/–50	70	–115/390	25/–30	60/–60	110	20	100
Medium to Poor Reported Braking Action									
MAX MANUAL	1900	55/–50	80	–120/430	60/–50	60/–60	85	210	585
AUTOBRAKE MAX	1920	60/–50	85	–120/430	65/–55	60/–60	85	215	600
AUTOBRAKE 3	2145	55/–55	75	–115/395	45/–40	60/–60	100	60	390
Poor Reported Braking Action									
MAX MANUAL	2430	65/–60	85	–165/645	200/–120	70/–70	85	465	1465
AUTOBRAKE MAX	2445	70/–60	90	–170/645	205/–125	70/–70	85	470	1480
AUTOBRAKE 3	2520	70/–60	90	–170/655	190/–115	70/–75	100	405	1420

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR CONTROL (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1190	30/–20	35	–60/195	10/–10	30/–30	50	20	50
AUTOBRAKE MAX	1420	35/–30	45	–70/230	5/–5	40/–40	80	0	0
AUTOBRAKE 2	2115	60/–55	80	–120/395	25/–35	60/–65	100	75	75
Good Reported Braking Action									
MAX MANUAL	1420	40/–30	55	–80/295	25/–20	45/–45	70	65	160
AUTOBRAKE MAX	1465	40/–30	55	–75/275	10/–5	40/–40	80	45	135
AUTOBRAKE 2	2135	60/–55	80	–120/400	35/–40	60/–65	105	80	80
Good to Medium Reported Braking Action									
MAX MANUAL	1540	35/–30	50	–85/295	35/–30	40/–40	65	90	220
AUTOBRAKE MAX	1575	40/–30	55	–85/300	30/–25	40/–40	75	90	225
AUTOBRAKE 2	2125	60/–55	80	–120/400	35/–40	60/–65	105	80	80
Medium Reported Braking Action									
MAX MANUAL	1660	40/–35	55	–95/335	45/–35	45/–45	70	125	315
AUTOBRAKE MAX	1675	40/–35	60	–95/335	40/–35	45/–45	80	125	310
AUTOBRAKE 3	2000	50/–45	70	–110/380	25/–30	60/–60	110	20	90
Medium to Poor Reported Braking Action									
MAX MANUAL	1835	55/–45	80	–120/420	60/–50	55/–55	85	195	520
AUTOBRAKE MAX	1850	55/–45	80	–120/425	65/–55	55/–60	85	195	530
AUTOBRAKE 3	2065	50/–50	70	–120/390	40/–40	60/–60	100	50	330
Poor Reported Braking Action									
MAX MANUAL	2360	65/–55	85	–165/635	195/–120	65/–65	85	435	1355
AUTOBRAKE MAX	2370	65/–55	85	–165/640	200/–125	65/–70	85	440	1365
AUTOBRAKE 3	2435	65/–55	85	–170/645	185/–115	70/–70	100	380	1315

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR DRAG BRACE L, R/GEAR SIDE BRACE L, R (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1190	30/–20	35	–60/195	10/–10	30/–30	50	20	50
AUTOBRAKE MAX	1420	35/–30	45	–70/230	5/–5	40/–40	80	0	0
AUTOBRAKE 2	2115	60/–55	80	–120/395	25/–35	60/–65	100	75	75
Good Reported Braking Action									
MAX MANUAL	1420	40/–30	55	–80/295	25/–20	45/–45	70	65	160
AUTOBRAKE MAX	1465	40/–30	55	–75/275	10/–5	40/–40	80	45	135
AUTOBRAKE 2	2135	60/–55	80	–120/400	35/–40	60/–65	105	80	80
Good to Medium Reported Braking Action									
MAX MANUAL	1540	35/–30	50	–85/295	35/–30	40/–40	65	90	220
AUTOBRAKE MAX	1575	40/–30	55	–85/300	30/–25	40/–40	75	90	225
AUTOBRAKE 2	2125	60/–55	80	–120/400	35/–40	60/–65	105	80	80
Medium Reported Braking Action									
MAX MANUAL	1660	40/–35	55	–95/335	45/–35	45/–45	70	125	315
AUTOBRAKE MAX	1675	40/–35	60	–95/335	40/–35	45/–45	80	125	310
AUTOBRAKE 3	2000	50/–45	70	–110/380	25/–30	60/–60	110	20	90
Medium to Poor Reported Braking Action									
MAX MANUAL	1835	55/–45	80	–120/420	60/–50	55/–55	85	195	520
AUTOBRAKE MAX	1850	55/–45	80	–120/425	65/–55	55/–60	85	195	530
AUTOBRAKE 3	2065	50/–50	70	–120/390	40/–40	60/–60	100	50	330
Poor Reported Braking Action									
MAX MANUAL	2360	65/–55	85	–165/635	195/–120	65/–65	85	435	1355
AUTOBRAKE MAX	2370	65/–55	85	–165/640	200/–125	65/–70	85	440	1365
AUTOBRAKE 3	2435	65/–55	85	–170/645	185/–115	70/–70	100	380	1315

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS C (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1270	30/–25	35	–60/200	15/–10	30/–30	55	25	60
AUTOBRAKE MAX	1565	35/–30	45	–75/240	5/–5	40/–45	90	0	0
AUTOBRAKE 2	2355	65/–60	90	–125/415	30/–40	70/–70	110	95	95
Good Reported Braking Action									
MAX MANUAL	1535	40/–35	60	–85/310	25/–25	45/–45	75	85	205
AUTOBRAKE MAX	1620	45/–35	65	–80/310	25/–10	45/–45	85	80	205
AUTOBRAKE 2	2375	65/–60	90	–125/420	40/–45	70/–70	110	100	100
Good to Medium Reported Braking Action									
MAX MANUAL	1650	40/–35	55	–90/305	35/–30	45/–45	70	105	265
AUTOBRAKE MAX	1735	40/–35	60	–90/310	35/–30	45/–45	80	115	285
AUTOBRAKE 2	2375	65/–60	90	–125/420	40/–45	70/–70	110	100	100
Medium Reported Braking Action									
MAX MANUAL	1780	45/–40	60	–100/345	50/–40	45/–50	70	145	375
AUTOBRAKE MAX	1845	45/–40	65	–100/350	50/–40	50/–50	85	150	390
AUTOBRAKE 3	2225	55/–50	75	–115/400	25/–35	65/–65	115	25	120
Medium to Poor Reported Braking Action									
MAX MANUAL	1990	60/–50	85	–125/440	65/–55	60/–60	90	240	670
AUTOBRAKE MAX	2075	60/–50	90	–125/450	75/–60	65/–65	90	260	735
AUTOBRAKE 3	2295	55/–55	80	–120/410	45/–45	65/–65	105	75	530
Poor Reported Braking Action									
MAX MANUAL	2530	70/–60	90	–170/655	210/–130	70/–70	90	500	1600
AUTOBRAKE MAX	2620	70/–65	95	–175/665	220/–135	75/–75	90	525	1665
AUTOBRAKE 3	2690	70/–65	95	–175/670	205/–125	75/–80	105	460	1605

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS L (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1235	35/–25	35	–60/200	15/–15	30/–30	55	0	30
AUTOBRAKE MAX	1525	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2395	60/–55	85	–125/425	0/–5	75/–75	145	0	0
Good Reported Braking Action									
MAX MANUAL	1540	45/–40	65	–90/335	35/–30	50/–50	80	0	115
AUTOBRAKE MAX	1630	45/–40	65	–90/335	30/–20	50/–50	90	0	120
AUTOBRAKE 2	2420	65/–55	85	–130/430	10/–15	75/–75	145	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1680	40/–35	55	–90/320	45/–40	45/–45	75	0	150
AUTOBRAKE MAX	1785	45/–40	60	–95/330	40/–35	50/–50	85	0	165
AUTOBRAKE 2	2405	65/–55	85	–130/430	10/–15	75/–75	145	0	0
Medium Reported Braking Action									
MAX MANUAL	1845	45/–40	65	–105/370	65/–50	50/–50	80	0	220
AUTOBRAKE MAX	1925	50/–45	70	–105/375	60/–45	55/–55	90	0	230
AUTOBRAKE 3	2195	55/–50	75	–120/410	30/–25	65/–65	130	0	85
Medium to Poor Reported Braking Action									
MAX MANUAL	2125	65/–60	100	–145/520	90/–75	75/–70	105	0	405
AUTOBRAKE MAX	2230	70/–60	105	–145/525	105/–80	75/–75	105	0	445
AUTOBRAKE 3	2285	70/–55	100	–125/500	75/–45	70/–70	110	0	410
Poor Reported Braking Action									
MAX MANUAL	2915	80/–70	105	–205/785	350/–190	85/–85	105	0	1060
AUTOBRAKE MAX	3015	85/–75	110	–210/795	360/–200	90/–85	105	0	1100
AUTOBRAKE 3	3030	85/–75	110	–210/795	355/–195	90/–85	110	0	1105

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS L (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1200	30/–25	35	–60/200	15/–15	30/–30	55	0	30
AUTOBRAKE MAX	1475	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2305	60/–50	80	–125/415	0/–5	70/–70	140	0	0
Good Reported Braking Action									
MAX MANUAL	1480	45/–35	60	–90/330	30/–25	50/–45	80	0	100
AUTOBRAKE MAX	1565	45/–35	65	–85/320	25/–20	50/–50	90	0	105
AUTOBRAKE 2	2325	60/–55	80	–125/420	10/–15	70/–70	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1625	40/–35	55	–90/315	45/–35	45/–45	70	0	140
AUTOBRAKE MAX	1725	40/–35	60	–95/325	40/–35	50/–50	85	0	150
AUTOBRAKE 2	2315	60/–55	80	–125/420	10/–15	70/–70	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1780	45/–40	60	–105/360	60/–50	50/–50	75	0	205
AUTOBRAKE MAX	1855	45/–40	65	–105/370	55/–45	50/–50	90	0	210
AUTOBRAKE 3	2110	55/–45	75	–115/400	30/–25	60/–60	125	0	80
Medium to Poor Reported Braking Action									
MAX MANUAL	2035	65/–55	95	–140/505	85/–70	70/–70	100	0	355
AUTOBRAKE MAX	2125	70/–55	100	–140/515	95/–75	75/–70	105	0	390
AUTOBRAKE 3	2195	65/–50	95	–125/480	65/–40	65/–65	110	0	340
Poor Reported Braking Action									
MAX MANUAL	2810	75/–65	100	–200/775	335/–185	85/–80	100	0	965
AUTOBRAKE MAX	2895	80/–70	105	–205/780	345/–195	85/–85	105	0	1000
AUTOBRAKE 3	2910	80/–70	105	–205/785	340/–190	85/–85	110	0	1005

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS L+C (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1505	35/–25	45	–65/220	20/–15	40/–40	60	0	50
AUTOBRAKE MAX	1825	40/–30	55	–80/255	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2890	70/–60	100	–140/460	0/–10	90/–90	155	0	0
Good Reported Braking Action									
MAX MANUAL	1940	55/–45	85	–105/385	45/–40	65/–65	95	0	195
AUTOBRAKE MAX	2040	55/–45	90	–110/395	55/–45	70/–70	100	0	215
AUTOBRAKE 2	2930	70/–60	105	–140/465	10/–25	90/–90	155	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	2050	45/–40	70	–105/350	60/–50	55/–55	85	0	220
AUTOBRAKE MAX	2160	50/–45	75	–105/360	55/–45	60/–60	95	0	235
AUTOBRAKE 2	2915	70/–60	105	–140/465	10/–25	90/–90	155	0	0
Medium Reported Braking Action									
MAX MANUAL	2245	50/–45	80	–115/400	80/–65	65/–65	90	0	315
AUTOBRAKE MAX	2335	55/–50	85	–120/410	85/–65	65/–65	100	0	330
AUTOBRAKE 3	2635	60/–50	90	–130/440	40/–25	80/–80	140	0	140
Medium to Poor Reported Braking Action									
MAX MANUAL	2650	80/–65	125	–160/575	125/–100	90/–90	115	0	650
AUTOBRAKE MAX	2780	85/–70	130	–160/585	140/–110	95/–95	120	0	705
AUTOBRAKE 3	2790	85/–55	130	–145/585	135/–75	95/–90	125	0	710
Poor Reported Braking Action									
MAX MANUAL	3490	90/–80	130	–225/845	405/–230	105/–100	115	0	1410
AUTOBRAKE MAX	3615	95/–85	135	–230/855	420/–240	110/–105	120	0	1465
AUTOBRAKE 3	3625	95/–80	135	–230/855	415/–230	110/–105	125	0	1470

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS L+R (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1530	40/–25	45	–70/230	25/–20	40/–40	65	0	0
AUTOBRAKE MAX	1825	40/–30	55	–80/255	10/–5	50/–50	95	0	0
AUTOBRAKE 2	2890	70/–55	100	–140/460	5/–5	90/–90	170	0	0
Good Reported Braking Action									
MAX MANUAL	2115	60/–50	95	–125/460	70/–60	80/–75	115	0	0
AUTOBRAKE MAX	2235	65/–50	100	–130/475	85/–65	85/–80	120	0	0
AUTOBRAKE 2	2930	70/–60	105	–140/465	10/–10	90/–90	160	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	2245	50/–45	75	–115/385	85/–70	65/–65	95	0	0
AUTOBRAKE MAX	2385	50/–45	80	–120/400	80/–65	70/–70	110	0	0
AUTOBRAKE 2	2920	70/–60	105	–140/465	10/–10	90/–90	160	0	0
Medium Reported Braking Action									
MAX MANUAL	2535	55/–50	90	–135/455	125/–95	75/–75	105	0	0
AUTOBRAKE MAX	2645	60/–50	95	–135/465	130/–95	80/–80	120	0	0
AUTOBRAKE 3	2775	60/–55	100	–140/475	105/–70	85/–85	140	0	0
Medium to Poor Reported Braking Action									
MAX MANUAL	3265	100/–80	160	–220/820	250/–180	130/–125	155	0	0
AUTOBRAKE MAX	3445	105/–85	165	–225/835	275/–200	140/–135	160	0	0
AUTOBRAKE 3	3465	105/–85	165	–225/835	265/–195	140/–135	165	0	0
Poor Reported Braking Action									
MAX MANUAL	4845	105/–90	150	–315/1160	1045/–475	155/–145	155	0	0
AUTOBRAKE MAX	5025	110/–95	160	–320/1175	1065/–490	165/–150	160	0	0
AUTOBRAKE 3	5045	115/–95	160	–320/1175	1060/–490	165/–155	165	0	0

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS R (Flaps 25)
VREF 25+5

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1305	35/–25	40	–60/205	15/–15	35/–35	55	0	40
AUTOBRAKE MAX	1545	35/–30	45	–75/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2420	60/–55	85	–125/425	0/0	75/–75	145	0	0
Good Reported Braking Action									
MAX MANUAL	1645	45/–40	70	–95/350	35/–30	55/–55	85	0	135
AUTOBRAKE MAX	1660	50/–40	70	–90/345	35/–25	55/–50	90	0	125
AUTOBRAKE 2	2445	60/–55	85	–130/430	10/–10	75/–75	145	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1775	40/–40	60	–95/325	50/–40	50/–50	75	0	170
AUTOBRAKE MAX	1820	45/–40	65	–95/330	45/–35	50/–50	85	0	170
AUTOBRAKE 2	2435	60/–55	85	–130/430	10/–10	75/–75	145	0	0
Medium Reported Braking Action									
MAX MANUAL	1950	45/–45	70	–110/375	65/–55	55/–55	80	0	245
AUTOBRAKE MAX	1960	50/–45	70	–110/380	65/–50	55/–55	90	0	245
AUTOBRAKE 3	2220	55/–50	75	–120/410	30/–20	65/–65	125	0	100
Medium to Poor Reported Braking Action									
MAX MANUAL	2265	70/–60	105	–145/535	100/–80	75/–75	105	0	475
AUTOBRAKE MAX	2285	70/–60	105	–145/535	105/–85	80/–80	105	0	480
AUTOBRAKE 3	2325	70/–55	105	–130/515	90/–45	75/–70	110	0	455
Poor Reported Braking Action									
MAX MANUAL	3065	80/–75	110	–210/800	365/–200	90/–90	105	0	1155
AUTOBRAKE MAX	3085	85/–75	110	–210/805	370/–205	90/–90	105	0	1165
AUTOBRAKE 3	3090	85/–75	110	–210/805	365/–200	90/–90	110	0	1170

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS R (Flaps 30)
VREF 30+5

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1260	35/–25	35	–60/205	15/–15	30/–30	55	0	35
AUTOBRAKE MAX	1495	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2330	60/–50	80	–125/420	0/–5	70/–70	140	0	0
Good Reported Braking Action									
MAX MANUAL	1575	45/–35	65	–95/340	35/–30	50/–50	80	0	115
AUTOBRAKE MAX	1595	45/–35	65	–85/330	30/–20	50/–50	90	0	110
AUTOBRAKE 2	2355	60/–50	85	–125/425	10/–10	70/–75	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1710	40/–35	60	–95/320	45/–40	45/–45	75	0	155
AUTOBRAKE MAX	1755	40/–35	60	–95/325	40/–35	50/–50	85	0	155
AUTOBRAKE 2	2345	60/–50	85	–125/425	10/–10	70/–75	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1875	45/–40	65	–105/370	65/–50	50/–50	80	0	225
AUTOBRAKE MAX	1890	45/–40	70	–105/370	60/–45	55/–55	90	0	220
AUTOBRAKE 3	2140	50/–45	75	–115/405	30/–25	65/–65	125	0	85
Medium to Poor Reported Braking Action									
MAX MANUAL	2165	70/–55	100	–145/520	95/–75	75/–75	105	0	410
AUTOBRAKE MAX	2175	70/–55	100	–145/520	100/–80	75/–75	105	0	415
AUTOBRAKE 3	2230	65/–50	100	–125/490	75/–45	70/–65	105	0	375
Poor Reported Braking Action									
MAX MANUAL	2945	80/–70	105	–205/790	350/–190	85/–85	105	0	1045
AUTOBRAKE MAX	2955	80/–70	105	–205/790	355/–200	90/–85	105	0	1045
AUTOBRAKE 3	2965	80/–70	110	–205/790	350/–195	90/–85	105	0	1050

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS R+C (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1520	35/–25	45	–70/225	20/–20	40/–40	65	0	55
AUTOBRAKE MAX	1825	40/–30	55	–80/255	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2890	70/–60	100	–140/460	0/–5	90/–90	160	0	0
Good Reported Braking Action									
MAX MANUAL	1970	55/–45	85	–110/390	50/–45	65/–65	100	0	210
AUTOBRAKE MAX	2070	60/–45	90	–110/400	60/–50	70/–70	105	0	235
AUTOBRAKE 2	2930	70/–60	105	–140/465	10/–15	90/–90	160	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	2075	45/–40	70	–105/355	60/–50	55/–60	85	0	230
AUTOBRAKE MAX	2180	50/–45	75	–105/360	60/–50	60/–60	100	0	245
AUTOBRAKE 2	2915	70/–60	105	–140/465	10/–15	90/–90	160	0	0
Medium Reported Braking Action									
MAX MANUAL	2275	55/–45	80	–120/405	85/–65	65/–65	90	0	335
AUTOBRAKE MAX	2365	55/–50	85	–120/410	90/–70	70/–70	100	0	350
AUTOBRAKE 3	2640	60/–50	90	–130/445	40/–25	80/–80	140	0	160
Medium to Poor Reported Braking Action									
MAX MANUAL	2700	80/–65	130	–160/585	130/–105	90/–90	120	0	705
AUTOBRAKE MAX	2830	85/–70	135	–165/595	145/–115	95/–95	120	0	765
AUTOBRAKE 3	2835	85/–60	135	–155/595	145/–85	95/–95	125	0	765
Poor Reported Braking Action									
MAX MANUAL	3550	95/–80	130	–230/855	420/–235	105/–105	120	0	1500
AUTOBRAKE MAX	3685	100/–85	140	–230/865	435/–250	110/–110	120	0	1565
AUTOBRAKE 3	3690	100/–85	140	–230/865	435/–240	110/–110	125	0	1565

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Loss of All Displays (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1390	35/–25	40	–70/225	20/–20	35/–35	70	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	1860	60/–45	85	–120/440	65/–55	70/–65	120	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	2050	50/–40	70	–110/380	85/–70	60/–60	105	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2320	55/–45	80	–130/450	125/–95	70/–70	115	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2925	100/–80	150	–220/830	255/–175	125/–120	180	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	4615	105/–85	190	–315/1165	1150/–495	150/–135	180	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
NAV AIR DATA SYS/NAV AIRSPEED DATA (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1235	30/–20	35	–60/200	15/–10	30/–30	50	25	55
AUTOBRAKE MAX	1535	35/–30	45	–75/240	5/–5	40/–40	90	0	0
AUTOBRAKE 2	2300	65/–55	85	–125/410	30/–40	65/–70	110	95	95
Good Reported Braking Action									
MAX MANUAL	1485	40/–30	60	–85/305	25/–25	45/–45	75	75	180
AUTOBRAKE MAX	1585	40/–30	60	–75/295	15/–10	45/–45	85	65	180
AUTOBRAKE 2	2325	65/–55	90	–125/420	35/–45	70/–70	110	100	100
Good to Medium Reported Braking Action									
MAX MANUAL	1600	40/–30	55	–85/300	35/–30	40/–45	65	100	245
AUTOBRAKE MAX	1695	40/–35	55	–90/310	35/–25	45/–45	80	105	265
AUTOBRAKE 2	2315	65/–55	90	–125/420	35/–45	70/–70	110	100	100
Medium Reported Braking Action									
MAX MANUAL	1730	40/–35	60	–95/340	45/–40	45/–45	70	135	345
AUTOBRAKE MAX	1805	45/–35	65	–100/345	45/–35	50/–50	80	145	365
AUTOBRAKE 3	2180	55/–50	75	–115/395	25/–35	65/–65	115	25	110
Medium to Poor Reported Braking Action									
MAX MANUAL	1930	60/–45	85	–125/435	65/–50	60/–60	85	220	605
AUTOBRAKE MAX	2015	60/–50	90	–125/440	70/–60	60/–65	90	240	665
AUTOBRAKE 3	2240	55/–50	80	–120/405	45/–45	65/–65	105	65	460
Poor Reported Braking Action									
MAX MANUAL	2470	70/–55	90	–170/650	205/–125	70/–70	85	475	1500
AUTOBRAKE MAX	2555	70/–60	95	–170/655	215/–135	70/–75	90	495	1565
AUTOBRAKE 3	2635	70/–60	90	–175/665	200/–120	75/–75	105	430	1505

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
NAV INERTIAL SYS (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1250	30/–20	35	–60/200	15/–10	30/–30	55	25	60
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	1510	40/–35	60	–85/310	25/–25	45/–45	75	80	195
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	1625	40/–35	55	–90/305	35/–30	45/–45	70	105	260
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	1755	45/–35	60	–100/345	50/–40	45/–45	75	145	370
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	1960	60/–50	85	–125/440	65/–55	60/–60	90	235	660
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	2510	70/–60	90	–170/655	215/–130	70/–70	90	500	1615
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PITCH DOWN AUTHORITY (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1315	35/–25	35	–60/205	15/–15	30/–30	60	20	45
AUTOBRAKE MAX	1475	35/–30	45	–70/235	10/–10	40/–40	90	0	0
AUTOBRAKE 2	2225	60/–55	85	–120/405	20/–30	65/–65	110	55	55
Good Reported Braking Action									
MAX MANUAL	1570	40/–35	60	–90/315	30/–25	45/–45	80	65	160
AUTOBRAKE MAX	1600	40/–35	60	–80/295	20/–15	45/–45	85	50	145
AUTOBRAKE 2	2280	60/–60	85	–125/420	40/–45	65/–70	115	70	70
Good to Medium Reported Braking Action									
MAX MANUAL	1685	40/–35	55	–90/310	35/–30	45/–45	70	90	220
AUTOBRAKE MAX	1700	40/–35	55	–90/310	40/–35	45/–45	80	95	230
AUTOBRAKE 2	2280	60/–60	85	–125/420	40/–45	65/–70	115	70	70
Medium Reported Braking Action									
MAX MANUAL	1810	45/–40	60	–100/345	50/–40	45/–50	75	125	320
AUTOBRAKE MAX	1820	45/–40	60	–100/350	50/–40	50/–50	80	125	325
AUTOBRAKE 3	2120	50/–50	70	–115/395	30/–30	60/–65	120	20	95
Medium to Poor Reported Braking Action									
MAX MANUAL	2015	60/–50	85	–125/440	65/–55	60/–60	90	200	555
AUTOBRAKE MAX	2035	60/–50	85	–125/440	70/–60	60/–60	90	205	570
AUTOBRAKE 3	2245	55/–55	75	–125/405	50/–50	65/–65	100	55	360
Poor Reported Braking Action									
MAX MANUAL	2540	70/–60	90	–170/655	205/–125	70/–70	90	455	1435
AUTOBRAKE MAX	2560	70/–60	90	–170/655	210/–130	70/–70	90	460	1450
AUTOBRAKE 3	2620	70/–60	90	–175/665	200/–120	75/–75	100	400	1395

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PITCH DOWN AUTHORITY (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1280	30/–25	35	–60/205	15/–15	30/–30	60	20	40
AUTOBRAKE MAX	1430	35/–25	45	–70/230	10/–10	40/–40	90	0	0
AUTOBRAKE 2	2150	60/–50	80	–120/400	20/–30	65/–65	110	45	45
Good Reported Braking Action									
MAX MANUAL	1515	40/–35	55	–85/310	25/–25	45/–45	75	60	140
AUTOBRAKE MAX	1545	40/–30	55	–80/290	20/–15	45/–45	85	45	125
AUTOBRAKE 2	2195	60/–55	80	–125/415	35/–45	65/–65	115	60	60
Good to Medium Reported Braking Action									
MAX MANUAL	1635	40/–35	55	–90/305	35/–30	40/–40	70	85	205
AUTOBRAKE MAX	1645	40/–35	55	–90/305	35/–30	45/–45	75	85	210
AUTOBRAKE 2	2195	60/–55	80	–125/415	35/–45	65/–65	115	60	60
Medium Reported Braking Action									
MAX MANUAL	1760	40/–35	60	–100/345	50/–40	45/–45	75	115	300
AUTOBRAKE MAX	1760	45/–35	60	–100/345	50/–40	45/–45	80	120	300
AUTOBRAKE 3	2040	50/–45	70	–110/385	30/–30	60/–60	115	20	90
Medium to Poor Reported Braking Action									
MAX MANUAL	1945	55/–45	80	–125/435	60/–50	60/–60	90	185	495
AUTOBRAKE MAX	1955	55/–50	80	–125/435	70/–60	60/–60	90	185	500
AUTOBRAKE 3	2160	50/–55	70	–125/400	50/–45	60/–60	100	45	300
Poor Reported Braking Action									
MAX MANUAL	2465	65/–55	85	–170/650	200/–120	65/–70	90	425	1325
AUTOBRAKE MAX	2480	65/–60	90	–170/650	205/–130	70/–70	90	430	1335
AUTOBRAKE 3	2530	65/–60	85	–170/655	195/–120	70/–70	100	375	1285

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PITCH UP AUTHORITY (Flaps ≤ 15)
VREF 30+40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1595	45/–25	45	–65/215	15/–15	40/–40	55	45	100
AUTOBRAKE MAX	2180	40/–35	65	–85/275	5/–5	60/–60	105	0	0
AUTOBRAKE 2	3080	80/–75	125	–140/465	65/–65	90/–90	105	345	440
Good Reported Braking Action									
MAX MANUAL	2025	50/–45	85	–100/345	35/–30	65/–65	80	155	385
AUTOBRAKE MAX	2215	50/–35	85	–85/320	15/–5	60/–60	95	125	380
AUTOBRAKE 2	3105	80/–75	125	–140/465	70/–70	90/–95	105	350	455
Good to Medium Reported Braking Action									
MAX MANUAL	2075	45/–40	70	–95/325	45/–35	55/–55	70	155	390
AUTOBRAKE MAX	2325	45/–40	80	–100/345	30/–25	65/–65	100	115	370
AUTOBRAKE 2	3095	80/–75	125	–140/465	70/–70	90/–95	105	350	455
Medium Reported Braking Action									
MAX MANUAL	2235	50/–45	80	–105/365	55/–50	60/–60	70	210	545
AUTOBRAKE MAX	2415	50/–45	85	–110/380	45/–35	65/–70	100	205	565
AUTOBRAKE 3	2975	70/–65	110	–135/450	65/–60	85/–90	105	200	295
Medium to Poor Reported Braking Action									
MAX MANUAL	2570	70/–60	115	–135/475	80/–65	80/–80	85	380	1115
AUTOBRAKE MAX	2680	75/–60	120	–135/480	85/–70	85/–85	90	400	1180
AUTOBRAKE 3	2995	70/–70	115	–135/455	70/–65	85/–90	100	225	900
Poor Reported Braking Action									
MAX MANUAL	3110	80/–70	115	–185/690	225/–140	90/–90	85	655	2105
AUTOBRAKE MAX	3225	85/–75	120	–185/695	230/–145	90/–95	90	670	2170
AUTOBRAKE 3	3385	85/–80	125	–190/715	230/–145	100/–100	100	615	2040

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PITCH UP AUTHORITY (Flaps ≥ 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1400	35/–25	40	–60/205	15/–15	35/–35	55	35	80
AUTOBRAKE MAX	1840	40/–30	55	–80/255	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2665	70/–65	105	–130/435	55/–60	80/–80	110	225	240
Good Reported Braking Action									
MAX MANUAL	1730	45/–40	70	–90/325	30/–30	55/–55	75	110	275
AUTOBRAKE MAX	1860	45/–35	75	–80/315	20/–5	55/–50	90	110	285
AUTOBRAKE 2	2675	70/–65	105	–130/440	55/–60	80/–80	100	230	250
Good to Medium Reported Braking Action									
MAX MANUAL	1820	40/–35	60	–90/315	40/–35	50/–50	70	130	320
AUTOBRAKE MAX	1975	45/–35	65	–95/325	30/–25	55/–55	90	130	340
AUTOBRAKE 2	2675	70/–65	105	–130/440	55/–60	80/–80	100	230	250
Medium Reported Braking Action									
MAX MANUAL	1960	45/–40	70	–100/355	55/–45	55/–55	70	175	445
AUTOBRAKE MAX	2080	50/–40	75	–105/365	50/–40	55/–60	85	185	470
AUTOBRAKE 3	2545	60/–60	90	–125/425	45/–50	75/–75	105	85	180
Medium to Poor Reported Braking Action									
MAX MANUAL	2215	65/–50	95	–125/455	70/–60	70/–70	85	290	820
AUTOBRAKE MAX	2310	65/–55	100	–130/460	80/–65	70/–70	90	315	890
AUTOBRAKE 3	2575	60/–60	95	–125/430	55/–55	75/–75	95	110	650
Poor Reported Braking Action									
MAX MANUAL	2750	75/–65	100	–175/670	215/–135	80/–80	85	550	1735
AUTOBRAKE MAX	2850	75/–65	105	–180/675	225/–140	80/–85	90	575	1805
AUTOBRAKE 3	2965	80/–70	110	–185/690	215/–135	85/–85	95	485	1710

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PRI FLIGHT COMPUTERS (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1265	30/–25	35	–60/200	15/–15	30/–30	55	30	65
AUTOBRAKE MAX	1535	35/–30	45	–75/240	5/–5	40/–40	90	0	0
AUTOBRAKE 2	2330	65/–55	90	–125/415	25/–35	70/–70	115	65	65
Good Reported Braking Action									
MAX MANUAL	1530	45/–35	60	–85/315	30/–25	45/–45	80	85	215
AUTOBRAKE MAX	1610	45/–30	65	–80/315	30/–15	50/–50	85	85	225
AUTOBRAKE 2	2355	65/–55	90	–125/420	35/–45	70/–70	120	75	75
Good to Medium Reported Braking Action									
MAX MANUAL	1650	40/–35	55	–90/305	40/–35	45/–45	70	110	280
AUTOBRAKE MAX	1725	40/–35	60	–90/310	35/–30	45/–45	80	120	295
AUTOBRAKE 2	2345	65/–55	90	–125/420	35/–45	70/–70	120	75	75
Medium Reported Braking Action									
MAX MANUAL	1780	45/–35	65	–100/345	50/–45	45/–50	75	155	400
AUTOBRAKE MAX	1845	45/–40	65	–100/350	55/–45	50/–50	85	160	415
AUTOBRAKE 3	2185	55/–50	75	–115/400	25/–30	65/–65	120	20	140
Medium to Poor Reported Braking Action									
MAX MANUAL	1990	60/–50	90	–125/445	70/–55	60/–60	90	250	710
AUTOBRAKE MAX	2080	65/–50	95	–125/450	80/–65	65/–65	95	275	790
AUTOBRAKE 3	2280	55/–50	80	–120/410	45/–45	65/–65	110	85	600
Poor Reported Braking Action									
MAX MANUAL	2540	70/–60	95	–175/660	220/–130	70/–70	90	525	1710
AUTOBRAKE MAX	2635	75/–60	95	–175/670	225/–140	75/–75	95	550	1785
AUTOBRAKE 3	2690	75/–60	95	–180/675	215/–125	75/–80	110	495	1735

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ROLL LEFT AUTHORITY/ROLL RIGHT AUTHORITY (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1380	35/–25	40	–60/205	15/–15	35/–35	55	35	75
AUTOBRAKE MAX	1825	40/–30	55	–80/255	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2640	70/–65	105	–130/435	50/–55	75/–80	105	220	240
Good Reported Braking Action									
MAX MANUAL	1705	45/–35	70	–90/325	30/–25	55/–55	75	105	255
AUTOBRAKE MAX	1850	45/–35	70	–80/305	15/–5	50/–50	90	90	255
AUTOBRAKE 2	2660	70/–65	105	–130/440	55/–60	80/–80	100	230	255
Good to Medium Reported Braking Action									
MAX MANUAL	1795	40/–35	60	–90/310	40/–35	50/–50	65	120	300
AUTOBRAKE MAX	1965	45/–35	65	–95/325	30/–25	55/–55	90	115	315
AUTOBRAKE 2	2655	70/–65	105	–130/440	55/–60	80/–80	100	230	255
Medium Reported Braking Action									
MAX MANUAL	1935	45/–40	70	–100/350	50/–45	50/–55	70	165	420
AUTOBRAKE MAX	2060	50/–40	75	–105/360	50/–35	55/–55	90	175	450
AUTOBRAKE 3	2535	60/–60	90	–125/420	45/–50	75/–75	105	85	170
Medium to Poor Reported Braking Action									
MAX MANUAL	2195	60/–50	95	–125/450	70/–60	70/–70	85	280	785
AUTOBRAKE MAX	2285	65/–55	100	–125/455	75/–65	70/–70	90	300	845
AUTOBRAKE 3	2560	60/–60	95	–125/425	55/–55	75/–75	95	105	600
Poor Reported Braking Action									
MAX MANUAL	2730	70/–65	100	–175/665	215/–130	75/–80	85	535	1685
AUTOBRAKE MAX	2825	75/–65	105	–175/675	220/–135	80/–80	90	560	1745
AUTOBRAKE 3	2950	75/–70	105	–180/685	210/–135	85/–85	95	470	1645

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SLATS DRIVE (Flaps 20)
VREF 30+30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1390	35/–25	40	–60/205	15/–15	35/–35	55	35	75
AUTOBRAKE MAX	1830	40/–30	55	–80/255	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2650	70/–65	105	–130/435	55/–55	75/–80	110	220	240
Good Reported Braking Action									
MAX MANUAL	1715	45/–35	70	–90/325	30/–25	55/–55	75	110	265
AUTOBRAKE MAX	1855	45/–35	70	–80/310	20/–5	50/–50	90	100	270
AUTOBRAKE 2	2670	70/–65	105	–130/440	55/–60	80/–80	100	230	250
Good to Medium Reported Braking Action									
MAX MANUAL	1805	40/–35	60	–90/310	40/–35	50/–50	65	125	310
AUTOBRAKE MAX	1970	45/–35	65	–95/325	30/–25	55/–55	90	120	325
AUTOBRAKE 2	2665	70/–65	105	–130/440	55/–60	80/–80	100	230	250
Medium Reported Braking Action									
MAX MANUAL	1945	45/–40	70	–100/355	50/–45	50/–55	70	170	430
AUTOBRAKE MAX	2070	50/–40	75	–105/360	50/–40	55/–55	90	180	460
AUTOBRAKE 3	2540	60/–60	90	–125/425	45/–50	75/–75	105	85	175
Medium to Poor Reported Braking Action									
MAX MANUAL	2205	65/–50	95	–125/450	70/–60	70/–70	85	285	805
AUTOBRAKE MAX	2300	65/–55	100	–130/460	80/–65	70/–70	90	305	870
AUTOBRAKE 3	2565	60/–60	95	–125/425	55/–55	75/–75	95	105	625
Poor Reported Braking Action									
MAX MANUAL	2745	75/–65	100	–175/670	215/–135	80/–80	85	545	1710
AUTOBRAKE MAX	2840	75/–65	105	–180/675	220/–140	80/–80	90	565	1775
AUTOBRAKE 3	2960	80/–70	110	–180/690	210/–135	85/–85	95	475	1680

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILER PAIRS (Flaps 25)
VREF 25+5

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1275	30/–25	35	–60/200	15/–10	30/–30	55	30	65
AUTOBRAKE MAX	1610	35/–35	50	–75/245	5/–5	45/–45	90	0	0
AUTOBRAKE 2	2400	65/–65	95	–125/420	35/–45	70/–70	105	130	130
Good Reported Braking Action									
MAX MANUAL	1555	45/–35	65	–85/310	30/–25	50/–50	75	90	225
AUTOBRAKE MAX	1650	45/–35	65	–80/305	25/–5	45/–45	85	85	225
AUTOBRAKE 2	2420	65/–65	95	–125/425	40/–50	70/–70	110	140	140
Good to Medium Reported Braking Action									
MAX MANUAL	1660	40/–35	55	–90/305	40/–30	45/–45	70	115	285
AUTOBRAKE MAX	1765	40/–35	60	–90/310	35/–25	50/–50	85	120	305
AUTOBRAKE 2	2410	65/–65	95	–125/425	40/–50	70/–70	110	140	140
Medium Reported Braking Action									
MAX MANUAL	1790	45/–40	65	–100/345	50/–40	50/–50	70	155	405
AUTOBRAKE MAX	1875	45/–40	70	–100/350	50/–40	50/–50	85	160	415
AUTOBRAKE 3	2280	55/–55	80	–120/405	35/–35	65/–65	115	40	135
Medium to Poor Reported Braking Action									
MAX MANUAL	2010	60/–50	90	–125/440	65/–55	60/–65	85	255	730
AUTOBRAKE MAX	2100	65/–55	95	–125/445	75/–60	65/–65	90	280	795
AUTOBRAKE 3	2330	60/–55	85	–120/410	45/–45	65/–70	105	85	580
Poor Reported Braking Action									
MAX MANUAL	2545	70/–65	95	–170/655	210/–130	70/–75	85	520	1675
AUTOBRAKE MAX	2635	75/–65	100	–175/660	215/–135	75/–75	90	540	1745
AUTOBRAKE 3	2720	75/–65	100	–175/670	205/–125	80/–80	105	465	1675

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILER PAIRS (Flaps 30)
VREF 30+5

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1235	30/–25	35	–60/200	15/–10	30/–30	55	25	60
AUTOBRAKE MAX	1560	35/–30	50	–75/240	5/–5	40/–40	90	0	0
AUTOBRAKE 2	2315	65/–60	90	–125/410	30/–45	65/–70	105	125	125
Good Reported Braking Action									
MAX MANUAL	1495	40/–35	60	–85/305	25/–25	45/–45	75	80	200
AUTOBRAKE MAX	1595	40/–30	60	–75/295	15/–5	45/–45	85	70	195
AUTOBRAKE 2	2330	65/–60	90	–125/415	40/–50	70/–70	105	135	135
Good to Medium Reported Braking Action									
MAX MANUAL	1605	40/–35	55	–85/300	35/–30	40/–45	65	105	260
AUTOBRAKE MAX	1710	40/–35	60	–90/310	35/–25	45/–45	85	110	280
AUTOBRAKE 2	2325	65/–60	90	–125/415	40/–50	70/–70	105	135	135
Medium Reported Braking Action									
MAX MANUAL	1735	40/–35	60	–95/340	50/–40	45/–45	70	145	370
AUTOBRAKE MAX	1810	45/–40	65	–100/345	45/–35	50/–50	80	150	380
AUTOBRAKE 3	2195	55/–50	80	–115/400	30/–35	65/–65	110	35	125
Medium to Poor Reported Braking Action									
MAX MANUAL	1935	60/–50	85	–120/430	65/–55	60/–60	85	230	640
AUTOBRAKE MAX	2010	60/–50	90	–120/435	70/–60	60/–65	90	245	690
AUTOBRAKE 3	2245	55/–55	80	–120/405	45/–45	65/–65	100	70	480
Poor Reported Braking Action									
MAX MANUAL	2465	70/–60	90	–170/650	205/–125	70/–70	85	485	1525
AUTOBRAKE MAX	2540	70/–60	95	–170/655	210/–130	70/–75	85	500	1580
AUTOBRAKE 3	2625	70/–60	95	–175/665	195/–120	75/–75	100	430	1515

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILERS (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1210	30/–25	35	–60/195	15/–10	30/–30	50	25	60
AUTOBRAKE MAX	1525	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2280	65/–60	90	–120/410	30/–40	65/–70	105	110	110
Good Reported Braking Action									
MAX MANUAL	1465	40/–35	60	–85/305	25/–25	45/–45	75	80	190
AUTOBRAKE MAX	1565	40/–35	60	–75/290	15/–5	45/–45	85	65	185
AUTOBRAKE 2	2300	65/–60	90	–125/415	35/–45	65/–70	105	115	115
Good to Medium Reported Braking Action									
MAX MANUAL	1575	40/–35	55	–85/295	35/–30	40/–40	65	105	255
AUTOBRAKE MAX	1675	40/–35	55	–90/305	30/–25	45/–45	80	110	270
AUTOBRAKE 2	2290	65/–60	90	–125/415	35/–45	65/–70	105	115	115
Medium Reported Braking Action									
MAX MANUAL	1705	40/–40	60	–95/335	45/–40	45/–45	70	140	360
AUTOBRAKE MAX	1780	45/–40	65	–100/345	45/–35	50/–50	80	145	375
AUTOBRAKE 3	2160	55/–55	75	–115/395	30/–35	65/–65	110	30	115
Medium to Poor Reported Braking Action									
MAX MANUAL	1905	60/–50	85	–120/430	60/–50	60/–60	85	225	630
AUTOBRAKE MAX	1985	60/–50	90	–120/435	70/–60	60/–60	90	245	690
AUTOBRAKE 3	2215	55/–55	80	–115/405	45/–40	65/–65	105	70	480
Poor Reported Braking Action									
MAX MANUAL	2435	70/–60	90	–170/645	205/–125	70/–70	85	485	1540
AUTOBRAKE MAX	2515	70/–65	95	–170/650	210/–130	70/–70	90	505	1600
AUTOBRAKE 3	2595	70/–65	90	–175/660	195/–115	75/–75	105	435	1540

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILERS (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1175	30/–20	35	–60/195	10/–10	30/–30	50	25	55
AUTOBRAKE MAX	1475	35/–30	45	–70/235	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2200	60/–55	85	–120/405	30/–40	65/–65	105	100	100
Good Reported Braking Action									
MAX MANUAL	1410	40/–30	55	–80/295	25/–20	45/–45	70	70	170
AUTOBRAKE MAX	1510	40/–30	55	–75/280	10/–5	40/–40	80	55	160
AUTOBRAKE 2	2215	65/–55	85	–120/405	35/–45	65/–65	105	105	105
Good to Medium Reported Braking Action									
MAX MANUAL	1530	35/–30	50	–85/295	35/–30	40/–40	65	95	235
AUTOBRAKE MAX	1625	40/–35	55	–85/300	30/–25	45/–45	80	100	250
AUTOBRAKE 2	2205	65/–55	85	–120/405	35/–45	65/–65	105	105	105
Medium Reported Braking Action									
MAX MANUAL	1650	40/–35	60	–95/335	45/–40	45/–45	70	130	335
AUTOBRAKE MAX	1725	45/–35	60	–95/340	45/–35	45/–45	80	135	340
AUTOBRAKE 3	2080	55/–50	75	–115/390	25/–35	60/–60	110	25	105
Medium to Poor Reported Braking Action									
MAX MANUAL	1835	55/–45	80	–120/425	60/–50	55/–55	85	205	560
AUTOBRAKE MAX	1905	60/–50	85	–120/430	65/–55	60/–60	85	220	610
AUTOBRAKE 3	2130	55/–50	75	–115/395	40/–40	60/–60	100	60	400
Poor Reported Braking Action									
MAX MANUAL	2360	65/–55	85	–165/640	200/–120	65/–65	85	450	1415
AUTOBRAKE MAX	2430	70/–60	90	–170/645	205/–125	70/–70	85	470	1465
AUTOBRAKE 3	2510	70/–60	90	–170/655	190/–115	70/–75	100	405	1410

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
STABILIZER (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1475	35/–25	45	–65/215	20/–15	35/–40	60	45	105
AUTOBRAKE MAX	1840	35/–30	55	–80/255	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2760	70/–65	110	–135/450	45/–55	80/–85	125	155	155
Good Reported Braking Action									
MAX MANUAL	1835	50/–40	75	–95/345	40/–35	55/–55	85	150	380
AUTOBRAKE MAX	1940	55/–40	80	–95/350	40/–30	60/–60	95	155	415
AUTOBRAKE 2	2775	75/–70	110	–135/450	45/–55	80/–85	115	160	160
Good to Medium Reported Braking Action									
MAX MANUAL	1925	45/–40	70	–95/325	45/–40	50/–55	75	160	415
AUTOBRAKE MAX	2030	45/–40	75	–100/335	50/–35	55/–55	90	170	435
AUTOBRAKE 2	2770	75/–70	110	–135/450	45/–55	80/–85	115	160	160
Medium Reported Braking Action									
MAX MANUAL	2075	50/–45	75	–105/370	60/–50	55/–55	80	215	575
AUTOBRAKE MAX	2170	50/–45	80	–110/375	65/–55	60/–60	90	225	605
AUTOBRAKE 3	2605	60/–60	90	–125/430	40/–40	75/–75	120	45	235
Medium to Poor Reported Braking Action									
MAX MANUAL	2345	70/–55	105	–135/475	85/–70	75/–75	95	370	1115
AUTOBRAKE MAX	2455	75/–60	115	–135/480	95/–75	75/–75	100	400	1210
AUTOBRAKE 3	2660	65/–60	100	–130/440	60/–50	75/–80	110	200	1010
Poor Reported Braking Action									
MAX MANUAL	2905	80/–70	110	–185/695	240/–150	85/–85	95	660	2215
AUTOBRAKE MAX	3015	85/–70	115	–185/700	250/–155	85/–90	100	690	2315
AUTOBRAKE 3	3095	85/–70	115	–190/710	235/–140	90/–90	110	620	2240

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	LANDING CLIMB LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	181.1	177.3							
52	184.5	180.8							
50	187.9	184.2	169.2						
48	191.4	187.6	173.6						
46	195.1	191.0	177.0	161.4					
44	198.8	194.5	180.2	164.6					
42	202.7	198.3	183.5	169.5	155.2				
40	206.5	202.0	186.9	173.7	158.3				
38	209.7	205.8	190.5	176.9	161.3	144.9			
36	212.3	209.6	194.0	180.2	164.3	148.0			
34	214.9	212.8	197.6	183.5	168.7	151.2	136.6		
32	215.1	215.4	201.1	186.7	173.1	154.3	139.4		
30	215.3	218.0	204.1	190.1	176.1	157.3	142.2		
28	215.4	218.1	206.7	193.5	179.2	160.3	145.0		
26	215.5	218.3	209.2	196.3	182.5	163.3	147.6		
24	215.6	218.4	209.3	198.6	185.7	166.9	150.5	135.9	
22	215.8	218.5	209.5	200.9	188.2	171.9	153.3	138.6	
20	215.9	218.6	209.6	201.0	190.4	175.0	156.2	141.4	129.0
18	216.0	218.8	209.7	201.1	192.4	177.9	158.9	144.1	131.1
16	216.0	218.9	209.8	201.2	192.4	180.7	161.6	146.8	133.4
14	216.1	219.0	209.9	201.3	192.5	183.2	164.6	149.7	135.7
12	216.2	219.0	210.0	201.3	192.6	183.3	169.3	152.5	138.1
10	216.3	219.1	210.1	201.4	192.7	183.4	173.3	155.3	140.6
0	216.7	219.5	210.4	201.9	193.1	183.7	176.7	164.9	151.3
–10	217.0	219.8	210.8	202.2	193.4	184.1	177.0	165.0	153.5
–20	217.4	220.2	211.2	202.6	193.8	184.4	177.2	165.2	
–30	218.0	220.6	211.5	203.0	194.2	184.7	177.4		
–40	218.6	221.2	212.0	203.4	194.5	185.0			

If airplane landing weight exceeds Landing Climb Limit Weight and further weight reduction is not possible, use flaps 20 for landing and flaps 5 for go-around.

When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10 deg. C, decrease weight by 22000 kg.

Anti-Ice Adjustments

Pressure Altitude ≤9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4900	–6400
ENGINE & WING ON	–350	–5850	–7350

Pressure Altitude >9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–2950	–5750	–6150
ENGINE & WING ON	–4150	–6450	–6850

ADVISORY INFORMATION

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 25

Based on anti-ice off

AIRPORT OAT (deg. C)	LANDING CLIMB LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	182.0	178.0							
52	185.3	181.5							
50	188.7	185.0	170.1						
48	192.3	188.4	174.3						
46	196.0	191.7	177.6	161.9					
44	199.7	195.3	180.9	165.1					
42	203.5	199.0	184.2	170.3	155.7				
40	207.3	202.7	187.6	174.3	158.8				
38	210.6	206.6	191.2	177.5	161.8	145.4			
36	213.1	210.3	194.6	180.6	164.7	148.5			
34	215.7	213.4	198.1	183.9	169.2	151.6	137.0		
32	215.9	216.0	201.6	187.1	173.4	154.6	139.8		
30	216.1	218.5	204.7	190.5	176.5	157.6	142.6		
28	216.3	218.7	207.2	193.9	179.6	160.6	145.3		
26	216.4	218.9	209.7	196.7	182.8	163.6	147.9		
24	216.5	219.0	209.8	199.1	186.0	167.5	150.8	136.5	
22	216.6	219.1	210.0	201.3	188.6	172.4	153.7	139.2	
20	216.7	219.2	210.1	201.4	190.7	175.4	156.5	141.9	129.3
18	216.8	219.3	210.2	201.5	192.8	178.3	159.3	144.7	131.4
16	216.9	219.4	210.3	201.6	192.8	181.1	162.0	147.4	133.7
14	217.0	219.5	210.4	201.7	192.9	183.7	165.0	150.3	136.0
12	217.1	219.6	210.5	201.8	193.0	183.8	170.0	153.1	138.4
10	217.1	219.7	210.6	201.9	193.1	183.8	173.8	155.9	140.9
0	217.5	220.0	211.0	202.3	193.5	184.2	177.2	165.4	151.7
–10	217.9	220.4	211.4	202.7	193.8	184.5	177.4	165.6	154.0
–20	218.2	220.7	211.7	203.1	194.2	184.9	177.7	165.9	
–30	218.8	221.2	212.1	203.5	194.6	185.2	177.9		
–40	219.5	221.8	212.6	203.9	194.9	185.5			

If airplane landing weight exceeds Landing Climb Limit Weight and further weight reduction is not possible, use flaps 20 for landing and flaps 5 for go-around.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10 deg. C, decrease weight by 22500 kg.

Anti-Ice Adjustments

Pressure Altitude ≤9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4950	–6350
ENGINE & WING ON	–350	–5850	–7300

Pressure Altitude >9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–2900	–5850	–6200
ENGINE & WING ON	–4100	–6750	–7150

ADVISORY INFORMATION

Tire Speed Landing Limit Weight
FLAPS DRIVE (1≤Flaps≤5)
PITCH UP AUTHORITY (Flaps≤15)

AIRPORT OAT (deg. C)	TIRE SPEED LANDING LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	6000	7000	8000	9000	10000	11000	12000	13000	14000
42	188.4	178.9	169.5	160.5	151.6	144.2	136.8	130.0	123.1
40	189.9	181.1	172.3	162.6	152.9	145.4	138.0	131.1	124.2
38	191.4	182.6	173.7	163.9	154.1	146.6	139.2	132.2	125.2
36	192.9	184.0	175.1	165.3	155.4	147.9	140.3	133.3	126.3
34	194.5	185.5	176.6	166.6	156.7	149.1	141.5	134.5	127.4
32	196.1	187.1	178.0	168.0	158.0	150.4	142.7	135.6	128.5
30	197.7	188.6	179.5	169.4	159.3	151.6	144.0	136.8	129.6
28	199.3	190.2	181.0	170.8	160.7	152.9	145.2	138.0	130.8
26	201.0	191.8	182.5	172.3	162.0	154.2	146.4	139.2	131.9
24	202.7	193.4	184.1	173.7	163.4	155.5	147.7	140.4	133.1
22	204.4	195.0	185.7	175.2	164.7	156.8	148.9	141.6	134.2
20	206.1	196.7	187.3	177.1	166.8	158.5	150.2	142.8	135.4
18	207.8	198.4	188.9	179.4	169.9	160.7	151.6	144.1	136.6
16	209.6	200.1	190.5	181.6	172.6	162.8	152.9	145.4	137.9
14	211.4	201.8	192.2	183.2	174.1	164.2	154.3	146.7	139.1
12	213.3	203.6	193.8	184.8	175.7	165.7	155.7	148.1	140.4
10	215.2	205.3	195.5	186.4	177.3	167.2	157.1	149.4	141.7
8	217.0	207.2	197.3	188.1	178.9	168.7	158.5	150.8	143.0
6	218.9	209.0	199.1	189.8	180.5	170.2	160.0	152.2	144.3
4	220.9	210.9	200.9	191.5	182.1	171.8	161.4	153.5	145.7
2	222.8	212.8	202.7	193.2	183.8	173.4	162.9	155.0	147.0
0	224.8	214.7	204.5	195.0	185.5	175.0	164.4	156.4	148.4
−10	235.4	224.5	213.7	204.0	194.4	185.2	175.9	165.8	155.7
−20	245.2	234.4	223.7	213.7	203.8	194.3	184.8	174.2	163.5
−30			235.4	224.4	213.3	203.8	194.3	185.0	175.7
−40			245.4	234.5	223.5	213.6	203.6	194.4	185.2

Based on 226 knots (260 MPH) tire speed limit with final approach speed that is higher of VREF 30+40 and the amber band, with a five knot approach speed additive.

Wind Adjustment

WIND (KTS)	15 TW	10 TW	5 TW	0	10 HW	20 HW	30 HW	40 HW
WEIGHT ADJUSTMENT (1000 KG)	−32	−23	−12	0	19	38	57	77

ADVISORY INFORMATION

Tire Speed Landing Limit Weight
Flaps+Slats Fail (Flaps and Slats Up)

AIRPORT OAT (deg. C)	TIRE SPEED LANDING LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	245.7	224.6							
52	247.6	226.2							
50	249.2	228.0	208.1						
48	249.2	229.8	209.8						
46	249.2	231.6	211.4	192.4					
44	249.2	233.3	213.0	193.9					
42	249.2	235.0	214.6	195.4	177.6				
40	249.2	237.1	216.3	197.1	179.0				
38	249.2	238.9	218.2	198.7	180.6	160.3			
36	249.2	240.8	219.8	200.2	182.0	161.6			
34	249.2	242.8	221.6	201.8	183.4	162.9	147.3		
32	249.2	244.6	223.3	203.5	185.1	165.1	148.7		
30	249.2	246.4	225.3	205.2	186.6	167.2	149.9		
28	249.2	248.6	227.0	206.8	188.1	169.5	151.2		
26	249.2	249.2	229.0	208.6	189.6	172.0	152.4		
24	249.2	249.2	230.8	210.3	191.3	173.5	153.8	138.8	
22	249.2	249.2	232.8	212.1	193.0	175.1	155.1	140.0	
20	249.2	249.2	234.8	214.0	194.5	176.5	156.5	141.2	127.2
18	249.2	249.2	236.6	215.8	196.3	178.2	157.9	142.5	128.3
16	249.2	249.2	238.7	217.7	198.0	179.6	159.3	143.8	129.5
14	249.2	249.2	240.8	219.4	199.8	181.2	160.7	145.1	130.7
12	249.2	249.2	242.8	221.3	201.3	182.8	162.2	146.5	131.9
10	249.2	249.2	244.9	223.3	203.2	184.5	163.8	147.8	133.0
8	249.2	249.2	247.0	225.3	205.0	186.1	166.3	149.2	134.2
6	249.2	249.2	249.2	227.2	206.8	187.8	168.7	150.5	135.4
4	249.2	249.2	249.2	229.3	208.6	189.6	171.4	151.9	136.8
2	249.2	249.2	249.2	231.3	210.5	191.3	173.3	153.3	138.1
0	249.2	249.2	249.2	233.5	212.5	193.0	174.9	154.7	139.4
–10	249.2	249.2	249.2	244.3	222.6	202.3	183.3	162.3	146.5
–20	249.2	249.2	249.2	249.2	233.3	212.3	192.4	174.1	154.0
–30	249.2	249.2	249.2	249.2	245.2	223.1	202.5		
–40	249.2	249.2	249.2	249.2	249.2	234.8			

Based on 226 knots (260 MPH) tire speed limit with final approach speed of VREF 30+50.

Wind Adjustment

WIND (KTS)	15 TW	10 TW	5 TW	0	10 HW	20 HW	30 HW	40 HW
WEIGHT ADJUSTMENT (1000 KG)	–49	–33	–20	0	6	14	21	28

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Reference Brake Energy (Millions of Foot Pounds)

Table 1(a) of 3: Sea Level to 10,000 ft Pressure Altitude

		BRAKES ON SPEED (KIAS)														
		100			120			140			160			180		
WEIGHT	OAT	PRESSURE ALTITUDE (1000 FT)														
(1000 KG)	(deg. C)	0	5	10	0	5	10	0	5	10	0	5	10	0	5	10
240	0	32.8	37.6	43.3	44.5	51.6	60.0	57.7	67.2	78.5	71.7	83.5	97.6	86.1	99.9	116.1
	10	33.8	38.9	44.8	46.0	53.3	62.0	59.6	69.4	81.1	74.1	86.3	100.7	88.9	103.0	119.4
	15	34.4	39.5	45.5	46.8	54.2	63.0	60.6	70.6	82.4	75.3	87.6	102.2	90.3	104.5	121.0
	20	34.9	40.1	46.2	47.5	55.1	64.0	61.6	71.7	83.6	76.5	89.0	103.7	91.7	106.0	122.5
	30	35.9	41.2	47.6	48.9	56.7	66.0	63.4	73.8	86.1	78.8	91.6	106.5	94.3	108.9	125.5
	40	36.2	41.7	48.3	49.6	57.7	67.2	64.5	75.2	87.8	80.3	93.3	108.3	96.1	110.6	126.8
220	0	31.5	36.1	41.5	42.7	49.4	57.4	55.3	64.3	75.1	68.7	80.1	93.6	82.5	95.9	111.6
	10	32.5	37.3	42.9	44.2	51.1	59.3	57.1	66.5	77.6	71.0	82.7	96.6	85.3	98.9	114.9
	15	33.0	37.9	43.6	44.9	51.9	60.3	58.1	67.6	78.8	72.2	84.0	98.0	86.6	100.4	116.5
	20	33.5	38.5	44.3	45.6	52.8	61.3	59.0	68.6	80.1	73.3	85.4	99.5	87.9	101.9	118.1
	30	34.4	39.6	45.6	46.9	54.3	63.1	60.8	70.7	82.5	75.5	87.9	102.3	90.5	104.7	121.0
	40	34.8	40.0	46.2	47.6	55.2	64.2	61.8	72.0	84.1	77.0	89.5	104.1	92.2	106.5	122.5
200	0	29.1	33.3	38.2	39.4	45.4	52.6	50.8	59.0	68.8	63.2	73.7	86.2	76.0	88.5	103.3
	10	30.0	34.4	39.5	40.7	47.0	54.4	52.5	61.0	71.1	65.4	76.2	89.0	78.5	91.4	106.5
	15	30.5	34.9	40.1	41.3	47.7	55.3	53.4	62.0	72.3	66.5	77.4	90.4	79.8	92.8	108.0
	20	31.0	35.5	40.8	42.0	48.5	56.2	54.2	63.0	73.4	67.5	78.6	91.8	81.0	94.2	109.5
	30	31.8	36.5	41.9	43.2	49.9	57.9	55.8	64.9	75.6	69.5	81.0	94.4	83.4	96.9	112.4
	40	32.1	36.8	42.4	43.7	50.6	58.8	56.7	66.1	77.1	70.8	82.5	96.2	85.1	98.7	114.1
180	0	26.7	30.5	34.9	36.0	41.4	47.9	46.2	53.6	62.4	57.4	66.9	78.1	69.4	80.9	94.5
	10	27.6	31.5	36.1	37.2	42.8	49.5	47.8	55.4	64.5	59.4	69.1	80.7	71.7	83.5	97.5
	15	28.0	32.0	36.7	37.8	43.5	50.3	48.6	56.3	65.5	60.3	70.3	82.0	72.9	84.9	99.0
	20	28.4	32.5	37.2	38.3	44.2	51.1	49.3	57.2	66.6	61.3	71.4	83.3	74.0	86.2	100.5
	30	29.2	33.4	38.3	39.4	45.5	52.6	50.8	58.9	68.6	63.1	73.5	85.7	76.2	88.7	103.3
	40	29.4	33.7	38.7	39.9	46.1	53.4	51.6	59.9	69.9	64.3	74.9	87.4	77.7	90.4	105.0
160	0	24.4	27.7	31.7	32.6	37.4	43.1	41.7	48.2	56.0	51.6	60.0	69.9	62.2	72.5	84.7
	10	25.1	28.6	32.7	33.7	38.7	44.6	43.1	49.9	57.9	53.3	62.0	72.3	64.3	74.9	87.5
	15	25.5	29.1	33.2	34.2	39.3	45.3	43.8	50.7	58.8	54.2	63.0	73.5	65.3	76.1	88.8
	20	25.9	29.5	33.7	34.7	39.9	46.0	44.5	51.5	59.7	55.1	64.0	74.6	66.4	77.3	90.2
	30	26.6	30.3	34.7	35.7	41.1	47.4	45.8	53.0	61.5	56.7	65.9	76.9	68.3	79.6	92.8
	40	26.7	30.5	35.0	36.1	41.5	48.0	46.4	53.8	62.6	57.6	67.1	78.3	69.6	81.1	94.6
140	0	22.0	24.9	28.4	29.2	33.4	38.3	37.1	42.8	49.5	45.7	53.0	61.7	54.9	63.9	74.6
	10	22.7	25.7	29.3	30.1	34.5	39.6	38.3	44.2	51.1	47.3	54.8	63.7	56.8	66.1	77.1
	15	23.0	26.1	29.8	30.6	35.0	40.2	38.9	44.9	52.0	48.0	55.7	64.8	57.7	67.2	78.4
	20	23.4	26.5	30.3	31.1	35.6	40.9	39.6	45.6	52.8	48.8	56.6	65.8	58.6	68.2	79.6
	30	24.0	27.3	31.1	31.9	36.6	42.1	40.7	46.9	54.4	50.2	58.3	67.8	60.4	70.3	82.0
	40	24.1	27.4	31.3	32.2	36.9	42.6	41.2	47.6	55.2	51.0	59.3	69.0	61.4	71.6	83.6
120	0	19.6	22.2	25.2	25.7	29.3	33.6	32.4	37.2	42.9	39.7	45.9	53.1	47.5	55.1	64.1
	10	20.2	22.9	26.0	26.6	30.3	34.7	33.5	38.5	44.3	41.0	47.4	54.9	49.1	57.0	66.3
	15	20.5	23.2	26.4	27.0	30.8	35.2	34.0	39.1	45.1	41.7	48.2	55.8	49.9	57.9	67.4
	20	20.8	23.6	26.8	27.4	31.2	35.8	34.6	39.7	45.8	42.3	48.9	56.7	50.7	58.8	68.5
	30	21.3	24.2	27.5	28.1	32.1	36.8	35.5	40.8	47.1	43.6	50.4	58.4	52.2	60.6	70.5
	40	21.4	24.3	27.7	28.3	32.4	37.1	35.9	41.3	47.8	44.1	51.1	59.4	53.0	61.6	71.8

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 with sea level, 15 deg. C.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Reference Brake Energy (Millions of Foot Pounds)

Table 1(b) of 3: 10,000 ft to 14,000 ft Pressure Altitude

		BRAKES ON SPEED (KIAS)														
		100			120			140			160			180		
WEIGHT	OAT	PRESSURE ALTITUDE (1000 FT)														
(1000 KG)	(deg. C)	10	12	14	10	12	14	10	12	14	10	12	14	10	12	14
240	0	43.3	45.9	48.8	60.0	63.8	67.9	78.5	83.6	89.2	97.6	104.0	110.9	116.1	123.3	
	10	44.8	47.5	50.4	62.0	66.0	70.2	81.1	86.4	92.1	100.7	107.2	114.2	119.4	126.6	
	15	45.5	48.3	51.3	63.0	67.0	71.4	82.4	87.7	93.5	102.2	108.7	115.7	121.0	128.2	
	20	46.2	49.0	52.1	64.0	68.1	72.5	83.6	89.1	94.9	103.7	110.2	117.3	122.5	129.8	
	30	47.6	50.5	53.6	66.0	70.1	74.7	86.1	91.7	97.6	106.5	113.2	120.3	125.5	132.7	
	40	48.3	51.2	54.5	67.2	71.4	76.1	87.8	93.4	99.4	108.3	114.8	121.8	126.8	133.6	
220	0	41.5	44.0	46.7	57.4	61.0	65.0	75.1	80.0	85.3	93.6	99.7	106.4	111.6	118.7	126.3
	10	42.9	45.5	48.3	59.3	63.1	67.2	77.6	82.6	88.1	96.6	102.8	109.6	114.9	122.0	129.7
	15	43.6	46.2	49.1	60.3	64.1	68.3	78.8	83.9	89.5	98.0	104.4	111.2	116.5	123.6	131.3
	20	44.3	46.9	49.8	61.3	65.1	69.4	80.1	85.3	90.9	99.5	105.9	112.7	118.1	125.2	132.8
	30	45.6	48.3	51.3	63.1	67.1	71.4	82.5	87.8	93.5	102.3	108.7	115.6	121.0	128.1	135.7
	40	46.2	49.0	52.1	64.2	68.3	72.8	84.1	89.4	95.2	104.1	110.5	117.3	122.5	129.3	136.5
200	0	38.2	40.5	42.9	52.6	55.9	59.5	68.8	73.3	78.1	86.2	91.9	98.0	103.3	110.0	117.2
	10	39.5	41.8	44.3	54.4	57.8	61.5	71.1	75.7	80.7	89.0	94.8	101.1	106.5	113.2	120.5
	15	40.1	42.5	45.1	55.3	58.8	62.5	72.3	76.9	82.0	90.4	96.2	102.6	108.0	114.8	122.1
	20	40.8	43.2	45.8	56.2	59.7	63.5	73.4	78.1	83.3	91.8	97.7	104.1	109.5	116.4	123.7
	30	41.9	44.4	47.1	57.9	61.5	65.4	75.6	80.5	85.7	94.4	100.4	106.9	112.4	119.3	126.7
	40	42.4	45.0	47.8	58.8	62.6	66.6	77.1	82.0	87.4	96.2	102.2	108.7	114.1	120.9	127.9
180	0	34.9	37.0	39.1	47.9	50.8	54.0	62.4	66.4	70.7	78.1	83.3	88.8	94.5	100.7	107.4
	10	36.1	38.2	40.5	49.5	52.5	55.8	64.5	68.6	73.1	80.7	86.0	91.7	97.5	103.8	110.6
	15	36.7	38.8	41.1	50.3	53.4	56.7	65.5	69.7	74.3	82.0	87.3	93.1	99.0	105.3	112.2
	20	37.2	39.4	41.7	51.1	54.2	57.6	66.6	70.8	75.5	83.3	88.7	94.5	100.5	106.9	113.8
	30	38.3	40.5	43.0	52.6	55.8	59.4	68.6	73.0	77.7	85.7	91.3	97.2	103.3	109.7	116.7
	40	38.7	41.0	43.5	53.4	56.8	60.4	69.9	74.3	79.2	87.4	93.0	99.0	105.0	111.5	118.3
160	0	31.7	33.5	35.4	43.1	45.7	48.5	56.0	59.5	63.3	69.9	74.5	79.4	84.7	90.3	96.3
	10	32.7	34.6	36.6	44.6	47.3	50.2	57.9	61.5	65.5	72.3	77.0	82.1	87.5	93.2	99.4
	15	33.2	35.1	37.2	45.3	48.0	51.0	58.8	62.5	66.5	73.5	78.2	83.4	88.8	94.6	100.8
	20	33.7	35.6	37.7	46.0	48.8	51.8	59.7	63.5	67.6	74.6	79.4	84.7	90.2	96.0	102.3
	30	34.7	36.7	38.8	47.4	50.2	53.3	61.5	65.4	69.6	76.9	81.8	87.1	92.8	98.8	105.1
	40	35.0	37.0	39.2	48.0	51.0	54.2	62.6	66.6	70.9	78.3	83.4	88.8	94.6	100.5	106.9
140	0	28.4	30.0	31.7	38.3	40.6	43.0	49.5	52.5	55.8	61.7	65.6	69.9	74.6	79.5	84.8
	10	29.3	31.0	32.7	39.6	41.9	44.5	51.1	54.3	57.7	63.7	67.8	72.2	77.1	82.1	87.6
	15	29.8	31.5	33.3	40.2	42.6	45.2	52.0	55.2	58.7	64.8	68.9	73.4	78.4	83.5	89.0
	20	30.3	31.9	33.8	40.9	43.3	45.9	52.8	56.0	59.6	65.8	70.0	74.6	79.6	84.7	90.3
	30	31.1	32.8	34.7	42.1	44.5	47.2	54.4	57.7	61.4	67.8	72.1	76.8	82.0	87.2	92.9
	40	31.3	33.1	35.0	42.6	45.1	47.9	55.2	58.7	62.5	69.0	73.5	78.3	83.6	88.9	94.7
120	0	25.2	26.5	28.0	33.6	35.5	37.6	42.9	45.5	48.3	53.1	56.5	60.1	64.1	68.3	72.7
	10	26.0	27.4	28.9	34.7	36.7	38.8	44.3	47.0	49.9	54.9	58.4	62.1	66.3	70.6	75.2
	15	26.4	27.8	29.4	35.2	37.2	39.4	45.1	47.8	50.7	55.8	59.3	63.1	67.4	71.7	76.4
	20	26.8	28.2	29.8	35.8	37.8	40.1	45.8	48.5	51.5	56.7	60.3	64.1	68.5	72.8	77.6
	30	27.5	29.0	30.6	36.8	38.9	41.2	47.1	50.0	53.1	58.4	62.1	66.1	70.5	75.0	79.9
	40	27.7	29.2	30.9	37.1	39.3	41.7	47.8	50.7	53.9	59.4	63.2	67.3	71.8	76.5	81.5

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 with sea level, 15 deg. 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
RTO MAX MAN		10	20	30	40	50	60	70	80	90	100	110	120
LANDING	MAX MAN	7.5	15.6	24.2	33.1	42.5	52.0	61.8	71.7	81.7	91.6	101.5	111.2
	MAX AUTO	6.9	14.3	22.2	30.5	39.1	48.1	57.4	66.9	76.6	86.4	96.4	106.5
	AUTOBRAKE 4	6.6	13.6	20.9	28.7	36.7	45.1	53.7	62.6	71.7	80.9	90.3	99.9
	AUTOBRAKE 3	6.3	12.9	19.9	27.2	34.7	42.6	50.7	59.1	67.6	76.3	85.1	94.1
	AUTOBRAKE 2	5.9	12.2	18.8	25.7	32.8	40.2	47.8	55.6	63.5	71.6	79.8	88.2
	AUTOBRAKE 1	5.5	11.3	17.3	23.7	30.2	37.0	43.9	51.0	58.3	65.7	73.1	80.7

Table 2(b) of 3: 2 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
RTO MAX MAN		10	20	30	40	50	60	70	80	90	100	110	120
LANDING	MAX MAN	6.9	14.3	22.2	30.5	39.1	47.8	56.7	65.7	74.6	83.4	91.9	100.2
	MAX AUTO	4.8	10.3	16.3	22.9	30.0	37.5	45.3	53.5	61.9	70.5	79.2	88.0
	AUTOBRAKE 4	3.2	7.1	11.7	16.8	22.4	28.5	35.0	41.8	48.8	56.0	63.4	70.8
	AUTOBRAKE 3	1.9	4.6	7.9	11.7	16.2	21.1	26.4	32.0	38.0	44.2	50.6	57.2
	AUTOBRAKE 2	1.6	3.6	6.0	8.7	11.8	15.3	19.0	23.1	27.6	32.3	37.3	42.6
	AUTOBRAKE 1	1.5	3.0	4.8	6.7	8.8	11.1	13.8	16.6	19.8	23.4	27.2	31.5

Table 3 of 3: Cooling Time (Minutes)

	EVENT ADJUSTED BRAKE ENERGY (MILLIONS OF FOOT POUNDS)									
	16 & BELOW	17	18	22	26	30	34	35	36 TO 50	51 & ABOVE
GEAR DOWN INFLIGHT	NO SPECIAL PROCEDURE REQUIRED	1.3	2.0	3.4	4.9	6.2	7.1	7.3	CAUTION	FUSE PLUG MELT ZONE
GROUND		13	20	34	49	62	71	73		
BRAKE TEMPERATURE INDICATION	UP TO 2.4	2.4	2.6	3.1	3.7	4.3	4.8	4.9	5.0 TO 7.0	7.1 & 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 15 percent.

With two brakes deactivated, increase brake energy by 34 percent.

When in caution zone, wheel fuse plugs may melt. Delay takeoff and inspect after one hour. If overheat occurs after takeoff, extend gear soon for at least 8 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not 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.

ENGINE INOP

Initial Max Continuous TPR
Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)								
	27	29	31	33	35	37	39	41	43
	310	310	310	.85	.85	.85	.85	.85	.85
20	76.1	76.0	75.3	74.2	72.2	70.4	70.1	69.5	68.9
15	81.2	81.3	80.4	79.1	77.8	76.0	75.2	74.6	74.0
10	86.0	86.5	85.6	84.4	83.2	81.5	80.3	79.7	79.0
5	90.1	90.7	90.2	89.9	88.1	86.7	85.7	85.1	84.5
0	93.5	94.4	93.9	93.8	92.9	91.8	91.2	90.6	90.0
–5	93.7	95.8	96.3	96.4	97.0	96.3	95.8	95.3	94.8
–10	93.9	96.0	96.6	97.4	99.2	99.5	99.0	98.8	98.7
–15	94.2	96.3	96.8	97.6	99.8	101.1	100.4	100.9	101.3
–20	94.4	96.5	97.0	97.8	100.1	101.3	100.7	101.1	101.5
–25	94.6	96.7	97.2	98.0	100.3	101.5	100.9	101.3	101.8
–30	94.8	96.9	97.5	98.3	100.5	101.8	101.1	101.6	102.0
–35	95.1	97.2	97.7	98.5	100.8	102.0	101.4	101.8	102.2
–40	95.3	97.4	97.9	98.7	101.0	102.2	101.6	102.0	102.5

TPR Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	27	29	31	33	35	37	39	41	43
ENGINE ON	–1.8	–2.0	–2.2	–2.4	–2.6	–2.9	–3.3	–4.0	–4.8
ENGINE & WING ON	–2.9	–3.2	–3.5	–3.9	–4.2	–4.8	–5.3	–6.6	–7.9

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	27	29	31	33	35	37	39	41	43
ENGINE ON	–1.8	–2.0	–2.1	–2.3	–2.5	–2.9	–3.2	–4.0	–4.8
ENGINE & WING ON	–2.9	–3.1	–3.5	–3.8	–4.2	–4.7	–5.2	–6.5	–7.8

ENGINE INOP

Max Continuous TPR

Based on anti-ice off or auto

37000 FT to 31000 FT Pressure Altitudes

37000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	–50	–45	–40	–35	–30	–25	–20	–15	–10	–5	0	5
280	.86	102.0	101.7	101.5	101.3	101.0	100.8	100.6	100.3	98.9	95.9	91.4	86.4
240	.74	103.0	102.7	102.5	102.2	102.0	101.8	101.0	98.6	94.4	89.2	84.0	78.3
200	.63	102.1	101.8	101.6	101.4	101.1	99.6	96.2	91.3	86.0	80.4	74.4	69.8

35000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	–50	–45	–40	–35	–30	–25	–20	–15	–10	–5	0	5
280	.82	102.2	102.0	101.8	101.5	101.3	101.1	100.8	100.6	99.1	95.9	91.5	86.6
240	.71	103.0	102.8	102.5	102.3	102.1	101.8	101.2	98.8	94.7	89.7	84.6	79.0
200	.60	100.6	100.3	100.1	99.8	99.6	98.4	95.3	90.7	85.4	80.0	74.0	68.7

33000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	–50	–45	–40	–35	–30	–25	–20	–15	–10	–5	0	5
320	.89	93.5	93.3	93.1	92.9	92.7	92.5	92.3	92.1	91.8	91.6	90.0	86.6
280	.79	101.5	101.3	101.1	100.8	100.6	100.4	100.1	99.9	99.1	96.5	92.5	87.4
240	.68	101.3	101.1	100.9	100.6	100.4	100.1	99.9	98.3	94.9	90.3	85.3	80.0
200	.58	99.6	99.4	99.2	98.9	98.7	98.4	96.4	92.3	87.3	82.2	76.5	70.7

31000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	–45	–40	–35	–30	–25	–20	–15	–10	–5	0	5	10
320	.85	96.2	95.9	95.7	95.5	95.3	95.1	94.9	94.6	94.4	93.2	89.9	85.7
280	.76	99.8	99.6	99.3	99.1	98.9	98.6	98.4	98.2	95.7	92.0	87.3	82.2
240	.66	99.4	99.2	99.0	98.7	98.5	98.2	97.6	94.9	90.7	85.8	80.9	75.3
200	.55	99.4	99.2	98.9	98.7	98.5	97.4	94.4	90.0	84.9	79.7	74.0	68.3

TPR Adjustments for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	31	33	35	37
ENGINE ON	–2.2	–2.4	–2.6	–2.9
ENGINE & WING ON	–3.5	–3.9	–4.2	–4.8

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	31	33	35	37
ENGINE ON	–2.1	–2.3	–2.5	–2.9
ENGINE & WING ON	–3.5	–3.8	–4.2	–4.7

29000 FT to 24000 FT Pressure Altitudes

29000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	–40	–35	–30	–25	–20	–15	–10	–5	0	5	10	15
320	.82	95.5	95.2	95.0	94.8	94.6	94.4	94.2	93.9	93.7	90.4	86.4	81.6
280	.73	98.0	97.8	97.5	97.3	97.1	96.8	96.6	95.2	91.8	87.5	82.5	77.5
240	.63	98.2	97.9	97.7	97.5	97.2	97.0	95.1	91.5	86.9	81.9	76.8	71.4
200	.53	98.7	98.5	98.2	98.0	97.7	95.6	91.8	87.0	81.9	76.5	70.9	67.9

ENGINE INOP

Max Continuous TPR
Based on anti-ice off or auto
29000 FT to 24000 FT Pressure Altitudes
27000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−40	−35	−30	−25	−20	−15	−10	−5	0	5	10	15
360	.88	83.6	83.5	83.3	83.1	82.9	82.7	82.5	82.3	82.1	82.0	81.6	79.8
320	.79	94.6	94.4	94.2	94.0	93.7	93.5	93.3	93.1	92.9	90.6	86.6	82.1
280	.70	97.3	97.1	96.8	96.6	96.4	96.1	95.9	95.7	92.6	88.5	83.7	78.6
240	.60	97.2	96.9	96.7	96.5	96.2	96.0	95.4	92.5	88.2	83.0	77.8	72.7
200	.51	97.7	97.4	97.2	96.9	96.7	96.0	92.8	88.4	83.3	78.2	72.8	67.4

25000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−35	−30	−25	−20	−15	−10	−5	0	5	10	15	20
360	.85	82.5	82.3	82.1	81.9	81.7	81.5	81.3	81.2	81.0	80.8	79.4	76.3
320	.76	92.7	92.5	92.2	92.0	91.8	91.6	91.4	91.2	90.4	86.6	82.4	77.5
280	.67	95.5	95.3	95.1	94.8	94.6	94.4	94.2	92.6	88.9	84.4	79.2	74.1
240	.58	95.7	95.5	95.3	95.0	94.8	94.6	92.7	89.1	84.4	79.1	74.0	69.2
200	.49	96.2	96.0	95.7	95.5	95.2	93.5	89.8	85.1	80.0	74.8	69.6	65.8

24000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−35	−30	−25	−20	−15	−10	−5	0	5	10	15	20
360	.83	83.2	83.0	82.8	82.6	82.4	82.2	82.0	81.9	81.7	81.5	79.9	76.8
320	.75	92.0	91.7	91.5	91.3	91.1	90.9	90.7	90.5	90.2	86.7	82.7	77.9
280	.66	94.6	94.4	94.2	93.9	93.7	93.5	93.2	92.5	89.0	84.8	79.6	74.5
240	.57	95.0	94.8	94.5	94.3	94.1	93.8	92.8	89.5	85.1	79.9	74.7	69.9
200	.48	95.5	95.3	95.1	94.8	94.6	93.8	90.7	86.2	81.0	75.8	70.8	65.7

TPR Adjustments for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	24	25	27	29
ENGINE ON	−1.6	−1.7	−1.8	−2.0
ENGINE & WING ON	−2.5	−2.6	−2.9	−3.2

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	24	25	27	29
ENGINE ON	−1.6	−1.7	−1.8	−2.0
ENGINE & WING ON	−2.5	−2.6	−2.9	−3.1

22000 FT to 16000 FT Pressure Altitudes
22000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−30	−25	−20	−15	−10	−5	0	5	10	15	20	25
360	.80	85.0	84.8	84.6	84.5	84.3	84.1	83.9	83.7	83.5	82.7	78.7	74.8
320	.72	90.8	90.6	90.3	90.1	89.9	89.7	89.5	89.3	87.4	83.5	79.3	74.3
280	.63	92.8	92.5	92.3	92.1	91.9	91.6	91.4	89.1	85.2	80.7	75.6	70.7
240	.55	93.3	93.0	92.8	92.6	92.3	92.1	90.0	86.2	81.5	76.3	71.4	66.7
200	.46	94.0	93.8	93.6	93.3	93.1	91.5	88.0	83.2	77.9	72.8	68.1	64.9

ENGINE INOP

Max Continuous TPR

Based on anti-ice off or auto

22000 FT to 16000 FT Pressure Altitudes

20000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−30	−25	−20	−15	−10	−5	0	5	10	15	20	25
360	.77	83.3	83.1	82.9	82.7	82.5	82.3	82.1	81.9	81.7	81.6	78.6	74.8
320	.69	89.7	89.5	89.3	89.1	88.9	88.7	88.5	88.2	88.0	84.0	79.9	75.3
280	.61	92.9	92.7	92.5	92.2	92.0	91.8	91.6	91.1	87.7	83.6	78.6	73.6
240	.53	93.4	93.2	93.0	92.7	92.5	92.3	91.9	89.3	85.2	80.2	75.1	70.4
200	.44	93.2	93.0	92.7	92.5	92.3	92.0	89.4	85.3	80.2	75.0	70.2	65.5

18000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−25	−20	−15	−10	−5	0	5	10	15	20	25	30
360	.75	81.4	81.2	81.1	80.9	80.7	80.5	80.3	80.1	79.9	78.6	74.7	71.0
320	.67	86.9	86.7	86.5	86.3	86.0	85.8	85.6	85.4	83.4	79.4	75.2	70.5
280	.59	89.3	89.1	88.8	88.6	88.4	88.2	88.0	85.8	81.7	77.4	72.5	67.8
240	.51	90.1	89.8	89.6	89.4	89.2	88.9	87.0	83.0	78.6	73.6	68.8	64.4
200	.42	90.5	90.2	90.0	89.8	89.5	88.4	84.2	79.9	74.8	69.8	65.3	61.1

16000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−25	−20	−15	−10	−5	0	5	10	15	20	25	30
360	.72	79.6	79.4	79.2	79.0	78.8	78.6	78.5	78.3	78.1	77.9	75.1	71.7
320	.64	85.0	84.8	84.6	84.4	84.2	84.0	83.8	83.6	83.4	79.7	75.8	71.4
280	.57	87.4	87.2	86.9	86.7	86.5	86.3	86.1	85.9	82.2	78.3	73.6	68.9
240	.49	87.9	87.7	87.5	87.3	87.0	86.8	86.6	83.6	79.7	75.0	70.1	65.7
200	.41	88.0	87.7	87.5	87.3	87.1	86.8	85.0	81.3	76.8	71.8	67.1	62.8

TPR Adjustments for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	16	18	20	22
ENGINE ON	−1.2	−1.3	−1.4	−1.5
ENGINE & WING ON	−1.7	−1.8	−2.0	−2.2

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	16	18	20	22
ENGINE ON	−1.2	−1.3	−1.4	−1.5
ENGINE & WING ON	−1.7	−1.9	−2.1	−2.3

14000 FT to 5000 FT Pressure Altitudes

14000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−20	−15	−10	−5	−0	5	10	15	20	25	30	35
360	.69	78.1	77.9	77.7	77.5	77.3	77.2	77.0	76.8	76.6	75.5	72.6	69.0
320	.62	83.0	82.8	82.6	82.4	82.2	82.0	81.8	81.6	80.0	76.3	72.4	67.9
280	.54	84.8	84.6	84.4	84.2	84.0	83.8	83.6	82.1	78.3	74.3	69.7	65.1
240	.47	85.6	85.4	85.2	85.0	84.8	84.6	83.8	80.3	76.2	71.5	66.7	62.6
200	.39	86.7	86.5	86.3	86.0	85.8	85.6	82.9	79.0	74.2	69.3	65.0	60.8

ENGINE INOP

Max Continuous TPR
Based on anti-ice off or auto
14000 FT to 5000 FT Pressure Altitudes
12000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−15	−10	−5	0	5	10	15	20	25	30	35	40
360	.67	74.9	74.7	74.5	74.3	74.2	74.0	73.8	73.6	73.4	72.1	69.2	65.3
320	.60	81.0	80.8	80.6	80.4	80.2	80.0	79.8	79.6	76.4	72.8	68.6	64.2
280	.52	82.0	81.8	81.6	81.4	81.2	81.0	80.8	77.9	74.1	69.9	65.4	61.3
240	.45	84.3	84.1	83.9	83.7	83.5	83.3	81.0	77.1	72.9	68.2	63.8	59.9
200	.38	87.0	86.8	86.5	86.3	86.1	85.1	81.0	76.9	72.2	67.4	63.4	59.4

10000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−15	−10	−5	0	5	10	15	20	25	30	35	40
360	.65	70.5	70.3	70.1	70.0	69.8	69.6	69.5	69.3	69.1	68.5	66.7	64.6
320	.58	76.4	76.2	76.0	75.9	75.7	75.5	75.3	75.1	74.1	70.7	67.2	63.0
280	.51	77.6	77.4	77.2	77.0	76.8	76.7	76.5	75.9	72.0	68.6	64.3	60.0
240	.43	80.2	80.0	79.8	79.6	79.4	79.2	79.0	75.6	71.9	67.6	63.2	59.4
200	.36	82.5	82.3	82.1	81.9	81.7	81.5	79.4	75.6	71.5	66.9	62.7	58.9

5000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−10	−5	0	5	10	15	20	25	30	35	40	45
360	.59	63.9	63.8	63.6	63.5	63.3	63.2	63.0	62.9	62.7	62.5	61.6	59.4
320	.53	67.4	67.3	67.1	66.9	66.8	66.6	66.4	66.3	66.1	64.3	61.6	58.2
280	.46	70.3	70.1	70.0	69.8	69.6	69.4	69.3	69.1	67.5	64.4	61.0	57.1
240	.40	72.7	72.5	72.4	72.2	72.0	71.8	71.6	70.9	67.7	64.3	60.3	56.3
200	.33	74.4	74.2	74.1	73.9	73.7	73.5	73.3	70.9	67.6	63.8	59.7	56.1

TPR Adjustments for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	5	10	12	14
ENGINE ON	0.0	0.0	−0.5	−1.1
ENGINE & WING ON	0.0	0.0	−0.8	−1.6

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	5	10	12	14
ENGINE ON	−0.8	−1.0	−1.0	−1.1
ENGINE & WING ON	−1.2	−1.4	−1.5	−1.6

ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude
100 ft/min residual rate of climb

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF PRESSURE ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
240	232	266	17000	15700	13600
230	222	261	18500	17100	15400
220	213	255	20200	19000	17000
210	203	250	21400	20600	19200
200	193	244	22800	21900	20700
190	184	238	24400	23500	22000
180	174	232	25900	25100	23700
170	164	226	27300	26600	25300
160	155	219	28700	28000	26900
150	145	213	30200	29600	28500
140	136	206	31600	31100	30100
130	126	199	33100	32700	31700
120	116	192	34900	34400	33400
110	107	185	36700	36200	35300
100	97	178	38500	38100	37200

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown/LRC Cruise Range Capability

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
276	257	240	225	211	200	189	179	171	163	156
552	513	479	449	423	400	379	360	343	327	313
828	769	718	674	634	600	568	540	514	491	470
1102	1024	957	898	846	800	758	720	686	656	627
1376	1279	1196	1122	1057	1000	948	901	859	820	785
1649	1534	1434	1346	1269	1200	1137	1081	1031	985	942
1923	1789	1673	1570	1480	1400	1327	1262	1203	1149	1100
2196	2044	1911	1795	1691	1600	1517	1443	1375	1314	1258
2470	2299	2150	2019	1903	1800	1707	1623	1547	1478	1415
2744	2554	2389	2243	2114	2000	1897	1804	1719	1643	1573
3019	2810	2628	2468	2326	2200	2086	1984	1891	1807	1730
3295	3066	2867	2692	2537	2400	2276	2164	2063	1971	1887
3572	3323	3107	2917	2749	2600	2465	2344	2234	2135	2043
3850	3581	3348	3142	2961	2800	2655	2524	2406	2298	2199

Table 2 of 2: Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG) WEIGHT AT START OF DRIFTDOWN (1000 KG)									TIME (HR:MIN)
	100	120	140	160	180	200	220	240	260	
200	1.3	1.4	1.5	1.7	1.9	2.1	2.3	2.4	2.6	0:33
400	2.8	3.2	3.5	3.9	4.4	4.8	5.3	5.8	6.2	1:06
600	4.2	4.8	5.5	6.2	6.8	7.6	8.4	9.2	9.9	1:39
800	5.6	6.4	7.3	8.2	9.1	10.2	11.3	12.4	13.4	2:12
1000	6.9	8.0	9.1	10.3	11.4	12.7	14.1	15.6	16.9	2:44
1200	8.2	9.6	10.9	12.3	13.7	15.3	17.0	18.7	20.3	3:16
1400	9.5	11.1	12.7	14.3	15.9	17.8	19.7	21.8	23.7	3:49
1600	10.8	12.6	14.4	16.3	18.1	20.2	22.5	24.9	27.0	4:21
1800	12.1	14.1	16.1	18.2	20.3	22.7	25.2	27.9	30.3	4:53
2000	13.4	15.6	17.9	20.2	22.4	25.1	27.9	30.9	33.5	5:26
2200	14.6	17.1	19.6	22.1	24.6	27.5	30.6	33.9	36.8	5:58
2400	15.9	18.5	21.2	24.0	26.7	29.9	33.2	36.8	40.0	6:31
2600	17.1	20.0	22.9	25.9	28.8	32.2	35.8	39.7	43.1	7:05
2800	18.3	21.4	24.6	27.7	30.9	34.6	38.4	42.5	46.2	7:38

Includes APU fuel burn.
Driftdown at optimum driftdown speed and cruise at Long Range Cruise speed.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability
100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
250	10100	5800	2200
240	13100	8300	4900
230	15200	10400	7200
220	16700	14600	10100
210	18500	16400	13700
200	20600	18300	16200
190	22200	20900	18100
180	24100	22400	20800
170	25800	24500	22200
160	27200	26300	24400
150	28700	27800	26300
140	30300	29500	28000
130	31900	31200	29800
120	33600	32900	31600
110	35500	34900	33400
100	37300	36800	35600

With engine anti-ice on, decrease altitude capability by 2,100 ft.
With engine and wing anti-ice on, decrease altitude capability by 3,000 ft.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)											
		10	15	17	19	21	23	25	27	29	31	33	35
260	TPR	72.8											
	MACH	.582											
	KIAS	323											
	FF/ENG	6666											
240	TPR	68.6	82.4										
	MACH	.563	.609										
	KIAS	312	309										
	FF/ENG	6133	6287										
220	TPR	64.1	76.5	82.3	88.4								
	MACH	.542	.589	.608	.626								
	KIAS	301	298	296	294								
	FF/ENG	5579	5666	5713	5740								
200	TPR	59.1	70.3	75.5	81.3	86.7	93.5						
	MACH	.520	.566	.586	.605	.624	.642						
	KIAS	288	286	285	283	281	278						
	FF/ENG	4989	5041	5066	5115	5106	5147						
180	TPR	54.2	64.6	68.6	73.8	79.6	84.7	90.6	99.5				
	MACH	.497	.541	.561	.580	.600	.620	.638	.658				
	KIAS	275	273	272	271	270	268	265	262				
	FF/ENG	4432	4475	4438	4475	4523	4508	4492	4639				
160	TPR	49.8	58.7	62.6	66.6	71.8	77.2	82.2	88.9	97.2			
	MACH	.472	.514	.533	.552	.572	.592	.613	.631	.651			
	KIAS	261	259	258	258	257	256	254	251	248			
	FF/ENG	3951	3919	3905	3886	3929	3964	3941	3969	4059			
140	TPR	45.3	53.0	56.7	60.5	64.7	69.4	74.4	80.1	86.5	94.3		
	MACH	.447	.485	.503	.521	.541	.561	.581	.602	.623	.642		
	KIAS	247	244	243	243	242	241	240	239	237	234		
	FF/ENG	3475	3403	3398	3388	3397	3424	3435	3441	3459	3505		
120	TPR	40.8	47.5	50.7	54.1	57.9	62.0	66.5	71.4	76.9	83.1	90.2	99.0
	MACH	.420	.455	.470	.487	.505	.524	.545	.566	.587	.608	.629	.649
	KIAS	323	228	227	226	226	225	224	224	223	221	219	216
	FF/ENG	3008	2918	2926	2935	2908	2922	2936	2942	2941	2947	2967	3029
100	TPR	36.3	41.9	44.6	47.6	50.8	54.4	58.3	62.6	67.3	72.4	78.2	84.8
	MACH	.392	.422	.436	.451	.467	.484	.503	.523	.544	.565	.587	.609
	KIAS	216	212	210	209	208	207	207	206	205	205	204	202
	FF/ENG	2565	2452	2452	2467	2462	2448	2442	2445	2446	2447	2446	2451

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
294	269	248	230	214	200	190	180	172	164	158
587	538	495	459	428	400	381	362	346	331	317
882	808	743	689	642	600	571	544	519	496	476
1177	1078	991	918	856	800	760	724	691	661	634
1473	1349	1240	1149	1070	1000	951	905	864	826	793
1771	1621	1489	1379	1284	1200	1141	1086	1037	992	951
2069	1894	1739	1610	1499	1400	1331	1268	1210	1157	1109
2369	2168	1990	1841	1714	1600	1521	1448	1381	1321	1267
2669	2441	2240	2072	1928	1800	1711	1629	1554	1486	1425
2971	2716	2491	2303	2143	2000	1901	1810	1726	1651	1583
3274	2991	2743	2535	2358	2200	2091	1990	1898	1815	1740
3578	3268	2995	2768	2573	2400	2281	2170	2070	1979	1897
3883	3545	3247	3000	2788	2600	2470	2351	2242	2143	2055
4189	3823	3500	3232	3003	2800	2660	2531	2414	2307	2212

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		26	
	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	2.6	0:42	2.3	0:40	2.0	0:38	1.8	0:37	1.6	0:36
400	5.5	1:20	5.1	1:16	4.6	1:12	4.3	1:09	4.0	1:07
600	8.4	1:58	7.8	1:52	7.1	1:47	6.8	1:42	6.4	1:38
800	11.2	2:37	10.5	2:29	9.7	2:21	9.2	2:15	8.7	2:09
1000	14.0	3:16	13.1	3:06	12.1	2:56	11.6	2:48	11.0	2:41
1200	16.8	3:55	15.8	3:43	14.6	3:31	14.0	3:21	13.2	3:12
1400	19.5	4:35	18.4	4:21	17.0	4:07	16.3	3:54	15.5	3:44
1600	22.3	5:15	20.9	4:58	19.5	4:42	18.7	4:28	17.7	4:16
1800	25.0	5:55	23.5	5:36	21.9	5:18	21.0	5:02	19.9	4:48
2000	27.7	6:35	26.0	6:15	24.2	5:54	23.3	5:36	22.1	5:20
2200	30.3	7:16	28.5	6:53	26.6	6:30	25.5	6:10	24.2	5:53
2400	33.0	7:57	31.0	7:32	28.9	7:07	27.8	6:44	26.4	6:25
2600	35.6	8:39	33.4	8:11	31.2	7:43	30.0	7:19	28.5	6:58
2800	38.2	9:20	35.9	8:50	33.5	8:20	35.2	7:54	30.6	7:31

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)								
	100	120	140	160	180	200	220	240	260
5	–1.1	–0.8	–0.5	–0.3	0.0	0.5	1.3	2.0	2.8
10	–2.3	–1.8	–1.1	–0.6	0.0	1.1	2.6	4.1	5.8
15	–3.6	–2.7	–1.8	–0.9	0.0	1.6	3.8	6.1	8.5
20	–4.8	–3.6	–2.4	–1.2	0.0	2.1	4.9	8.0	11.2
25	–6.1	–4.6	–3.0	–1.5	0.0	2.6	5.9	9.7	13.6
30	–7.3	–5.5	–3.6	–1.8	0.0	3.0	6.7	11.2	15.9
35	–8.6	–6.4	–4.3	–2.1	0.0	3.3	7.5	12.6	18.0
40	–9.8	–7.4	–4.9	–2.4	0.0	3.6	8.2	13.8	20.0

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Holding
Flaps up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)						
		1500	5000	10000	15000	20000	25000	30000
260	TPR	50.6	57.2	68.7	84.4			
	KIAS	258	259	284	285			
	FF/ENG	5710	5820	6180	6530			
240	TPR	47.3	53.3	64.6	78.2			
	KIAS	251	251	252	274			
	FF/ENG	5250	5300	5530	5870			
220	TPR	44.0	49.4	59.6	71.7	87.8		
	KIAS	243	244	245	262	264		
	FF/ENG	4790	4820	4990	5200	5460		
200	TPR	40.8	45.7	54.5	65.0	80.2	97.4	
	KIAS	235	236	237	238	251	253	
	FF/ENG	4350	4360	4450	4470	4810	5010	
180	TPR	37.6	42.0	49.8	59.6	72.0	86.7	
	KIAS	227	227	228	229	238	239	
	FF/ENG	3920	3920	3960	3990	4140	4260	
160	TPR	34.5	38.5	45.4	53.8	64.5	78.1	98.8
	KIAS	220	220	221	222	223	225	227
	FF/ENG	3530	3510	3530	3500	3560	3690	3970
140	TPR	31.5	35.0	41.1	48.7	58.3	70.2	86.1
	KIAS	211	211	211	212	213	213	213
	FF/ENG	3140	3120	3110	3070	3130	3200	3300
120	TPR	28.5	31.7	37.0	43.8	52.3	62.8	76.0
	KIAS	202	202	202	203	203	203	203
	FF/ENG	2780	2750	2720	2670	2750	2770	2810
100	TPR	26.1	28.9	33.7	39.8	47.4	56.7	68.3
	KIAS	198	198	198	198	198	199	199
	FF/ENG	2490	2460	2430	2380	2440	2450	2470

This table includes 5% additional fuel for holding in a racetrack pattern.

ENGINE INOP

ADVISORY INFORMATION

Gear Down Landing Rate of Climb Available
Flaps 20

TAT (deg. C)	RATE OF CLIMB (FT/MIN) PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
52	250	230							
50	280	260	130						
48	320	290	160						
46	350	320	190	70					
44	390	360	230	100					
42	420	390	260	130	0				
40	450	430	290	160	30				
38	470	470	330	190	50	–120			
36	490	490	360	220	80	–90			
34	490	520	390	260	120	–60	–230		
32	490	530	420	290	150	–30	–210		
30	500	530	450	320	180	0	–180	–340	
20	510	550	470	380	280	150	–30	–220	–430
10	520	560	480	390	290	180	90	–80	–300
0	530	570	490	400	300	190	100	–40	–230
–20	560	600	520	420	320	200	100	–40	–240
–40	600	640	550	450	330	210	110	–40	–250

Rate of climb capability shown is valid for 170000 kg, gear down at VREF 20+5.
Decrease rate of climb 40 ft/min per 5000 kg greater than 170000 kg.
Increase rate of climb 60 ft/min per 5000 kg less than 170000 kg.

Flaps 30

TAT (deg. C)	RATE OF CLIMB (FT/MIN) PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
52	70	40							
50	100	70	–60						
48	130	100	–30						
46	170	130	–120						
44	200	170	30	–100					
42	240	200	60	–70	–200				
40	260	240	100	–40	–170				
38	280	270	130	–10	–150	–320			
36	300	300	160	20	–120	–290			
34	300	320	200	50	–90	–270	–440		
32	300	330	220	90	–60	–240	–410		
30	300	340	250	120	–30	–210	–390	–560	
20	310	350	260	170	70	–60	–250	–440	–650
10	320	360	270	180	80	–40	–130	–310	–530
0	330	370	280	190	80	–30	–130	–270	–460
–20	350	390	300	200	90	–30	–130	–280	–480
–40	380	410	320	220	100	–30	–130	–290	–490

Rate of climb capability shown is valid for 170000 kg, gear down at VREF 30+5.
Decrease rate of climb 40 ft/min per 5000 kg greater than 170000 kg.
Increase rate of climb 60 ft/min per 5000 kg less than 170000 kg.

ALTERNATE MODE EEC

Fuel Jettison Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	159.4	156.3							
52	162.9	159.5							
50	166.4	162.6	150.3						
48	169.6	165.8	153.3						
46	181.7	169.1	156.5	144.9					
44	184.7	181.6	159.9	148.2					
42	188.2	184.9	163.1	151.4	140.0				
40	192.0	188.3	166.4	154.5	143.0				
38	195.0	191.9	169.7	157.7	146.0	131.1			
36	197.5	195.2	181.7	160.6	148.9	134.2			
34	206.5	197.8	184.5	163.3	151.4	137.2	124.1		
32	207.5	206.8	187.4	166.0	154.0	139.9	126.8		
30	208.3	214.3	190.1	169.0	156.7	142.5	129.3		
28	209.2	215.0	192.6	181.2	159.7	145.3	131.6		
26	210.0	215.6	195.1	183.9	162.9	148.3	134.0		
24	210.9	215.8	195.3	186.2	166.1	151.2	136.9	123.3	
22	211.7	216.1	195.5	188.5	168.7	154.2	139.7	125.8	
20	212.6	216.3	195.7	188.7	170.8	157.1	142.5	128.5	117.5
18	213.2	216.5	195.9	188.9	181.8	159.9	145.3	131.1	119.7
16	213.8	216.8	196.1	189.0	182.0	162.7	148.0	133.8	122.0
14	214.3	217.0	196.3	189.2	182.1	165.3	150.9	136.7	124.3
12	214.8	217.1	196.5	189.4	182.3	165.4	154.0	139.6	126.7
10	215.3	217.3	196.7	189.6	182.4	165.5	157.0	142.5	129.2
0	216.3	218.0	197.4	190.3	183.1	166.2	160.8	153.6	140.7
–10	217.0	218.7	198.0	190.9	183.7	166.7	161.3	154.2	144.0
–20	217.5	219.3	200.5	191.6	184.2	167.3	161.9	154.7	
–30	218.0	219.8	203.3	192.1	184.7	167.8	162.4		
–40	218.6	220.4	205.6	192.5	185.2	168.2			

Table valid for Zero Fuel Weight up to 161025 kg.

Anti-Ice Adjustments

Pressure Altitude ≤9000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–5700	–6550
ENGINE & WING ON	–350	–7050	–7500

Pressure Altitude >9000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–3550	–6700	–6500
ENGINE & WING ON	–4950	–7450	–7300

DELETION

ALTERNATE MODE EEC

Limit Weight

PERFORMANCE LIMIT	ALTERNATE MODE EEC LIMIT WEIGHT (1000 KG)							
	PRIMARY MODE PERFORMANCE LIMIT WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
FIELD	107.4	125.9	144.5	163.1	181.6	200.2	218.7	237.3
CLIMB	106.1	123.8	141.4	159.0	176.7	194.3	211.9	229.6
OBSTACLE	106.8	124.3	141.8	159.3	176.7	194.2	211.7	229.2
NET LEVEL OFF WEIGHT	105.9	123.4	141.0	158.5	176.1	193.6	211.2	228.7
LANDING CLIMB	102.4	120.5	138.6	156.7	174.8	192.9	211.0	229.1

Takeoff Speed Adjustments

TAKEOFF SPEEDS	TAKEOFF SPEED ADJUSTMENT (KTS)	
	DRY	WET
V1	3	4
VR	2	2
V2	2	2

ALTERNATE MODE EEC

Max Takeoff %N1

Based on anti-ice off

AIRPORT OAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
55	82.1	83.1	83.9	83.6	83.3	83.0	82.6	82.3	81.9	80.8	80.0	79.4	78.5	77.6	76.6	75.9	75.3
50	83.1	84.1	85.0	84.9	84.7	84.6	84.3	84.0	83.8	82.6	81.9	81.4	80.6	79.8	78.9	78.4	77.9
45	84.1	85.1	85.9	85.9	85.8	85.8	85.7	85.6	85.4	84.3	83.7	83.2	82.5	81.8	81.0	80.6	80.2
40	85.1	86.0	86.9	86.8	86.8	86.7	86.7	86.7	86.7	85.8	85.3	84.9	84.2	83.5	82.8	82.5	82.2
35	85.7	86.8	87.7	87.7	87.6	87.6	87.5	87.5	87.5	86.9	86.6	86.4	85.8	85.1	84.5	84.3	84.0
30	85.3	86.7	88.0	88.2	88.3	88.4	88.4	88.3	88.3	87.8	87.6	87.4	86.8	86.4	85.9	85.8	85.6
25	84.7	86.1	87.4	87.9	88.5	88.9	89.1	89.3	89.2	88.7	88.6	88.4	87.8	87.3	86.8	86.7	86.6
20	84.1	85.4	86.7	87.3	87.8	88.4	89.0	89.6	89.8	89.6	89.4	89.3	88.7	88.3	87.8	87.6	87.5
15	83.5	84.8	86.1	86.6	87.2	87.8	88.4	88.9	89.5	90.0	90.2	90.1	89.6	89.2	88.8	88.6	88.4
10	82.8	84.1	85.4	85.9	86.5	87.1	87.7	88.3	88.8	89.3	89.8	90.2	90.6	90.3	89.9	89.6	89.4
5	82.2	83.4	84.7	85.3	85.8	86.4	87.0	87.6	88.1	88.6	89.1	89.5	90.7	90.9	90.8	90.5	90.2
0	81.5	82.8	84.1	84.6	85.1	85.7	86.3	86.9	87.4	87.9	88.3	88.8	90.0	90.6	91.2	91.2	91.0
–10	80.1	81.4	82.7	83.2	83.7	84.3	84.9	85.4	86.0	86.4	86.9	87.4	88.5	89.1	89.7	90.0	90.3
–20	78.7	80.0	81.2	81.7	82.3	82.9	83.4	84.0	84.5	85.0	85.4	85.9	87.0	87.6	88.2	88.5	88.8
–30	77.3	78.5	79.8	80.3	80.8	81.4	81.9	82.5	83.0	83.4	83.9	84.3	85.5	86.1	86.6	86.9	87.2
–40	75.8	77.1	78.3	78.8	79.3	79.8	80.4	80.9	81.4	81.9	82.3	82.8	83.9	84.5	85.0	85.4	85.7
–50	74.3	75.5	76.7	77.2	77.7	78.3	78.8	79.3	79.8	80.3	80.7	81.1	82.3	82.8	83.4	83.8	84.1

%N1 Adjustment for Anti-ice

For OAT≤10 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)							
	–2	0	9	10	11	12	13	14
ENGINE ON	0.0	0.0	0.0	–0.4	–0.5	–0.5	–0.5	–0.5
ENGINE & WING ON	0.0	0.0	0.0	–0.6	–0.6	–0.7	–0.7	–0.6
ENGINE AUTO	0.0	0.0	0.0	–0.4	–0.5	–0.5	–0.5	–0.5
ENGINE & WING AUTO	0.0	0.0	0.0	–0.6	–0.6	–0.7	–0.7	–0.6

For 10 deg. C<OAT≤20 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ENGINE ON	–0.7	–0.6	–0.6	–0.6	–0.7	–0.7	–0.7	–0.7	–0.7	–0.8	–0.8	–0.8	–0.8	–0.9	–0.9	–0.9	–0.9
ENGINE & WING ON	–0.9	–0.7	–0.7	–0.8	–0.8	–0.8	–0.8	–0.9	–0.9	–0.9	–0.9	–1.0	–1.0	–1.0	–1.1	–1.1	–1.2
With engine anti-ice auto or engine and wing anti-ice auto, no adjustment is necessary.																	

ALTERNATE MODE EEC

Max Climb %N1

Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)									
	0	5	10	15	20	25	30	35	40	43
	310	310	310	310	310	310	310	.85	.85	.85
60	77.6	77.6	79.3	82.3	85.0	86.7	88.4	90.2	90.6	90.5
50	80.9	80.5	80.0	81.1	83.7	85.4	87.1	88.8	89.2	89.1
40	83.3	83.7	83.1	83.3	83.1	84.1	85.7	87.5	87.8	87.7
30	82.8	85.2	85.8	86.2	86.0	85.6	85.0	86.1	86.4	86.3
20	81.6	84.0	86.6	88.3	88.7	88.4	88.7	86.3	85.3	85.2
15	81.0	83.3	85.9	88.4	89.8	89.6	89.5	88.0	87.1	86.9
10	80.3	82.7	85.2	87.8	90.0	90.7	90.4	89.3	88.7	88.5
5	79.7	82.0	84.5	87.1	89.5	91.0	91.4	90.3	89.8	89.6
0	79.1	81.3	83.8	86.3	88.8	90.6	91.8	91.2	90.7	90.5
–5	78.4	80.7	83.1	85.6	88.0	89.8	91.4	92.4	91.9	91.8
–10	77.8	80.0	82.4	84.9	87.3	89.1	90.6	92.6	92.8	92.8
–15	77.1	79.3	81.7	84.2	86.5	88.3	89.8	92.1	92.7	92.7
–20	76.4	78.6	81.0	83.4	85.8	87.5	89.0	91.3	91.9	91.9
–25	75.7	77.9	80.3	82.6	85.0	86.7	88.3	90.5	91.1	91.1
–30	75.0	77.2	79.5	81.9	84.2	85.9	87.5	89.7	90.3	90.3
–35	74.3	76.5	78.8	81.1	83.4	85.1	86.6	88.9	89.5	89.5
–40	73.6	75.7	78.0	80.3	82.6	84.3	85.8	88.0	88.6	88.7

%N1 Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	43
ENGINE ON	0.0	0.0	0.0	–0.4	–0.6	–0.7	–0.8	–1.0	–1.5	–1.9
ENGINE & WING ON	0.0	0.0	0.0	–0.6	–0.8	–1.0	–1.3	–1.7	–2.3	–3.1

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	43
ENGINE ON	–0.4	–0.4	–0.4	–0.5	–0.6	–0.7	–0.8	–1.0	–1.5	–2.0
ENGINE & WING ON	–0.6	–0.5	–0.6	–0.6	–0.8	–1.0	–1.3	–1.7	–2.5	–3.4

ALTERNATE MODE EEC

Max Cruise %N1

Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)									
	25	27	29	31	33	35	37	39	41	43
	310	310	310	310	.85	.85	.85	.85	.85	.85
25	85.3	85.3	85.4	84.9	84.2	83.7	84.0	84.1	84.0	83.9
20	86.6	86.6	86.9	86.6	86.0	84.6	83.7	83.7	83.6	83.5
15	87.7	87.7	87.8	87.5	87.3	86.3	85.5	85.5	85.4	85.3
10	88.6	88.5	88.5	88.2	88.0	87.5	87.0	87.0	86.9	86.7
5	88.7	89.2	89.3	88.9	88.6	88.2	87.8	87.8	87.7	87.6
0	88.3	88.9	89.3	89.3	89.5	88.8	88.5	88.5	88.4	88.3
–5	87.5	88.2	88.7	89.0	89.5	89.6	89.2	89.3	89.2	89.2
–10	86.8	87.4	88.0	88.2	88.9	89.6	89.6	89.7	89.7	89.7
–15	86.0	86.6	87.2	87.4	88.1	89.0	89.4	89.4	89.4	89.4
–20	85.2	85.9	86.4	86.6	87.3	88.2	88.6	88.6	88.6	88.6
–25	84.5	85.1	85.6	85.8	86.5	87.4	87.8	87.8	87.8	87.8
–30	83.7	84.3	84.8	85.0	85.7	86.5	87.0	87.0	87.0	87.0
–35	82.9	83.5	84.0	84.2	84.9	85.7	86.2	86.2	86.2	86.2

%N1 Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	25	27	29	31	33	35	37	39	41	43
ENGINE ON	–0.6	–0.6	–0.7	–0.7	–0.8	–0.9	–1.0	–1.1	–1.4	–1.7
ENGINE & WING ON	–0.9	–1.0	–1.1	–1.2	–1.3	–1.4	–1.6	–1.8	–2.3	–2.8

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	25	27	29	31	33	35	37	39	41	43
ENGINE ON	–0.6	–0.7	–0.7	–0.8	–0.9	–1.0	–1.2	–1.3	–1.6	–2.0
ENGINE & WING ON	–1.0	–1.1	–1.2	–1.3	–1.4	–1.7	–1.9	–2.2	–2.7	–3.3

ALTERNATE MODE EEC

Go-Around %N1

Based on anti-ice off

AIRPORT OAT (deg. C)	TAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
		–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
56	60	81.9	82.8	83.5	83.2	82.9	82.6	82.3	81.9	81.6	80.5	79.7	79.0	78.1	77.2	76.1	75.5	74.7
51	55	82.8	83.8	84.6	84.5	84.4	84.2	84.0	83.7	83.4	82.3	81.7	81.1	80.3	79.4	78.5	78.0	77.4
46	50	83.8	84.7	85.5	85.5	85.4	85.4	85.4	85.2	85.0	84.0	83.4	82.9	82.2	81.4	80.6	80.2	79.6
41	45	84.8	85.7	86.5	86.4	86.4	86.4	86.4	86.4	86.3	85.6	85.0	84.6	83.9	83.2	82.5	82.1	81.6
36	40	85.4	86.5	87.5	87.4	87.3	87.3	87.3	87.3	87.3	86.7	86.3	86.0	85.4	84.8	84.1	83.8	83.4
31	35	85.3	86.8	87.9	88.0	88.1	88.1	88.1	88.1	88.1	87.6	87.4	87.2	86.6	86.1	85.6	85.3	85.0
26	30	84.7	86.1	87.5	88.0	88.5	88.7	88.8	88.9	88.9	88.5	88.3	88.1	87.5	87.1	86.6	86.5	86.4
21	25	84.0	85.5	86.8	87.3	87.9	88.5	89.1	89.4	89.6	89.3	89.1	89.0	88.4	87.9	87.5	87.3	87.2
16	20	83.4	84.9	86.2	86.7	87.2	87.8	88.4	89.0	89.6	90.1	90.0	89.9	89.3	88.9	88.4	88.2	88.0
11	15	82.8	84.2	85.5	86.0	86.6	87.1	87.7	88.3	88.9	89.5	90.0	90.4	90.3	90.0	89.5	89.2	88.9
7	10	82.2	83.6	84.9	85.4	85.9	86.5	87.0	87.6	88.2	88.8	89.3	89.7	90.7	90.8	90.7	90.2	89.9
2	5	81.5	82.9	84.2	84.7	85.2	85.8	86.4	86.9	87.5	88.1	88.6	89.0	90.2	90.8	91.3	91.0	90.6
–3	0	80.9	82.2	83.5	84.0	84.5	85.1	85.7	86.2	86.8	87.4	87.9	88.3	89.5	90.1	90.7	90.9	91.1
–13	–10	79.5	80.9	82.1	82.6	83.1	83.7	84.2	84.8	85.4	85.9	86.4	86.9	88.0	88.6	89.3	89.5	89.7
–23	–20	78.2	79.4	80.7	81.2	81.7	82.2	82.8	83.4	83.9	84.5	84.9	85.4	86.5	87.1	87.8	88.0	88.2
–33	–30	76.8	78.0	79.2	79.7	80.2	80.7	81.3	81.9	82.4	82.9	83.4	83.9	85.0	85.6	86.2	86.4	86.6
–43	–40	75.3	76.5	77.7	78.2	78.7	79.2	79.8	80.3	80.9	81.4	81.8	82.3	83.4	84.0	84.6	84.8	85.0
–53	–50	73.8	75.0	76.2	76.6	77.1	77.7	78.2	78.7	79.3	79.8	80.2	80.7	81.8	82.4	83.0	83.2	83.4

%N1 Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)							
	–2	0	9	10	11	12	13	14
ENGINE ON	0.0	0.0	0.0	–0.4	–0.5	–0.5	–0.5	–0.5
ENGINE & WING ON	0.0	0.0	0.0	–0.6	–0.6	–0.7	–0.7	–0.6
ENGINE AUTO	0.0	0.0	0.0	–0.4	–0.5	–0.5	–0.5	–0.5
ENGINE & WING AUTO	0.0	0.0	0.0	–0.6	–0.6	–0.7	–0.7	–0.6

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ENGINE ON	–0.7	–0.6	–0.6	–0.6	–0.7	–0.7	–0.7	–0.7	–0.7	–0.8	–0.8	–0.8	–0.8	–0.9	–0.9	–0.9	–0.9
ENGINE & WING ON	–0.9	–0.8	–0.7	–0.8	–0.8	–0.8	–0.8	–0.9	–0.9	–0.9	–0.9	–1.0	–1.0	–1.0	–1.1	–1.1	–1.1
With engine anti-ice auto or wing anti-ice auto, no adjustment is necessary.																	

ALTERNATE MODE EEC
ENGINE INOP

Initial Max Continuous %N1
Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)								
	27	29	31	33	35	37	39	41	43
	310	310	310	.85	.85	.85	.85	.85	.85
20	89.0	89.1	89.0	88.6	87.8	87.1	87.0	86.7	86.5
15	90.3	90.5	90.2	89.8	89.3	88.6	88.3	88.1	87.8
10	91.5	91.8	91.6	91.2	90.7	90.0	89.5	89.3	89.0
5	92.2	92.7	92.6	92.5	91.8	91.3	90.9	90.6	90.4
0	93.0	93.5	93.5	93.5	93.1	92.6	92.3	92.0	91.8
–5	92.3	93.4	93.8	93.9	94.2	93.9	93.6	93.4	93.1
–10	91.5	92.6	93.0	93.5	94.4	94.5	94.3	94.2	94.1
–15	90.7	91.8	92.2	92.7	93.8	94.4	94.1	94.3	94.6
–20	89.9	91.1	91.5	91.9	93.0	93.6	93.3	93.5	93.8
–25	89.1	90.3	90.7	91.1	92.2	92.8	92.5	92.7	93.0
–30	88.3	89.5	89.8	90.3	91.4	92.0	91.7	91.9	92.1
–35	87.5	88.6	89.0	89.5	90.6	91.2	90.9	91.1	91.3
–40	86.7	87.8	88.2	88.6	89.7	90.3	90.0	90.2	90.5

%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	27	29	31	33	35	37	39	41	43
ENGINE ON	–0.7	–0.8	–0.9	–1.0	–1.0	–1.2	–1.3	–1.6	–1.9
ENGINE & WING ON	–1.2	–1.3	–1.4	–1.6	–1.7	–1.9	–2.1	–2.6	–3.1

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	27	29	31	33	35	37	39	41	43
ENGINE ON	–0.7	–0.8	–0.8	–0.9	–1.0	–1.2	–1.3	–1.7	–2.0
ENGINE & WING ON	–1.1	–1.2	–1.4	–1.5	–1.7	–2.0	–2.2	–2.8	–3.4

ALTERNATE MODE EEC
ENGINE INOP

Max Continuous %N1
Based on anti-ice off or auto
320 KIAS

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)																
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
30	85.0	87.5	88.6	88.5	88.2	87.8	87.8	87.4	87.0	86.9	86.8	86.8	86.7	85.2	84.2	84.0
25	84.4	88.3	89.4	89.4	89.3	89.1	89.2	88.9	88.4	88.2	88.1	88.1	88.0	86.9	85.9	85.7
20	83.8	88.0	89.9	90.2	90.1	90.0	90.3	90.1	89.7	89.5	89.5	89.4	89.2	88.4	87.6	87.3
15	83.1	87.3	89.2	90.1	90.9	90.9	91.1	91.0	90.8	90.8	90.8	90.7	90.4	89.4	88.6	88.3
10	82.5	86.6	88.5	89.4	90.1	90.9	92.0	91.8	91.6	91.7	91.8	91.9	91.7	90.3	89.5	89.1
5	81.8	85.9	87.8	88.6	89.4	90.2	91.2	91.7	92.2	92.4	92.6	92.6	92.6	91.2	90.3	89.9
0	81.2	85.2	87.1	87.9	88.7	89.5	90.5	91.0	91.5	91.9	92.8	93.3	93.2	91.6	91.0	90.5
–5	80.5	84.5	86.4	87.2	88.0	88.7	89.7	90.2	90.8	91.2	92.0	92.6	92.9	91.5	91.1	90.5
–10	79.8	83.8	85.7	86.5	87.2	88.0	89.0	89.5	90.0	90.4	91.3	91.8	92.1	90.7	90.4	89.7
–15	79.1	83.0	84.9	85.7	86.5	87.2	88.2	88.7	89.2	89.6	90.5	91.0	91.4	90.0	89.6	88.9
–20	78.4	82.3	84.2	85.0	85.7	86.4	87.4	87.9	88.5	88.9	89.7	90.3	90.6	89.2	88.8	88.1
–25	77.7	81.6	83.4	84.2	84.9	85.7	86.6	87.1	87.7	88.1	88.9	89.5	89.8	88.4	88.0	87.3
–30	77.0	80.8	82.7	83.4	84.2	84.9	85.8	86.4	86.9	87.3	88.1	88.6	89.0	87.6	87.2	86.5
–35	76.3	80.0	81.9	82.6	83.4	84.1	85.0	85.6	86.1	86.5	87.3	87.8	88.2	86.7	86.4	85.7
–40	75.5	79.3	81.1	81.8	82.6	83.3	84.2	84.8	85.3	85.6	86.5	87.0	87.3	85.9	85.6	84.9

%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)																
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	0.0	0.0	–0.2	–0.4	–0.5	–0.5	–0.6	–0.6	–0.6	–0.7	–0.7	–0.8	–0.9	–1.0	–1.1	–1.2
ENGINE & WING ON	0.0	0.0	–0.3	–0.6	–0.7	–0.8	–0.8	–0.9	–1.0	–1.0	–1.1	–1.3	–1.4	–1.6	–1.7	–1.9

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)																
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	–0.4	–0.4	–0.4	–0.4	–0.5	–0.5	–0.5	–0.6	–0.6	–0.7	–0.7	–0.8	–0.9	–1.0	–1.0	–1.2
ENGINE & WING ON	–0.6	–0.6	–0.6	–0.6	–0.7	–0.8	–0.8	–0.9	–1.0	–1.0	–1.1	–1.3	–1.4	–1.6	–1.8	–2.0

280 KIAS

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)																
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
30	85.3	86.0	86.8	86.8	86.6	86.3	87.0	85.7	85.3	85.1	85.5	85.9	86.7	87.7	88.0	88.0
25	85.4	86.9	87.9	88.2	88.0	87.7	88.3	87.1	86.8	86.6	86.3	85.8	86.0	87.0	87.3	87.3
20	84.7	87.8	88.8	89.1	89.2	89.0	89.6	88.4	88.0	87.9	87.7	87.3	87.2	87.3	86.8	87.1
15	84.1	87.3	89.2	89.9	90.1	90.0	90.9	89.7	89.3	89.2	89.0	88.7	88.6	88.7	88.4	88.5
10	83.4	86.6	88.5	89.7	90.8	90.9	91.8	90.8	90.6	90.5	90.2	89.9	89.9	90.1	89.9	89.9
5	82.8	85.9	87.8	89.0	90.1	91.0	92.5	91.6	91.5	91.5	91.3	91.1	91.1	91.3	91.1	91.1
0	82.1	85.2	87.1	88.3	89.4	90.3	91.9	91.8	92.3	92.3	92.3	92.0	92.2	92.6	92.3	92.4
–5	81.4	84.5	86.4	87.6	88.7	89.6	91.1	91.1	91.8	92.2	92.9	92.8	93.2	93.7	93.5	93.6
–10	80.7	83.8	85.7	86.9	87.9	88.8	90.4	90.3	91.0	91.5	92.2	92.7	93.6	94.1	94.2	94.2
–15	80.0	83.1	84.9	86.1	87.2	88.0	89.6	89.5	90.3	90.7	91.4	91.9	92.8	93.6	94.1	94.0
–20	79.3	82.3	84.2	85.4	86.4	87.3	88.9	88.8	89.5	89.9	90.7	91.1	92.0	92.8	93.3	93.2
–25	78.6	81.6	83.4	84.6	85.6	86.5	88.1	88.0	88.7	89.1	89.9	90.3	91.2	92.0	92.5	92.4
–30	77.9	80.8	82.7	83.8	84.8	85.7	87.3	87.2	87.9	88.3	89.1	89.5	90.4	91.2	91.7	91.6
–35	77.2	80.1	81.9	83.0	84.1	84.9	86.5	86.4	87.1	87.5	88.3	88.7	89.6	90.4	90.9	90.8
–40	76.4	79.3	81.1	82.2	83.2	84.1	85.7	85.6	86.3	86.7	87.5	87.9	88.7	89.6	90.0	89.9

ALTERNATE MODE EEC
ENGINE INOP

Max Continuous %N1
Based on anti-ice off or auto
280 KIAS
%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)																
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	0.0	0.0	−0.2	−0.4	−0.5	−0.5	−0.6	−0.6	−0.6	−0.7	−0.7	−0.8	−0.9	−1.0	−1.1	−1.2
ENGINE & WING ON	0.0	0.0	−0.3	−0.6	−0.7	−0.8	−0.8	−0.9	−1.0	−1.0	−1.1	−1.3	−1.4	−1.6	−1.7	−1.9

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	−0.4	−0.4	−0.4	−0.4	−0.5	−0.5	−0.5	−0.6	−0.6	−0.7	−0.7	−0.8	−0.9	−1.0	−1.0	−1.2
ENGINE & WING ON	−0.6	−0.6	−0.6	−0.6	−0.7	−0.8	−0.8	−0.9	−1.0	−1.0	−1.1	−1.3	−1.4	−1.6	−1.8	−2.0

240 KIAS

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
30	85.1	85.3	85.6	85.0	84.6	84.0	84.8	83.9	84.6	84.9	85.6	86.1	86.6	87.4	88.1	88.0
25	85.9	86.5	87.0	86.5	86.0	85.4	86.3	84.8	84.2	84.2	84.9	85.4	85.9	86.6	87.3	87.2
20	85.5	87.4	88.1	87.8	87.4	86.8	87.6	86.2	85.7	85.4	84.9	84.7	85.2	85.9	86.6	86.5
15	84.9	88.1	89.0	88.7	88.5	88.2	88.9	87.5	87.0	86.8	86.4	85.9	85.3	85.2	85.9	85.8
10	84.2	87.4	89.1	89.4	89.4	89.3	90.3	88.9	88.3	88.1	87.7	87.4	86.9	86.5	86.1	86.0
5	83.5	86.7	88.4	89.0	89.9	90.2	91.2	90.1	89.7	89.5	89.0	88.6	88.3	87.9	87.6	87.5
0	82.9	86.0	87.7	88.3	89.2	90.2	91.6	90.8	90.7	90.6	90.4	89.9	89.4	89.2	89.1	88.9
−5	82.2	85.3	87.0	87.5	88.5	89.4	91.0	91.0	91.5	91.5	91.5	91.0	90.6	90.4	90.2	90.1
−10	81.5	84.6	86.3	86.8	87.7	88.7	90.2	90.3	91.1	91.5	92.1	91.8	91.7	91.7	91.7	91.6
−15	80.8	83.8	85.5	86.1	87.0	87.9	89.5	89.5	90.4	90.8	91.5	92.0	92.2	92.6	92.8	92.8
−20	80.1	83.1	84.8	85.3	86.2	87.2	88.7	88.8	89.6	90.0	90.7	91.2	91.7	92.5	93.2	93.2
−25	79.4	82.3	84.0	84.6	85.4	86.4	88.0	88.0	88.8	89.2	90.0	90.4	90.9	91.7	92.6	92.7
−30	78.6	81.6	83.3	83.8	84.7	85.6	87.2	87.2	88.0	88.4	89.2	89.7	90.1	90.9	91.8	91.9
−35	77.9	80.8	82.5	83.0	83.9	84.8	86.4	86.4	87.2	87.7	88.4	88.8	89.3	90.1	91.0	91.1
−40	77.1	80.0	81.7	82.2	83.1	84.0	85.6	85.6	86.4	86.9	87.6	88.0	88.5	89.3	90.2	90.2

%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	0.0	0.0	−0.2	−0.4	−0.5	−0.5	−0.6	−0.6	−0.6	−0.7	−0.7	−0.8	−0.9	−1.0	−1.1	−1.2
ENGINE & WING ON	0.0	0.0	−0.3	−0.6	−0.7	−0.8	−0.8	−0.9	−1.0	−1.0	−1.1	−1.3	−1.4	−1.6	−1.7	−1.9

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	−0.4	−0.4	−0.4	−0.4	−0.5	−0.5	−0.5	−0.6	−0.6	−0.7	−0.7	−0.8	−0.9	−1.0	−1.0	−1.2
ENGINE & WING ON	−0.6	−0.6	−0.6	−0.6	−0.7	−0.8	−0.8	−0.9	−1.0	−1.0	−1.1	−1.3	−1.4	−1.6	−1.8	−2.0

ALTERNATE MODE EEC
ENGINE INOP

Max Continuous %N1
Based on anti-ice off or auto
200 KIAS

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
30	84.9	84.7	85.0	83.8	82.7	81.9	83.6	84.1	84.4	84.6	85.2	85.9	86.3	86.4	86.8	87.4
25	85.8	86.1	86.4	85.2	84.2	83.4	83.6	83.4	83.7	83.9	84.5	85.2	85.6	85.7	86.1	86.7
20	86.1	87.2	87.8	86.6	85.6	84.8	85.1	84.2	83.2	83.2	83.8	84.5	84.8	84.9	85.4	86.0
15	85.4	88.0	88.7	87.9	87.0	86.3	86.4	85.6	84.7	84.3	83.4	83.7	84.1	84.2	84.6	85.2
10	84.8	88.1	89.7	88.8	88.2	87.6	87.8	86.9	86.1	85.8	85.0	84.4	83.4	83.5	83.9	84.5
5	84.1	87.4	89.3	89.1	88.9	88.7	89.2	88.4	87.5	87.1	86.5	85.9	85.1	83.8	83.1	83.8
0	83.4	86.7	88.6	88.4	88.9	89.6	90.1	89.6	88.9	88.5	87.8	87.3	86.6	85.5	84.6	84.9
–5	82.7	86.0	87.9	87.7	88.2	89.3	90.5	90.3	90.0	89.6	89.1	88.6	87.9	86.9	86.2	86.4
–10	82.0	85.3	87.1	87.0	87.4	88.5	89.7	90.2	90.6	90.5	90.3	89.9	89.2	88.2	87.6	87.8
–15	81.3	84.6	86.4	86.2	86.7	87.8	89.0	89.4	90.1	90.5	91.0	90.9	90.4	89.6	88.9	89.2
–20	80.6	83.8	85.6	85.5	85.9	87.0	88.2	88.7	89.4	89.7	90.5	91.2	91.1	90.7	90.3	90.6
–25	79.9	83.1	84.9	84.7	85.2	86.3	87.5	87.9	88.6	89.0	89.7	90.4	90.8	90.9	91.0	91.6
–30	79.1	82.3	84.1	83.9	84.4	85.5	86.7	87.1	87.8	88.2	88.9	89.6	90.0	90.1	90.7	91.5
–35	78.4	81.5	83.3	83.2	83.6	84.7	85.9	86.3	87.0	87.4	88.1	88.8	89.2	89.3	89.9	90.7
–40	77.6	80.8	82.5	82.4	82.8	83.9	85.1	85.5	86.2	86.6	87.3	88.0	88.4	88.5	89.1	89.9

%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	0.0	0.0	–0.2	–0.4	–0.5	–0.5	–0.6	–0.6	–0.6	–0.7	–0.7	–0.8	–0.9	–1.0	–1.1	–1.2
ENGINE & WING ON	0.0	0.0	–0.3	–0.6	–0.7	–0.8	–0.8	–0.9	–1.0	–1.0	–1.1	–1.3	–1.4	–1.6	–1.7	–1.9

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	–0.4	–0.4	–0.4	–0.4	–0.5	–0.5	–0.5	–0.6	–0.6	–0.7	–0.7	–0.8	–0.9	–1.0	–1.0	–1.2
ENGINE & WING ON	–0.6	–0.6	–0.6	–0.6	–0.7	–0.8	–0.8	–0.9	–1.0	–1.0	–1.1	–1.3	–1.4	–1.6	–1.8	–2.0

GEAR DOWN

220 KIAS Max Climb TPR

Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)														
	0	5	10	12	14	16	18	20	22	24	26	28	30	32	34
55	50.1	50.2	53.9	54.0	51.4	48.6	59.2	61.4	63.3	63.9	64.5	65.4	66.3	66.4	66.6
50	53.2	52.5	53.9	55.1	55.2	52.4	59.2	61.4	63.3	63.9	64.5	65.4	66.3	66.4	66.6
45	56.8	55.7	53.9	55.1	57.2	56.2	59.2	61.4	63.3	63.9	64.5	65.4	66.3	66.4	66.6
40	60.3	59.5	57.6	56.4	57.2	58.6	59.2	61.4	63.3	63.9	64.5	65.4	66.3	66.4	66.6
35	63.6	63.5	61.3	60.2	60.0	58.7	59.2	61.4	63.3	63.9	64.5	65.4	66.3	66.4	66.6
30	66.1	67.3	65.7	64.3	64.0	63.0	60.9	61.4	63.3	63.9	64.5	65.4	66.3	66.4	66.6
25	66.3	70.7	70.1	68.9	68.5	67.2	65.3	64.8	64.0	63.9	64.5	65.4	66.3	66.4	66.6
20	66.5	72.3	74.2	73.4	73.3	72.1	69.8	69.4	68.7	66.8	64.5	65.4	66.3	66.4	66.6
15	66.6	72.5	77.7	77.4	77.9	77.0	74.8	74.3	73.4	71.9	69.9	67.9	66.3	66.4	66.6
10	66.8	72.7	78.5	79.9	81.4	81.6	79.8	79.5	78.7	77.0	75.4	73.7	71.9	68.7	66.6
5	67.0	72.9	78.7	80.1	83.0	84.4	84.1	84.5	84.0	82.0	80.3	79.3	78.2	75.0	72.0
0	67.2	73.1	78.9	80.3	83.2	85.1	86.0	87.9	88.9	87.0	85.2	84.0	83.2	80.9	78.2
–5	67.3	73.2	79.1	80.5	83.4	85.3	86.2	89.1	91.4	91.1	90.1	88.8	87.7	85.5	83.3
–10	67.5	73.4	79.3	80.8	83.6	85.5	86.4	89.3	91.9	92.6	92.7	93.3	92.4	90.0	87.9
–15	67.7	73.6	79.5	81.0	83.8	85.7	86.6	89.5	92.1	92.8	93.5	95.3	95.9	94.9	92.7
–20	67.8	73.8	79.7	81.2	84.0	85.9	86.9	89.7	92.3	93.0	93.7	95.5	97.4	97.2	96.3

TPR Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)														
	0	5	10	12	14	16	18	20	22	24	26	28	30	32	34
ENGINE ON	0.0	0.0	0.0	–0.5	–1.1	–1.2	–1.3	–1.4	–1.5	–1.6	–1.8	–1.9	–2.1	–2.3	–2.5
ENGINE & WING ON	0.0	0.0	0.0	–0.8	–1.6	–1.7	–1.8	–2.0	–2.2	–2.5	–2.8	–3.0	–3.3	–3.7	–4.1

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)														
	0	5	10	12	14	16	18	20	22	24	26	28	30	32	34
ENGINE ON	–0.8	–0.8	–1.0	–1.0	–1.1	–1.2	–1.3	–1.4	–1.5	–1.6	–1.8	–1.9	–2.0	–2.2	–2.4
ENGINE & WING ON	–1.1	–1.2	–1.4	–1.5	–1.6	–1.7	–1.9	–2.1	–2.3	–2.5	–2.8	–3.0	–3.3	–3.6	–4.0

GEAR DOWN

Long Range Cruise Altitude Capability
Max Climb Thrust, 300 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
250	16700	15700	12200
240	17800	17000	15100
230	19300	18300	16300
220	20700	19900	17500
210	22100	21300	19000
200	23300	22700	20700
190	24500	24000	22400
180	25800	25300	23700
170	27000	26600	25100
160	28400	27800	26300
150	29900	29200	27800
140	31100	30600	29300
130	32400	31900	30800
120	33700	33300	32100
110	34900	34400	33200
100	36100	35600	34200

GEAR DOWN

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)											
		10	15	17	19	21	23	25	27	29	31	33	35
260	TPR	61.7	73.4	79.4									
	MACH	.478	.520	.538									
	KIAS	265	262	261									
	FF/ENG	5076	5090	5162									
240	TPR	57.8	68.4	73.8	80.2								
	MACH	.463	.503	.522	.543								
	KIAS	256	253	253	253								
	FF/ENG	4656	4614	4669	4775								
220	TPR	53.8	63.8	68.7	74.5	80.9							
	MACH	.446	.488	.507	.528	.550							
	KIAS	247	245	246	246	246							
	FF/ENG	4234	4217	4245	4325	4423							
200	TPR	49.7	59.4	63.8	69.1	75.0	81.2						
	MACH	.429	.473	.492	.513	.534	.556						
	KIAS	237	238	238	239	239	239						
	FF/ENG	3810	3838	3858	3911	3993	4068						
180	TPR	45.9	55.0	59.1	63.6	69.0	74.6	80.5	88.2				
	MACH	.413	.456	.475	.494	.515	.537	.559	.582				
	KIAS	228	229	229	230	230	231	231	231				
	FF/ENG	3436	3461	3484	3511	3573	3637	3678	3765				
160	TPR	42.6	50.7	54.7	58.9	63.6	68.9	74.2	80.5	88.2			
	MACH	.400	.441	.460	.479	.499	.520	.541	.564	.588			
	KIAS	221	222	222	222	223	223	223	223	223			
	FF/ENG	3116	3112	3158	3182	3219	3275	3309	3352	3423			
140	TPR	39.0	46.4	49.9	53.8	58.1	62.7	67.7	73.2	79.4	86.9		
	MACH	.383	.423	.440	.458	.478	.498	.519	.540	.563	.587		
	KIAS	211	212	212	213	213	213	213	213	213	213		
	FF/ENG	2777	2762	2804	2852	2858	2893	2928	2958	2987	3041		
120	TPR	35.6	42.3	45.4	48.9	52.6	56.7	61.2	66.2	71.6	77.7	84.9	94.0
	MACH	.367	.404	.421	.438	.456	.475	.495	.516	.538	.561	.585	.611
	KIAS	202	203	203	203	203	203	203	203	203	203	203	203
	FF/ENG	2477	2441	2470	2516	2539	2542	2565	2587	2609	2632	2670	2750
100	TPR	33.3	39.4	42.4	45.6	49.0	52.8	57.0	61.6	66.6	72.1	78.4	85.9
	MACH	.359	.396	.412	.428	.446	.465	.484	.504	.526	.549	.573	.599
	KIAS	198	198	198	198	198	199	199	199	199	199	199	199
	FF/ENG	2282	2244	2261	2302	2324	2333	2345	2364	2381	2402	2424	2460

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
321	288	259	236	217	200	189	179	170	161	154
646	578	520	473	434	400	378	358	340	324	310
972	869	781	710	651	600	568	538	511	487	465
1299	1161	1042	947	869	800	757	717	681	649	620
1629	1455	1305	1185	1086	1000	946	896	851	811	775
1961	1750	1569	1423	1304	1200	1135	1075	1021	973	930
2295	2047	1833	1662	1522	1400	1324	1254	1191	1134	1084
2632	2344	2098	1901	1741	1600	1513	1433	1361	1296	1238
2970	2644	2364	2141	1959	1800	1702	1612	1530	1457	1392
3310	2945	2631	2382	2178	2000	1890	1790	1699	1618	1546
3653	3247	2899	2622	2397	2200	2079	1968	1868	1778	1699
3999	3551	3167	2863	2616	2400	2268	2147	2037	1939	1852
4346	3856	3436	3105	2835	2600	2456	2325	2206	2099	2005
4696	4162	3706	3347	3054	2800	2645	2502	2374	2259	2157
5046	4470	3977	3589	3274	3000	2833	2680	2542	2418	2309
5398	4778	4249	3832	3494	3200	3021	2857	2710	2577	2461
5750	5087	4520	4075	3714	3400	3209	3035	2877	2736	2612
6103	5396	4792	4317	3933	3600	3397	3213	3045	2896	2764
6458	5706	5064	4560	4153	3800	3586	3390	3213	3055	2915
6814	6016	5336	4804	4373	4000	3774	3567	3380	3213	3066

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		20		24		28	
	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	4.9	0:48	4.5	0:46	3.9	0:43	3.7	0:41	3.5	0:39
400	9.9	1:35	9.2	1:29	8.49	1:22	8.0	1:18	7.7	1:14
600	15.0	2:21	14.0	2:13	12.8	2:01	12.3	1:54	11.8	1:48
800	19.9	3:08	18.6	2:57	17.1	2:41	16.5	2:32	15.9	2:23
1000	24.7	3:55	23.2	3:41	21.4	3:21	20.6	3:09	19.9	2:58
1200	29.5	4:43	27.6	4:26	25.6	4:01	24.7	3:47	23.8	3:33
1400	34.2	5:31	32.1	5:10	29.8	4:42	28.8	4:24	27.7	4:09
1600	38.8	6:20	36.4	5:56	33.9	5:23	32.7	5:03	31.5	4:44
1800	43.3	7:08	40.7	6:42	38.0	6:04	36.6	5:41	35.3	5:20
2000	47.8	7:58	44.9	7:28	41.9	6:46	40.4	6:20	38.9	5:57
2200	52.2	8:48	49.0	8:15	45.9	7:28	44.2	6:59	42.6	6:33
2400	56.5	9:39	53.1	9:02	49.7	8:10	47.9	7:39	46.1	7:10
2600	60.8	10:30	57.1	9:49	53.6	8:53	51.6	8:19	49.7	7:47
2800	64.9	11:21	61.0	10:37	57.3	9:36	55.2	8:59	53.1	8:25
3000	69.1	12:13	64.9	11:26	61.1	10:20	58.7	9:40	56.6	9:03
3200	73.2	13:05	68.8	12:14	64.7	11:04	62.2	10:21	59.9	9:41
3400	77.2	13:57	72.6	13:03	68.4	11:48	65.7	11:02	63.3	10:19
3600	81.2	14:49	76.3	13:52	71.9	12:32	69.1	11:43	66.5	10:58
3800	85.2	15:42	80.0	14:41	75.5	13:17	72.5	12:25	69.8	11:36
4000	89.1	16:34	83.7	15:30	79.0	14:01	75.8	13:06	73.0	12:15

GEAR DOWN

Long Range Cruise Enroute Fuel and Time

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)								
	100	120	140	160	180	200	220	240	260
10	–2.2	–1.8	–1.2	–0.6	0.0	1.0	2.2	3.7	5.3
20	–4.5	–3.6	–2.5	–1.3	0.0	1.9	4.3	7.0	10.2
30	–6.6	–5.3	–3.7	–1.9	0.0	2.8	6.1	10.0	14.5
40	–8.7	–6.9	–4.9	–2.5	0.0	3.6	7.8	12.8	18.4
50	–10.6	–8.4	–5.9	–3.1	0.0	4.3	9.4	15.2	21.8
60	–12.3	–9.8	–6.9	–3.6	0.0	5.0	10.7	17.3	24.7
70	–13.9	–11.2	–7.9	–4.1	0.0	5.6	11.9	19.0	27.1
80	–15.5	–12.4	–8.7	–4.6	0.0	6.1	12.9	20.5	29.0
90	–16.8	–13.5	–9.5	–5.0	0.0	6.6	13.8	21.7	30.5
100	–18.1	–14.5	–10.2	–5.4	0.0	7.0	14.4	22.5	31.4

Based on Long Range Cruise speed and 220 KIAS descent.

GEAR DOWN

Descent at 220 KIAS

PRESSURE ALTITUDE (1000 FT)	17	19	21	23	25	27	29	31	33	35
DISTANCE (NM)	38	43	47	51	56	60	65	69	73	78
TIME (MINUTES)	11	12	13	14	15	16	16	17	18	19

GEAR DOWN

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)						
		1500	5000	10000	15000	20000	25000	30000
260	TPR	44.9	50.6	60.9	73.1			
	KIAS	258	259	260	261			
	FF/ENG	4970	5050	5220	5300			
240	TPR	42.3	47.6	57.3	68.3	83.7		
	KIAS	251	251	252	253	253		
	FF/ENG	4600	4660	4810	4840	5070		
220	TPR	39.7	44.6	53.5	63.8	77.7		
	KIAS	243	244	245	245	246		
	FF/ENG	4240	4280	4400	4430	4590		
200	TPR	37.1	41.6	49.6	59.4	72.0		
	KIAS	235	236	237	238	239		
	FF/ENG	3890	3910	3990	4030	4150		
180	TPR	34.5	38.7	45.9	55.0	66.2	80.5	
	KIAS	227	227	228	229	230	231	
	FF/ENG	3550	3550	3610	3630	3710	3860	
160	TPR	32.2	36.0	42.6	50.7	61.2	74.2	
	KIAS	220	220	221	222	223	223	
	FF/ENG	3250	3250	3270	3270	3360	3470	
140	TPR	29.7	33.0	39.0	46.4	55.9	67.7	82.9
	KIAS	211	211	211	212	213	213	213
	FF/ENG	2930	2910	2920	2900	3000	3070	3160
120	TPR	27.3	30.4	35.6	42.3	50.7	61.2	74.5
	KIAS	202	202	202	203	203	203	203
	FF/ENG	2640	2620	2600	2560	2660	2690	2750
100	TPR	25.6	28.4	33.3	39.4	47.3	57.0	69.3
	KIAS	198	198	198	198	198	199	199
	FF/ENG	2440	2420	2400	2360	2430	2460	2510
This table includes 5% additional fuel for holding in a racetrack pattern.								

GEAR DOWN

Holding
Flaps 1

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
260	TPR	45.4	50.9	60.3	72.3	
	KIAS	239	239	240	241	
	FF/ENG	4950	4970	5020	5060	
240	TPR	42.6	47.7	56.5	67.5	81.7
	KIAS	231	232	232	233	233
	FF/ENG	4560	4570	4610	4630	4750
220	TPR	39.8	44.5	52.7	62.9	76.4
	KIAS	223	224	225	226	228
	FF/ENG	4180	4180	4210	4220	4350
200	TPR	36.9	41.2	48.8	58.4	71.2
	KIAS	214	215	216	218	223
	FF/ENG	3800	3790	3820	3820	3980
180	TPR	33.9	37.7	44.5	53.2	64.3
	KIAS	203	204	204	206	208
	FF/ENG	3400	3380	3390	3360	3480
160	TPR	31.2	34.7	40.8	48.5	58.4
	KIAS	195	195	196	197	198
	FF/ENG	3070	3040	3030	2990	3070
140	TPR	28.5	31.6	37.0	43.9	52.8
	KIAS	186	186	186	187	188
	FF/ENG	2740	2700	2670	2640	2710
120	TPR	25.9	28.7	33.5	39.5	47.4
	KIAS	177	177	177	178	178
	FF/ENG	2450	2410	2360	2320	2350
100	TPR	24.1	26.6	30.9	36.4	43.5
	KIAS	173	173	173	173	173
	FF/ENG	2250	2200	2150	2110	2110

This table includes 5% additional fuel for holding in a racetrack pattern.

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude
100 ft/min residual rate of climb

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFTDOWN	LEVEL OFF		ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
200	190	235	2600		
190	181	231	4800	2400	
180	171	227	6900	4700	2100
170	162	224	9300	6600	4200
160	155	221	12000	9400	6500
150	145	217	13300	12200	9500
140	135	212	14700	13800	12400
130	125	208	16600	15400	13900
120	115	203	18400	18400	15500
110	105	201	19600	18400	16700
100	96	199	20700	20000	17900

Includes APU fuel burn.

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability
100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
190	2800		
180	5100	2600	
170	7200	5000	2200
160	10200	7100	4600
150	12600	10500	7100
140	14000	13000	10800
130	15600	14600	13100
120	17600	16300	14800
110	19100	17700	16100
100	20300	19300	17300

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)							
		5	7	9	11	13	15	17	19
180	TPR	68.8	74.2	80.5					
	MACH	.376	.390	.405					
	KIAS	227	228	228					
	FF/ENG	6616	6712	6837					
170	TPR	65.9	71.1	76.9	83.9				
	MACH	.370	.384	.399	.414				
	KIAS	224	224	224	225				
	FF/ENG	6280	6365	6459	6589				
160	TPR	63.3	68.2	73.7	79.9	87.2			
	MACH	.364	.378	.393	.408	.424			
	KIAS	220	220	221	221	221			
	FF/ENG	5969	6043	6122	6200	6317			
150	TPR	60.3	65.0	70.1	75.9	82.5			
	MACH	.356	.370	.384	.399	.415			
	KIAS	215	216	216	216	217			
	FF/ENG	5620	5686	5750	5807	5888			
140	TPR	57.4	61.8	66.6	72.0	78.1	85.3		
	MACH	.348	.362	.376	.391	.406	.423		
	KIAS	211	211	211	211	212	212		
	FF/ENG	5277	5335	5391	5432	5487	5585		
130	TPR	54.7	58.8	63.3	68.4	74.0	80.4	88.0	
	MACH	.341	.354	.368	.382	.398	.414	.430	
	KIAS	206	207	207	207	207	207	208	
	FF/ENG	4964	5011	5061	5090	5122	5188	5327	
120	TPR	52.1	55.9	60.2	64.9	70.2	76.0	82.8	91.1
	MACH	.335	.347	.360	.374	.389	.404	.421	.438
	KIAS	202	202	202	203	203	203	203	203
	FF/ENG	4674	4709	4751	4774	4787	4827	4924	5093
110	TPR	50.1	53.8	57.9	62.4	67.4	73.0	79.2	86.6
	MACH	.331	.343	.356	.370	.384	.399	.415	.432
	KIAS	200	200	200	200	200	200	200	200
	FF/ENG	4460	4490	4526	4548	4554	4582	4659	4784
100	TPR	48.4	52.0	55.9	60.2	65.0	70.4	76.3	83.1
	MACH	.328	.340	.353	.366	.381	.396	.412	.428
	KIAS	198	198	198	198	198	198	198	198
	FF/ENG	4277	4303	4335	4356	4361	4381	4451	4551

GEAR DOWN
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
333	296	264	239	218	200	187	175	165	156	148
672	595	530	478	436	400	374	351	330	311	295
1012	896	796	718	655	600	561	525	494	466	442
1354	1197	1063	958	874	800	747	700	657	620	588
1698	1500	1331	1199	1093	1000	934	874	821	774	734
2045	1805	1601	1441	1312	1200	1120	1048	984	928	880
2395	2112	1872	1683	1532	1400	1306	1222	1147	1081	1025
2748	2421	2143	1926	1751	1600	1492	1395	1309	1234	1170
3104	2732	2415	2169	1971	1800	1678	1569	1472	1387	1314
3462	3044	2689	2413	2192	2000	1865	1743	1634	1540	1458
3823	3358	2963	2657	2412	2200	2050	1916	1796	1692	1602
4186	3673	3238	2902	2633	2400	2236	2089	1958	1843	1745
4552	3991	3515	3147	2854	2600	2422	2261	2119	1995	1888
4919	4309	3792	3393	3075	2800	2607	2433	2280	2145	2031

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	6		8		10		12		14	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	5.3	0:51	5.1	0:50	5.0	0:48	4.9	0:47	4.9	0:46
400	10.7	1:40	10.4	1:37	10.2	1:35	10.1	1:32	10.2	1:29
600	16.0	2:30	15.6	2:25	15.3	2:21	15.1	2:17	15.2	2:13
800	21.2	3:19	20.7	3:13	20.3	3:08	20.1	3:02	20.2	2:57
1000	26.3	4:10	25.7	4:02	25.2	3:55	24.9	3:48	24.9	3:41
1200	31.3	5:01	30.6	4:52	30.0	4:43	29.6	4:34	29.6	4:26
1400	36.2	5:52	35.4	5:41	34.8	5:31	34.2	5:21	34.2	5:11
1600	41.0	6:44	40.2	6:32	39.4	6:20	38.8	6:08	38.6	5:57
1800	45.7	7:37	44.8	7:23	43.9	7:09	43.2	6:56	43.0	6:43
2000	50.3	8:30	49.4	8:14	48.4	7:59	47.6	7:44	47.2	7:30
2200	54.9	9:23	53.8	9:06	52.8	8:49	51.8	8:32	51.4	8:17
2400	59.4	10:17	58.2	9:58	57.1	9:40	56.1	9:21	55.5	9:04
2600	63.8	11:12	62.6	10:51	61.3	10:31	60.2	10:11	59.6	9:52
2800	68.1	12:07	66.8	11:44	65.5	11:22	64.2	11:01	63.5	10:40

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)								
	100	120	140	160	180	200	220	240	260
5	−1.1	−0.9	−0.6	−0.3	0.0	0.6	1.2	1.7	2.2
10	−2.4	−1.9	−1.3	−0.6	0.0	1.3	2.6	3.8	5.1
15	−3.6	−2.9	−2.0	−1.0	0.0	2.0	4.0	5.9	7.8
20	−4.8	−3.8	−2.7	−1.4	0.0	2.6	5.2	7.9	10.4
25	−5.9	−4.8	−3.3	−1.7	0.0	3.1	6.4	9.7	12.9
30	−7.0	−5.6	−4.0	−2.0	0.0	3.6	7.6	11.5	15.3
35	−8.1	−6.5	−4.6	−2.4	0.0	4.1	8.6	13.2	17.6
40	−9.1	−7.3	−5.2	−2.7	0.0	4.6	9.6	14.8	19.8
45	−10.1	−8.1	−5.8	−3.0	0.0	5.0	10.5	16.2	21.9
50	−11.1	−8.9	−6.3	−3.3	0.0	5.4	11.4	17.6	23.9
55	−12.1	−9.7	−6.9	−3.6	0.0	5.7	12.1	18.9	25.8
60	−13.0	−10.4	−7.4	−3.9	0.0	6.0	12.8	20.1	27.6
65	−13.9	−11.1	−7.9	−4.1	0.0	6.3	13.4	21.2	29.2
70	−14.7	−11.7	−8.3	−4.4	0.0	6.5	14.0	22.2	30.8
75	−15.5	−12.4	−8.8	−4.6	0.0	6.7	14.4	23.1	32.3

Includes APU fuel burn.

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
220	TPR	71.0				
	KIAS	243				
	FF/ENG	8330				
210	TPR	68.3				
	KIAS	239				
	FF/ENG	7940				
200	TPR	65.7	74.9			
	KIAS	235	236			
	FF/ENG	7560	7730			
190	TPR	63.0	71.8			
	KIAS	231	232			
	FF/ENG	7190	7330			
180	TPR	60.4	68.8	84.1		
	KIAS	227	227	228		
	FF/ENG	6820	6950	7260		
170	TPR	58.0	65.9	80.2		
	KIAS	223	224	224		
	FF/ENG	6480	6590	6840		
160	TPR	55.7	63.3	76.7		
	KIAS	220	220	221		
	FF/ENG	6170	6270	6470		
150	TPR	53.2	60.3	72.9		
	KIAS	215	215	216		
	FF/ENG	5820	5900	6070		
140	TPR	50.7	57.4	69.2	85.3	
	KIAS	211	211	211	212	
	FF/ENG	5490	5540	5680	5860	
130	TPR	48.4	54.7	65.8	80.4	
	KIAS	206	206	207	207	
	FF/ENG	5170	5210	5330	5450	
120	TPR	46.1	52.1	62.5	76.0	
	KIAS	202	202	202	203	
	FF/ENG	4880	4910	5010	5070	
110	TPR	44.4	50.1	60.1	73.0	91.1
	KIAS	200	200	200	200	200
	FF/ENG	4660	4680	4770	4810	5120
100	TPR	42.9	48.4	58.0	70.4	87.1
	KIAS	198	198	198	198	198
	FF/ENG	4470	4490	4570	4600	4850

This table includes 5% additional fuel for holding in a racetrack pattern.

Introduction

This chapter contains information to supplement performance data from the Flight Management System (FMS). In addition, sufficient inflight data is provided to complete a flight with the FMS inoperative. In the event of conflict between data presented in this chapter and that contained in the Approved Flight Manual, the Flight Manual shall always take precedence.

General

Minimum Takeoff Weight

Light weight takeoffs may be limited by minimum takeoff weight. For takeoff at 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 can be used for all performance conditions with the exception of assumed temperature reduced thrust. Takeoff speeds are not valid for assumed temperatures. They can also be used for non-standard conditions provided that appropriate adjustments are made to V1, for example when operating with brakes deactivated or operating on contaminated runways. These speeds may be used for weights less than or equal to the performance limited weight.

In certain high thrust/low gross weight or low thrust/high gross weight conditions, the FMC advisory message "MIN VSPEEDS UNAVAILABLE" will appear in the CDU help window.

Takeoff is not permitted in this condition as certified limits have been exceeded. Manually verify takeoff speed entries generated using Onboard Performance Tool (OPT) or another approved source of takeoff performance information. Upon verifying takeoff speeds, takeoff is permitted.

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 wind and slope from the Slope and Wind V1 Adjustments table (Table 3).
4. Determine the V1(MCG) from the V1(MCG) table (Table 4).
5. If V1 from Step 3 is less than V1(MCG), set V1=V1(MCG).
6. Using V1(MCG) from Step (4), determine Minimum VR (MIN VR) from the Minimum VR table (Table 5).

7. Using V1(MCG) from Step (4), determine Minimum V2 (MIN V2) from the Minimum V2 table (Table 6).
8. If VR from Step 2 is less than MIN VR, set VR=MIN VR.
9. If V2 from Step 2 is less than MIN V2, set V2=MIN V2.

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 minimum V2 (MIN V2). It is therefore necessary to compare the adjusted V1, VR, and V2 to V1(MCG) MIN VR and MIN V2 respectively. No takeoff weight adjustment is necessary provided that the field length available exceeds the minimum field length shown in the Field and Climb Limit Weight table in Chapter Performance Dispatch.

Stabilizer Trim Setting

To find takeoff stabilizer trim setting, enter the Stabilizer Trim Setting table with anticipated brake release weight and center of gravity (C.G. % MAC) and read required stabilizer trim units.

VREF Speeds

This table contains flaps 30, 25 and 20 reference speeds for a given weight.

Flap Maneuver Speeds

This table provides flap maneuver speeds for various flap settings. During flap retraction, selection of the next flap position is initiated when reaching the maneuver speed for the existing flap position. During flap retraction, at least adequate maneuver capability of 30° of bank (15° of bank and 15° overshoot) to sticker shaker is provided at the flap retraction speed. Full maneuvering capability of 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 the 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 varies with airplane weight and provides full maneuver capability of at least 40° of bank (25° of bank and 15° overshoot) to stick shaker at all weights.

Slush/Standing Water Takeoff

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water or ice. Therefore, reductions in runway/obstacle limited takeoff weight and revised takeoff speeds are necessary. The tables are intended for guidance in accordance with advisory material and assume an engine failure at the critical point during the takeoff.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore this information is conservative when

operating under typical colder weather conditions where patches of slush exist and some degree of sanding is common.

Takeoffs in slush depths greater than 0.5 inches (13 mm) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Takeoff weight is determined as follows:

1. Determine the 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 and pressure altitude to obtain the slush/standing water limit weight with respect to minimum field length required for V1(MCG) speed.
5. 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) considerations, enter the V1 Adjustment table (Table 3) with actual brake release weight to determine the V1 reduction to apply to V1 speed. If the adjusted V1 is less than V1(MCG), set V1=V1(MCG).

Dry Snow Runway Takeoff

In addition to slush/standing water, the data are provided for dry snow covered runways. Takeoff in dry snow depths greater than 4.0 inches (100 mm) is not recommended. The tables provided are used in the same manner as the Slush/ Standing Water Takeoff tables.

Wet Snow Runway Takeoff

In addition to slush/standing water and dry snow, data are provided for wet snow covered runways. 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 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.

Takeoff TPR

To find Max Takeoff TPR based on anti-ice off, enter the Max Takeoff TPR table with airport pressure altitude and airport OAT and read TPR. Adjust for anti-ice operation as noted below the table.

Regulations permit the use of up to 25% takeoff thrust reduction for operation with assumed temperature reduced thrust. Use of reduced thrust is not allowed on runways contaminated with water, ice, slush or snow. Use of assumed temperature reduced thrust is not recommended if potential windshear conditions exist. The assumed temperature reduced takeoff TPR is read from the Max Takeoff TPR table at the assumed temperature. The minimum allowable TPR for reduced thrust, based on 25% takeoff thrust reduction, is read by entering Minimum Allowable TPR for Reduced Thrust Table with the maximum allowable TPR for the actual OAT.

Go-Around TPR

To find Go-Around TPR based on anti-ice off, enter the Go-Around TPR table with airport pressure altitude and reported OAT or TAT and read TPR. Adjust for anti-ice operation as noted below the table.

Max Climb TPR

This table shows Max Climb TPR for a 310/.85 climb speed schedule and anti-ice off or auto. Enter the table with airport pressure altitude and TAT and read TPR. Adjust for anti-ice operation as noted below the table.

Flight with Unreliable Airspeed

Information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking of the pitot system. Loss of radome may also cause unreliable airspeed/Mach indications. Climb, cruise and descent information are provided for a speed schedule of 270 knots below 38,000 feet and 260 knots above 38,000 ft. These speeds provide ample protection from stall and high speed buffet, while also providing protection from exceeding the structural limits.

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 the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. Note that these tables consider both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 300 ft/min residual rate of climb.

Flying above these altitudes with sustained banks in excess of approximately 22° may cause the airplane to lose speed and/or altitude. The altitudes shown in the table are limited to the maximum certified altitude of 43,100 ft.

Long Range Cruise Control

This table provides target TPR, Long Range Cruise Mach number, IAS 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.

APU Operation During Flight

For APU operation during flight, increase fuel flow according to the table in the Engine Inoperative text section.

Long Range Cruise Enroute Fuel and Time

Long Range Cruise Enroute Fuel and Time tables are provided to determine remaining time and fuel required to destination. The data is based on Long Range Cruise and .85/310/250 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 which may justify operations considerably below optimum altitude. For example, a favorable wind component may have an effect on ground speed which more than compensates for the loss in air range.

Using this table, it is possible to determine the break-even wind (advantage necessary or disadvantage that can be tolerated) to maintain the same range at another altitude and long range cruise speed. The tables make no allowance for climb or descent time, fuel or distance, and are based on comparing ground fuel mileage.

Descent at .85/310/250

Distance and time for descent are shown for a .85/310/250 descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach with gear down and landing Flaps 30 at the outer marker.

Holding

Target TPR, indicated airspeed and fuel flow per engine information is tabulated for holding with Flaps Up and Flaps 1 based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed for the selected flap setting. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read TPR, IAS and fuel flow per engine.

Advisory Information

Runway Surface Condition Correlation

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. A table is provided that correlates runway condition code to runway surface condition description and reported braking action that can then be used to determine the appropriate Normal Configuration Operational Landing Distance or Non-Normal Configuration Landing Distance.

Normal Configuration Operational Landing Distance

Tables are provided as advisory information for normal configuration operational landing distances on dry runways and runways with good, good to medium, medium, medium to poor, and poor reported braking action. Operational Landing distances (reference distances plus adjustments) are 115% of the actual landing distance. The Normal Configuration Operational Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance from threshold to touchdown associated with

a flare time of 7 seconds. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, two engine maximum reverse thrust, and auto speedbrakes.

To use these tables, determine the reference landing distance for the selected braking configuration and reported braking action. Adjust this reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers. Each correction is applied independently to the reference landing distance. A correction for use of manual speedbrakes is provided in the table notes.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" 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. Landing distances and adjustments are provided for dry runways and runways with good, good-to-medium, medium, medium-to-poor, and poor reported braking action. Landing distances (reference distances plus adjustments) are representative of the actual landing distance, and are not factored. The Non-Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance from threshold to touchdown associated with a flare time of 7 seconds. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, and maximum available reverse thrust.

Tables for Non-Normal Configuration Operational Landing Distance in this section are similar in format and used in the same manner as tables for the Normal Configuration Operational Landing Distance previously described.

For an engine inoperative landing, check the rate of climb capability shown in Gear Down Landing Rate of Climb Available tables to ensure adequate climb performance.

Landing Climb Limit Weight

The table "Landing Climb Limit Weight" presents the data which are the more limiting of Approach Climb Limit Weight and Landing Climb Limit Weight. Enter the table with airport OAT and pressure altitude to read landing climb limit weight. Apply the noted adjustments as required.

Tire Speed Landing Limit Weight

For normal operations, the tires have a speed limit of 204 knots (235 MPH). For non-normal landings, the tires are allowed to exceed this speed limit, but may not exceed the maximum tire speed limit of 226 knots (260 MPH). For FLAPS DRIVE (1≤Flaps≤5) or PITCH UP AUTHORITY (Flaps≤15), the resultant touchdown speed can potentially be higher than this maximum speed limit. In order to avoid this, the tire speed landing limit weight should be checked.

The tire speed landing limit weight is based on a final approach speed that is higher of VREF30+40 and the amber band speed, with a five knot approach speed additive. Enter the table with airport OAT and pressure altitude to read tire speed landing limit weight. Apply the noted adjustments for wind as required. If planned landing weight exceeds the tire speed landing limit weight, reduce gross weight by burning fuel or fuel jettison. If unable to reduce weight below the tire speed landing limit weight, divert to a lower elevation airport.

Recommended Brake Cooling Schedule

Advisory information is provided to assist in avoiding problems associated with hot brakes. For normal operation, most landings are at weights below the AFM quick turnaround limit weight.

Use of the recommended cooling schedule will help avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Enter the Reference Brake Energy table (Table 1) with the airplane weight and brakes on speed, adjusted for wind, at the appropriate temperature and altitude condition. Instructions for applying wind adjustments are included below the table. Linear interpolation may be used to obtain intermediate values. The resulting number is the reference brake energy per brake in millions of foot-pounds, and represents the amount of energy absorbed by each brake during a rejected takeoff.

To determine the energy per brake absorbed during landing, enter the Event Adjusted Brake Energy table (Table 2) for no reverse thrust or 2 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 indications on Multifunction Display are also shown. 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 5.0 or higher on the gear synoptic display and disappear as the hottest brake cools

below 3.0. Note that even without an EICAS advisory message, brake cooling is recommended.

Engine Inoperative

Initial Max Continuous TPR

The Initial Max Continuous TPR setting for use following an engine failure is shown. The table is based on 310 KIAS or .85 M to provide a target TPR setting at the start of driftdown. Once driftdown is established, the Max Continuous TPR table should be used to determine TPR for the given conditions. Adjust for anti-ice operation as noted below the table.

Max Continuous TPR

Power setting is based on one engine operating with anti-ice off or auto. Enter the table with pressure altitude and IAS or Mach to read TPR. Adjust for anti-ice operation as noted below the table.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Driftdown Speed/Level Off Altitude

The table shows optimum driftdown speed as a function of cruise weight at start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off considering 100 ft/min residual rate of climb.

The level off altitude is dependent on air temperature (ISA deviation).

Driftdown/Cruise Range Capability

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to long range cruise speed. Cruise is continued at level off altitude and long range cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion table (Table 1) with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time table (Table 2) with air distance and weight at start of driftdown to determine fuel and time required. If altitudes other than the level off altitude is used, fuel and time required may be obtained by using the Engine Inoperative Long Range Cruise Diversion Fuel and Time table.

Long Range Cruise Altitude Capability

The table shows the maximum altitude that can be maintained at a given weight and air temperature (ISA deviation), based on LRC speed, Max Continuous thrust, and 100 ft/min residual rate of climb.

Long Range Cruise Control

The table provides target TPR, engine inoperative Long Range Cruise Mach number, IAS and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect single engine fuel burn.

APU Operation During Flight

For APU operation during flight, increase fuel flow according to the following table. These increments include the APU fuel flow and the effect of increased drag from the APU door.

PRESSURE ALTITUDE (1000 FT)	APU FUEL FLOW PENALTY (KG/HR)
43	80
39	100
35	120
31	120
25	150
20	170
15	200
10	210
5	240

Long Range Cruise Diversion Fuel and Time

Tables are provided for crews to determine the fuel and time required to proceed to an alternate airfield with one engine inoperative. The data is based on single engine Long Range Cruise speed and .85/310/250 descent.

To determine the 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.

Holding

Single engine holding data is provided in the same format as the all engine holding data and is based on the same assumptions.

Gear Down Landing Rate of Climb Available

Rate of climb data is provided as guidance information in the event an engine inoperative landing is planned. The tables show gear down rate of climb available for Flaps 20 and Flaps 30. Enter the table with TAT and pressure altitude to read rate of climb available. Apply adjustments shown to correct for weight.

Alternate Mode EEC

Fuel Jettison Limit Weight

The Alternate Mode EEC Return to Land Fuel Jettison Limit Weight is defined as the landing climb limit weight plus the fuel burned over 30 minutes and the fuel jettisoned over 15 minutes.

The table presented provides the Alternate Mode EEC Fuel Jettison Limit Weight for a given altitude and temperature. Enter the table with airport OAT and pressure altitude to read the Alternate Mode EEC Fuel Jettison Limit Weight. Apply the noted adjustments for anti-ice as required. Intermediate altitudes or temperatures may be interpolated.

The table presented is based on the entry-into-service maximum zero fuel weight. Analysis from the Airplane Flight Manual - Digital Performance Information software using a lower zero fuel weight may yield less restrictive performance.

DELETION

Limit Weight

A simplified method which conservatively accounts for the effects of EEC in the ALTERNATE mode is to reduce the normal mode performance limited weights. The Limit Weight table provides takeoff field, climb, obstacle, net level off and landing climb weights. To determine the limit weights for operations with the EEC in the ALTERNATE mode, enter the table with each of 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 and the Alternate Mode EEC Fuel Jettison Climb Limit Weight must be used. The Alternate Mode EEC 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.

Derated or reduced takeoff thrust takeoffs are not allowed with the EEC in the ALTERNATE mode. Adjustments to the limit weights provided in this section are not valid for takeoffs using improved climb. Likewise, adjustments to the limit weights are not valid for takeoffs with a contaminated runway. Analysis from the Airplane Flight Manual - Digital Performance Information may yield less restrictive limit weights.

Takeoff Speed Adjustment

Takeoff speeds computed for the reduced weight should be increased by the amount shown in the Takeoff Speeds Adjustments table.

Max Takeoff %N1

Takeoff power settings are presented for anti-ice off. Max Takeoff %N1 may be read directly from the table for the desired pressure altitude and airport OAT.

The EEC ALTERNATE mode schedule provides equal or greater thrust than the normal mode for the same lever position. Thrust protection is not provided in the ALTERNATE mode and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions.

Max Climb %N1

This table shows Max Climb %N1 for a 310/.85 climb speed schedule with anti-ice off or auto. Enter the table with pressure altitude and TAT to read Max Climb %N1. Apply adjustments as required.

Max Cruise %N1

Maximum Cruise %N1 is presented for 310 KIAS or .85 M, which approximates Long Range Cruise speed. Enter the table with pressure altitude and TAT to read Max Cruise %N1. Appropriate adjustments are shown.

Go-Around %N1

Go-Around power setting for ALTERNATE MODE EEC operation is presented for anti-ice off. Go-Around %N1 may be read directly from the tables for the desired pressure altitude and airport OAT.

The ALTERNATE MODE EEC schedule provides equal or greater thrust than the normal mode for the same lever position. Thrust protection is not provided in the ALTERNATE mode and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions.

Alternate Mode EEC, Engine Inoperative

Initial Max Continuous %N1

Initial Max Continuous %N1 settings for use following an engine failure are presented. The table is based on 310 KIAS or .85 M to provide a target %N1 setting at the start of driftdown. Once driftdown is established, the Max Continuous %N1 table should be used to determine %N1 for the given conditions.

Max Continuous %N1

Max Continuous %N1 settings are presented as a function of pressure altitude and TAT for engine inoperative speeds of 320, 280, 240, and 200 KIAS. Power settings may be interpolated for intermediate airspeeds.

Gear Down

This section contains performance for airplane operation with the landing gear extended for all phases of flight.

Note: The Flight Management System (FMS) does not contain special provisions for operation with landing gear extended. As a result, the (FMS) 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. An accurate estimated time of arrival is available if current speed or Mach is entered into the VNAV cruise page. Estimates of fuel remaining at waypoints or the destination may be computed by the crew based on current fuel flow indications, but should be updated frequently.

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.

Performance Inflight — Chapter PI

Table of Contents

787-9 TRENT1000-D KG C M FAA

General PI.20

Minimum Takeoff Weight PI.20.1
Takeoff Speeds—Dry Runway PI.20.2
Takeoff Speeds—Wet Runway PI.20.8
Stabilizer Trim Setting PI.20.14
VREF PI.20.16
Flap Maneuver Speed PI.20.17
Slush/Standing Water Takeoff PI.20.19
Dry Snow Takeoff PI.20.22
Wet Snow Takeoff PI.20.25
Slippery Runway Takeoff PI.20.28
Takeoff TPR PI.20.32
Go-Around TPR PI.20.34
Max Climb TPR PI.20.35
Flight With Unreliable Airspeed PI.20.36
ISFD Airspeed and Altitude Correction PI.20.40
ISFD Airspeed and Altitude Correction PI.20.43

All Engine PI.21

Long Range Cruise Maximum Operating Altitude PI.21.1
Long Range Cruise Control PI.21.3
Long Range Cruise Enroute Fuel and Time—Low Altitude PI.21.4
Long Range Cruise Enroute Fuel and Time—High Altitude PI.21.5
Long Range Cruise Wind-Altitude Trade PI.21.7
Holding PI.21.8

Advisory Information PI.22

Runway Surface Condition Correlation PI.22.1

Normal Configuration Landing Distance PI.22.2
Non-Normal Configuration Landing Distance PI.22.5
Landing Climb Limit Weight PI.22.53
Tire Speed Landing Limit Weight PI.22.55
Recommended Brake Cooling Schedule PI.22.57

Engine Inoperative PI.23
Initial Max Continuous TPR PI.23.1
Max Continuous TPR PI.23.2
Driftdown Speed/Level Off Altitude PI.23.6
Driftdown/LRC Cruise Range Capability PI.23.7
Long Range Cruise Altitude Capability PI.23.8
Long Range Cruise Control PI.23.9
Long Range Cruise Diversion Fuel and Time PI.23.10
Holding PI.23.11
Gear Down Landing Rate of Climb Available PI.23.12

Alternate Mode EEC PI.24
Fuel Jettison Limit Weight PI.24.1
Limit Weight PI.24.2
Max Takeoff %N1 . . . . . PI.24.3
Max Climb %N1 . . . . . PI.24.4
Max Cruise %N1 . . . . . PI.24.5
Go-Around %N1 . . . . . PI.24.6

Alternate Mode EEC, Engine Inoperative PI.25
Initial Max Continuous %N1 . . . . . PI.25.1
Max Continuous %N1 . . . . . PI.25.2

Gear Down PI.26
220 KIAS Max Climb TPR PI.26.1
Long Range Cruise Altitude Capability PI.26.2

Long Range Cruise Control PI.26.3
Long Range Cruise Enroute Fuel and Time PI.26.4
Descent at 220 KIAS PI.26.6
Holding PI.26.7

Gear Down, Engine INOP PI.27

Driftdown Speed/Level Off Altitude PI.27.1
Long Range Cruise Altitude Capability PI.27.2
Long Range Cruise Control PI.27.3
Long Range Cruise Diversion Fuel and Time PI.27.4
Holding PI.27.6

Text PI.28

Introduction PI.28.1
General PI.28.1
All Engines PI.28.5
Advisory Information PI.28.6
Engine Inoperative PI.28.9
Alternate Mode EEC PI.28.11
Alternate Mode EEC, Engine Inoperative PI.28.12
Gear Down PI.28.12

Minimum Takeoff Weight
Maximum Takeoff Thrust
Based on anti-ice off
Weight Limit (1000 KG)

Flaps 5

OAT (deg. C)	MINIMUM TAKEOFF WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (1000 FT)														
	S.L & BLW	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50	110.7	110.7	110.7												
40	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7							
30	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7				
20 & BLW	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability during takeoff. For takeoff at weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

Flaps 15

OAT (deg. C)	MINIMUM TAKEOFF WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (1000 FT)														
	S.L & BLW	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50	110.7	110.7	110.7												
40	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7							
30	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7				
20 & BLW	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7	110.7

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability during takeoff. For takeoff at weights below the minimum takeoff weight, use of a lower thrust rating, different flap or higher takeoff weight is required.

Flaps 20

OAT (deg. C)	MINIMUM TAKEOFF WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (1000 FT)														
	S.L & BLW	1	2	3	4	5	6	7	8	9	10	11	12	13	14
50	139.9	135.9	132.0												
45	145.9	141.8	137.6	133.7	127.9										
40	150.5	146.9	143.1	139.2	133.5	127.7	122.2	116.7							
35	155.1	151.3	147.5	143.7	138.1	133.0	127.5	121.9	117.1	113.9					
30	155.3	153.1	150.7	147.7	142.0	136.3	131.6	126.5	122.0	117.2	113.9				
25	155.5	153.3	150.9	148.5	144.5	140.5	134.8	129.8	125.5	121.1	116.5	113.8	114.5		
20	155.6	153.4	151.0	148.6	144.6	140.7	136.1	132.0	128.2	123.8	119.4	115.1	113.9	114.6	115.4
15	155.7	153.5	151.2	148.7	144.7	140.7	136.2	132.2	128.9	125.3	121.7	117.5	113.5	114.2	114.9
10	155.8	153.6	151.3	148.8	144.8	140.8	136.3	132.3	129.1	125.6	122.1	118.5	115.0	113.9	114.5
0 & BLW	155.9	153.8	151.4	149.0	145.0	141.0	136.4	132.4	129.2	125.7	122.2	118.8	115.4	113.7	114.3

Light weight takeoffs may be limited by minimum takeoff weight in order to maintain airplane controllability during takeoff. For takeoff at 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 5
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	TAKEOFF SPEEDS (KIAS)		
	V1	VR	V2
260	170	174	178
250	168	173	177
240	165	170	174
230	161	166	171
220	157	162	167
210	153	157	164
200	148	153	160
190	143	148	156
180	138	144	152
170	133	139	147
160	128	134	143
150	123	130	139
140	117	124	135
130	111	119	130
120	105	114	126
110	99	108	121
Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																								
	V1									VR									V2						
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)						
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	6	7	7	8	8	9	11	11	11	2	3	3	3	4	4	5	5	5	–1	–1	–2	–2	–2	–2	–1	–2	–2
50	3	4	6	8	8	9	11	11	11	1	1	2	3	4	4	5	5	5	–1	–1	–1	–2	–2	–2	–1	–2	–2
40	1	1	3	5	7	9	11	11	11	0	0	1	2	3	4	5	5	5	0	0	0	–1	–1	–2	–1	–2	–2
30	1	0	1	3	4	6	8	10	11	0	0	0	1	2	3	4	4	5	0	0	0	0	–1	–1	–1	–2	–2
20	1	0	1	2	3	5	6	8	11	0	0	0	1	2	2	3	3	5	0	0	0	0	–1	–1	–1	–2	–2
10	1	0	1	2	3	5	6	7	9	0	0	0	0	1	2	2	3	3	5	0	0	0	0	–1	–1	–1	–2	–2
0	1	0	1	2	3	5	6	7	9	0	0	0	0	1	2	2	3	3	4	0	0	0	0	0	–1	–1	–2	–2
–60	2	1	2	3	4	6	7	8	8	0	0	0	1	2	2	3	3	4	0	0	0	0	0	–1	–1	–2	–2
***V1 not to exceed VR.**																											

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
260	–3	–2	0	1	3	–2	–1	–1	0	1	1
240	–3	–2	0	1	3	–2	–1	–1	0	1	1
220	–3	–1	0	1	3	–2	–1	–1	0	1	2
200	–3	–1	0	1	2	–2	–1	–1	0	1	2
180	–3	–1	0	1	2	–2	–1	–1	0	1	2
160	–3	–1	0	1	2	–2	–1	–1	0	1	2
140	–3	–1	0	1	2	–2	–1	–1	0	1	2
120	–2	–1	0	1	2	–2	–1	–1	0	1	2
100	–2	–1	0	1	2	–2	–1	–1	0	1	2
***V1 not to exceed VR.**											

Takeoff Speeds—Dry Runway

Max Takeoff Thrust

Flaps 5

Table 4 of 6: V1(MCG)

TEMP (deg. C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
60	116	114	112	109	107	104	101	101	97
55	116	114	112	109	107	104	101	101	97
50	119	117	112	109	107	104	101	101	97
45	122	121	116	110	107	104	101	101	97
40	125	123	119	114	108	104	101	101	97
35	125	126	121	116	112	106	101	101	97
30	126	126	123	119	114	109	104	101	97
25	126	127	123	120	116	112	107	101	97
20	126	127	123	120	117	113	108	103	98
15	126	127	123	120	117	114	110	105	100
10	126	127	124	120	117	114	110	106	101
5	126	127	124	121	117	114	110	106	102
0	126	127	124	121	117	114	110	106	102
–60	128	128	125	122	118	115	111	107	103

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	MINIMUM VR (KIAS)																	
	V1(MCG) (KIAS)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	147	147	147	147	147	147	147	147	146	146	146	145	145	145	144	144	144
170	143	143	143	143	143	143	143	142	142	141	141	141	140	140	140	139	139
160	139	139	139	139	139	138	138	138	137	137	136	136	136	135	135	134	134
150	135	135	134	134	133	133	133	132	132	132	131	131	130	130	130	130	131
140	130	130	129	129	129	128	128	127	127	127	126	126	125	126	128	130	131
130	125	124	124	124	123	123	122	122	122	121	121	122	124	126	128	130	131
120	119	119	119	118	118	117	117	116	116	118	120	122	124	126	128	130	131
110	114	114	113	113	112	112	112	114	116	118	120	122	124	126	128	130	131

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	MINIMUM V2 (KIAS)																	
	V1(MCG) (KIAS)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	151	151	151	151	151	151	151	151	151	151	151	152	152	152	153	153	153
170	147	147	147	147	147	147	147	147	147	147	148	148	148	148	149	149	149
160	142	142	142	142	142	143	143	143	143	143	144	144	144	145	145	145	145
150	138	138	138	138	138	138	139	139	139	139	140	140	140	141	141	142	143
140	133	133	133	134	134	134	134	135	135	135	136	136	136	137	139	142	143
130	129	129	129	129	130	130	130	130	131	131	131	133	135	137	139	141	143
120	124	124	124	125	125	125	126	126	126	129	131	133	135	137	139	141	143
110	120	120	120	120	121	121	122	124	126	129	131	133	135	137	139	141	142

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 15
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	TAKEOFF SPEEDS (KIAS)		
	V1	VR	V2
240	157	161	166
230	153	158	163
220	149	154	160
210	145	150	156
200	140	146	153
190	136	142	149
180	131	137	145
170	127	133	141
160	123	127	137
150	118	122	133
140	113	117	128
130	108	112	124
120	103	109	120
110	100	107	118
Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																								
	V1									VR									V2						
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)						
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	5	6	6	6	7	7	8	8	8	2	2	2	3	3	4	4	4	4	–1	–1	–1	–1	–1	–1	–1	–1	–1
50	3	3	5	6	7	7	8	8	8	1	1	2	3	3	4	4	4	4	–1	–1	–1	–1	–1	–1	–1	–1	–1
40	1	1	3	5	6	6	8	8	8	0	0	1	2	2	4	4	4	4	0	0	–1	–1	–1	–1	–1	–1	–1
30	1	0	1	3	3	5	6	7	8	0	0	0	1	2	3	4	4	4	0	0	0	–1	–1	–1	–1	–1	–1
20	1	0	1	3	3	4	5	6	8	0	0	0	1	1	2	3	3	3	0	0	0	0	–1	–1	–1	–1	–1
10	1	0	1	3	3	4	5	5	6	0	0	0	1	1	2	3	3	3	0	0	0	0	–1	–1	–1	–1	–1
0	1	0	1	3	3	4	5	5	6	0	0	0	1	1	2	3	3	3	0	0	0	0	–1	–1	–1	–1	–1
–60	2	1	2	3	4	5	6	6	6	0	0	0	1	1	2	3	3	3	0	0	0	0	–1	–1	–1	–1	–1
*V1 not to exceed VR.																											

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
260	–3	–2	0	1	3	–2	–1	–1	0	1	1
240	–3	–2	0	1	3	–2	–1	–1	0	1	1
220	–3	–1	0	1	3	–2	–1	–1	0	1	2
200	–3	–1	0	1	2	–2	–1	–1	0	1	2
180	–3	–1	0	1	2	–2	–1	–1	0	1	2
160	–3	–1	0	1	2	–2	–1	–1	0	1	2
140	–3	–1	0	1	2	–2	–1	–1	0	1	2
120	–2	–1	0	1	2	–2	–1	–1	0	1	2
100	–2	–1	0	1	2	–2	–1	–1	0	1	2
*V1 not to exceed VR.											

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 15
Table 4 of 6: V1 (MCG)

TEMP (deg. C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
60	116	114	111	109	106	103	100	100	96
55	115	114	111	109	106	103	100	100	96
50	118	117	111	109	106	103	100	100	96
45	121	120	115	110	106	103	100	100	96
40	124	123	118	113	108	103	100	100	96
35	125	126	121	116	111	106	100	100	96
30	125	126	123	118	114	109	103	100	96
25	125	126	123	120	116	111	106	101	96
20	125	126	123	120	116	113	108	103	97
15	125	126	123	120	117	113	109	104	99
10	125	126	123	120	117	113	109	106	101
5	126	126	123	120	117	113	110	106	101
0	126	126	123	120	117	113	110	106	102
–60	127	128	124	121	118	114	111	107	103

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	MINIMUM VR (KIAS)																	
	V1(MCG) (KIAS)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	140	140	140	140	140	140	140	140	139	139	139	138	138	138	137	137	137
170	136	136	136	136	136	136	136	135	135	135	134	134	134	134	134	133	133
160	132	132	132	132	132	132	131	131	131	130	130	130	130	130	130	130	131
150	128	128	128	127	127	127	126	126	126	126	127	127	127	127	128	130	131
140	124	123	123	123	122	122	122	122	123	123	123	123	124	126	128	130	131
130	119	118	118	118	118	118	118	119	119	119	120	122	124	126	128	130	131
120	115	114	114	113	114	114	115	115	116	118	120	122	124	126	128	130	131
110	114	114	113	113	112	111	112	114	116	118	120	122	124	126	128	130	131

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	MINIMUM V2 (KIAS)																	
	V1(MCG) (KIAS)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	144	144	144	144	144	144	144	144	144	145	145	145	145	146	146	146	146
170	140	140	140	140	140	140	140	140	141	141	141	142	143	143	143	143	143
160	136	136	136	136	136	136	136	137	137	138	139	139	140	140	141	141	142
150	132	132	132	132	132	132	133	134	135	135	136	137	138	138	139	141	142
140	127	127	127	128	128	129	130	131	132	132	133	134	135	137	139	141	142
130	123	123	123	124	125	125	127	128	129	130	131	132	135	137	139	141	142
120	120	120	120	120	121	122	123	124	126	128	130	132	134	136	138	140	141
110	120	120	120	120	120	120	122	124	126	128	130	132	134	136	138	140	141

Takeoff Speeds—Dry Runway
Max Takeoff Thrust
Flaps 20
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	TAKEOFF SPEEDS (KIAS)		
	V1	VR	V2
230	147	149	156
220	143	145	152
210	139	142	149
200	136	139	147
190	133	136	142
180	130	132	137
170	127	128	133
160	123	124	128
150	120	120	125
140	116	116	122
130	112	113	118
120	109	109	115
110	106	106	112
Check V1 (MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																								
	V1									VR									V2						
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)						
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	2	2	2	2	2	2	2	2	2	1	0	2	2	2	2	2	2	2	–1	–1	–1	–1	–2	–2	–2	–3	–3
50	2	1	1	1	1	1	1	1	1	0	0	2	2	2	2	2	2	2	–1	–1	–1	–1	–2	–2	–2	–3	–3
40	1	1	1	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	–1	–1	–1	–2	–2	–2	–2	–3
30	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–2	–2	–2	–3
20	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–1	–2	–2	–3
10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–1	–1	–2	–2
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–1	–1	–2	–2
–60	2	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–1	–1	–2	–2
***V1 not to exceed VR.**																									

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
260	–3	–2	0	1	3	–2	–1	–1	0	1	1
240	–3	–2	0	1	3	–2	–1	–1	0	1	1
220	–3	–1	0	1	3	–2	–1	–1	0	1	2
200	–3	–1	0	1	2	–2	–1	–1	0	1	2
180	–3	–1	0	1	2	–2	–1	–1	0	1	2
160	–3	–1	0	1	2	–2	–1	–1	0	1	2
140	–3	–1	0	1	2	–2	–1	–1	0	1	2
120	–2	–1	0	1	2	–2	–1	–1	0	1	2
100	–2	–1	0	1	2	–2	–1	–1	0	1	2
***V1 not to exceed VR.**											

Takeoff Speeds—Dry Runway

Max Takeoff Thrust

Flaps 20

Table 4 of 6: V1 (MCG)

TEMP (deg. C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
60	114	113	110	108	105	103	100	100	96
55	114	113	110	108	105	103	100	100	96
50	118	116	111	108	105	103	100	100	96
45	121	119	114	109	105	103	100	100	96
40	123	122	117	112	107	103	100	100	96
35	124	125	120	115	110	105	100	100	96
30	124	125	122	117	113	108	103	100	96
25	124	125	122	119	115	110	105	100	96
20	124	125	122	119	116	112	107	102	96
15	124	125	122	119	116	112	108	104	99
10	125	125	122	119	116	113	109	105	100
5	125	125	122	119	116	113	109	105	101
0	125	126	122	119	116	113	109	105	101
–60	126	127	123	120	117	114	110	106	102

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	MINIMUM VR (KIAS)																
	V1(MCG) (KIAS)																
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
200 & ABV	138	138	138	138	138	138	138	138	138	138	138	138	138	139	140	140	140
190	135	135	135	135	135	135	135	135	135	135	135	136	137	137	138	138	138
180	132	132	132	132	132	132	132	132	132	132	133	134	135	135	136	136	136
170	128	128	128	128	128	128	128	128	129	130	131	132	132	133	133	134	135
160	125	125	125	125	125	125	125	126	127	128	129	130	130	131	132	132	132
150	121	121	121	121	121	122	123	124	125	125	126	127	128	129	129	130	131
140	117	117	117	118	119	120	121	121	122	123	124	124	125	126	128	130	131
130	115	115	115	116	117	118	118	119	120	120	121	122	124	126	128	130	131
120	115	114	114	113	114	115	116	116	117	118	120	122	124	126	128	130	131
110	114	114	114	113	112	112	113	114	116	118	120	122	124	126	128	130	131

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	MINIMUM V2 (KIAS)																
	V1(MCG) (KIAS)																
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
200 & ABV	145	145	145	145	145	145	145	145	145	145	145	145	146	147	147	148	148
190	142	142	142	142	142	142	142	142	142	142	142	143	144	145	146	147	147
180	138	138	138	138	138	138	138	138	138	139	140	141	142	144	144	145	146
170	134	134	134	134	134	134	134	135	136	137	138	140	141	142	143	143	143
160	130	130	130	130	130	130	131	133	134	135	137	138	139	140	141	142	142
150	126	126	126	126	127	128	130	131	132	134	135	136	137	138	139	141	142
140	122	122	122	124	125	127	128	130	131	132	133	134	135	137	139	141	142
130	120	120	121	122	123	125	126	128	128	129	131	132	135	137	139	141	142
120	120	120	120	120	121	123	124	125	126	128	130	132	134	136	138	140	141
110	120	120	120	120	120	120	122	124	126	128	130	132	134	136	138	140	141

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 5
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	TAKEOFF SPEEDS (KIAS)		
	V1	VR	V2
260	163	174	178
250	161	173	177
240	157	170	174
230	153	166	171
220	148	162	167
210	144	157	164
200	139	153	160
190	134	148	156
180	129	144	152
170	124	139	147
160	119	134	143
150	114	130	139
140	108	124	135
130	103	119	130
120	97	114	126
110	91	108	121
Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																								
	V1									VR									V2						
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)						
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	6	7	7	8	8	9	11	11	11	2	3	3	3	4	4	5	5	5	–1	–1	–2	–2	–2	–2	–1	–2	–2
50	3	4	6	8	8	9	11	11	11	1	1	2	3	4	4	5	5	5	–1	–1	–1	–2	–2	–2	–1	–2	–2
40	1	1	3	5	7	9	11	11	11	0	0	1	2	3	4	5	5	5	0	0	0	–1	–1	–2	–1	–2	–2
30	1	0	1	3	4	6	9	10	11	0	0	0	1	2	3	4	4	5	0	0	0	0	–1	–1	–1	–2	–2
20	1	0	1	2	3	5	6	8	11	0	0	0	1	2	2	3	3	5	0	0	0	0	–1	–1	–1	–2	–2
10	1	0	1	2	3	5	6	7	9	0	0	0	1	2	2	3	3	5	0	0	0	0	–1	–1	–1	–2	–2
0	1	0	1	2	3	5	6	7	9	0	0	0	1	2	2	3	3	4	0	0	0	0	0	–1	–1	–2	–2
–60	2	1	3	4	5	6	7	8	10	0	0	0	1	2	2	3	3	4	0	0	0	0	0	–1	–1	–2	–2
*V1 not to exceed VR.																											

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
260	–5	–3	0	3	5	–4	–2	–1	0	1	3
240	–5	–2	0	2	5	–4	–2	–1	0	1	3
220	–5	–2	0	2	4	–4	–3	–1	0	2	3
200	–4	–2	0	2	4	–4	–3	–1	0	2	3
180	–4	–2	0	2	4	–4	–3	–1	0	2	3
160	–4	–2	0	2	4	–4	–3	–1	0	2	3
140	–4	–2	0	2	3	–4	–3	–1	0	2	3
120	–4	–2	0	2	3	–3	–2	–1	0	1	3
100	–4	–2	0	2	3	–3	–2	–1	0	1	3
*V1 not to exceed VR.											

Takeoff Speeds—Wet Runway

Max Takeoff Thrust

Flaps 5

Table 4 of 6: V1(MCG)

TEMP (deg. C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
60	116	114	112	109	107	104	101	101	97
55	116	114	112	109	107	104	101	101	97
50	119	117	112	109	107	104	101	101	97
45	122	121	116	110	107	104	101	101	97
40	125	123	119	114	108	104	101	101	97
35	125	126	121	116	112	106	101	101	97
30	126	126	123	119	114	109	104	101	97
25	126	127	123	120	116	112	107	101	97
20	126	127	123	120	117	113	108	103	98
15	126	127	123	120	117	114	110	105	100
10	126	127	124	120	117	114	110	106	101
5	126	127	124	121	117	114	110	106	102
0	126	127	124	121	117	114	110	106	102
–60	128	128	125	122	118	115	111	107	103

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	MINIMUM VR (KIAS)																	
	V1(MCG) (KIAS)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	147	147	147	147	147	147	147	147	146	146	146	145	145	145	144	144	144
170	143	143	143	143	143	143	143	142	142	141	141	141	140	140	140	139	139
160	139	139	139	139	139	138	138	138	137	137	136	136	136	135	135	134	134
150	135	135	134	134	133	133	133	132	132	132	131	131	130	130	130	130	131
140	130	130	129	129	129	128	128	127	127	127	126	126	125	126	128	130	131
130	125	124	124	124	123	123	122	122	122	121	121	122	124	126	128	130	131
120	119	119	119	118	118	117	117	116	116	118	120	122	124	126	128	130	131
110	114	114	113	113	112	112	112	114	116	118	120	122	124	126	128	130	131

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	MINIMUM V2 (KIAS)																	
	V1(MCG) (KIAS)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
180 & ABV	151	151	151	151	151	151	151	151	151	151	151	152	152	152	153	153	153
170	147	147	147	147	147	147	147	147	147	147	148	148	148	148	149	149	149
160	142	142	142	142	142	143	143	143	143	143	144	144	144	145	145	145	145
150	138	138	138	138	138	138	139	139	139	139	140	140	140	141	141	142	143
140	133	133	133	134	134	134	134	135	135	135	136	136	136	137	139	142	143
130	129	129	129	129	130	130	130	130	131	131	131	133	135	137	139	141	143
120	124	124	124	125	125	125	126	126	126	129	131	133	135	137	139	141	143
110	120	120	120	120	121	121	122	124	126	129	131	133	135	137	139	141	142

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 15
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	TAKEOFF SPEEDS (KIAS)		
	V1	VR	V2
240	149	161	166
230	145	158	163
220	141	154	160
210	137	150	156
200	132	146	153
190	128	142	149
180	123	137	145
170	119	133	141
160	114	127	137
150	110	122	133
140	105	117	128
130	100	112	124
120	95	109	120
110	93	107	118
Check V1(MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																								
	V1									VR									V2						
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)						
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	6	6	6	7	7	8	8	8	8	2	2	2	3	3	4	4	4	4	–1	–1	–1	–1	–1	–1	–1	–1	–1
50	3	3	6	7	7	8	8	8	8	1	1	2	3	3	4	4	4	4	–1	–1	–1	–1	–1	–1	–1	–1	–1
40	1	1	3	4	5	7	8	8	8	0	0	1	2	2	4	4	4	4	0	0	–1	–1	–1	–1	–1	–1	–1
30	1	0	1	2	3	5	7	7	8	0	0	0	1	2	3	4	4	4	0	0	0	–1	–1	–1	–1	–1	–1
20	1	0	1	2	2	3	5	6	8	0	0	0	1	1	2	3	3	3	0	0	0	0	–1	–1	–1	–1	–1
10	1	0	1	2	2	3	4	5	7	0	0	0	1	1	2	3	3	3	0	0	0	0	–1	–1	–1	–1	–1
0	1	0	1	2	2	3	4	5	7	0	0	0	1	1	2	3	3	3	0	0	0	0	–1	–1	–1	–1	–1
–60	2	1	3	3	3	5	6	7	7	0	0	0	1	1	2	3	3	3	0	0	0	0	–1	–1	–1	–1	–1
***V1 not to exceed VR.**																											

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
240	–5	–2	0	2	5	–4	–2	–1	0	1	3
220	–5	–2	0	2	4	–4	–3	–1	0	2	3
200	–4	–2	0	2	4	–4	–3	–1	0	2	3
180	–4	–2	0	2	4	–4	–3	–1	0	2	3
160	–4	–2	0	2	4	–4	–3	–1	0	2	3
140	–4	–2	0	2	3	–4	–3	–1	0	2	3
120	–4	–2	0	2	3	–3	–2	–1	0	1	3
100	–4	–2	0	2	3	–3	–2	–1	0	1	3
***V1 not to exceed VR.**											

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 15
Table 4 of 6: V1 (MCG)

TEMP (deg. C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
60	115	114	111	109	106	103	100	100	96
55	115	114	111	109	106	103	100	100	96
50	118	117	111	109	106	103	100	100	96
45	121	120	115	110	106	103	100	100	96
40	124	123	118	113	108	103	100	100	96
35	125	126	121	116	111	106	100	100	96
30	125	126	123	118	114	109	103	100	96
25	125	126	123	120	116	111	106	101	96
20	125	126	123	120	116	113	108	103	97
15	125	126	123	120	117	113	109	104	99
10	125	126	123	120	117	113	109	106	101
5	126	126	123	120	117	113	110	106	101
0	126	126	123	120	117	113	110	106	102
–60	127	128	124	121	118	114	111	107	103

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	MINIMUM VR (KIAS)																	
	V1(MCG) (KIAS)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	
180 & ABV	140	140	140	140	140	140	140	140	139	139	139	138	138	138	137	137	137	
170	136	136	136	136	136	136	136	135	135	135	134	134	134	134	134	133	133	
160	132	132	132	132	132	132	131	131	131	130	130	130	130	130	130	130	131	
150	128	128	128	127	127	127	126	126	126	126	127	127	127	127	128	130	131	
140	124	123	123	123	122	122	122	122	123	123	123	123	124	126	128	130	131	
130	119	118	118	118	118	118	118	119	119	119	120	122	124	126	128	130	131	
120	115	114	114	113	114	114	115	115	116	118	120	122	124	126	128	130	131	
110	114	114	113	113	112	111	112	114	116	118	120	122	124	126	128	130	131	

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	MINIMUM V2 (KIAS)																	
	V1(MCG) (KIAS)																	
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128	
180 & ABV	144	144	144	144	144	144	144	144	144	145	145	145	145	146	146	146	146	
170	140	140	140	140	140	140	140	140	141	141	141	142	143	143	143	143	143	
160	136	136	136	136	136	136	136	137	137	138	139	139	140	140	141	141	142	
150	132	132	132	132	132	132	133	134	135	135	136	137	138	138	139	141	142	
140	127	127	127	128	128	129	130	131	132	132	133	134	135	137	139	141	142	
130	123	123	123	124	125	125	127	128	129	130	131	132	135	137	139	141	142	
120	120	120	120	120	121	122	123	124	126	128	130	132	134	136	138	140	141	
110	120	120	120	120	120	120	122	124	126	128	130	132	134	136	138	140	141	

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 20
Table 1 of 6: V1, VR, V2

WEIGHT (1000 KG)	TAKEOFF SPEEDS (KIAS)		
	V1	VR	V2
230	139	149	156
220	135	145	152
210	132	142	149
200	129	139	147
190	126	136	142
180	122	132	137
170	119	128	133
160	116	124	128
150	112	120	125
140	109	116	122
130	105	113	118
120	102	109	115
110	100	106	112
Check V1 (MCG), Minimum VR, Minimum V2 and Minimum Takeoff Weight.			

Table 2 of 6: V1, VR, V2 Adjustments*

TEMP (deg. C)	TAKEOFF SPEEDS ADJUSTMENTS (KIAS)																								
	V1									VR									V2						
	PRESS ALT (1000 FT)									PRESS ALT (1000 FT)									PRESS ALT (1000 FT)						
	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14	–2	0	2	4	6	8	10	12	14
60	3	3	3	3	3	3	3	3	3	1	0	2	2	2	2	2	2	2	–1	–1	–1	–1	–2	–2	–2	–3	–3
50	2	1	2	2	2	2	2	2	2	0	0	2	2	2	2	2	2	2	–1	–1	–1	–1	–2	–2	–2	–3	–3
40	1	0	0	1	1	1	1	1	1	0	0	0	1	1	1	1	1	1	0	–1	–1	–1	–2	–2	–2	–2	–3
30	1	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–2	–2	–2	–3
20	1	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–1	–2	–2	–3
10	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–1	–1	–2	–2
0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–1	–1	–2	–2
–60	3	1	1	1	1	1	1	1	1	0	0	0	0	0	0	0	0	0	0	0	0	–1	–1	–1	–1	–2	–2
***V1 not to exceed VR.**																									

Table 3 of 6: Slope and Wind V1 Adjustments*

WEIGHT (1000 KG)	V1 SPEED ADJUSTMENTS (KIAS)										
	SLOPE (%)					WIND (KTS)					
	–2	–1	0	1	2	–15	–10	–5	0	20	40
240	–5	–2	0	2	5	–4	–2	–1	0	1	3
220	–5	–2	0	2	4	–4	–3	–1	0	2	3
200	–4	–2	0	2	4	–4	–3	–1	0	2	3
180	–4	–2	0	2	4	–4	–3	–1	0	2	3
160	–4	–2	0	2	4	–4	–3	–1	0	2	3
140	–4	–2	0	2	3	–4	–3	–1	0	2	3
120	–4	–2	0	2	3	–3	–2	–1	0	1	3
100	–4	–2	0	2	3	–3	–2	–1	0	1	3
***V1 not to exceed VR.**											

Takeoff Speeds—Wet Runway
Max Takeoff Thrust
Flaps 20
Table 4 of 6: V1 (MCG)

TEMP (deg. C)	V1(MCG) (KIAS)								
	PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
60	114	113	110	108	105	103	100	100	96
55	114	113	110	108	105	103	100	100	96
50	118	116	111	108	105	103	100	100	96
45	121	119	114	109	105	103	100	100	96
40	123	122	117	112	107	103	100	100	96
35	124	125	120	115	110	105	100	100	96
30	124	125	122	117	113	108	103	100	96
25	124	125	122	119	115	110	105	100	96
20	124	125	122	119	116	112	107	102	96
15	124	125	122	119	116	112	108	104	99
10	125	125	122	119	116	113	109	105	100
5	125	125	122	119	116	113	109	105	101
0	125	126	122	119	116	113	109	105	101
–60	126	127	123	120	117	114	110	106	102

Table 5 of 6: Minimum VR

WEIGHT (1000 KG)	MINIMUM VR (KIAS)																
	V1(MCG) (KIAS)																
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
200 & ABV	138	138	138	138	138	138	138	138	138	138	138	138	138	139	140	140	140
190	135	135	135	135	135	135	135	135	135	135	135	136	137	137	138	138	138
180	132	132	132	132	132	132	132	132	132	132	133	134	135	135	136	136	136
170	128	128	128	128	128	128	128	128	129	130	131	132	132	133	133	134	135
160	125	125	125	125	125	125	125	126	127	128	129	130	130	131	132	132	132
150	121	121	121	121	121	122	123	124	125	125	126	127	128	129	129	130	131
140	117	117	117	118	119	120	121	121	122	123	124	124	125	126	128	130	131
130	115	115	115	116	117	118	118	119	120	120	121	122	124	126	128	130	131
120	115	114	114	113	114	115	116	116	117	118	120	122	124	126	128	130	131
110	114	114	114	113	112	112	113	114	116	118	120	122	124	126	128	130	131

Table 6 of 6: Minimum V2

WEIGHT (1000 KG)	MINIMUM V2 (KIAS)																
	V1(MCG) (KIAS)																
	96	98	100	102	104	106	108	110	112	114	116	118	120	122	124	126	128
200 & ABV	145	145	145	145	145	145	145	145	145	145	145	145	146	147	147	148	148
190	142	142	142	142	142	142	142	142	142	142	142	143	144	145	146	147	147
180	138	138	138	138	138	138	138	138	138	139	140	141	142	144	144	145	146
170	134	134	134	134	134	134	134	135	136	137	138	140	141	142	143	143	143
160	130	130	130	130	130	130	131	133	134	135	137	138	139	140	141	142	142
150	126	126	126	126	127	128	130	131	132	134	135	136	137	138	139	141	142
140	122	122	122	124	125	127	128	130	131	132	133	134	135	137	139	141	142
130	120	120	121	122	123	125	126	128	128	129	131	132	135	137	139	141	142
120	120	120	120	120	121	123	124	125	126	128	130	132	134	136	138	140	141
110	120	120	120	120	120	120	122	124	126	128	130	132	134	136	138	140	141

Stabilizer Trim Setting

Max Takeoff Thrust

Flaps 5

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)									
	C.G. (%MAC)									
	8	10	14	18	22	26	30	32	34	38
263	9.4	8.8	7.8	6.8	5.8	4.7	3.7	3.2	2.7	1.7
260	9.3	8.8	7.8	6.7	5.7	4.7	3.7	3.2	2.6	1.6
250	9.2	8.6	7.6	6.6	5.6	4.6	3.5	3.0	2.5	1.5
240	9.0	8.5	7.5	6.4	5.4	4.4	3.4	2.9	2.4	1.4
230	8.8	8.3	7.3	6.3	5.3	4.3	3.3	2.7	2.2	1.2
220	8.7	8.2	7.2	6.1	5.1	4.1	3.1	2.6	2.1	1.1
210	8.5	8.0	7.0	6.0	5.0	4.0	3.0	2.5	2.0	1.0
200	8.3	7.8	6.8	5.8	4.8	3.8	2.8	2.3	1.8	0.8
190	8.1	7.6	6.7	5.7	4.7	3.7	2.8	2.3	1.8	0.8
180	7.9	7.5	6.5	5.5	4.6	3.6	2.7	2.2	1.7	0.8
170	7.8	7.3	6.3	5.4	4.4	3.4	2.5	2.0	1.5	0.6
160	7.6	7.1	6.1	5.2	4.2	3.3	2.3	1.8	1.4	0.4
150	7.1	6.6	5.7	4.7	3.8	2.9	2.0	1.6	1.1	0.3
140	6.6	6.1	5.2	4.3	3.4	2.6	1.7	1.3	0.9	0.3
130	5.9	5.5	4.7	3.8	3.0	2.2	1.4	1.1	0.6	0.3
120	5.3	4.9	4.1	3.4	2.6	1.9	1.1	0.8	0.4	0.3
110	4.6	4.2	3.6	2.9	2.2	1.5	0.9	0.5	0.3	0.3

Flaps 15

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)									
	C.G. (%MAC)									
	8	10	14	18	22	26	30	32	34	38
263	10.4	9.9	8.8	7.7	6.6	5.6	4.5	3.9	3.4	2.3
260	10.3	9.8	8.7	7.6	6.6	5.5	4.4	3.9	3.3	2.3
250	10.1	9.6	8.5	7.4	6.4	5.3	4.2	3.7	3.2	2.1
240	10.0	9.5	8.4	7.3	6.2	5.1	4.1	3.5	3.0	1.9
230	9.8	9.3	8.2	7.1	6.0	5.0	3.9	3.3	2.8	1.7
220	9.7	9.1	8.0	7.0	5.9	4.8	3.7	3.2	2.6	1.5
210	9.4	8.9	7.8	6.7	5.6	4.6	3.5	3.0	2.5	1.4
200	9.2	8.7	7.6	6.5	5.4	4.3	3.3	2.8	2.3	1.3
190	9.0	8.5	7.4	6.3	5.2	4.2	3.2	2.7	2.2	1.1
180	8.8	8.3	7.2	6.1	5.1	4.1	3.2	2.6	2.1	1.0
170	8.5	8.0	7.0	5.9	4.9	3.9	3.0	2.4	1.9	0.8
160	8.2	7.7	6.7	5.7	4.8	3.8	2.8	2.3	1.7	0.6
150	7.6	7.1	6.2	5.3	4.3	3.4	2.4	1.9	1.4	0.4
140	7.1	6.6	5.7	4.8	3.9	3.0	2.1	1.6	1.1	0.3
130	6.5	6.1	5.2	4.3	3.5	2.6	1.8	1.3	0.9	0.3
120	6.0	5.6	4.7	3.9	3.0	2.3	1.5	1.1	0.6	0.3
110	5.5	5.1	4.3	3.5	2.6	1.9	1.2	0.8	0.4	0.3

Stabilizer Trim Setting
Max Takeoff Thrust
Flaps 20

WEIGHT (1000 KG)	STABILIZER TRIM SETTING (UNITS)									
	C.G. (%MAC)									
	8	10	14	18	22	26	30	32	34	38
263	11.3	10.7	9.5	8.2	7.0	5.7	4.5	3.9	3.2	2.0
260	11.2	10.6	9.4	8.1	6.9	5.6	4.4	3.8	3.2	1.9
250	10.8	10.2	9.0	7.8	6.6	5.4	4.2	3.6	2.9	1.8
240	10.7	10.1	8.9	7.7	6.5	5.3	4.1	3.5	2.8	1.7
230	10.6	10.0	8.8	7.6	6.4	5.1	4.0	3.4	2.8	1.6
220	10.4	9.8	8.6	7.5	6.3	5.0	3.9	3.3	2.7	1.5
210	10.2	9.6	8.5	7.3	6.1	4.9	3.7	3.2	2.6	1.4
200	10.0	9.4	8.3	7.1	5.9	4.8	3.6	3.0	2.4	1.3
190	9.7	9.1	8.0	6.8	5.7	4.5	3.4	2.8	2.2	1.0
180	9.4	8.8	7.7	6.5	5.4	4.3	3.1	2.6	2.0	0.8
170	9.0	8.5	7.4	6.3	5.2	4.0	2.9	2.3	1.8	0.6
160	8.6	8.1	7.0	6.0	4.9	3.8	2.7	2.1	1.5	0.4
150	8.1	7.5	6.5	5.5	4.4	3.4	2.4	1.9	1.3	0.3
140	7.5	7.0	6.0	5.0	4.0	3.1	2.2	1.6	1.1	0.3
130	6.9	6.5	5.5	4.6	3.7	2.8	2.0	1.5	0.9	0.3
120	6.4	6.0	5.1	4.3	3.4	2.6	1.7	1.3	0.8	0.3
110	5.9	5.5	4.7	4.0	3.2	2.4	1.5	1.1	0.7	0.3

VREF

Based on 10,000 ft pressure altitude

WEIGHT (1000 KG)	VREF (KIAS)		
	FLAPS		
	30	25	20
250	175	182	182
240	172	179	179
230	168	175	175
220	165	171	171
210	161	166	167
200	157	162	162
190	152	158	158
180	148	153	153
170	144	148	148
160	139	144	144
150	135	139	139
140	130	134	134
130	126	129	129
120	122	124	124

Flap Maneuver Speed

Sea Level Pressure Altitude

WEIGHT (1000 KG)	MANEUVER SPEED (KIAS)							
	FLAPS							
	UP	1	5	10	15,17,18	20	25	30
260	258	238	208	198	193	188	182	176
250	258	238	208	198	193	188	179	173
240	258	237	208	195	190	185	176	171
230	256	233	206	192	187	182	172	167
220	251	228	203	188	183	178	168	163
210	245	223	199	184	179	174	164	159
200	239	217	195	180	175	170	160	155
190	231	212	191	176	171	166	156	151
180	227	206	187	172	167	162	152	147
170	223	200	183	168	163	158	148	143
160	219	195	179	164	159	153	143	138
150	214	189	174	159	154	149	139	134
140	210	185	170	155	149	144	134	129
130	206	181	166	151	146	140	129	125
120	202	177	162	147	142	137	124	121

Flaps 25 maneuver speed based on VREF25.
Flaps 30 maneuver speed based on VREF30.

10,000 FT Pressure Altitude

WEIGHT (1000 KG)	MANEUVER SPEED (KIAS)							
	FLAPS							
	UP	1	5	10	15,17,18	20	25	30
260	258	239	208	200	194	188	185	178
250	258	239	208	200	194	188	182	175
240	258	238	208	197	192	187	179	172
230	256	234	207	193	188	183	175	168
220	251	229	204	189	184	179	171	165
210	245	224	200	185	180	175	166	161
200	239	219	196	181	176	171	162	157
190	233	213	192	177	172	167	158	152
180	228	207	188	173	168	163	153	148
170	224	201	184	169	164	159	148	144
160	219	195	179	164	159	154	144	139
150	215	190	175	160	155	150	139	135
140	210	185	170	155	150	145	134	130
130	206	181	166	151	146	141	129	126
120	203	178	163	147	142	137	124	122

Flaps 25 maneuver speed based on VREF25.
Flaps 30 maneuver speed based on VREF30.

Flap Maneuver Speed

20,000 FT Pressure Altitude and Above

WEIGHT (1000 KG)	MANEUVER SPEED (KIAS)							
	FLAPS							
	UP	1	5	10	15,17,18	20	25	30
260	260	239	209	202	194	189	186	178
250	260	239	209	202	194	189	183	176
240	259	239	209	199	193	188	180	173
230	259	237	208	195	190	185	176	169
220	256	233	206	191	186	181	172	165
210	250	227	202	187	182	177	168	161
200	243	221	198	183	178	173	163	157
190	237	215	194	179	174	169	159	153
180	230	209	190	175	170	165	154	149
170	225	203	185	170	165	160	149	144
160	221	197	181	166	161	156	145	140
150	216	191	176	161	156	151	140	135
140	211	186	171	156	151	146	134	130
130	207	182	167	152	147	142	129	126
120	203	178	163	148	143	138	124	122

Flaps 25 maneuver speed based on VREF25.
Flaps 30 maneuver speed based on VREF30.

ADVISORY INFORMATION

Slush/Standing Water Takeoff

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–17.4	–26.6	–35.8	–43.2	–26.4	–35.6	–44.8	–52.2	–42.9	–52.1	–61.4	–68.7
250	–17.0	–26.2	–35.4	–42.8	–25.6	–34.8	–44.0	–51.4	–41.3	–50.5	–59.7	–67.1
240	–16.4	–25.7	–34.9	–42.3	–24.8	–34.0	–43.2	–50.6	–39.6	–48.8	–58.0	–65.4
230	–15.9	–25.1	–34.3	–41.7	–23.9	–33.1	–42.3	–49.7	–37.7	–47.0	–56.2	–63.6
220	–15.3	–24.5	–33.7	–41.1	–22.9	–32.1	–41.3	–48.7	–35.8	–45.0	–54.2	–61.6
210	–14.6	–23.8	–33.1	–40.4	–21.9	–31.1	–40.3	–47.7	–33.7	–43.0	–52.2	–59.6
200	–13.9	–23.1	–32.3	–39.7	–20.8	–30.0	–39.2	–46.6	–31.5	–40.8	–50.0	–57.4
190	–13.2	–22.4	–31.6	–39.0	–19.6	–28.8	–38.1	–45.4	–29.3	–38.5	–47.7	–55.1
180	–12.3	–21.5	–30.8	–38.1	–18.4	–27.6	–36.8	–44.2	–26.8	–36.0	–45.3	–52.6
170	–11.4	–20.7	–29.9	–37.3	–17.1	–26.3	–35.5	–42.9	–24.3	–33.5	–42.7	–50.1
160	–10.5	–19.8	–29.0	–36.3	–15.7	–24.9	–34.2	–41.5	–21.6	–30.8	–40.1	–47.4
150	–9.6	–18.8	–28.0	–35.4	–14.3	–23.5	–32.7	–40.1	–18.8	–28.1	–37.3	–44.6
140	–8.5	–17.8	–27.0	–34.3	–12.8	–22.0	–31.2	–38.6	–15.9	–25.2	–34.4	–41.8
130	–7.4	–16.7	–25.9	–33.3	–11.2	–20.4	–29.7	–37.0	–12.9	–22.1	–31.4	–38.7
120	–6.4	–15.6	–24.8	–32.2	–9.6	–18.8	–28.0	–35.4	–9.8	–19.0	–28.2	–35.6

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1400	85.1				91.0				99.2			
1600	122.3				127.2				133.0			
1800	160.1	104.5			164.0	110.0			167.6	116.7		
2000	199.3	141.9	86.6		202.0	146.3	92.5		203.2	150.9	100.6	
2200	240.0	180.4	123.9		241.1	183.7	128.8	85.9	239.9	186.0	134.4	94.5
2400	282.1	220.3	161.8	117.1	281.4	222.2	165.6	122.2	277.6	222.2	169.1	128.2
2600		261.8	201.1	154.8		262.0	203.6	158.9		259.4	204.8	162.7
2800			241.8	193.9			242.8	196.6		297.0	241.5	198.2
3000			283.9	234.2			283.2	235.5			279.3	234.6
3200				276.2				275.8				272.3

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 –55 m/+55 m for every 10 deg. C above/below 0 deg. 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

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–11	–9	–6	–4	–5	–3	0	0	0	0	0	0
250	–12	–9	–7	–5	–6	–4	–1	0	0	0	0	0
240	–12	–10	–7	–5	–7	–4	–2	0	0	0	0	0
230	–13	–10	–8	–6	–8	–5	–3	–1	0	0	0	0
220	–13	–11	–8	–6	–9	–6	–4	–2	0	0	0	0
210	–14	–11	–9	–7	–9	–7	–4	–2	0	0	0	0
200	–14	–12	–9	–7	–10	–7	–5	–3	–1	0	0	0
190	–14	–12	–9	–7	–11	–8	–6	–4	–3	0	0	0
180	–15	–12	–10	–8	–11	–9	–6	–4	–4	–1	0	0
170	–15	–12	–10	–8	–12	–9	–7	–5	–5	–3	0	0
160	–15	–13	–10	–8	–12	–10	–7	–5	–6	–4	–1	0
150	–15	–13	–10	–8	–13	–10	–8	–6	–7	–5	–2	0
140	–15	–13	–10	–8	–13	–10	–8	–6	–8	–6	–3	–1
130	–15	–13	–10	–8	–13	–11	–8	–6	–9	–6	–4	–2
120	–16	–13	–11	–9	–14	–11	–9	–7	–10	–7	–5	–3

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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–25.2	–32.7	–40.1	–46.1	–34.9	–42.4	–49.8	–55.7	–52.0	–59.5	–67.0	–72.9
250	–23.9	–31.3	–38.8	–44.7	–32.7	–40.2	–47.6	–53.6	–48.2	–55.7	–63.1	–69.1
240	–22.6	–30.0	–37.5	–43.4	–30.6	–38.1	–45.5	–51.4	–44.5	–52.0	–59.5	–65.4
230	–21.3	–28.7	–36.2	–42.1	–28.5	–36.0	–43.4	–49.4	–41.1	–48.5	–55.9	–61.9
220	–20.0	–27.4	–34.8	–40.8	–26.5	–33.9	–41.4	–47.4	–37.6	–45.1	–52.6	–58.5
210	–18.6	–26.1	–33.6	–39.5	–24.5	–31.9	–39.4	–45.4	–34.4	–41.9	–49.3	–55.3
200	–17.4	–24.8	–32.3	–38.2	–22.6	–30.0	–37.5	–43.4	–31.3	–38.8	–46.2	–52.2
190	–16.1	–23.5	–31.0	–37.0	–20.7	–28.1	–35.6	–41.5	–28.4	–35.8	–43.3	–49.2
180	–14.8	–22.3	–29.7	–35.7	–18.9	–26.3	–33.7	–39.7	–25.6	–33.0	–40.5	–46.4
170	–13.6	–21.0	–28.5	–34.4	–17.1	–24.5	–32.0	–38.0	–22.9	–30.3	–37.8	–43.8
160	–12.3	–19.8	–27.2	–33.2	–15.4	–22.8	–30.3	–36.2	–20.4	–27.9	–35.3	–41.2
150	–11.1	–18.6	–26.0	–31.9	–13.7	–21.1	–28.6	–34.6	–18.0	–25.4	–32.9	–38.9
140	–9.8	–17.3	–24.8	–30.7	–12.1	–19.5	–27.0	–32.9	–15.8	–23.2	–30.7	–36.7
130	–8.6	–16.1	–23.5	–29.5	–10.5	–18.0	–25.4	–31.3	–13.7	–21.1	–28.6	–34.5
120	–7.4	–14.9	–22.3	–28.3	–9.0	–16.4	–23.9	–29.8	–11.7	–19.2	–26.6	–32.6

ADVISORY INFORMATION

Slush/Standing Water Takeoff

No Reverse Thrust

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1800					85.2				111.8			
2000	110.4				129.8				150.6	94.9		
2200	159.8	88.5			174.8	110.2			190.2	133.5		
2400	209.4	138.1			220.3	155.0	90.5		230.5	172.7	116.4	
2600	258.9	187.6	116.2		266.2	200.2	135.2	83.7	271.5	212.6	155.3	110.5
2800	308.5	237.2	165.8	108.7		245.9	180.2	128.4		253.4	195.0	149.4
3000		286.6	215.3	158.3		291.9	225.7	173.3		294.5	235.3	188.9
3200			264.8	207.9			271.7	218.8			276.5	229.1
3400				257.3				264.7				270.1
3600				306.9								

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 –65 m/+65 m for every 10 deg. C above/below 0 deg. 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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–16	–11	–6	–2	–8	–3	0	0	0	0	0	0
250	–17	–12	–7	–3	–10	–5	0	0	0	0	0	0
240	–18	–13	–8	–4	–11	–6	–1	0	0	0	0	0
230	–19	–14	–9	–5	–12	–7	–2	0	0	0	0	0
220	–19	–14	–9	–5	–13	–8	–3	0	0	0	0	0
210	–20	–15	–10	–6	–14	–9	–4	0	–2	0	0	0
200	–21	–16	–11	–7	–15	–10	–5	–1	–3	0	0	0
190	–21	–16	–11	–7	–16	–11	–6	–2	–5	0	0	0
180	–22	–17	–12	–8	–17	–12	–7	–3	–7	–2	0	0
170	–23	–18	–13	–9	–18	–13	–8	–4	–9	–4	0	0
160	–23	–18	–13	–9	–19	–14	–9	–5	–11	–6	–1	0
150	–24	–19	–14	–10	–20	–15	–10	–6	–13	–8	–3	0
140	–24	–19	–14	–10	–21	–16	–11	–7	–15	–10	–5	–1
130	–25	–20	–15	–11	–22	–17	–12	–8	–17	–12	–7	–3
120	–26	–21	–16	–12	–23	–18	–13	–9	–18	–13	–8	–4

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

Maximum 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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–10.8	–12.8	–14.8	–16.4	–14.1	–16.1	–18.1	–19.7	–20.3	–22.4	–24.4	–26.0
250	–10.8	–12.8	–14.8	–16.4	–13.7	–15.8	–17.8	–19.4	–19.4	–21.4	–23.4	–25.0
240	–10.7	–12.7	–14.7	–16.4	–13.4	–15.4	–17.4	–19.1	–18.4	–20.4	–22.4	–24.0
230	–10.5	–12.6	–14.6	–16.2	–13.0	–15.0	–17.0	–18.6	–17.4	–19.4	–21.4	–23.0
220	–10.3	–12.3	–14.3	–15.9	–12.4	–14.5	–16.5	–18.1	–16.4	–18.4	–20.4	–22.0
210	–9.9	–12.0	–14.0	–15.6	–11.9	–13.9	–15.9	–17.5	–15.3	–17.3	–19.4	–21.0
200	–9.5	–11.5	–13.5	–15.1	–11.2	–13.2	–15.2	–16.9	–14.3	–16.3	–18.3	–19.9
190	–9.0	–11.0	–13.0	–14.6	–10.5	–12.5	–14.6	–16.1	–13.2	–15.2	–17.2	–18.9
180	–8.3	–10.4	–12.4	–14.0	–9.7	–11.7	–13.7	–15.4	–12.1	–14.2	–16.1	–17.8
170	–7.6	–9.7	–11.7	–13.3	–8.8	–10.9	–12.9	–14.5	–11.0	–13.0	–15.1	–16.6
160	–6.8	–8.8	–10.8	–12.5	–7.9	–9.9	–12.0	–13.6	–9.9	–11.9	–13.9	–15.6
150	–5.9	–7.9	–10.0	–11.6	–6.9	–8.9	–11.0	–12.6	–8.8	–10.8	–12.8	–14.4
140	–4.9	–6.9	–9.0	–10.6	–5.9	–7.9	–9.9	–11.5	–7.6	–9.6	–11.7	–13.2
130	–3.9	–5.9	–7.9	–9.5	–4.7	–6.8	–8.8	–10.4	–6.4	–8.4	–10.5	–12.1
120	–2.7	–4.7	–6.7	–8.3	–3.5	–5.5	–7.5	–9.2	–5.3	–7.3	–9.3	–10.9

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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1400	92.4				96.5				101.8			
1600	132.5				135.2				138.9	86.8		
1800	173.3	116.7			175.0	119.9			177.1	124.1		
2000	215.5	157.0	101.1		216.2	159.2	104.6		216.5	161.9	109.5	
2200	259.3	198.7	141.0	96.5	258.8	199.8	143.6	100.1	257.4	200.8	146.9	105.1
2400	303.8	241.8	182.1	136.3	302.2	241.8	183.6	139.0	298.9	241.1	185.3	142.5
2600		286.1	224.6	177.2		284.8	225.0	178.9		282.3	225.0	180.8
2800			268.7	219.7			268.0	220.2			266.2	220.4
3000				263.4				262.9				261.3

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 –50 m/+50 m for every 10 deg. C above/below 0 deg. 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

Maximum 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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–8	–3	0	0	–6	–1	0	0	–3	0	0	0
250	–9	–4	0	0	–7	–2	0	0	–4	0	0	0
240	–10	–5	0	0	–8	–3	0	0	–5	0	0	0
230	–11	–6	–1	0	–9	–4	0	0	–6	–1	0	0
220	–11	–6	–1	0	–10	–5	0	0	–7	–2	0	0
210	–12	–7	–2	0	–11	–6	–1	0	–8	–3	0	0
200	–13	–8	–3	0	–11	–6	–1	0	–9	–4	0	0
190	–14	–9	–4	0	–12	–7	–2	0	–9	–4	0	0
180	–14	–9	–4	0	–13	–8	–3	0	–10	–5	0	0
170	–15	–10	–5	–1	–13	–8	–3	0	–11	–6	–1	0
160	–15	–10	–5	–1	–14	–9	–4	0	–11	–6	–1	0
150	–15	–10	–5	–1	–14	–9	–4	0	–11	–6	–1	0
140	–16	–11	–6	–2	–14	–9	–4	0	–12	–7	–2	0
130	–16	–11	–6	–2	–15	–10	–5	–1	–12	–7	–2	0
120	–16	–11	–6	–2	–15	–10	–5	–1	–12	–7	–2	0

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.

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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–16.6	–18.1	–19.6	–20.9	–19.9	–21.5	–23.0	–24.2	–26.2	–27.7	–29.3	–30.5
250	–16.6	–18.1	–19.7	–20.9	–19.6	–21.1	–22.7	–23.9	–25.2	–26.7	–28.3	–29.5
240	–16.5	–18.1	–19.6	–20.8	–19.2	–20.7	–22.3	–23.5	–24.1	–25.7	–27.2	–28.5
230	–16.3	–17.8	–19.4	–20.6	–18.7	–20.3	–21.8	–23.0	–23.1	–24.6	–26.2	–27.4
220	–16.0	–17.6	–19.1	–20.3	–18.1	–19.7	–21.2	–22.5	–22.0	–23.6	–25.1	–26.4
210	–15.6	–17.1	–18.7	–19.9	–17.5	–19.1	–20.6	–21.8	–21.0	–22.5	–24.0	–25.3
200	–15.1	–16.6	–18.1	–19.4	–16.8	–18.3	–19.9	–21.1	–19.8	–21.4	–22.9	–24.1
190	–14.4	–16.0	–17.5	–18.8	–16.0	–17.5	–19.1	–20.3	–18.6	–20.2	–21.7	–23.0
180	–13.7	–15.2	–16.8	–18.1	–15.1	–16.6	–18.2	–19.4	–17.5	–19.0	–20.5	–21.8
170	–12.9	–14.4	–16.0	–17.2	–14.2	–15.7	–17.2	–18.5	–16.3	–17.8	–19.4	–20.6
160	–11.9	–13.5	–15.0	–16.2	–13.1	–14.6	–16.1	–17.4	–15.1	–16.6	–18.1	–19.4
150	–10.9	–12.4	–14.0	–15.2	–12.0	–13.5	–15.1	–16.3	–13.8	–15.3	–16.9	–18.1
140	–9.7	–11.2	–12.8	–14.1	–10.8	–12.3	–13.8	–15.1	–12.5	–14.0	–15.6	–16.8
130	–8.5	–10.0	–11.6	–12.8	–9.4	–11.0	–12.5	–13.7	–11.2	–12.7	–14.2	–15.5
120	–7.1	–8.6	–10.2	–11.4	–8.1	–9.6	–11.2	–12.4	–9.8	–11.3	–12.9	–14.2

ADVISORY INFORMATION

Dry Snow Takeoff

No Reverse Thrust

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)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1600									76.0			
1800	95.8				106.8				120.9			
2000	149.4	77.0			156.8	89.3			166.1	105.3		
2200	202.1	130.7			206.5	139.4	71.9		211.6	150.3	89.7	
2400	254.0	183.8	112.0		256.1	189.2	121.9		257.9	195.7	134.5	86.2
2600	305.4	236.1	165.4	107.8	305.4	238.8	171.9	118.0	304.5	241.7	179.8	130.9
2800		287.5	217.9	161.2		288.2	221.6	167.9		288.2	225.6	176.2
3000			269.6	213.9			271.0	217.6			272.0	221.9
3200				265.5				267.1				268.3

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 –55 m/+55 m for every 10 deg. C above/below 0 deg. 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.

Table 3 of 3: V1 Adjustment (KIAS)

WEIGHT (1000 KG)	DRY SNOW DEPTH											
	30 mm (1.18 INCHES)				60 mm (2.36 INCHES)				100 mm (4.00 INCHES)			
	PRESS ALT (FT)				PRESS ALT (FT)				PRESS ALT (FT)			
	S.L.	5000	10000	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–11	–6	–1	0	–9	–4	0	0	–4	0	0	0
250	–12	–7	–2	0	–10	–5	0	0	–6	–1	0	0
240	–13	–8	–3	0	–11	–6	–1	0	–7	–2	0	0
230	–15	–10	–5	–1	–13	–8	–3	0	–9	–4	0	0
220	–16	–11	–6	–2	–14	–9	–4	0	–10	–5	0	0
210	–17	–12	–7	–3	–15	–10	–5	–1	–11	–6	–1	0
200	–18	–13	–8	–4	–16	–11	–6	–2	–13	–8	–3	0
190	–19	–14	–9	–5	–17	–12	–7	–3	–14	–9	–4	0
180	–21	–16	–11	–7	–19	–14	–9	–5	–15	–10	–5	–1
170	–22	–17	–12	–8	–20	–15	–10	–6	–16	–11	–6	–2
160	–23	–18	–13	–9	–21	–16	–11	–7	–17	–12	–7	–3
150	–24	–19	–14	–10	–22	–17	–12	–8	–18	–13	–8	–4
140	–25	–20	–15	–11	–23	–18	–13	–9	–19	–14	–9	–5
130	–26	–21	–16	–12	–24	–19	–14	–10	–20	–15	–10	–6
120	–27	–22	–17	–13	–25	–20	–15	–11	–21	–16	–11	–7

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

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–12.1	–15.1	–18.1	–20.6	–18.3	–21.3	–24.4	–26.8	–34.2	–37.3	–40.3	–42.8
250	–12.0	–15.1	–18.1	–20.5	–17.8	–20.8	–23.9	–26.3	–32.5	–35.6	–38.6	–41.0
240	–11.9	–15.0	–18.0	–20.5	–17.2	–20.2	–23.3	–25.7	–30.7	–33.7	–36.8	–39.2
230	–11.7	–14.7	–17.8	–20.2	–16.5	–19.5	–22.6	–25.0	–28.8	–31.9	–35.0	–37.4
220	–11.4	–14.4	–17.5	–19.9	–15.7	–18.8	–21.8	–24.3	–27.0	–30.0	–33.1	–35.5
210	–10.9	–14.0	–17.1	–19.5	–14.9	–17.9	–21.0	–23.4	–25.1	–28.1	–31.2	–33.6
200	–10.4	–13.5	–16.5	–19.0	–14.0	–17.0	–20.0	–22.5	–23.1	–26.2	–29.2	–31.7
190	–9.8	–12.8	–15.9	–18.3	–12.9	–16.0	–19.1	–21.5	–21.1	–24.2	–27.2	–29.7
180	–9.1	–12.1	–15.1	–17.6	–11.8	–14.9	–17.9	–20.4	–19.1	–22.1	–25.2	–27.6
170	–8.3	–11.3	–14.3	–16.8	–10.7	–13.7	–16.7	–19.2	–17.0	–20.0	–23.1	–25.5
160	–7.3	–10.3	–13.4	–15.8	–9.4	–12.4	–15.5	–17.9	–14.9	–17.9	–21.0	–23.4
150	–6.3	–9.3	–12.4	–14.8	–8.1	–11.1	–14.2	–16.6	–12.7	–15.8	–18.8	–21.2
140	–5.2	–8.2	–11.2	–13.7	–6.6	–9.7	–12.7	–15.1	–10.5	–13.6	–16.6	–19.1
130	–3.9	–7.0	–10.0	–12.5	–5.1	–8.2	–11.2	–13.7	–8.3	–11.3	–14.4	–16.8
120	–2.6	–5.6	–8.7	–11.1	–3.5	–6.6	–9.6	–12.1	–6.0	–9.0	–12.1	–14.5

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1400	91.8				95.3				102.0			
1600	131.9				134.4				138.0	87.6		
1800	172.8	116.1			174.1	119.0			174.7	123.7		
2000	215.0	156.4	100.4		215.0	158.3	103.7		212.3	160.1	109.5	
2200	258.8	198.2	140.5	95.8	257.2	198.8	142.7	99.2	251.1	197.4	145.6	105.3
2400	303.2	241.3	181.6	135.8	300.0	240.4	182.7	138.2	290.2	235.7	182.5	141.4
2600		285.5	224.1	176.7		282.9	223.8	178.0		275.0	220.4	178.2
2800			268.1	219.2			266.2	219.0			259.4	216.0
3000				262.9				261.3			298.8	254.8
3200												294.4

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 –50 m/+50 m for every 10 deg. C above/below 0 deg. 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

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–7	–5	–2	0	–5	–2	0	0	0	0	0	0
250	–8	–6	–3	–1	–5	–3	0	0	0	0	0	0
240	–9	–7	–4	–2	–6	–4	–1	0	0	0	0	0
230	–10	–7	–5	–3	–7	–4	–2	0	0	0	0	0
220	–11	–8	–6	–4	–8	–5	–3	–1	0	0	0	0
210	–12	–9	–7	–5	–9	–6	–4	–2	–1	0	0	0
200	–12	–10	–7	–5	–9	–7	–4	–2	–2	0	0	0
190	–13	–10	–8	–6	–10	–8	–5	–3	–3	0	0	0
180	–14	–11	–9	–7	–11	–8	–6	–4	–4	–1	0	0
170	–14	–12	–9	–7	–12	–9	–7	–5	–5	–3	0	0
160	–15	–12	–10	–8	–13	–10	–8	–6	–6	–4	–1	0
150	–15	–13	–10	–8	–13	–11	–8	–6	–7	–5	–2	0
140	–16	–13	–11	–9	–14	–11	–9	–7	–9	–6	–4	–2
130	–16	–14	–11	–9	–14	–12	–9	–7	–10	–7	–5	–3
120	–17	–14	–12	–10	–15	–13	–10	–8	–11	–8	–6	–4

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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–18.1	–20.8	–23.5	–25.7	–24.7	–27.4	–30.1	–32.3	–40.7	–43.4	–46.2	–48.4
250	–18.0	–20.7	–23.5	–25.6	–24.0	–26.8	–29.5	–31.7	–38.9	–41.6	–44.4	–46.5
240	–17.8	–20.5	–23.3	–25.5	–23.3	–26.0	–28.8	–31.0	–37.0	–39.7	–42.5	–44.7
230	–17.6	–20.3	–23.0	–25.2	–22.5	–25.3	–28.0	–30.2	–35.1	–37.8	–40.6	–42.8
220	–17.1	–19.9	–22.6	–24.8	–21.6	–24.4	–27.1	–29.3	–33.1	–35.8	–38.6	–40.8
210	–16.6	–19.4	–22.1	–24.3	–20.7	–23.4	–26.1	–28.3	–31.1	–33.8	–36.6	–38.7
200	–16.0	–18.8	–21.5	–23.7	–19.6	–22.4	–25.1	–27.3	–29.0	–31.8	–34.5	–36.7
190	–15.3	–18.1	–20.8	–23.0	–18.5	–21.2	–23.9	–26.1	–26.9	–29.6	–32.3	–34.5
180	–14.5	–17.2	–19.9	–22.1	–17.2	–20.0	–22.7	–24.9	–24.6	–27.4	–30.1	–32.3
170	–13.5	–16.2	–19.0	–21.2	–16.0	–18.7	–21.4	–23.6	–22.4	–25.1	–27.9	–30.0
160	–12.4	–15.1	–17.9	–20.1	–14.6	–17.3	–20.0	–22.2	–20.0	–22.8	–25.5	–27.7
150	–11.2	–14.0	–16.7	–18.9	–13.1	–15.8	–18.6	–20.8	–17.7	–20.4	–23.2	–25.4
140	–10.0	–12.7	–15.4	–17.6	–11.5	–14.3	–17.0	–19.2	–15.3	–18.0	–20.7	–23.0
130	–8.6	–11.3	–14.0	–16.2	–9.9	–12.6	–15.4	–17.6	–12.8	–15.5	–18.2	–20.5
120	–7.0	–9.8	–12.5	–14.7	–8.2	–10.9	–13.7	–15.8	–10.3	–13.0	–15.7	–17.9

ADVISORY INFORMATION

Wet Snow Takeoff

No Reverse Thrust

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1600									83.1			
1800	94.9				106.7				126.0			
2000	148.8	76.4			157.0	89.5			168.8	111.4		
2200	201.8	130.4			206.5	140.0	72.4		211.9	154.2	96.8	
2400	253.7	183.8	111.9		255.5	189.8	122.8		255.2	197.2	139.5	93.6
2600	304.9	236.2	165.8	108.1	303.9	238.9	172.8	119.1	298.7	240.4	182.5	136.4
2800		287.5	218.4	161.8		287.4	222.2	169.2		283.8	225.7	179.4
3000			270.0	214.7			270.9	218.7			269.0	222.5
3200				266.2				267.3				265.9

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 –55 m/+55 m for every 10 deg. C above/below 0 deg. 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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–10	–5	0	0	–7	–2	0	0	0	0	0	0
250	–11	–6	–1	0	–8	–3	0	0	0	0	0	0
240	–13	–8	–3	0	–9	–4	0	0	0	0	0	0
230	–14	–9	–4	0	–10	–5	0	0	0	0	0	0
220	–15	–10	–5	–1	–11	–6	–1	0	–1	0	0	0
210	–16	–11	–6	–2	–12	–7	–2	0	–2	0	0	0
200	–17	–12	–7	–3	–14	–9	–4	0	–4	0	0	0
190	–19	–14	–9	–5	–15	–10	–5	–1	–5	0	0	0
180	–20	–15	–10	–6	–16	–11	–6	–2	–7	–2	0	0
170	–21	–16	–11	–7	–18	–13	–8	–4	–9	–4	0	0
160	–22	–17	–12	–8	–19	–14	–9	–5	–11	–6	–1	0
150	–24	–19	–14	–10	–21	–16	–11	–7	–13	–8	–3	0
140	–25	–20	–15	–11	–22	–17	–12	–8	–15	–10	–5	–1
130	–26	–21	–16	–12	–24	–19	–14	–10	–17	–12	–7	–3
120	–27	–22	–17	–13	–25	–20	–15	–11	–20	–15	–10	–6

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

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–2.6	–4.5	–6.4	–7.8	–7.9	–9.8	–11.7	–13.2	–30.1	–31.9	–33.8	–35.3
250	–2.9	–4.8	–6.6	–8.1	–8.5	–10.4	–12.2	–13.7	–29.4	–31.2	–33.1	–34.6
240	–3.1	–4.9	–6.8	–8.3	–8.9	–10.8	–12.6	–14.1	–28.5	–30.3	–32.2	–33.7
230	–3.1	–4.9	–6.8	–8.3	–9.1	–10.9	–12.8	–14.2	–27.5	–29.3	–31.2	–32.7
220	–2.9	–4.8	–6.6	–8.1	–9.0	–10.9	–12.7	–14.2	–26.3	–28.2	–30.0	–31.5
210	–2.5	–4.4	–6.3	–7.8	–8.8	–10.6	–12.5	–14.0	–24.9	–26.8	–28.7	–30.2
200	–2.0	–3.9	–5.8	–7.3	–8.3	–10.2	–12.0	–13.5	–23.5	–25.4	–27.2	–28.7
190	–1.4	–3.2	–5.1	–6.6	–7.6	–9.5	–11.3	–12.8	–21.9	–23.7	–25.6	–27.0
180	–0.6	–2.4	–4.3	–5.8	–6.8	–8.6	–10.5	–12.0	–20.1	–22.0	–23.8	–25.3
170	0.0	–1.9	–3.8	–5.3	–6.0	–7.9	–9.8	–11.2	–18.5	–20.3	–22.2	–23.7
160	0.0	–1.9	–3.7	–5.2	–5.4	–7.3	–9.1	–10.6	–17.0	–18.8	–20.7	–22.2
150	0.0	–1.9	–3.7	–5.2	–4.9	–6.8	–8.7	–10.1	–15.6	–17.5	–19.3	–20.8
140	0.0	–1.9	–3.7	–5.2	–4.6	–6.4	–8.3	–9.8	–14.4	–16.2	–18.1	–19.6
130	0.0	–1.9	–3.7	–5.2	–4.4	–6.3	–8.1	–9.6	–13.3	–15.1	–17.0	–18.5
120	0.0	–1.9	–3.8	–5.3	–4.3	–6.2	–8.0	–9.5	–12.3	–14.2	–16.1	–17.6

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1200	88.29											
1400	138.3	78.7			89.2							
1600	187.6	128.9			130.0							
1800	235.9	178.4	119.4	71.5	171.5	116.1						
2000	283.3	226.9	169.1	121.9	214.6	157.2	102.3					
2200		274.4	217.7	171.5	259.4	199.8	143.0	99.3	105.2			
2400			265.5	220.1	304.9	243.9	185.1	140.0	128.0			
2600				267.8		289.3	228.6	182.0	151.6			
2800							273.7	225.5	176.0	116.3		
3000								270.5	201.4	139.3		
3200									227.9	163.3	104.6	
3400									255.8	188.2	127.4	
3600									284.4	214.1	150.8	104.1
3800										241.2	175.3	127.1
4000										269.6	200.6	150.6
4200											227.1	174.9
4400											254.9	200.3
4600											283.3	226.8
4800												254.6

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 –45 m/+45 m for every 10 deg. C above/below 0 deg. C.
   Adjust "Medium" field length available by –50 m/+50 m for every 10 deg. C above/below 0 deg. C.
   Adjust "Poor" field length available by –90 m/+90 m for every 10 deg. C above/below 0 deg. 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

Maximum 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–6	–4	–1	0	–9	–7	–4	–2	–27	–24	–22	–20
250	–7	–4	–2	0	–10	–8	–5	–3	–28	–26	–23	–21
240	–7	–5	–2	0	–11	–9	–6	–4	–30	–27	–25	–23
230	–8	–5	–3	–1	–12	–9	–7	–5	–31	–29	–26	–24
220	–8	–6	–3	–1	–13	–10	–8	–6	–33	–30	–28	–26
210	–8	–6	–3	–1	–13	–11	–8	–6	–34	–32	–29	–27
200	–9	–6	–4	–2	–14	–12	–9	–7	–35	–33	–30	–28
190	–9	–6	–4	–2	–15	–12	–10	–8	–36	–34	–31	–29
180	–9	–6	–4	–2	–15	–13	–10	–8	–38	–35	–33	–31
170	–9	–6	–4	–2	–16	–13	–11	–9	–39	–36	–34	–32
160	–9	–6	–4	–2	–16	–14	–11	–9	–39	–37	–34	–32
150	–8	–6	–3	–1	–17	–14	–12	–10	–40	–38	–35	–33
140	–8	–6	–3	–1	–17	–14	–12	–10	–41	–39	–36	–34
130	–8	–5	–3	–1	–17	–15	–12	–10	–42	–39	–37	–35
120	–7	–5	–2	0	–18	–15	–13	–11	–42	–40	–37	–35

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.

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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–7.3	–9.4	–11.4	–13.0	–13.7	–15.7	–17.7	–19.3	–42.5	–44.6	–46.6	–48.2
250	–7.5	–9.5	–11.5	–13.2	–14.3	–16.3	–18.3	–20.0	–41.2	–43.2	–45.2	–46.9
240	–7.5	–9.5	–11.5	–13.2	–14.7	–16.7	–18.7	–20.3	–39.7	–41.7	–43.7	–45.4
230	–7.3	–9.3	–11.4	–13.0	–14.8	–16.8	–18.8	–20.5	–38.1	–40.1	–42.1	–43.7
220	–7.0	–9.1	–11.1	–12.7	–14.7	–16.7	–18.7	–20.4	–36.2	–38.2	–40.3	–41.9
210	–6.6	–8.6	–10.6	–12.2	–14.4	–16.4	–18.5	–20.0	–34.3	–36.3	–38.3	–39.9
200	–6.0	–8.0	–10.0	–11.7	–13.9	–15.9	–17.9	–19.5	–32.2	–34.2	–36.2	–37.8
190	–5.3	–7.3	–9.3	–10.9	–13.1	–15.1	–17.1	–18.8	–29.9	–31.9	–33.9	–35.6
180	–4.4	–6.4	–8.4	–10.0	–12.2	–14.2	–16.2	–17.8	–27.6	–29.6	–31.6	–33.2
170	–3.6	–5.7	–7.7	–9.3	–11.3	–13.3	–15.3	–17.0	–25.4	–27.4	–29.4	–31.0
160	–3.0	–5.0	–7.0	–8.7	–10.5	–12.6	–14.6	–16.2	–23.4	–25.4	–27.4	–29.0
150	–2.5	–4.5	–6.5	–8.1	–9.9	–11.9	–13.9	–15.6	–21.6	–23.6	–25.6	–27.3
140	–2.1	–4.1	–6.1	–7.8	–9.3	–11.4	–13.4	–15.0	–20.0	–22.0	–24.1	–25.7
130	–1.9	–3.9	–5.9	–7.5	–8.9	–10.9	–13.0	–14.6	–18.7	–20.7	–22.7	–24.4
120	–1.7	–3.7	–5.8	–7.3	–8.6	–10.7	–12.7	–14.3	–17.6	–19.5	–21.6	–23.2

ADVISORY INFORMATION

Slippery Runway Takeoff
No Reverse Thrust
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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
1400	70.7											
1600	134.9	59.3										
1800	195.8	123.3										
2000	251.5	185.3	111.8		142.2	68.5						
2200	304.0	241.6	174.4	115.0	197.7	125.4						
2400		294.5	231.8	177.8	251.8	181.5	108.6					
2600			285.0	234.9	304.9	236.0	165.1	106.6				
2800				288.1		289.3	220.0	163.0				
3000							273.6	218.1				
3200								271.6				
3800									94.3			
4000									127.4			
4200									161.4			
4400									196.9	117.8		
4600									233.8	151.5		
4800									272.5	186.6	108.4	
5000										223.1	141.8	
5200										261.3	176.5	114.0
5400											212.5	147.7
5600											250.0	182.4
5800											287.6	217.1
6000												251.9
6200												286.7

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 –60 m/+60 m for every 10 deg. C above/below 0 deg. C.
   Adjust "Medium" field length available by –65 m/+65 m for every 10 deg. C above/below 0 deg. C.
   Adjust "Poor" field length available by –145 m/+145 m for every 10 deg. C above/below 0 deg. 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	14000	S.L.	5000	10000	14000	S.L.	5000	10000	14000
260	–9	–4	0	0	–13	–8	–3	0	–44	–39	–34	–30
250	–10	–5	0	0	–14	–9	–4	0	–47	–42	–37	–33
240	–10	–5	0	0	–15	–10	–5	–1	–49	–44	–39	–35
230	–11	–6	–1	0	–16	–11	–6	–2	–52	–47	–42	–38
220	–11	–6	–1	0	–18	–13	–8	–4	–54	–49	–44	–40
210	–12	–7	–2	0	–19	–14	–9	–5	–56	–51	–46	–42
200	–12	–7	–2	0	–20	–15	–10	–6	–58	–53	–48	–44
190	–12	–7	–2	0	–21	–16	–11	–7	–60	–55	–50	–46
180	–13	–8	–3	0	–22	–17	–12	–8	–62	–57	–52	–48
170	–13	–8	–3	0	–23	–18	–13	–9	–64	–59	–54	–50
160	–13	–8	–3	0	–24	–19	–14	–10	–65	–60	–55	–51
150	–13	–8	–3	0	–25	–20	–15	–11	–67	–62	–57	–53
140	–13	–8	–3	0	–26	–21	–16	–12	–68	–63	–58	–54
130	–12	–7	–2	0	–27	–22	–17	–13	–70	–65	–60	–56
120	–12	–7	–2	0	–28	–23	–18	–14	–71	–66	–61	–57

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

Takeoff TPR

Max Takeoff Thrust

Based on anti-ice off

AIRPORT OAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
75	48.3	49.1	49.8	49.0	48.1	47.1	46.1	45.0	44.1	42.9	41.6	40.1	38.6	37.1	35.5	33.6	31.7
70	48.3	49.1	49.8	49.0	48.1	47.1	46.1	45.0	44.1	42.9	41.6	40.1	38.6	37.1	35.5	33.6	31.7
65	55.6	56.9	58.0	57.3	56.5	55.7	54.8	53.9	53.2	52.2	50.9	49.6	48.2	46.8	45.3	43.4	41.4
60	59.3	60.7	62.0	61.4	60.8	60.0	59.2	58.3	57.7	56.8	55.6	54.3	52.9	51.6	50.2	48.2	46.3
55	63.1	64.7	66.1	65.6	65.0	64.3	63.6	62.8	62.2	61.4	60.3	59.0	57.7	56.4	55.0	53.1	51.2
50	67.0	68.8	70.4	69.9	69.3	68.6	67.9	67.2	66.8	66.0	64.9	63.7	62.5	61.2	59.9	58.0	56.1
45	70.4	72.6	74.7	74.3	73.8	73.1	72.5	71.7	71.3	70.6	69.6	68.5	67.3	66.1	64.8	62.9	61.0
40	73.8	76.0	78.1	78.1	78.0	77.8	77.2	76.5	76.0	75.3	74.3	73.2	72.1	70.9	69.7	67.8	65.9
35	74.6	78.3	81.9	81.7	81.5	81.4	81.3	81.4	80.8	80.1	79.1	78.0	76.8	75.7	74.6	72.7	70.8
30	74.8	78.5	82.1	83.2	84.2	84.7	84.7	84.5	85.0	84.7	84.0	83.1	81.9	80.7	79.5	77.6	75.7
25	75.0	78.7	82.3	83.4	84.5	85.6	87.0	88.4	88.2	88.2	87.8	87.3	86.8	85.7	84.5	82.5	80.6
20	75.2	78.9	82.5	83.6	84.7	85.8	87.2	88.7	89.5	90.8	91.0	90.6	90.1	89.6	89.1	87.5	85.6
15	75.4	79.1	82.8	83.9	84.9	86.0	87.4	88.9	89.8	91.2	92.2	92.7	93.3	92.9	92.4	91.1	89.8
10	75.6	79.3	83.0	84.1	85.1	86.2	87.7	89.1	90.0	91.4	92.5	93.3	94.0	94.6	95.1	94.5	93.2
5	75.8	79.5	83.2	84.3	85.3	86.5	87.9	89.4	90.2	91.6	92.7	93.5	94.3	95.0	95.8	95.7	95.4
0	76.0	79.7	83.4	84.5	85.6	86.7	88.1	89.6	90.5	91.9	93.0	93.7	94.5	95.3	96.1	96.0	96.0
–10	76.4	80.1	83.8	85.0	86.0	87.1	88.6	90.1	90.9	92.4	93.5	94.2	95.0	95.8	96.6	96.5	96.5
–20	76.8	80.5	84.3	85.4	86.5	87.6	89.1	90.5	91.4	92.9	93.9	94.7	95.5	96.3	97.1	97.1	97.0
–30	77.2	81.0	84.7	85.8	86.9	88.0	89.5	91.0	91.9	93.3	94.4	95.2	96.0	96.8	97.6	97.6	97.6
–40	77.6	81.4	85.1	86.3	87.4	88.5	90.0	91.5	92.4	93.8	94.9	95.7	96.5	97.3	98.1	98.1	98.1
–50	78.0	81.8	85.6	86.7	87.8	88.9	90.4	91.9	92.8	94.3	95.4	96.2	97.0	97.8	98.6	98.6	98.6

TPR Adjustment for Anti-ice

For OAT≤10 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)							
	–2	0	9	10	11	12	13	14
ENGINE ON	0.0	0.0	0.0	–0.9	–1.0	–1.0	–1.0	–1.0
ENGINE & WING ON	0.0	0.0	0.0	–1.3	–1.4	–1.4	–1.5	–1.5
ENGINE AUTO	0.0	0.0	0.0	–0.9	–1.0	–1.0	–1.0	–1.0
ENGINE & WING AUTO	0.0	0.0	0.0	–1.3	–1.4	–1.4	–1.5	–1.5

For 10 deg. C<OAT≤20 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ENGINE ON	–1.4	–1.5	–1.5	–1.6	–1.6	–1.7	–1.7	–1.8	–1.8	–1.8	–1.9	–1.9	–1.9	–2.0	–2.0	–2.1	–2.2
ENGINE & WING ON	–1.7	–1.8	–1.8	–1.9	–1.9	–2.0	–2.0	–2.1	–2.1	–2.2	–2.2	–2.3	–2.3	–2.4	–2.4	–2.5	–2.6
With engine anti-ice auto or engine and wing anti-ice auto, no adjustment is necessary.																	

ADVISORY INFORMATION

Takeoff TPR
Max Takeoff Thrust
Based on anti-ice off
Minimum Allowable TPR for Reduced Thrust
Based on 25% thrust reduction

MAX TAKEOFF TPR FOR ACTUAL OAT	MIN TAKEOFF TPR ALLOWED
45.0	45.0
50.0	45.0
55.0	45.0
60.0	47.2
65.0	51.0
70.0	54.6
75.0	58.3
80.0	61.8
85.0	65.1
90.0	68.3
95.0	71.0
100.0	73.5
105.0	75.6
110.0	77.8

Go-Around TPR

Based on anti-ice off

REPORTED OAT (deg. C)	TAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
		–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
56	60	61.3	62.7	64.0	63.5	62.9	62.2	61.5	60.7	60.1	59.3	58.2	57.0	55.7	54.4	53.0	51.2	49.3
51	55	65.0	66.6	68.1	67.6	67.0	66.4	65.7	65.0	64.5	63.7	62.7	61.6	60.3	59.0	57.7	55.9	54.0
46	50	68.5	70.4	72.2	71.8	71.3	70.7	70.0	69.3	68.9	68.2	67.2	66.1	64.9	63.7	62.4	60.6	58.8
41	45	71.7	73.8	75.8	75.7	75.6	75.1	74.6	73.9	73.4	72.6	71.7	70.7	69.5	68.4	67.1	65.3	63.5
36	40	73.2	76.6	79.3	79.2	79.1	79.0	78.9	78.6	78.1	77.5	76.6	75.4	74.2	73.0	71.8	70.0	68.2
31	35	73.4	76.8	80.2	81.6	82.7	82.5	82.4	82.2	82.4	82.3	81.6	80.6	79.1	77.8	76.6	74.7	72.9
26	30	73.6	77.0	80.5	81.8	83.0	84.1	85.6	86.2	86.0	86.0	85.7	85.4	84.0	82.9	81.7	79.7	77.7
21	25	73.8	77.2	80.7	82.0	83.2	84.3	85.8	87.3	88.3	89.2	89.0	88.5	87.9	87.3	86.8	84.8	82.8
16	20	74.0	77.4	80.9	82.2	83.4	84.6	86.0	87.5	88.5	89.9	90.7	91.3	91.2	90.7	90.1	88.9	87.6
11	15	74.2	77.6	81.1	82.4	83.6	84.8	86.3	87.8	88.7	90.1	91.2	92.0	92.5	93.0	93.4	92.2	90.9
7	10	74.4	77.8	81.3	82.6	83.9	85.0	86.5	88.0	88.9	90.3	91.4	92.2	92.9	93.6	94.3	94.1	93.9
2	5	74.6	78.0	81.5	82.8	84.1	85.2	86.7	88.2	89.2	90.6	91.7	92.4	93.1	93.8	94.5	94.7	94.7
–3	0	74.8	78.2	81.7	83.1	84.3	85.4	86.9	88.4	89.4	90.8	91.9	92.7	93.4	94.1	94.8	95.0	95.2
–13	–10	75.2	78.6	82.1	83.5	84.7	85.9	87.4	88.9	89.9	91.3	92.4	93.2	93.9	94.6	95.3	95.5	95.7
–23	–20	75.5	79.0	82.5	83.9	85.2	86.3	87.8	89.4	90.3	91.7	92.9	93.6	94.4	95.1	95.8	96.0	96.2
–33	–30	75.9	79.4	83.0	84.3	85.6	86.8	88.3	89.8	90.8	92.2	93.3	94.1	94.8	95.6	96.3	96.5	96.7
–43	–40	76.3	79.8	83.4	84.8	86.0	87.2	88.7	90.3	91.2	92.7	93.8	94.6	95.3	96.0	96.8	97.0	97.2
–53	–50	76.7	80.2	83.8	85.2	86.5	87.6	89.2	90.7	91.7	93.1	94.3	95.1	95.8	96.5	97.3	97.5	97.7

TPR Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)							
	–2	0	9	10	11	12	13	14
ENGINE ON	0.0	0.0	0.0	–0.9	–1.0	–1.0	–1.0	–1.0
ENGINE & WING ON	0.0	0.0	0.0	–1.3	–1.4	–1.4	–1.5	–1.5
ENGINE AUTO	0.0	0.0	0.0	–0.9	–1.0	–1.0	–1.0	–1.0
ENGINE & WING AUTO	0.0	0.0	0.0	–1.3	–1.4	–1.4	–1.5	–1.5

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ENGINE ON	–1.4	–1.5	–1.5	–1.6	–1.6	–1.7	–1.7	–1.8	–1.8	–1.8	–1.9	–1.9	–1.9	–2.0	–2.0	–2.1	–2.2
ENGINE & WING ON	–1.7	–1.8	–1.8	–1.9	–1.9	–2.0	–2.0	–2.1	–2.1	–2.2	–2.2	–2.3	–2.3	–2.4	–2.4	–2.5	–2.6
With engine anti-ice auto or engine and wing anti-ice auto, no adjustment is necessary.																	

Max Climb TPR

Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)									
	0	5	10	15	20	25	30	35	40	43
	310	310	310	310	310	310	310	0.85	0.85	0.85
60	48.7	48.8	51.0	55.4	57.9	62.0	66.6	74.1	72.0	70.9
50	55.3	55.0	54.0	55.4	57.9	62.0	66.6	74.1	72.0	70.9
40	61.8	62.6	61.5	60.9	59.2	62.0	66.6	74.1	72.0	70.9
30	63.5	69.9	69.3	69.8	67.9	67.3	67.7	74.1	72.0	70.9
20	63.9	70.2	75.5	78.1	77.2	76.4	76.6	76.6	72.5	71.4
15	64.0	70.4	75.7	81.8	81.4	81.1	81.2	80.7	76.8	75.7
10	64.2	70.6	75.9	82.0	85.8	85.5	85.7	84.9	81.1	80.0
5	64.3	70.8	76.0	82.2	87.1	89.7	90.0	89.1	85.5	84.4
0	64.5	70.9	76.2	82.4	87.3	91.8	94.0	93.4	90.0	88.7
–5	64.7	71.1	76.4	82.6	87.5	92.0	96.2	97.2	94.3	93.3
–10	64.8	71.3	76.6	82.8	87.7	92.2	96.4	101.4	98.5	97.7
–15	65.0	71.5	76.8	83.0	87.9	92.4	96.7	102.6	101.7	100.8
–20	65.1	71.6	77.0	83.2	88.1	92.7	96.9	102.9	101.9	101.1
–25	65.3	71.8	77.2	83.4	88.3	92.9	97.1	103.1	102.1	101.3
–30	65.5	72.0	77.4	83.6	88.5	93.1	97.3	103.4	102.4	101.5
–35	65.6	72.2	77.5	83.8	88.8	93.3	97.6	103.6	102.6	101.8
–40	65.8	72.3	77.7	84.0	89.0	93.5	97.8	103.8	102.8	102.0

TPR Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	43
ENGINE ON	0.0	0.0	0.0	–1.1	–1.3	–1.7	–1.9	–2.5	–3.4	–4.3
ENGINE & WING ON	0.0	0.0	0.0	–1.6	–2.0	–2.5	–3.0	–3.9	–5.4	–7.0

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	43
ENGINE ON	–0.7	–0.9	–1.0	–1.2	–1.4	–1.7	–1.9	–2.5	–3.4	–4.2
ENGINE & WING ON	–1.1	–1.2	–1.4	–1.7	–2.0	–2.6	–3.0	–3.9	–5.4	–6.8

Flight With Unreliable Airspeed

Altitude and/or vertical speed indications may also be unreliable.

Climb

Flaps Up, Set Max Climb Thrust

Based on 270 KIAS/260 KIAS

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		130	150	170	190	210	230	250
40000 (260 KIAS)	PITCH ATT	3.0	3.0	3.0				
	V/S (FT/MIN)	1000	700	500				
38000 (270 KIAS)	PITCH ATT	3.0	3.0	3.0	3.0			
	V/S (FT/MIN)	1200	1000	700	500			
35000 (270 KIAS)	PITCH ATT	3.5	3.5	3.5	3.5	4.0		
	V/S (FT/MIN)	1800	1400	1100	900	600		
30000 (270 KIAS)	PITCH ATT	4.5	4.5	4.5	4.5	4.5	4.5	4.5
	V/S (FT/MIN)	2300	1900	1600	1300	1000	800	600
25000 (270 KIAS)	PITCH ATT	6.0	5.5	5.5	5.5	5.5	5.5	5.5
	V/S (FT/MIN)	3000	2500	2100	1800	1500	1200	1000
20000 (270 KIAS)	PITCH ATT	7.5	7.0	6.5	6.5	6.5	6.5	6.5
	V/S (FT/MIN)	3700	3100	2600	2300	1900	1700	1400
10000 (270 KIAS)	PITCH ATT	10.5	9.5	9.0	8.5	8.5	8.0	8.0
	V/S (FT/MIN)	4900	4200	3600	3100	2700	2400	2100
SEA LEVEL (270 KIAS)	PITCH ATT	13.5	12.0	11.0	10.5	10.0	9.5	9.5
	V/S (FT/MIN)	5600	4800	4200	3700	3200	2900	2500

Cruise

Flaps Up, Set Thrust for Level Flight

Based on 270 KIAS/260 KIAS

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		130	150	170	190	210	230	250
40000 (260 KIAS)	PITCH ATT	1.5	2.0	2.5	3.0			
	TPR	69.4	73.5	79.5	88.9			
	(Alt Mode %N1)	(81.5)	(83.0)	(85.2)	(88.2)			
38000 (270 KIAS)	PITCH ATT	1.5	2.0	2.0	2.5	3.0		
	TPR	66.2	69.4	73.7	79.3	87.3		
	(Alt Mode %N1)	(80.2)	(81.4)	(83.0)	(85.0)	(87.6)		
35000 (270 KIAS)	PITCH ATT	1.5	2.0	2.0	2.5	3.0	3.5	3.5
	TPR	59.6	62.4	66.1	70.4	75.9	83.0	92.7
	(Alt Mode %N1)	(76.7)	(78.0)	(79.6)	(81.3)	(83.4)	(85.9)	(89.2)
30000 (270 KIAS)	PITCH ATT	1.5	2.0	2.5	2.5	3.0	3.5	4.0
	TPR	51.2	53.5	56.2	59.4	63.2	68.2	74.2
	(Alt Mode %N1)	(72.7)	(73.9)	(75.4)	(76.9)	(78.8)	(81.0)	(83.5)
25000 (270 KIAS)	PITCH ATT	1.5	2.0	2.5	3.0	3.0	3.5	4.0
	TPR	44.1	45.8	47.9	50.4	53.2	57.0	61.1
	(Alt Mode %N1)	(68.7)	(69.9)	(71.4)	(72.8)	(74.4)	(76.4)	(78.5)
20000 (270 KIAS)	PITCH ATT	1.5	2.0	2.5	3.0	3.5	3.5	4.0
	TPR	38.1	39.4	41.1	43.0	45.1	48.0	51.2
	(Alt Mode %N1)	(64.7)	(65.8)	(67.2)	(68.6)	(70.1)	(72.0)	(73.9)
15000 (270 KIAS)	PITCH ATT	1.5	2.0	2.5	3.0	3.5	4.0	4.0
	TPR	33.1	34.2	35.5	37.1	38.7	40.9	43.5
	(Alt Mode %N1)	(60.8)	(61.9)	(63.0)	(64.4)	(65.8)	(67.6)	(69.5)

Flight With Unreliable Airspeed

Altitude and/or vertical speed indications may also be unreliable.

Descent

Flaps Up, Set Idle Thrust

Based on 270 KIAS/260 KIAS

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		130	150	170	190	210	230	250
40000	PITCH ATT	–0.5	–0.0	0.5	0.5	1.0	1.0	1.5
(260 KIAS)	V/S (FT/MIN)	–2000	–1800	–1800	–1800	–1900	–2000	–2300
38000	PITCH ATT	–1.0	–0.5	0.0	0.5	1.0	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–2100	–2000	–1800	–1800	–1800	–1900	–2000
35000	PITCH ATT	–1.5	–1.0	0.0	0.5	0.5	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–2300	–2100	–2000	–1900	–1900	–1900	–1900
30000	PITCH ATT	–1.5	–1.0	–0.5	0.5	0.5	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–2300	–2100	–1900	–1800	–1800	–1800	–1800
25000	PITCH ATT	–1.5	–1.0	–0.5	0.0	0.5	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–2200	–2000	–1900	–1800	–1700	–1700	–1700
20000	PITCH ATT	–1.5	–1.0	–0.5	0.0	0.5	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–2100	–1900	–1800	–1700	–1600	–1600	–1600
10000	PITCH ATT	–2.0	–1.5	–0.5	0.0	0.5	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–1900	–1800	–1600	–1600	–1500	–1500	–1500
SEA LEVEL	PITCH ATT	–2.0	–1.5	–0.5	0.0	0.5	1.0	1.5
(270 KIAS)	V/S (FT/MIN)	–1700	–1500	–1400	–1300	–1300	–1300	–1300

Holding

Flaps Up, Set Thrust for Level Flight

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		130	150	170	190	210	230	250
10000	PITCH ATT	3.5	4.0	4.0	4.5	4.5	4.5	5.0
	TPR	24.3	26.5	28.9	31.1	33.2	35.5	37.7
	(Alt Mode %N1)	(50.7)	(53.3)	(55.8)	(58.4)	(60.7)	(63.0)	(65.1)
	KIAS	206	215	224	233	245	256	258
5000	PITCH ATT	3.5	4.0	4.5	4.5	4.5	4.5	5.0
	TPR	21.2	23.1	25.0	27.0	28.9	30.9	32.7
	(Alt Mode %N1)	(47.4)	(50.0)	(52.5)	(54.7)	(57.0)	(59.3)	(61.2)
	KIAS	206	214	223	232	245	256	258

Flight With Unreliable Airspeed

Altitude and/or vertical speed indications may also be unreliable.

Terminal Area (5000 FT)

Set Thrust for Level Flight

FLAP/GEAR POSITION		WEIGHT (1000 KG)						
		130	150	170	190	210	230	250
FLAPS UP GEAR UP	PITCH ATT	3.5	4.0	4.0	4.5	4.5	4.5	5.0
	TPR	21.4	23.3	25.4	27.4	29.6	31.6	33.5
	(Alt Mode %N1)	(48.5)	(51.2)	(53.8)	(56.1)	(58.6)	(61.1)	(63.0)
	KIAS	206	215	223	232	245	256	258
FLAPS 1 GEAR UP	PITCH ATT	5.5	5.5	6.0	6.0	6.0	6.0	6.0
	TPR	21.9	24.0	26.3	28.6	30.9	33.1	35.3
	(Alt Mode %N1)	(49.0)	(51.8)	(54.5)	(57.2)	(59.8)	(62.1)	(64.3)
	KIAS	181	190	201	212	223	234	238
FLAPS 5 GEAR UP	PITCH ATT	2.5	3.0	3.0	3.0	3.5	3.5	4.0
	TPR	22.3	24.6	27.0	29.3	31.7	34.0	36.6
	(Alt Mode %N1)	(49.4)	(52.2)	(55.1)	(57.9)	(60.4)	(62.7)	(65.3)
	KIAS	166	175	183	192	200	207	208
FLAPS 15 GEAR UP	PITCH ATT	3.0	3.5	3.5	3.5	4.0	4.0	4.0
	TPR	23.3	25.9	28.5	36.6	33.8	36.4	39.0
	(Alt Mode %N1)	(50.1)	(53.4)	(56.6)	(59.5)	(62.2)	(64.8)	(67.1)
	KIAS	146	154	163	172	180	187	193
FLAPS 20 GEAR DOWN	PITCH ATT	3.5	3.5	3.5	3.5	3.5	3.5	4.0
	TPR	30.7	34.0	37.5	41.1	44.7	48.4	51.4
	(Alt Mode %N1)	(58.6)	(62.1)	(65.0)	(68.5)	(71.4)	(74.1)	(76.1)
	KIAS	141	149	158	167	175	182	188

Final Approach (1500 FT)

Gear Down, Set Thrust for 3° Glideslope

FLAP POSITION		WEIGHT (1000 KG)						
		130	150	170	190	210	230	250
FLAPS 20	PITCH ATT	0.5	0.5	0.5	0.5	0.5	0.5	1.0
	TPR	17.7	19.2	20.6	22.1	23.6	25.1	26.3
	(Alt Mode %N1)	(42.2)	(44.7)	(47.1)	(49.3)	(50.9)	(52.7)	(54.3)
	KIAS	132	149	158	166	175	183	189
Pitch and power from the above table will result in a speed of approximately VREF 20+10 KIAS.								

Go-Around

Flaps 20, Gear Up, Set Go-Around Thrust

Table 1(a): Normal Mode

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		130	150	170	190	210	230	250
10000	PITCH ATT	14.0	12.0	10.0	8.5	7.5	6.5	6.0
	VS (FT/MIN)	3700	3100	2700	2300	2000	1700	1500
	KIAS	141	150	159	167	176	183	188
5000	PITCH ATT	17.0	14.5	12.5	10.5	9.5	8.5	7.5
	VS (FT/MIN)	4200	3700	3200	2800	2500	2200	1900
	KIAS	141	149	158	167	175	182	188
SEA LEVEL	PITCH ATT	20.0	17.0	14.5	12.5	11.0	10.0	9.0
	VS (FT/MIN)	4600	4000	3500	3100	2800	2500	2200
	KIAS	141	149	158	166	174	182	188

Flight With Unreliable Airspeed

Altitude and/or vertical speed indications may also be unreliable.

Go-Around

Flaps 20, Gear Up, Set Go-Around Thrust

Table 1(b): Alternate Mode EEC

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)						
		130	150	170	190	210	230	250
10000	PITCH ATT	12.5	10.5	9.0	7.5	6.5	6.0	5.5
	VS (FT/MIN)	3300	2800	2400	2000	1700	1400	1200
	KIAS	141	150	159	167	176	183	188
5000	PITCH ATT	15.0	12.5	11.0	9.5	8.0	7.0	6.5
	VS (FT/MIN)	3700	3200	2700	2400	2100	1800	1500
	KIAS	141	149	158	167	175	182	188
SEA LEVEL	PITCH ATT	17.5	14.5	12.5	11.0	9.5	8.5	7.5
	VS (FT/MIN)	4000	3500	3000	2600	2300	2000	1800
	KIAS	141	149	158	166	174	182	188

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps Up and 1

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
196	195	195	196	196	197	198	199	200
200	199	199	199	200	201	202	203	204
204	202	203	203	204	205	205	206	207
208	206	207	207	208	208	209	210	211
212	210	211	211	211	212	213	213	214
216	214	214	215	215	216	216	217	218
220	218	218	219	219	220	220	221	222
230	228	228	228	229	229	230	230	231
240	238	238	238	238	239	239	240	240
260	258	258	258	258	258	258	259	259
280	278	278	278	278	278	278	278	278
300	299	298	298	298	298	298	298	298
320	319	318	318	318	318	317	317	317
340	339	339	338	338	338	337	337	337
360	360	359	359	358	358	358	357	357

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
196	30	20	10	–10	–20	–40	–60	–90
200	30	20	10	0	–20	–40	–60	–80
204	30	30	20	0	–10	–30	–50	–70
208	40	30	20	10	–10	–20	–40	–60
212	40	30	20	10	0	–20	–30	–50
216	40	40	30	20	10	–10	–30	–40
220	40	40	30	20	10	0	–20	–40
230	50	50	40	30	20	10	0	–20
240	50	50	50	40	30	20	10	0
260	50	60	60	60	60	50	40	30
280	50	60	70	70	70	70	60	50
300	50	60	70	80	80	80	80	80
320	40	60	70	80	90	90	100	100
340	30	50	70	80	90	100	110	110
360	10	40	60	80	90	100	110	120
Actual altitude = ISFD altitude + pressure altitude adjustment.								

Flaps 5

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
156	154	154	155	156	157	159	161	163
160	158	158	159	159	161	162	164	166
164	162	162	162	163	164	165	167	168
168	166	166	166	167	167	169	170	171
172	170	170	170	170	171	172	173	175
176	174	174	174	174	175	175	177	178
180	178	178	178	178	178	179	180	181
190	188	188	188	188	188	188	189	190
200	198	197	197	198	198	198	198	199
210	208	207	207	207	207	207	208	208
220	218	217	217	217	217	217	217	218
230	228	227	227	227	227	227	227	227
240	238	237	237	237	237	237	237	237

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 5

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
156	30	30	20	0	–20	–50	–80	–120
160	30	30	20	10	–10	–30	–60	–90
164	40	30	30	20	0	–20	–50	–80
168	40	40	30	20	10	–10	–30	–60
172	40	40	40	30	20	0	–20	–50
176	40	40	40	30	20	10	–10	–30
180	50	40	40	40	30	20	0	–20
190	50	50	50	50	40	40	20	10
200	50	60	60	50	50	50	40	30
210	60	60	60	60	60	60	50	50
220	60	60	70	70	70	70	60	60
230	60	70	70	70	80	70	70	70
240	50	70	80	80	80	80	80	80
Actual altitude = ISFD altitude + pressure altitude adjustment.								

Flaps 15

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
140	138	138	139	141	142	145	153	
144	142	142	143	144	146	147	151	161
148	146	146	146	147	149	150	152	158
152	150	150	150	151	152	154	155	158
156	154	154	154	154	155	157	158	160
160	158	157	158	158	159	160	161	163
170	168	167	167	167	168	169	170	171
180	178	177	177	177	177	178	178	179
190	188	188	187	187	187	187	187	188
200	198	198	197	197	197	197	197	197
210	208	208	207	207	207	207	207	207
220	218	218	218	217	217	217	217	217

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
140	30	20	10	–10	–40	–70	–170	
144	40	30	20	0	–20	–50	–100	–220
148	40	30	30	10	–10	–40	–70	–140
152	40	40	30	20	0	–20	–50	–90
156	40	40	40	30	10	–10	–40	–60
160	40	40	40	30	20	0	–20	–50
170	40	50	50	50	40	30	10	–10
180	40	50	50	60	50	50	40	20
190	40	50	60	60	60	60	60	40
200	40	50	60	60	70	70	70	60
210	40	50	60	70	70	80	80	80
220	40	50	60	70	70	80	80	80
Actual altitude = ISFD altitude + pressure altitude adjustment.								

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 20

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
136	133	134	134	135	137	142		
140	137	137	138	138	140	143	149	
144	141	141	141	142	143	145	148	156
148	145	145	145	146	146	147	150	154
152	149	149	149	149	150	151	152	155
156	153	153	153	153	153	154	155	157
160	158	157	157	157	157	158	158	160
170	168	167	167	167	167	167	167	168
180	178	177	177	177	177	177	177	177
190	188	188	187	187	187	186	186	186
200	199	198	197	197	197	196	196	196
210	209	208	208	207	207	207	206	206
220		219	218	217	217	217	216	216

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
136	40	40	30	20	–20	–80		
140	40	40	40	30	0	–40	–120	
144	40	40	40	30	20	–10	–60	–160
148	40	50	40	40	30	10	–30	–100
152	40	50	50	40	40	20	0	–50
156	40	50	50	50	40	30	20	–20
160	40	50	50	50	50	40	30	10
170	40	50	60	60	60	60	50	40
180	40	50	60	60	70	70	70	60
190	40	50	60	70	70	80	80	70
200	30	50	60	60	70	80	80	90
210	30	40	50	60	70	80	90	90
220		30	50	60	70	80	90	100

Actual altitude = ISFD altitude + pressure altitude adjustment.

GEAR DOWN

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps Up

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
190	188	189	189	190	191	192	194	196
200	198	198	199	200	200	201	202	204
210	208	208	208	209	210	210	211	212
220	218	218	218	218	219	220	220	221
230	228	228	228	228	228	229	230	230
240	238	238	238	238	238	238	239	239
260	258	258	258	258	258	258	258	258
280	279	278	278	278	278	278	278	278

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
190	30	20	10	0	–20	–50	–80	–120
200	40	30	20	10	–10	–20	–50	–80
210	40	40	40	20	10	–10	–20	–50
220	50	50	40	40	20	10	–10	–20
230	50	50	50	50	40	30	10	0
240	50	60	60	60	50	40	30	10
260	50	60	70	70	70	60	60	50
280	40	60	70	80	80	80	80	70
Actual altitude = ISFD altitude + pressure altitude adjustment.								

Flaps 5

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
156	154	154	155	156	157	159	161	163
160	158	158	159	159	161	162	164	166
164	162	162	162	163	164	165	167	168
168	166	166	166	167	167	169	170	171
172	170	170	170	170	171	172	173	175
176	174	174	174	174	175	175	177	178
180	178	178	178	178	178	179	180	181
190	188	188	188	188	188	188	189	190
200	198	197	197	198	198	198	198	199
210	208	207	207	207	207	207	208	208
220	218	217	217	217	217	217	217	218
230	228	227	227	227	227	227	227	227
240	238	237	237	237	237	237	237	237

GEAR DOWN

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 5

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
156	30	30	20	0	–20	–50	–80	–120
160	30	30	20	10	–10	–30	–60	–90
164	40	30	30	20	0	–20	–50	–80
168	40	40	30	20	10	–10	–30	–60
172	40	40	40	30	20	0	–20	–50
176	40	40	40	30	20	10	–10	–30
180	50	40	40	40	30	20	0	–20
190	50	50	50	50	40	40	20	10
200	50	60	60	50	50	50	40	30
210	60	60	60	60	60	60	50	50
220	60	60	70	70	70	70	60	60
230	60	70	70	70	80	70	70	70
240	50	70	80	80	80	80	80	80
Actual altitude = ISFD altitude + pressure altitude adjustment.								

Flaps 20

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
136	133	134	134	135	137	142		
140	137	137	138	138	140	143	149	
144	141	141	141	142	143	145	148	156
148	145	145	145	146	146	147	150	154
152	149	149	149	149	150	151	152	155
156	153	153	153	153	153	154	155	157
160	158	157	157	157	157	158	158	160
170	168	167	167	167	167	167	167	168
180	178	177	177	177	177	177	177	177
190	188	188	187	187	187	186	186	186
200	199	198	197	197	197	196	196	196
210	209	208	208	207	207	207	206	206
220		219	218	217	217	217	216	216

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
136	40	40	30	20	–20	–80		
140	40	40	40	30	0	–40	–120	
144	40	40	40	30	20	–10	–60	–160
148	40	50	40	40	30	10	–30	–100
152	40	50	50	40	40	20	0	–50
156	40	50	50	50	40	30	20	–20
160	40	50	50	50	50	40	30	10
170	40	50	60	60	60	60	50	40
180	40	50	60	60	70	70	70	60
190	40	50	60	70	70	80	80	70
200	30	50	60	60	70	80	80	90
210	30	40	50	60	70	80	90	90
220		30	50	60	70	80	90	100
Actual altitude = ISFD altitude + pressure altitude adjustment.								

GEAR DOWN

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 25

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
120	118	119	122	128				
124	122	122	124	128				
128	126	126	127	129	135			
132	129	130	130	132	135			
136	133	133	134	135	137	141		
140	137	137	138	138	140	142	147	
144	141	141	141	142	143	145	148	154
148	145	145	145	145	146	147	150	154
152	149	149	149	149	150	150	152	155
156	153	153	153	153	153	154	155	157
160	157	157	157	157	157	157	158	160
170	167	167	167	167	167	167	167	168
180	177	177	177	177	176	176	177	177
190	187	187	187	186	186	186	186	186

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
120	30	10	–20	–90				
124	30	20	0	–50				
128	30	30	10	–20	–80			
132	40	30	20	0	–40			
136	40	40	30	20	–10	–70		
140	40	40	40	30	10	–30	–100	
144	40	40	40	30	20	–10	–60	–140
148	50	50	50	40	30	10	–20	–80
152	50	50	50	50	40	30	0	–40
156	50	50	50	50	50	40	20	–10
160	50	50	60	50	50	40	30	10
170	50	60	60	60	60	60	50	40
180	50	60	70	70	70	70	70	60
190	50	60	70	70	80	80	80	80
Actual altitude = ISFD altitude + pressure altitude adjustment.								

Flaps 30

Table 1 of 2: ISFD Airspeed

TARGET AIRSPEED (KIAS)	ISFD AIRSPEED (KIAS)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
120	117	117	119	125				
124	121	121	122	125	133			
128	125	125	125	127	131	140		
132	129	129	129	130	132	138		
136	133	133	133	133	134	138	145	
140	137	137	137	137	137	139	144	152
144	141	141	141	141	141	142	144	150
148	145	145	145	145	145	145	147	150
152	149	149	149	148	148	149	149	151
156	153	153	153	152	152	152	153	154
160	157	157	157	156	156	156	156	157
170	167	167	167	166	166	166	166	166
180	177	177	177	176	176	176	176	176

GEAR DOWN

ISFD Airspeed and Altitude Correction

Applicable to low speed operations below 15,000 ft pressure altitude

Flaps 30

Table 2 of 2: Pressure Altitude Adjustment

ISFD AIRSPEED (KIAS)	ISFD PRESSURE ALTITUDE ADJUSTMENT (FT)							
	WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
120	40	30	10	–60				
124	40	40	30	–10	–100			
128	40	40	40	20	–40	–150		
132	40	40	40	30	0	–80		
136	40	50	50	40	20	–20	–120	
140	40	50	50	50	40	10	–60	–160
144	50	50	50	50	50	30	0	–90
148	50	50	50	60	60	50	20	–30
152	50	50	60	60	60	60	40	10
156	50	50	60	60	60	60	60	40
160	50	50	60	60	60	70	60	50
170	50	60	60	70	70	70	80	80
180	50	60	60	70	70	80	80	80

Actual altitude = ISFD altitude + pressure altitude adjustment.

Long Range Cruise Maximum Operating Altitude
Max Climb Thrust
ISA + 10 deg. C and Below

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33º)	1.30 (39º)
260	31800	–4	34400*	34400*
250	32600	–6	35300*	35300*
240	33500	–8	36100*	36100*
230	34400	–10	36900*	36900*
220	35300	–12	37800*	37800*
210	36300	–14	38700*	38700*
200	37300	–14	39600*	39600*
190	38400	–14	40600*	40600*
180	39500	–14	41600*	41600*
170	40700	–14	42600*	42600*
160	41900	–14	43100	43100
150	43100	–14	43100	43100
140	43100	–14	43100	43100
130	43100	–14	43100	43100
120	43100	–14	43100	43100
110	43100	–14	43100	43100

*Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.

ISA + 15 deg. C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33º)	1.30 (39º)
260	31800	2	33500*	33500*
250	32600	0	34500*	34500*
240	33500	–2	35300*	35300*
230	34400	–4	36100*	36100*
220	35300	–6	37000*	37000*
210	36300	–8	37900*	37900*
200	37300	–8	38800*	38800*
190	38400	–8	39700*	39700*
180	39500	–8	40600*	40600*
170	40700	–8	41500*	41500*
160	41900	–8	42500*	42500*
150	43100	–8	43100	43100
140	43100	–8	43100	43100
130	43100	–8	43100	43100
120	43100	–8	43100	43100
110	43100	–8	43100	43100

*Denotes altitude thrust limited in level flight, 300 fpm residual rate of climb.

Long Range Cruise Maximum Operating Altitude
Max Climb Thrust
ISA + 20 deg. C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (deg. C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)	
			1.20 (33º)	1.30 (39º)
260	31800	8	30600*	30600*
250	32600	6	32400*	32400*
240	33500	4	34100*	34100*
230	34400	2	35300*	35300*
220	35300	0	36100*	36100*
210	36300	–2	36900*	36900*
200	37300	–2	37700*	37700*
190	38400	–2	38600*	38600*
180	39500	–2	39500*	39500*
170	40700	–2	40400*	40400*
160	41900	–2	41300*	41300*
150	43100	–2	42200*	42200*
140	43100	–2	43100	43100
130	43100	–2	43100	43100
120	43100	–2	43100	43100
110	43100	–2	43100	43100

***Denotes altitude thrust limited in level flight, 300 fpm 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
260	TPR	63.9	68.3	73.1	**78.6**	**85.2**	96.3				
	MACH	.794	.826	.849	**.853**	**.850**	.843				
	KIAS	335	335	331	**319**	**304**	288				
	FF/ENG	3562	3612	3629	**3576**	**3508**	3603				
240	TPR	60.3	64.3	68.8	**73.7**	**79.2**	86.9				
	MACH	.764	.796	.829	**.850**	**.853**	.849				
	KIAS	321	322	323	**318**	**306**	291				
	FF/ENG	3228	3266	3313	**3313**	**3246**	3221				
220	TPR	56.7	60.3	64.3	68.7	**73.6**	**79.5**	87.5			
	MACH	.734	.764	.797	.830	**.851**	**.853**	.848			
	KIAS	308	308	309	310	**305**	**292**	277			
	FF/ENG	2911	2927	2964	2993	**2983**	**2930**	2931			
200	TPR	53.3	56.7	60.4	64.4	68.9	**73.9**	**79.9**	87.9		
	MACH	.704	.731	.762	.796	.829	**.851**	**.853**	.848		
	KIAS	294	294	294	296	296	**291**	**279**	265		
	FF/ENG	2632	2631	2649	2681	2706	**2700**	**2662**	2682		
180	TPR	50.0	53.2	56.6	60.3	64.3	68.9	**73.9**	**79.9**	87.7	
	MACH	.675	.699	.726	.756	.791	.826	**.850**	**.853**	.849	
	KIAS	281	280	279	280	281	282	**278**	**267**	253	
	FF/ENG	2371	2362	2360	2375	2404	2435	**2447**	**2426**	2447	
160	TPR	46.6	49.5	52.6	56.1	59.8	63.8	68.4	73.5	**79.2**	**86.6**
	MACH	.644	.667	.691	.718	.748	.782	.818	.846	**.853**	**.851**
	KIAS	268	266	265	264	264	265	266	264	**255**	**242**
	FF/ENG	2119	2107	2095	2091	2103	2133	2171	2207	**2201**	**2211**
140	TPR	43.0	45.7	48.6	51.7	55.1	58.7	62.8	67.4	72.3	**77.6**
	MACH	.611	.633	.656	.679	.706	.735	.768	.804	.837	**.853**
	KIAS	253	252	250	249	248	248	248	249	249	**243**
	FF/ENG	1873	1860	1849	1835	1828	1843	1871	1917	1959	**1972**
120	TPR	39.3	41.7	44.3	47.1	50.2	53.5	57.2	61.2	65.5	70.2
	MACH	.574	.595	.617	.639	.663	.688	.716	.747	.783	.818
	KIAS	237	236	235	233	232	231	230	230	231	232
	FF/ENG	1633	1620	1608	1596	1585	1582	1589	1618	1654	1696

Boldface area approximates optimum altitude.

Long Range Cruise Enroute Fuel and Time—Low Altitude

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
279	259	241	226	212	200	191	182	174	167	161
555	516	481	451	424	400	383	367	352	338	325
831	773	721	676	636	600	574	550	528	508	489
1108	1030	961	901	848	800	766	734	705	678	653
1386	1288	1201	1126	1060	1000	957	918	881	848	817
1664	1547	1442	1351	1272	1200	1149	1102	1059	1018	981
1943	1806	1683	1577	1484	1400	1341	1286	1235	1188	1145
2223	2065	1924	1803	1696	1600	1532	1469	1410	1357	1308
2504	2326	2167	2029	1909	1800	1724	1652	1587	1527	1472
2785	2587	2409	2256	2121	2000	1915	1836	1763	1696	1635

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		20		24		28	
	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	3.0	0:38	2.6	0:37	2.1	0:35	1.9	0:34	1.6	0:33
400	6.3	1:11	5.6	1:08	4.9	1:04	4.5	1:02	4.1	0:59
600	9.6	1:44	8.7	1:40	7.7	1:34	7.1	1:30	6.6	1:25
800	12.8	2:18	11.7	2:12	10.5	2:03	9.8	1:58	9.1	1:52
1000	16.0	2:51	14.7	2:44	13.2	2:33	12.3	2:26	11.6	2:18
1200	19.2	3:25	17.7	3:16	15.9	3:03	14.9	2:54	14.0	2:45
1400	22.4	4:00	20.6	3:48	18.6	3:33	17.5	3:23	16.4	3:11
1600	25.5	4:34	23.6	4:21	21.3	4:03	20.0	3:51	18.8	3:38
1800	28.7	5:09	26.5	4:54	24.0	4:33	22.5	4:20	21.2	4:05
2000	31.8	5:43	29.4	5:27	26.6	5:04	25.0	4:49	23.6	4:33

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)							
	120	140	160	180	200	220	240	260
2	–0.3	–0.2	–0.2	–0.1	–0.1	0.0	0.1	0.2
4	–0.8	–0.7	–0.5	–0.3	–0.2	0.0	0.2	0.5
6	–1.3	–1.0	–0.8	–0.5	–0.3	0.0	0.4	0.8
8	–1.7	–1.4	–1.1	–0.7	–0.4	0.0	0.5	1.1
10	–2.2	–1.8	–1.3	–0.9	–0.5	0.0	0.6	1.4
12	–2.6	–2.1	–1.6	–1.1	–0.5	0.0	0.8	1.6
14	–3.1	–2.5	–1.9	–1.3	–0.6	0.0	0.9	1.9
16	–3.5	–2.9	–2.2	–1.5	–0.7	0.0	1.0	2.2
18	–4.0	–3.2	–2.5	–1.6	–0.8	0.0	1.1	2.5
20	–4.4	–3.6	–2.7	–1.8	–0.9	0.0	1.3	2.7
22	–4.9	–4.0	–3.0	–2.0	–1.0	0.0	1.4	3.0
24	–5.3	–4.3	–3.3	–2.2	–1.1	0.0	1.5	3.3
26	–5.7	–4.7	–3.6	–2.4	–1.2	0.0	1.6	3.5
28	–6.2	–5.0	–3.8	–2.6	–1.3	0.0	1.8	3.8
30	–6.6	–5.4	–4.1	–2.8	–1.4	0.0	1.9	4.0
32	–7.1	–5.8	–4.4	–2.9	–1.5	0.0	2.0	4.3

Long Range Cruise Enroute Fuel and Time—High Altitude

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
517	489	463	440	419	400	383	367	353	339	327
1022	969	920	876	836	800	768	737	709	683	659
1528	1449	1377	1313	1254	1200	1151	1106	1064	1026	990
2035	1931	1836	1750	1672	1600	1535	1475	1420	1369	1322
2544	2414	2294	2187	2090	2000	1920	1846	1776	1712	1653
3055	2898	2755	2626	2508	2400	2305	2216	2133	2056	1985
3567	3384	3216	3064	2927	2800	2689	2585	2489	2399	2317
4081	3870	3677	3503	3346	3200	3073	2955	2845	2743	2650
4596	4358	4139	3943	3765	3600	3458	3325	3201	3087	2982
5113	4847	4602	4383	4184	4000	3842	3695	3558	3431	3314
5631	5337	5066	4823	4603	4400	4227	4064	3914	3774	3646
6151	5828	5531	5264	5023	4800	4611	4434	4270	4118	3978
6673	6320	5996	5706	5443	5200	4995	4804	4626	4461	4310
7197	6814	6463	6148	5863	5600	5380	5174	4983	4805	4642
7722	7309	6930	6590	6283	6000	5764	5543	5338	5149	4974
8249	7805	7398	7033	6704	6400	6148	5912	5694	5492	5306
8778	8302	7866	7476	7124	6800	6532	6282	6050	5835	5637
9309	8800	8335	7920	7545	7200	6916	6651	6405	6177	5967
9841	9300	8806	8365	7967	7600	7300	7020	6759	6518	6297
10375	9802	9278	8810	8388	8000	7684	7389	7114	6860	6627
10912	10305	9750	9256	8810	8400	8067	7756	7467	7200	6955

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	31		33		35		37		39	
	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	3.9	0:57	3.8	0.57	3.7	0:57	3.6	0:57	3.8	0:58
800	8.7	1:47	8.5	1:46	8.3	1:46	8.3	1:46	6.6	1:47
1200	13.4	2:38	13.1	2:35	12.9	2:34	12.8	2:36	13.4	2:37
1600	18.1	3:28	17.7	3:24	17.4	3:23	17.3	3:25	18.0	3:26
2000	22.7	4:20	22.2	4:13	21.8	4:12	21.7	4:14	22.4	4:15
2400	27.2	5:12	26.6	5:04	26.2	5:01	26.0	5:03	26.7	5:05
2800	31.7	6:04	31.0	5:54	30.5	5:51	30.3	5:52	30.9	5:54
3200	36.1	6:57	35.3	6:45	34.7	6:40	34.4	6:41	35.0	6:43
3600	40.4	7:51	39.5	7:37	38.9	7:30	38.5	7:30	39.1	7:32
4000	44.7	8:45	43.7	8:29	43.0	8:21	42.5	8:19	43.0	8:21
4400	48.9	9:40	47.8	9:22	47.0	9:12	46.5	9:08	46.9	9:10
4800	53.0	10:36	51.9	10:16	51.0	10:03	50.4	9:58	50.8	9:59
5200	57.1	11:32	55.9	11:10	54.9	10:55	54.2	10:48	54.6	10:48
5600	61.1	12:29	59.8	12:05	58.7	11:48	58.0	11:39	58.3	11:37
6000	65.0	13:26	63.6	13:00	62.5	12:41	61.7	12:30	61.9	12:26
6400	68.9	14:24	67.4	13:56	66.3	13:35	65.4	13:21	65.5	13:16
6800	72.7	15:23	71.2	14:53	69.9	14:29	69.0	14:14	69.0	14:06
7200	76.5	16:22	74.9	15:50	73.5	15:24	72.5	15:06	72.5	14:57
7600	80.2	17:22	78.5	16:48	77.1	16:20	76.1	16:00	76.0	15:48
8000	83.9	18:22	82.1	17:46	80.6	17:17	79.5	16:54	79.3	16:39
8400	87.5	19:23	85.6	18:45	84.1	18:13	82.9	17:48	82.7	17:31

Long Range Cruise Enroute Fuel and Time—High Altitude

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)							
	120	140	160	180	200	220	240	260
5	–1.1	–1.0	–0.8	–0.5	–0.2	0.0	1.4	3.0
10	–2.7	–2.2	–1.7	–1.1	–0.6	0.0	2.1	4.8
15	–4.2	–3.4	–2.6	–1.8	–0.9	0.0	2.8	6.5
20	–5.8	–4.7	–3.6	–2.4	–1.2	0.0	3.5	8.1
25	–7.3	–5.9	–4.5	–3.0	–1.5	0.0	4.1	9.5
30	–8.8	–7.1	–5.4	–3.7	–1.9	0.0	4.7	10.9
35	–10.3	–8.3	–6.3	–4.3	–2.2	0.0	5.2	12.1
40	–11.8	–9.5	–7.2	–4.9	–2.5	0.0	5.7	13.2
45	–13.3	–10.7	–8.1	–5.5	–2.8	0.0	6.2	14.2
50	–14.8	–11.9	–9.0	–6.1	–3.1	0.0	6.6	15.1
55	–16.3	–13.1	–9.9	–6.7	–3.4	0.0	6.9	15.8
60	–17.7	–14.3	–10.8	–7.3	–3.7	0.0	7.2	16.5
65	–19.2	–15.5	–11.7	–7.9	–4.0	0.0	7.5	17.0
70	–20.6	–16.6	–12.6	–8.5	–4.3	0.0	7.7	17.4
75	–22.0	–17.8	–13.5	–9.1	–4.6	0.0	7.9	17.7
80	–23.4	–19.0	–14.3	–9.6	–4.9	0.0	8.0	17.8
85	–24.8	–20.2	–15.2	–10.2	–5.2	0.0	8.1	17.9
90	–26.2	–21.3	–16.1	–10.8	–5.4	0.0	8.2	17.8

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 KG)								
	280	260	240	220	200	180	160	140	120
43						14	1	3	16
41					16	2	1	10	27
39				16	3	0	7	20	40
37			14	3	0	5	16	32	52
35		11	2	0	4	14	27	45	64
33	8	1	0	4	12	24	39	57	76
31	1	1	5	12	23	36	52	68	86
29	1	5	13	22	34	48	63	79	96
27	7	14	23	34	46	60	74	89	105
25	15	24	34	45	57	71	84	98	112
23	25	35	45	56	68	81	94	106	119

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 .85/310/250 KIAS

PRESSURE ALT (1000 FT)	25	27	29	31	33	35	37	39	41	43
DISTANCE (NM)	88	95	102	109	115	120	126	132	138	145
TIME (MINUTES)	19	20	20	21	22	23	23	24	25	26

Holding

Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)									
		1500	5000	10000	15000	20000	25000	30000	35000	40000	43000
260	TPR	30.6	33.6	38.8	45.3	53.3	63.0	75.1	95.4		
	KIAS	258	258	258	259	261	286	290	283		
	FF/ENG	3160	3130	3090	3070	3080	3270	3410	3690		
240	TPR	28.9	31.8	36.5	42.4	49.9	59.1	70.7	86.0		
	KIAS	258	258	258	259	259	268	278	283		
	FF/ENG	2960	2920	2880	2840	2840	2910	3070	3270		
220	TPR	27.1	29.9	34.3	39.7	46.4	55.2	65.8	79.3		
	KIAS	251	251	251	253	256	257	265	269		
	FF/ENG	2740	2690	2640	2600	2610	2630	2730	2880		
200	TPR	25.3	28.0	32.2	37.2	43.4	51.3	61.3	73.7	92.7	
	KIAS	239	239	239	241	243	243	251	256	252	
	FF/ENG	2510	2450	2400	2360	2360	2360	2430	2550	2800	
180	TPR	23.6	26.0	30.0	34.7	40.4	47.5	56.9	68.2	83.0	
	KIAS	227	228	228	229	230	230	230	241	245	
	FF/ENG	2290	2230	2180	2130	2120	2110	2130	2240	2420	
160	TPR	21.9	24.0	27.7	32.1	37.3	43.6	52.1	62.6	75.9	85.7
	KIAS	219	219	219	220	221	221	221	226	230	232
	FF/ENG	2080	2030	1970	1920	1900	1880	1890	1950	2090	2220
140	TPR	20.2	22.1	25.4	29.5	34.2	39.9	47.3	56.8	68.9	77.2
	KIAS	210	210	210	211	211	212	212	212	213	215
	FF/ENG	1890	1830	1770	1710	1690	1670	1660	1690	1780	1870
120	TPR	18.6	20.3	23.2	27.0	31.3	36.4	42.8	51.0	61.6	69.0
	KIAS	203	203	203	203	203	203	203	203	203	203
	FF/ENG	1860	1790	1590	1530	1500	1470	1460	1470	1530	1580

This table includes 5% additional fuel for holding in a racetrack pattern.

Flaps 1

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
260	TPR	32.7	36.4	42.5	50.3	59.9
	KIAS	238	238	239	239	239
	FF/ENG	3390	3370	3360	3350	3390
240	TPR	30.8	34.2	39.8	46.9	55.7
	KIAS	237	237	238	239	239
	FF/ENG	3150	3120	3110	3090	3120
220	TPR	28.8	32.0	37.2	43.7	51.9
	KIAS	228	228	229	230	233
	FF/ENG	2900	2850	2840	2820	2840
200	TPR	26.8	29.7	34.6	40.5	48.2
	KIAS	217	218	219	219	221
	FF/ENG	2650	2580	2570	2540	2560
180	TPR	24.8	27.4	31.9	37.4	44.3
	KIAS	206	207	207	208	209
	FF/ENG	2400	2320	2300	2270	2280
160	TPR	22.8	25.1	29.1	34.2	40.4
	KIAS	195	195	195	196	197
	FF/ENG	2160	2080	2040	2010	2010
140	TPR	20.9	22.9	26.4	31.0	36.5
	KIAS	185	185	185	186	186
	FF/ENG	1940	1870	1800	1760	1760
120	TPR	19.1	20.9	23.9	28.0	32.9
	KIAS	178	178	178	178	178
	FF/ENG	1890	1680	1610	1550	1540

This table includes 5% additional fuel for holding in a racetrack pattern.

Runway Surface Condition Correlation

RUNWAY CONDITION CODE	RUNWAY SURFACE CONDITION DESCRIPTION	REPORTED BRAKING ACTION
6	Dry	Dry
5	Wet (Smooth, Grooved or PFC) or Frost 3 mm (0.12 inches) or less of: Water, Slush, Dry Snow or Wet Snow	Good
4	Compacted Snow at or below -15 deg. C OAT	Good to Medium
3	Wet (Slippery), Dry Snow or Wet Snow (any depth) over Compacted Snow Greater than 3 mm (0.12 inches) of : Dry Snow or Wet Snow Compacted Snow at OAT warmer than -15 deg. C	Medium
2	Greater than 3 mm (0.12 inches) of: Water or Slush	Medium to Poor
1	Ice	Poor
0	Wet Ice, Water on top of Compacted Snow, Dry Snow or Wet Snow over Ice	Nil

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF30	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1490	35/–30	45	–70/235	15/–15	35/–40	65	30	60
AUTOBRAKE MAX	1780	35/–35	55	–85/275	5/–5	50/–50	95	0	0
AUTOBRAKE 4	2160	45/–45	70	–110/355	5/0	60/–65	130	0	0
AUTOBRAKE 3	2490	55/–55	85	–130/425	0/–15	75/–75	130	0	0
AUTOBRAKE 2	2715	65/–65	100	–145/480	30/–45	80/–80	125	85	85
AUTOBRAKE 1	2935	75/–75	120	–160/545	70/–75	85/–85	120	315	370
Good Reported Braking Action									
MAX MANUAL	1790	45/–40	70	–100/360	35/–30	55/–55	90	85	185
AUTOBRAKE MAX	1830	40/–40	70	–90/340	20/–10	55/–50	95	75	165
AUTOBRAKE 4	2200	45/–45	70	–110/365	10/–5	65/–65	125	0	0
AUTOBRAKE 3	2520	55/–60	85	–130/430	10/–20	75/–75	135	5	5
AUTOBRAKE 2	2730	65/–65	100	–145/485	35/–55	80/–80	125	90	90
AUTOBRAKE 1	2935	75/–75	120	–160/550	80/–75	85/–90	125	315	370
Good to Medium Reported Braking Action									
MAX MANUAL	1965	45/–45	75	–110/390	45/–40	55/–55	90	120	265
AUTOBRALE MAX	1990	45/–40	75	–105/375	40/–35	55/–55	95	120	260
AUTOBRAKE 4	2235	45/–50	75	–115/395	20/–15	65/–65	125	15	90
AUTOBRAKE 3	2520	55/–60	85	–130/435	15/–25	75/–75	135	5	15
AUTOBRAKE 2	2730	65/–65	100	–145/485	35/–55	80/–80	125	90	90
AUTOBRAKE 1	2935	75/–75	120	–160/550	80/–75	85/–90	125	315	370
Medium Reported Braking Action									
MAX MANUAL	2090	45/–45	75	–115/410	60/–50	60/–60	90	160	370
AUTOBRAKE MAX	2105	45/–45	75	–115/405	55/–45	60/–60	95	160	360
AUTOBRAKE 4	2285	45/–50	75	–120/425	35/–25	65/–65	125	65	250
AUTOBRAKE 3	2550	55/–60	85	–135/460	25/–35	75/–75	135	20	95
AUTOBRAKE 2	2735	65/–65	100	–145/490	50/–55	80/–80	125	95	120
AUTOBRAKE 1	2935	75/–75	120	–160/550	80/–75	85/–90	125	315	370
Medium to Poor Reported Braking Action									
MAX MANUAL	2350	60/–60	100	–145/515	80/–65	75/–75	105	270	675
AUTOBRALE MAX	2360	65/–60	105	–145/515	85/–70	75/–75	105	270	685
AUTOBRAKE 4	2390	60/–55	100	–130/495	75/–45	70/–70	105	245	655
AUTOBRAKE 3	2610	55/–60	90	–135/465	45/–45	75/–75	125	75	455
AUTOBRAKE 2	2770	65/–70	100	–145/490	60/–65	80/–80	115	110	300
AUTOBRAKE 1	2950	75/–75	120	–160/550	80/–85	85/–90	120	320	395
Poor Reported Braking Action									
MAX MANUAL	3010	75/–70	125	–200/765	250/–155	85/–85	105	570	1665
AUTOBRALE MAX	3020	75/–70	125	–200/765	255/–160	85/–85	105	570	1670
AUTOBRAKE 4	3020	75/–70	125	–200/765	255/–155	85/–85	105	570	1670
AUTOBRAKE 3	3095	75/–70	125	–205/770	235/–140	90/–90	125	510	1610
AUTOBRAKE 2	3175	75/–75	130	–205/785	240/–155	90/–90	115	465	1535
AUTOBRAKE 1	3265	80/–80	135	–215/800	250/–165	95/–95	120	545	1470

Reference distance is for sea level, standard day, no wind or slope, VREF 30 approach speed, 2 engine maximum reverse thrust and auto speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 25 m.
For autobrake and manual speedbrakes, increase reference landing distance by 25 m.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
All reference distances and adjustments shown have been increased by 15%.

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF25	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1545	35/–30	45	–70/240	15/–15	40/–40	65	30	65
AUTOBRAKE MAX	1865	35/–40	55	–85/280	5/–5	50/–50	100	0	0
AUTOBRAKE 4	2280	45/–50	75	–110/365	0/0	65/–65	125	0	0
AUTOBRAKE 3	2620	55/–65	90	–130/435	10/–20	75/–80	130	15	15
AUTOBRAKE 2	2830	65/–70	110	–145/485	35/–50	80/–85	120	135	135
AUTOBRAKE 1	3030	80/–80	125	–165/550	80/–80	90/–90	120	380	470
Good Reported Braking Action									
MAX MANUAL	1865	45/–45	75	–100/365	35/–30	60/–60	90	100	215
AUTOBRAKE MAX	1915	45/–40	75	–90/340	20/–10	55/–55	95	85	190
AUTOBRAKE 4	2325	45/–50	75	–115/375	10/–5	65/–70	125	0	0
AUTOBRAKE 3	2650	60/–65	95	–135/440	20/–30	80/–80	130	20	20
AUTOBRAKE 2	2845	65/–75	110	–145/490	45/–60	85/–85	120	140	140
AUTOBRAKE 1	3030	80/–80	125	–165/555	85/–80	90/–90	125	385	470
Good to Medium Reported Braking Action									
MAX MANUAL	2035	45/–45	80	–110/390	45/–40	60/–60	90	140	305
AUTOBRAKE MAX	2065	45/–45	80	–105/380	45/–35	60/–60	95	140	300
AUTOBRAKE 4	2355	50/–55	80	–120/400	20/–15	70/–70	125	15	90
AUTOBRAKE 3	2650	60/–65	95	–135/445	25/–30	80/–80	130	25	35
AUTOBRAKE 2	2845	65/–75	110	–145/490	45/–60	85/–85	120	140	140
AUTOBRAKE 1	3030	80/–80	125	–165/555	85/–80	90/–90	125	385	470
Medium Reported Braking Action									
MAX MANUAL	2155	50/–50	80	–115/415	60/–50	60/–60	90	180	415
AUTOBRAKE MAX	2185	50/–50	80	–115/410	55/–45	60/–60	95	180	410
AUTOBRAKE 4	2405	50/–55	80	–125/435	30/–20	70/–70	125	60	255
AUTOBRAKE 3	2680	60/–65	95	–140/470	35/–40	80/–80	130	40	115
AUTOBRAKE 2	2850	65/–75	110	–150/500	60/–60	85/–85	120	150	170
AUTOBRAKE 1	3030	80/–80	125	–165/555	85/–80	90/–90	125	385	470
Medium to Poor Reported Braking Action									
MAX MANUAL	2435	65/–60	110	–145/515	80/–65	75/–75	100	305	795
AUTOBRAKE MAX	2455	65/–60	110	–145/515	85/–70	75/–75	105	310	810
AUTOBRAKE 4	2500	60/–55	105	–130/485	65/–40	70/–70	110	270	770
AUTOBRAKE 3	2735	60/–65	100	–140/475	55/–50	80/–80	120	95	550
AUTOBRAKE 2	2885	65/–75	110	–150/500	70/–70	85/–85	110	165	405
AUTOBRAKE 1	3050	80/–80	125	–165/555	85/–85	90/–90	120	390	515
Poor Reported Braking Action									
MAX MANUAL	3075	75/–75	130	–200/760	245/–150	85/–85	100	615	1850
AUTOBRAKE MAX	3100	75/–75	130	–200/765	255/–160	85/–90	105	620	1865
AUTOBRAKE 4	3100	75/–75	130	–200/765	250/–150	85/–90	110	620	1865
AUTOBRAKE 3	3195	75/–75	130	–205/775	235/–140	90/–90	120	535	1785
AUTOBRAKE 2	3275	80/–80	135	–210/785	240/–155	95/–95	110	515	1715
AUTOBRAKE 1	3355	85/–85	145	–215/800	250/–165	95/–100	120	610	1665

Reference distance is based on sea level, standard day, no wind or slope, VREF25 approach speed, two-engine maximum reverse thrust, and auto speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 25 m.
For autobrake and manual speedbrakes, increase reference landing distance by 25 m.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
All reference distances and adjustments shown have been increased by 15%.

ADVISORY INFORMATION

Normal Configuration Landing Distance
Flaps 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF20	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1550	35/–30	45	–70/240	15/–15	40/–40	65	35	75
AUTOBRAKE MAX	1870	35/–40	60	–85/280	5/–5	50/–50	100	0	0
AUTOBRAKE 4	2280	45/–50	75	–110/365	5/0	65/–65	125	0	0
AUTOBRAKE 3	2625	55/–65	90	–130/435	5/–20	75/–80	130	15	15
AUTOBRAKE 2	2835	65/–70	110	–145/490	35/–50	85/–85	125	125	125
AUTOBRAKE 1	3045	80/–80	130	–165/555	80/–80	90/–90	120	385	465
Good Reported Braking Action									
MAX MANUAL	1870	45/–45	75	–100/365	35/–30	60/–60	90	105	235
AUTOBRAKE MAX	1920	45/–40	75	–90/345	25/–10	55/–55	95	85	205
AUTOBRAKE 4	2325	50/–50	80	–115/380	10/–5	70/–70	125	0	0
AUTOBRAKE 3	2655	60/–65	95	–135/440	15/–30	80/–80	130	15	15
AUTOBRAKE 2	2855	65/–75	110	–145/490	45/–60	85/–85	125	135	135
AUTOBRAKE 1	3045	80/–80	130	–165/555	85/–80	90/–90	125	385	465
Good to Medium Reported Braking Action									
MAX MANUAL	2040	45/–45	80	–110/395	50/–40	60/–60	90	140	325
AUTOBRAKE MAX	2070	45/–45	80	–105/390	45/–30	60/–60	95	140	320
AUTOBRAKE 4	2360	50/–50	80	–120/405	20/–15	70/–70	125	15	100
AUTOBRAKE 3	2655	60/–65	95	–135/445	25/–30	80/–80	130	20	35
AUTOBRAKE 2	2855	65/–75	110	–145/490	45/–60	85/–85	125	135	135
AUTOBRAKE 1	3045	80/–80	130	–165/555	85/–80	90/–90	125	385	465
Medium Reported Braking Action									
MAX MANUAL	2165	50/–50	80	–115/415	60/–50	60/–60	90	185	440
AUTOBRAKE MAX	2190	50/–50	85	–115/415	60/–45	60/–60	95	180	430
AUTOBRAKE 4	2405	50/–55	85	–125/435	30/–20	70/–70	125	60	280
AUTOBRAKE 3	2685	60/–65	95	–140/470	35/–40	80/–80	130	35	120
AUTOBRAKE 2	2860	70/–75	110	–150/500	55/–60	85/–85	125	145	170
AUTOBRAKE 1	3045	80/–80	130	–165/555	85/–80	90/–90	125	385	465
Medium to Poor Reported Braking Action									
MAX MANUAL	2445	65/–60	110	–145/515	80/–65	75/–75	105	315	840
AUTOBRAKE MAX	2470	65/–60	110	–145/515	85/–75	75/–75	105	320	860
AUTOBRAKE 4	2510	65/–55	110	–130/485	70/–45	70/–70	110	280	820
AUTOBRAKE 3	2745	60/–65	100	–140/475	55/–50	80/–80	125	100	595
AUTOBRAKE 2	2900	70/–75	110	–150/500	70/–70	85/–85	115	160	450
AUTOBRAKE 1	3065	80/–80	130	–165/555	90/–90	90/–90	120	395	525
oor Reported Braking Action									
MAX MANUAL	3090	75/–75	130	–200/765	250/–155	85/–85	105	625	1930
AUTOBRAKE MAX	3115	75/–75	135	–200/765	255/–160	85/–90	105	635	1945
AUTOBRAKE 4	3115	75/–75	135	–200/765	255/–150	85/–90	110	635	1945
AUTOBRAKE 3	3205	75/–75	135	–205/775	240/–140	90/–95	125	550	1865
AUTOBRAKE 2	3290	80/–80	135	–210/785	240/–155	95/–95	115	520	1790
AUTOBRAKE 1	3370	85/–85	145	–215/800	250/–165	95/–100	120	620	1725

Reference distance is based on sea level, standard day, no wind or slope, VREF20 approach speed, two-engine maximum reverse thrust, and auto speedbrakes.
For max manual braking and manual speedbrakes, increase reference landing distance by 30 m.
For autobrake and manual speedbrakes, increase reference landing distance by 25 m.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
All reference distances and adjustments shown have been increased by 15%.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
AIRSPEED UNRELIABLE (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1390	30/–30	40	–65/210	15/–15	35/–35	60	30	65
AUTOBRAKE MAX	1630	30/–35	50	–75/245	5/–5	45/–45	90	0	0
AUTOBRAKE 2	2490	60/–65	95	–130/425	30/–40	75/–75	115	85	85
Good Reported Braking Action									
MAX MANUAL	1675	40/–40	70	–90/325	30/–25	50/–50	80	100	220
AUTOBRAKE MAX	1705	40/–35	70	–80/315	30/–15	50/–50	85	85	200
AUTOBRAKE 2	2515	60/–65	95	–130/430	40/–50	75/–75	115	90	90
Good to Medium Reported Braking Action									
MAX MANUAL	1825	40/–40	70	–100/350	45/–35	55/–55	80	130	300
AUTOBRAKE MAX	1840	45/–40	75	–95/350	45/–35	55/–55	85	130	295
AUTOBRAKE 2	2515	60/–65	95	–130/430	40/–50	75/–75	115	90	90
Medium Reported Braking Action									
MAX MANUAL	1935	45/–45	75	–105/370	55/–45	55/–55	80	170	405
AUTOBRAKE MAX	1945	45/–45	75	–105/370	60/–45	55/–55	85	165	400
AUTOBRAKE 3	2355	50/–55	80	–120/415	25/–35	70/–70	120	25	115
Medium to Poor Reported Braking Action									
MAX MANUAL	2185	60/–55	100	–125/455	75/–60	65/–65	95	290	790
AUTOBRAKE MAX	2210	60/–55	100	–130/460	80/–65	70/–70	95	295	810
AUTOBRAKE 3	2435	50/–60	90	–125/415	50/–45	70/–70	110	100	590
Poor Reported Braking Action									
MAX MANUAL	2750	65/–65	115	–180/670	220/–135	75/–80	95	570	1790
AUTOBRAKE MAX	2780	70/–65	120	–180/675	230/–145	80/–80	95	580	1815
AUTOBRAKE 3	2845	65/–65	120	–180/680	215/–130	80/–80	110	515	1745

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTI-ICE LEAK ENG L, R (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1375	30/–30	40	–65/215	15/–15	35/–35	60	0	35
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2580	55/–60	90	–130/435	0/–5	80/–80	145	0	0
Good Reported Braking Action									
MAX MANUAL	1715	45/–40	70	–100/355	40/–35	55/–55	85	0	110
AUTOBRAKE MAX	1745	45/–40	75	–90/345	35/–25	55/–55	95	0	105
AUTOBRAKE 2	2605	55/–60	90	–135/445	10/–15	80/–80	145	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1895	45/–45	75	–105/375	55/–45	60/–55	85	0	160
AUTOBRAKE MAX	1925	45/–45	75	–100/370	50/–40	55/–55	95	0	155
AUTOBRAKE 2	2605	55/–60	90	–135/445	10/–15	80/–80	145	0	0
Medium Reported Braking Action									
MAX MANUAL	2040	45/–45	75	–110/400	70/–55	60/–60	85	0	220
AUTOBRAKE MAX	2065	45/–45	80	–110/395	70/–50	60/–60	95	0	215
AUTOBRAKE 3	2370	50/–55	85	–125/420	30/–20	70/–70	130	0	75
Medium to Poor Reported Braking Action									
MAX MANUAL	2395	65/–65	110	–150/545	105/–85	80/–80	110	0	460
AUTOBRAKE MAX	2425	65/–65	115	–150/545	115/–90	85/–80	110	0	470
AUTOBRAKE 3	2475	65/–60	110	–130/520	90/–50	75/–75	115	0	435
Poor Reported Braking Action									
MAX MANUAL	3230	75/–75	135	–215/810	370/–210	95/–90	110	0	1130
AUTOBRAKE MAX	3260	80/–75	135	–215/810	380/–215	95/–95	110	0	1140
AUTOBRAKE 3	3265	80/–75	140	–215/810	375/–205	95/–95	115	0	1145

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTI-ICE LEAK ENG L, R (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1320	30/–25	40	–65/210	15/–15	35/–35	60	0	25
AUTOBRAKE MAX	1550	30/–30	45	–75/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2430	55/–55	85	–125/425	0/–5	75/–75	140	0	0
Good Reported Braking Action									
MAX MANUAL	1630	40/–40	65	–95/345	35/–30	55/–55	85	0	85
AUTOBRAKE MAX	1655	40/–35	65	–90/330	30/–20	50/–50	90	0	80
AUTOBRAKE 2	2455	55/–55	85	–130/430	10/–15	75/–75	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1810	40/–40	70	–100/370	50/–45	55/–55	85	0	125
AUTOBRAKE MAX	1835	40/–40	70	–100/355	45/–40	55/–55	90	0	120
AUTOBRAKE 2	2455	55/–55	85	–130/430	10/–15	75/–75	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1955	45/–40	70	–110/390	70/–55	55/–55	85	0	180
AUTOBRAKE MAX	1970	45/–40	70	–110/380	65/–50	55/–55	95	0	175
AUTOBRAKE 3	2245	45/–45	75	–120/410	30/–20	65/–65	130	0	65
Medium to Poor Reported Braking Action									
MAX MANUAL	2280	60/–60	100	–145/535	100/–80	80/–75	105	0	355
AUTOBRAKE MAX	2290	65/–60	105	–145/535	110/–85	80/–80	110	0	360
AUTOBRAKE 3	2335	60/–55	100	–130/510	85/–45	75/–70	110	0	330
Poor Reported Braking Action									
MAX MANUAL	3110	75/–70	125	–210/800	365/–205	90/–90	105	0	950
AUTOBRAKE MAX	3125	75/–70	125	–210/800	375/–210	90/–90	110	0	955
AUTOBRAKE 3	3135	75/–70	130	–210/800	370/–205	90/–90	110	0	960

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTISKID (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	2140	55/–50	80	–120/415	75/–60	55/–60	80	220	540
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	2320	60/–55	100	–135/505	85/–70	70/–70	95	315	855
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	2620	65/–60	110	–165/620	170/–115	75/–75	95	450	1300
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2765	65/–65	115	–180/685	225/–135	75/–75	90	535	1635
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2880	75/–70	130	–190/735	235/–145	85/–85	100	615	1970
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	3580	90/–85	165	–290/1230	770/–320	100/–100	100	1255	5580
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ANTISKID (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	2080	50/–45	75	–115/415	75/–60	55/–55	80	200	480
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	2250	55/–50	95	–135/500	85/–70	65/–65	95	285	745
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	2555	60/–55	105	–165/620	170/–115	70/–75	95	410	1160
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2705	65/–60	110	–180/685	230/–140	75/–75	95	500	1470
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2810	75/–65	125	–195/740	240/–145	80/–85	100	565	1735
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	3530	90/–85	160	–290/1245	795/–325	100/–100	100	1200	5100
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
AUTO SPEEDBRAKE (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	170000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 170000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1370	30/–30	40	–65/210	15/–15	35/–35	55	25	55
AUTOBRAKE MAX	1630	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2470	60/–65	95	–125/425	30/–45	70/–75	105	110	110
Good Reported Braking Action									
MAX MANUAL	1640	40/–40	65	–90/315	30/–25	50/–50	80	85	180
AUTOBRAKE MAX	1690	40/–35	65	–80/300	20/–10	50/–45	85	75	165
AUTOBRAKE 2	2490	60/–65	95	–130/430	40/–50	75/–75	110	115	115
Good to Medium Reported Braking Action									
MAX MANUAL	1790	40/–40	70	–95/345	40/–35	50/–50	80	120	260
AUTOBRAKE MAX	1820	40/–40	70	–95/335	40/–30	50/–50	85	120	260
AUTOBRAKE 2	2490	60/–65	95	–130/430	40/–50	75/–75	110	115	115
Medium Reported Braking Action									
MAX MANUAL	1895	40/–40	70	–100/365	50/–45	50/–50	75	155	355
AUTOBRAKE MAX	1920	40/–45	70	–100/360	50/–40	50/–55	85	155	355
AUTOBRAKE 3	2345	50/–55	80	–120/410	30/–35	70/–70	115	30	100
Medium to Poor Reported Braking Action									
MAX MANUAL	2135	55/–55	95	–125/450	70/–60	65/–65	90	260	680
AUTOBRAKE MAX	2165	55/–55	95	–125/450	75/–65	65/–65	90	270	700
AUTOBRAKE 3	2400	50/–60	85	–120/415	50/–45	70/–70	105	80	470
Poor Reported Braking Action									
MAX MANUAL	2695	65/–65	115	–175/665	215/–130	75/–75	90	530	1595
AUTOBRAKE MAX	2720	65/–65	115	–175/665	220/–140	75/–75	90	535	1615
AUTOBRAKE 3	2805	65/–65	115	–180/675	205/–125	80/–80	105	465	1545

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
AUTO SPEEDBRAKE (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1320	30/–25	40	–60/205	15/–15	35/–35	55	25	50
AUTOBRAKE MAX	1555	30/–30	45	–75/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2365	55/–55	85	–125/415	25/–40	70/–70	110	65	65
Good Reported Braking Action									
MAX MANUAL	1575	40/–35	60	–90/315	30/–25	50/–50	80	75	155
AUTOBRAKE MAX	1610	35/–30	60	–80/300	20/–10	45/–45	85	65	140
AUTOBRAKE 2	2385	55/–55	90	–125/420	35/–45	70/–70	110	70	70
Good to Medium Reported Braking Action									
MAX MANUAL	1725	40/–35	65	–95/340	40/–35	50/–50	80	105	225
AUTOBRAKE MAX	1750	40/–35	65	–90/330	40/–30	50/–50	85	105	225
AUTOBRAKE 2	2385	55/–55	90	–125/420	35/–45	70/–70	110	70	70
Medium Reported Braking Action									
MAX MANUAL	1835	40/–40	65	–100/360	50/–45	50/–50	75	135	315
AUTOBRAKE MAX	1855	40/–40	65	–100/355	50/–40	50/–50	85	135	315
AUTOBRAKE 3	2230	45/–50	75	–120/405	25/–30	65/–65	115	20	85
Medium to Poor Reported Braking Action									
MAX MANUAL	2065	55/–50	90	–125/445	70/–55	65/–65	90	230	575
AUTOBRAKE MAX	2080	55/–50	90	–125/450	75/–65	65/–65	90	235	590
AUTOBRAKE 3	2290	50/–55	80	–120/405	40/–40	65/–65	105	65	385
Poor Reported Braking Action									
MAX MANUAL	2635	65/–60	110	–175/665	220/–135	75/–75	90	490	1435
AUTOBRAKE MAX	2650	65/–60	110	–175/665	225/–140	75/–75	90	495	1445
AUTOBRAKE 3	2715	65/–60	110	–180/675	210/–125	75/–80	105	440	1395

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
BRAKES (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1750	50/–40	60	–90/310	40/–35	45/–45	70	115	260
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	2020	50/–50	90	–115/425	60/–50	60/–65	85	230	565
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	2240	55/–55	95	–135/485	95/–75	65/–65	85	300	770
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2365	55/–55	100	–145/530	125/–90	65/–65	85	360	980
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2540	70/–65	115	–160/595	140/–100	75/–75	95	470	1405
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	3200	80/–80	145	–240/975	695/–235	90/–90	95	925	3330
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
BRAKES (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1690	45/–35	55	–90/310	40/–35	45/–45	70	105	230
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	1950	50/–45	85	–115/425	60/–50	60/–60	90	200	490
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	2175	55/–50	90	–130/485	95/–75	65/–65	90	270	685
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2305	55/–50	95	–140/530	125/–90	65/–65	85	330	880
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2470	65/–60	110	–160/595	140/–105	75/–75	95	425	1225
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	3145	80/–75	140	–240/985	720/–240	90/–90	95	870	3010
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ENG SHUTDOWN L, R (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1365	30/–30	40	–65/210	15/–15	35/–35	55	0	40
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2575	55/–60	90	–130/435	0/–15	80/–80	140	0	0
Good Reported Braking Action									
MAX MANUAL	1685	45/–40	70	–95/345	35/–30	55/–55	85	0	120
AUTOBRAKE MAX	1720	40/–40	70	–90/335	30/–20	55/–55	90	0	115
AUTOBRAKE 2	2595	55/–60	90	–135/440	10/–20	80/–80	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1860	45/–45	70	–100/365	50/–45	55/–55	85	0	165
AUTOBRAKE MAX	1890	45/–40	70	–100/355	45/–35	55/–55	90	0	165
AUTOBRAKE 2	2595	55/–60	90	–135/440	10/–20	80/–80	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1995	45/–45	75	–105/385	65/–55	60/–55	85	0	225
AUTOBRAKE MAX	2020	45/–45	75	–110/380	60/–50	55/–60	90	0	220
AUTOBRAKE 3	2355	50/–55	80	–120/415	25/–20	70/–70	130	0	65
Medium to Poor Reported Braking Action									
MAX MANUAL	2335	65/–60	105	–145/525	100/–80	80/–80	105	0	450
AUTOBRAKE MAX	2360	65/–65	110	–145/530	105/–85	80/–80	105	0	460
AUTOBRAKE 3	2435	60/–60	105	–125/485	70/–40	75/–75	120	0	400
Poor Reported Braking Action									
MAX MANUAL	3100	75/–75	125	–200/745	310/–185	90/–90	105	0	1040
AUTOBRAKE MAX	3120	75/–75	130	–200/750	320/–195	90/–95	105	0	1050
AUTOBRAKE 3	3135	75/–75	130	–200/750	310/–180	90/–95	120	0	1055

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ENG SHUTDOWN L, R (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1305	30/–25	40	–60/205	15/–15	35/–35	55	0	30
AUTOBRAKE MAX	1545	30/–30	45	–70/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2430	55/–55	85	–125/425	0/–10	75/–75	140	0	0
Good Reported Braking Action									
MAX MANUAL	1600	40/–35	65	–95/335	35/–30	50/–50	85	0	95
AUTOBRAKE MAX	1630	40/–35	65	–85/320	25/–20	50/–50	90	0	90
AUTOBRAKE 2	2445	55/–55	85	–130/430	10/–15	75/–75	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1770	40/–40	65	–100/355	50/–40	55/–55	85	0	135
AUTOBRAKE MAX	1800	40/–40	65	–95/345	40/–35	50/–50	90	0	135
AUTOBRAKE 2	2445	55/–55	85	–130/430	10/–15	75/–75	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1910	45/–40	70	–105/375	65/–50	55/–55	80	0	190
AUTOBRAKE MAX	1930	40/–40	70	–105/370	55/–45	55/–55	90	0	185
AUTOBRAKE 3	2230	45/–50	75	–120/405	25/–20	65/–65	125	0	55
Medium to Poor Reported Braking Action									
MAX MANUAL	2215	60/–55	100	–140/515	95/–75	75/–75	105	0	355
AUTOBRAKE MAX	2220	60/–55	100	–145/515	100/–80	75/–75	105	0	360
AUTOBRAKE 3	2300	60/–50	95	–125/475	65/–40	70/–70	110	0	300
Poor Reported Braking Action									
MAX MANUAL	2975	70/–70	120	–200/740	305/–185	85/–90	105	0	880
AUTOBRAKE MAX	2985	75/–70	120	–200/740	310/–190	90/–90	105	0	880
AUTOBRAKE 3	3000	75/–70	120	–200/740	305/–180	90/–90	110	0	890

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAP/SLAT CONTROL (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1345	30/–30	40	–60/205	15/–15	35/–35	55	30	65
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2465	60/–65	95	–125/425	30/–45	70/–75	105	110	110
Good Reported Braking Action									
MAX MANUAL	1625	40/–40	65	–90/315	30/–25	50/–50	80	90	205
AUTOBRAKE MAX	1670	40/–35	65	–80/300	20/–10	45/–45	85	75	180
AUTOBRAKE 2	2485	60/–65	95	–130/430	40/–50	75/–75	110	115	115
Good to Medium Reported Braking Action									
MAX MANUAL	1775	40/–40	70	–95/340	40/–35	50/–50	80	125	285
AUTOBRAKE MAX	1800	40/–40	70	–95/335	40/–30	50/–50	85	120	275
AUTOBRAKE 2	2485	60/–65	95	–130/430	40/–50	75/–75	110	115	115
Medium Reported Braking Action									
MAX MANUAL	1880	45/–40	70	–100/365	50/–45	50/–50	75	160	380
AUTOBRAKE MAX	1905	40/–40	70	–100/360	50/–40	50/–55	85	160	375
AUTOBRAKE 3	2340	50/–55	85	–120/410	30/–35	70/–70	115	30	105
Medium to Poor Reported Braking Action									
MAX MANUAL	2125	55/–55	95	–125/450	70/–60	65/–65	90	275	730
AUTOBRAKE MAX	2150	55/–55	95	–125/450	75/–65	65/–65	90	280	745
AUTOBRAKE 3	2390	50/–60	85	–120/410	45/–40	70/–70	105	85	520
Poor Reported Braking Action									
MAX MANUAL	2685	65/–65	115	–175/665	215/–135	75/–75	90	545	1675
AUTOBRAKE MAX	2710	65/–65	115	–175/665	220/–140	75/–75	90	550	1695
AUTOBRAKE 3	2790	65/–65	115	–180/675	205/–125	80/–80	105	475	1620

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Flaps + Slats Fail (Flaps and Slats Up)
VREF 30+55

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1955	50/–35	60	–75/240	25/–20	50/–50	N/A	60	90
AUTOBRAKE MAX	2490	40/–40	75	–90/295	0/0	70/–70	N/A	0	5
AUTOBRAKE 2	3730	80/–80	150	–155/505	75/–80	110/–110	N/A	410	470
Good Reported Braking Action									
MAX MANUAL	2535	55/–50	105	–115/390	50/–45	80/–80	N/A	235	450
AUTOBRAKE MAX	2585	55/–40	105	–100/375	40/–20	80/–80	N/A	225	435
AUTOBRAKE 2	3730	80/–80	150	–155/505	80/–80	110/–110	N/A	410	470
Good to Medium Reported Braking Action									
MAX MANUAL	2690	55/–55	110	–120/415	65/–55	80/–85	N/A	265	530
AUTOBRAKE MAX	2725	55/–45	110	–115/410	55/–40	80/–85	N/A	270	530
AUTOBRAKE 2	3730	80/–80	150	–155/505	80/–80	110/–110	N/A	410	470
Medium Reported Braking Action									
MAX MANUAL	2805	55/–55	110	–125/435	75/–65	85/–85	N/A	310	640
AUTOBRAKE MAX	2835	55/–50	115	–120/430	70/–50	85/–85	N/A	310	635
AUTOBRAKE 3	3565	70/–75	130	–145/490	65/–70	105/–105	N/A	205	295
Medium to Poor Reported Braking Action									
MAX MANUAL	3235	75/–70	145	–150/530	105/–90	100/–100	N/A	570	1510
AUTOBRAKE MAX	3245	75/–70	145	–150/530	115/–95	100/–105	N/A	575	1520
AUTOBRAKE 3	3600	70/–75	140	–145/490	75/–80	105/–105	N/A	320	1215
Poor Reported Braking Action									
MAX MANUAL	3835	85/–80	165	–200/745	265/–170	110/–110	N/A	880	2630
AUTOBRAKE MAX	3850	85/–80	170	–200/745	270/–175	110/–115	N/A	885	2640
AUTOBRAKE 3	4050	90/–85	170	–210/765	255/–170	120/–120	N/A	780	2480

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS DRIVE (1 ≤ Flaps ≤5)
VREF 30+40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1750	45/–30	55	–70/230	20/–20	45/–45	60	45	75
AUTOBRAKE MAX	2220	40/–35	70	–85/280	5/–5	60/–60	100	0	5
AUTOBRAKE 2	3305	80/–75	130	–145/480	65/–70	95/–100	110	325	365
Good Reported Braking Action									
MAX MANUAL	2220	55/–45	95	–105/365	40/–40	70/–70	85	170	330
AUTOBRAKE MAX	2285	55/–40	90	–90/350	30/–10	70/–65	95	165	320
AUTOBRAKE 2	3305	80/–75	130	–145/480	65/–70	95/–100	110	325	365
Good to Medium Reported Braking Action									
MAX MANUAL	2370	55/–50	95	–110/390	55/–45	70/–70	85	200	405
AUTOBRAKE MAX	2420	55/–40	95	–105/380	50/–30	70/–70	95	210	415
AUTOBRAKE 2	3305	80/–75	130	–145/480	65/–70	95/–100	110	325	365
Medium Reported Braking Action									
MAX MANUAL	2480	55/–50	100	–120/410	65/–55	75/–75	85	240	505
AUTOBRAKE MAX	2530	55/–45	100	–115/405	60/–45	75/–75	95	245	515
AUTOBRAKE 3	3155	70/–70	115	–140/460	60/–65	90/–95	105	170	240
Medium to Poor Reported Braking Action									
MAX MANUAL	2850	75/–65	125	–140/500	95/–80	90/–90	95	445	1155
AUTOBRAKE MAX	2855	75/–65	130	–140/500	100/–80	90/–90	95	445	1155
AUTOBRAKE 3	3185	70/–70	120	–140/465	65/–70	90/–95	100	210	865
Poor Reported Braking Action									
MAX MANUAL	3435	85/–75	145	–190/715	245/–155	95/–100	95	735	2170
AUTOBRAKE MAX	3440	85/–75	150	–190/715	250/–160	100/–100	95	735	2175
AUTOBRAKE 3	3615	85/–80	150	–200/735	235/–155	105/–105	100	640	2040

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS DRIVE (5 < Flaps < 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1525	35/–30	45	–65/215	15/–15	40/–40	60	35	75
AUTOBRAKE MAX	1870	35/–35	55	–80/260	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2845	65/–65	110	–135/450	40/–55	85/–85	110	175	175
Good Reported Braking Action									
MAX MANUAL	1890	45/–40	80	–95/340	35/–30	60/–60	85	130	265
AUTOBRAKE MAX	1930	45/–35	75	–85/325	25/–10	55/–55	90	115	245
AUTOBRAKE 2	2855	65/–65	110	–135/455	50/–60	85/–85	110	195	195
Good to Medium Reported Braking Action									
MAX MANUAL	2040	45/–40	80	–105/365	50/–40	60/–60	85	160	345
AUTOBRAKE MAX	2070	45/–40	80	–100/360	45/–35	60/–60	90	160	340
AUTOBRAKE 2	2855	65/–65	110	–135/455	50/–60	85/–85	110	195	195
Medium Reported Braking Action									
MAX MANUAL	2145	45/–45	85	–110/385	60/–50	60/–60	85	200	445
AUTOBRAKE MAX	2175	45/–45	85	–105/380	55/–45	60/–60	90	200	440
AUTOBRAKE 3	2700	55/–60	95	–130/435	40/–45	80/–80	115	65	145
Medium to Poor Reported Braking Action									
MAX MANUAL	2455	60/–55	110	–135/475	80/–70	75/–75	95	355	935
AUTOBRAKE MAX	2475	60/–55	110	–135/475	90/–75	75/–80	95	360	950
AUTOBRAKE 3	2745	55/–60	100	–130/435	50/–50	80/–80	110	130	705
Poor Reported Braking Action									
MAX MANUAL	3035	70/–70	130	–185/690	235/–145	85/–85	95	645	1935
AUTOBRAKE MAX	3055	70/–70	130	–185/695	240/–150	85/–90	95	650	1950
AUTOBRAKE 3	3170	70/–70	130	–190/705	220/–140	90/–90	110	550	1855

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS DRIVE (Flaps ≥ 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1350	30/–30	40	–60/205	15/–15	35/–35	55	30	65
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2475	60/–65	95	–125/425	30/–45	70/–75	110	100	100
Good Reported Braking Action									
MAX MANUAL	1635	40/–40	65	–90/320	30/–25	50/–50	80	95	205
AUTOBRAKE MAX	1675	40/–35	65	–80/305	20/–10	50/–45	85	75	180
AUTOBRAKE 2	2495	60/–65	95	–130/430	40/–50	75/–75	110	110	110
Good to Medium Reported Braking Action									
MAX MANUAL	1785	40/–40	70	–95/345	40/–35	50/–50	80	125	280
AUTOBRAKE MAX	1805	40/–40	70	–95/340	40/–30	50/–50	85	125	275
AUTOBRAKE 2	2495	60/–65	95	–130/430	40/–50	75/–75	110	110	110
Medium Reported Braking Action									
MAX MANUAL	1890	45/–40	70	–100/365	50/–45	55/–55	80	160	380
AUTOBRAKE MAX	1910	45/–45	75	–100/365	50/–40	55/–55	85	160	375
AUTOBRAKE 3	2340	50/–55	85	–120/410	30/–35	70/–70	115	30	105
Medium to Poor Reported Braking Action									
MAX MANUAL	2140	55/–55	95	–125/450	70/–60	65/–65	90	280	745
AUTOBRAKE MAX	2165	55/–55	100	–125/455	75/–65	65/–70	90	285	760
AUTOBRAKE 3	2400	50/–60	85	–120/415	50/–40	70/–70	110	90	535
Poor Reported Braking Action									
MAX MANUAL	2705	65/–65	115	–175/665	220/–135	75/–75	90	555	1705
AUTOBRAKE MAX	2730	65/–65	115	–175/670	225/–140	75/–80	90	560	1720
AUTOBRAKE 3	2805	65/–65	115	–180/675	210/–125	80/–80	110	490	1655

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLAPS PRIMARY FAIL (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1370	30/–30	40	–65/210	15/–15	35/–35	60	35	70
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2490	60/–65	95	–130/425	30/–40	75/–75	115	90	90
Good Reported Braking Action									
MAX MANUAL	1665	40/–40	70	–90/325	30/–30	50/–50	80	105	230
AUTOBRAKE MAX	1690	40/–35	70	–85/315	30/–15	50/–50	85	90	210
AUTOBRAKE 2	2510	60/–65	95	–130/430	35/–45	75/–75	115	95	95
Good to Medium Reported Braking Action									
MAX MANUAL	1815	40/–40	70	–100/350	45/–40	55/–55	80	135	315
AUTOBRAKE MAX	1830	45/–40	75	–95/350	45/–35	55/–55	85	135	305
AUTOBRAKE 2	2510	60/–65	95	–130/430	35/–45	75/–75	115	95	95
Medium Reported Braking Action									
MAX MANUAL	1920	45/–45	75	–100/370	55/–45	55/–55	80	175	420
AUTOBRAKE MAX	1935	45/–45	75	–105/370	55/–45	55/–55	85	170	415
AUTOBRAKE 3	2350	50/–55	80	–120/410	25/–35	70/–70	120	25	120
Medium to Poor Reported Braking Action									
MAX MANUAL	2175	60/–55	100	–125/455	75/–60	65/–70	95	300	825
AUTOBRAKE MAX	2200	60/–55	100	–130/455	80/–70	70/–70	95	305	840
AUTOBRAKE 3	2415	50/–60	90	–120/415	50/–45	70/–70	110	105	625
Poor Reported Braking Action									
MAX MANUAL	2745	70/–65	120	–180/670	225/–140	75/–80	95	585	1840
AUTOBRAKE MAX	2770	70/–65	120	–180/675	230/–145	80/–80	95	590	1860
AUTOBRAKE 3	2835	65/–65	120	–180/680	215/–130	80/–80	110	525	1790

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLIGHT CONTROL MODE (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1390	30/–30	40	–65/210	15/–15	35/–35	60	30	65
AUTOBRAKE MAX	1630	30/–35	50	–75/245	5/–5	45/–45	90	0	0
AUTOBRAKE 2	2490	60/–65	95	–130/425	30/–40	75/–75	115	85	85
Good Reported Braking Action									
MAX MANUAL	1675	40/–40	70	–90/325	30/–25	50/–50	80	100	220
AUTOBRAKE MAX	1705	40/–35	70	–80/315	30/–15	50/–50	85	85	200
AUTOBRAKE 2	2515	60/–65	95	–130/430	40/–50	75/–75	115	90	90
Good to Medium Reported Braking Action									
MAX MANUAL	1825	40/–40	70	–100/350	45/–35	55/–55	80	130	300
AUTOBRAKE MAX	1840	45/–40	75	–95/350	45/–35	55/–55	85	130	295
AUTOBRAKE 2	2515	60/–65	95	–130/430	40/–50	75/–75	115	90	90
Medium Reported Braking Action									
MAX MANUAL	1935	45/–45	75	–105/370	55/–45	55/–55	80	170	405
AUTOBRAKE MAX	1945	45/–45	75	–105/370	60/–45	55/–55	85	165	400
AUTOBRAKE 3	2355	50/–55	80	–120/415	25/–35	70/–70	120	25	115
Medium to Poor Reported Braking Action									
MAX MANUAL	2185	60/–55	100	–125/455	75/–60	65/–65	95	290	790
AUTOBRAKE MAX	2210	60/–55	100	–130/460	80/–65	70/–70	95	295	810
AUTOBRAKE 3	2435	50/–60	90	–125/415	50/–45	70/–70	110	100	590
Poor Reported Braking Action									
MAX MANUAL	2750	65/–65	115	–180/670	220/–135	75/–80	95	570	1790
AUTOBRAKE MAX	2780	70/–65	120	–180/675	230/–145	80/–80	95	580	1815
AUTOBRAKE 3	2845	65/–65	120	–180/680	215/–130	80/–80	110	515	1745

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FLIGHT CONTROLS (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1615	30/–30	50	–70/225	20/–20	40/–40	70	55	110
AUTOBRAKE MAX	1885	30/–35	55	–80/260	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2900	65/–65	110	–140/455	40/–50	85/–85	125	120	120
Good Reported Braking Action									
MAX MANUAL	2025	50/–45	85	–100/360	45/–40	65/–65	95	180	415
AUTOBRAKE MAX	2050	50/–40	90	–100/360	45/–35	65/–65	100	180	420
AUTOBRAKE 2	2925	65/–70	110	–140/460	45/–55	85/–90	125	130	130
Good to Medium Reported Braking Action									
MAX MANUAL	2180	50/–45	90	–110/385	60/–50	65/–65	95	220	510
AUTOBRAKE MAX	2200	50/–45	90	–110/385	65/–55	65/–65	100	220	515
AUTOBRAKE 2	2925	65/–70	110	–140/460	45/–55	85/–90	125	130	130
Medium Reported Braking Action									
MAX MANUAL	2290	50/–50	90	–115/405	70/–60	65/–65	95	260	635
AUTOBRAKE MAX	2310	50/–50	95	–115/405	75/–60	70/–70	100	265	645
AUTOBRAKE 3	2750	55/–60	95	–130/445	40/–45	80/–85	125	35	245
Medium to Poor Reported Braking Action									
MAX MANUAL	2595	65/–60	120	–140/495	95/–80	80/–80	105	455	1350
AUTOBRAKE MAX	2625	70/–60	120	–140/495	105/–85	80/–85	105	465	1375
AUTOBRAKE 3	2830	60/–60	110	–130/450	60/–60	80/–85	115	265	1175
Poor Reported Braking Action									
MAX MANUAL	3185	75/–70	140	–190/710	255/–160	90/–90	105	775	2555
AUTOBRAKE MAX	3215	80/–75	145	–190/715	260/–165	90/–95	105	785	2585
AUTOBRAKE 3	3285	75/–75	140	–195/720	250/–155	95/–95	115	710	2510

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Fuel Leak (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1365	30/–30	40	–65/210	15/–15	35/–35	55	0	40
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2575	55/–60	90	–130/435	0/–15	80/–80	140	0	0
Good Reported Braking Action									
MAX MANUAL	1685	45/–40	70	–95/345	35/–30	55/–55	85	0	120
AUTOBRAKE MAX	1720	40/–40	70	–90/335	30/–20	55/–55	90	0	115
AUTOBRAKE 2	2595	55/–60	90	–135/440	10/–20	80/–80	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1860	45/–45	70	–100/365	50/–45	55/–55	85	0	165
AUTOBRAKE MAX	1890	45/–40	70	–100/355	45/–35	55/–55	90	0	165
AUTOBRAKE 2	2595	55/–60	90	–135/440	10/–20	80/–80	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1995	45/–45	75	–105/385	65/–55	60/–55	85	0	225
AUTOBRAKE MAX	2020	45/–45	75	–110/380	60/–50	55/–60	90	0	220
AUTOBRAKE 3	2355	50/–55	80	–120/415	25/–20	70/–70	130	0	65
Medium to Poor Reported Braking Action									
MAX MANUAL	2335	65/–60	105	–145/525	100/–80	80/–80	105	0	450
AUTOBRAKE MAX	2360	65/–65	110	–145/530	105/–85	80/–80	105	0	460
AUTOBRAKE 3	2435	60/–60	105	–125/485	70/–40	75/–75	120	0	400
Poor Reported Braking Action									
MAX MANUAL	3100	75/–75	125	–200/745	310/–185	90/–90	105	0	1040
AUTOBRAKE MAX	3120	75/–75	130	–200/750	320/–195	90/–95	105	0	1050
AUTOBRAKE 3	3135	75/–75	130	–200/750	310/–180	90/–95	120	0	1055

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Fuel Leak (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1305	30/–25	40	–60/205	15/–15	35/–35	55	0	30
AUTOBRAKE MAX	1545	30/–30	45	–70/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2430	55/–55	85	–125/425	0/–10	75/–75	140	0	0
Good Reported Braking Action									
MAX MANUAL	1600	40/–35	65	–95/335	35/–30	50/–50	85	0	95
AUTOBRAKE MAX	1630	40/–35	65	–85/320	25/–20	50/–50	90	0	90
AUTOBRAKE 2	2445	55/–55	85	–130/430	10/–15	75/–75	140	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1770	40/–40	65	–100/355	50/–40	55/–55	85	0	135
AUTOBRAKE MAX	1800	40/–40	65	–95/345	40/–35	50/–50	90	0	135
AUTOBRAKE 2	2445	55/–55	85	–130/430	10/–15	75/–75	140	0	0
Medium Reported Braking Action									
MAX MANUAL	1910	45/–40	70	–105/375	65/–50	55/–55	80	0	190
AUTOBRAKE MAX	1930	40/–40	70	–105/370	55/–45	55/–55	90	0	185
AUTOBRAKE 3	2230	45/–50	75	–120/405	25/–20	65/–65	125	0	55
Medium to Poor Reported Braking Action									
MAX MANUAL	2215	60/–55	100	–140/515	95/–75	75/–75	105	0	355
AUTOBRAKE MAX	2220	60/–55	100	–145/515	100/–80	75/–75	105	0	360
AUTOBRAKE 3	2300	60/–50	95	–125/475	65/–40	70/–70	110	0	300
Poor Reported Braking Action									
MAX MANUAL	2975	70/–70	120	–200/740	305/–185	85/–90	105	0	880
AUTOBRAKE MAX	2985	75/–70	120	–200/740	310/–190	90/–90	105	0	880
AUTOBRAKE 3	3000	75/–70	120	–200/740	305/–180	90/–90	110	0	890

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
FUEL QTY LOW (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1345	30/–30	40	–60/205	15/–15	35/–35	55	30	65
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2465	60/–65	95	–125/425	30/–45	70/–75	105	110	110
Good Reported Braking Action									
MAX MANUAL	1625	40/–40	65	–90/315	30/–25	50/–50	80	90	205
AUTOBRAKE MAX	1670	40/–35	65	–80/300	20/–10	45/–45	85	75	180
AUTOBRAKE 2	2485	60/–65	95	–130/430	40/–50	75/–75	110	115	115
Good to Medium Reported Braking Action									
MAX MANUAL	1775	40/–40	70	–95/340	40/–35	50/–50	80	125	285
AUTOBRAKE MAX	1800	40/–40	70	–95/335	40/–30	50/–50	85	120	275
AUTOBRAKE 2	2485	60/–65	95	–130/430	40/–50	75/–75	110	115	115
Medium Reported Braking Action									
MAX MANUAL	1880	45/–40	70	–100/365	50/–45	50/–50	75	160	380
AUTOBRAKE MAX	1905	40/–40	70	–100/360	50/–40	50/–55	85	160	375
AUTOBRAKE 3	2340	50/–55	85	–120/410	30/–35	70/–70	115	30	105
Medium to Poor Reported Braking Action									
MAX MANUAL	2125	55/–55	95	–125/450	70/–60	65/–65	90	275	730
AUTOBRAKE MAX	2150	55/–55	95	–125/450	75/–65	65/–65	90	280	745
AUTOBRAKE 3	2390	50/–60	85	–120/410	45/–40	70/–70	105	85	520
Poor Reported Braking Action									
MAX MANUAL	2685	65/–65	115	–175/665	215/–135	75/–75	90	545	1675
AUTOBRAKE MAX	2710	65/–65	115	–175/665	220/–140	75/–75	90	550	1695
AUTOBRAKE 3	2790	65/–65	115	–180/675	205/–125	80/–80	105	475	1620

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR CONTROL (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1370	30/–30	40	–65/210	15/–15	35/–35	55	25	55
AUTOBRAKE MAX	1630	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2470	60/–65	95	–125/425	30/–45	70/–75	105	110	110
Good Reported Braking Action									
MAX MANUAL	1640	40/–40	65	–90/315	30/–25	50/–50	80	85	180
AUTOBRAKE MAX	1690	40/–35	65	–80/300	20/–10	50/–45	85	75	165
AUTOBRAKE 2	2490	60/–65	95	–130/430	40/–50	75/–75	110	115	115
Good to Medium Reported Braking Action									
MAX MANUAL	1790	40/–40	70	–95/345	40/–35	50/–50	80	120	260
AUTOBRAKE MAX	1820	40/–40	70	–95/335	40/–30	50/–50	85	120	260
AUTOBRAKE 2	2490	60/–65	95	–130/430	40/–50	75/–75	110	115	115
Medium Reported Braking Action									
MAX MANUAL	1895	40/–40	70	–100/365	50/–45	50/–50	75	155	355
AUTOBRAKE MAX	1920	40/–45	70	–100/360	50/–40	50/–55	85	155	355
AUTOBRAKE 3	2345	50/–55	80	–120/410	30/–35	70/–70	115	30	100
Medium to Poor Reported Braking Action									
MAX MANUAL	2135	55/–55	95	–125/450	70/–60	65/–65	90	260	680
AUTOBRAKE MAX	2165	55/–55	95	–125/450	75/–65	65/–65	90	270	700
AUTOBRAKE 3	2400	50/–60	85	–120/415	50/–45	70/–70	105	80	470
Poor Reported Braking Action									
MAX MANUAL	2695	65/–65	115	–175/665	215/–130	75/–75	90	530	1595
AUTOBRAKE MAX	2720	65/–65	115	–175/665	220/–140	75/–75	90	535	1615
AUTOBRAKE 3	2805	65/–65	115	–180/675	205/–125	80/–80	105	465	1545

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR CONTROL (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1320	30/–25	40	–60/205	15/–15	35/–35	55	25	50
AUTOBRAKE MAX	1555	30/–30	45	–75/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2365	55/–55	85	–125/415	25/–40	70/–70	110	65	65
Good Reported Braking Action									
MAX MANUAL	1575	40/–35	60	–90/315	30/–25	50/–50	80	75	155
AUTOBRAKE MAX	1610	35/–30	60	–80/300	20/–10	45/–45	85	65	140
AUTOBRAKE 2	2385	55/–55	90	–125/420	35/–45	70/–70	110	70	70
Good to Medium Reported Braking Action									
MAX MANUAL	1725	40/–35	65	–95/340	40/–35	50/–50	80	105	225
AUTOBRAKE MAX	1750	40/–35	65	–90/330	40/–30	50/–50	85	105	225
AUTOBRAKE 2	2385	55/–55	90	–125/420	35/–45	70/–70	110	70	70
Medium Reported Braking Action									
MAX MANUAL	1835	40/–40	65	–100/360	50/–45	50/–50	75	135	315
AUTOBRAKE MAX	1855	40/–40	65	–100/355	50/–40	50/–50	85	135	315
AUTOBRAKE 3	2230	45/–50	75	–120/405	25/–30	65/–65	115	20	85
Medium to Poor Reported Braking Action									
MAX MANUAL	2065	55/–50	90	–125/445	70/–55	65/–65	90	230	575
AUTOBRAKE MAX	2080	55/–50	90	–125/450	75/–65	65/–65	90	235	590
AUTOBRAKE 3	2290	50/–55	80	–120/405	40/–40	65/–65	105	65	385
Poor Reported Braking Action									
MAX MANUAL	2635	65/–60	110	–175/665	220/–135	75/–75	90	490	1435
AUTOBRAKE MAX	2650	65/–60	110	–175/665	225/–140	75/–75	90	495	1445
AUTOBRAKE 3	2715	65/–60	110	–180/675	210/–125	75/–80	105	440	1395

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
GEAR DRAG BRACE L, R/GEAR SIDE BRACE L, R (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1320	30/–25	40	–60/205	15/–15	35/–35	55	25	50
AUTOBRAKE MAX	1555	30/–30	45	–75/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2365	55/–55	85	–125/415	25/–40	70/–70	110	65	65
Good Reported Braking Action									
MAX MANUAL	1575	40/–35	60	–90/315	30/–25	50/–50	80	75	155
AUTOBRAKE MAX	1610	35/–30	60	–80/300	20/–10	45/–45	85	65	140
AUTOBRAKE 2	2385	55/–55	90	–125/420	35/–45	70/–70	110	70	70
Good to Medium Reported Braking Action									
MAX MANUAL	1725	40/–35	65	–95/340	40/–35	50/–50	80	105	225
AUTOBRAKE MAX	1750	40/–35	65	–90/330	40/–30	50/–50	85	105	225
AUTOBRAKE 2	2385	55/–55	90	–125/420	35/–45	70/–70	110	70	70
Medium Reported Braking Action									
MAX MANUAL	1835	40/–40	65	–100/360	50/–45	50/–50	75	135	315
AUTOBRAKE MAX	1855	40/–40	65	–100/355	50/–40	50/–50	85	135	315
AUTOBRAKE 3	2230	45/–50	75	–120/405	25/–30	65/–65	115	20	85
Medium to Poor Reported Braking Action									
MAX MANUAL	2065	55/–50	90	–125/445	70/–55	65/–65	90	230	575
AUTOBRAKE MAX	2080	55/–50	90	–125/450	75/–65	65/–65	90	235	590
AUTOBRAKE 3	2290	50/–55	80	–120/405	40/–40	65/–65	105	65	385
Poor Reported Braking Action									
MAX MANUAL	2635	65/–60	110	–175/665	220/–135	75/–75	90	490	1435
AUTOBRAKE MAX	2650	65/–60	110	–175/665	225/–140	75/–75	90	495	1445
AUTOBRAKE 3	2715	65/–60	110	–180/675	210/–125	75/–80	105	440	1395

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS C (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1390	30/–30	40	–65/210	15/–15	35/–35	60	30	65
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2490	60/–65	95	–125/425	30/–40	75/–75	115	90	90
Good Reported Braking Action									
MAX MANUAL	1675	40/–40	70	–90/325	30/–25	50/–50	80	100	220
AUTOBRAKE MAX	1700	40/–35	70	–80/315	30/–15	50/–50	85	85	200
AUTOBRAKE 2	2505	60/–65	95	–130/430	40/–50	75/–75	115	95	95
Good to Medium Reported Braking Action									
MAX MANUAL	1825	40/–40	70	–100/350	45/–35	55/–55	80	130	300
AUTOBRAKE MAX	1835	45/–40	70	–95/350	45/–35	55/–55	85	130	295
AUTOBRAKE 2	2505	60/–65	95	–130/430	40/–50	75/–75	115	95	95
Medium Reported Braking Action									
MAX MANUAL	1935	45/–45	75	–100/370	55/–45	55/–55	80	170	405
AUTOBRAKE MAX	1945	45/–45	75	–105/370	60/–45	55/–55	85	165	400
AUTOBRAKE 3	2350	50/–55	80	–120/410	30/–35	70/–70	120	25	115
Medium to Poor Reported Braking Action									
MAX MANUAL	2180	55/–55	95	–125/455	75/–60	65/–65	95	285	780
AUTOBRAKE MAX	2205	60/–55	100	–130/455	80/–65	70/–70	95	295	800
AUTOBRAKE 3	2425	50/–60	90	–120/415	50/–45	70/–70	105	95	580
Poor Reported Braking Action									
MAX MANUAL	2745	65/–65	115	–175/670	220/–135	75/–75	95	565	1765
AUTOBRAKE MAX	2770	70/–65	120	–180/675	230/–145	75/–80	95	575	1785
AUTOBRAKE 3	2835	65/–65	115	–180/680	215/–130	80/–80	105	505	1720

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS L (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1385	30/–30	40	–65/215	20/–15	35/–35	60	0	30
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2575	55/–60	90	–130/435	0/–5	80/–80	145	0	0
Good Reported Braking Action									
MAX MANUAL	1735	45/–45	75	–100/360	40/–35	60/–55	90	0	105
AUTOBRAKE MAX	1755	45/–40	75	–90/350	40/–25	55/–55	95	0	100
AUTOBRAKE 2	2600	55/–60	90	–135/445	10/–15	80/–80	150	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1915	45/–45	75	–105/380	55/–45	60/–60	90	0	150
AUTOBRAKE MAX	1935	45/–45	75	–100/375	55/–40	60/–55	95	0	145
AUTOBRAKE 2	2600	55/–60	90	–135/445	10/–15	80/–80	150	0	0
Medium Reported Braking Action									
MAX MANUAL	2060	45/–45	75	–110/400	70/–60	60/–60	90	0	215
AUTOBRAKE MAX	2075	45/–45	80	–110/400	70/–50	60/–60	95	0	210
AUTOBRAKE 3	2370	50/–55	80	–125/420	30/–20	70/–70	130	0	75
Medium to Poor Reported Braking Action									
MAX MANUAL	2420	65/–65	110	–150/550	110/–85	80/–80	110	0	455
AUTOBRAKE MAX	2445	70/–65	115	–150/550	115/–95	85/–85	110	0	460
AUTOBRAKE 3	2485	65/–60	110	–135/530	100/–50	80/–75	115	0	435
Poor Reported Braking Action									
MAX MANUAL	3255	80/–75	135	–215/810	375/–210	95/–90	110	0	1130
AUTOBRAKE MAX	3280	80/–75	140	–215/815	385/–220	95/–95	110	0	1140
AUTOBRAKE 3	3290	80/–80	140	–215/815	380/–210	95/–95	115	0	1140

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS L (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1330	30/–25	40	–65/210	15/–15	35/–35	60	0	30
AUTOBRAKE MAX	1550	30/–30	45	–75/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2430	55/–55	85	–125/425	0/–5	75/–75	140	0	0
Good Reported Braking Action									
MAX MANUAL	1650	40/–40	65	–95/350	35/–30	55/–55	90	0	90
AUTOBRAKE MAX	1665	40/–35	65	–90/340	35/–20	55/–50	95	0	80
AUTOBRAKE 2	2455	55/–55	85	–130/430	10/–10	75/–75	145	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1830	45/–40	70	–105/370	55/–45	55/–55	90	0	130
AUTOBRAKE MAX	1845	40/–40	70	–100/365	50/–40	55/–55	95	0	125
AUTOBRAKE 2	2455	55/–55	85	–130/430	10/–10	75/–75	145	0	0
Medium Reported Braking Action									
MAX MANUAL	1975	45/–40	70	–110/395	70/–55	55/–55	85	0	190
AUTOBRAKE MAX	1985	45/–40	70	–110/390	70/–50	55/–55	95	0	185
AUTOBRAKE 3	2245	45/–45	75	–120/410	30/–20	65/–65	130	0	70
Medium to Poor Reported Braking Action									
MAX MANUAL	2305	65/–60	105	–150/540	105/–85	80/–80	110	0	375
AUTOBRAKE MAX	2320	65/–60	105	–150/540	110/–90	80/–80	110	0	375
AUTOBRAKE 3	2350	65/–55	105	–130/525	95/–50	75/–75	115	0	355
Poor Reported Braking Action									
MAX MANUAL	3145	75/–70	130	–215/805	375/–210	90/–90	110	0	990
AUTOBRAKE MAX	3160	75/–70	130	–215/805	380/–215	95/–90	110	0	990
AUTOBRAKE 3	3165	75/–70	130	–215/810	375/–210	95/–90	115	0	995

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS L+C (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1650	35/–30	50	–70/235	25/–20	45/–45	70	0	50
AUTOBRAKE MAX	1890	30/–35	55	–80/260	5/–5	50/–50	95	0	0
AUTOBRAKE 2	3020	60/–60	105	–140/470	0/–5	95/–95	160	0	0
Good Reported Braking Action									
MAX MANUAL	2135	50/–45	90	–115/405	55/–45	70/–70	105	0	195
AUTOBRAKE MAX	2155	50/–45	95	–115/405	65/–50	75/–75	105	0	195
AUTOBRAKE 2	3055	60/–60	105	–145/475	10/–20	95/–95	160	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	2325	50/–50	95	–120/425	75/–60	75/–70	105	0	245
AUTOBRAKE MAX	2340	55/–50	95	–120/425	80/–65	75/–75	105	0	250
AUTOBRAKE 2	3055	60/–60	105	–145/475	10/–20	95/–95	160	0	0
Medium Reported Braking Action									
MAX MANUAL	2475	55/–50	95	–125/445	90/–75	75/–75	105	0	320
AUTOBRAKE MAX	2490	55/–50	100	–125/450	100/–80	75/–75	105	0	325
AUTOBRAKE 3	2775	50/–55	95	–135/450	40/–25	85/–85	145	0	130
Medium to Poor Reported Braking Action									
MAX MANUAL	2935	75/–70	135	–165/600	140/–115	100/–100	125	0	735
AUTOBRAKE MAX	2970	75/–70	140	–170/605	155/–120	100/–100	125	0	750
AUTOBRAKE 3	2975	75/–60	140	–155/605	150/–85	100/–100	125	0	750
Poor Reported Braking Action									
MAX MANUAL	3810	85/–85	160	–235/865	430/–245	110/–110	125	0	1530
AUTOBRAKE MAX	3850	90/–85	165	–235/870	440/–255	115/–110	125	0	1545
AUTOBRAKE 3	3850	90/–85	165	–235/870	440/–245	115/–110	125	0	1545

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS L+R (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1665	35/–30	50	–70/240	25/–25	45/–45	70	0	0
AUTOBRAKE MAX	1885	35/–35	55	–80/260	10/–5	50/–50	95	0	0
AUTOBRAKE 2	3020	60/–60	105	–140/470	0/–5	95/–95	160	0	0
Good Reported Braking Action									
MAX MANUAL	2280	55/–50	100	–130/475	75/–65	85/–80	120	0	0
AUTOBRAKE MAX	2305	55/–50	100	–130/480	85/–65	85/–85	120	0	0
AUTOBRAKE 2	3055	60/–60	105	–145/475	10/–15	95/–95	160	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	2520	55/–50	100	–135/490	100/–80	85/–85	120	0	0
AUTOBRAKE MAX	2540	55/–50	105	–135/490	110/–90	85/–85	120	0	0
AUTOBRAKE 2	3055	60/–60	105	–145/475	15/–15	95/–95	160	0	0
Medium Reported Braking Action									
MAX MANUAL	2740	55/–55	105	–145/510	130/–105	85/–85	120	0	0
AUTOBRAKE MAX	2760	55/–55	105	–145/515	140/–110	90/–85	120	0	0
AUTOBRAKE 3	2890	55/–55	100	–140/480	100/–60	85/–85	145	0	0
Medium to Poor Reported Braking Action									
MAX MANUAL	3570	90/–85	165	–230/845	275/–200	140/–135	160	0	0
AUTOBRAKE MAX	3615	95/–85	170	–230/850	290/–210	145/–140	160	0	0
AUTOBRAKE 3	3625	95/–90	170	–230/850	285/–200	145/–140	165	0	0
Poor Reported Braking Action									
MAX MANUAL	5200	100/–95	195	–320/1170	1060/–495	160/–145	160	0	0
AUTOBRAKE MAX	5245	100/–95	195	–320/1175	1075/–505	165/–145	160	0	0
AUTOBRAKE 3	5255	100/–95	200	–325/1175	1070/–500	165/–150	165	0	0

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS R (Flaps 25)
VREF 25+5

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1460	35/–30	45	–65/220	20/–15	40/–40	60	0	35
AUTOBRAKE MAX	1710	30/–35	50	–75/250	5/–5	45/–45	90	0	0
AUTOBRAKE 2	2720	55/–65	95	–135/450	0/–10	85/–85	150	0	0
Good Reported Braking Action									
MAX MANUAL	1850	45/–45	80	–105/370	45/–40	60/–60	95	0	125
AUTOBRAKE MAX	1870	45/–45	80	–95/370	45/–30	65/–60	100	0	115
AUTOBRAKE 2	2750	60/–65	95	–135/455	10/–15	85/–85	150	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	2035	50/–45	80	–110/395	60/–50	65/–65	95	0	170
AUTOBRAKE MAX	2050	50/–45	80	–105/390	65/–45	65/–60	100	0	165
AUTOBRAKE 2	2750	60/–65	95	–135/455	10/–15	85/–85	150	0	0
Medium Reported Braking Action									
MAX MANUAL	2180	50/–50	85	–115/415	75/–65	65/–65	95	0	235
AUTOBRAKE MAX	2195	50/–50	85	–115/415	80/–55	65/–65	100	0	235
AUTOBRAKE 3	2500	50/–55	85	–125/430	35/–20	75/–75	135	0	85
Medium to Poor Reported Braking Action									
MAX MANUAL	2575	70/–65	120	–155/565	120/–95	85/–85	115	0	525
AUTOBRAKE MAX	2600	70/–65	120	–155/565	125/–100	90/–90	115	0	530
AUTOBRAKE 3	2625	70/–60	120	–140/555	115/–60	85/–85	120	0	520
Poor Reported Braking Action									
MAX MANUAL	3420	80/–80	145	–220/830	390/–220	100/–95	115	0	1230
AUTOBRAKE MAX	3450	80/–80	145	–220/830	400/–230	100/–100	115	0	1240
AUTOBRAKE 3	3455	80/–80	145	–220/830	395/–220	100/–100	120	0	1240

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS R (Flaps 30)
VREF 30+5

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1400	30/–25	40	–65/215	20/–15	35/–35	60	0	30
AUTOBRAKE MAX	1635	30/–30	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2575	55/–55	90	–130/435	0/–5	80/–80	145	0	0
Good Reported Braking Action									
MAX MANUAL	1755	45/–40	70	–100/360	40/–35	60/–60	90	0	100
AUTOBRAKE MAX	1770	45/–40	75	–95/355	40/–25	60/–55	95	0	95
AUTOBRAKE 2	2600	55/–55	90	–130/440	10/–15	80/–80	145	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	1940	45/–40	75	–105/385	60/–50	60/–60	90	0	145
AUTOBRAKE MAX	1950	45/–40	75	–100/380	60/–40	60/–55	95	0	140
AUTOBRAKE 2	2600	55/–55	90	–130/440	10/–15	80/–80	145	0	0
Medium Reported Braking Action									
MAX MANUAL	2085	45/–45	75	–115/405	75/–60	60/–60	90	0	205
AUTOBRAKE MAX	2095	45/–45	75	–110/405	75/–55	60/–60	100	0	200
AUTOBRAKE 3	2370	50/–50	80	–125/420	35/–20	70/–70	130	0	80
Medium to Poor Reported Braking Action									
MAX MANUAL	2445	65/–60	110	–150/555	115/–90	85/–85	110	0	425
AUTOBRAKE MAX	2460	65/–60	110	–150/555	120/–95	85/–85	110	0	430
AUTOBRAKE 3	2485	65/–55	110	–135/545	110/–55	80/–80	115	0	415
Poor Reported Braking Action									
MAX MANUAL	3295	75/–75	135	–220/820	385/–220	95/–95	110	0	1060
AUTOBRAKE MAX	3310	80/–75	135	–220/820	395/–225	95/–95	110	0	1065
AUTOBRAKE 3	3320	80/–75	135	–220/820	390/–220	95/–95	115	0	1070

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
HYD PRESS SYS R+C (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1670	35/–30	50	–70/235	25/–20	45/–45	70	0	50
AUTOBRAKE MAX	1890	30/–35	55	–80/260	10/–5	50/–50	95	0	0
AUTOBRAKE 2	3020	60/–60	105	–140/470	0/0	95/–95	160	0	0
Good Reported Braking Action									
MAX MANUAL	2180	55/–50	95	–115/410	60/–50	75/–75	110	0	210
AUTOBRAKE MAX	2200	55/–50	95	–115/415	65/–55	75/–75	115	0	215
AUTOBRAKE 2	3055	60/–60	105	–145/475	10/–10	95/–95	165	0	0
Good to Medium Reported Braking Action									
MAX MANUAL	2370	55/–50	95	–125/435	75/–65	75/–75	110	0	265
AUTOBRAKE MAX	2390	55/–50	100	–125/435	85/–70	75/–75	115	0	270
AUTOBRAKE 2	3055	60/–60	105	–145/475	10/–10	95/–95	165	0	0
Medium Reported Braking Action									
MAX MANUAL	2525	55/–50	100	–130/455	95/–80	75/–75	110	0	345
AUTOBRAKE MAX	2540	55/–50	100	–130/460	105/–85	80/–80	115	0	350
AUTOBRAKE 3	2775	55/–55	95	–135/460	50/–25	85/–85	145	0	160
Medium to Poor Reported Braking Action									
MAX MANUAL	3015	80/–70	140	–170/615	155/–120	105/–100	130	0	825
AUTOBRAKE MAX	3055	80/–75	145	–175/620	165/–130	105/–105	130	0	845
AUTOBRAKE 3	3055	80/–65	145	–165/620	165/–105	105/–105	130	0	840
Poor Reported Braking Action									
MAX MANUAL	3915	90/–85	170	–240/880	455/–260	115/–110	130	0	1680
AUTOBRAKE MAX	3955	90/–90	170	–240/885	465/–270	115/–115	130	0	1700
AUTOBRAKE 3	3955	90/–85	170	–240/885	465/–265	115/–115	130	0	1700

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
Loss of All Displays (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1540	35/–30	45	–70/235	25/–20	40/–40	75	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	2075	55/–50	95	–125/465	75/–60	75/–75	130	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	2320	55/–50	95	–130/475	100/–80	75/–75	130	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	2560	55/–55	100	–135/495	135/–105	80/–75	130	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	3335	95/–95	170	–235/880	300/–205	140/–130	190	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	5095	105/–100	195	–330/1190	1200/–540	155/–140	190	0	0
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
NAV AIR DATA SYS/NAV AIRSPEED DATA (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1390	30/–30	40	–65/210	15/–15	35/–35	60	30	65
AUTOBRAKE MAX	1630	30/–35	50	–75/245	5/–5	45/–45	90	0	0
AUTOBRAKE 2	2490	60/–65	95	–130/425	30/–40	75/–75	115	85	85
Good Reported Braking Action									
MAX MANUAL	1675	40/–40	70	–90/325	30/–25	50/–50	80	100	220
AUTOBRAKE MAX	1705	40/–35	70	–80/315	30/–15	50/–50	85	85	200
AUTOBRAKE 2	2515	60/–65	95	–130/430	40/–50	75/–75	115	90	90
Good to Medium Reported Braking Action									
MAX MANUAL	1825	40/–40	70	–100/350	45/–35	55/–55	80	130	300
AUTOBRAKE MAX	1840	45/–40	75	–95/350	45/–35	55/–55	85	130	295
AUTOBRAKE 2	2515	60/–65	95	–130/430	40/–50	75/–75	115	90	90
Medium Reported Braking Action									
MAX MANUAL	1935	45/–45	75	–105/370	55/–45	55/–55	80	170	405
AUTOBRAKE MAX	1945	45/–45	75	–105/370	60/–45	55/–55	85	165	400
AUTOBRAKE 3	2355	50/–55	80	–120/415	25/–35	70/–70	120	25	115
Medium to Poor Reported Braking Action									
MAX MANUAL	2185	60/–55	100	–125/455	75/–60	65/–65	95	290	790
AUTOBRAKE MAX	2210	60/–55	100	–130/460	80/–65	70/–70	95	295	810
AUTOBRAKE 3	2435	50/–60	90	–125/415	50/–45	70/–70	110	100	590
Poor Reported Braking Action									
MAX MANUAL	2750	65/–65	115	–180/670	220/–135	75/–80	95	570	1790
AUTOBRAKE MAX	2780	70/–65	120	–180/675	230/–145	80/–80	95	580	1815
AUTOBRAKE 3	2845	65/–65	120	–180/680	215/–130	80/–80	110	515	1745

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
NAV INERTIAL SYS (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1390	30/–30	40	–65/210	15/–15	35/–35	60	30	65
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good Reported Braking Action									
MAX MANUAL	1675	40/–40	70	–90/325	30/–25	50/–50	80	100	220
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Good to Medium Reported Braking Action									
MAX MANUAL	1825	40/–40	70	–100/350	45/–35	55/–55	80	130	300
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 2	Autobrake inoperative								
Medium Reported Braking Action									
MAX MANUAL	1935	45/–45	75	–105/370	55/–45	55/–55	80	170	405
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Medium to Poor Reported Braking Action									
MAX MANUAL	2185	60/–55	100	–125/455	75/–60	65/–65	95	290	790
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								
Poor Reported Braking Action									
MAX MANUAL	2750	65/–65	115	–180/670	220/–135	75/–80	95	570	1790
AUTOBRAKE MAX	Autobrake inoperative								
AUTOBRAKE 3	Autobrake inoperative								

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PITCH DOWN AUTHORITY (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1465	30/–30	40	–65/220	15/–15	35/–35	65	25	50
AUTOBRAKE MAX	1645	30/–35	50	–75/245	10/–10	45/–45	95	0	0
AUTOBRAKE 2	2505	60/–60	95	–130/430	25/–35	75/–75	115	70	70
Good Reported Braking Action									
MAX MANUAL	1750	40/–40	70	–95/330	35/–30	50/–55	85	80	165
AUTOBRAKE MAX	1785	40/–40	70	–85/315	25/–20	50/–50	90	65	155
AUTOBRAKE 2	2560	60/–65	95	–130/440	45/–50	75/–75	120	90	90
Good to Medium Reported Braking Action									
MAX MANUAL	1900	40/–40	70	–100/355	45/–40	55/–55	85	110	245
AUTOBRAKE MAX	1915	40/–40	70	–100/350	45/–40	55/–55	90	110	250
AUTOBRAKE 2	2560	60/–65	95	–130/440	45/–50	75/–75	120	90	90
Medium Reported Braking Action									
MAX MANUAL	2005	45/–45	75	–105/375	55/–45	55/–55	85	145	335
AUTOBRAKE MAX	2020	45/–45	75	–105/375	55/–45	55/–55	90	150	340
AUTOBRAKE 3	2400	50/–55	85	–125/420	35/–40	70/–70	125	20	90
Medium to Poor Reported Braking Action									
MAX MANUAL	2255	55/–55	95	–130/460	75/–60	65/–70	95	250	650
AUTOBRAKE MAX	2285	60/–55	95	–130/460	80/–70	70/–70	95	260	670
AUTOBRAKE 3	2510	50/–60	85	–125/425	60/–55	70/–70	105	75	445
Poor Reported Braking Action									
MAX MANUAL	2815	65/–65	115	–180/675	220/–135	75/–80	95	520	1565
AUTOBRAKE MAX	2840	65/–65	115	–180/675	225/–145	80/–80	95	525	1585
AUTOBRAKE 3	2910	65/–65	115	–180/685	215/–135	80/–85	105	460	1520

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PITCH DOWN AUTHORITY (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1420	30/–25	40	–65/215	15/–15	35/–35	65	20	45
AUTOBRAKE MAX	1580	30/–30	45	–75/240	10/–10	40/–45	95	0	0
AUTOBRAKE 2	2395	55/–55	85	–125/420	20/–30	70/–70	120	35	35
Good Reported Braking Action									
MAX MANUAL	1680	40/–35	65	–90/325	30/–30	50/–50	85	65	140
AUTOBRAKE MAX	1700	40/–35	65	–85/315	25/–20	50/–50	90	55	130
AUTOBRAKE 2	2455	55/–55	90	–130/435	40/–45	70/–75	120	50	50
Good to Medium Reported Braking Action									
MAX MANUAL	1830	40/–40	65	–100/350	45/–40	50/–50	85	95	210
AUTOBRAKE MAX	1840	40/–40	65	–95/345	45/–40	50/–50	90	95	215
AUTOBRAKE 2	2455	55/–55	90	–130/435	40/–45	70/–75	120	50	50
Medium Reported Braking Action									
MAX MANUAL	1945	40/–40	70	–105/370	55/–45	50/–50	80	130	300
AUTOBRAKE MAX	1950	40/–40	70	–105/365	55/–45	55/–55	90	130	300
AUTOBRAKE 3	2280	50/–50	75	–120/410	35/–30	70/–70	130	15	80
Medium to Poor Reported Braking Action									
MAX MANUAL	2175	55/–50	90	–130/460	75/–60	65/–65	95	220	550
AUTOBRAKE MAX	2195	55/–50	90	–130/460	80/–70	65/–65	95	225	560
AUTOBRAKE 3	2390	50/–55	80	–125/415	50/–50	65/–70	105	60	360
Poor Reported Braking Action									
MAX MANUAL	2745	65/–60	110	–180/675	225/–140	75/–75	95	480	1405
AUTOBRAKE MAX	2765	65/–60	110	–180/680	230/–145	75/–80	95	485	1415
AUTOBRAKE 3	2815	65/–60	110	–180/685	220/–135	80/–80	105	435	1370

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PITCH UP AUTHORITY (Flaps ≤ 18)
VREF 30+40

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1775	40/–30	55	–70/230	20/–20	45/–45	60	50	80
AUTOBRAKE MAX	2240	35/–35	70	–85/280	5/–5	60/–65	100	0	5
AUTOBRAKE 2	3290	70/–75	130	–145/480	65/–65	95/–100	110	325	370
Good Reported Braking Action									
MAX MANUAL	2250	50/–45	95	–105/365	45/–40	70/–70	85	185	355
AUTOBRAKE MAX	2310	50/–40	95	–95/355	35/–20	70/–70	95	180	345
AUTOBRAKE 2	3315	70/–75	130	–145/480	70/–75	95/–100	110	330	385
Good to Medium Reported Braking Action									
MAX MANUAL	2400	50/–50	95	–115/390	55/–50	70/–75	85	215	435
AUTOBRAKE MAX	2450	50/–45	95	–110/385	50/–40	70/–75	95	220	435
AUTOBRAKE 2	3315	70/–75	130	–145/480	70/–75	95/–100	110	330	385
Medium Reported Braking Action									
MAX MANUAL	2510	50/–50	100	–120/415	70/–60	75/–75	85	255	535
AUTOBRAKE MAX	2560	50/–45	100	–115/405	60/–50	75/–75	95	260	540
AUTOBRAKE 3	3175	60/–70	115	–140/465	60/–65	90/–95	105	165	250
Medium to Poor Reported Braking Action									
MAX MANUAL	2860	70/–65	125	–140/500	95/–80	90/–90	95	450	1180
AUTOBRAKE MAX	2885	70/–65	130	–140/500	100/–85	90/–90	95	460	1195
AUTOBRAKE 3	3195	65/–70	120	–140/465	70/–70	90/–95	100	230	920
Poor Reported Braking Action									
MAX MANUAL	3440	80/–75	145	–190/715	245/–155	95/–100	95	740	2195
AUTOBRAKE MAX	3465	80/–75	150	–195/720	250/–160	100/–100	95	750	2215
AUTOBRAKE 3	3625	80/–80	150	–200/735	240/–160	105/–105	100	660	2090

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PITCH UP AUTHORITY (Flaps ≥ 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1530	30/–30	45	–65/215	20/–15	40/–40	60	40	85
AUTOBRAKE MAX	1900	30/–35	55	–80/260	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2800	60/–65	110	–135/445	55/–60	80/–85	110	220	225
Good Reported Braking Action									
MAX MANUAL	1880	45/–40	75	–95/335	35/–30	60/–60	80	130	290
AUTOBRAKE MAX	1935	40/–35	75	–85/325	30/–10	55/–55	90	120	270
AUTOBRAKE 2	2820	65/–65	110	–135/450	55/–60	80/–85	105	230	240
Good to Medium Reported Braking Action									
MAX MANUAL	2030	45/–40	80	–105/360	50/–40	60/–60	80	160	370
AUTOBRAKE MAX	2070	45/–40	80	–100/360	45/–30	60/–60	90	160	365
AUTOBRAKE 2	2820	65/–65	110	–135/450	55/–60	80/–85	105	230	240
Medium Reported Braking Action									
MAX MANUAL	2135	45/–45	80	–110/385	60/–50	60/–60	80	200	470
AUTOBRAKE MAX	2175	45/–45	85	–105/380	60/–45	60/–60	90	200	470
AUTOBRAKE 3	2690	55/–60	95	–130/430	45/–50	80/–80	110	90	175
Medium to Poor Reported Braking Action									
MAX MANUAL	2415	60/–55	105	–130/465	80/–65	75/–75	90	340	930
AUTOBRAKE MAX	2440	60/–55	110	–130/470	85/–70	75/–75	90	350	950
AUTOBRAKE 3	2715	55/–60	100	–130/435	55/–55	80/–80	100	130	700
Poor Reported Braking Action									
MAX MANUAL	2975	70/–65	125	–180/685	225/–140	85/–85	90	615	1895
AUTOBRAKE MAX	3000	70/–65	125	–180/685	230/–145	85/–85	90	625	1910
AUTOBRAKE 3	3120	70/–70	130	–185/700	215/–140	90/–90	100	530	1820

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
PRI FLIGHT COMPUTERS (Flaps 20)
VREF 20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1405	30/–30	40	–65/215	15/–15	35/–35	60	35	70
AUTOBRAKE MAX	1630	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2505	60/–65	95	–130/430	25/–35	75/–75	115	75	75
Good Reported Braking Action									
MAX MANUAL	1700	40/–40	70	–90/325	30/–30	50/–55	85	105	240
AUTOBRAKE MAX	1725	40/–40	70	–85/320	30/–25	55/–55	85	95	225
AUTOBRAKE 2	2525	60/–65	95	–130/435	35/–45	75/–75	120	80	80
Good to Medium Reported Braking Action									
MAX MANUAL	1855	45/–40	75	–100/350	45/–40	55/–55	85	140	320
AUTOBRAKE MAX	1865	45/–40	75	–100/355	50/–40	55/–55	85	140	320
AUTOBRAKE 2	2525	60/–65	95	–130/435	35/–45	75/–75	120	80	80
Medium Reported Braking Action									
MAX MANUAL	1965	45/–45	75	–105/375	55/–45	55/–55	85	180	430
AUTOBRAKE MAX	1975	45/–45	75	–105/375	60/–50	55/–55	85	175	430
AUTOBRAKE 3	2360	50/–55	80	–120/415	25/–30	70/–70	120	20	130
Medium to Poor Reported Braking Action									
MAX MANUAL	2215	60/–55	100	–130/460	75/–65	70/–70	95	305	850
AUTOBRAKE MAX	2240	60/–55	100	–130/465	85/–70	70/–70	95	315	875
AUTOBRAKE 3	2450	50/–60	90	–125/420	50/–50	70/–70	110	110	665
Poor Reported Braking Action									
MAX MANUAL	2785	70/–65	120	–180/680	230/–140	75/–80	95	600	1900
AUTOBRAKE MAX	2815	70/–65	120	–180/680	235/–145	80/–80	95	605	1925
AUTOBRAKE 3	2875	70/–70	120	–185/685	220/–135	80/–85	110	545	1860

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
ROLL LEFT AUTHORITY/ROLL RIGHT AUTHORITY (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1515	30/–30	45	–65/215	15/–15	40/–40	55	40	80
AUTOBRAKE MAX	1885	35/–35	55	–80/260	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2780	60/–65	105	–135/445	50/–55	80/–80	105	220	230
Good Reported Braking Action									
MAX MANUAL	1855	45/–40	75	–95/335	35/–30	60/–60	80	120	270
AUTOBRAKE MAX	1920	40/–35	75	–80/315	20/–5	55/–55	90	105	250
AUTOBRAKE 2	2800	65/–65	110	–135/450	55/–60	80/–85	105	230	240
Good to Medium Reported Braking Action									
MAX MANUAL	2005	45/–40	80	–100/360	45/–40	60/–60	80	155	345
AUTOBRAKE MAX	2050	45/–40	80	–100/350	40/–30	60/–60	90	155	345
AUTOBRAKE 2	2800	65/–65	110	–135/450	55/–60	80/–85	105	230	240
Medium Reported Braking Action									
MAX MANUAL	2110	45/–45	80	–105/380	55/–50	60/–60	80	190	445
AUTOBRAKE MAX	2155	45/–40	80	–105/375	50/–40	60/–60	90	190	445
AUTOBRAKE 3	2675	55/–60	95	–130/430	45/–50	80/–80	105	90	165
Medium to Poor Reported Braking Action									
MAX MANUAL	2390	60/–55	105	–130/465	75/–65	75/–75	90	330	890
AUTOBRAKE MAX	2415	60/–55	105	–130/465	80/–70	75/–75	90	335	905
AUTOBRAKE 3	2705	55/–60	100	–130/435	55/–60	80/–80	100	120	645
Poor Reported Braking Action									
MAX MANUAL	2950	70/–65	125	–180/680	220/–140	85/–85	90	600	1835
AUTOBRAKE MAX	2975	70/–65	125	–180/680	230/–145	85/–85	90	605	1850
AUTOBRAKE 3	3105	70/–70	130	–185/695	215/–140	90/–90	100	515	1750

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SLATS DRIVE (Flaps 20)
VREF 30+30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1635	35/–30	50	–65/220	20/–15	40/–40	60	45	90
AUTOBRAKE MAX	2080	35/–35	65	–85/270	5/–5	55/–55	100	0	0
AUTOBRAKE 2	3010	65/–70	115	–140/460	65/–65	85/–90	110	290	335
Good Reported Braking Action									
MAX MANUAL	2030	45/–40	80	–100/345	40/–35	65/–65	80	145	325
AUTOBRAKE MAX	2105	45/–35	80	–85/330	25/–10	60/–60	90	135	310
AUTOBRAKE 2	3020	65/–70	115	–140/460	65/–65	90/–90	105	295	345
Good to Medium Reported Braking Action									
MAX MANUAL	2180	45/–45	85	–105/370	50/–45	65/–65	80	180	405
AUTOBRAKE MAX	2235	45/–40	85	–100/365	45/–30	65/–65	90	180	410
AUTOBRAKE 2	3020	65/–70	115	–140/460	65/–65	90/–90	105	295	345
Medium Reported Braking Action									
MAX MANUAL	2285	50/–45	90	–110/395	60/–50	65/–65	80	215	505
AUTOBRAKE MAX	2340	45/–45	90	–110/390	55/–40	65/–65	90	220	510
AUTOBRAKE 3	2900	60/–65	105	–130/445	55/–60	85/–85	105	150	225
Medium to Poor Reported Braking Action									
MAX MANUAL	2585	60/–55	115	–135/475	80/–70	80/–80	90	370	1010
AUTOBRAKE MAX	2610	65/–55	115	–135/480	85/–75	80/–80	90	380	1030
AUTOBRAKE 3	2915	60/–65	110	–130/445	65/–65	85/–85	95	175	760
Poor Reported Braking Action									
MAX MANUAL	3145	70/–70	130	–185/690	230/–145	90/–90	90	645	1970
AUTOBRAKE MAX	3170	75/–70	135	–185/695	235/–150	90/–90	90	655	1985
AUTOBRAKE 3	3320	75/–75	135	–190/710	225/–145	95/–95	95	575	1870

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILER PAIRS (Flaps 25)
VREF 25+5

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1425	30/–30	45	–65/210	15/–15	35/–35	60	35	70
AUTOBRAKE MAX	1710	30/–35	50	–75/250	5/–5	45/–45	90	0	0
AUTOBRAKE 2	2595	60/–65	100	–130/435	35/–50	75/–75	110	125	125
Good Reported Braking Action									
MAX MANUAL	1740	40/–40	70	–95/330	35/–30	55/–55	80	110	235
AUTOBRAKE MAX	1770	40/–35	70	–85/320	30/–15	55/–50	85	100	215
AUTOBRAKE 2	2615	60/–65	100	–130/440	40/–55	75/–80	110	135	135
Good to Medium Reported Braking Action									
MAX MANUAL	1890	45/–45	75	–100/355	45/–40	55/–55	80	145	315
AUTOBRAKE MAX	1905	45/–40	75	–95/355	50/–35	55/–55	85	140	305
AUTOBRAKE 2	2615	60/–65	100	–130/440	40/–55	75/–80	110	135	135
Medium Reported Braking Action									
MAX MANUAL	1995	45/–45	75	–105/375	55/–45	55/–55	80	180	420
AUTOBRAKE MAX	2015	45/–45	80	–105/375	60/–40	55/–55	85	180	410
AUTOBRAKE 3	2460	50/–60	85	–125/420	35/–35	70/–75	115	40	125
Medium to Poor Reported Braking Action									
MAX MANUAL	2260	60/–55	100	–130/460	75/–65	70/–70	95	315	835
AUTOBRAKE MAX	2280	60/–55	105	–130/460	85/–70	70/–70	95	320	850
AUTOBRAKE 3	2515	55/–60	90	–125/420	50/–45	70/–75	110	110	625
Poor Reported Braking Action									
MAX MANUAL	2825	70/–65	120	–180/675	225/–140	80/–80	95	595	1820
AUTOBRAKE MAX	2845	70/–70	125	–180/680	230/–145	80/–80	95	600	1835
AUTOBRAKE 3	2930	70/–70	120	–185/685	220/–130	85/–85	110	525	1765

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILER PAIRS (Flaps 30)
VREF 30+5

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1370	30/–25	40	–65/210	15/–15	35/–35	60	30	60
AUTOBRAKE MAX	1635	30/–30	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2490	55/–60	90	–130/425	30/–45	75/–75	110	85	85
Good Reported Braking Action									
MAX MANUAL	1665	40/–35	70	–90/325	30/–30	50/–50	80	90	195
AUTOBRAKE MAX	1690	40/–35	70	–80/315	30/–15	50/–50	85	80	175
AUTOBRAKE 2	2510	55/–60	95	–130/430	35/–50	75/–75	110	90	90
Good to Medium Reported Braking Action									
MAX MANUAL	1820	40/–40	70	–100/350	45/–40	55/–55	80	125	270
AUTOBRAKE MAX	1830	40/–40	70	–95/345	45/–35	55/–50	85	120	260
AUTOBRAKE 2	2510	55/–60	95	–130/430	35/–50	75/–75	110	90	90
Medium Reported Braking Action									
MAX MANUAL	1930	45/–40	75	–105/370	55/–45	55/–55	80	160	365
AUTOBRAKE MAX	1940	45/–40	75	–105/370	55/–40	55/–55	85	155	355
AUTOBRAKE 3	2350	50/–50	80	–120/410	25/–30	70/–70	120	25	100
Medium to Poor Reported Braking Action									
MAX MANUAL	2175	55/–50	95	–130/460	75/–65	70/–70	95	270	700
AUTOBRAKE MAX	2190	55/–50	95	–130/460	80/–70	70/–70	95	275	705
AUTOBRAKE 3	2400	50/–55	85	–120/415	45/–40	70/–70	110	90	505
Poor Reported Braking Action									
MAX MANUAL	2755	65/–65	115	–180/675	230/–140	75/–80	95	545	1610
AUTOBRAKE MAX	2770	65/–65	115	–180/680	235/–145	80/–80	95	545	1615
AUTOBRAKE 3	2835	65/–65	115	–180/685	215/–130	80/–80	110	490	1560

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILERS (Flaps 25)
VREF 25

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1355	30/–30	40	–65/210	15/–15	35/–35	55	30	60
AUTOBRAKE MAX	1625	30/–35	50	–75/245	5/–5	45/–45	85	0	0
AUTOBRAKE 2	2470	60/–65	95	–125/425	30/–45	70/–75	110	105	105
Good Reported Braking Action									
MAX MANUAL	1640	40/–40	65	–90/320	30/–25	50/–50	80	95	200
AUTOBRAKE MAX	1675	40/–35	65	–80/305	25/–10	50/–50	85	80	180
AUTOBRAKE 2	2490	60/–65	95	–130/430	40/–50	75/–75	110	110	110
Good to Medium Reported Braking Action									
MAX MANUAL	1790	40/–40	70	–95/345	45/–35	50/–50	80	125	280
AUTOBRAKE MAX	1810	40/–40	70	–95/340	40/–30	50/–50	85	125	270
AUTOBRAKE 2	2490	60/–65	95	–130/430	40/–50	75/–75	110	110	110
Medium Reported Braking Action									
MAX MANUAL	1895	45/–40	70	–100/365	55/–45	55/–55	80	165	375
AUTOBRAKE MAX	1915	45/–45	75	–100/365	55/–40	55/–55	85	160	370
AUTOBRAKE 3	2340	50/–55	80	–120/410	30/–35	70/–70	115	30	105
Medium to Poor Reported Braking Action									
MAX MANUAL	2140	55/–55	95	–125/450	70/–60	65/–65	90	280	730
AUTOBRAKE MAX	2160	55/–55	95	–125/450	80/–65	65/–70	90	285	745
AUTOBRAKE 3	2390	50/–60	85	–120/415	50/–45	70/–70	105	90	525
Poor Reported Braking Action									
MAX MANUAL	2705	65/–65	115	–175/665	220/–135	75/–75	90	555	1680
AUTOBRAKE MAX	2725	65/–65	115	–175/670	225/–140	75/–80	90	560	1695
AUTOBRAKE 3	2800	65/–65	115	–180/675	210/–125	80/–80	105	490	1630

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
SPOILERS (Flaps 30)
VREF 30

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1305	30/–25	40	–60/205	15/–15	35/–35	55	25	55
AUTOBRAKE MAX	1550	30/–30	45	–75/240	5/–5	40/–40	85	0	0
AUTOBRAKE 2	2365	55/–55	85	–125/420	25/–40	70/–70	110	65	65
Good Reported Braking Action									
MAX MANUAL	1570	40/–35	65	–90/315	30/–25	50/–50	80	80	165
AUTOBRAKE MAX	1600	40/–30	65	–80/305	25/–10	45/–45	85	70	150
AUTOBRAKE 2	2385	55/–55	90	–125/420	30/–45	70/–70	110	70	70
Good to Medium Reported Braking Action									
MAX MANUAL	1725	40/–35	65	–95/340	40/–35	50/–50	80	110	240
AUTOBRAKE MAX	1740	40/–35	65	–90/335	40/–30	50/–50	85	105	235
AUTOBRAKE 2	2385	55/–55	90	–125/420	30/–45	70/–70	110	70	70
Medium Reported Braking Action									
MAX MANUAL	1835	40/–40	70	–100/360	55/–45	50/–50	80	145	335
AUTOBRAKE MAX	1845	40/–40	70	–100/360	50/–40	50/–50	85	140	325
AUTOBRAKE 3	2225	45/–50	75	–115/400	25/–30	65/–65	115	20	90
Medium to Poor Reported Braking Action									
MAX MANUAL	2065	55/–50	90	–125/450	70/–60	65/–65	90	245	615
AUTOBRAKE MAX	2075	55/–50	90	–125/450	75/–65	65/–65	90	245	625
AUTOBRAKE 3	2280	50/–50	80	–120/405	40/–40	65/–65	105	70	425
Poor Reported Braking Action									
MAX MANUAL	2640	65/–60	110	–175/665	220/–135	75/–75	90	510	1500
AUTOBRAKE MAX	2650	65/–60	110	–175/670	230/–140	75/–75	90	510	1505
AUTOBRAKE 3	2710	65/–60	110	–180/675	210/–125	80/–80	105	460	1455

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Non-Normal Configuration Landing Distance
STABILIZER (Flaps 20)
VREF 30+20

	LANDING DISTANCE AND ADJUSTMENTS (M)								
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ	SLOPE ADJ	TEMP ADJ	APP SPD ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	190000 KG LANDING WEIGHT	PER 5000 KG ABV/BLW 190000 KG	PER 1000 FT ABOVE SEA LEVEL	PER 10 KTS HEAD/ TAIL WIND	PER 1% DOWN/ UP HILL	PER 10 deg. C ABV/ BLW ISA	PER 5 KTS ABOVE VREF	ONE REV	NO REV
Dry Runway									
MAX MANUAL	1530	30/–30	45	–65/215	20/–15	40/–40	60	40	85
AUTOBRAKE MAX	1900	30/–35	55	–80/260	5/–5	50/–50	95	0	0
AUTOBRAKE 2	2800	60/–65	110	–135/445	55/–60	80/–85	110	220	225
Good Reported Braking Action									
MAX MANUAL	1880	45/–40	75	–95/335	35/–30	60/–60	80	130	290
AUTOBRAKE MAX	1935	40/–35	75	–85/325	30/–10	55/–55	90	120	270
AUTOBRAKE 2	2820	65/–65	110	–135/450	55/–60	80/–85	105	230	240
Good to Medium Reported Braking Action									
MAX MANUAL	2030	45/–40	80	–105/360	50/–40	60/–60	80	160	370
AUTOBRAKE MAX	2070	45/–40	80	–100/360	45/–30	60/–60	90	160	365
AUTOBRAKE 2	2820	65/–65	110	–135/450	55/–60	80/–85	105	230	240
Medium Reported Braking Action									
MAX MANUAL	2135	45/–45	80	–110/385	60/–50	60/–60	80	200	470
AUTOBRAKE MAX	2175	45/–45	85	–105/380	60/–45	60/–60	90	200	470
AUTOBRAKE 3	2690	55/–60	95	–130/430	45/–50	80/–80	110	90	175
Medium to Poor Reported Braking Action									
MAX MANUAL	2415	60/–55	105	–130/465	80/–65	75/–75	90	340	930
AUTOBRAKE MAX	2440	60/–55	110	–130/470	85/–70	75/–75	90	350	950
AUTOBRAKE 3	2715	55/–60	100	–130/435	55/–55	80/–80	100	130	700
Poor Reported Braking Action									
MAX MANUAL	2975	70/–65	125	–180/685	225/–140	85/–85	90	615	1895
AUTOBRAKE MAX	3000	70/–65	125	–180/685	230/–145	85/–85	90	625	1910
AUTOBRAKE 3	3120	70/–70	130	–185/700	215/–140	90/–90	100	530	1820

Reference distance is based on sea level, standard day, no wind or slope, and maximum available reverse thrust.
MAX MANUAL assumes maximum achievable manual braking.
Includes an air distance from threshold to touchdown associated with a flare time of 7 seconds.
Actual (unfactored) distances are shown.

ADVISORY INFORMATION

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	LANDING CLIMB LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	200.9	195.6							
52	205.8	200.4							
50	210.7	205.2	187.9						
48	215.2	210.1	192.6						
46	219.2	214.8	197.2	180.0					
44	223.3	219.2	201.8	184.5					
42	227.3	223.0	206.4	189.0	172.5				
40	231.3	226.8	210.5	193.6	176.8				
38	233.4	230.6	214.1	198.0	181.2	164.3			
36	233.6	234.3	217.6	201.8	185.4	168.5			
34	233.7	236.2	221.0	204.9	189.5	172.6	155.1		
32	233.9	236.3	224.4	208.1	193.0	176.5	158.9		
30	234.1	236.5	226.1	211.4	196.0	180.4	162.6		
28	234.2	236.6	226.2	214.6	198.9	183.6	166.2		
26	234.3	236.8	226.3	216.2	201.8	186.3	169.7		
24	234.4	236.9	226.5	216.3	204.7	189.0	172.7	156.3	
22	234.6	237.0	226.6	216.4	206.1	191.4	175.3	159.7	
20	234.7	237.1	226.7	216.5	206.2	193.7	177.7	162.3	144.5
18	234.8	237.2	226.8	216.6	206.3	194.8	179.8	164.4	147.6
16	234.8	237.3	226.9	216.7	206.4	195.2	181.7	166.4	149.9
14	234.9	237.4	227.0	216.7	206.4	195.6	182.6	168.2	151.9
12	235.0	237.5	227.1	216.8	206.5	195.6	183.0	169.9	153.7
10	235.1	237.6	227.2	216.9	206.6	195.7	183.3	170.7	155.4
0	235.5	237.9	227.5	217.3	206.9	195.9	183.5	171.3	158.6
–10	235.8	238.2	227.9	217.7	207.2	196.1	183.6	171.5	159.1
–20	236.2	238.5	228.2	218.0	207.5	196.3	183.8	171.6	
–30	236.8	238.9	228.5	218.4	207.8	196.5	183.9		
–40	237.5	239.5	229.0	218.7	208.1	196.7			

If airplane landing weight exceeds Landing Climb Limit Weight and further weight reduction is not possible, use flaps 20 for landing and flaps 5 for go-around.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10 deg. C, decrease weight by 17100 kg.

Anti-Ice Adjustments

Pressure Altitude ≤9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4650	–4650
ENGINE & WING ON	–350	–5500	–5500

Pressure Altitude >9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1500	–3100	–3500
ENGINE & WING ON	–2100	–3700	–4300

ADVISORY INFORMATION

Landing Climb Limit Weight

Valid for approach with flaps 20 and landing with flaps 25

Based on anti-ice off

AIRPORT OAT (deg. C)	LANDING CLIMB LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	201.9	196.4							
52	206.8	201.3							
50	211.7	206.1	188.6						
48	216.1	210.9	193.2						
46	220.1	215.8	197.9	180.6					
44	224.1	220.1	202.6	185.1					
42	228.1	223.9	207.3	189.7	173.0				
40	232.0	227.7	211.4	194.3	177.4				
38	234.2	231.4	215.0	198.8	181.8	164.9			
36	234.3	235.1	218.4	202.6	186.1	169.1			
34	234.5	236.9	221.8	205.8	190.2	173.1	155.6		
32	234.7	237.1	225.2	208.9	193.8	177.0	159.4		
30	234.8	237.2	226.8	212.2	196.7	180.9	163.1		
28	235.0	237.4	226.9	215.4	199.5	184.1	166.8		
26	235.1	237.5	227.1	216.9	202.5	186.9	170.3		
24	235.2	237.7	227.2	217.1	205.5	189.7	173.3	156.8	
22	235.3	237.8	227.3	217.2	206.9	192.2	175.9	160.2	
20	235.4	237.9	227.5	217.3	207.0	194.5	178.5	162.8	144.9
18	235.5	238.0	227.5	217.3	207.1	195.6	180.5	165.0	148.0
16	235.6	238.1	227.6	217.4	207.2	196.0	182.4	167.0	150.4
14	235.7	238.2	227.7	217.5	207.3	196.4	183.4	168.8	152.4
12	235.8	238.3	227.8	217.6	207.4	196.5	183.7	170.6	154.3
10	235.8	238.3	227.9	217.7	207.5	196.5	184.1	171.4	156.0
0	236.2	238.7	228.3	218.1	207.8	196.7	184.2	172.0	159.2
–10	236.6	239.0	228.6	218.4	208.1	196.9	184.4	172.2	159.7
–20	237.0	239.3	228.9	218.8	208.4	197.1	184.6	172.3	
–30	237.6	239.7	229.3	219.1	208.7	197.3	184.7		
–40	238.2	240.3	229.8	219.5	209.0	197.5			

If airplane landing weight exceeds Landing Climb Limit Weight and further weight reduction is not possible, use flaps 20 for landing and flaps 5 for go-around.
When operating in icing conditions during any part of the flight with forecast landing temperature at or below 10 deg. C, decrease weight by 17550 kg.

Anti-Ice Adjustments

Pressure Altitude ≤9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4650	–4650
ENGINE & WING ON	–350	–5550	–5550

Pressure Altitude >9000 FT

	LANDING CLIMB LIMIT WEIGHT ADJUSTMENT (KG)		
ANTI-ICE CONFIGURATION	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–1550	–3100	–3550
ENGINE & WING ON	–2150	–3750	–4350

ADVISORY INFORMATION

Tire Speed Landing Limit Weight
FLAPS DRIVE (1≤Flaps≤5)
PITCH UP AUTHORITY (Flaps≤18)

AIRPORT OAT (deg. C)	TIRE SPEED LANDING LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	255.6	232.6							
52	257.2	234.1							
50	258.9	235.6	218.3						
48	260.5	237.1	219.7						
46	262.1	238.7	221.1	203.3					
44	263.8	240.3	222.5	204.8					
42	265.5	241.8	223.9	206.3	188.2				
40	267.3	243.3	225.4	207.8	189.8				
38	269.2	245.3	227.0	209.2	191.3	173.5			
36	269.8	248.2	228.4	210.8	192.8	175.1			
34	269.8	251.4	229.9	212.4	194.5	176.5	159.8		
32	269.8	254.2	231.5	214.0	196.1	177.9	161.1		
30	269.8	256.0	232.9	215.5	197.8	179.4	162.3		
28	269.8	257.7	234.5	217.2	199.3	181.0	163.8		
26	269.8	259.3	236.0	218.7	200.8	182.4	165.2		
24	269.8	261.2	237.8	220.2	202.3	184.1	166.7	150.6	
22	269.8	263.0	239.4	221.6	203.8	185.7	168.2	151.9	
20	269.8	264.7	241.0	223.2	205.1	187.3	169.6	153.3	138.1
18	269.8	266.6	242.7	224.8	206.7	189.0	171.1	154.7	139.4
16	269.8	268.5	244.4	226.2	208.2	190.5	172.7	156.0	140.6
14	269.8	269.8	247.2	227.7	209.8	192.2	174.3	157.4	141.9
12	269.8	269.8	250.2	229.4	211.4	193.9	175.8	158.9	143.1
10	269.8	269.8	253.6	231.0	212.8	195.6	177.3	160.3	144.5
8	269.8	269.8	255.5	232.7	214.5	197.4	179.0	161.8	145.8
6	269.8	269.8	257.4	234.4	216.0	199.1	180.6	163.2	147.2
4	269.8	269.8	259.3	236.0	217.9	200.8	182.2	164.8	148.6
2	269.8	269.8	261.2	237.7	219.4	202.2	183.8	166.3	150.1
0	269.8	269.8	263.0	239.4	220.9	203.7	185.5	167.9	151.5
–10	269.8	269.8	269.8	251.2	229.2	211.4	193.9	176.1	159.1
–20	269.8	269.8	269.8	262.4	238.1	219.8	202.4	184.8	167.1
–30	269.8	269.8	269.8	269.8	250.0	228.5	210.5		
–40	269.8	269.8	269.8	269.8	262.4	238.1			

Based on 226 knots (260 MPH) tire speed limit with final approach speed that is higher of VREF 30+40 and the amber band, with a five knot approach speed additive.

Wind Adjustment

WIND (KTS)	15 TW	10 TW	5 TW	0.0	10 HW	20 HW	30 HW	40 HW
WEIGHT ADJUSTMENT (1000 KG)	–51	–35	–20	0	7	15	22	30

ADVISORY INFORMATION

Tire Speed Landing Limit Weight
Flaps + Slats Fail (Flaps and Slats Up)

AIRPORT OAT (deg. C)	TIRE SPEED LANDING LIMIT WEIGHT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	231.4	210.8							
52	233.2	212.5							
50	235.0	214.2	194.8						
48	237.0	216.0	196.4						
46	238.9	217.7	197.9	179.7					
44	240.9	219.4	199.8	181.2					
42	243.0	221.3	201.4	182.7	165.4				
40	244.9	223.2	203.0	184.2	166.8				
38	250.2	225.0	204.7	185.8	168.2	151.8			
36	254.6	226.7	206.5	187.4	169.7	153.3			
34	256.6	228.8	208.1	189.0	171.1	154.5	139.1		
32	259.0	230.7	210.1	190.7	172.7	155.8	140.4		
30	261.0	232.6	211.8	192.3	174.2	157.4	141.7		
28	263.3	234.7	213.5	194.0	175.7	158.7	143.0		
26	265.4	236.6	215.5	195.7	177.3	160.2	144.2		
24	267.9	238.9	217.2	197.5	178.8	161.6	145.6	128.9	
22	269.8	240.8	219.2	199.1	180.3	163.1	146.9	130.5	
20	269.8	243.0	221.2	200.9	182.0	164.6	148.3	132.3	113.0
18	269.8	245.6	223.1	202.8	183.7	166.1	149.7	134.0	114.7
16	269.8	251.1	225.0	204.6	185.5	167.6	151.1	135.6	116.4
14	269.8	255.1	227.0	206.5	187.1	169.1	152.5	137.1	118.1
12	269.8	257.5	229.1	208.1	188.7	170.7	154.0	138.4	119.8
10	269.8	259.8	231.1	210.1	190.5	172.3	155.5	139.8	121.3
8	269.8	262.1	233.4	212.0	192.3	173.9	157.0	141.2	123.1
6	269.8	264.5	235.5	214.0	194.1	175.6	158.5	142.5	124.8
4	269.8	267.0	237.7	216.0	195.9	177.4	160.0	143.9	126.7
2	269.8	269.4	239.9	218.2	197.9	179.1	161.6	145.3	128.5
0	269.8	269.8	242.1	220.2	199.8	180.8	163.1	146.7	130.2
–10	269.8	269.8	259.8	230.9	209.6	189.8	171.5	154.4	138.6
–20	269.8	269.8	269.8	242.9	220.4	199.8	180.5	162.7	146.2
–30	269.8	269.8	269.8	261.3	232.1	210.5	190.2		
–40	269.8	269.8	269.8	269.8	245.6	222.2			

Based on 226 knots (260 MPH) tire speed limit with final approach speed of VREF30+55.

Wind Adjustment

WIND (KTS)	15 TW	10 TW	5 TW	0.0	10 HW	20 HW	30 HW	40 HW
WEIGHT ADJUSTMENT (1000 KG)	–64	–45	–26	0	7	15	23	31

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Reference Brake Energy (Millions of Foot Pounds)

Table 1(a) of 3: Sea Level to 10,000 ft Pressure Altitude

		BRAKES ON SPEED (KIAS)														
		100			120			140			160			180		
WEIGHT	OAT	PRESSURE ALTITUDE														
(1000 KG)	(deg. C)	0	5	10	0	5	10	0	5	10	0	5	10	0	5	10
240	0	32.4	37.3	43.1	44.6	51.7	60.2	58.2	67.9	79.5	73.1	85.6	100.5	88.7	103.9	122.1
	10	33.5	38.5	44.6	46.1	53.4	62.2	60.2	70.2	82.2	75.6	88.4	103.9	91.7	107.4	126.2
	15	34.1	39.1	45.3	46.8	54.2	63.2	61.2	71.3	83.5	76.8	89.9	105.6	93.2	109.2	128.3
	20	34.6	39.8	46.0	47.6	55.1	64.2	62.1	72.4	84.9	78.0	91.3	107.3	94.7	110.9	130.3
	30	35.6	40.9	47.4	49.0	56.8	66.2	64.0	74.6	87.5	80.4	94.1	110.7	97.6	114.4	134.5
	40	36.2	41.7	48.2	49.9	57.9	67.5	65.3	76.3	89.5	82.2	96.4	113.5	100.0	117.4	138.3
220	0	30.2	34.6	39.9	41.3	47.8	55.6	53.9	62.7	73.3	67.7	79.1	92.9	82.2	96.2	113.1
	10	31.2	35.7	41.3	42.7	49.4	57.4	55.7	64.8	75.8	69.9	81.8	96.0	84.9	99.5	117.0
	15	31.7	36.3	41.9	43.4	50.2	58.3	56.6	65.8	77.0	71.1	83.1	97.6	86.3	101.1	118.9
	20	32.2	36.9	42.6	44.1	51.0	59.3	57.4	66.9	78.2	72.2	84.4	99.2	87.7	102.7	120.8
	30	33.1	38.0	43.9	45.4	52.5	61.1	59.2	68.9	80.6	74.4	87.0	102.2	90.4	105.9	124.6
	40	33.7	38.7	44.7	46.2	53.5	62.3	60.4	70.4	82.4	76.0	89.0	104.8	92.5	108.6	128.0
200	0	27.9	31.9	36.8	38.0	43.8	50.9	49.4	57.3	67.0	61.9	72.3	84.8	75.5	88.4	103.9
	10	28.8	33.0	38.0	39.3	45.3	52.6	51.0	59.3	69.2	64.0	74.7	87.6	78.1	91.4	107.4
	15	29.3	33.5	38.6	39.9	46.0	53.4	51.9	60.2	70.3	65.0	75.9	89.1	79.3	92.9	109.2
	20	29.7	34.0	39.2	40.5	46.8	54.3	52.7	61.2	71.4	66.1	77.1	90.5	80.6	94.4	110.9
	30	30.6	35.0	40.4	41.8	48.2	55.9	54.3	63.0	73.6	68.1	79.5	93.3	83.1	97.3	114.4
	40	31.1	35.6	41.1	42.5	49.1	57.0	55.3	64.3	75.2	69.5	81.3	95.5	84.9	99.6	117.4
180	0	25.6	29.2	33.6	34.7	39.9	46.3	44.9	52.0	60.6	56.1	65.3	76.5	68.2	79.8	93.7
	10	26.4	30.2	34.8	35.9	41.3	47.8	46.4	53.7	62.6	58.0	67.5	79.1	70.5	82.5	96.9
	15	26.9	30.7	35.3	36.4	41.9	48.6	47.1	54.6	63.6	58.9	68.6	80.4	71.7	83.8	98.4
	20	27.3	31.2	35.9	37.0	42.6	49.3	47.9	55.5	64.6	59.8	69.7	81.6	72.8	85.2	100.0
	30	28.1	32.1	36.9	38.1	43.9	50.8	49.3	57.1	66.6	61.7	71.8	84.1	75.0	87.8	103.1
	40	28.6	32.6	37.6	38.8	44.7	51.8	50.2	58.3	68.0	62.9	73.4	86.1	76.7	89.8	105.7
160	0	23.3	26.6	30.5	31.4	36.0	41.6	40.4	46.6	54.2	50.3	58.4	68.2	60.9	71.1	83.4
	10	24.1	27.4	31.5	32.4	37.2	43.0	41.7	48.2	56.0	51.9	60.4	70.5	63.0	73.5	86.2
	15	24.5	27.9	32.0	32.9	37.8	43.7	42.4	49.0	56.9	52.8	61.3	71.6	64.0	74.7	87.6
	20	24.8	28.3	32.5	33.5	38.4	44.4	43.1	49.8	57.8	53.6	62.3	72.8	65.0	75.9	89.0
	30	25.6	29.2	33.5	34.5	39.6	45.7	44.4	51.3	59.6	55.2	64.2	75.0	67.0	78.2	91.7
	40	26.0	29.6	34.1	35.1	40.3	46.6	45.2	52.2	60.8	56.3	65.5	76.6	68.4	79.9	93.9
140	0	21.0	23.9	27.4	28.1	32.1	37.0	35.9	41.3	47.9	44.5	51.5	60.0	53.7	62.5	73.1
	10	21.7	24.7	28.3	29.0	33.2	38.3	37.1	42.7	49.5	45.9	53.2	62.0	55.5	64.6	75.5
	15	22.0	25.1	28.7	29.5	33.7	38.9	37.7	43.4	50.3	46.7	54.1	63.0	56.4	65.6	76.8
	20	22.4	25.5	29.2	29.9	34.2	39.5	38.3	44.1	51.1	47.4	54.9	64.0	57.3	66.7	78.0
	30	23.1	26.2	30.1	30.8	35.3	40.7	39.4	45.4	52.6	48.9	56.6	65.9	59.0	68.7	80.4
	40	23.4	26.7	30.6	31.3	35.9	41.4	40.1	46.2	53.6	49.8	57.7	67.3	60.2	70.1	82.2
120	0	18.7	21.2	24.3	24.7	28.2	32.4	31.3	36.0	41.6	38.6	44.5	51.7	46.4	53.8	62.8
	10	19.3	21.9	25.1	25.5	29.1	33.5	32.4	37.2	42.9	39.9	46.0	53.4	48.0	55.6	64.9
	15	19.6	22.3	25.5	25.9	29.6	34.0	32.9	37.8	43.6	40.5	46.8	54.3	48.8	56.5	65.9
	20	19.9	22.6	25.9	26.3	30.1	34.6	33.4	38.3	44.3	41.2	47.5	55.2	49.5	57.4	67.0
	30	20.5	23.3	26.7	27.1	31.0	35.6	34.4	39.5	45.7	42.4	48.9	56.8	51.0	59.2	69.0
	40	20.8	23.7	27.1	27.6	31.5	36.2	35.0	40.2	46.5	43.2	49.9	58.0	52.0	60.4	70.5

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 with sea level, 15 deg. C.

ADVISORY INFORMATION

Recommended Brake Cooling Schedule

Reference Brake Energy (Millions of Foot Pounds)

Table 1(b) of 3: 10,000 ft to 14,000 ft Pressure Altitude

		BRAKES ON SPEED (KIAS)														
		100			120			140			160			180		
WEIGHT	OAT	PRESSURE ALTITUDE														
(1000 KG)	(deg. C)	10	12	14	10	12	14	10	12	14	10	12	14	10	12	14
240	0	43.1	45.8	48.7	60.2	64.1	68.4	79.5	84.9	90.8	100.5	107.4	114.9	122.1		
	10	44.6	47.3	50.4	62.2	66.3	70.7	82.2	87.8	93.8	103.9	111.1	118.8	126.2		
	15	45.3	48.1	51.2	63.2	67.4	71.9	83.5	89.2	95.4	105.6	112.9	120.7	128.3		
	20	46.0	48.9	52.0	64.2	68.4	73.0	84.9	90.6	96.9	107.3	114.7	122.7	130.3		
	30	47.4	50.3	53.6	66.2	70.5	75.2	87.5	93.4	99.9	110.7	118.3	126.5	134.5		
	40	48.2	51.3	54.6	67.5	72.0	76.9	89.5	95.7	102.3	113.5	121.5	130.0	138.3		
220	0	39.9	42.4	45.1	55.6	59.2	63.1	73.3	78.3	83.6	92.9	99.3	106.1	113.1	120.9	
	10	41.3	43.8	46.6	57.4	61.2	65.2	75.8	80.9	86.4	96.0	102.6	109.7	117.0	125.0	
	15	41.9	44.5	47.4	58.3	62.1	66.3	77.0	82.2	87.8	97.6	104.3	111.5	118.9	127.0	
	20	42.6	45.2	48.1	59.3	63.1	67.3	78.2	83.5	89.2	99.2	106.0	113.3	120.8	129.1	
	30	43.9	46.6	49.5	61.1	65.0	69.4	80.6	86.1	92.0	102.2	109.3	116.9	124.6	133.1	
	40	44.7	47.5	50.5	62.3	66.4	70.8	82.4	88.1	94.1	104.8	112.1	120.0	128.0	136.9	
200	0	36.8	39.0	41.5	50.9	54.2	57.7	67.0	71.4	76.3	84.8	90.6	96.8	103.9	111.0	118.7
	10	38.0	40.3	42.9	52.6	56.0	59.6	69.2	73.8	78.8	87.6	93.6	100.1	107.4	114.8	122.8
	15	38.6	41.0	43.5	53.4	56.9	60.6	70.3	75.0	80.1	89.1	95.1	101.7	109.2	116.7	124.8
	20	39.2	41.6	44.2	54.3	57.8	61.6	71.4	76.2	81.4	90.5	96.7	103.4	110.9	118.6	126.8
	30	40.4	42.9	45.6	55.9	59.5	63.4	73.6	78.5	83.9	93.3	99.7	106.6	114.4	122.3	130.8
	40	41.1	43.7	46.4	57.0	60.7	64.7	75.2	80.3	85.8	95.5	102.1	109.3	117.4	125.6	134.5
180	0	33.6	35.7	37.9	46.3	49.2	52.4	60.6	64.6	68.9	76.5	81.7	87.3	93.7	100.1	107.1
	10	34.8	36.9	39.1	47.8	50.8	54.1	62.6	66.7	71.2	79.1	84.4	90.2	96.9	103.5	110.7
	15	35.3	37.4	39.8	48.6	51.6	55.0	63.6	67.8	72.3	80.4	85.8	91.7	98.4	105.2	112.5
	20	35.9	38.0	40.4	49.3	52.5	55.8	64.6	68.9	73.5	81.6	87.2	93.1	100.0	106.9	114.3
	30	36.9	39.2	41.6	50.8	54.0	57.5	66.6	71.0	75.7	84.1	89.8	96.0	103.1	110.2	117.9
	40	37.6	39.9	42.3	51.8	55.1	58.7	68.0	72.5	77.4	86.1	91.9	98.3	105.7	113.1	121.0
160	0	30.5	32.3	34.3	41.6	44.2	47.0	54.2	57.7	61.5	68.2	72.8	77.7	83.4	89.1	95.2
	10	31.5	33.4	35.4	43.0	45.7	48.6	56.0	59.7	63.6	70.5	75.2	80.3	86.2	92.1	98.4
	15	32.0	33.9	36.0	43.7	46.4	49.4	56.9	60.6	64.6	71.6	76.4	81.6	87.6	93.6	100.0
	20	32.5	34.5	36.6	44.4	47.2	50.2	57.8	61.6	65.7	72.8	77.6	82.9	89.0	95.1	101.6
	30	33.5	35.5	37.7	45.7	48.6	51.7	59.6	63.5	67.7	75.0	80.0	85.5	91.7	98.0	104.8
	40	34.1	36.1	38.3	46.6	49.5	52.7	60.8	64.8	69.1	76.6	81.8	87.4	93.9	100.4	107.4
140	0	27.4	29.0	30.7	37.0	39.3	41.7	47.9	50.9	54.2	60.0	63.9	68.2	73.1	78.0	83.3
	10	28.3	30.0	31.8	38.3	40.6	43.1	49.5	52.7	56.1	62.0	66.1	70.5	75.5	80.6	86.1
	15	28.7	30.4	32.3	38.9	41.3	43.8	50.3	53.5	57.0	63.0	67.1	71.6	76.8	81.9	87.5
	20	29.2	30.9	32.8	39.5	41.9	44.5	51.1	54.3	57.9	64.0	68.2	72.8	78.0	83.2	88.9
	30	30.1	31.8	33.8	40.7	43.2	45.9	52.6	56.0	59.6	65.9	70.3	75.0	80.4	85.8	91.7
	40	30.6	32.4	34.3	41.4	43.9	46.7	53.6	57.1	60.8	67.3	71.8	76.6	82.2	87.8	93.8
120	0	24.3	25.7	27.2	32.4	34.4	36.5	41.6	44.1	47.0	51.7	55.0	58.6	62.8	66.9	71.4
	10	25.1	26.5	28.1	33.5	35.5	37.7	42.9	45.6	48.5	53.4	56.9	60.6	64.9	69.2	73.8
	15	25.5	27.0	28.5	34.0	36.1	38.3	43.6	46.4	49.3	54.3	57.8	61.6	65.9	70.3	75.0
	20	25.9	27.4	29.0	34.6	36.7	38.9	44.3	47.1	50.1	55.2	58.7	62.6	67.0	71.4	76.2
	30	26.7	28.2	29.9	35.6	37.8	40.1	45.7	48.5	51.6	56.8	60.5	64.5	69.0	73.6	78.6
	40	27.1	28.7	30.4	36.2	38.4	40.8	46.5	49.4	52.6	58.0	61.7	65.8	70.5	75.2	80.3

To correct for wind, enter table with the brakes-on speed minus one-half the headwind or plus 1.5 times the tailwind. If ground speed is used for brakes-on speed, ignore wind and enter table with sea level, 15 deg. 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		20	30	40	50	60	70	80	90	100	110	120
RTO MAX MAN		20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
LANDING	MAX MAN	16.4	25.2	34.2	43.4	52.9	62.5	72.3	82.1	92.1	102.0	112.0
	MAX AUTO	15.2	23.2	31.6	40.1	48.9	57.9	67.1	76.5	86.0	95.7	105.5
	AUTOBRAKE 4	14.4	22.0	29.7	37.7	45.8	54.1	62.6	71.3	80.1	89.1	98.3
	AUTOBRAKE 3	13.7	20.8	28.1	35.6	43.1	50.9	58.8	66.8	75.0	83.4	91.9
	AUTOBRAKE 2	13.1	19.8	26.5	33.4	40.4	47.5	54.8	62.2	69.7	77.3	85.2
	AUTOBRAKE 1	11.9	17.9	24.0	30.1	36.3	42.7	49.1	55.6	62.2	68.9	75.8

Table 2(b) of 3: 2 Engine Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)										
EVENT		20	30	40	50	60	70	80	90	100	110	120
RTO MAX MAN		20.0	30.0	40.0	50.0	60.0	70.0	80.0	90.0	100.0	110.0	120.0
LANDING	MAX MAN	15.0	22.9	31.1	39.4	47.9	56.6	65.2	74.0	82.7	91.3	99.9
	MAX AUTO	11.0	17.1	23.5	30.3	37.4	44.8	52.5	60.4	68.6	77.0	85.6
	AUTOBRAKE 4	7.9	12.5	17.4	22.6	28.2	34.2	40.4	46.9	53.6	60.6	67.9
	AUTOBRAKE 3	5.3	8.5	12.0	15.9	20.2	24.8	29.7	34.9	40.5	46.4	52.6
	AUTOBRAKE 2	4.0	6.2	8.7	11.5	14.4	17.7	21.2	25.1	29.2	33.7	38.6
	AUTOBRAKE 1	3.1	4.7	6.4	8.1	10.0	12.1	14.3	16.8	19.6	22.6	26.0

Table 3 of 3: Cooling Time (Minutes)

	EVENT ADJUSTED BRAKE ENERGY (MILLIONS OF FOOT POUNDS)									
	19 & BELOW	20	21	26	30	35	39	40	41 TO 56	57 & ABOVE
GEAR DOWN INFLIGHT	NO SPECIAL PROCEDURE REQUIRED	1.3	2.0	3.4	4.9	6.2	7.1	7.3	CAUTION	FUSE PLUG MELT ZONE
GROUND		13	20	34	49	62	71	73		
BRAKE TEMPERATURE INDICATION	UP TO 2.4	2.4	2.6	3.1	3.7	4.3	4.8	4.9	5.0 TO 7.0	7.1 & 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 15 percent.

With two brakes deactivated, increase brake energy by 34 percent.

When in caution zone, wheel fuse plugs may melt. Delay takeoff and inspect after one hour. If overheat occurs after takeoff, extend gear soon for at least 8 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not 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.

ENGINE INOP

Initial Max Continuous TPR
Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)								
	27	29	31	33	35	37	39	41	43
	310	310	310	.85	.85	.85	.85	.85	.85
20	77.4	77.6	77.2	77.7	77.0	74.5	73.3	72.6	71.9
15	81.7	82.1	81.7	82.1	81.1	78.7	77.6	77.0	76.3
10	86.0	86.6	86.1	86.2	85.2	82.8	81.9	81.3	80.8
5	90.6	90.7	90.4	90.4	89.5	87.4	86.7	86.1	85.5
0	96.8	95.3	94.5	95.0	93.8	92.0	91.5	90.9	90.3
–5	97.0	97.1	97.3	98.7	97.7	96.3	95.8	95.3	94.8
–10	97.2	97.3	97.5	100.1	101.9	100.4	100.1	99.9	99.6
–15	97.5	97.6	97.7	100.3	103.1	103.7	103.7	103.9	104.1
–20	97.7	97.8	98.0	100.5	103.4	103.9	103.9	104.1	104.3
–25	97.9	98.0	98.2	100.8	103.6	104.1	104.2	104.4	104.5
–30	98.2	98.3	98.4	101.0	103.8	104.4	104.4	104.6	104.8
–35	98.4	98.5	98.6	101.2	104.1	104.6	104.7	104.8	105.0
–40	98.6	98.7	98.9	101.5	104.3	104.9	104.9	105.1	105.3

TPR Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	27	29	31	33	35	37	39	41	43
ENGINE ON	–1.8	–1.9	–2.0	–2.3	–2.5	–2.8	–3.1	–3.7	–4.3
ENGINE & WING ON	–2.7	–2.9	–3.2	–3.5	–3.9	–4.4	–4.9	–6.0	–7.0

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	27	29	31	33	35	37	39	41	43
ENGINE ON	–1.8	–1.9	–2.1	–2.3	–2.5	–2.8	–3.1	–3.6	–4.2
ENGINE & WING ON	–2.8	–2.9	–3.2	–3.5	–3.9	–4.4	–4.9	–5.9	–6.8

ENGINE INOP

Max Continuous TPR

Based on anti-ice off or auto

37000 FT to 31000 FT Pressure Altitudes

37000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−50	−45	−40	−35	−30	−25	−20	−15	−10	−5	0	5
280	.86	104.8	104.6	104.3	104.1	103.9	103.6	103.4	103.1	100.3	96.2	91.9	87.3
240	.74	105.5	105.3	105.0	104.8	104.5	104.3	103.0	98.7	94.6	89.9	85.2	80.8
200	.63	105.6	105.3	105.0	104.8	104.5	101.8	97.8	93.2	88.3	83.5	79.0	75.5

35000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−50	−45	−40	−35	−30	−25	−20	−15	−10	−5	0	5
280	.82	104.9	104.6	104.4	104.2	103.9	103.7	103.4	103.2	100.3	96.3	92.1	87.7
240	.71	105.2	105.0	104.7	104.5	104.2	104.0	102.9	98.8	94.8	90.2	85.6	81.1
200	.60	105.3	105.1	104.8	104.6	104.3	102.3	98.4	94.0	89.1	84.3	79.7	75.7

33000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−50	−45	−40	−35	−30	−25	−20	−15	−10	−5	0	5
320	.89	98.5	98.3	98.1	97.9	97.7	97.4	97.2	97.0	96.8	96.6	93.6	89.5
280	.79	103.1	102.9	102.6	102.4	102.2	101.9	101.7	101.4	100.2	96.5	92.5	87.8
240	.68	104.0	103.8	103.5	103.3	103.0	102.8	102.5	99.5	95.3	90.8	86.1	81.4
200	.58	104.7	104.4	104.2	103.9	103.7	103.4	98.7	94.4	89.8	85.0	80.5	76.0

31000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−45	−40	−35	−30	−25	−20	−15	−10	−5	0	5	10
320	.85	97.8	97.5	97.3	97.1	96.9	96.6	96.4	96.2	96.0	94.5	90.5	86.2
280	.76	101.5	101.2	101.0	100.8	100.5	100.3	100.0	99.8	96.1	92.0	87.5	82.8
240	.66	103.1	102.9	102.7	102.4	102.2	101.9	100.6	95.2	91.0	86.2	81.4	76.7
200	.55	103.9	103.6	103.3	103.1	102.8	100.4	95.1	90.7	85.8	80.9	76.2	71.7

TPR Adjustments for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	31	33	35	37
ENGINE ON	−2.0	−2.3	−2.5	−2.8
ENGINE & WING ON	−3.2	−3.5	−3.9	−4.4

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	31	33	35	37
ENGINE ON	−2.1	−2.3	−2.5	−2.8
ENGINE & WING ON	−3.2	−3.5	−3.9	−4.4

29000 FT to 24000 FT Pressure Altitudes

29000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−40	−35	−30	−25	−20	−15	−10	−5	0	5	10	15
320	.82	96.7	96.4	96.2	96.0	95.8	95.5	95.3	95.1	94.9	90.6	86.4	82.1
280	.73	100.8	100.5	100.3	100.0	99.8	99.6	99.3	97.0	91.8	87.6	83.0	78.4
240	.63	102.4	102.2	101.9	101.7	101.4	101.2	96.7	91.5	87.0	82.3	77.5	72.7
200	.53	103.0	102.7	102.5	102.2	102.0	96.7	91.8	87.1	82.1	77.3	72.6	70.1

ENGINE INOP

Max Continuous TPR
Based on anti-ice off or auto
29000 FT to 24000 FT Pressure Altitudes
27000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−40	−35	−30	−25	−20	−15	−10	−5	0	5	10	15
360	.88	86.8	86.6	86.4	86.2	86.0	85.8	85.6	85.4	85.2	85.0	84.4	80.3
320	.79	98.0	97.7	97.5	97.3	97.1	96.8	96.6	96.4	96.1	92.2	86.6	82.4
280	.70	100.6	100.4	100.1	99.9	99.7	99.4	99.2	98.9	93.2	88.5	84.2	79.8
240	.60	102.0	101.8	101.5	101.3	101.1	100.8	99.7	92.5	88.2	83.6	79.0	74.5
200	.51	102.4	102.1	101.9	101.6	101.3	99.9	92.8	88.4	83.7	79.0	74.3	69.7

25000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−35	−30	−25	−20	−15	−10	−5	0	5	10	15	20
360	.85	85.7	85.5	85.3	85.1	84.9	84.8	84.6	84.4	84.2	84.0	80.8	76.7
320	.76	96.5	96.3	96.0	95.8	95.6	95.4	95.1	94.9	93.7	86.8	82.7	78.6
280	.67	99.2	98.9	98.7	98.5	98.2	98.0	97.8	95.0	89.3	85.0	80.7	76.4
240	.58	100.6	100.3	100.1	99.9	99.6	99.4	95.3	89.6	85.2	80.8	76.3	71.8
200	.49	100.4	100.2	99.9	99.7	99.4	95.7	90.1	85.6	80.9	76.2	71.5	68.1

24000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−35	−30	−25	−20	−15	−10	−5	0	5	10	15	20
360	.83	86.7	86.5	86.3	86.1	85.9	85.7	85.5	85.3	85.1	84.9	82.0	77.4
320	.75	95.4	95.2	95.0	94.8	94.5	94.3	94.1	93.9	93.7	87.8	83.2	79.1
280	.66	98.3	98.1	97.9	97.6	97.4	97.2	96.9	95.8	89.8	85.6	81.3	77.1
240	.57	99.5	99.2	99.0	98.7	98.5	98.3	96.4	90.5	86.2	81.8	77.3	72.7
200	.48	99.1	98.9	98.6	98.4	98.1	96.7	91.2	86.8	82.0	77.3	72.6	67.9

TPR Adjustments for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	24	25	27	29
ENGINE ON	−1.6	−1.7	−1.8	−1.9
ENGINE & WING ON	−2.4	−2.5	−2.7	−2.9

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	24	25	27	29
ENGINE ON	−1.6	−1.7	−1.8	−1.9
ENGINE & WING ON	−2.5	−2.6	−2.8	−2.9

22000 FT to 16000 FT Pressure Altitudes
22000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−30	−25	−20	−15	−10	−5	0	5	10	15	20	25
360	.80	88.9	88.7	88.5	88.3	88.1	87.9	87.7	87.5	87.3	86.1	79.9	76.0
320	.72	93.5	93.3	93.1	92.8	92.6	92.4	92.2	92.0	89.4	84.6	80.5	76.6
280	.63	96.7	96.5	96.3	96.0	95.8	95.6	95.3	91.8	87.1	83.0	78.9	74.6
240	.55	96.5	96.3	96.1	95.8	95.6	95.4	92.3	88.0	83.6	79.1	74.5	69.8
200	.46	96.6	96.4	96.1	95.9	95.6	93.1	88.8	84.3	79.4	74.6	69.8	66.6

ENGINE INOP

Max Continuous TPR
Based on anti-ice off or auto
22000 FT to 16000 FT Pressure Altitudes
20000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−30	−25	−20	−15	−10	−5	0	5	10	15	20	25
360	.77	87.4	87.2	87.0	86.8	86.6	86.4	86.2	86.0	85.8	85.6	82.5	78.6
320	.69	91.9	91.7	91.5	91.2	91.0	90.8	90.6	90.4	90.2	86.4	82.4	78.5
280	.61	95.2	94.9	94.7	94.5	94.3	94.0	93.8	93.3	89.5	85.5	81.4	77.3
240	.53	94.7	94.5	94.2	94.0	93.8	93.5	93.1	89.8	85.7	80.9	76.0	71.3
200	.44	95.6	95.3	95.1	94.9	94.6	94.4	90.3	86.1	81.5	76.7	72.0	67.2

18000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−25	−20	−15	−10	−5	0	5	10	15	20	25	30
360	.75	84.3	84.1	83.9	83.7	83.5	83.3	83.1	82.9	82.7	81.6	78.3	74.6
320	.67	89.6	89.4	89.1	88.9	88.7	88.5	88.3	88.1	86.1	82.1	78.2	74.4
280	.59	92.3	92.1	91.9	91.7	91.4	91.2	91.0	89.1	85.3	81.4	77.4	73.2
240	.51	91.6	91.3	91.1	90.9	90.7	90.4	88.7	84.9	80.9	76.8	72.6	67.7
200	.42	94.2	93.9	93.7	93.5	93.2	91.9	87.3	83.1	78.9	74.6	69.7	65.0

16000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−25	−20	−15	−10	−5	0	5	10	15	20	25	30
360	.72	81.5	81.3	81.2	81.0	80.8	80.6	80.4	80.2	80.0	79.8	77.0	73.7
320	.64	87.3	87.1	86.9	86.7	86.4	86.2	86.0	85.8	85.6	81.9	78.0	74.3
280	.57	89.8	89.6	89.4	89.2	88.9	88.7	88.5	88.3	84.4	80.4	76.5	72.7
240	.49	90.9	90.7	90.5	90.3	90.0	89.8	89.6	85.7	81.5	77.5	73.5	69.1
200	.41	93.1	92.9	92.6	92.4	92.2	91.9	88.8	84.1	80.0	75.9	71.4	66.6

TPR Adjustments for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	16	18	20	22
ENGINE ON	−1.1	−1.2	−1.3	−1.5
ENGINE & WING ON	−1.6	−1.8	−2.0	−2.2

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	16	18	20	22
ENGINE ON	−1.2	−1.3	−1.4	−1.5
ENGINE & WING ON	−1.7	−1.9	−2.0	−2.2

14000 FT to 5000 FT Pressure Altitudes
14000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−20	−15	−10	−5	−0	5	10	15	20	25	30	35
360	.69	79.5	79.3	79.1	78.9	78.7	78.5	78.3	78.1	78.0	76.9	74.0	70.6
320	.62	84.6	84.4	84.2	84.0	83.8	83.6	83.4	83.2	81.5	77.8	74.1	70.5
280	.54	87.7	87.5	87.3	87.1	86.8	86.6	86.4	84.6	80.1	76.2	72.5	68.7
240	.47	89.9	89.7	89.5	89.3	89.0	88.8	87.6	82.2	78.3	74.4	70.6	66.0
200	.39	92.0	91.7	91.5	91.3	91.0	90.8	85.4	81.1	77.1	73.0	68.5	63.7

ENGINE INOP

Max Continuous TPR
Based on anti-ice off or auto
14000 FT to 5000 FT Pressure Altitudes
12000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−15	−10	−5	0	5	10	15	20	25	30	35	40
360	.67	75.3	75.1	74.9	74.7	74.6	74.4	74.2	74.0	73.8	72.8	70.2	66.9
320	.60	82.4	82.2	82.0	81.8	81.6	81.4	81.2	81.0	77.5	73.8	70.3	66.9
280	.52	86.1	85.9	85.7	85.4	85.2	85.0	84.8	80.7	76.4	72.7	69.1	65.3
240	.45	88.9	88.7	88.5	88.2	88.0	87.8	84.3	79.1	75.2	71.5	67.5	63.3
200	.38	91.2	90.9	90.7	90.5	90.2	88.7	82.2	78.3	74.4	70.4	65.7	61.2

10000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−15	−10	−5	0	5	10	15	20	25	30	35	40
360	.65	71.5	71.4	71.2	71.0	70.9	70.7	70.5	70.3	70.2	69.4	67.2	65.2
320	.58	79.1	78.9	78.7	78.6	78.4	78.2	78.0	77.8	76.6	72.6	69.1	65.7
280	.51	82.5	82.3	82.1	81.9	81.7	81.5	81.2	80.6	76.6	72.9	69.4	65.9
240	.43	85.1	84.9	84.7	84.5	84.2	84.0	83.8	80.2	76.3	72.6	69.0	65.0
200	.36	86.8	86.6	86.4	86.1	85.9	85.7	83.8	80.1	76.2	72.4	68.3	63.7

5000 FT Pressure Altitudes

		TAT (deg. C)											
KIAS	M	−10	−5	0	5	10	15	20	25	30	35	40	45
360	.59	64.7	64.5	64.4	64.2	64.1	63.9	63.8	63.6	63.5	63.3	62.1	59.9
320	.53	71.7	71.5	71.3	71.2	71.0	70.8	70.6	70.5	70.3	67.7	64.7	61.6
280	.46	76.3	76.1	75.9	75.7	75.5	75.4	75.2	75.0	72.7	68.9	65.6	62.3
240	.40	79.1	78.9	78.7	78.5	78.3	78.1	77.9	77.0	72.9	69.4	66.0	62.6
200	.33	80.7	80.5	80.3	80.1	79.9	79.7	79.5	76.5	72.8	69.3	65.9	61.9

TPR Adjustments for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	5	10	12	14
ENGINE ON	0.0	0.0	−0.5	−1.1
ENGINE & WING ON	0.0	0.0	−0.7	−1.5

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)			
	5	10	12	14
ENGINE ON	−0.9	−1.0	−1.1	−1.1
ENGINE & WING ON	−1.2	−1.4	−1.5	−1.6

ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude
100 ft/min residual rate of climb

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF PRESSURE ALTITUDE (FT)		
START DRIFT DOWN	LEVEL OFF		ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
260	251	276	15600	13600	11400
250	241	271	16800	15100	12900
240	231	266	18100	16600	14500
230	222	261	19600	18200	16100
220	212	255	20900	19800	17900
210	203	250	22300	21000	19700
200	193	244	23700	22100	20900
190	184	239	25000	23300	22100
180	174	233	26400	24600	23400
170	165	226	27700	25900	24800
160	155	220	29000	27400	26200
150	145	213	30500	29000	27900
140	136	206	32000	30700	29600
130	126	199	33500	32500	31400
120	116	192	35200	34400	33400

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown/LRC Cruise Range Capability

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
275	256	239	224	211	200	189	180	171	164	157
550	511	478	449	423	400	379	360	343	328	314
824	767	717	673	634	600	569	541	515	492	471
1098	1022	955	897	845	800	758	721	687	657	629
1371	1276	1194	1121	1057	1000	948	902	860	821	786
1645	1531	1432	1345	1268	1200	1138	1082	1032	986	944
1918	1786	1671	1569	1480	1400	1328	1263	1204	1151	1102
2192	2041	1909	1793	1691	1600	1517	1443	1376	1315	1259
2465	2296	2148	2017	1902	1800	1707	1624	1549	1480	1417
2739	2551	2386	2242	2114	2000	1897	1805	1721	1644	1574
3014	2806	2625	2466	2325	2200	2087	1985	1893	1808	1732
3289	3062	2864	2691	2537	2400	2276	2165	2064	1973	1889
3565	3318	3104	2915	2748	2600	2466	2345	2236	2137	2046
3841	3575	3344	3140	2960	2800	2655	2525	2408	2300	2202

Table 2 of 2: Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG) WEIGHT AT START OF DRIFTDOWN (1000 KG)								TIME (HR:MIN)
	120	140	160	180	200	220	240	260	
200	1.5	1.6	1.8	2.0	2.2	2.4	2.6	2.8	0:32
400	3.3	3.7	4.2	4.6	5.0	5.5	6.0	6.4	1:05
600	5.0	5.7	6.4	7.1	7.8	8.6	9.3	10.1	1:37
800	6.7	7.6	8.5	9.5	10.5	11.4	12.4	13.5	2:09
1000	8.3	9.4	10.6	11.9	13.0	14.2	15.5	16.9	2:41
1200	9.9	11.3	12.7	14.2	15.6	17.0	18.6	20.2	3:12
1400	11.4	13.1	14.8	16.5	18.1	19.8	21.5	23.5	3:44
1600	13.0	14.9	16.8	18.7	20.6	22.5	24.5	26.7	4:16
1800	14.5	16.6	18.8	21.0	23.1	25.2	27.4	29.9	4:48
2000	16.1	18.4	20.8	23.2	25.5	27.8	30.3	33.0	5:20
2200	17.6	20.1	22.7	25.3	27.9	30.5	33.2	36.1	5:52
2400	19.0	21.8	24.7	27.5	30.3	33.1	36.0	39.2	6:25
2600	20.5	23.5	26.6	29.6	32.6	35.6	38.8	42.3	6:57
2800	22.0	25.2	28.5	31.7	35.0	38.2	41.5	45.3	7:30

Includes APU fuel burn.
Driftdown at optimum driftdown speed and cruise at Long Range Cruise speed.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability
100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
260	8900	3200	
250	12400	5800	2600
240	15000	10800	5700
230	17000	14100	9200
220	18700	16700	12800
210	20400	18800	15700
200	21800	20300	18400
190	23300	21500	20200
180	24800	22800	21400
170	26200	24200	22800
160	27600	25600	24200
150	29100	27200	25600
140	30600	28800	27400
130	32200	30700	29200
120	33900	32700	31300
110	35800	34900	33500
100	37300	36500	35600

With engine anti-ice on, decrease altitude capability by 1,500 ft.
With engine and wing anti-ice on, decrease altitude capability by 3,400 ft.

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)											
		10	15	17	19	21	23	25	27	29	31	33	35
280	TPR	78.3											
	MACH	.597											
	KIAS	332											
	FF/ENG	7322											
260	TPR	74.2											
	MACH	.582											
	KIAS	323											
	FF/ENG	6796											
240	TPR	69.6	81.4	87.3									
	MACH	.566	.606	.622									
	KIAS	314	307	303									
	FF/ENG	6224	6182	6212									
220	TPR	65.1	75.7	80.9	86.8	94.5							
	MACH	.549	.588	.605	.621	.641							
	KIAS	304	297	295	291	289							
	FF/ENG	5682	5603	5599	5618	5738							
200	TPR	60.5	70.7	75.2	80.5	86.4	94.0						
	MACH	.526	.569	.585	.602	.619	.638						
	KIAS	292	288	285	282	279	276						
	FF/ENG	5133	5089	5062	5054	5069	5167						
180	TPR	56.0	65.7	70.0	74.5	79.7	85.7	93.1	102.5				
	MACH	.501	.548	.565	.581	.598	.615	.634	.656				
	KIAS	277	277	274	272	269	266	263	262				
	FF/ENG	4586	4601	4571	4542	4531	4542	4617	4777				
160	TPR	51.3	60.3	64.4	68.7	73.3	78.4	84.3	91.3	100.5			
	MACH	.476	.520	.540	.558	.574	.591	.609	.627	.649			
	KIAS	263	262	262	260	258	255	252	249	248			
	FF/ENG	4080	4071	4077	4058	4028	4009	4021	4069	4182			
140	TPR	46.5	54.6	58.3	62.4	66.8	71.4	76.3	81.9	88.5	97.2	107.4	
	MACH	.449	.489	.507	.527	.547	.565	.582	.599	.617	.638	.663	
	KIAS	248	246	245	246	245	243	240	238	235	233	232	
	FF/ENG	3584	3546	3541	3551	3547	3518	3498	3505	3533	3597	3741	
120	TPR	41.3	48.8	52.1	55.7	59.6	64.0	68.6	73.4	78.6	84.8	92.4	102.1
	MACH	.414	.459	.475	.491	.510	.531	.551	.569	.586	.605	.624	.646
	KIAS	229	231	229	228	228	228	227	225	222	220	217	215
	FF/ENG	3053	3056	3040	3028	3022	3029	3020	3003	2999	3005	3030	3126

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
293	268	247	229	214	200	190	180	172	164	158
585	537	494	458	427	400	380	362	345	330	317
879	806	742	688	641	600	570	543	518	495	475
1173	1076	990	917	855	800	761	724	691	660	633
1468	1346	1239	1148	1070	1000	951	905	864	826	792
1765	1617	1487	1377	1284	1200	1140	1086	1036	990	950
2062	1889	1736	1608	1498	1400	1331	1267	1208	1155	1107
2360	2161	1986	1839	1713	1600	1521	1447	1380	1320	1265
2660	2435	2236	2070	1927	1800	1710	1628	1552	1484	1423
2960	2708	2487	2301	2142	2000	1900	1808	1724	1648	1580
3262	2984	2738	2533	2357	2200	2090	1988	1896	1812	1737
3565	3259	2989	2764	2571	2400	2280	2169	2068	1976	1894
3869	3536	3242	2996	2787	2600	2469	2349	2239	2140	2051
4174	3813	3495	3229	3002	2800	2659	2530	2411	2304	2208
4481	4091	3748	3462	3217	3000	2849	2710	2583	2468	2364

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		26	
	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	2.7	0:41	2.3	0:40	2.1	0:38	1.9	0:37	1.7	0:36
400	5.6	1:19	5.1	1:15	4.7	1:12	4.4	1:10	4.1	1:07
600	8.6	1:57	7.9	1:51	7.3	1:46	6.8	1:42	6.6	1:39
800	11.5	2:36	10.6	2:27	9.9	2:21	9.3	2:15	8.9	2:10
1000	14.3	3:15	13.4	3:04	12.5	2:55	11.7	2:49	11.3	2:42
1200	17.2	3:54	16.0	3:41	15.0	3:30	14.1	3:22	13.6	3:14
1400	20.0	4:33	18.7	4:18	17.5	4:05	16.5	3:55	15.9	3:46
1600	22.8	5:13	21.4	4:55	20.0	4:40	18.9	4:29	18.2	4:18
1800	25.6	5:52	24.0	5:33	22.5	5:16	21.2	5:03	20.5	4:50
2000	28.3	6:33	26.6	6:11	24.9	5:51	23.5	5:37	22.7	5:23
2200	31.0	7:13	29.1	6:49	27.4	6:27	25.8	6:11	24.9	5:55
2400	33.7	7:54	31.7	7:28	29.8	7:03	28.1	6:45	27.1	6:28
2600	36.4	8:35	34.2	8:07	32.2	7:40	30.4	7:20	29.3	7:01
2800	39.0	9:16	36.7	8:46	34.5	8:16	32.6	7:54	31.4	7:34
3000	41.7	9:58	39.2	9:25	36.9	8:53	34.8	8:29	33.5	8:08

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)								
	100	120	140	160	180	200	220	240	260
5	–1.1	–0.8	–0.5	–0.3	0.0	0.5	1.1	1.8	2.5
10	–2.4	–1.7	–1.1	–0.6	0.0	1.0	2.4	3.8	5.2
15	–3.6	–2.6	–1.7	–0.9	0.0	1.6	3.5	5.7	7.9
20	–4.9	–3.6	–2.3	–1.2	0.0	2.0	4.6	7.4	10.3
25	–6.1	–4.5	–2.9	–1.5	0.0	2.5	5.6	9.1	12.7
30	–7.3	–5.4	–3.5	–1.8	0.0	2.9	6.6	10.6	14.9
35	–8.5	–6.4	–4.2	–2.1	0.0	3.3	7.4	12.1	17.0
40	–9.7	–7.4	–4.8	–2.4	0.0	3.7	8.2	13.4	19.0
45	–10.9	–8.3	–5.4	–2.7	0.0	4.1	8.9	14.6	20.8
50	–12.0	–9.3	–6.0	–3.0	0.0	4.4	9.5	15.7	22.5

Includes APU fuel burn.

ENGINE INOP

MAX CONTINUOUS THRUST

Holding
Flaps up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)						
		1500	5000	10000	15000	20000	25000	30000
260	TPR	52.5	58.8	69.7	83.9			
	KIAS	258	258	258	259			
	FF/ENG	5990	6010	6040	6210			
240	TPR	49.0	54.8	64.7	77.5	96.2		
	KIAS	258	258	258	259	259		
	FF/ENG	5530	5540	5560	5650	6050		
220	TPR	45.5	50.9	60.0	71.7	86.8		
	KIAS	251	251	251	253	256		
	FF/ENG	5050	5050	5060	5120	5340		
200	TPR	42.0	47.1	55.4	66.0	79.4	100.3	
	KIAS	239	239	239	241	243	243	
	FF/ENG	4560	4560	4550	4590	4700	5080	
180	TPR	38.6	43.2	51.0	60.5	72.7	89.2	
	KIAS	227	228	228	229	230	230	
	FF/ENG	4090	4090	4080	4090	4140	4330	
160	TPR	35.3	39.4	46.5	55.0	66.0	79.9	102.2
	KIAS	219	219	219	220	221	221	221
	FF/ENG	3660	3640	3620	3630	3660	3740	4060
140	TPR	32.0	35.6	41.9	49.7	59.4	71.8	88.3
	KIAS	210	210	210	211	211	212	212
	FF/ENG	3240	3200	3190	3180	3210	3240	3390
120	TPR	29.1	32.3	37.8	44.7	53.4	64.2	77.7
	KIAS	203	203	203	203	203	203	203
	FF/ENG	2870	2810	2800	2780	2800	2820	2870

This table includes 5% additional fuel for holding in a racetrack pattern.

ENGINE INOP

ADVISORY INFORMATION

Gear Down Landing Rate of Climb Available
Flaps 20

TAT (deg. C)	RATE OF CLIMB (FT/MIN) PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
52	260	230							
50	300	270	120						
48	330	310	160	0					
46	370	340	200	40					
44	400	380	240	80					
42	430	410	270	130	–40				
40	430	450	310	160	0				
38	440	470	340	190	40	–140			
36	440	470	370	220	70	–100			
34	440	480	390	250	90	–70	–250		
32	440	480	390	280	120	–40	–220		
30	450	480	390	290	150	–10	–190	–390	
20	460	500	410	300	190	70	–80	–270	–490
10	470	510	420	310	200	70	–70	–240	–440
0	480	520	430	320	200	80	–70	–250	–430
–20	510	550	450	340	220	80	–70	–250	–450
–40	540	580	480	360	230	90	–70	–260	–460

Rate of climb capability shown is valid for 190000 kg, gear down at VREF 20+5.
Decrease rate of climb 40 ft/min per 5000 kg greater than 190000 kg.
Increase rate of climb 60 ft/min per 5000 kg less than 190000 kg.

Flaps 30

TAT (deg. C)	RATE OF CLIMB (FT/MIN) PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
52	30	–10							
50	70	30	–120						
48	100	70	–80	–240					
46	130	100	–40	–200					
44	170	140	0	–160					
42	200	170	30	–120	–290				
40	200	210	60	–90	–250				
38	200	230	90	–60	–210	–390			
36	200	230	120	–30	–180	–350			
34	210	240	140	0	–160	–320	–510		
32	210	240	140	30	–130	–290	–480		
30	210	240	150	40	–110	–270	–450	–650	
20	220	250	150	50	–70	–190	–340	–540	–760
10	220	260	160	50	–70	–190	–340	–510	–710
0	230	260	170	60	–60	–190	–340	–520	–710
–20	250	280	180	60	–60	–200	–350	–540	–730
–40	270	300	190	70	–60	–200	–370	–560	–760

Rate of climb capability shown is valid for 190000 kg, gear down at VREF 30+5.
Decrease rate of climb 40 ft/min per 5000 kg greater than 190000 kg.
Increase rate of climb 60 ft/min per 5000 kg less than 190000 kg.

ALTERNATE MODE EEC

Fuel Jettison Limit Weight

Valid for approach with flaps 20 and landing with flaps 30

Based on anti-ice off

AIRPORT OAT (deg. C)	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (1000 KG) AIRPORT PRESSURE ALTITUDE (FT)								
	–2000	0	2000	4000	6000	8000	10000	12000	14000
54	179.5	174.6							
52	184.1	179.5							
50	189.1	184.3	168.4						
48	202.9	188.8	173.1						
46	206.8	202.4	177.2	162.0					
44	210.7	206.1	181.1	165.9					
42	214.1	209.7	185.3	169.7	155.2				
40	217.4	213.5	189.4	174.0	158.9				
38	225.6	217.3	202.5	178.5	163.1	147.9			
36	226.4	233.8	206.0	182.2	167.4	152.0			
34	227.3	236.5	209.5	185.4	171.5	156.1	140.1		
32	228.5	236.8	213.0	188.5	175.1	160.2	143.9		
30	229.7	237.0	214.8	201.5	178.2	164.3	147.6		
28	230.8	237.3	215.1	205.0	181.3	167.6	151.3		
26	231.7	237.6	215.3	206.6	184.2	170.3	155.0		
24	232.7	237.9	215.6	206.9	187.3	173.1	158.1	142.9	
22	233.7	238.1	215.8	207.1	188.8	175.6	160.7	146.4	
20	234.8	238.3	216.0	207.3	189.1	178.2	163.4	149.1	132.5
18	235.0	238.6	216.2	207.5	189.3	179.7	165.8	151.4	135.6
16	235.2	238.8	216.5	207.7	189.5	180.3	168.3	153.7	138.1
14	235.4	239.0	216.7	207.9	189.6	180.8	169.6	156.1	140.1
12	235.5	239.2	216.9	208.1	189.8	181.0	170.2	158.5	142.3
10	235.7	239.3	217.1	208.3	190.0	181.2	170.7	159.8	144.5
0	236.6	240.1	217.8	209.1	190.7	182.0	171.4	161.0	149.3
–10	237.5	240.8	218.7	209.8	200.9	182.7	172.1	161.6	150.3
–20	238.0	241.4	225.1	210.5	201.5	183.3	172.6	162.2	
–30	238.6	241.9	227.3	211.1	202.2	183.9	173.2		
–40	239.3	242.6	229.8	211.6	202.8	184.5			

Table valid for Zero Fuel Weight up to 181437 kg.

Anti-Ice Adjustments

Pressure Altitude ≤9000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–350	–4450	–4450
ENGINE & WING ON	–350	–5250	–5250

Pressure Altitude >9000 FT

ANTI-ICE CONFIGURATION	FUEL JETTISON LIMIT WEIGHT ADJUSTMENT (KG)		
	OAT≤5 deg. C	5 deg. C<OAT≤10 deg. C	10 deg. C<OAT≤20 deg. C
ENGINE ON	–2050	–4100	–4100
ENGINE & WING ON	–2900	–4850	–4850

DELETION

ALTERNATE MODE EEC

Limit Weight

PERFORMANCE LIMIT	ALTERNATE MODE EEC LIMIT WEIGHT (1000 KG)							
	PRIMARY MODE PERFORMANCE LIMIT WEIGHT (1000 KG)							
	120	140	160	180	200	220	240	260
FIELD	109.9	128.1	146.4	164.6	182.8	201.0	219.2	237.5
CLIMB	106.2	123.8	141.4	159.0	176.6	194.2	211.8	229.4
OBSTACLE	105.3	123.1	140.9	158.7	176.6	194.4	212.2	230.1
NET LEVEL OFF WEIGHT	107.2	124.8	142.4	160.0	177.7	195.3	212.9	230.5
LANDING CLIMB	106.9	124.3	141.7	159.1	176.5	193.9	211.4	228.8

Takeoff Speed Adjustments

TAKEOFF SPEEDS	TAKEOFF SPEED ADJUSTMENT (KTS)	
	DRY	WET
V1	2	2
VR	1	1
V2	1	1

ALTERNATE MODE EEC

Max Takeoff %N1

Based on anti-ice off

AIRPORT OAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
55	85.4	86.3	87.1	86.8	86.5	86.1	85.7	85.3	85.0	84.5	83.8	83.1	82.3	81.5	80.7	79.5	78.2
50	86.9	87.8	88.6	88.4	88.1	87.7	87.4	87.0	86.8	86.4	85.9	85.2	84.5	83.8	83.1	81.9	80.8
45	88.0	88.9	89.9	89.7	89.5	89.2	88.9	88.6	88.4	88.1	87.6	87.0	86.4	85.8	85.2	84.1	83.0
40	88.7	89.7	90.7	90.7	90.7	90.5	90.3	90.0	89.8	89.5	89.0	88.6	88.1	87.6	87.0	86.1	85.1
35	88.4	90.0	91.6	91.5	91.5	91.4	91.4	91.5	91.2	90.9	90.5	90.0	89.5	89.0	88.5	87.7	86.9
30	87.8	89.4	91.0	91.5	91.9	92.2	92.2	92.1	92.3	92.2	91.9	91.5	91.0	90.4	89.9	89.1	88.3
25	87.1	88.7	90.3	90.8	91.3	91.8	92.4	93.0	92.9	92.9	92.8	92.6	92.4	91.9	91.4	90.5	89.7
20	86.5	88.1	89.7	90.1	90.6	91.1	91.7	92.3	92.7	93.3	93.4	93.2	93.0	92.8	92.6	91.9	91.1
15	85.8	87.4	89.0	89.5	89.9	90.4	91.0	91.6	92.0	92.7	93.1	93.4	93.6	93.5	93.3	92.7	92.1
10	85.2	86.7	88.3	88.8	89.2	89.7	90.3	90.9	91.3	92.0	92.4	92.8	93.2	93.4	93.7	93.4	92.8
5	84.5	86.1	87.6	88.1	88.5	89.0	89.6	90.2	90.6	91.2	91.7	92.1	92.5	92.8	93.2	93.2	93.1
0	83.8	85.4	86.9	87.4	87.8	88.3	88.9	89.5	89.9	90.5	91.0	91.4	91.7	92.1	92.5	92.5	92.5
–10	82.4	84.0	85.5	86.0	86.4	86.9	87.4	88.0	88.4	89.1	89.6	89.9	90.3	90.7	91.1	91.1	91.1
–20	81.0	82.5	84.0	84.5	84.9	85.4	86.0	86.6	86.9	87.6	88.0	88.4	88.8	89.2	89.6	89.6	89.6
–30	79.5	81.0	82.5	83.0	83.4	83.8	84.4	85.0	85.4	86.0	86.5	86.8	87.3	87.6	88.0	88.1	88.1
–40	78.0	79.5	81.0	81.4	81.8	82.3	82.8	83.5	83.8	84.4	84.9	85.3	85.7	86.1	86.5	86.5	86.5
–50	76.5	77.9	79.4	79.8	80.2	80.7	81.2	81.8	82.2	82.8	83.3	83.7	84.1	84.4	84.8	84.8	84.9

%N1 Adjustment for Anti-ice

For OAT≤10 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)							
	–2	0	9	10	11	12	13	14
ENGINE ON	0	0	0	–0.4	–0.4	–0.5	–0.5	–0.5
ENGINE & WING ON	0	0	0	–0.6	–0.6	–0.7	–0.7	–0.7
ENGINE AUTO	0	0	0	–0.4	–0.4	–0.5	–0.5	–0.5
ENGINE & WING AUTO	0	0	0	–0.6	–0.6	–0.7	–0.7	–0.7

For 10 deg. C<OAT≤20 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ENGINE ON	–0.6	–0.6	–0.7	–0.7	–0.7	–0.7	–0.7	–0.7	–0.8	–0.8	–0.8	–0.9	–0.9	–0.9	–0.9	–1.0	–0.9
ENGINE & WING ON	–0.7	–0.8	–0.8	–0.8	–0.8	–0.8	–0.9	–0.9	–0.9	–1.0	–1.0	–1.0	–1.1	–1.1	–1.1	–1.1	–1.1
With engine anti-ice auto or engine and wing anti-ice auto, no adjustment is necessary.																	

ALTERNATE MODE EEC

Max Climb %N1

Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)									
	0	5	10	15	20	25	30	35	40	43
	310	310	310	310	310	310	310	.85	.85	.85
60	78.2	78.6	80.5	83.8	85.6	88.1	90.8	94.5	93.6	93.1
50	81.4	81.5	81.3	82.5	84.3	86.8	89.4	93.1	92.1	91.7
40	83.9	84.5	84.3	84.4	83.7	85.4	88.0	91.6	90.7	90.3
30	83.4	86.7	86.8	87.3	86.6	86.6	87.1	90.1	89.2	88.8
20	82.2	85.4	88.0	89.4	89.1	89.0	89.4	89.6	88.0	87.5
15	81.6	84.8	87.3	90.1	90.1	90.1	90.5	90.5	88.9	88.5
10	80.9	84.1	86.6	89.4	91.1	91.1	91.6	91.4	89.8	89.4
5	80.3	83.4	85.9	88.7	90.8	92.0	92.4	92.3	90.8	90.3
0	79.7	82.7	85.2	88.0	90.0	92.1	93.4	93.3	91.8	91.3
–5	79.0	82.1	84.5	87.3	89.3	91.3	93.6	94.3	92.9	92.4
–10	78.3	81.4	83.8	86.5	88.5	90.6	92.9	95.5	94.1	93.7
–15	77.7	80.7	83.1	85.8	87.8	89.8	92.1	95.3	94.8	94.3
–20	77.0	79.9	82.3	85.0	87.0	89.1	91.3	94.5	94.0	93.5
–25	76.3	79.2	81.6	84.3	86.2	88.3	90.5	93.7	93.2	92.7
–30	75.6	78.5	80.8	83.5	85.4	87.5	89.7	92.9	92.3	91.9
–35	74.9	77.7	80.1	82.7	84.6	86.7	88.9	92.0	91.5	91.1
–40	74.1	77.0	79.3	81.9	83.8	85.8	88.1	91.2	90.7	90.2

%N1 Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	43
ENGINE ON	0.0	0.0	0.0	–0.5	–0.5	–0.7	–0.8	–1.0	–1.4	–1.7
ENGINE & WING ON	0.0	0.0	0.0	–0.7	–0.8	–1.0	–1.2	–1.6	–2.2	–2.8

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	0	5	10	15	20	25	30	35	40	43
ENGINE ON	–0.4	–0.4	–0.4	–0.5	–0.6	–0.7	–0.8	–1.0	–1.3	–1.7
ENGINE & WING ON	–0.5	–0.5	–0.6	–0.7	–0.8	–1.0	–1.2	–1.5	–2.1	–2.8

ALTERNATE MODE EEC

Max Cruise %N1

Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)									
	25	27	29	31	33	35	37	39	41	43
	310	310	310	310	.85	.85	.85	.85	.85	.85
25	86.1	86.1	86.5	86.7	87.1	87.7	87.5	86.9	86.6	86.3
20	87.2	87.3	87.5	87.7	88.0	87.9	86.9	86.4	86.1	85.8
15	88.2	88.2	88.5	88.6	88.8	88.6	87.7	87.3	87.0	86.8
10	88.9	89.0	89.3	89.3	89.5	89.2	88.4	88.1	87.8	87.6
5	89.6	89.7	90.0	90.0	90.2	89.9	89.1	88.8	88.5	88.3
0	89.5	90.2	90.5	90.6	90.9	90.5	89.7	89.5	89.2	88.9
–5	88.7	89.4	90.2	90.7	91.3	91.0	90.3	90.1	89.9	89.6
–10	87.9	88.6	89.4	89.9	91.0	91.8	90.9	90.7	90.5	90.3
–15	87.2	87.9	88.6	89.1	90.2	91.4	91.3	91.1	90.9	90.7
–20	86.4	87.1	87.8	88.4	89.4	90.6	90.5	90.3	90.1	89.9
–25	85.6	86.3	87.0	87.6	88.6	89.8	89.7	89.5	89.3	89.1
–30	84.8	85.5	86.2	86.8	87.8	89.0	88.9	88.7	88.5	88.2
–35	84.0	84.7	85.4	86.0	87.0	88.1	88.1	87.9	87.6	87.4

%N1 Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	25	27	29	31	33	35	37	39	41	43
ENGINE ON	–0.6	–0.6	–0.6	–0.7	–0.8	–0.9	–1.0	–1.0	–1.3	–1.5
ENGINE & WING ON	–0.9	–0.9	–1.0	–1.1	–1.2	–1.3	–1.5	–1.7	–2.0	–2.4

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)									
	25	27	29	31	33	35	37	39	41	43
ENGINE ON	–0.6	–0.6	–0.7	–0.7	–0.8	–0.9	–1.0	–1.1	–1.4	–1.6
ENGINE & WING ON	–0.9	–1.0	–1.0	–1.1	–1.3	–1.4	–1.6	–1.9	–2.3	–2.7

ALTERNATE MODE EEC

Go-Around %N1

Based on anti-ice off

AIRPORT OAT (deg. C)	TAT (deg. C)	AIRPORT PRESSURE ALTITUDE (1000 FT)																
		–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
56	60	85.2	86.0	86.7	86.5	86.1	85.7	85.3	84.9	84.5	84.0	83.4	82.6	81.8	81.0	80.1	78.8	77.6
51	55	86.7	87.5	88.3	88.0	87.7	87.4	87.0	86.7	86.4	85.9	85.4	84.7	84.0	83.2	82.4	81.3	80.2
46	50	87.8	88.8	89.5	89.4	89.1	88.9	88.6	88.2	88.0	87.6	87.1	86.6	85.9	85.3	84.5	83.5	82.4
41	45	88.7	89.6	90.4	90.4	90.4	90.2	89.9	89.6	89.4	89.1	88.7	88.2	87.7	87.0	86.4	85.5	84.5
36	40	88.6	90.1	91.3	91.2	91.2	91.2	91.1	91.0	90.8	90.5	90.1	89.6	89.0	88.5	88.0	87.2	86.3
31	35	88.0	89.5	91.0	91.5	92.0	92.0	91.9	91.8	91.9	91.9	91.5	91.1	90.4	89.9	89.3	88.6	87.8
26	30	87.4	88.8	90.3	90.9	91.4	91.9	92.6	92.8	92.7	92.7	92.6	92.4	91.9	91.4	90.8	90.0	89.1
21	25	86.7	88.2	89.6	90.2	90.8	91.2	91.9	92.5	92.9	93.3	93.2	93.0	92.8	92.5	92.3	91.5	90.6
16	20	86.1	87.5	89.0	89.6	90.1	90.6	91.2	91.8	92.2	92.8	93.2	93.5	93.4	93.2	92.9	92.4	91.9
11	15	85.4	86.9	88.3	88.9	89.4	89.9	90.5	91.1	91.5	92.1	92.6	93.0	93.3	93.5	93.7	93.1	92.5
7	10	84.8	86.2	87.6	88.2	88.7	89.2	89.8	90.4	90.8	91.4	91.9	92.3	92.6	93.0	93.3	93.2	93.1
2	5	84.1	85.5	86.9	87.5	88.0	88.5	89.1	89.7	90.1	90.7	91.2	91.6	91.9	92.2	92.6	92.6	92.6
–3	0	83.4	84.8	86.2	86.8	87.3	87.8	88.4	89.0	89.4	90.0	90.5	90.9	91.2	91.5	91.9	91.9	92.0
–13	–10	82.0	83.4	84.8	85.4	85.9	86.3	86.9	87.5	87.9	88.6	89.1	89.4	89.7	90.1	90.4	90.5	90.6
–23	–20	80.6	82.0	83.4	83.9	84.4	84.9	85.5	86.0	86.4	87.1	87.6	87.9	88.2	88.6	88.9	89.0	89.1
–33	–30	79.1	80.5	81.9	82.4	82.9	83.3	83.9	84.5	84.9	85.5	86.0	86.4	86.7	87.0	87.4	87.5	87.6
–43	–40	77.6	79.0	80.3	80.8	81.3	81.8	82.3	82.9	83.4	84.0	84.4	84.8	85.1	85.5	85.9	86.0	86.1
–53	–50	76.1	77.4	78.7	79.3	79.7	80.2	80.7	81.3	81.7	82.3	82.8	83.1	83.5	83.9	84.2	84.3	84.4

%N1 Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)							
	–2	0	9	10	11	12	13	14
ENGINE ON	0.0	0.0	0.0	–0.4	–0.5	–0.5	–0.5	–0.5
ENGINE & WING ON	0.0	0.0	0.0	–0.6	–0.6	–0.7	–0.7	–0.7
ENGINE AUTO	0.0	0.0	0.0	–0.4	–0.5	–0.5	–0.5	–0.5
ENGINE & WING AUTO	0.0	0.0	0.0	–0.6	–0.6	–0.7	–0.7	–0.7

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	AIRPORT PRESSURE ALTITUDE (1000 FT)																	
	–2	–1	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14
ENGINE ON	–0.6	–0.6	–0.7	–0.7	–0.7	–0.7	–0.7	–0.7	–0.8	–0.8	–0.8	–0.9	–0.9	–0.9	–1	–1	–1
ENGINE & WING ON	–0.7	–0.7	–0.8	–0.8	–0.8	–0.8	–0.9	–0.9	–0.9	–0.9	–1	–1.1	–1.1	–1.1	–1.1	–1.2	–1.2
With engine anti-ice auto or wing anti-ice auto, no adjustment is necessary.																	

ALTERNATE MODE EEC
ENGINE INOP

Initial Max Continuous %N1
Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)								
	27	29	31	33	35	37	39	41	43
	310	310	310	.85	.85	.85	.85	.85	.85
20	89.5	89.7	89.8	90.0	89.8	88.8	88.3	88.0	87.7
15	90.5	90.8	90.8	91.0	90.6	89.7	89.2	89.0	88.7
10	91.5	91.8	91.8	91.9	91.5	90.5	90.2	89.9	89.7
5	92.5	92.7	92.7	92.8	92.4	91.6	91.3	91.0	90.8
0	94.6	94.0	93.7	94.1	93.5	92.7	92.4	92.2	91.9
–5	93.9	94.0	94.3	95.1	94.6	93.9	93.6	93.4	93.1
–10	93.1	93.3	93.5	94.8	95.8	95.0	94.8	94.7	94.6
–15	92.3	92.5	92.7	94.0	95.6	95.8	95.9	96.0	96.1
–20	91.6	91.7	91.9	93.3	94.7	95.0	95.1	95.1	95.2
–25	90.8	90.9	91.1	92.4	93.9	94.2	94.2	94.3	94.4
–30	90.0	90.1	90.3	91.6	93.1	93.4	93.4	93.5	93.6
–35	89.1	89.3	89.5	90.8	92.3	92.5	92.6	92.7	92.7
–40	88.3	88.4	88.6	90.0	91.4	91.7	91.7	91.8	91.9

%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	27	29	31	33	35	37	39	41	43
ENGINE ON	–0.7	–0.8	–0.8	–0.9	–1.0	–1.1	–1.2	–1.5	–1.7
ENGINE & WING ON	–1.1	–1.2	–1.3	–1.4	–1.6	–1.8	–2.0	–2.4	–2.8

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	27	29	31	33	35	37	39	41	43
ENGINE ON	–0.7	–0.8	–0.8	–0.9	–1.0	–1.1	–1.2	–1.4	–1.7
ENGINE & WING ON	–1.1	–1.2	–1.3	–1.4	–1.5	–1.7	–1.9	–2.3	–2.8

ALTERNATE MODE EEC
ENGINE INOP

Max Continuous %N1
Based on anti-ice off or auto
320 KIAS

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
30	87.0	88.4	89.0	89.2	89.4	89.5	89.6	88.8	88.2	87.9	87.6	87.6	87.9	87.9	87.4	86.4
25	86.4	89.3	89.9	90.0	90.2	90.3	90.4	89.8	89.3	89.1	88.9	88.9	89.0	89.0	88.4	87.4
20	85.7	89.1	90.5	90.8	91.0	91.1	91.3	90.6	90.1	90.0	89.9	89.9	90.1	89.8	89.2	88.3
15	85.1	88.4	89.8	90.7	91.8	92.0	92.1	91.5	91.0	90.9	90.9	90.9	91.0	90.7	90.0	89.0
10	84.4	87.7	89.1	90.0	91.1	92.0	92.8	92.6	92.1	91.8	91.8	91.9	91.9	91.5	90.8	89.7
5	83.7	87.0	88.4	89.3	90.3	91.2	92.1	92.9	93.8	93.9	93.3	92.7	92.8	92.3	91.6	90.3
0	83.0	86.3	87.7	88.6	89.6	90.5	91.4	92.2	93.1	93.6	94.4	93.9	93.8	93.2	92.3	91.0
–5	82.3	85.6	87.0	87.8	88.9	89.8	90.6	91.5	92.3	92.9	93.6	93.1	93.7	93.7	93.3	91.8
–10	81.6	84.8	86.2	87.1	88.1	89.0	89.9	90.7	91.6	92.1	92.9	92.4	92.9	92.9	92.6	91.0
–15	80.9	84.1	85.5	86.4	87.3	88.2	89.1	89.9	90.8	91.4	92.1	91.6	92.1	92.2	91.9	90.2
–20	80.2	83.3	84.8	85.6	86.6	87.5	88.4	89.2	90.0	90.6	91.3	90.8	91.3	91.4	91.1	89.4
–25	79.5	82.6	84.0	84.8	85.8	86.7	87.6	88.4	89.2	89.8	90.5	90.0	90.5	90.6	90.3	88.6
–30	78.7	81.8	83.2	84.0	85.0	85.9	86.8	87.6	88.4	89.0	89.7	89.2	89.7	89.7	89.5	87.8
–35	78.0	81.0	82.4	83.3	84.2	85.1	86.0	86.8	87.6	88.2	88.9	88.4	88.9	88.9	88.6	87.0
–40	77.2	80.3	81.6	82.5	83.4	84.3	85.2	85.9	86.8	87.4	88.1	87.6	88.1	88.1	87.8	86.2

%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	0.0	0.0	–0.2	–0.4	–0.5	–0.5	–0.5	–0.6	–0.7	–0.7	–0.7	–0.7	–0.8	–0.9	–1.0	–1.1
ENGINE & WING ON	0.0	0.0	–0.3	–0.6	–0.7	–0.7	–0.8	–0.9	–1.0	–1.0	–1.1	–1.2	–1.3	–1.4	–1.6	–1.8

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	–0.4	–0.4	–0.4	–0.5	–0.5	–0.5	–0.6	–0.6	–0.6	–0.7	–0.7	–0.7	–0.8	–0.9	–1.0	–1.1
ENGINE & WING ON	–0.5	–0.6	–0.6	–0.7	–0.7	–0.8	–0.8	–0.9	–1.0	–1.0	–1.1	–1.2	–1.3	–1.4	–1.5	–1.7

280 KIAS

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
30	87.7	88.0	88.0	88.1	88.3	88.7	88.6	87.5	86.5	86.2	86.2	86.7	87.7	89.0	90.1	89.9
25	88.0	88.8	88.9	89.0	89.2	89.7	89.8	88.8	87.9	87.6	87.0	86.5	87.0	88.2	89.4	89.1
20	87.3	89.8	89.9	89.8	90.1	90.6	90.8	89.7	89.1	88.8	88.4	87.8	87.9	88.3	88.8	88.7
15	86.7	89.3	90.9	91.0	91.0	91.5	91.7	90.7	90.0	89.8	89.4	89.0	89.0	89.3	89.7	89.6
10	86.0	88.6	90.2	90.9	91.9	92.3	92.5	91.6	91.0	90.7	90.4	90.1	90.1	90.3	90.6	90.5
5	85.3	87.9	89.5	90.2	91.1	92.4	93.6	92.8	91.8	91.6	91.3	91.1	91.2	91.4	91.5	91.5
0	84.6	87.2	88.8	89.5	90.4	91.6	93.0	93.7	93.9	93.5	92.6	92.0	92.2	92.6	92.6	92.6
–5	83.9	86.5	88.1	88.8	89.7	90.9	92.2	93.0	93.7	94.1	94.7	93.7	93.4	93.7	93.7	93.8
–10	83.2	85.7	87.3	88.0	88.9	90.2	91.5	92.2	92.9	93.3	93.9	94.0	94.4	94.7	94.9	94.9
–15	82.5	85.0	86.6	87.3	88.1	89.4	90.7	91.5	92.1	92.6	93.1	93.3	93.6	94.5	95.5	95.5
–20	81.7	84.3	85.8	86.5	87.4	88.6	89.9	90.7	91.4	91.8	92.3	92.5	92.8	93.7	94.7	94.7
–25	81.0	83.5	85.1	85.7	86.6	87.9	89.1	89.9	90.6	91.0	91.5	91.7	92.0	92.9	93.9	93.9
–30	80.3	82.7	84.3	84.9	85.8	87.1	88.4	89.1	89.8	90.2	90.7	90.9	91.2	92.1	93.1	93.1
–35	79.5	82.0	83.5	84.2	85.0	86.3	87.6	88.3	89.0	89.4	89.9	90.1	90.4	91.2	92.2	92.2
–40	78.7	81.2	82.7	83.4	84.2	85.5	86.8	87.5	88.2	88.5	89.1	89.3	89.6	90.4	91.4	91.4

ALTERNATE MODE EEC
ENGINE INOP

Max Continuous %N1
Based on anti-ice off or auto
280 KIAS
%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)																
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	0.0	0.0	−0.2	−0.4	−0.5	−0.5	−0.5	−0.6	−0.7	−0.7	−0.7	−0.7	−0.8	−0.9	−1.0	−1.1
ENGINE & WING ON	0.0	0.0	−0.3	−0.6	−0.7	−0.7	−0.8	−0.9	−1.0	−1.0	−1.1	−1.2	−1.3	−1.4	−1.6	−1.8

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	−0.4	−0.4	−0.4	−0.5	−0.5	−0.5	−0.6	−0.6	−0.6	−0.7	−0.7	−0.7	−0.8	−0.9	−1.0	−1.1
ENGINE & WING ON	−0.5	−0.6	−0.6	−0.7	−0.7	−0.8	−0.8	−0.9	−1.0	−1.0	−1.1	−1.2	−1.3	−1.4	−1.5	−1.7

240 KIAS

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
30	87.5	87.6	87.1	86.8	86.2	85.6	85.2	85.4	86.0	86.3	86.7	87.0	87.8	89.0	89.9	89.8
25	88.6	88.5	88.1	87.8	87.5	87.1	86.7	86.2	85.6	85.6	86.0	86.2	87.1	88.3	89.1	89.1
20	88.2	89.3	88.9	88.6	88.4	88.2	88.0	87.5	86.9	86.6	85.9	85.5	86.3	87.5	88.4	88.3
15	87.6	90.1	90.4	89.6	89.3	89.1	89.3	88.6	88.1	87.7	87.1	86.4	86.2	86.8	87.6	87.6
10	86.9	89.4	91.1	91.1	90.3	90.1	90.5	89.8	89.1	88.8	88.2	87.6	87.4	87.5	87.5	87.5
5	86.2	88.7	90.4	90.8	91.2	90.9	91.4	90.8	90.2	89.9	89.3	88.8	88.5	88.5	88.5	88.4
0	85.5	88.0	89.6	90.0	90.4	90.8	92.2	91.9	91.2	90.8	90.4	89.9	89.6	89.5	89.4	89.4
−5	84.8	87.3	88.9	89.3	89.7	90.1	91.6	92.6	93.3	92.8	91.5	91.0	90.8	90.6	90.4	90.4
−10	84.1	86.5	88.2	88.6	89.0	89.4	90.8	91.9	93.5	94.2	94.4	92.7	91.8	91.9	91.7	91.7
−15	83.4	85.8	87.4	87.8	88.2	88.6	90.1	91.1	92.7	93.4	94.2	94.3	93.9	93.2	92.8	92.9
−20	82.6	85.1	86.7	87.1	87.5	87.8	89.3	90.4	91.9	92.6	93.4	93.5	93.7	94.0	94.2	94.3
−25	81.9	84.3	85.9	86.3	86.7	87.1	88.5	89.6	91.2	91.8	92.6	92.8	92.9	93.2	93.8	94.1
−30	81.1	83.5	85.1	85.5	85.9	86.3	87.7	88.8	90.4	91.1	91.8	92.0	92.1	92.4	93.0	93.2
−35	80.4	82.7	84.3	84.7	85.2	85.5	86.9	88.0	89.6	90.3	91.0	91.1	91.3	91.6	92.2	92.4
−40	79.6	82.0	83.5	83.9	84.4	84.7	86.1	87.2	88.7	89.4	90.2	90.3	90.5	90.7	91.4	91.6

%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	0.0	0.0	−0.2	−0.4	−0.5	−0.5	−0.5	−0.6	−0.7	−0.7	−0.7	−0.7	−0.8	−0.9	−1.0	−1.1
ENGINE & WING ON	0.0	0.0	−0.3	−0.6	−0.7	−0.7	−0.8	−0.9	−1.0	−1.0	−1.1	−1.2	−1.3	−1.4	−1.6	−1.8

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	−0.4	−0.4	−0.4	−0.5	−0.5	−0.5	−0.6	−0.6	−0.6	−0.7	−0.7	−0.7	−0.8	−0.9	−1.0	−1.1
ENGINE & WING ON	−0.5	−0.6	−0.6	−0.7	−0.7	−0.8	−0.8	−0.9	−1.0	−1.0	−1.1	−1.2	−1.3	−1.4	−1.5	−1.7

ALTERNATE MODE EEC
ENGINE INOP

Max Continuous %N1
Based on anti-ice off or auto
200 KIAS

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
30	87.3	87.2	86.4	85.5	84.7	84.0	84.4	84.9	85.5	85.7	86.3	86.9	87.8	89.0	89.9	89.9
25	88.2	88.2	87.4	86.9	86.2	85.5	84.4	84.2	84.8	85.0	85.6	86.2	87.1	88.3	89.1	89.1
20	88.7	89.1	88.3	87.9	87.4	86.9	85.8	85.0	84.2	84.3	84.8	85.5	86.3	87.5	88.4	88.4
15	88.0	89.9	89.2	88.8	88.4	88.0	87.1	86.3	85.5	85.1	84.4	84.8	85.6	86.8	87.6	87.6
10	87.4	89.9	91.2	89.8	89.3	89.0	88.3	87.6	86.7	86.3	85.7	85.1	84.8	86.0	86.8	86.8
5	86.7	89.2	91.1	91.4	90.5	89.9	89.5	88.8	87.9	87.5	86.8	86.3	86.0	86.0	86.1	86.1
0	86.0	88.5	90.3	90.6	91.1	91.2	90.5	89.9	89.1	88.7	88.0	87.4	87.1	87.0	86.9	86.7
–5	85.3	87.7	89.6	89.9	90.4	91.0	91.6	91.0	90.2	89.8	89.1	88.7	88.3	88.1	88.0	87.7
–10	84.5	87.0	88.9	89.2	89.7	90.2	90.8	91.5	92.1	91.6	90.3	89.9	89.5	89.2	89.1	88.8
–15	83.8	86.3	88.2	88.4	88.9	89.5	90.1	90.7	92.0	92.7	93.1	91.5	90.8	90.6	90.5	90.1
–20	83.1	85.5	87.4	87.7	88.2	88.7	89.3	90.0	91.2	92.0	93.1	93.6	92.8	91.9	91.9	91.5
–25	82.3	84.8	86.6	86.9	87.4	87.9	88.6	89.2	90.5	91.2	92.3	92.8	93.3	93.8	93.2	92.8
–30	81.6	84.0	85.9	86.2	86.6	87.2	87.8	88.4	89.7	90.4	91.5	92.0	92.5	93.0	93.5	93.5
–35	80.8	83.2	85.1	85.4	85.8	86.4	87.0	87.6	88.9	89.6	90.7	91.2	91.7	92.2	92.7	92.6
–40	80.1	82.4	84.3	84.6	85.0	85.6	86.2	86.8	88.1	88.8	89.9	90.4	90.9	91.4	91.8	91.8

%N1 Adjustment for Anti-ice
For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	0.0	0.0	–0.2	–0.4	–0.5	–0.5	–0.5	–0.6	–0.7	–0.7	–0.7	–0.7	–0.8	–0.9	–1.0	–1.1
ENGINE & WING ON	0.0	0.0	–0.3	–0.6	–0.7	–0.7	–0.8	–0.9	–1.0	–1.0	–1.1	–1.2	–1.3	–1.4	–1.6	–1.8

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)															
	5	10	12	14	16	18	20	22	24	25	27	29	31	33	35	37
ENGINE ON	–0.4	–0.4	–0.4	–0.5	–0.5	–0.5	–0.6	–0.6	–0.6	–0.7	–0.7	–0.7	–0.8	–0.9	–1.0	–1.1
ENGINE & WING ON	–0.5	–0.6	–0.6	–0.7	–0.7	–0.8	–0.8	–0.9	–1.0	–1.0	–1.1	–1.2	–1.3	–1.4	–1.5	–1.7

GEAR DOWN

220 KIAS Max Climb TPR

Based on anti-ice off or auto

TAT (deg. C)	PRESSURE ALTITUDE (1000 FT)														
	0	5	10	12	14	16	18	20	22	24	26	28	30	32	34
55	51.2	52.2	55.7	56.1	56.5	53.2	62.1	63.3	64.0	65.6	67.1	68.2	69.3	71.9	74.7
50	54.4	54.6	55.7	56.1	58.2	57.4	62.1	63.3	64.0	65.6	67.1	68.2	69.3	71.9	74.7
45	58.1	58.0	55.7	56.1	58.2	60.1	62.1	63.3	64.0	65.6	67.1	68.2	69.3	71.9	74.7
40	61.5	61.8	59.6	57.5	58.2	60.1	62.1	63.3	64.0	65.6	67.1	68.2	69.3	71.9	74.7
35	64.9	66.0	63.6	61.9	61.1	60.3	62.1	63.3	64.0	65.6	67.1	68.2	69.3	71.9	74.7
30	67.8	69.7	67.9	66.2	65.3	64.5	63.8	63.3	64.0	65.6	67.1	68.2	69.3	71.9	74.7
25	68.0	73.9	72.3	70.4	69.6	68.7	68.1	66.6	64.7	65.6	67.1	68.2	69.3	71.9	74.7
20	68.2	76.2	76.1	74.5	73.9	73.1	72.4	70.9	69.1	68.1	67.1	68.2	69.3	71.9	74.7
15	68.4	76.4	80.4	78.4	78.2	77.5	76.8	75.3	73.5	72.7	71.7	70.2	69.3	71.9	74.7
10	68.5	76.6	81.5	82.5	82.2	82.0	81.2	79.8	78.7	77.4	76.4	75.0	73.6	73.6	74.7
5	68.7	76.8	81.7	82.7	84.3	85.7	85.4	84.5	84.0	82.4	81.2	79.8	78.6	78.2	78.4
0	68.9	77.0	81.9	82.9	84.6	86.7	89.2	88.9	88.9	87.3	86.1	84.5	83.2	82.8	82.6
–5	69.1	77.2	82.1	83.1	84.8	86.9	89.5	91.0	91.3	91.5	90.6	89.2	87.8	87.4	87.1
–10	69.2	77.4	82.3	83.3	85.0	87.1	89.7	91.2	91.9	93.9	94.6	93.7	92.4	91.9	91.6
–15	69.4	77.6	82.5	83.5	85.2	87.3	89.9	91.5	92.1	94.1	96.2	97.2	96.4	96.3	95.9
–20	69.6	77.8	82.7	83.7	85.4	87.6	90.1	91.7	92.3	94.3	96.5	97.5	98.4	100.2	100.1

TPR Adjustment for Anti-ice

For TAT≤10 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)														
	0	5	10	12	14	16	18	20	22	24	26	28	30	32	34
ENGINE ON	0.0	0.0	0.0	–0.5	–1.1	–1.1	–1.2	–1.3	–1.5	–1.6	–1.8	–1.9	–1.9	–2.2	–2.4
ENGINE & WING ON	0.0	0.0	0.0	–0.7	–1.5	–1.6	–1.8	–2.0	–2.2	–2.4	–2.6	–2.8	–3.0	–3.4	–3.7

For 10 deg. C<TAT≤20 deg. C

ANTI-ICE CONFIGURATION	PRESSURE ALTITUDE (1000 FT)														
	0	5	10	12	14	16	18	20	22	24	26	28	30	32	34
ENGINE ON	–0.7	–0.9	–1.0	–1.1	–1.1	–1.2	–1.3	–1.4	–1.5	–1.6	–1.8	–1.9	–1.9	–2.2	–2.4
ENGINE & WING ON	–1.1	–1.2	–1.4	–1.5	–1.6	–1.7	–1.8	–2.0	–2.2	–2.5	–2.7	–2.9	–3.0	–3.4	–3.7

GEAR DOWN

Long Range Cruise Altitude Capability
Max Climb Thrust, 300 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
260	15200	13200	10700
250	16300	14300	11700
240	17200	15300	12600
230	18200	16300	13900
220	19200	17700	15500
210	20600	19300	17400
200	21900	21000	19000
190	23500	22700	20800
180	25200	24200	22700
170	26500	25500	24100
160	27800	26800	25500
150	29100	28200	27000
140	30500	29600	28400
130	32000	31100	29800
120	33500	32500	31300
110	34600	33700	32600

GEAR DOWN

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)										
		10	15	17	19	21	23	25	27	29	31	33
280	TPR	67.2	79.9									
	MACH	.486	.527									
	KIAS	269	265									
	FF/ENG	5592	5647									
260	TPR	63.0	75.5	81.6								
	MACH	.470	.515	.535								
	KIAS	260	259	260								
	FF/ENG	5148	5231	5321								
240	TPR	60.4	72.4	78.1	84.7							
	MACH	.467	.513	.534	.555							
	KIAS	258	259	259	259							
	FF/ENG	4901	4983	5051	5156							
220	TPR	56.7	68.4	73.8	80.1	87.5						
	MACH	.454	.503	.525	.548	.572						
	KIAS	251	253	254	256	257						
	FF/ENG	4512	4623	4695	4803	4941						
200	TPR	52.1	62.6	67.7	73.1	79.2	86.2					
	MACH	.433	.479	.499	.521	.543	.565					
	KIAS	239	241	242	243	243	243					
	FF/ENG	4036	4116	4161	4222	4296	4391					
180	TPR	48.0	57.2	61.7	66.6	71.9	77.7	84.6	93.4			
	MACH	.413	.456	.474	.494	.514	.536	.558	.581			
	KIAS	228	229	229	230	230	230	230	230			
	FF/ENG	3620	3659	3685	3713	3747	3795	3871	4011			
160	TPR	44.3	52.7	56.7	61.1	66.1	71.4	77.2	83.9	92.7		
	MACH	.398	.438	.456	.475	.495	.515	.537	.559	.583		
	KIAS	219	220	220	221	221	221	221	221	221		
	FF/ENG	3265	3284	3307	3331	3354	3379	3419	3490	3611		
140	TPR	40.5	48.2	51.8	55.8	60.2	65.0	70.3	76.0	82.6	91.2	
	MACH	.381	.420	.437	.455	.474	.494	.515	.536	.559	.583	
	KIAS	210	211	211	211	211	212	212	212	212	212	
	FF/ENG	2915	2922	2940	2960	2980	2997	3015	3049	3110	3205	
120	TPR	37.3	44.3	47.6	51.2	55.1	59.4	64.2	69.4	75.1	81.7	90.1
	MACH	.368	.405	.421	.438	.457	.476	.495	.516	.538	.562	.586
	KIAS	203	203	203	203	203	203	203	203	203	203	203
	FF/ENG	2620	2619	2632	2646	2658	2672	2685	2700	2731	2779	2854

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
314	283	256	234	216	200	189	180	171	163	156
631	568	513	469	432	400	379	360	343	327	313
951	855	772	705	649	600	569	540	514	491	470
1273	1144	1032	941	866	800	758	720	685	654	626
1597	1434	1292	1178	1083	1000	948	899	856	816	781
1923	1725	1553	1415	1300	1200	1137	1079	1027	979	937
2251	2017	1815	1652	1518	1400	1326	1259	1197	1141	1092
2581	2311	2078	1891	1736	1600	1515	1437	1366	1303	1247
2913	2606	2342	2129	1954	1800	1704	1616	1536	1464	1401
3248	2903	2606	2368	2172	2000	1893	1795	1706	1626	1555
3585	3201	2871	2607	2390	2200	2082	1974	1876	1788	1709
3925	3502	3138	2848	2609	2400	2271	2153	2045	1948	1863
4266	3804	3406	3088	2828	2600	2460	2331	2214	2109	2016
4610	4106	3674	3329	3047	2800	2648	2509	2383	2270	2169
4955	4410	3942	3570	3266	3000	2837	2688	2552	2430	2322
5302	4715	4211	3812	3485	3200	3025	2866	2720	2590	2475
5651	5021	4481	4054	3704	3400	3214	3043	2889	2750	2627
6001	5329	4752	4296	3924	3600	3402	3221	3056	2909	2779
6352	5636	5023	4538	4144	3800	3590	3398	3224	3069	2931
6703	5944	5294	4781	4363	4000	3779	3576	3393	3228	3083

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		20		24		28	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	5.4	0:47	5.0	0:44	4.5	0:41	4.2	0:39	4.2	0:38
400	11.1	1:31	10.4	1:26	9.5	1:19	9.1	1:15	9.2	1:11
600	16.7	2:16	15.8	2:08	14.5	1:56	14.0	1:50	14.2	1:44
800	22.2	3:02	21.0	2:51	19.4	2:35	18.7	2:26	18.9	2:18
1000	27.7	3:47	26.1	3:34	24.2	3:14	23.4	3:02	23.6	2:52
1200	32.9	4:34	31.1	4:17	28.9	3:53	27.9	3:39	28.0	3:27
1400	38.2	5:21	36.2	5:01	33.6	4:33	32.4	4:16	32.5	4:01
1600	43.3	6:08	41.0	5:45	38.1	5:13	36.7	4:54	36.8	4:36
1800	48.4	6:56	45.8	6:30	42.6	5:53	41.0	5:31	41.0	5:12
2000	53.3	7:44	50.5	7:15	47.0	6:34	45.2	6:09	45.1	5:47
2200	58.3	8:33	55.2	8:01	51.4	7:15	49.4	6:47	49.2	6:23
2400	63.0	9:23	59.7	8:47	55.7	7:56	53.5	7:26	53.1	6:59
2600	67.8	10:12	64.2	9:33	60.0	8:38	57.6	8:05	57.1	7:36
2800	72.4	11:03	68.6	10:20	64.1	9:20	61.5	8:44	60.8	8:12
3000	77.0	11:53	73.0	11:07	68.2	10:03	65.5	9:24	64.6	8:49
3200	81.4	12:45	77.2	11:55	72.2	10:46	69.3	10:04	68.3	9:27
3400	85.9	13:36	81.5	12:43	76.3	11:29	73.1	10:44	72.0	10:04
3600	90.2	14:27	85.6	13:31	80.2	12:12	76.8	11:25	75.5	10:42
3800	94.5	15:19	89.7	14:20	84.1	12:56	80.5	12:05	79.1	11:20
4000	98.8	16:11	93.8	15:09	88.0	13:40	84.2	12:46	82.5	11:58

GEAR DOWN

Long Range Cruise Enroute Fuel and Time

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)							
	120	140	160	180	200	220	240	260
10	–2.2	–1.7	–1.1	–0.5	0.0	1.4	2.5	3.2
20	–4.5	–3.6	–2.4	–1.2	0.0	2.6	5.1	7.2
30	–6.7	–5.3	–3.6	–1.8	0.0	3.7	7.5	10.8
40	–8.7	–7.0	–4.8	–2.4	0.0	4.7	9.6	14.1
50	–10.5	–8.5	–5.9	–3.0	0.0	5.5	11.4	17.0
60	–12.2	–9.9	–6.9	–3.5	0.0	6.3	13.1	19.6
70	–13.6	–11.1	–7.8	–4.0	0.0	6.9	14.4	21.9
80	–14.9	–12.2	–8.6	–4.5	0.0	7.4	15.5	23.8
90	–16.1	–13.1	–9.4	–4.9	0.0	7.8	16.3	25.4
100	–17.0	–14.0	–10.0	–5.3	0.0	8.1	16.9	26.7

Based on Long Range Cruise speed and 220 KIAS descent.

GEAR DOWN

Descent at 220 KIAS

PRESSURE ALTITUDE (1000 FT)	17	19	21	23	25	27	29	31	33	35
DISTANCE (NM)	36	40	44	49	53	57	62	66	70	74
TIME (MINUTES)	11	12	12	13	14	15	15	16	17	17

GEAR DOWN

Holding

Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)						
		1500	5000	10000	15000	20000	25000	30000
260	TPR	47.2	52.9	62.7	75.5			
	KIAS	258	258	258	259			
	FF/ENG	5300	5320	5370	5490			
240	TPR	45.6	51.0	60.4	72.4	88.7		
	KIAS	258	258	258	259	259		
	FF/ENG	5090	5100	5150	5230	5500		
220	TPR	42.8	47.9	56.7	68.4	83.7		
	KIAS	251	251	251	253	256		
	FF/ENG	4700	4710	4740	4850	5120		
200	TPR	39.4	44.1	52.1	62.6	76.1		
	KIAS	239	239	239	241	243		
	FF/ENG	4220	4230	4240	4320	4480		
180	TPR	36.2	40.5	48.0	57.2	69.2	84.6	
	KIAS	227	228	228	229	230	230	
	FF/ENG	3790	3790	3800	3840	3920	4060	
160	TPR	33.5	37.4	44.3	52.7	63.5	77.2	
	KIAS	219	219	219	220	221	221	
	FF/ENG	3430	3420	3430	3450	3510	3590	
140	TPR	30.8	34.3	40.5	48.2	57.9	70.3	86.6
	KIAS	210	210	210	211	211	212	212
	FF/ENG	3090	3060	3060	3070	3120	3170	3310
120	TPR	28.5	31.7	37.3	44.3	53.1	64.2	78.2
	KIAS	203	203	203	203	203	203	203
	FF/ENG	2810	2740	2750	2750	2780	2820	2890

This table includes 5% additional fuel for holding in a racetrack pattern.

Flaps 1

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
260	TPR	46.6	52.4	62.0	74.2	
	KIAS	238	238	239	239	
	FF/ENG	5140	5150	5180	5230	
240	TPR	44.6	50.1	59.3	70.9	86.0
	KIAS	237	237	238	239	239
	FF/ENG	4890	4890	4910	4960	5120
220	TPR	41.6	46.6	55.2	66.0	80.1
	KIAS	228	228	229	230	233
	FF/ENG	4470	4470	4480	4530	4660
200	TPR	38.4	43.0	50.9	60.7	73.3
	KIAS	217	218	219	219	221
	FF/ENG	4040	4030	4020	4050	4130
180	TPR	35.2	39.3	46.4	55.4	66.7
	KIAS	206	207	207	208	209
	FF/ENG	3620	3590	3570	3590	3640
160	TPR	32.1	35.7	42.0	50.0	60.2
	KIAS	195	195	195	196	197
	FF/ENG	3210	3160	3140	3140	3180
140	TPR	29.2	32.5	38.0	45.2	54.3
	KIAS	185	185	185	186	186
	FF/ENG	2860	2780	2750	2740	2780
120	TPR	26.8	29.7	34.7	41.1	49.2
	KIAS	178	178	178	178	178
	FF/ENG	2580	2480	2450	2430	2460

This table includes 5% additional fuel for holding in a racetrack pattern.

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Driftdown Speed/Level Off Altitude
100 ft/min residual rate of climb

WEIGHT (1000 KG)		OPTIMUM DRIFTDOWN SPEED (KIAS)	LEVEL OFF ALTITUDE (FT)		
START DRIFTDOWN	LEVEL OFF		ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
210	200	243	900		
200	192	237	3900		
190	182	232	6000	3400	
180	173	228	8000	5700	3200
170	163	224	10000	7900	5700
160	155	220	12100	9900	7900
150	145	215	13500	11500	10100
140	135	211	15000	13200	11700
130	125	207	16300	14800	13300
120	116	203	17700	16400	14900
110	105	202	18600	17400	15900

Includes APU fuel burn.

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Altitude Capability
100 ft/min residual rate of climb

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10 deg. C & BELOW	ISA + 15 deg. C	ISA + 20 deg. C
200	1000		
190	4500		
180	6500	3800	
170	8500	6300	3600
160	10800	8600	6300
150	12800	10600	8800
140	14300	12300	10800
130	15700	14000	12400
120	17100	15700	14100
110	18300	17000	15500

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)							
		5	7	9	11	13	15	17	19
200	TPR	80.3							
	MACH	.395							
	KIAS	239							
	FF/ENG	8024							
190	TPR	75.9	82.3						
	MACH	.383	.398						
	KIAS	232	232						
	FF/ENG	7478	7590						
180	TPR	72.6	78.5	85.3	94.0				
	MACH	.376	.390	.406	.421				
	KIAS	228	228	228	228				
	FF/ENG	7077	7162	7284	7557				
170	TPR	69.4	74.9	81.2	88.6				
	MACH	.369	.383	.398	.413				
	KIAS	223	224	224	224				
	FF/ENG	6690	6762	6849	7013				
160	TPR	66.2	71.4	77.2	83.9	92.2			
	MACH	.362	.376	.390	.405	.421			
	KIAS	219	219	219	220	220			
	FF/ENG	6312	6369	6439	6546	6764			
150	TPR	63.1	67.9	73.3	79.5	86.7	96.2		
	MACH	.355	.368	.382	.397	.413	.429		
	KIAS	214	215	215	215	215	215		
	FF/ENG	5944	5992	6045	6124	6259	6536		
140	TPR	60.0	64.6	69.6	75.3	81.8	89.7		
	MACH	.347	.360	.374	.388	.404	.420		
	KIAS	210	210	210	210	210	211		
	FF/ENG	5586	5628	5667	5727	5822	5981		
130	TPR	57.3	61.6	66.3	71.6	77.7	84.6	93.4	
	MACH	.341	.353	.367	.381	.396	.412	.429	
	KIAS	206	206	206	206	206	207	207	
	FF/ENG	5271	5310	5343	5386	5459	5563	5765	
120	TPR	54.8	58.9	63.4	68.4	74.0	80.3	87.9	98.0
	MACH	.335	.348	.361	.375	.389	.405	.421	.438
	KIAS	203	203	203	203	203	203	203	203
	FF/ENG	4992	5026	5057	5088	5142	5219	5342	5606
110	TPR	52.8	56.8	61.1	65.8	71.2	77.1	84.0	92.7
	MACH	.331	.344	.357	.370	.385	.400	.416	.433
	KIAS	200	200	200	200	200	200	201	201
	FF/ENG	4778	4806	4836	4860	4902	4963	5053	5225

GEAR DOWN
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
333	296	264	239	218	200	187	175	165	156	148
672	595	530	478	436	400	374	350	329	311	295
1013	896	796	718	655	600	560	524	493	465	441
1357	1199	1065	959	874	800	747	699	656	619	587
1704	1504	1334	1201	1093	1000	933	874	820	773	733
2053	1810	1604	1443	1313	1200	1120	1047	983	926	878
2406	2120	1876	1686	1533	1400	1306	1221	1145	1080	1023
2761	2430	2148	1929	1753	1600	1492	1395	1308	1232	1167
3119	2742	2421	2172	1973	1800	1678	1567	1470	1384	1311
3479	3056	2696	2417	2193	2000	1863	1740	1631	1536	1455
3842	3370	2970	2661	2414	2200	2049	1913	1793	1688	1598
4207	3687	3247	2906	2635	2400	2235	2086	1954	1839	1741
4574	4005	3523	3152	2856	2600	2420	2258	2115	1990	1883
4942	4324	3800	3397	3076	2800	2606	2431	2276	2141	2026

Table 2 of 3: Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	6		8		10		12		14	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	5.6	0:51	5.4	0:50	5.3	0:49	5.3	0:47	5.4	0:46
400	11.4	1:40	11.1	1:38	10.8	1:35	10.8	1:32	11.1	1:30
600	17.0	2:30	16.6	2:26	16.2	2:21	16.2	2:17	16.6	2:13
800	22.5	3:20	21.9	3:14	21.5	3:09	21.4	3:03	21.9	2:58
1000	27.8	4:11	27.2	4:04	26.7	3:56	26.6	3:49	27.0	3:43
1200	33.1	5:02	32.4	4:53	31.7	4:45	31.5	4:36	32.0	4:28
1400	38.3	5:54	37.4	5:44	36.7	5:33	36.4	5:23	36.8	5:14
1600	43.3	6:47	42.4	6:34	41.5	6:23	41.2	6:11	41.5	6:00
1800	48.3	7:40	47.2	7:26	46.3	7:12	45.8	6:59	46.1	6:47
2000	53.2	8:33	52.0	8:18	51.0	8:03	50.4	7:48	50.6	7:34
2200	58.0	9:27	56.7	9:10	55.6	8:53	54.9	8:37	55.0	8:21
2400	62.7	10:22	61.3	10:03	60.1	9:44	59.3	9:26	59.3	9:09
2600	67.3	11:16	65.9	10:56	64.5	10:35	63.7	10:16	63.6	9:57
2800	71.9	12:11	70.3	11:49	68.9	11:27	68.0	11:06	67.8	10:46

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Table 3 of 3: Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)								
	100	120	140	160	180	200	220	240	260
5	–1.1	–0.9	–0.6	–0.3	0.0	0.7	1.3	1.8	2.1
10	–2.3	–1.9	–1.3	–0.7	0.0	1.5	2.9	4.3	5.2
15	–3.3	–2.9	–2.1	–1.1	0.0	2.2	4.5	6.6	8.3
20	–4.4	–3.8	–2.7	–1.4	0.0	2.8	5.9	8.8	11.3
25	–5.4	–4.6	–3.4	–1.8	0.0	3.5	7.2	10.9	14.1
30	–6.3	–5.5	–4.0	–2.1	0.0	4.0	8.5	12.9	16.7
35	–7.2	–6.2	–4.6	–2.4	0.0	4.6	9.6	14.7	19.3
40	–8.1	–6.9	–5.1	–2.7	0.0	5.1	10.7	16.5	21.7
45	–8.9	–7.6	–5.6	–3.0	0.0	5.5	11.7	18.0	23.9
50	–9.6	–8.2	–6.1	–3.3	0.0	5.9	12.5	19.5	26.0
55	–10.3	–8.8	–6.5	–3.5	0.0	6.2	13.3	20.8	28.0
60	–11.0	–9.3	–6.9	–3.8	0.0	6.5	14.0	22.0	29.8
65	–11.5	–9.8	–7.3	–4.0	0.0	6.8	14.6	23.0	31.5
70	–12.1	–10.2	–7.6	–4.2	0.0	7.0	15.1	24.0	33.1
75	–12.6	–10.6	–7.9	–4.4	0.0	7.1	15.5	24.8	34.5
80	–13.0	–10.9	–8.2	–4.6	0.0	7.2	15.8	25.5	35.7

Includes APU fuel burn.

GEAR DOWN
ENGINE INOP

MAX CONTINUOUS THRUST

Holding
Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
210	TPR	73.7				
	KIAS	245				
	FF/ENG	8770				
200	TPR	70.3	80.3			
	KIAS	239	239			
	FF/ENG	8260	8430			
190	TPR	66.5	75.9			
	KIAS	231	232			
	FF/ENG	7700	7850			
180	TPR	63.8	72.6	89.3		
	KIAS	227	228	228		
	FF/ENG	7310	7430	7760		
170	TPR	61.0	69.4	84.6		
	KIAS	223	223	224		
	FF/ENG	6920	7020	7260		
160	TPR	58.3	66.2	80.4		
	KIAS	219	219	219		
	FF/ENG	6540	6630	6810		
150	TPR	55.6	63.1	76.3	96.2	
	KIAS	214	214	215	215	
	FF/ENG	6160	6240	6380	6860	
140	TPR	53.0	60.0	72.3	89.7	
	KIAS	210	210	210	211	
	FF/ENG	5800	5870	5980	6280	
130	TPR	50.6	57.3	68.9	84.6	
	KIAS	206	206	206	207	
	FF/ENG	5490	5530	5630	5840	
120	TPR	48.5	54.8	65.8	80.3	
	KIAS	203	203	203	203	
	FF/ENG	5200	5240	5320	5480	
110	TPR	46.8	52.8	63.4	77.1	98.1
	KIAS	200	200	200	200	201
	FF/ENG	4990	5020	5090	5210	5640

This table includes 5% additional fuel for holding in a racetrack pattern.

Introduction

This chapter contains information to supplement performance data from the Flight Management System (FMS). In addition, sufficient inflight data is provided to complete a flight with the FMS inoperative. In the event of conflict between data presented in this chapter and that contained in the Approved Flight Manual, the Flight Manual shall always take precedence.

General

Minimum Takeoff Weight

Light weight takeoffs may be limited by minimum takeoff weight. For takeoff at 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 can be used for all performance conditions with the exception of assumed temperature reduced thrust. Takeoff speeds are not valid for assumed temperatures. They can also be used for non-standard conditions provided that appropriate adjustments are made to V1, for example when operating with brakes deactivated or operating on contaminated runways. These speeds may be used for weights less than or equal to the performance limited weight.

In certain high thrust/low gross weight or low thrust/high gross weight conditions, the FMC advisory message "MIN VSPEEDS UNAVAILABLE" will appear in the CDU help window. Takeoff is not permitted in this condition as certified limits have been exceeded. Manually verify takeoff speed entries generated using Onboard Performance Tool (OPT) or another approved source of takeoff performance information. Upon verifying takeoff speeds, takeoff is permitted.

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 wind and slope from the Slope and Wind V1 Adjustments table (Table 3).
4. Determine the V1(MCG) from the V1(MCG) table (Table 4).
5. If V1 from Step 3 is less than V1(MCG), set V1=V1(MCG).
6. Using V1(MCG) from Step (4), determine Minimum VR (MIN VR) from the Minimum VR table (Table 5).

7. Using V1(MCG) from Step (4), determine Minimum V2 (MIN V2) from the Minimum V2 table (Table 6).
8. If VR from Step 2 is less than MIN VR, set VR=MIN VR.
9. If V2 from Step 2 is less than MIN V2, set V2=MIN V2.

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 minimum V2 (MIN V2). It is therefore necessary to compare the adjusted V1, VR, and V2 to V1(MCG) MIN VR and MIN V2 respectively. No takeoff weight adjustment is necessary provided that the field length available exceeds the minimum field length shown in the Field and Climb Limit Weight table in Chapter Performance Dispatch.

Stabilizer Trim Setting

To find takeoff stabilizer trim setting, enter the Stabilizer Trim Setting table with anticipated brake release weight and center of gravity (C.G. % MAC) and read required stabilizer trim units.

VREF Speeds

This table contains flaps 30, 25 and 20 reference speeds for a given weight.

Flap Maneuver Speeds

This table provides flap maneuver speeds for various flap settings. During flap retraction, selection of the next flap position is initiated when reaching the maneuver speed for the existing flap position. During flap retraction, at least adequate maneuver capability of 30° of bank (15° of bank and 15° overshoot) to sticker shaker is provided at the flap retraction speed. Full maneuvering capability of 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 the 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 varies with airplane weight and provides full maneuver capability of at least 40° of bank (25° of bank and 15° overshoot) to stick shaker at all weights.

Slush/Standing Water Takeoff

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water or ice. Therefore, reductions in runway/obstacle limited takeoff weight and revised takeoff speeds are necessary. The tables are intended for guidance in accordance with advisory material and assume an engine failure at the critical point during the takeoff.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore this information is conservative when

operating under typical colder weather conditions where patches of slush exist and some degree of sanding is common.

Takeoffs in slush depths greater than 0.5 inches (13 mm) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Takeoff weight is determined as follows:

1. Determine the 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 and pressure altitude to obtain the slush/standing water limit weight with respect to minimum field length required for V1(MCG) speed.
5. 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) considerations, enter the V1 Adjustment table (Table 3) with actual brake release weight to determine the V1 reduction to apply to V1 speed. If the adjusted V1 is less than V1(MCG), set V1=V1(MCG).

Dry Snow Runway Takeoff

In addition to slush/standing water, the data are provided for dry snow covered runways. Takeoff in dry snow depths greater than 4.0 inches (100 mm) is not recommended. The tables provided are used in the same manner as the Slush/ Standing Water Takeoff tables.

Wet Snow Runway Takeoff

In addition to slush/standing water and dry snow, data are provided for wet snow covered runways. 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 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.

Takeoff TPR

To find Max Takeoff TPR based on anti-ice off, enter the Max Takeoff TPR table with airport pressure altitude and airport OAT and read TPR. Adjust for anti-ice operation as noted below the table.

Regulations permit the use of up to 25% takeoff thrust reduction for operation with assumed temperature reduced thrust. Use of reduced thrust is not allowed on runways contaminated with water, ice, slush or snow. Use of assumed temperature reduced thrust is not recommended if potential windshear conditions exist. The assumed temperature reduced takeoff TPR is read from the Max Takeoff TPR table at the assumed temperature. The minimum allowable TPR for reduced thrust, based on 25% takeoff thrust reduction, is read by entering Minimum Allowable TPR for Reduced Thrust Table with the maximum allowable TPR for the actual OAT.

Go-Around TPR

To find Go-Around TPR based on anti-ice off, enter the Go-Around TPR table with airport pressure altitude and reported OAT or TAT and read TPR. Adjust for anti-ice operation as noted below the table.

Max Climb TPR

This table shows Max Climb TPR for a 310/.85 climb speed schedule and anti-ice off or auto. Enter the table with airport pressure altitude and TAT and read TPR. Adjust for anti-ice operation as noted below the table.

Flight with Unreliable Airspeed

Information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking of the pitot system. Loss of radome may also cause unreliable airspeed/Mach indications. Climb, cruise and descent information are provided for a speed schedule of 270 knots below 38,000 feet and 260 knots above 38,000 ft. These speeds provide ample protection from stall and high speed buffet, while also providing protection from exceeding the structural limits.

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 the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. Note that these tables consider both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 300 ft/min residual rate of climb.

Flying above these altitudes with sustained banks in excess of approximately 21° may cause the airplane to lose speed and/or altitude. The altitudes shown in the table are limited to the maximum certified altitude of 43,100 ft.

Long Range Cruise Control

This table provides target TPR, Long Range Cruise Mach number, IAS 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.

APU Operation During Flight

For APU operation during flight, increase fuel flow according to the table in the Engine Inoperative text section.

Long Range Cruise Enroute Fuel and Time

Long Range Cruise Enroute Fuel and Time tables are provided to determine remaining time and fuel required to destination. The data is based on Long Range Cruise and .85/310/250 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 which may justify operations considerably below optimum altitude. For example, a favorable wind component may have an effect on ground speed which more than compensates for the loss in air range.

Using this table, it is possible to determine the break-even wind (advantage necessary or disadvantage that can be tolerated) to maintain the same range at another altitude and long range cruise speed. The tables make no allowance for climb or descent time, fuel or distance, and are based on comparing ground fuel mileage.

Descent at .85/310/250

Distance and time for descent are shown for a .85/310/250 descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach with gear down and landing Flaps 30 at the outer marker.

Holding

Target TPR, indicated airspeed and fuel flow per engine information is tabulated for holding with Flaps Up and Flaps 1 based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed for the selected flap setting. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read TPR, IAS and fuel flow per engine.

Advisory Information

Runway Surface Condition Correlation

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. A table is provided that correlates runway condition code to runway surface condition description and reported braking action that can then be used to determine the appropriate Normal Configuration Operational Landing Distance or Non-Normal Configuration Landing Distance.

Normal Configuration Operational Landing Distance

Tables are provided as advisory information for normal configuration operational landing distances on dry runways and runways with good, good to medium, medium, medium to poor, and poor reported braking action. Operational Landing distances (reference distances plus adjustments) are 115% of the actual landing distance. The Normal Configuration Operational Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance from threshold to touchdown associated with

a flare time of 7 seconds. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, two engine maximum reverse thrust, and auto speedbrakes.

To use these tables, determine the reference landing distance for the selected braking configuration and reported braking action. Adjust this reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers. Each correction is applied independently to the reference landing distance. A correction for use of manual speedbrakes is provided in the table notes.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" 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. Landing distances and adjustments are provided for dry runways and runways with good, good-to-medium, medium, medium-to-poor, and poor reported braking action. Landing distances (reference distances plus adjustments) are representative of the actual landing distance, and are not factored. The Non-Normal Configuration Landing Distance tables should be used enroute to make a landing distance assessment for time of arrival.

The reference landing distance is the distance from threshold to complete stop. It includes an air distance allowance from threshold to touchdown associated with a flare time of 7 seconds. The reference distance is based on a reference landing weight and speed at sea level, standard day, zero wind, zero slope, and maximum available reverse thrust.

Tables for Non-Normal Configuration Operational Landing Distance in this section are similar in format and used in the same manner as tables for the Normal Configuration Operational Landing Distance previously described.

For an engine inoperative landing, check the rate of climb capability shown in Gear Down Landing Rate of Climb Available tables to ensure adequate climb performance.

Landing Climb Limit Weight

The table "Landing Climb Limit Weight" presents the data which are the more limiting of Approach Climb Limit Weight and Landing Climb Limit Weight. Enter the table with airport OAT and pressure altitude to read landing climb limit weight. Apply the noted adjustments as required.

Tire Speed Landing Limit Weight

For normal operations, the tires have a speed limit of 204 knots (235 MPH). For non-normal landings, the tires are allowed to exceed this speed limit, but may not exceed the maximum tire speed limit of 226 knots (260 MPH). For FLAPS DRIVE (1≤Flaps≤5) or PITCH UP AUTHORITY (Flaps≤15), the resultant touchdown speed can potentially be higher than this maximum speed limit. In order to avoid this, the tire speed landing limit weight should be checked.

The tire speed landing limit weight is based on a final approach speed that is higher of VREF30+40 and the amber band speed, with a five knot approach speed additive. Enter the table with airport OAT and pressure altitude to read tire speed landing limit weight. Apply the noted adjustments for wind as required. If planned landing weight exceeds the tire speed landing limit weight, reduce gross weight by burning fuel or fuel jettison. If unable to reduce weight below the tire speed landing limit weight, divert to a lower elevation airport.

Recommended Brake Cooling Schedule

Advisory information is provided to assist in avoiding problems associated with hot brakes. For normal operation, most landings are at weights below the AFM quick turnaround limit weight.

Use of the recommended cooling schedule will help avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Enter the Reference Brake Energy table (Table 1) with the airplane weight and brakes on speed, adjusted for wind, at the appropriate temperature and altitude condition. Instructions for applying wind adjustments are included below the table. Linear interpolation may be used to obtain intermediate values. The resulting number is the reference brake energy per brake in millions of foot-pounds, and represents the amount of energy absorbed by each brake during a rejected takeoff.

To determine the energy per brake absorbed during landing, enter the Event Adjusted Brake Energy table (Table 2) for no reverse thrust or 2 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 indications on Multifunction Display are also shown. 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 5.0 or higher on the gear synoptic display and disappear as the hottest brake cools

below 3.0. Note that even without an EICAS advisory message, brake cooling is recommended.

Engine Inoperative

Initial Max Continuous TPR

The Initial Max Continuous TPR setting for use following an engine failure is shown. The table is based on 310 KIAS or .85 M to provide a target TPR setting at the start of driftdown. Once driftdown is established, the Max Continuous TPR table should be used to determine TPR for the given conditions. Adjust for anti-ice operation as noted below the table.

Max Continuous TPR

Power setting is based on one engine operating with anti-ice off or auto. Enter the table with pressure altitude and IAS or Mach to read TPR. Adjust for anti-ice operation as noted below the table.

It is desirable to maintain engine thrust level within the limits of the Max Cruise thrust rating. However, where thrust level in excess of Max Cruise rating is required, such as for meeting terrain clearance, ATC altitude assignments, or to attain maximum range capability, it is permissible to use the thrust needed up to the Max Continuous thrust rating. The Max Continuous thrust rating is intended primarily for emergency use at the discretion of the pilot and is the maximum thrust that may be used continuously.

Driftdown Speed/Level Off Altitude

The table shows optimum driftdown speed as a function of cruise weight at start of driftdown. Also shown are the approximate weight and pressure altitude at which the airplane will level off considering 100 ft/min residual rate of climb.

The level off altitude is dependent on air temperature (ISA deviation).

Driftdown/Cruise Range Capability

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to long range cruise speed. Cruise is continued at level off altitude and long range cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion table (Table 1) with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time table (Table 2) with air distance and weight at start of driftdown to determine fuel and time required. If altitudes other than the level off altitude is used, fuel and time required may be obtained by using the Engine Inoperative Long Range Cruise Diversion Fuel and Time table.

Long Range Cruise Altitude Capability

The table shows the maximum altitude that can be maintained at a given weight and air temperature (ISA deviation), based on LRC speed, Max Continuous thrust, and 100 ft/min residual rate of climb.

Long Range Cruise Control

The table provides target TPR, engine inoperative Long Range Cruise Mach number, IAS and fuel flow for the airplane weight and pressure altitude. The fuel flow values in this table reflect single engine fuel burn.

APU Operation During Flight

For APU operation during flight, increase fuel flow according to the following table. These increments include the APU fuel flow and the effect of increased drag from the APU door.

PRESSURE ALTITUDE (1000 FT)	APU FUEL FLOW PENALTY (KG/HR)
43	80
39	100
35	120
31	130
25	150
20	170
15	200
10	210
5	240

Long Range Cruise Diversion Fuel and Time

Tables are provided for crews to determine the fuel and time required to proceed to an alternate airfield with one engine inoperative. The data is based on single engine Long Range Cruise speed and .85/310/250 descent.

To determine the 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.

Holding

Single engine holding data is provided in the same format as the all engine holding data and is based on the same assumptions.

Gear Down Landing Rate of Climb Available

Rate of climb data is provided as guidance information in the event an engine inoperative landing is planned. The tables show gear down rate of climb available for Flaps 20 and Flaps 30. Enter the table with TAT and pressure altitude to read rate of climb available. Apply adjustments shown to correct for weight.

Alternate Mode EEC

Fuel Jettison Limit Weight

The Alternate Mode EEC Return to Land Fuel Jettison Limit Weight is defined as the landing climb limit weight plus the fuel burned over 30 minutes and the fuel jettisoned over 15 minutes.

The table presented provides the Alternate Mode EEC Fuel Jettison Limit Weight for a given altitude and temperature. Enter the table with airport OAT and pressure altitude to read the Alternate Mode EEC Fuel Jettison Limit Weight. Apply the noted adjustments for anti-ice as required. Intermediate altitudes or temperatures may be interpolated.

The table presented is based on the entry-into-service maximum zero fuel weight. Analysis from the Airplane Flight Manual - Digital Performance Information software using a lower zero fuel weight may yield less restrictive performance.

DELETION

Limit Weight

A simplified method which conservatively accounts for the effects of EEC in the ALTERNATE mode is to reduce the normal mode performance limited weights. The Limit Weight table provides takeoff field, climb, obstacle, net level off and landing climb weights. To determine the limit weights for operations with the EEC in the ALTERNATE mode, enter the table with each of 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 and the Alternate Mode EEC Fuel Jettison Climb Limit Weight must be used. The Alternate Mode EEC 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.

Derated or reduced takeoff thrust takeoffs are not allowed with the EEC in the ALTERNATE mode. Adjustments to the limit weights provided in this section are not valid for takeoffs using improved climb. Likewise, adjustments to the limit weights are not valid for takeoffs with a contaminated runway. Analysis from the Airplane Flight Manual - Digital Performance Information may yield less restrictive limit weights.

Takeoff Speed Adjustment

Takeoff speeds computed for the reduced weight should be increased by the amount shown in the Takeoff Speeds Adjustments table.

Max Takeoff %N1

Takeoff power settings are presented for anti-ice off. Max Takeoff %N1 may be read directly from the table for the desired pressure altitude and airport OAT.

The EEC ALTERNATE mode schedule provides equal or greater thrust than the normal mode for the same lever position. Thrust protection is not provided in the ALTERNATE mode and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions.

Max Climb %N1

This table shows Max Climb %N1 for a 310/.85 climb speed schedule with anti-ice off or auto. Enter the table with pressure altitude and TAT to read Max Climb %N1. Apply adjustments as required.

Max Cruise %N1

Maximum Cruise %N1 is presented for 310 KIAS or .85 M, which approximates Long Range Cruise speed. Enter the table with pressure altitude and TAT to read Max Cruise %N1. Appropriate adjustments are shown.

Go-Around %N1

Go-Around power setting for ALTERNATE MODE EEC operation is presented for anti-ice off. Go-Around %N1 may be read directly from the tables for the desired pressure altitude and airport OAT.

The ALTERNATE MODE EEC schedule provides equal or greater thrust than the normal mode for the same lever position. Thrust protection is not provided in the ALTERNATE mode and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions.

Alternate Mode EEC, Engine Inoperative

Initial Max Continuous %N1

Initial Max Continuous %N1 settings for use following an engine failure are presented. The table is based on 310 KIAS or .85 M to provide a target %N1 setting at the start of driftdown. Once driftdown is established, the Max Continuous %N1 table should be used to determine %N1 for the given conditions.

Max Continuous %N1

Max Continuous %N1 settings are presented as a function of pressure altitude and TAT for engine inoperative speeds of 320, 280, 240, and 200 KIAS. Power settings may be interpolated for intermediate airspeeds.

Gear Down

This section contains performance for airplane operation with the landing gear extended for all phases of flight.

Note: The Flight Management System (FMS) does not contain special provisions for operation with landing gear extended. As a result, the (FMS) 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. An accurate estimated time of arrival is available if current speed or Mach is entered into the VNAV cruise page. Estimates of fuel remaining at waypoints or the destination may be computed by the crew based on current fuel flow indications, but should be updated frequently.

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.

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

Table of Contents

Dimensions 1.10
Principal Dimensions 1.10.1
Turning Radius 1.10.3

Flight Deck Panels 1.20
Introduction 1.20.1
Flight Deck Panels 1.20.1

Overhead Panel 1.21
Introduction 1.21.1
Overhead Panel 1.21.1

Forward Panels 1.22
Introduction 1.22.1
Left Forward Panel 1.22.1
Right Forward Panel 1.22.1
EICAS Display 1.22.2
Glareshield Panel 1.22.3
Center Forward Panel 1.22.4
Forward Aisle Stand 1.22.4
System Displays 1.22.5

Aft and Side Panels 1.23
Introduction 1.23.1
Control Stand 1.23.1
Aft Aisle Stand 1.23.3
Left Sidewall 1.23.4
Right Sidewall 1.23.5
First and Second Observer Panels 1.23.6

Controls and Indicators 1.30

Push-Button Switches 1.30.1
Alternate Action Switches 1.30.1
Momentary Action Switches 1.30.2
Seat Belt Signs and Lighting 1.30.3
Lighting Panel 1.30.5
Miscellaneous Lighting Controls 1.30.7
Flight Deck Emergency Lights Switch 1.30.7
Passenger Cabin Emergency Lights Switch 1.30.8
Floor Lights Switch 1.30.9
Aisle Stand Panel/Flood Light Control 1.30.9
Map Light Control 1.30.10
Forward Panel Brightness Controls 1.30.10
Doors and Windows 1.30.12
Door Synoptic Display 1.30.12
Passenger Entry Door 1.30.14
Door Viewing Window 1.30.15
Door Mode Select Panel 1.30.17
Flight Deck Door 1.30.20
Passenger Cabin Window 1.30.24
Flight Deck Overhead Door and Vent 1.30.25
Common Computing Resource (CCR) Reset Switches 1.30.28
Oxygen Systems 1.30.29
Oxygen Indications 1.30.29
Passenger Oxygen Switch 1.30.29
Oxygen Mask Panel 1.30.30
Oxygen Mask and Regulator 1.30.31
Emergency Evacuation 1.30.34
Fuselage Mounted Emergency Locator Transmitter 1.30.35
Emergency Locator Transmitter Control Panel 1.30.35

Systems Description 1.40

Introduction 1.40.1

Common Core System 1.40.1

CCS Start-Up 1.40.1

Lighting Systems 1.40.2

Exterior Lighting 1.40.2

Exterior Lighting Locations 1.40.4

Flight Deck Lighting 1.40.4

Master Brightness Control System 1.40.5

Passenger Cabin Lighting 1.40.5

Passenger Cabin Signs 1.40.6

Emergency Lighting 1.40.6

Oxygen Systems 1.40.10

Flight Deck Oxygen System 1.40.10

Passenger Cabin Oxygen System 1.40.18

Overhead Crew Rest Oxygen System 1.40.18

Portable Oxygen Bottles 1.40.19

Doors 1.40.19

Flight Deck Door 1.40.19

Flight Deck Overhead Door 1.40.21

Passenger Entry Doors 1.40.25

Cargo Doors 1.40.29

Flight Deck Seats 1.40.30

Pilot Seats 1.40.30

Pilot Seat Adjustment 1.40.33

Observer Seats 1.40.33

Flight Deck Personal Electronic Device (PED) Power 1.40.34

Emergency Equipment 1.45

Introduction 1.45.1

Emergency Evacuation Signal System 1.45.1

Emergency Locator Transmitter (ELT) 1.45.1

Emergency Descent Devices 1.45.2
Fire Extinguishers 1.45.2
Flashlights 1.45.3
Emergency Equipment Symbols 1.45.5
Emergency Equipment Locations—Flight Deck 1.45.8
Emergency Equipment Locations—Passenger Cabin 1.45.10

Flight Crew Rest 1.46

Overhead Flight Crew Rest 1.46.1
Occupancy 1.46.1
Layout 1.46.2
Entrance Enclosure 1.46.5
Main Control Panel 1.46.7
Common Area Control Panel 1.46.8
Temperature Control Panel 1.46.8
Seat Area Control Panel 1.46.10
Bunk Light Control Panel 1.46.11
Oxygen System 1.46.12
Crew Rest Smoke Detection 1.46.12
Smoke Detector 1.46.13
Crew Rest Smoke Detection System Operation 1.46.14
Emergency Equipment 1.46.15
Emergency Equipment Sysbols 1.46.15
Emergency Equipment Location 1.46.16
OFCR Non-Normal Situation Guidelines 1.46.16
Decompression 1.46.16
Crew Rest Area Fire Fighting 1.46.17
Evacuation 1.46.19

Flight Attendant Rest 1.47

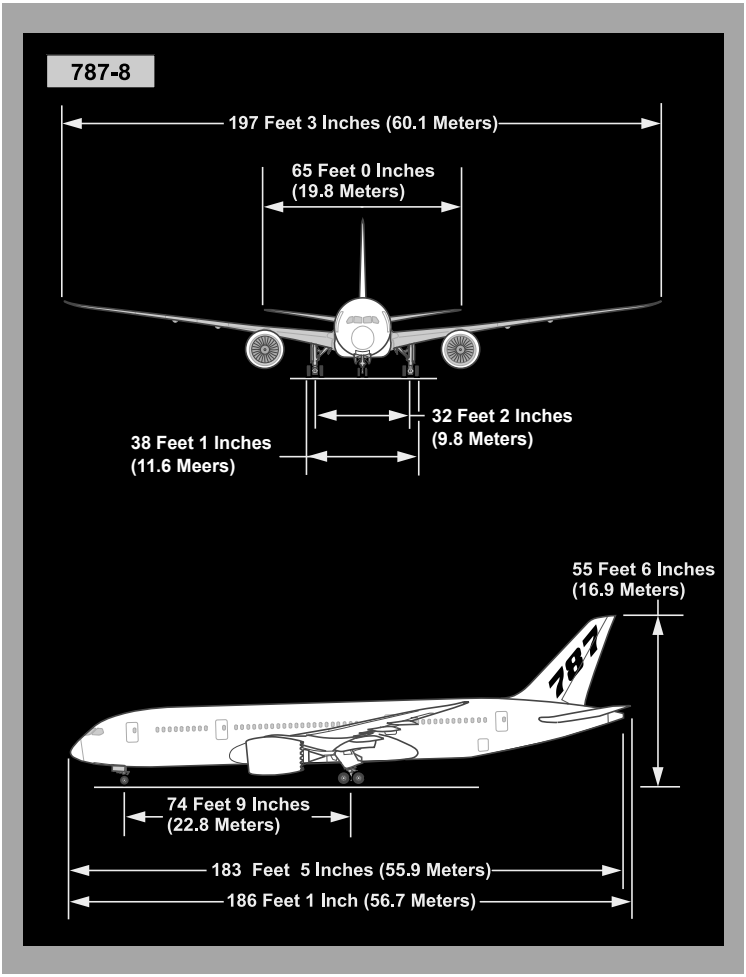
Overhead Flight Attendant Rest 1.47.1
Occupancy 1.47.1
Layout 1.47.2

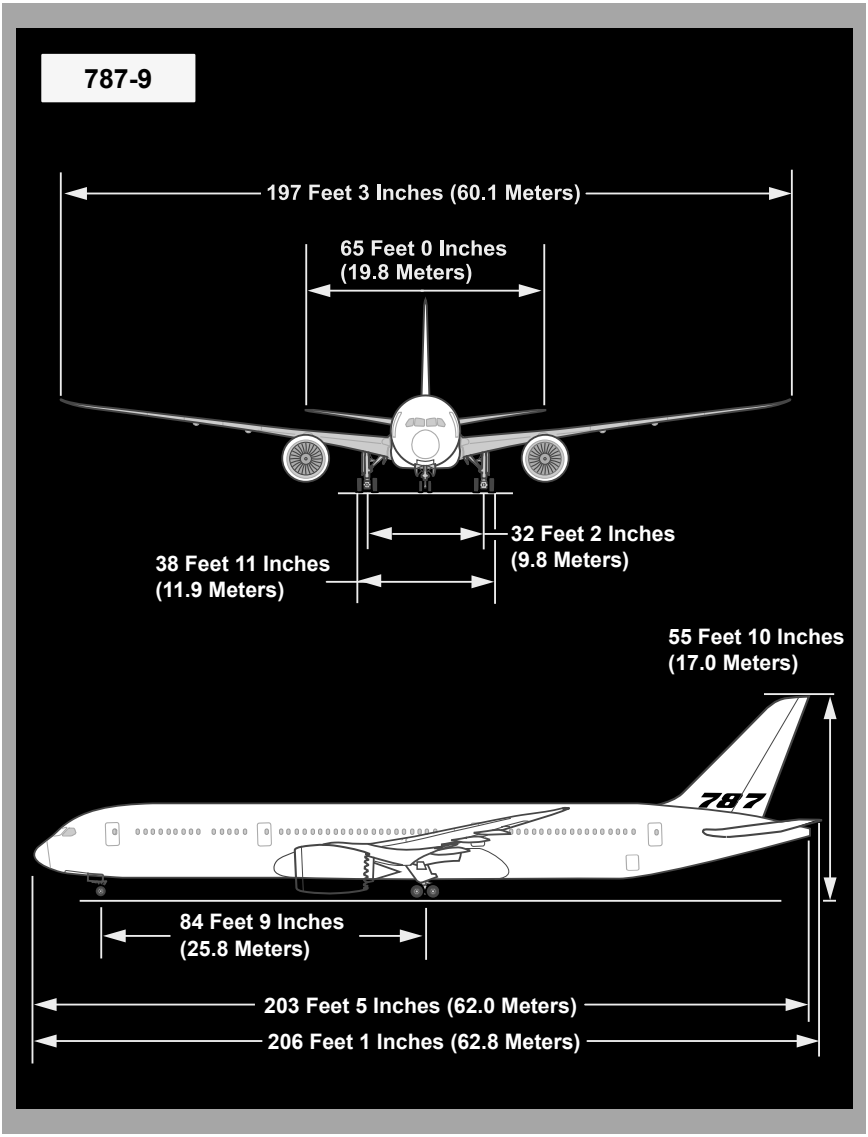
Entrance Enclosure 1.47.4
Entrance Enclosure Control Panels 1.47.5
Temperature Control System 1.47.7
Bunk Lighting Control Panel 1.47.8
Oxygen System 1.47.9
Crew Rest Smoke Detection 1.47.9
Emergency Equipment 1.47.12
Emergency Equipment Symbols 1.47.12
Emergency Equipment Location 1.47.13
OFAR Non-Normal Situation Guidelines 1.47.13
Decompression 1.47.13
Crew Rest Area Fire Fighting 1.47.14
Evacuation from the Crew Rest Compartment 1.47.16

EICAS Messages 1.60

Airplane General, Emergency Equipment, Doors, Windows
EICAS Messages 1.60.1
Doors and Windows 1.60.1
Emergency Lights and Passenger Signs 1.60.2
Oxygen System 1.60.2
Miscellaneous Emergency Equipment 1.60.2

Principal Dimensions

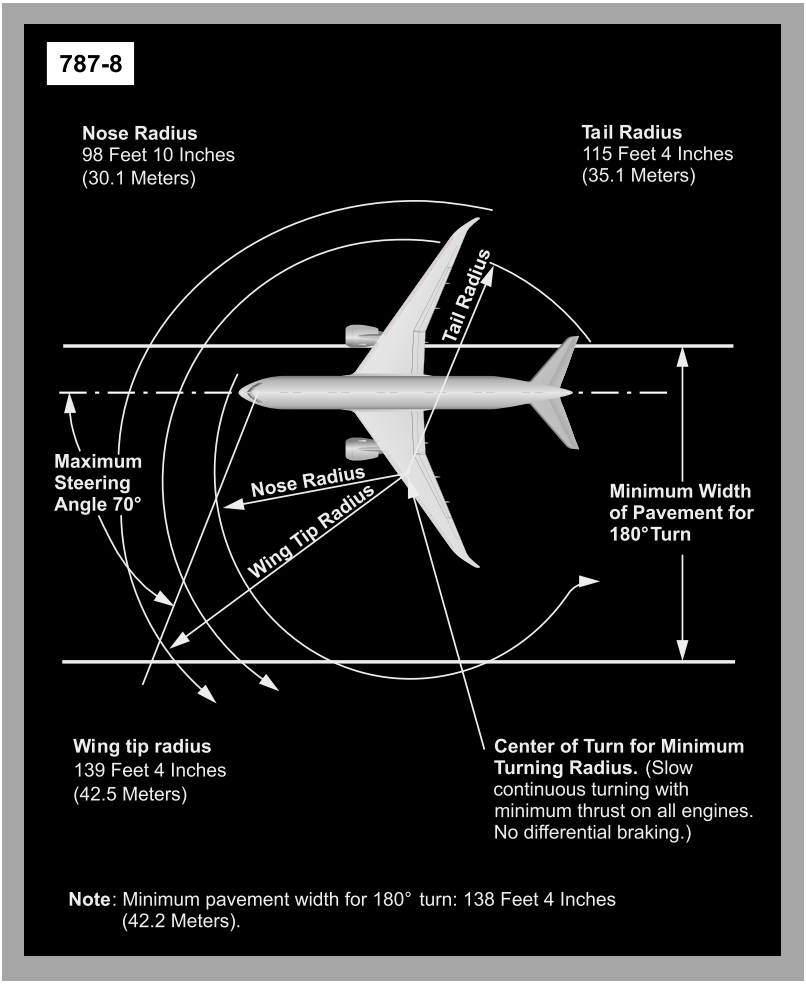



787-9
197 Feet 3 Inches (60.1 Meters)
65 Feet 0 Inches
(19.8 Meters)
32 Feet 2 Inches
(9.8 Meters)
38 Feet 11 Inches
(11.9 Meters)
55 Feet 10 Inches
(17.0 Meters)
787
84 Feet 9 Inches
(25.8 Meters)
203 Feet 5 Inches (62.0 Meters)
206 Feet 1 Inches (62.8 Meters)

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.

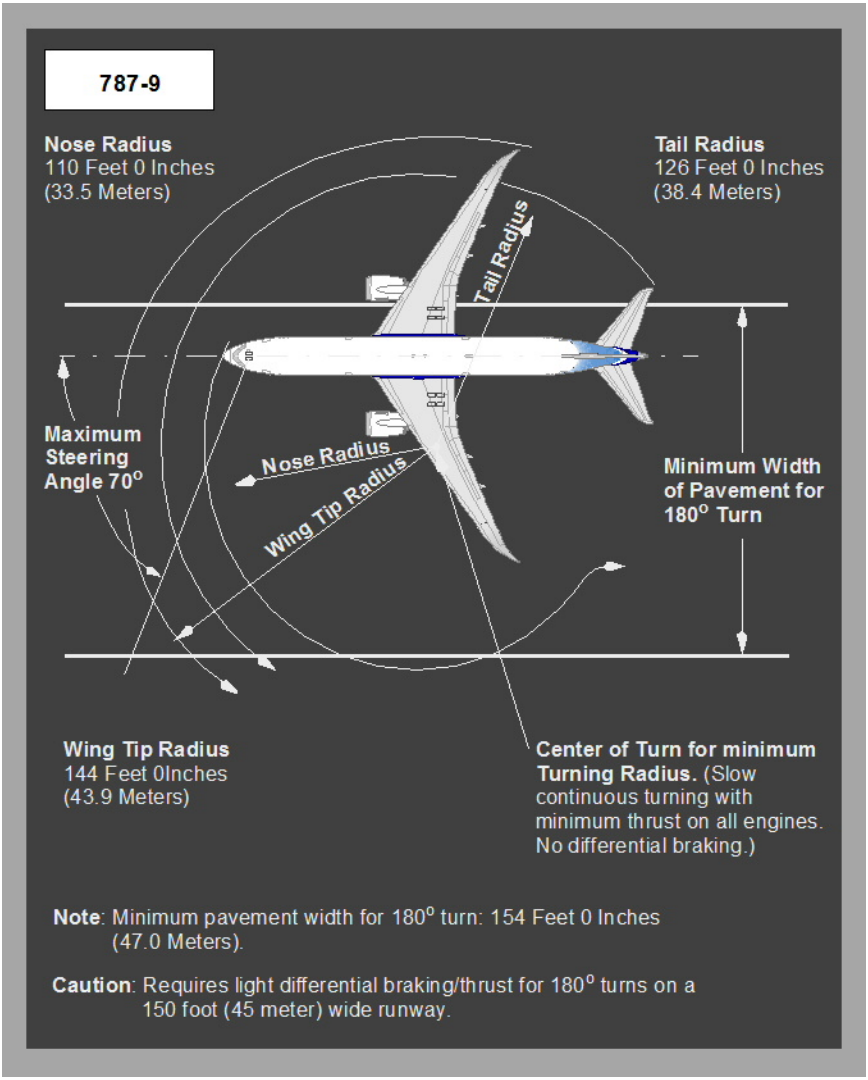
TQA to TQF



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

TQA to TQF

TWA,B



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

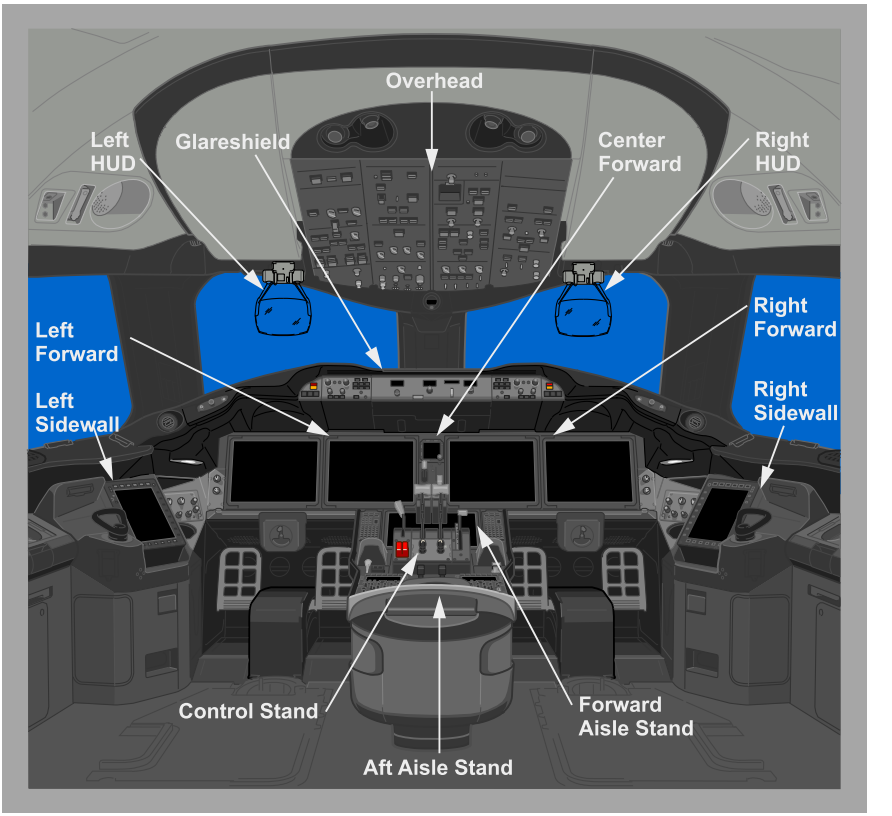
Airplane General, Emergency Equipment, Doors, Windows — Chapter 1

Flight Deck Panels — Section 20

Introduction

The panels shown in this illustration are representative of installed units and may not exactly match the latest configuration. See the relevant chapter's system description for the most current information.

Flight Deck Panels



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

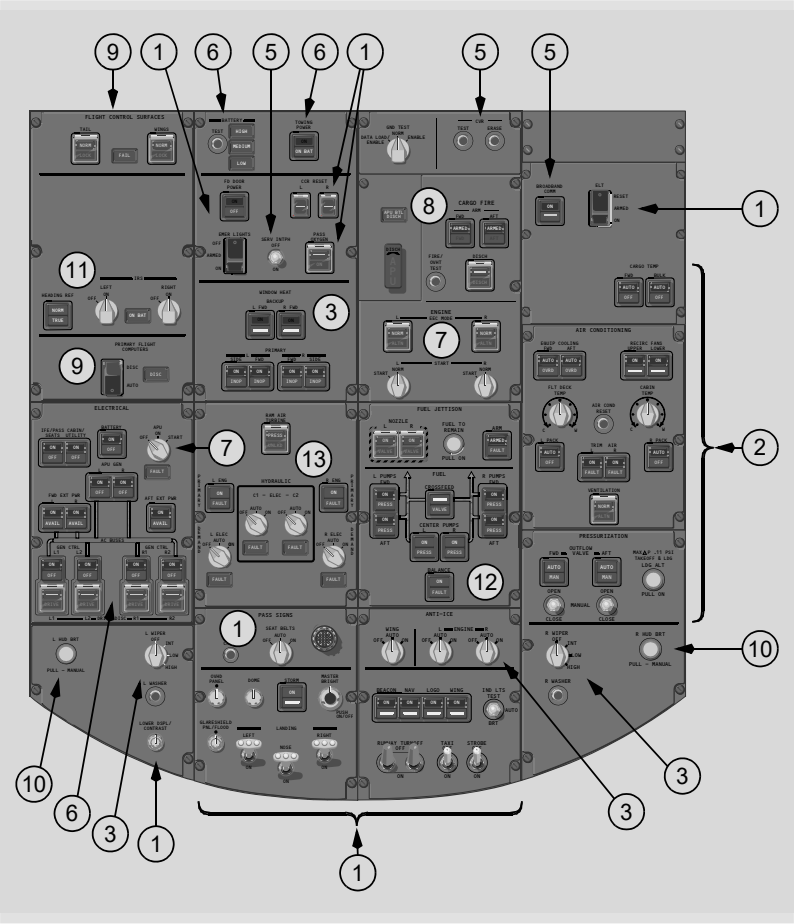
Airplane General, Emergency Equipment, Doors, Windows — Chapter 1

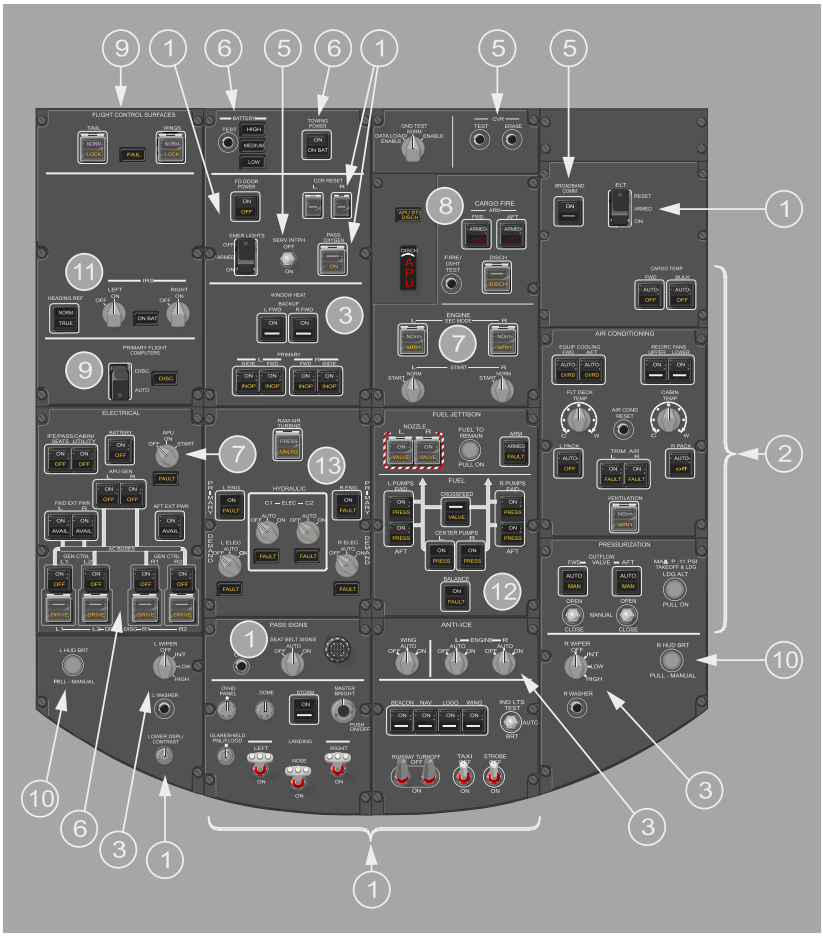
Overhead Panel — Section 21

Introduction

The numbered callouts for each item refer to the relevant chapter where individual panel layouts and detailed system description information can be found.

Overhead Panel

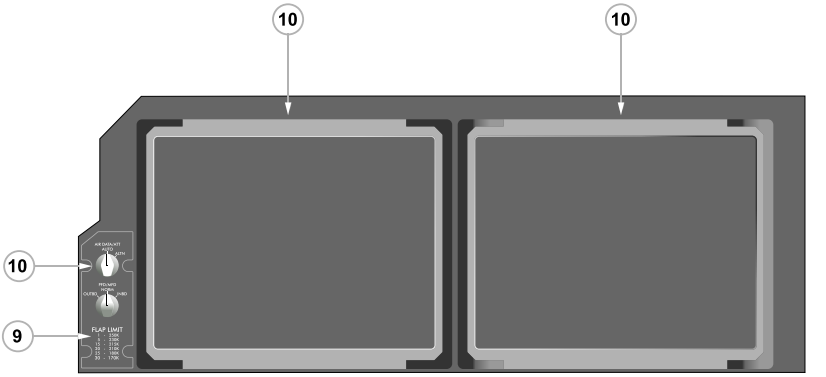



FLIGHT CONTROL SURFACES
ELECTRICAL
FUEL JETTISON
AIR CONDITIONING
PRESSURIZATION
ANTI-ICE
PASS SIGNS
CARGO FIRE
ENGINE
WINDOW HEAT
PRIMARY FLIGHT COMPUTERS
HYDRAULIC
FUEL
1
2
3
5
6
7
8
9
10
11
12
13

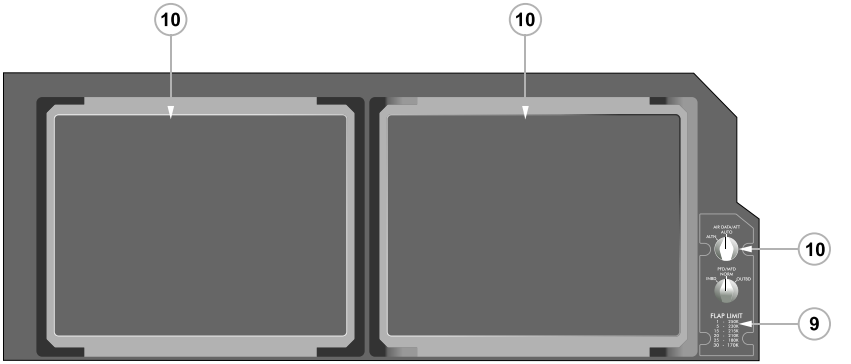
Introduction

The numbered callouts for each item refer to the relevant chapter where individual panel layouts and detailed system description information can be found.

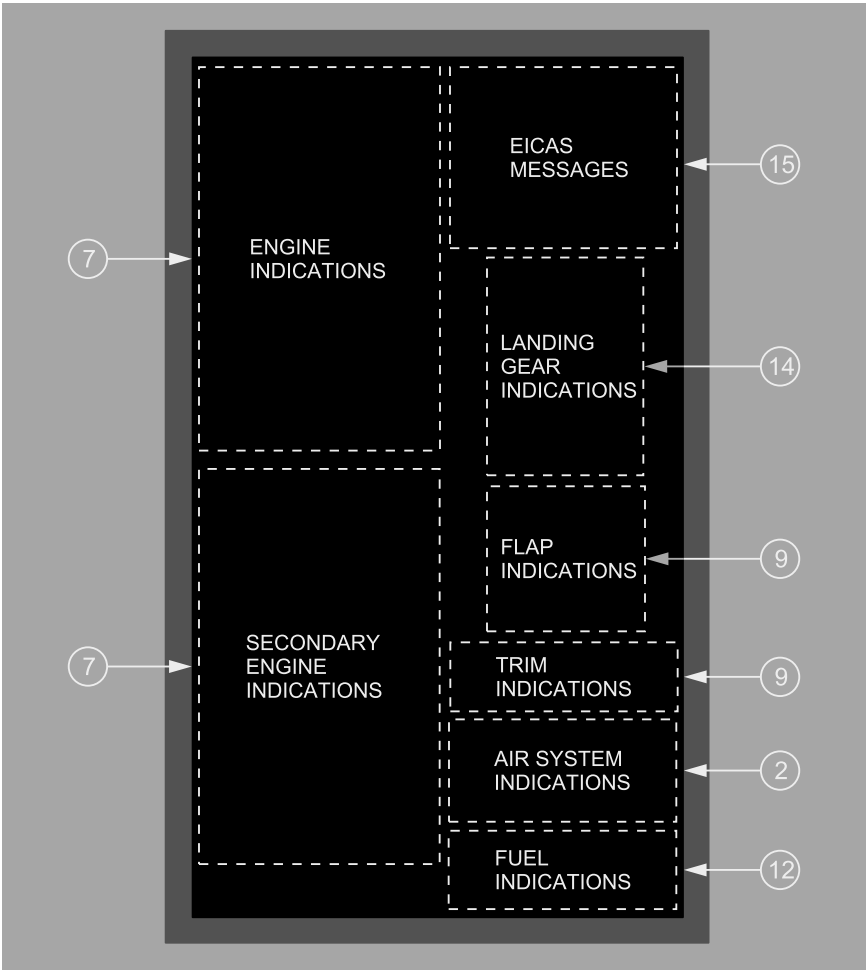
Left Forward Panel



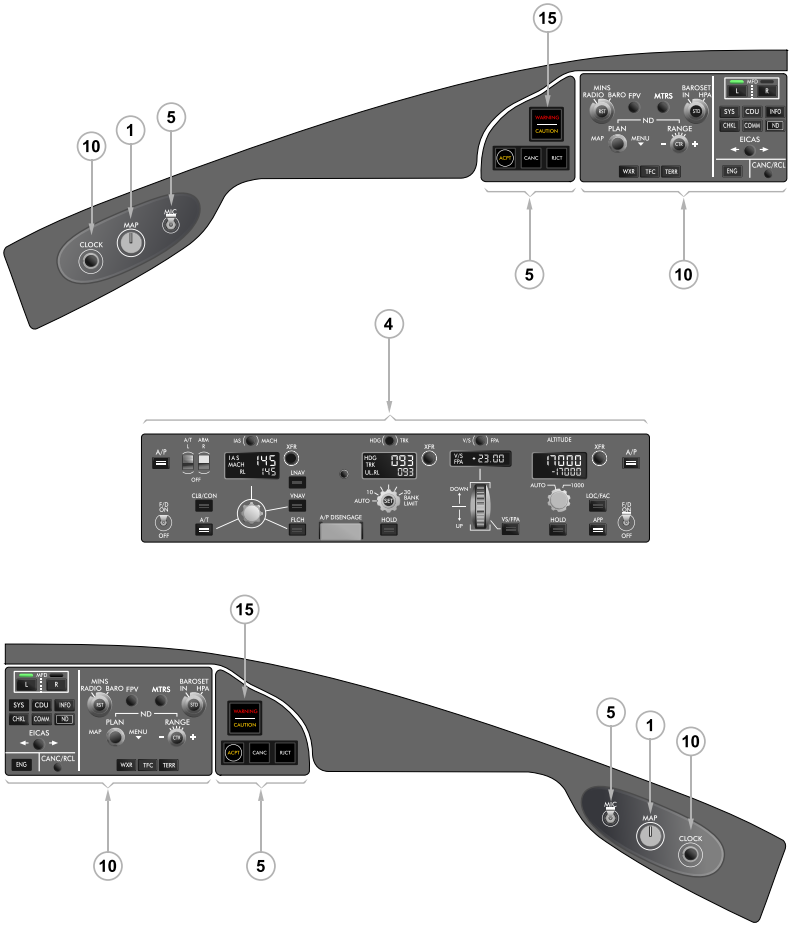
Right Forward Panel



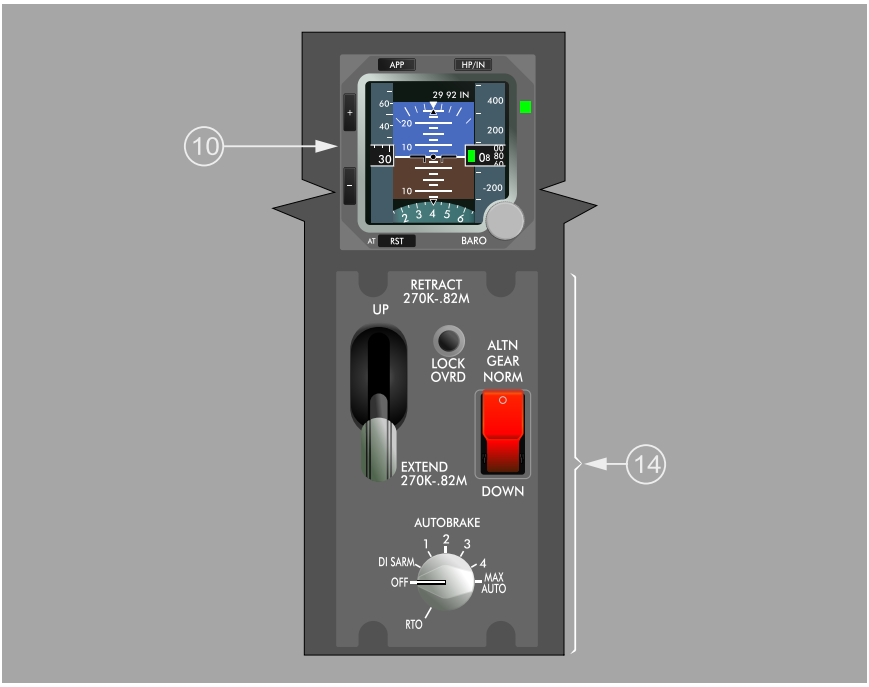
EICAS Display



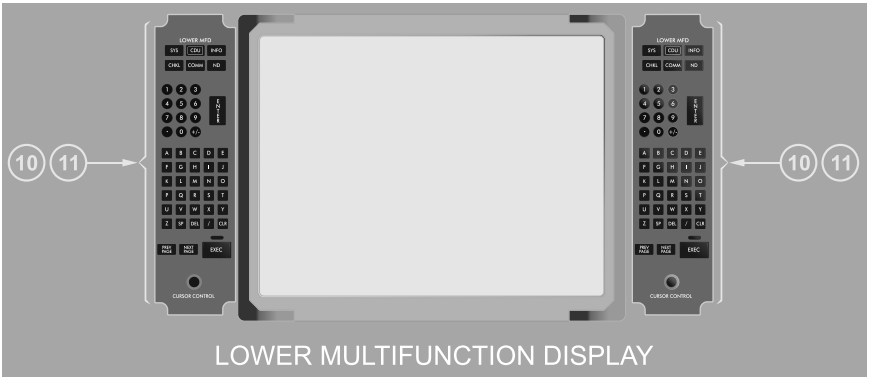
Glareshield Panel



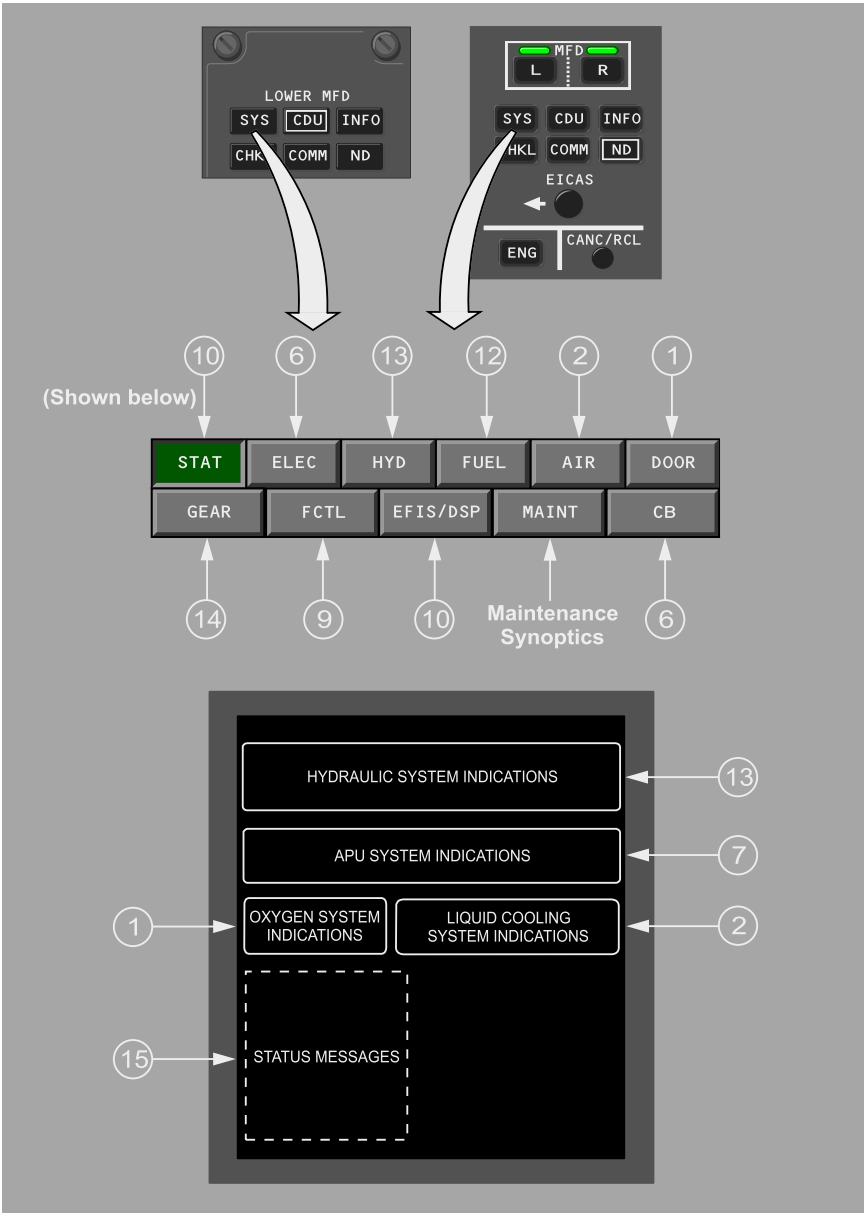
Center Forward Panel



Forward Aisle Stand



System Displays

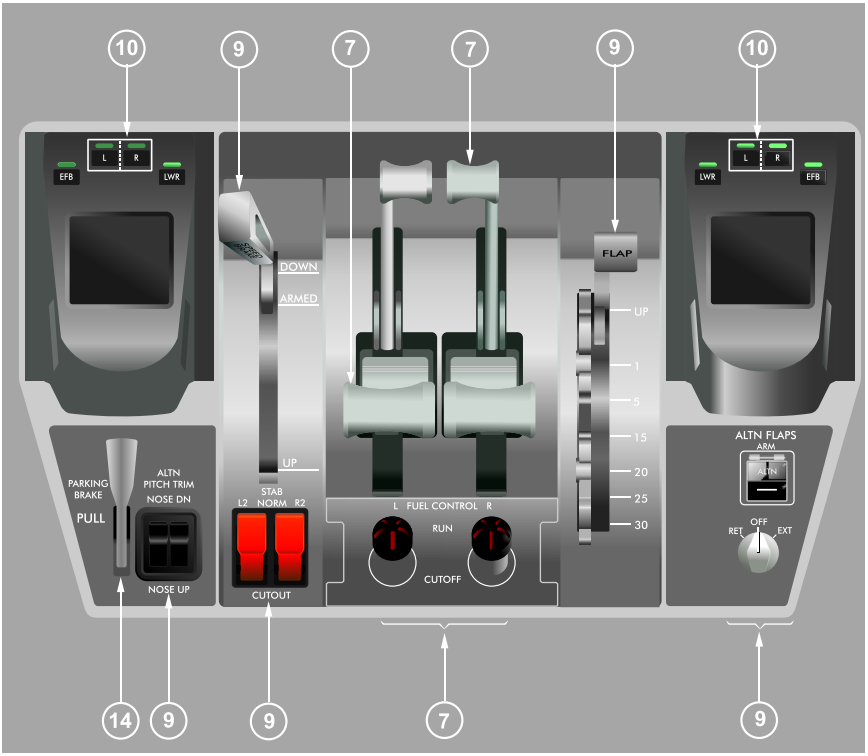


Introduction

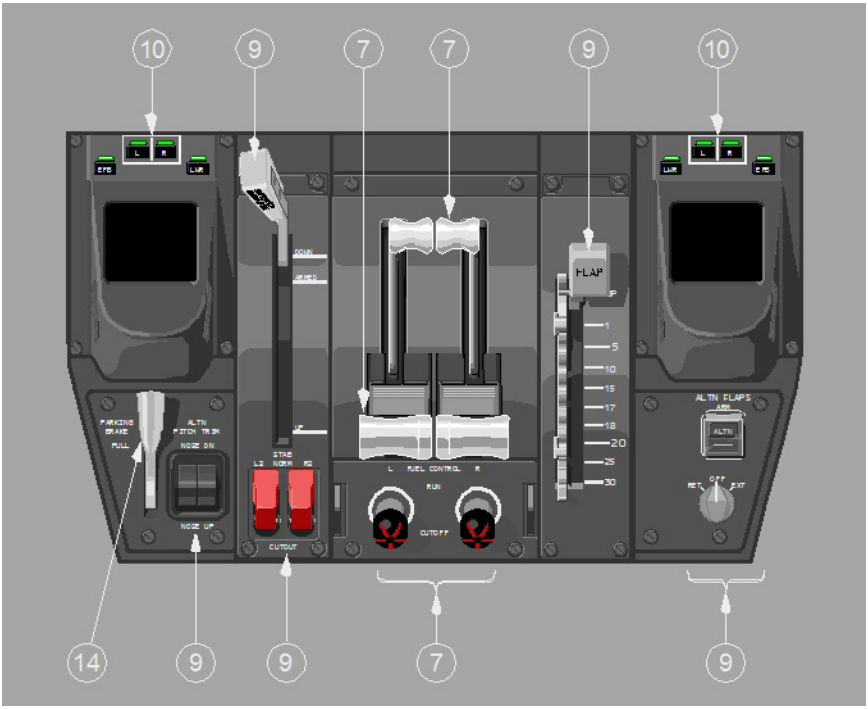
The numbered callouts for each item refer to the relevant chapter where individual panel layouts and detailed system description information can be found.

Control Stand

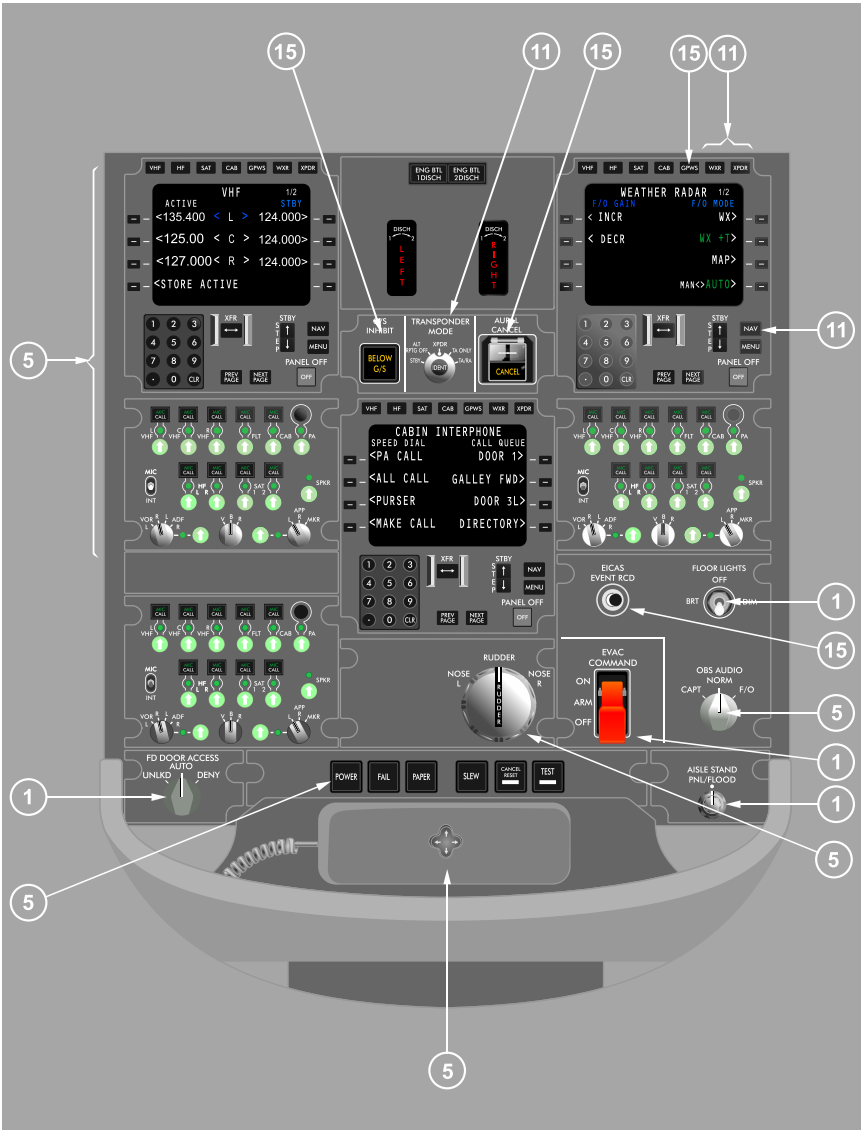
TQA to TQF



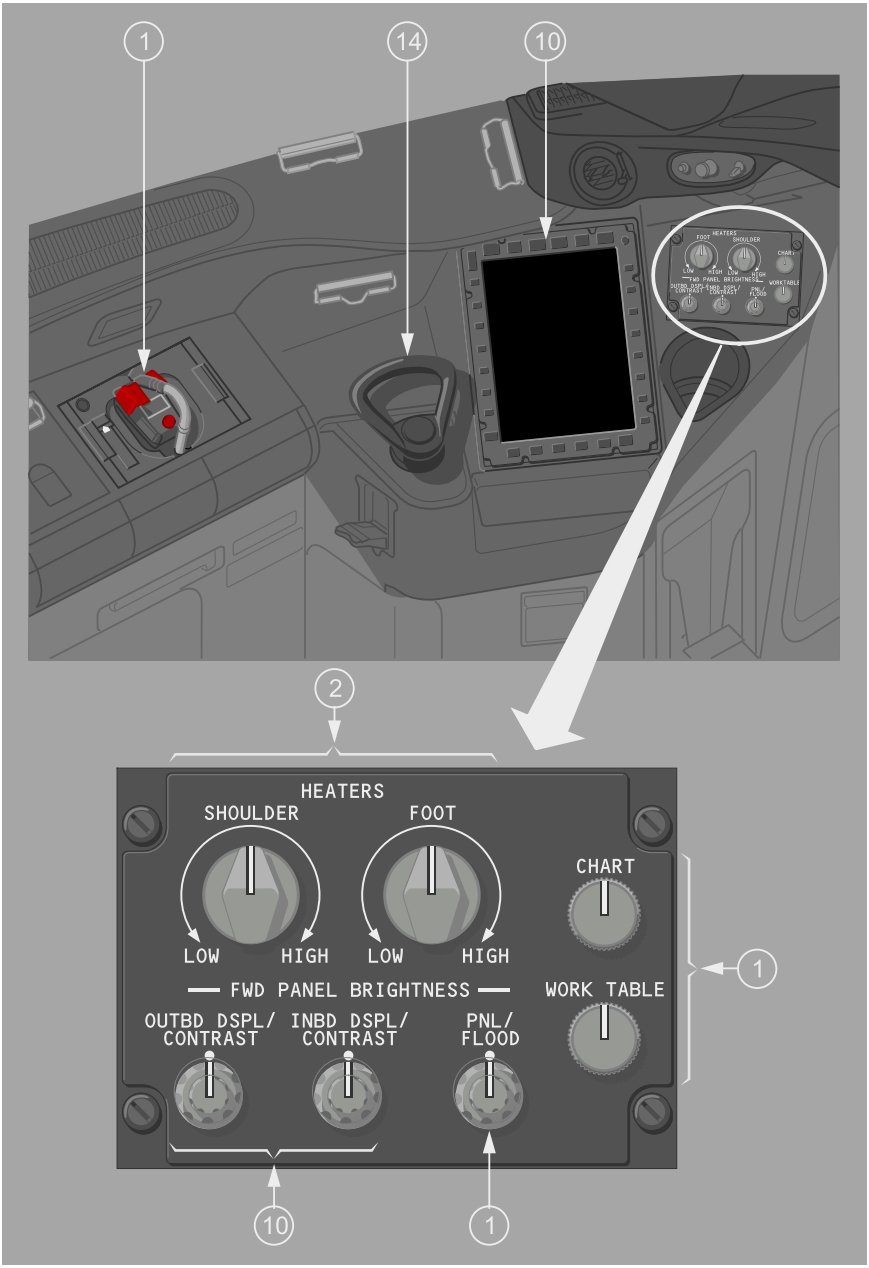
TWA,B



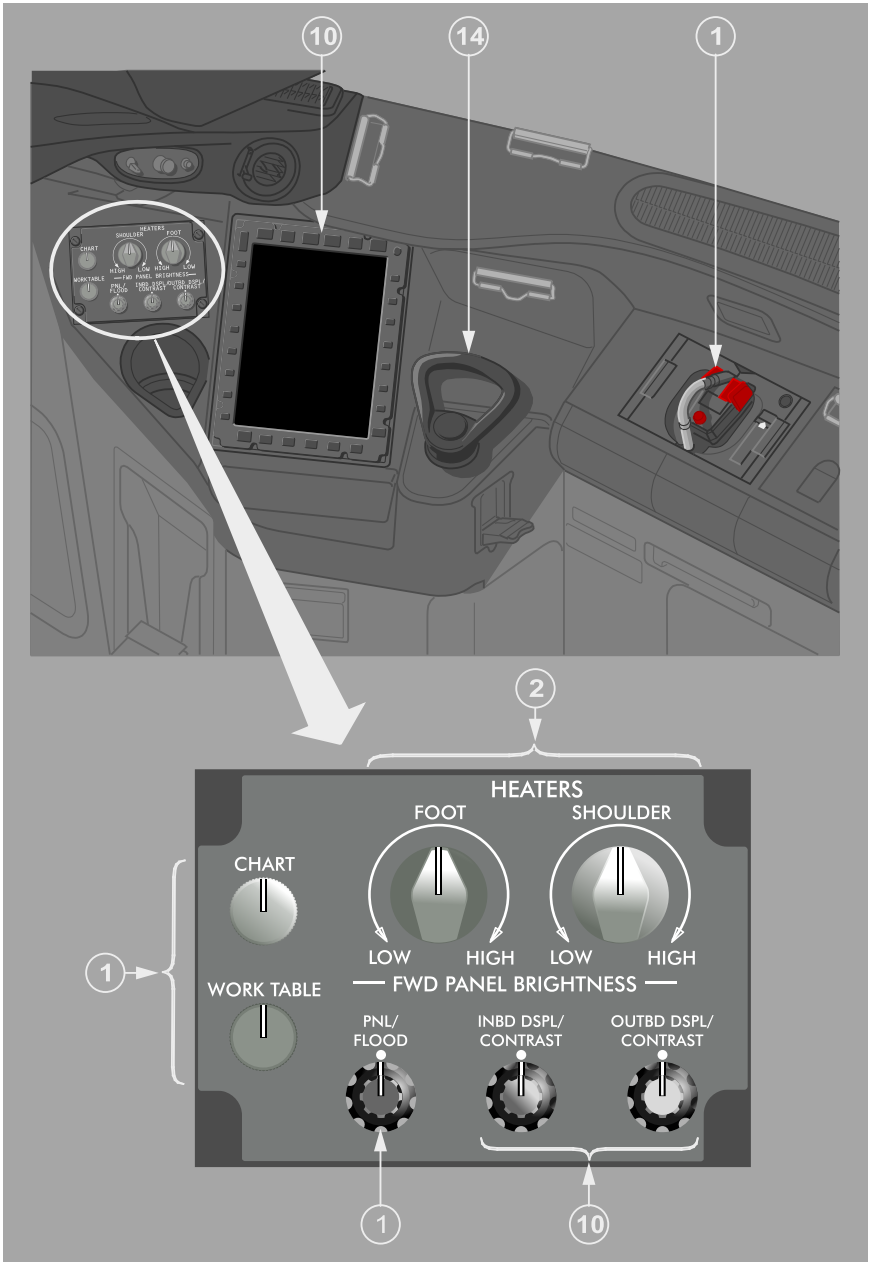
Aft Aisle Stand



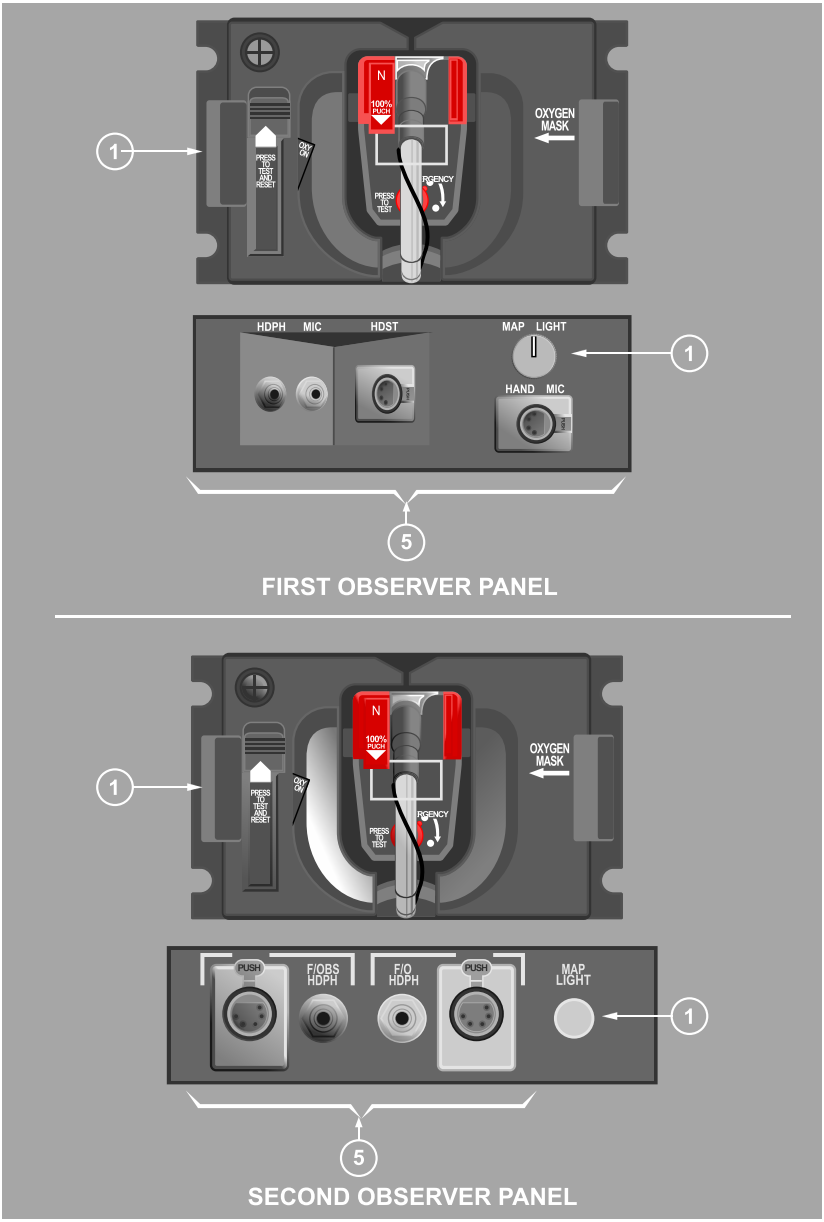
Left Sidewall



Right Sidewall



First and Second Observer Panels



Push-Button Switches

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

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

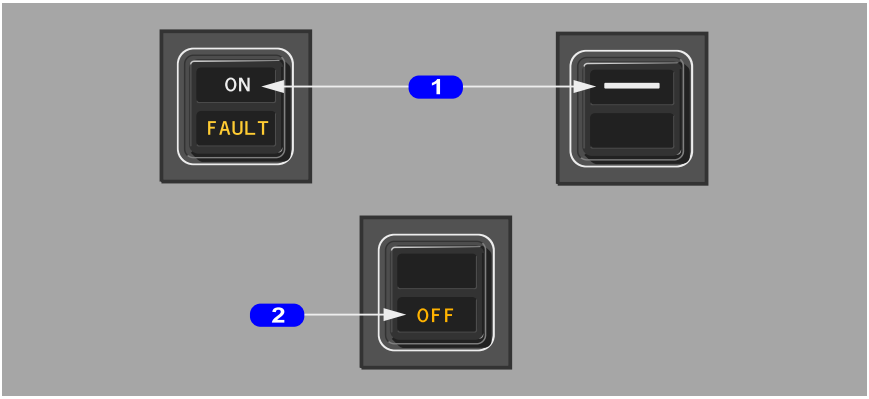
Alternate Action Switches

Alternate action switches have two positions: on and off.

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

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

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



1 Switch is ON

ON, AUTO, or flow bar visible.

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

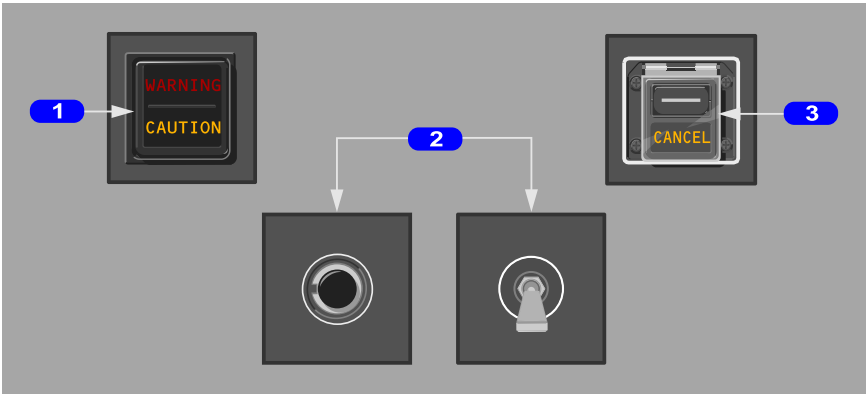
2 Switch is OFF

OFF or a line is visible—

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

Momentary Action Switches

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



1 Push to Reset

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

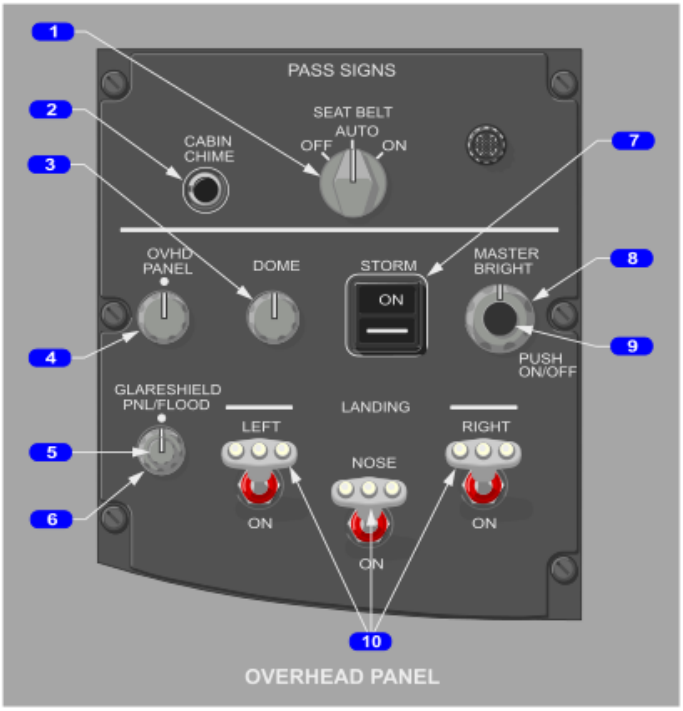
2 System Operation

Push—activates the system. Push and hold keeps some systems activated.

3 System Selection

Push—activates or deactivates the system.

Seat Belt Signs and Lighting



1 SEAT BELTS Selector

OFF—the fasten seat belt and return to seat signs are not illuminated.

AUTO—the fasten seat belt and return to seat signs are illuminated or extinguished automatically with reference to airplane altitude and system configuration. (See Passenger Cabin Signs on page 1.40.6 for additional information.)

ON—the fasten seat belt and return to seat signs are illuminated.

Note: Anytime passenger oxygen deploys, the FASTEN SEAT BELT signs illuminate and the RETURN TO SEAT signs extinguish, regardless of selector position.

2 CABIN CHIME Switch

Push—rings chime in cabin.

3 DOME Light Control

Rotate—adjusts overhead dome light brightness.

4 Overhead (OVHD) PANEL Light Control

Rotate—adjusts overhead panel light brightness.

5 GLARESHIELD Panel (PNL) Light Control (outer)

Rotate—adjusts glareshield panel light brightness.

6 GLARESHIELD FLOOD Light Control (inner)

Rotate—adjusts glareshield flood light brightness.

7 STORM Light Switch

ON—overrides normal controls and illuminates the following lights:

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

8 MASTER Brightness (BRIGHT) Control (outer)

Rotate (when the MASTER BRIGHTNESS switch is pushed on)—

- adjusts the brightness of all panel lights and displays (does not control: dome lights, flood lights, area lights, HUD, standby compass, handset and annunciators)
- overrides individual brightness control settings
- limits adjustment range of individual brightness controls
- has full adjustment range of all lights when all individual brightness controls are set to the center detent.

9 MASTER Brightness (BRIGHT) Switch (inner)

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

Push ON (in)—the MASTER BRIGHTNESS control is on.

Push OFF (out)—the MASTER BRIGHTNESS control is off.

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

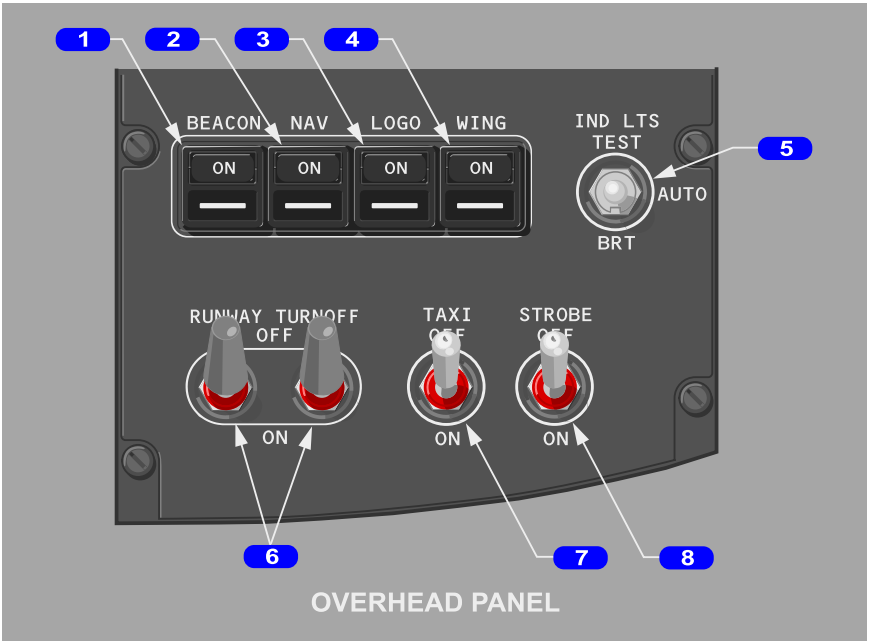
10 LANDING Light Switches

OFF—the landing light is not illuminated.

ON—the landing light is illuminated.

Note: The nose gear landing lights cannot illuminate when the nose landing gear is not down and locked. When the nose gear landing lights are ON, the taxi lights are also illuminated.

Lighting Panel



1 BEACON Light Switch

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

2 Navigation (NAV) Light Switch

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

3 LOGO Light Switch

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

4 WING Light Switch

ON—the wing leading edge illumination lights are illuminated.

5 Indicator Lights (IND LTS) Switch

TEST (spring–loaded)—

While the switch is being held in the TEST position:

- illuminates all annunciator lights to full brightness for 10 seconds to check the bulbs, then dims the lights for the next 20 seconds. If the switch is held longer than 30 seconds, all annunciator lights that were illuminated prior to the TEST, go to full brightness
- all display windows on the MCP blink on for 2 seconds, then off for 1 second and repeat until the TEST switch is released.

AUTO—sets all illuminated annunciator lights to full brightness when the forward field of view light sensors reach the high ambient lighting limit and returns to normal when the reset lighting intensity level is reached.

BRT (Bright)—sets all illuminated annunciator lights to full bright (overrides the automatic system operation).

6 RUNWAY TURNOFF Light Switches

OFF—the runway turnoff light is extinguished.

ON—the runway turnoff light is illuminated.

7 TAXI Light Switch

OFF—the taxi lights are extinguished.

ON—the taxi lights are illuminated.

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

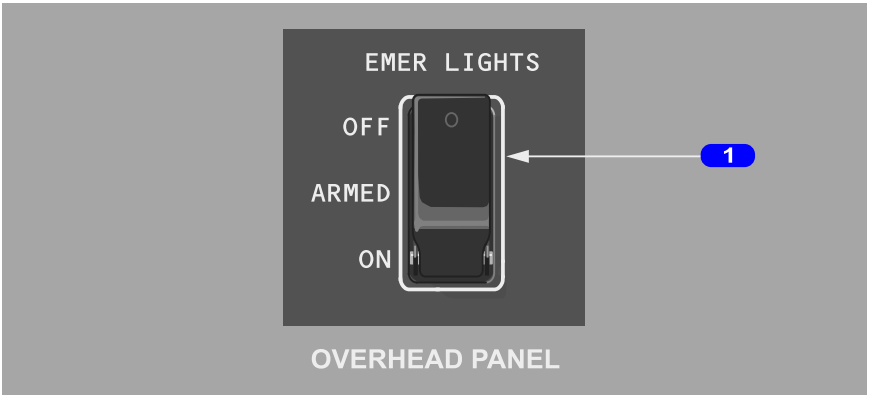
8 STROBE Light Switch

OFF—the white anticollision strobe lights on the tips of each wing and the tailcone are off.

ON—the strobe lights operate.

Miscellaneous Lighting Controls

Flight Deck Emergency Lights Switch



1 Emergency (EMER) LIGHTS Switch

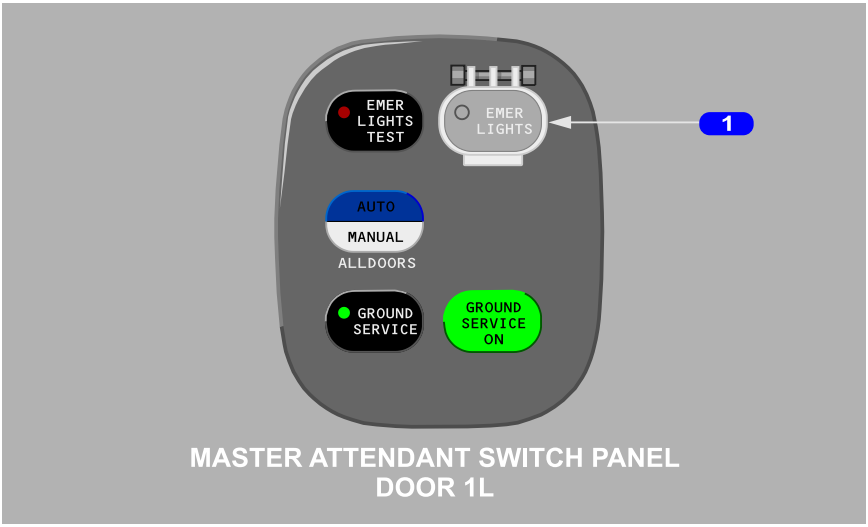
OFF—prevents emergency lights system operation if airplane electrical power fails or is turned off.

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

ON—all emergency lights illuminate.

Passenger Cabin Emergency Lights Switch

The passenger cabin emergency lights switch is located at the master attendant switch panel at door 1 left.



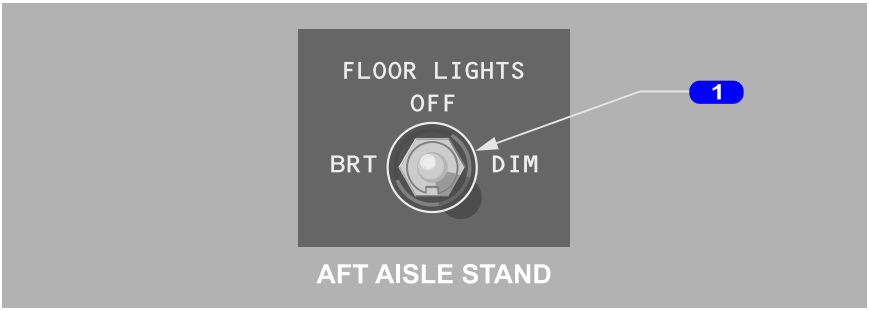
MASTER ATTENDANT SWITCH PANEL
DOOR 1L

1 Passenger Cabin Emergency (EMER) LIGHTS Switch

Push—

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

Floor Lights Switch



1 FLOOR LIGHTS Switch

OFF—the flight deck floor lights are not illuminated.

BRT—the floor lights are illuminated bright.

DIM—the floor lights are illuminated dim.

Aisle Stand Panel/Flood Light Control



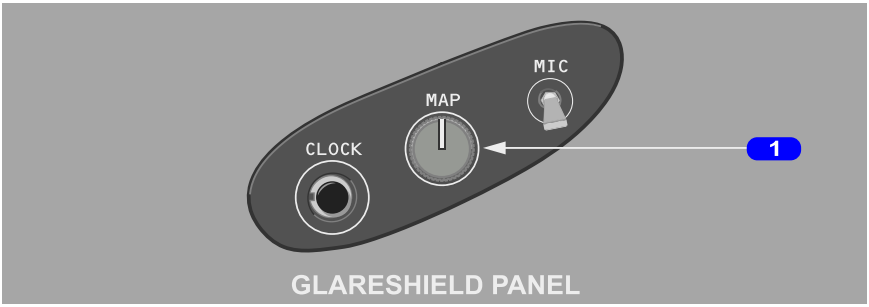
1 AISLE STAND Panel (PNL) Light Control (outer)

Rotate—adjusts the aisle stand instrument panel light brightness.

2 AISLE STAND FLOOD Light Control (inner)

Rotate—adjusts the aisle stand flood light brightness.

Map Light Control



1 MAP Light Control

Pull—on.

Push—off.

Rotate—adjusts map light brightness.

Note: MAP light switches are also located on the first and second observers panels.

Forward Panel Brightness Controls

For additional information:

- Forward/Lower Displays—see Display Brightness Controls on page 10.10.57

- HUD—see HUD Brightness Control on page 10.12.30.



1 CHART Light Control

Pull—on.

Push—off.

Rotate—adjusts chart light brightness.

2 WORK TABLE Light Control

Pull—on.

Push—off.

Rotate—adjusts work table light brightness.

3 FWD PANEL (PNL) BRIGHTNESS Light Control (outer)

Rotate—adjusts forward panel lights brightness.

4 FWD PANEL BRIGHTNESS FLOOD Light Control (inner)

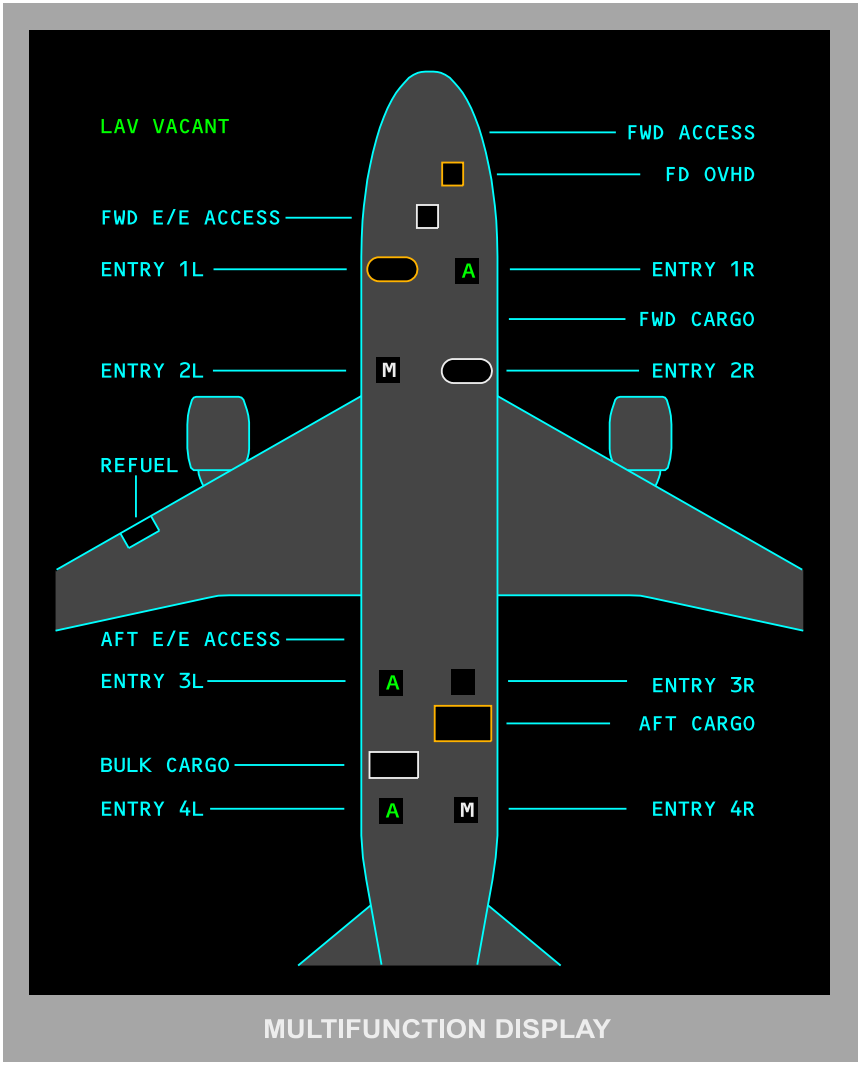
Rotate—adjusts forward panel flood light brightness.

Doors and Windows

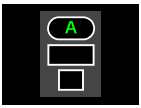
Door Synoptic Display

The doors synoptic is displayed by pushing the systems (SYS) display switch on the display select panel, and then selecting the DOOR synoptic key from

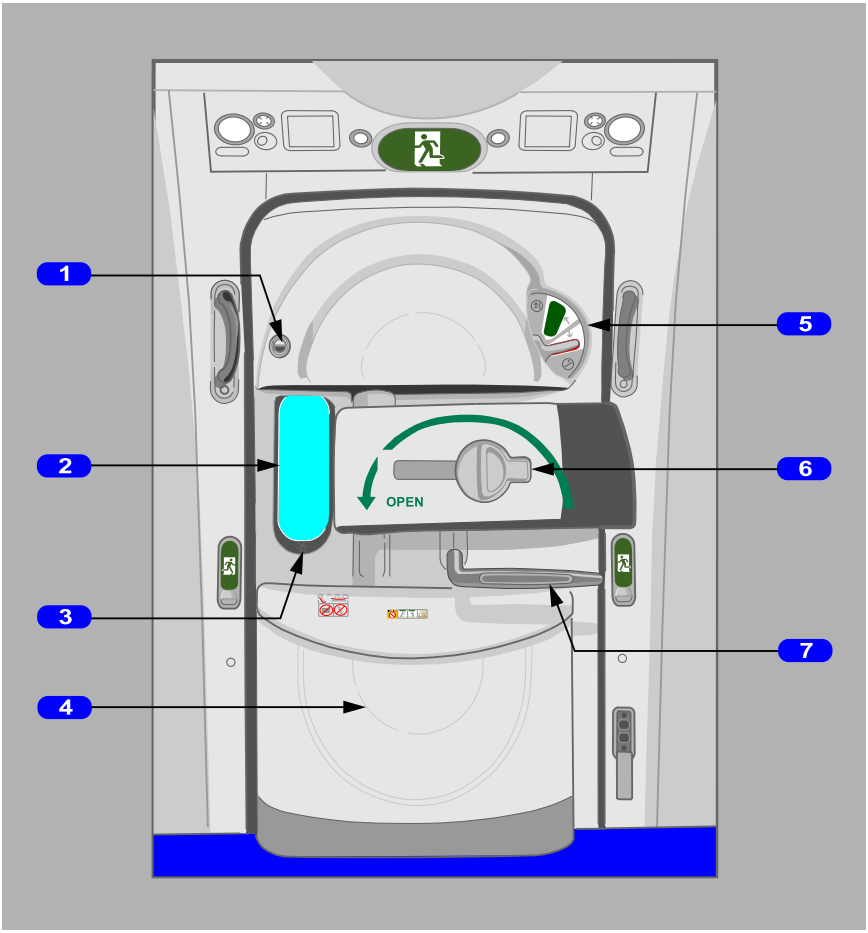
the menu page. (See Display Select Panel on page 10.10.51 for additional information.)



Door Synoptic Indications

Symbol	Indication	Description
	Door symbol blank	Large cargo door is closed, latched, and locked. Flight deck overhead door, bulk cargo door, or an access door is closed and latched. **Note:** Forward access door is not installed; associated door symbol is always blank. TWA,B
	Door symbol amber	Passenger entry or large cargo door is NOT closed, latched, and locked. Flight deck overhead door, bulk cargo door, or an access door is NOT closed and latched. **Note:** Forward access door is not installed. TWA,B
	Door symbol white	Door signal is invalid or unknown. Door position is unknown. Slide indication shows if valid.
	Green letter A	Passenger door is closed, latched, and locked; and the slide in the automatic mode.
	White letter M	Passenger door is closed, latched, and locked; and the slide in the manual mode.
	Slide mode blank	Passenger door is closed, latched and locked; and the slide mode is unknown.
	Lavatory availability	LAV VACANT—lavatory is available. LAV OCCUPIED—lavatory is unavailable. Indication is blank—availability is unknown.

Passenger Entry Door



1 Window Dimming Control Switch

Push (upper half of switch)—lightens viewing window.

Push (lower half of switch)—darkens viewing window. (See Door Viewing Window on page 1.30.15 for additional information.)

2 Viewing Window

Allows observation outside the airplane.

3 Door Locked Indicator

Illuminated (green)—padlock symbol indicates the door is closed, latched, and locked.

4 Door Bustle

Contains the slide/raft.

5 Door Mode Select Panel

See Door Mode Select Panel on page 1.30.17 for details.

6 Gust Lock Release Handle

Grab and pull inward to release the gust lock and move the door inward.

7 Door Operating Handle

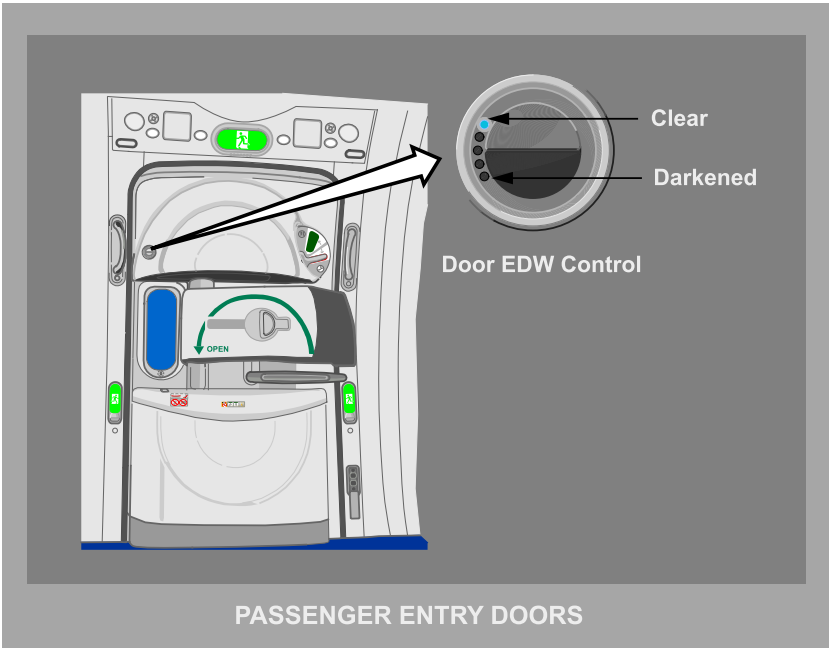
To open the door—rotate in the direction of the arrow.

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

Door Viewing Window

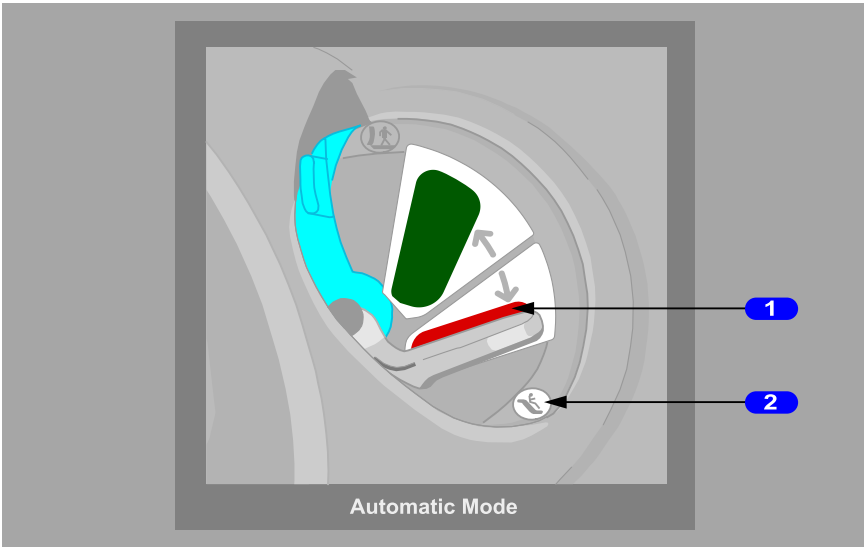
Each passenger door has an Electronically Dimmable Window (EDW) to quickly assess outside conditions before deciding to open the door in an emergency situation. Each window on a passenger entry door is independent of the other door windows. Door windows cannot be controlled from the Cabin Attendant Panel. No single failure can affect more than one door window other than loss of normal airplane electrical power. A control switch allows the dimmable window to change between two states: darkened and clear. A blue LED illuminates when the window is in the darkened state. During transition the blue switch LED flashes. When the window is in the clear state, the switch LED is not illuminated. If normal electrical power is lost, the door windows automatically become clear.

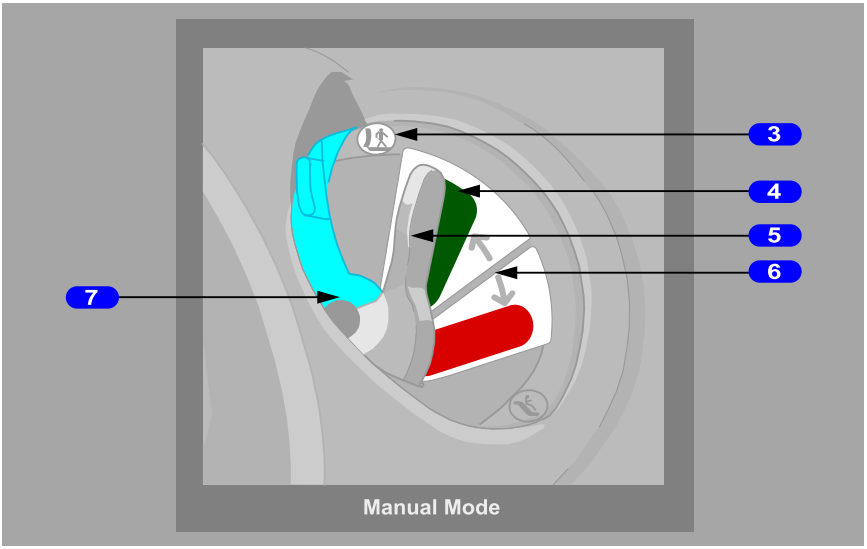
Note: The EDWs could take up to one minute to become fully clear.



If one side of the control switch fails, override the switch by pushing on the functioning side for 10 seconds. For example, if the window is fully dimmed and the clear window function fails, hold down the window dimming side of the switch for 10 seconds. This has the same effect as pushing the window clearing side of the switch in normal operation.

Door Mode Select Panel





1 Automatic mode (Armed)

Door is in the automatic mode if:

- the mode select lever is located fully in the RED band

- the door automatic mode indicator is illuminated
- the door manual mode indicator is not illuminated.

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

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

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

2 Automatic mode indicator

Indication light, symbolic of emergency slide use, is illuminated when the door mechanism has completely reached the automatic mode position actuated by the door mode select lever. If the door is not completely in the automatic mode, both automatic and manual indicators flash.

CAUTION: Do not rely on the symbolic indication as a means of determining if the door is in the automatic mode. Ensure the door mode selector is directly on top of the red band, and the automatic symbolic indicator is illuminated steady and not flashing.

3 Manual mode indicator

Indication light, symbolic of normal disembarkation, is illuminated when the door mechanism has completely reached the manual mode position actuated by the door mode select lever. If the door is not completely in the manual mode, both automatic and manual indicators flash.

CAUTION: Do not rely on the symbolic indication as a means of determining if the door is in the manual mode. Ensure the door mode selector is directly on top of the green band, and the manual symbolic indicator is illuminated steady and not flashing.

4 Manual mode (Disarmed)

Door is in the manual mode if:

- the mode select lever is located fully in the GREEN band, and
- the door manual mode indicator is illuminated, and
- the door automatic mode indicator is not illuminated.

Moving the door operating handle to the OPEN position disables:

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

5 Door Mode Select Lever

Used to select the required mode; automatic for flight or manual for arrival.

CAUTION: Ensure the door mode is properly selected by positioning the door mode select lever directly over the red or green band and ensuring that the appropriate symbolic indicator is illuminated steady and not flashing.

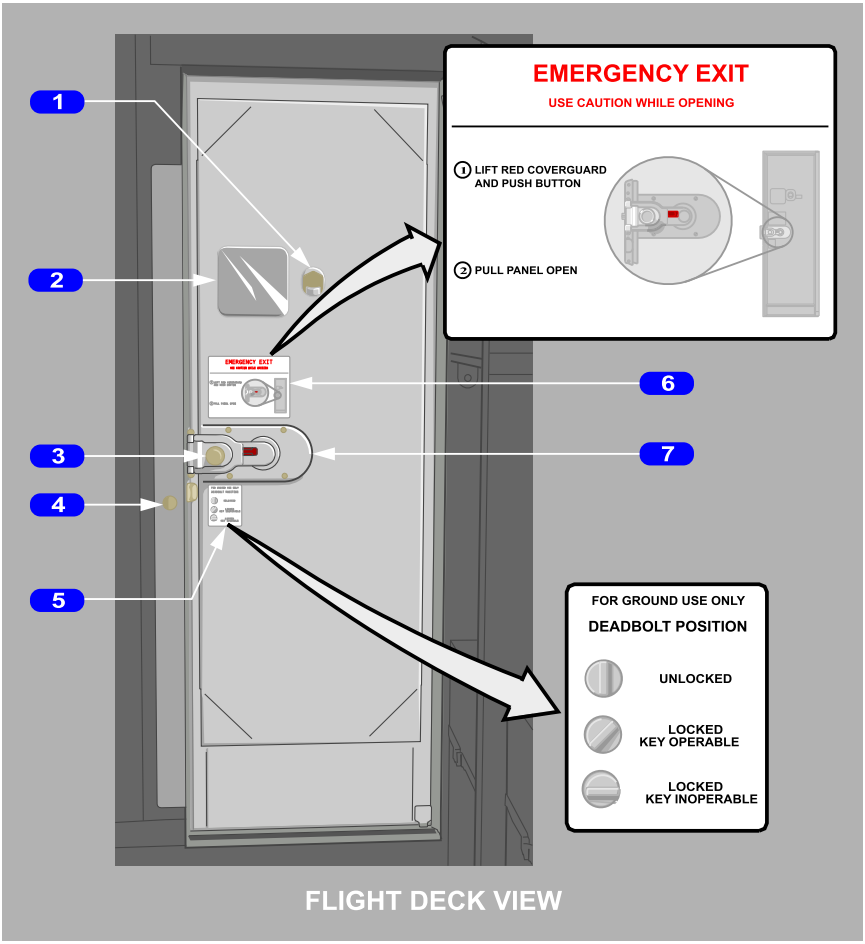
6 Unsafe area

If the mode select lever is not fully on top of the green or red band, or the automatic/manual symbolic indicators are flashing, the door mode is unknown.

7 Door Mode Select Lever cover

Slide the clear plastic cover closed to protect the mode select lever against inadvertent movement.

Flight Deck Door



1 Viewing Port

Allows viewing outside the flight deck door.

2 Mirror

3 Door Handle

Rotate—opens door manually.

4 Deadbolt Selector

Rotate—extends or retracts mechanical deadbolt, and allows or denies keyed access from cabin.

5 DEADBOLT POSITION Placard

Depicts selectable positions of the deadbolt.

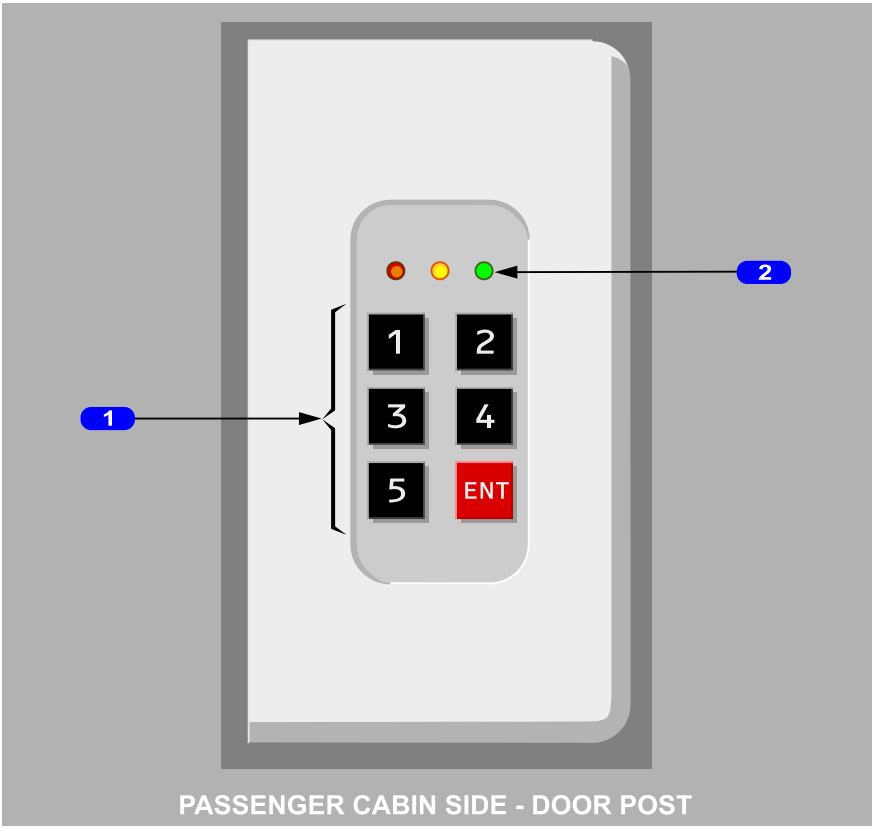
6 Decompression Latch Instruction Placard

Depicts decompression latch manual operation procedure.

7 Decompression Latch Override

Allows the flight crew to manually open the decompression panel for egress if the flight deck door is jammed.

Flight Deck Access Keypad



1 Keypad

Push—

- enter the 3 to 8 digit emergency access code followed by the ENT key. Entry of the correct emergency access code initiates the EICAS warning message FD DOOR AUTO UNLOCK, and illuminates the amber light on the keypad
- enter 1 then the ENT key to activate the optional doorbell function. A hi-low chime and EICAS COMM message FD DOOR CALL are initiated.

2 Access Indicator Lights

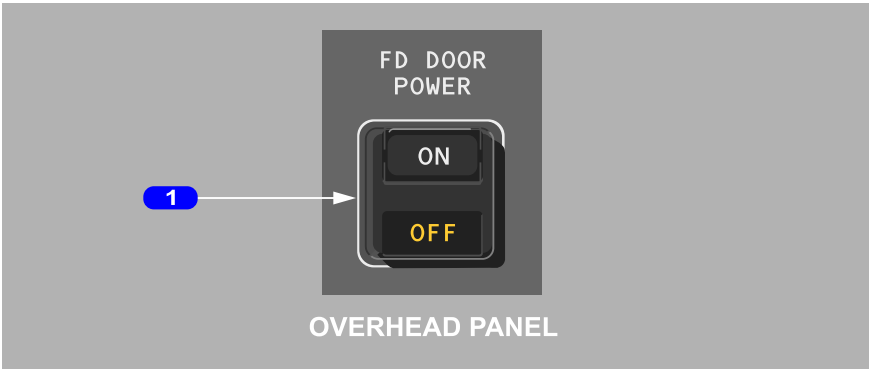
Illuminated (red)—door lock is powered and commanded locked.

Illuminated (amber)—correct emergency access code has been entered.

Illuminated (green)—door is commanded unlocked.

Note: Access indicator lights are in a dormant state until the first keystroke is made. Once active, they return to the dormant state 3 minutes after last keystroke.

Flight Deck Door Power Switch

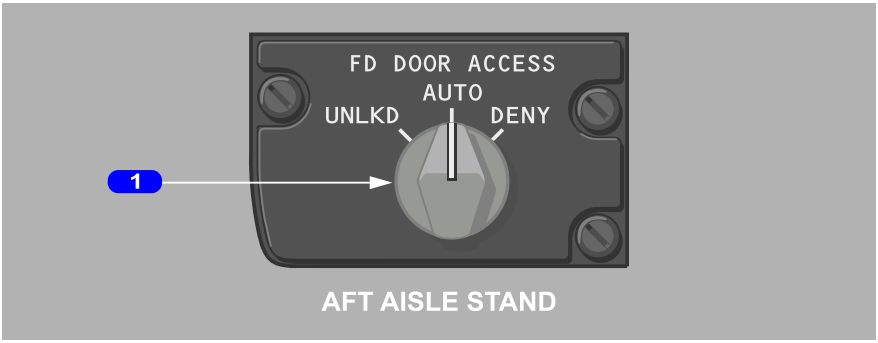


1 Flight Deck (FD) DOOR POWER Switch

ON—door lock is powered. Door is locked when closed.

OFF—removes electrical power from door lock. Door is unlocked.

Flight Deck Door Access Panel



1 Flight Deck (FD) DOOR ACCESS Selector

Spring loaded to AUTO position. Selector must be pushed in to rotate from AUTO to UNLKD. Selector rotates freely from AUTO to DENY.

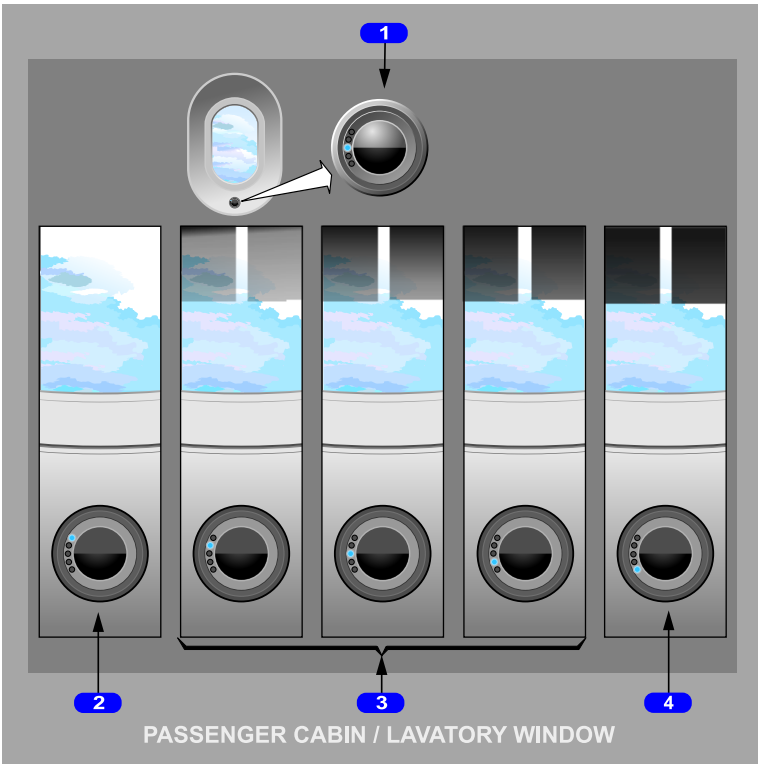
UNLKD—door commanded unlocked while selector is held in this position.

AUTO—door commanded locked when closed. Door unlocks after entry of emergency access code and expiration of timer unless crew selects DENY.

DENY—denies emergency access keypad request. Further access keypad requests are automatically denied for an operator defined time delay.

Note: Allow two seconds between changes in selector position to avoid system faults.

Passenger Cabin Window



1 Window Dimming Control Switch

Individual window dimming is controlled by using this switch. The switch includes five blue indicator LEDs to indicate the level of dimming. Push the upper part to lighten the window. Push the lower part to darken the window. The LEDs may flash when transitioning between dimming levels.

Push—

- first push illuminates the blue LED to indicate the current window dimming state.

- second and subsequent pushes change the dimming state and illuminate the blue LED to indicate the new dimming state.

Individual control switch(es) can be overridden or locked out at the Cabin Attendant Panel.

When the switch is not in use, the LED turns off.

2 Clear

This indicates a clear window (no dimming) has been selected.

Notes: 1. The EDWs could take up to one minute to become fully clear.

2. Windows automatically transition to clear when airplane power is removed.

3 Intermediate Levels

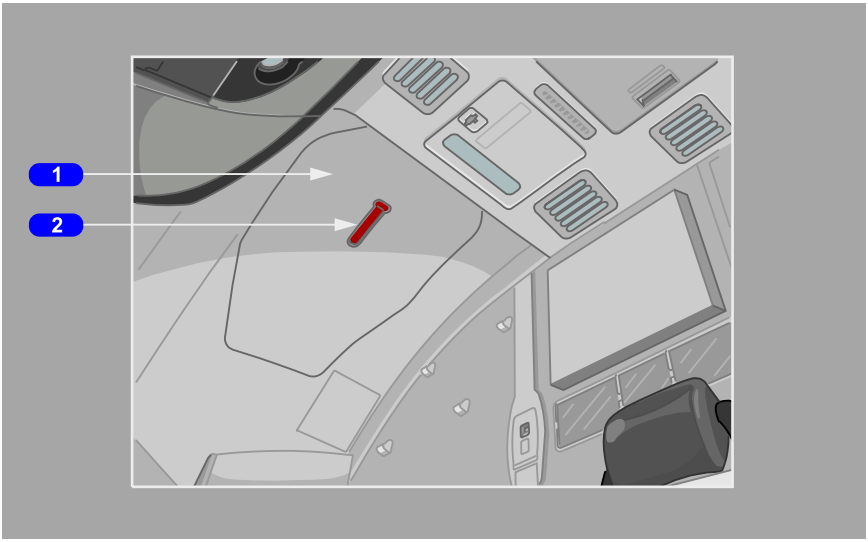
One of these three indications is displayed when an intermediate level (partial dimming) has been selected.

4 Dark

This indicates a dark window (full dimming) has been selected.

Flight Deck Overhead Door and Vent

Flight Deck Overhead Door Cover



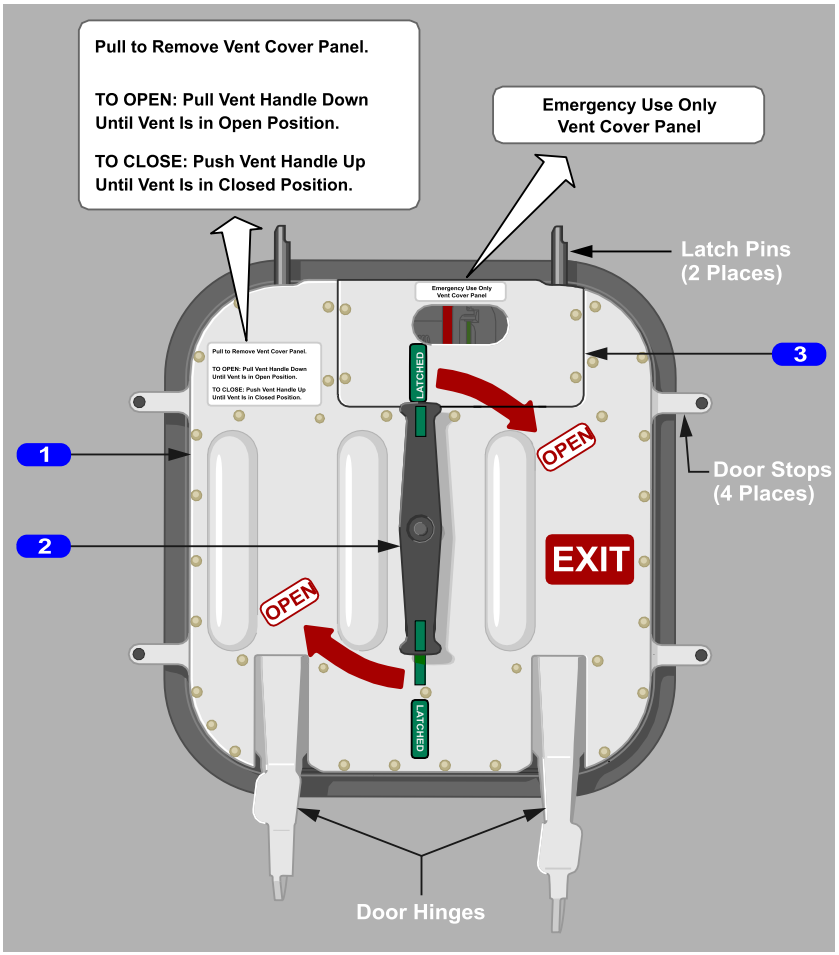
1 Overhead Door Cover

The panel serves only as a cover for the overhead door and vent.

2 Overhead Door Cover Handle

To remove the panel and access the overhead door and vent, pull down on red strap handle.

Flight Deck Overhead Door



1 Overhead Door

The overhead door allows egress from the flight deck should the flight deck door become impassable. (See Flight Deck Overhead Door on page 1.40.21 for additional information.)

2 Overhead Door Handle

To open the door, rotate the handle in the direction of the arrows.

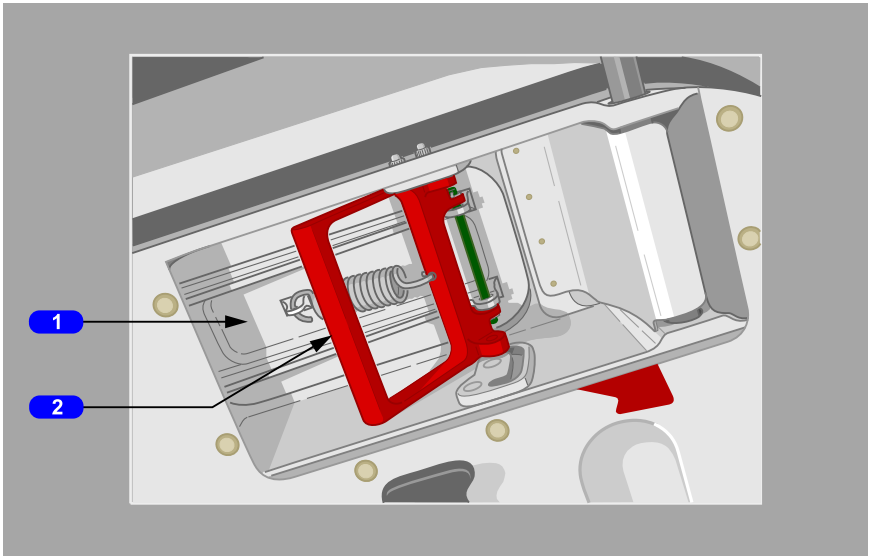
WARNING: The flight deck overhead door is hinged to fall inward when opened. Care should be taken to avoid injury when opening the overhead door.

To close the door, lift the door into position and rotate the handle in the opposite direction of the arrows.

3 Overhead Vent Cover Panel

Pull down to remove vent cover panel.

Flight Deck Overhead Vent



1 Overhead Vent

Allows ventilation of the flight deck in non-normal conditions.

CAUTION: The vent should only be opened if the airplane is depressurized and in association with a non-normal checklist procedure.

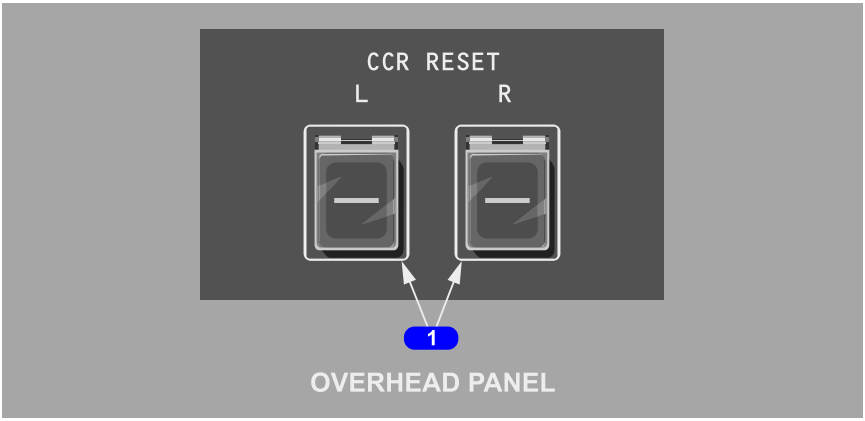
2 Overhead Vent Handle

Pull—opens vent in the inboard direction.

Push—closes vent in the outboard direction.

Motion is controlled by guide tracks. Spring restrains handle, securing the vent in either the open or closed position.

Common Computing Resource (CCR) Reset Switches



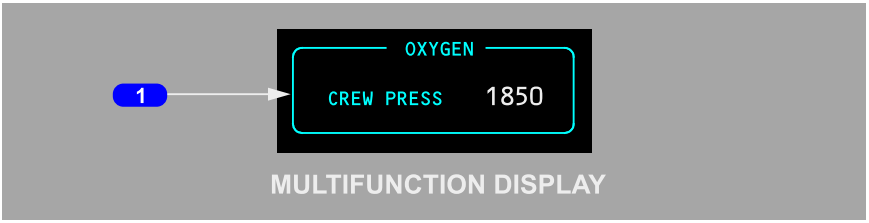
1 CCR RESET Switches

Push—

- temporarily removes all power from the related CCR causing a restart within the associated system
- restart cycle takes approximately 1 minute for the CCR to begin running
- restart attempts to recover a blanking condition of the forward display.

Oxygen Systems

Oxygen Indications

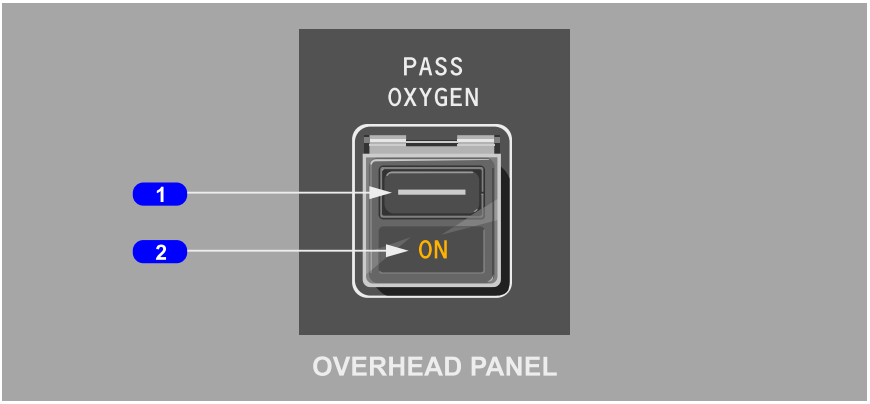


1 Oxygen Pressure Display

Displays crew oxygen cylinder pressure (PSI).

Note: Oxygen indication is displayed by pushing the system (SYS) display switch on the display select panel, and then selecting the status (STAT) synoptic key from the menu page.

Passenger Oxygen Switch



1 Passenger (PASS) OXYGEN Switch

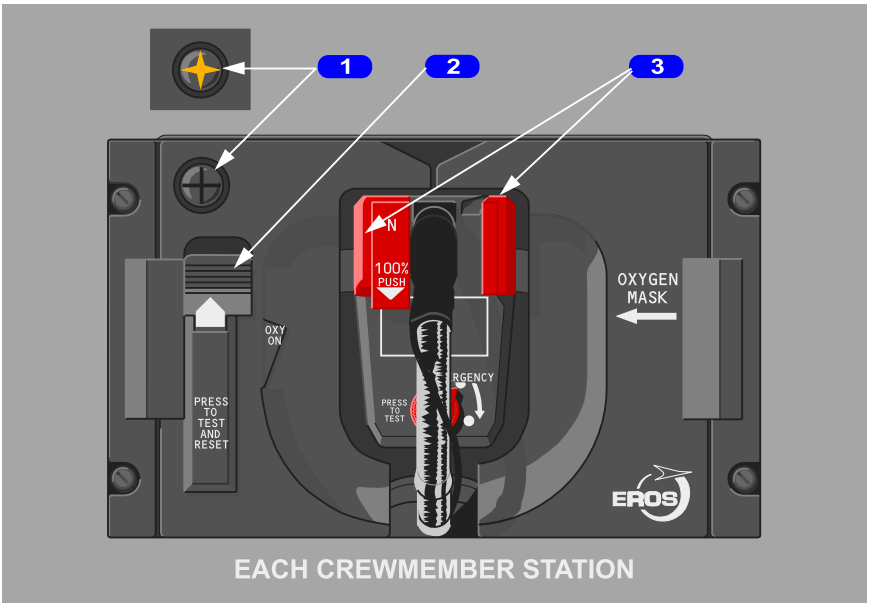
Push—the passenger cabin oxygen masks drop.

2 Passenger Oxygen ON Light

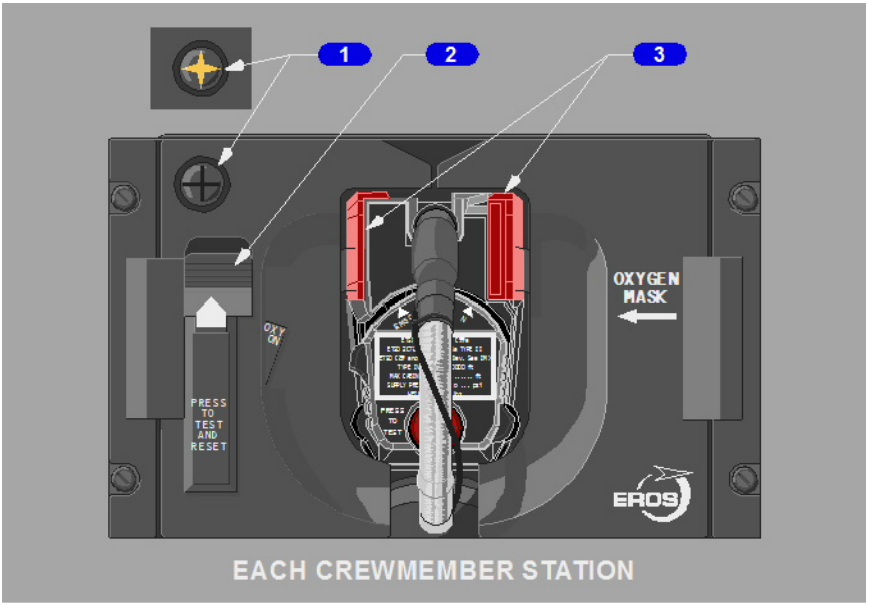
Illuminated (amber)—the passenger oxygen system is operating and the masks have dropped.

Oxygen Mask Panel

TQA to TQF



TWA,B



1 Oxygen Flow Indicator

Shows a yellow cross when oxygen is flowing.

2 RESET/TEST Switch

Push—

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

3 Oxygen Mask Release Levers

Squeeze and pull—

- opens oxygen panel doors and starts the flow of oxygen
- inflates the mask harness
- selects the mask microphone (the boom microphone is deselected).

Squeeze (right lever)—inflates the mask harness.

Release (right lever)—deflates the mask harness into position on back of head.

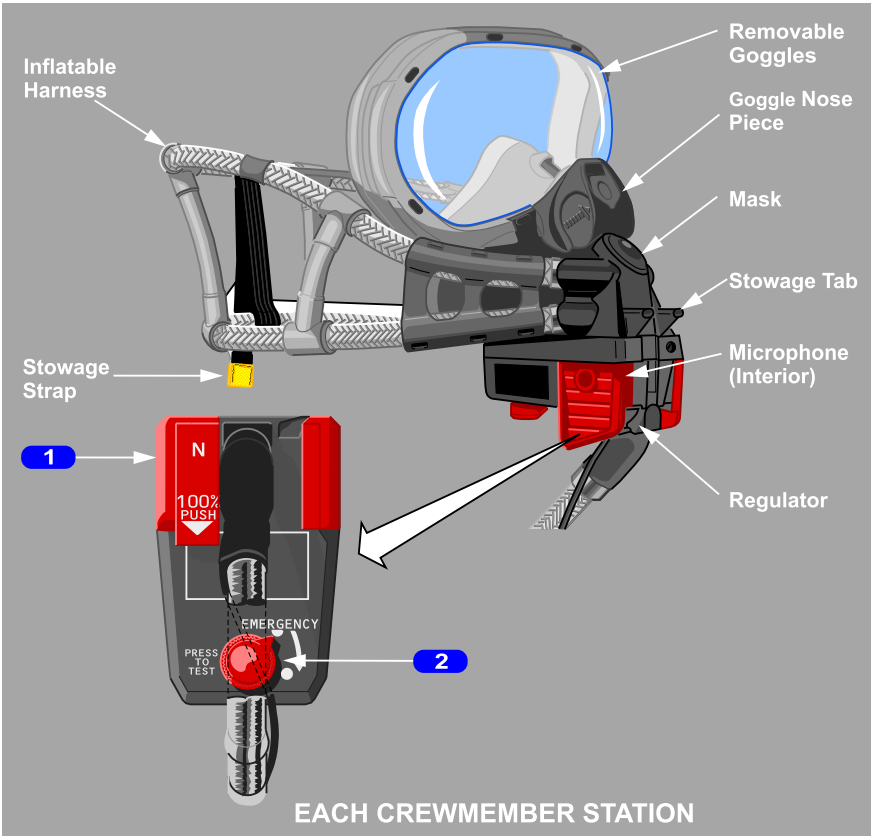
Oxygen Mask and Regulator

TQA to TQF

The oxygen mask has a removable pair of smoke goggles attached just above the regulator. To remove the goggles:

- firmly grasp each side of the goggle clip nose piece
- depress the tabs to unlock the clip mechanism
- pull the goggles away from the mask in an up and forward direction as indicated by the arrow on the goggle nose piece.

TQA to TQF



TQA to TQF

1 NORMAL/100% Switch

N (normal)—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

Normal (non-emergency) position—supplies air/oxygen mixture or 100% oxygen on demand, depending upon the position of the Normal/100% switch. Automatically supplies 100% oxygen under positive pressure when cabin altitude is above a preset value.

EMERGENCY position (rotate in the direction of the arrow)—supplies 100% oxygen under positive pressure at all cabin altitudes (protects against smoke

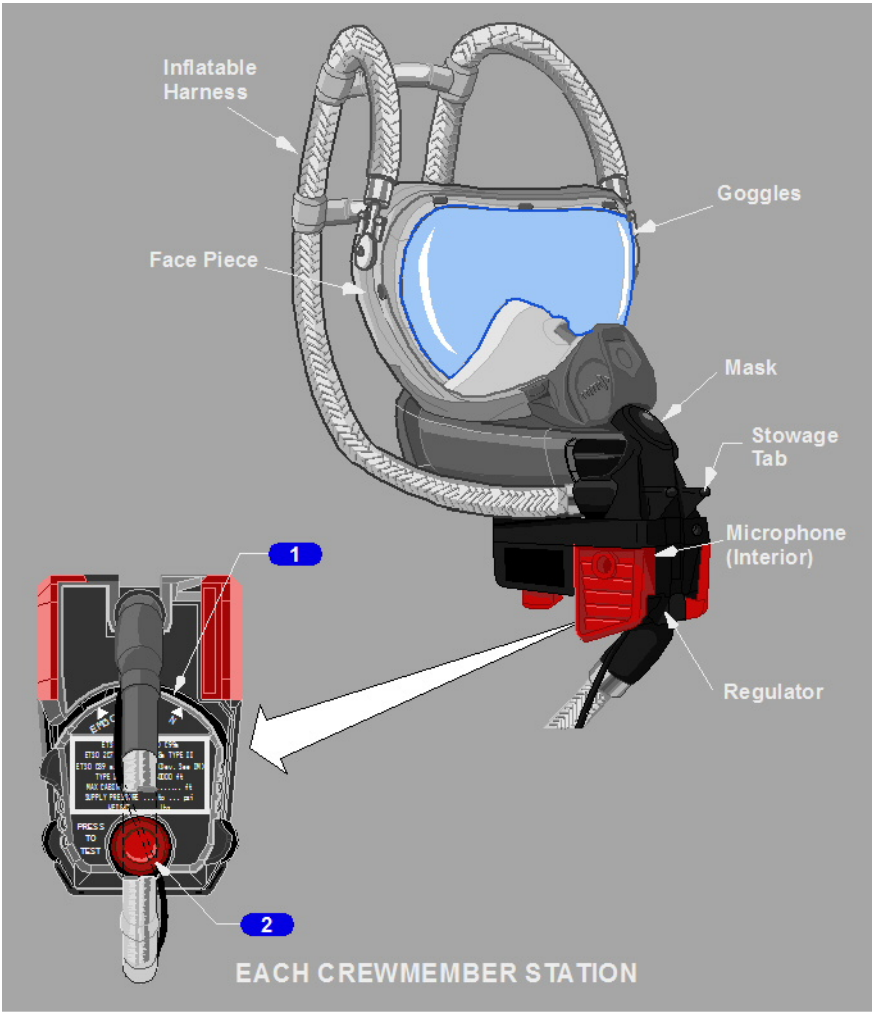
and harmful vapors). Use to purge contaminants from mask and to remove condensation or fogging from interior of mask lens.

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

CAUTION: Use of EMER mode depletes oxygen supply at higher rate than 100% or NORM mode. Use EMER mode only as conditions require.

Note: Communication in EMER mode may be difficult. Switch to 100% or NORM mode if conditions allow.

TWA,B



TWA,B

1 Emergency (EMGCY)/100%/Normal (N) Selector

EMGCY (emergency) – 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.

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

N (normal) – supplies an air/oxygen mixture on demand (the ratio depends on cabin altitude). Automatically supplies 100% oxygen under positive pressure when cabin altitude is above a preset value.

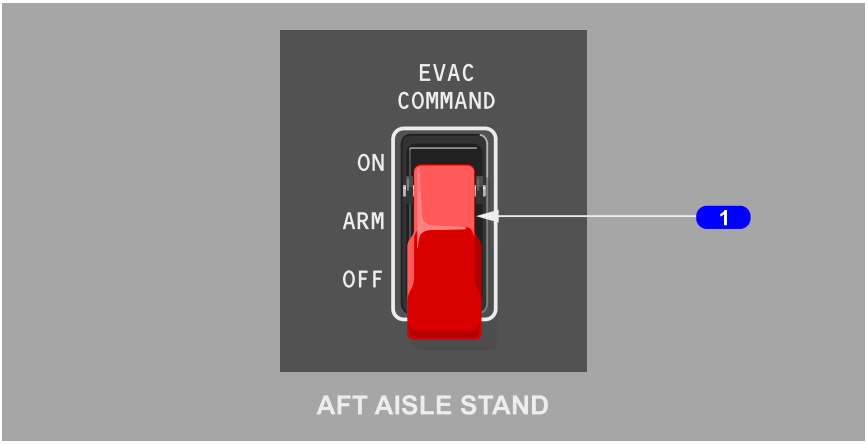
CAUTION: Use of EMGCY mode depletes oxygen supply at higher rate than 100% or N mode. Use EMGCY mode only as conditions require.

Note: Communication in EMGCY mode may be difficult. Switch to 100% or N mode if conditions allow.

2 Oxygen Mask Test Switch

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

Emergency Evacuation



1 Evacuation (EVAC) COMMAND Switch

ON—

- EVAC COMMAND EICAS warning shows on the flight deck
- EVAC lights flash at the designated flight attendant switch panel(s)

- an aural horn sounds in the cabin at all flight attendant locations with evacuation controls.

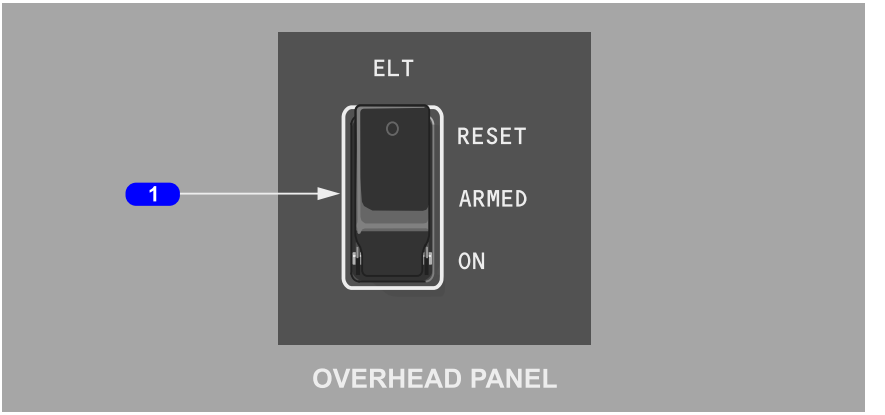
ARM—

- normal operating position
- the evacuation signals can be activated at the designated flight attendant switch panel(s).

OFF—the evacuation command signal is off.

Fuselage Mounted Emergency Locator Transmitter

Emergency Locator Transmitter Control Panel



1 Emergency Locator Transmitter (ELT) Switch

RESET (spring–loaded)—push and hold momentarily (between 1 to 3 seconds):

- stops ELT transmission if transmitting
- starts ELT self–test if not transmitting.

ARMED—ELT starts transmitting if high deceleration is sensed.

ON—ELT transmits continuously.

Introduction

This section describes miscellaneous airplane systems, including:

- Common Core System (CCS)
- lighting systems
- oxygen systems
- doors
- flight deck seats.

Common Core System

The Common Core System (CCS) provides a common computing network and data exchange system for the majority of airplane systems. CCS operation is automatic.

The CCSs main component is the Common Computing Resource (CCR), which has a left and right cabinet. Separate modules within each CCR cabinet perform distinct functions. The CCRs can isolate most faults, allowing the cabinet to continue operation.

There are no CCS controls or indications for normal operations. In the event a CCR fault occurs resulting in the loss of displays, a CCR reset procedure can be found in the unannunciated non-normal checklist: LOSS OF ALL DISPLAYS. Two (L, R) CCR RESET switches are located on the overhead panel for use during this procedure.

CCS Start-Up

The left CCR always starts-up first. When a power source other than the battery is available to close the electronic circuit breakers (ECB), the right CCR start-up cycle is enabled.

Battery power start-up sequence:

- the BATTERY switch is pushed and the left CCR start-up cycle begins (approximately 2-3 minutes in duration)
- the left CCR is on-line when the captain’s inboard and lower display unit show the default format (CDU pages)
- the right CCR will not begin the start-up cycle until the left CCR completes start-up and a power source other than the battery (APU or external power) is available.

External power start-up sequence:

- when external power becomes available (AVAIL is displayed on either forward EXT PWR switch), left CCR begins a start-up cycle (approximately 2-3 minutes in duration) followed by the right CCR
- both CCRs are on-line when all displays and the HUD combiners show their default format.

Lighting Systems

Lighting systems described in this chapter include:

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

Exterior Lighting

Exterior lighting consists of these lights:

- landing
- runway turnoff
- taxi
- strobe
- beacon
- navigation (position)
- logo
- wing leading edge illumination
- exterior passenger door viewing lights.

Landing Lights

The landing lights consist of the left, right, and nose gear landing lights. The left and right landing lights are located in the left and right wing root. These lights are optimized for flare and ground roll. The two nose gear landing lights are optimized for approach. The nose gear landing lights are inhibited when the nose landing gear is not down and locked.

Runway Turnoff Lights

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

Taxi Lights

Taxi lights are installed on the non–steerable portion of the nose strut. To add lighting during ground roll, the two taxi lights are also illuminated when the nose gear landing lights are selected ON. They are inoperative when the nose landing gear is not down and locked.

Strobe Lights

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

Beacon Lights

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

Navigation Lights

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

Logo Lights

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

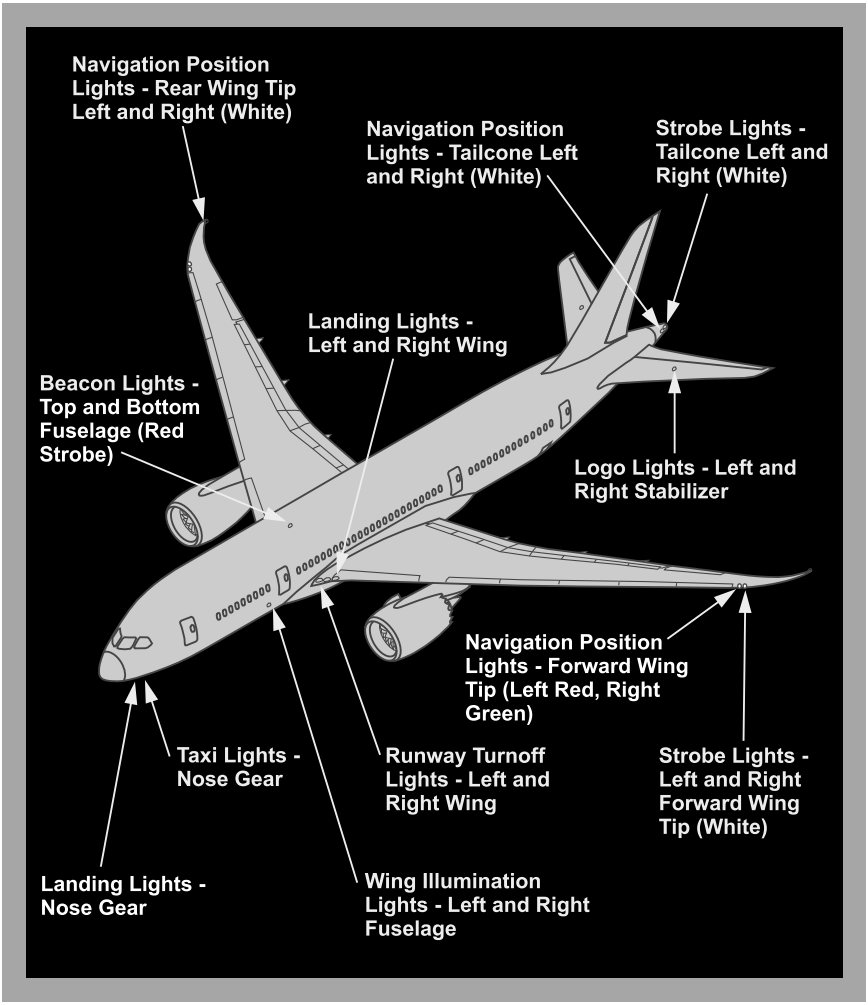
Wing Leading Edge Illumination

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

Exterior Passenger Door Viewing Lights

Exterior passenger door viewing lights are part of the emergency lighting system and located aft of each passenger door to illuminate the emergency exit slide landing area prior to opening of the door. (See Exterior Emergency Lighting on page 1.40.8 for additional information.)

Exterior Lighting Locations



Flight Deck Lighting

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

Panel and flood lights illuminate the forward panels, glareshield and aisle stand panels. When the storm light switch is ON, the left and right forward panel flood

lights, glare shield flood lights, aisle stand flood light, and forward dome lights all illuminate to a bright intensity, and all annunciator lights illuminate at full brightness.

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

Master Brightness Control System

The MASTER BRIGHTNESS control provides the means of controlling panel and display lighting brightness with the use of one control. The control is turned on when the MASTER BRIGHTNESS switch is pushed on.

Lighting controlled through the master brightness system are:

- display units
- ISFD
- digital displays
- overhead panel
- glareshield panels
- forward panels (left, center, and right)
- aisle stand panels (forward and aft)
- side panels (left and right).

The individual lighting controls for the above displays and panels have a center detent position identified by a white dot at the middle adjustment position, and physical stops at the minimum and maximum levels.

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

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

Passenger Cabin Lighting

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

Passenger Cabin Signs

The fasten seat belt signs are controlled by an overhead panel selector. The signs automatically illuminate when the SEAT BELTS switch is in the AUTO position and:

- landing gear not up and locked, or
- flap lever at 5 or greater, or
- airplane altitude below an airline defined altitude, or
- cabin altitude above 10,000 feet, or
- passenger oxygen on.

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

Return to seat signs are illuminated with the fasten seat belt signs, except when oxygen is deployed.

When the fasten seat belt signs illuminate or extinguish, a low tone sounds over the PA system.

No smoking signs are not electrically illuminated. No smoking placards are installed throughout the airplane.

Emergency Lighting

The emergency lighting system is powered by remote batteries. Battery charge is maintained by the airplane electrical system. A fully charged battery provides at least 10 minutes of operation.

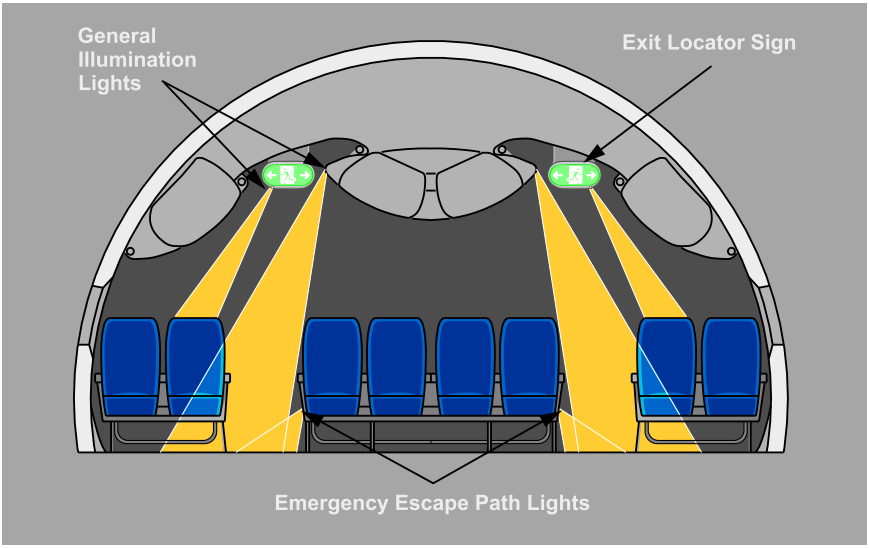
Emergency lighting is controlled by the emergency lights (EMER LIGHTS) switch on the overhead panel. The switch can be used to manually activate or arm the system for automatic operation. The system monitors airplane power and automatic operation occurs when required power fails or is turned off with the system armed.

The emergency lighting system can also be activated by the EMER LIGHTS switch on the master attendant switch panel at door 1L.

The EICAS advisory message EMER LIGHTS is displayed when:

- the emergency lights switch is not in the ARMED position, or
- the emergency lights are on.

Interior Emergency Lighting



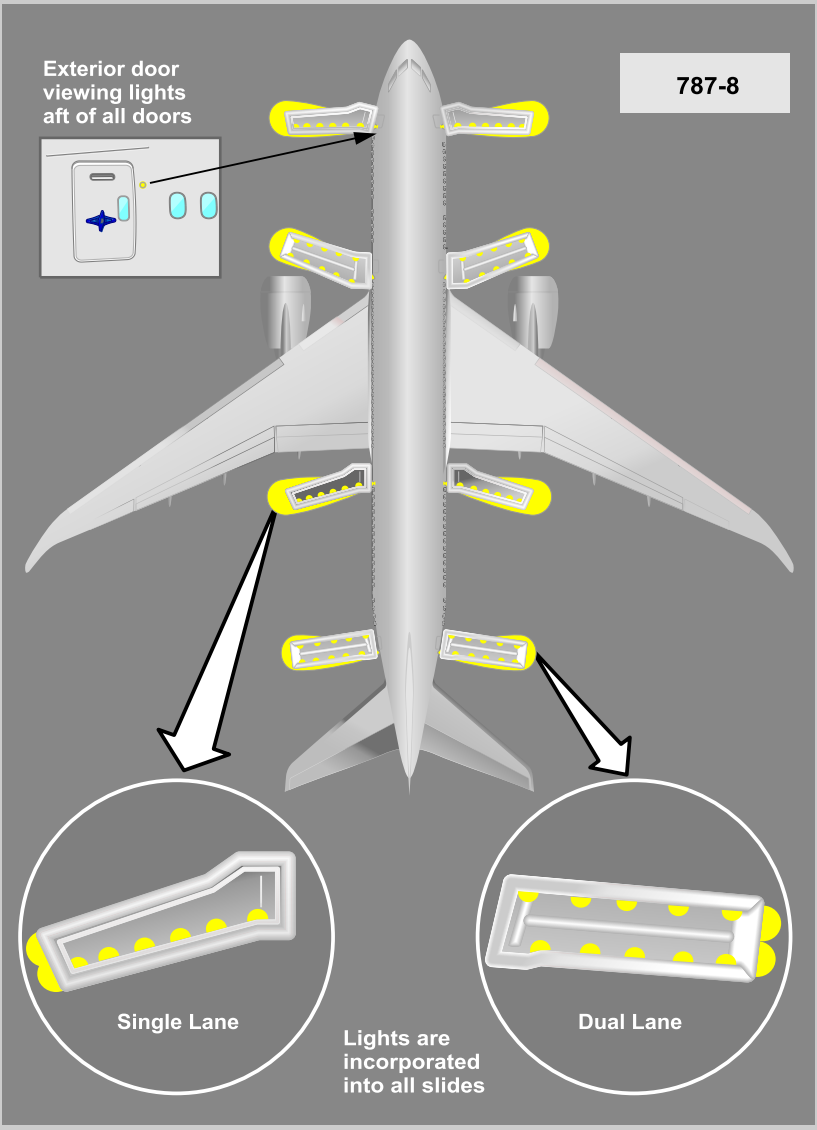
Interior emergency lighting consists of door, aisle, cross-aisle, escape path, exit lights, and luminous exit signs.

General illumination emergency lights are installed on centerline stowage bins or ceiling panels and integrated into the exit locator signs to provide required illumination in aisles and exit areas. They are also integrated into exit marking and exit identifier signs to provide illumination on the exit door, handle and instructions and the floor of the exit aisle.

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

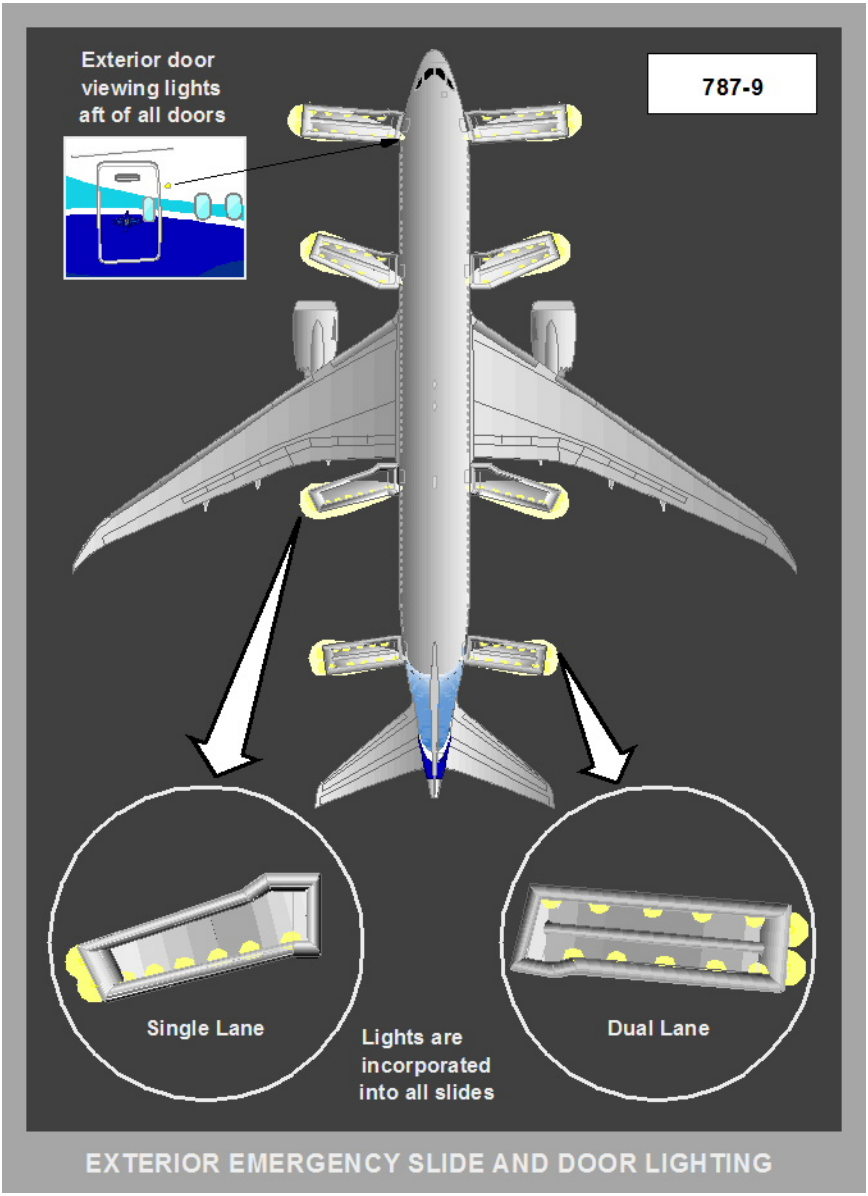
Exterior Emergency Lighting

TQA to TQF



EXTERIOR EMERGENCY SLIDE AND DOOR LIGHTING

TWA,B



EXTERIOR EMERGENCY SLIDE AND DOOR LIGHTING

Exterior emergency lighting consists of integrated escape slide lighting. Each slide has several lights built into the sliding lane and at the base near the landing

area. When the slide is deployed, the lights turn on automatically to illuminate the slide and the landing area.

Lights are located aft of each passenger door to illuminate the area at the base of the escape slides. Lights are controlled by the emergency lights (EMER LIGHTS) switch on the flight deck overhead panel or the master attendant switch panel at door 1L.

Oxygen Systems

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

Flight Deck Oxygen System

TQA to TQF The flight crew oxygen system uses quick-donning diluter-demand masks located at flight crew and observer stations. 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.

TWA,B The flight crew oxygen system uses quick-donning diluter-demand masks located at flight crew and observer stations. Oxygen flow is controlled by an automatic pressure breathing regulator mounted on each mask.

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, oxygen flows to the mask regulator and the 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.

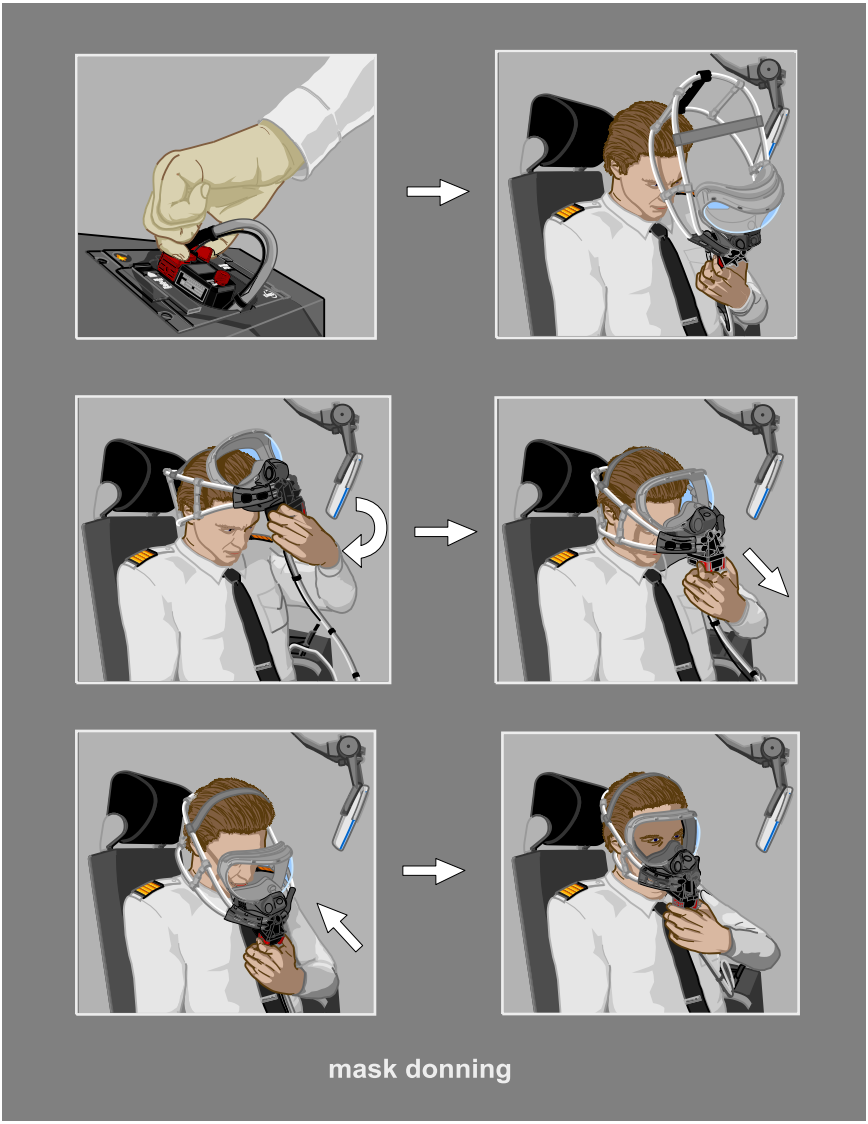
Flight Crew Oxygen Mask Usage Donning Instructions

To don the oxygen mask accomplish the following:

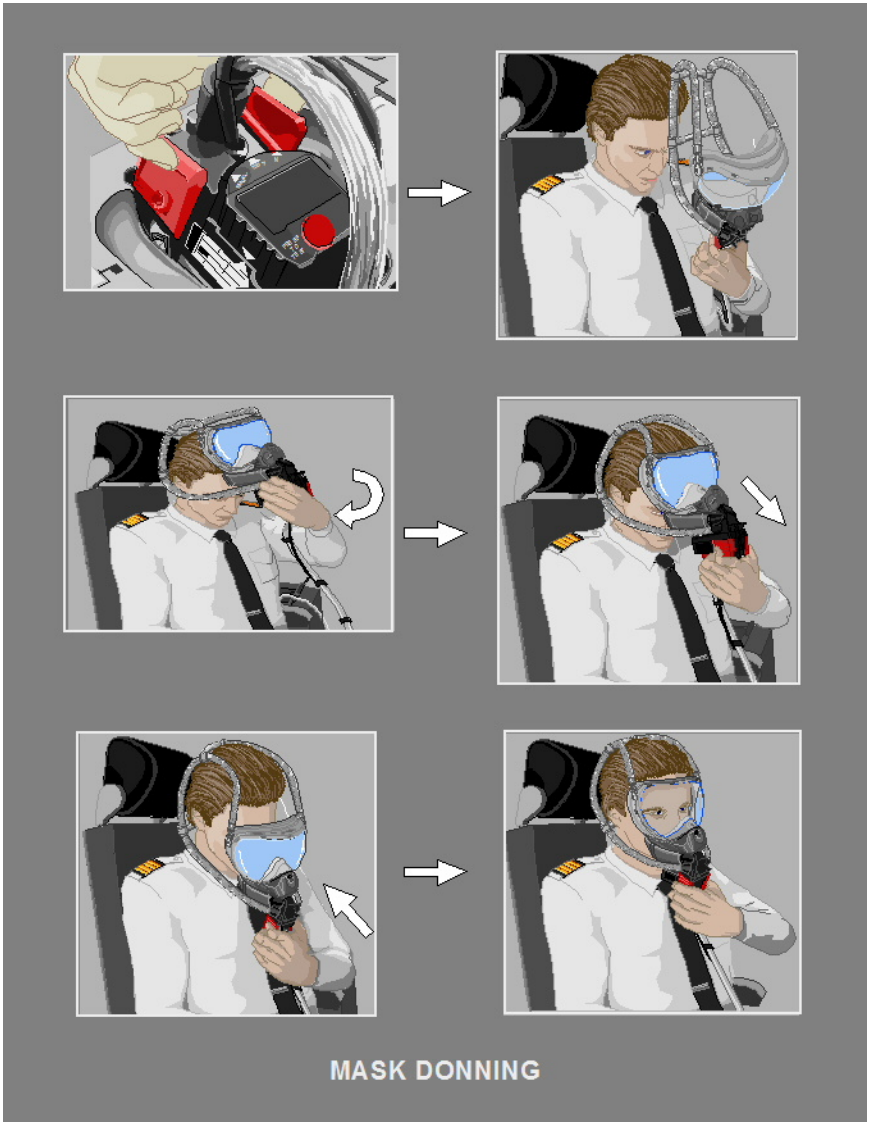
- grasp and squeeze the regulator's red inflation levers to remove the mask from the stowage box

  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 or outboard (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.

TQA to TQF



TWA,B



Stowing Instructions

To stow the oxygen mask accomplish the following:

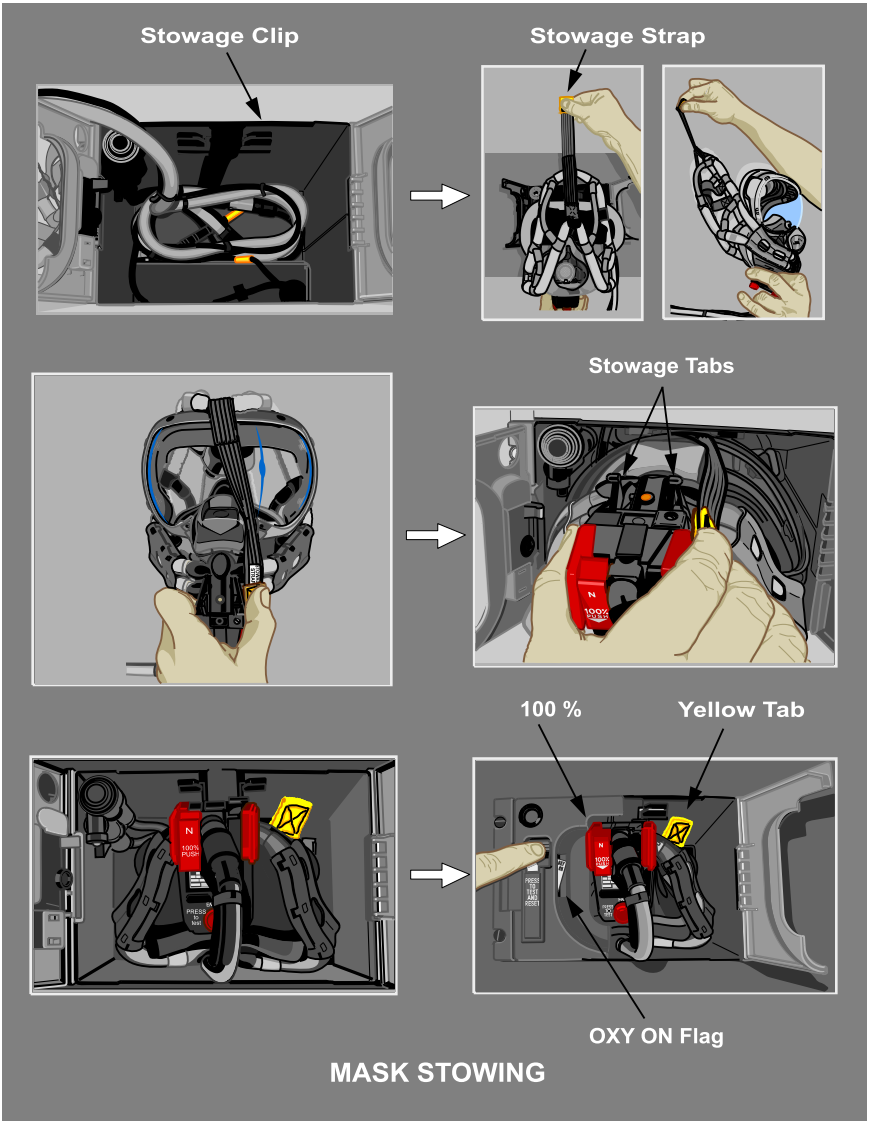
TQA to TQF

- 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

  CAUTION: Take care the mask goggle lens does not contact the valve assembly inside the oxygen box. This can cause damage to equipment.
- 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.



To stow the oxygen mask accomplish the following: TWA,B

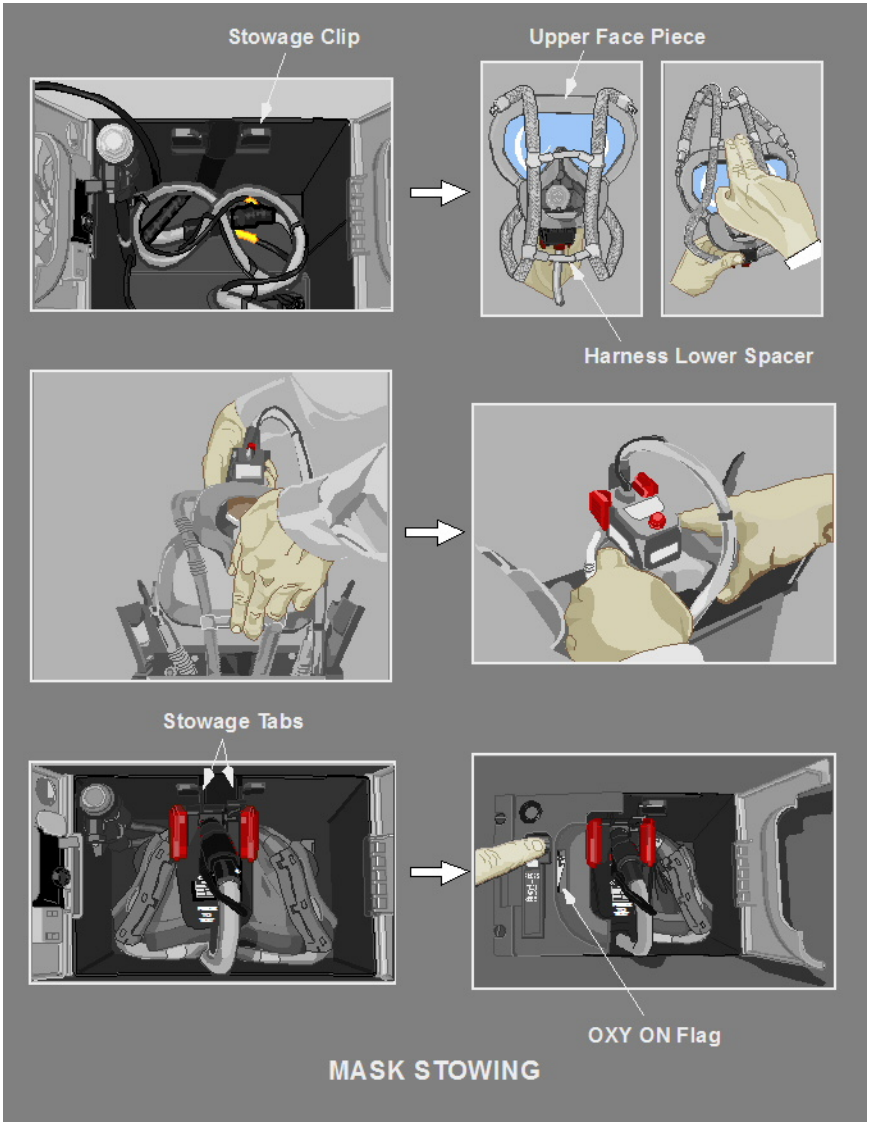
- ensure the harness is completely deflated
- fully extend the supply hose from the stowage box and rotate the mask, as necessary, to ensure the supply hose is not twisted

- rotate the regulator EMGCY/100%/N selector to the 100% position and verify the two arrows are aligned
- coil the supply hose into the bottom of the stowage box in a "figure eight" pattern. DO NOT tangle or twist the supply hose
- hold the mask by the regulator and position the harness lower spacer against the upper face piece

  WARNING: Do not squeeze the red inflation levers during stowing. Doing so will inflate the harness and prevent the correct stowing of the mask.
- insert the harness and upper face piece into the stowage box, then the lower face piece and regulator
- when inserting the mask, keep the harness lower spacer against the upper face piece and avoid trapping the harness inside the face piece or goggles

  CAUTION: Take care the mask goggle lens does not contact the valve assembly inside the oxygen box. This can cause damage to equipment.
- position and maintain the supply hose down the center of the mask
- guide the stowage tabs on the mask regulator down into the stowage box clip stops until the tabs click into place with the regulator fully seated
- close the left-hand door. The OXY ON flag will slide into view at the center of the door
- push, then release, the RESET/TEST switch on the left-hand door. Verify the OXY ON flag disappears when the button is released
- push, then release, the PRESS TO TEST button on the mask regulator to release any residual pressure in the mask supply hose
- close the right-hand door, ensuring not to pinch the hose.

TWA,B



Crew Oxygen Mask Microphone Test

The oxygen mask microphone can be tested without removing it from the stowage box using the following procedure:

- select the FLIGHT interphone transmitter and set the speaker volume as desired

- push and hold a MIC switch on either the audio control panel or the glare shield
- push both the oxygen mask TEST button and the stowage box TEST AND RESET switch.

The sound of oxygen flowing is heard through the speaker, verifying microphone operation.

Passenger Cabin Oxygen System

The passenger cabin system provides oxygen to the main seating area, galleys, flight attendant stations, overhead crew rest areas, and lavatories.

The passenger cabin oxygen system is supplied by gaseous oxygen stored in small high pressure cylinders. The passenger and flight attendant oxygen masks and gaseous oxygen cylinders are located throughout the cabin in passenger service units (PSUs) fitted to the ceiling panels.

For each mask, normal breathing initiates the oxygen flow. The system regulates the pressure and distributes oxygen to the masks by providing small pulses of oxygen to the user during inhalation. The pulse duration is dependent on cabin altitude, longer pulses at higher altitudes and shorter ones at lower altitudes. The oxygen cylinders are single use devices and once activated, provides oxygen until the cylinder is depleted.

Oxygen is available for approximately 22 minutes.

Note: The pulse delivery system provides supplemental oxygen for longer durations at lower altitudes and a shorter duration at higher altitudes. Time above is based on a typical descent profile and route.

The masks automatically drop from the PSUs prior to the cabin altitude reaching the greater of:

- 14,500 feet, or
- origin airfield altitude +1,500 feet, or
- destination airfield altitude +1,500 feet.

The passenger cabin masks can be manually deployed from the flight deck by pushing the PASS OXYGEN switch on the overhead panel to the ON position.

Overhead Crew Rest Oxygen System

The overhead crew rest oxygen system is considered part of the passenger cabin oxygen system and its operation is identical.

One oxygen mask is located in the ceiling above each crew rest bunk and the above the seat in the flight crew rest area.

Portable Oxygen Bottles

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

Doors

The airplane has eight passenger cabin entry doors, a flight deck door, and two large cargo doors. It also has a bulk cargo door, an overhead door in the flight deck ceiling, one equipment access door located forward of the nose gear, and two electrical and electronic (E/E) equipment access doors, one aft of the nose gear and one aft of the wing box.

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

An EICAS message is displayed when the flight deck door, a passenger cabin door, or large cargo door is not closed, latched, and locked. Likewise, an EICAS message is displayed when the bulk cargo door, overhead flight deck door, or an access door is not closed and latched (there are no locks on these doors).

Flight Deck Door

The flight deck door and aft wall meet requirements for resistance to ballistic penetration and intruder entrance. The door opens into the cabin. A viewing port lens in the door and a security camera system viewable in the EFB allows observation of the cabin area immediately outside the flight deck door.

The door features an inset decompression panel that allows air to vent from the passenger cabin into the flight deck in the event of a rapid decompression in the flight deck. The inset decompression panel is hinged, allowing it to swing open from right to left. The panel uses a mechanical decompression latch that senses the onset of a rapid decompression, thereby allowing it to open. The decompression latch contains features that make it tamper and ballistic resistant from the passenger cabin side. In the event of a passenger cabin decompression, the entire flight deck door is allowed to open permitting flight deck air to vent into the passenger cabin.

The decompression panel also features an escape mechanism that allows the flight crew to open it if the door becomes jammed. This feature allows for egress from the flight deck to the passenger cabin. The escape mechanism is integrated into the decompression latch allowing the flight crew to manually trigger the latch to open the decompression panel. Instructions for using the latch are placarded on the interior of the flight deck door.

Flight Deck Access Systems

An electronic flight deck access system secures the flight deck door, and provides controls and indications for both the flight deck and passenger cabin sides of the door.

An access keypad with indicator lights is located on the passenger cabin side of the door. A numeric code can be entered on the keypad to gain entry to the flight deck during an emergency, such as pilot incapacitation.

A red light illuminates on the keypad to indicate the door is commanded locked. When the correct emergency access code is entered, an amber light illuminates until access is automatically granted after an operator defined time delay, or is intentionally granted or denied by the flight crew. The red indicator light illuminates again if the flight crew denies the access request, and further keypad access requests are automatically denied for an operator defined time period. A green light illuminates to indicate access is granted and the door is commanded unlocked.

In addition, the keypad can be used to sound a flight deck “doorbell” chime (if enabled by operator) to request access to the flight deck. Pressing the 1 and then ENT keys on keypad sounds a flight deck chime and initiates the EICAS COMM message FD DOOR CALL. The door remains locked unless the flight crew grants access.

Note: The keypad indicator lights are in a dormant state until the first keystroke is made. Once active, they return to the dormant state 3 minutes after the last keystroke.

Access controls and indications in the flight deck include a flight deck door power (FD DOOR POWER) switch on the overhead panel, a three position (UNLKD, AUTO, DENY) flight deck door access (FD DOOR ACCESS) selector on the aisle stand, and EICAS alerting. The door access selector is spring-loaded to the AUTO position. With the power switch ON and the access selector in AUTO, the door is commanded locked while closed. With the power switch OFF or the access selector held in the UNLKD position, the door is unlocked.

Activation of the EICAS warning message FD DOOR AUTO UNLOCK indicates the correct emergency access code has been entered on the passenger cabin keypad. If no flight crew action is taken, access is automatically granted after an operator defined time delay. Using the door access selector, access can be immediately granted by selecting UNLKD. Selecting the DENY position denies access, and further keypad access requests are automatically denied for an operator specified time period. The door can be manually opened from the flight deck at any time by turning the door handle.

The electronic flight deck access system incorporates a check to verify the flight deck door is properly closed and locked. Activation of the EICAS advisory message FD DOOR OPEN indicates the door lock pin is extended while the door sensor is indicating the door is open. The EICAS advisory message FD DOOR

LOCK FAIL indicates the door lock has failed or the door power switch is in the OFF position.

Deadbolt Lock

The flight deck door also incorporates a keyed mechanical deadbolt system used to secure the flight deck when power is not available to the electronic locking system. There is a placard on the door that states “FOR GROUND USE ONLY", and depicts the selectable positions of the deadbolt.

Three positions can be selected from the flight deck by rotating the deadbolt selector:

- UNLOCKED: deadbolt is retracted and does not affect door operation.
- LOCKED-KEY OPERABLE: deadbolt is extended and the door is locked. The door can be unlocked with a key from the passenger cabin.
- LOCKED-KEY INOPERABLE: deadbolt is extended and the door is locked. The door cannot be unlocked with a key from the passenger cabin.

Two positions can be selected from the passenger cabin using a key. These positions are UNLOCKED, and LOCKED-KEY OPERABLE. The position LOCKED-KEY INOPERABLE can only be selected with the deadbolt selector from the flight deck.

Flight Deck Overhead Door

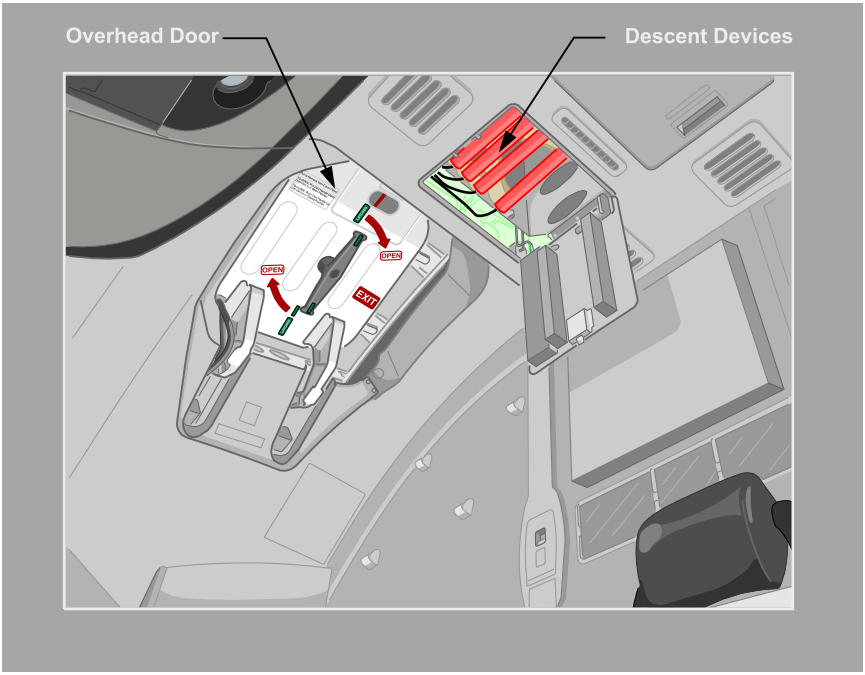
The flight deck overhead door is used for emergency egress using the installed descent devices. The door can only be opened on the ground with the airplane depressurized. (See Flight Deck Overhead Door and Vent on page 1.30.25 for additional information.)

WARNING: The flight deck overhead door is hinged to fall inward when opened. Care should be taken to avoid personal injury when opening the overhead door.

To open the door:

- remove protective cover from overhead door
- rotate the door lock handle to the open position
- the door opens inside the flight deck and hangs from the ceiling on hinges.

The EICAS advisory message DOOR FD OVHD is displayed if the door is not closed and secure.


Overhead Door
Descent Devices
OPEN
OPEN
EXIT

Flight Deck Emergency Egress

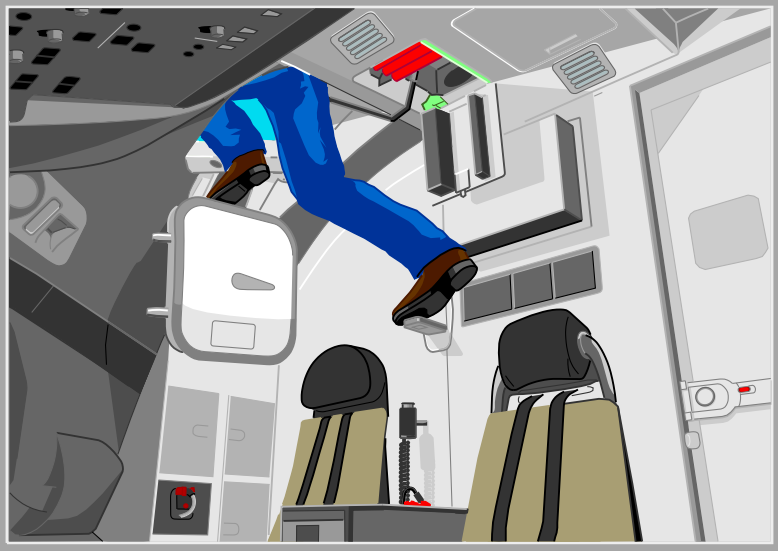


To access the descent devices:

- slide the descent device stowage compartment latch to the open position
- grasp and remove a descent device from the stowage compartment
- descent device handle extends (telescopes) automatically when removed from stowage compartment to allow two handed grasp
- ensure the descent device handle is held securely through all egress steps until safely on the ground.

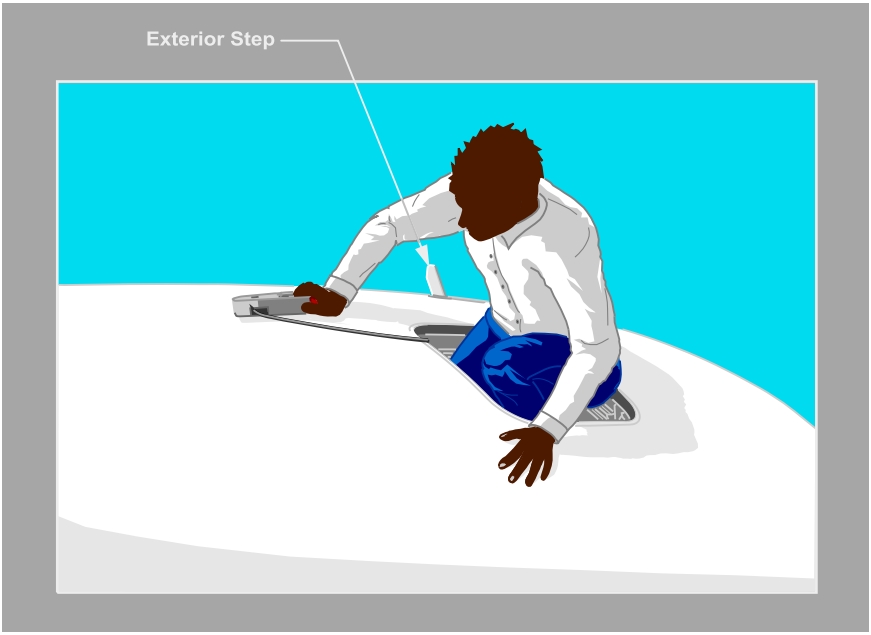
WARNING: Ensure the descent device cable is securely fastened to airplane structure.





To exit the airplane through the overhead door:

- climb out the door using the first observer's seat (right foot), the observer's console (left foot), the fold-down step in the bulkhead (right foot), and the overhead door between the hinged area (left foot/left knee)



To prepare for descent once outside the airplane:

- check descent area for hazards
- if hazards exists on the right side of airplane, use exterior step to escape to the left side of airplane
- grasp descent device handle firmly with both hands before descending.

Passenger Entry Doors

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

The entry doors are translating, plug–type doors. During opening, the door first moves inward and upward, then translates outward and forward. Each door is held in the open position by a gust lock. The gust lock drops into a latch as the

door nears its forward limit of travel. A window in each door allows observation outside of the airplane.

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

Flight Lock

Each door handle is automatically locked when groundspeed is greater than 80 knots. The locked door handle has sufficient rotation to partially open the door vent, but prevents complete door opening. Flight locks are unlocked when groundspeed is less than 70 knots, or if electrical power is removed or failed.

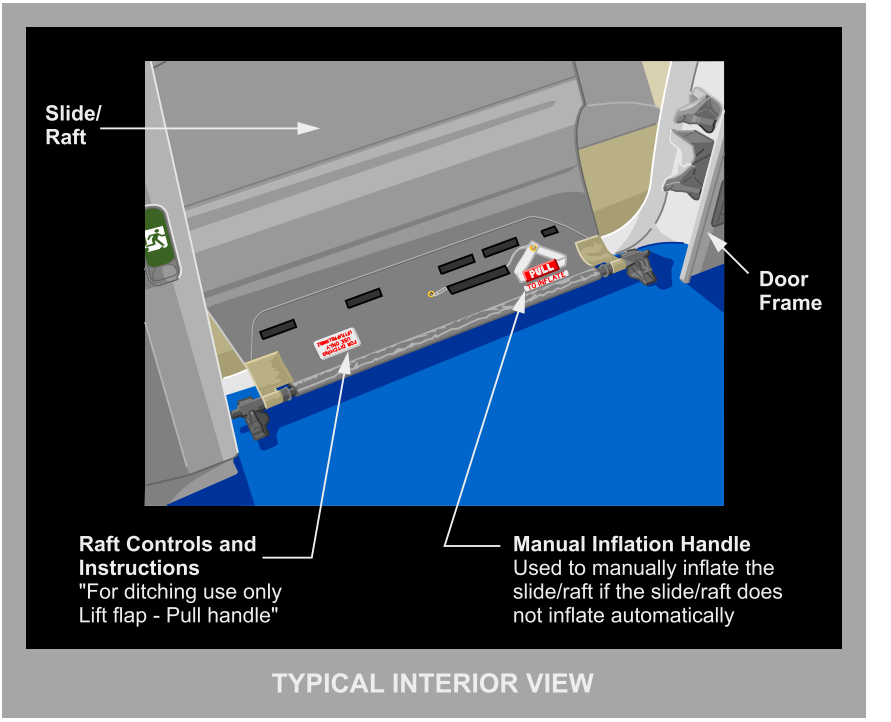
Emergency System Operation

Emergency evacuation slide/raft and pneumatic door opening systems are contained in each passenger entry door. Each door system has enough power to open the door unassisted, even if the airplane is not level due to a landing gear collapse condition. A bustle in the lower face of the door contains the slide/raft.

The pneumatic door opening system is armed when the mode select lever is in the automatic mode. This engages the door girt bar and arms both the slide/raft and the pneumatic door opening systems. Once armed, moving the interior door handle to the open position operates the pneumatic opening actuator. The actuator drives the door open and the slide/raft automatically deploys and inflates.

The pneumatic door opening system and the slide/raft are automatically disarmed when the door is opened from the outside. If the mode select lever is in the automatic mode and the door is opened using the exterior door handle, the mode select lever automatically moves to the manual mode and the door opens without slide/raft deployment.

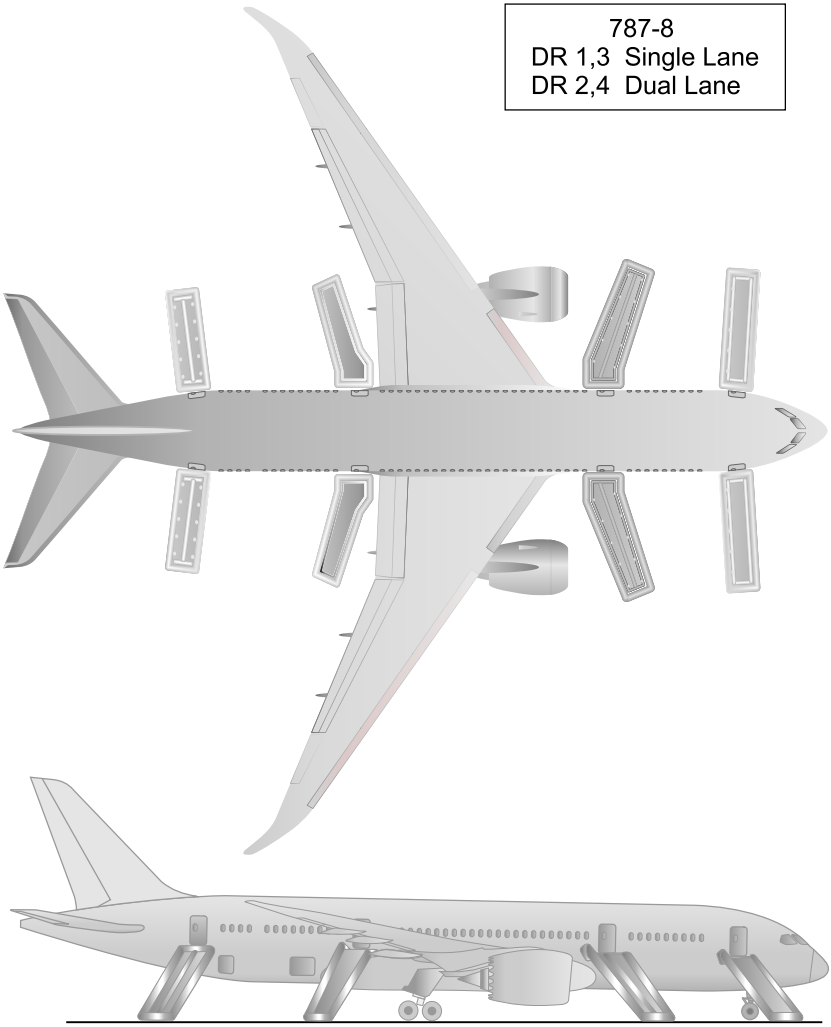
Slide/Raft Deployed



TYPICAL INTERIOR VIEW

Evacuation Slides/Rafts

TQA to TQF



TWA,B



Cargo Doors

There are three cargo doors; one forward, one aft, and one bulk. The large forward and aft cargo doors are located on the right side of the airplane and each opens up and outside the airplane. The smaller bulk cargo door is on the left side of the airplane and opens up and into the cargo area.

Both forward and aft cargo doors are normally operated electrically from an exterior fuselage mounted control panel located near each door. If necessary, the forward and aft cargo doors may be operated manually. Opening the doors does not turn off cargo area heating, ventilation, or fire detection. The doors are locked by closing an external lock handle.

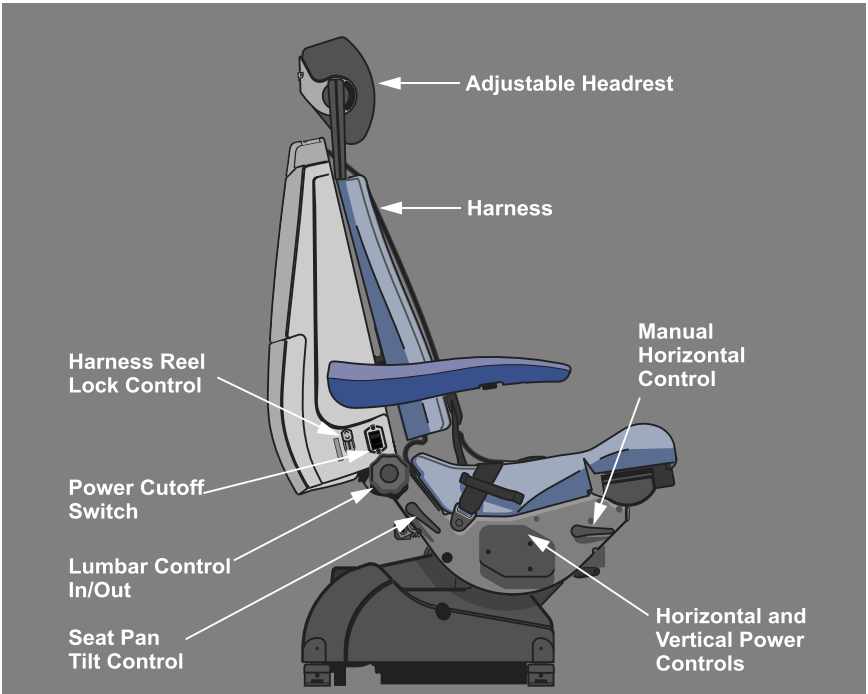
The bulk cargo door is operated manually using an external handle and is counterbalanced for ease of operation. Opening the door does not turn off cargo area heating, ventilation, or fire detection.

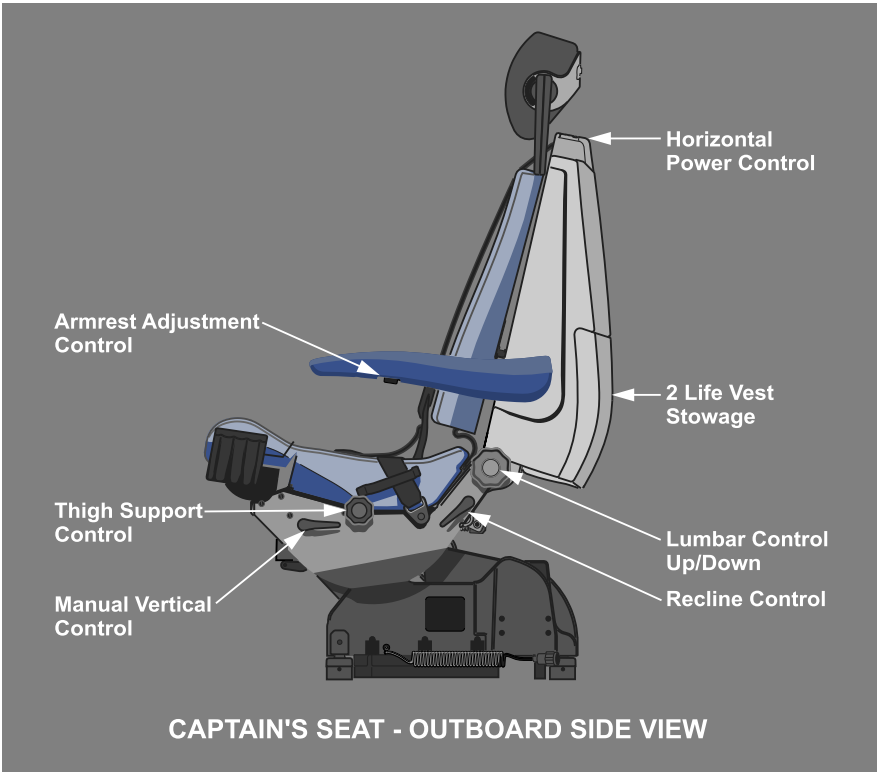
Flight Deck Seats

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 lumbar support
- adjust for seat pan tilt angle.

WARNING: Seat pan tilt must be rotated fully FWD except during cruise.

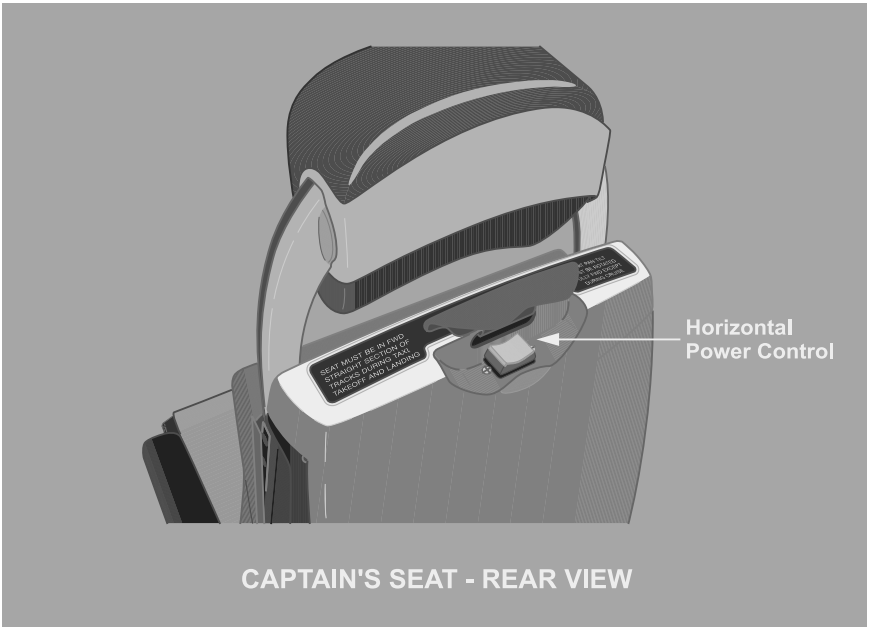
The seats also have:

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

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

WARNING: Seat must be in FWD straight section of tracks during taxi, takeoff and landing.

WARNING: When manually adjusting the vertical seat position, pilots should use their legs and/or the overhead hand-hold to unload their weight from the seat prior to releasing the manual lever. A weighted seat may rapidly fall to the full down position upon lever release and may result in personal injury.

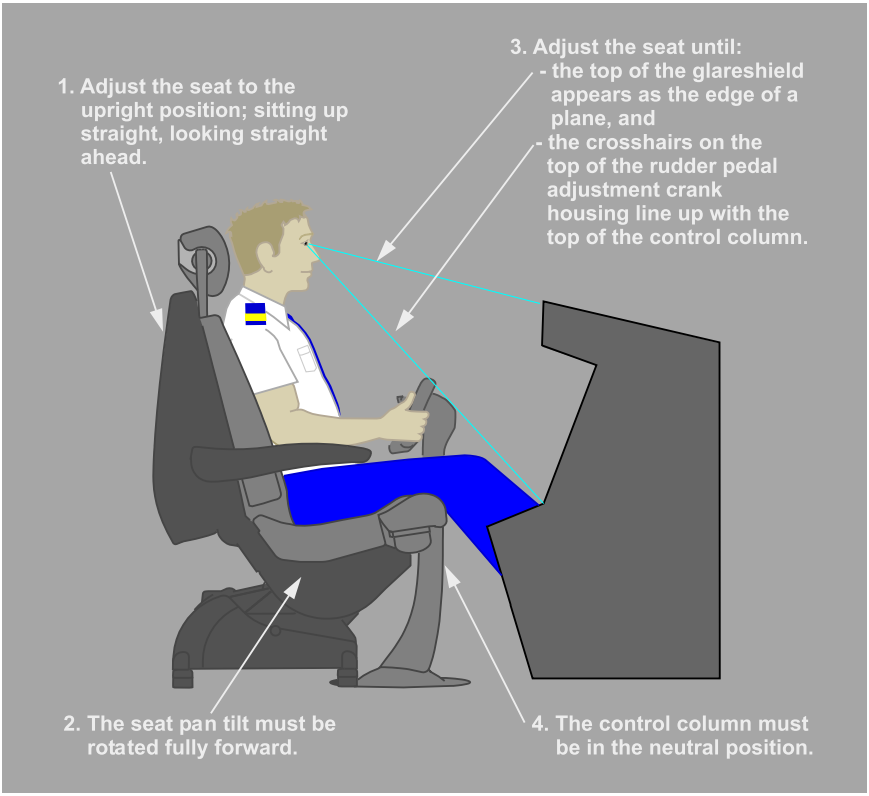


A secondary horizontal (fore/aft) power control is located in the upper seat back near the headrest (guarded by a cover) for easier horizontal seat movement when not seated.

Manual levers provide other adjustments. Lumbar and thigh pad support can be adjusted using the control wheels. Armrest pitch can be adjusted using the control knob under the armrest. The armrests can be stowed vertically for easier seat access. Headrest angle can be adjusted by moving the cushion to the right and rotating it.

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

Pilot Seat Adjustment



Observer Seats

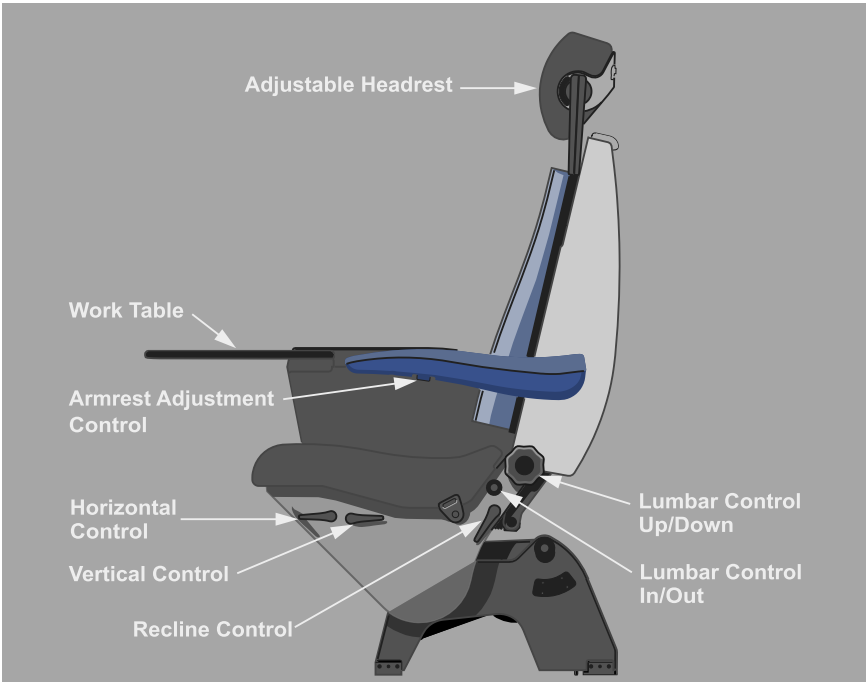
The first observer seat is track mounted. The seat:

- adjusts vertically
- adjusts forward and aft
- reclines
- adjusts for lumbar support.

The seat also has:

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

The lumbar support can be adjusted using the manual control wheel and the push-button on the left side of the seat. The left side armrest pitch can be adjusted using the control knob under the armrest and can be stowed vertically for easier seat access. The headrest angle can be adjusted by moving the cushion to the right and rotating it.



FIRST OBSERVER'S SEAT - PORT SIDE VIEW

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

- crotch strap
- inertial reel shoulder harness
- lap belt
- folding seat cushion access to under seat stowage.

Flight Deck Personal Electronic Device (PED) Power

Three 110-V AC, Personal Electronic Device (PED) power outlets are located on the flight deck. There is one each on the left and right aft sidewall panels and a third at the forward base of the observer's seat console. Power to the outlets

is controlled by the IFE/PASS SEATS power switch. Total available power is 250 watts for all outlets and 150 watts maximum at any one outlet.

Note: During hot ground and flight conditions, the quantity of outlets receiving power may be limited to prevent overheating of power components. If power is lost at one outlet, switch to another working outlet until power is restored. When normal temperature conditions return, full power becomes available to all outlets.

Note: PED power outlet indication on the flight deck is disabled to prevent flight crew disorientation.

Introduction

Emergency equipment described in this chapter includes:

- emergency evacuation signal system
- emergency locator transmitters (ELTs)
- emergency descent devices
- fire extinguishers
- flashlights
- portable flight deck emergency equipment locations
- portable passenger cabin emergency equipment locations.

Emergency Evacuation Signal System

The emergency evacuation signal system alerts the flight crew and the flight attendants to evacuate the airplane. Evacuation command switches are located on the flight deck aft aisle stand, and at designated flight attendant switch panels.

Placing the flight deck EVAC COMMAND switch to ON activates the following evacuation signals:

- EVAC COMMAND EICAS warning is displayed on the flight deck
- EVAC lights flash at the designated flight attendant switch panels
- an aural horn sounds in the cabin at all flight attendant locations with evacuation controls.

With the flight deck EVAC COMMAND switch in the ARM position, pressing an EVAC COMMAND switch on a flight attendant switch panel activates the same evacuation signals. The ARM switch position is the normal operating position.

With the flight deck EVAC COMMAND switch in the OFF position, the evacuation command signal is off, and all emergency evacuation panel switches in the cabin are disabled.

Emergency Locator Transmitter (ELT)

Passenger Cabin

ELTs are installed in the passenger cabin, as shown in the Emergency Equipment Locations—Passenger Cabin diagram.

Fuselage Mounted Emergency Locator Transmitter (ELT)

An ELT is mounted to the top of the fuselage in the passenger cabin area.

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

The EICAS alert message ELT ON is displayed if the transmitter is activated. The ELT can be deactivated by placing the ELT switch to RESET momentarily (1 to 3 seconds), then ARMED.

Emergency Descent Devices

Emergency descent devices are used to lower flight deck occupants to the ground during emergency egress through the flight deck overhead door. The devices utilize inertia reels which limit the rate of the occupant's descent. They are attached and stowed in a ceiling compartment near the flight deck overhead door. (See Flight Deck Overhead Door on page 1.40.21 for additional information.)

Fire Extinguishers

Halon and water fire extinguishers are located throughout the passenger cabin. A Halon extinguisher is also located on the flight deck.

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.

Note: The directions for use of the fire extinguisher are printed on the extinguisher.

WARNINGS:

1. **If a Halon bottle or equivalent fire extinguisher is to be discharged on the flight deck, all crewmembers in the flight deck must wear oxygen masks and use 100% oxygen with emergency selected.**
2. **The concentrated agent, and the by-products created by the heat of fire, are toxic. Unprotected exposure to high concentrations of agent or by-products can result in dizziness, difficulty breathing, as well as eye and nose irritation. After discharge of an entire fire extinguisher, it can take up to 7 minutes for the agent to dissipate. Signs of smoke should be clear, and the agent dissipated before removal of oxygen masks or protective breathing equipment.**

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

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.

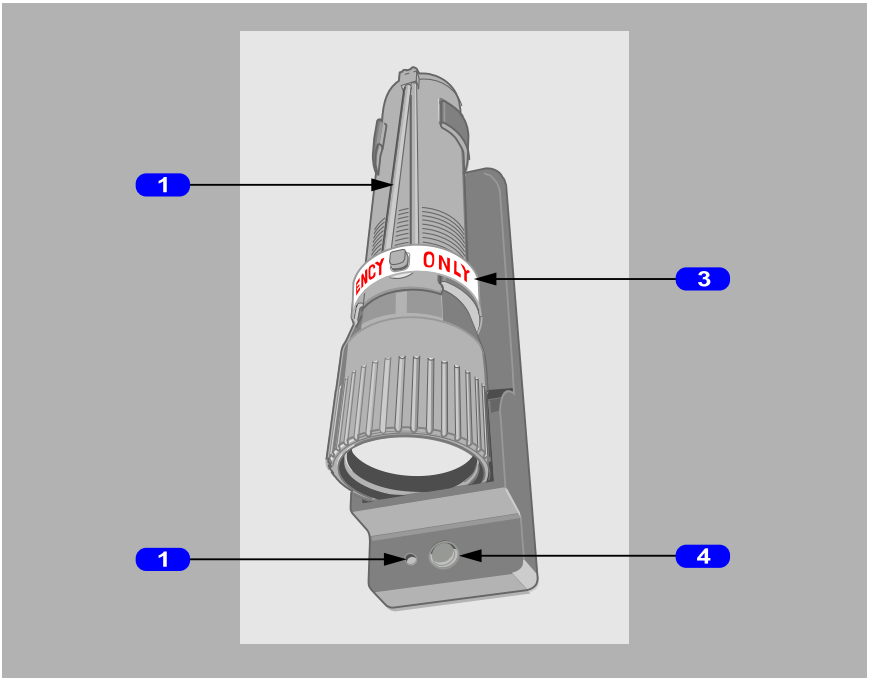
Note: The directions for use of the fire extinguisher are printed on the extinguisher.

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

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

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.

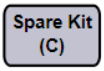
Emergency Equipment Symbols

SYMBOL	DESIGNATION
	Oxygen mask, full-faced
	Descent device
	AED + AED supplementary kit
 In use	Medical kit (in use)
 Spare	Medical kit (spare)
	O2 bottle, 310 liter, with 1 mask
	Universal Precaution Kit (UPK)
	Emergency Locator Transmitter (ELT)
	Emergency flashlight
	Life vest, red

TQA to TQF

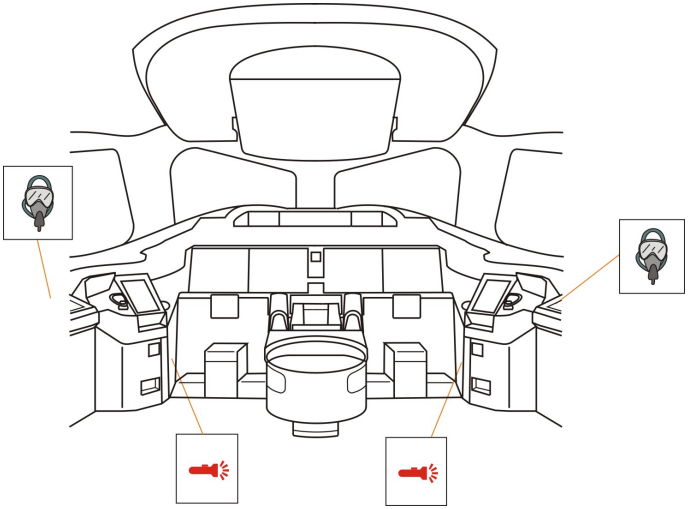
SYMBOL	DESIGNATION
	Megaphone
	First aid kit
	Fire extinguisher, halon
	Protective Breathing Equipment (PBE)
	Axe
	Fire gloves, pair
	Demo kit (1 x life vest, demo + 1 x O2 mask + 1 x demo seatbelt)
	Spare kit (2 x life vest, yellow + 2 x extension belt)
	Infant life vest
	Handcuff with keys, plastic restraints and scissors

TWA,B

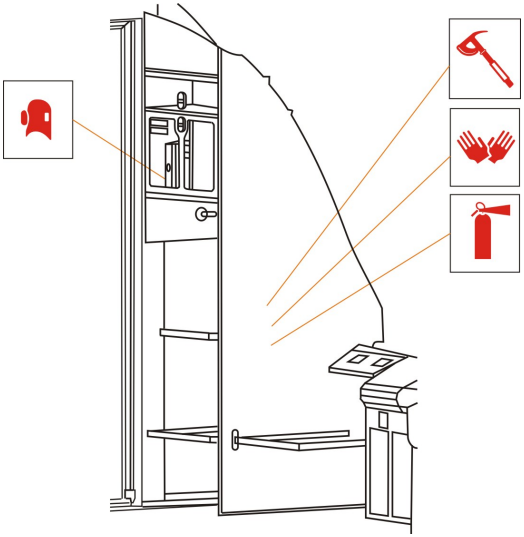
SYMBOL	DESIGNATION
	Megaphone
	First aid kit
	Fire extinguisher, halon
	Protective Breathing Equipment (PBE)
	Axe
	Fire gloves, pair
	Demo kit (1 x life vest, demo + 1 x O2 mask + 1 x demo seatbelt)
	Spare kit (2 x life vest, yellow + 2 x extension belt)
	Spare kit, business class (2 x life vest, yellow + 2 x business class extension belt)
	Infant life vest
	Handcuff with keys, plastic restraints and scissors

Emergency Equipment Locations—Flight Deck

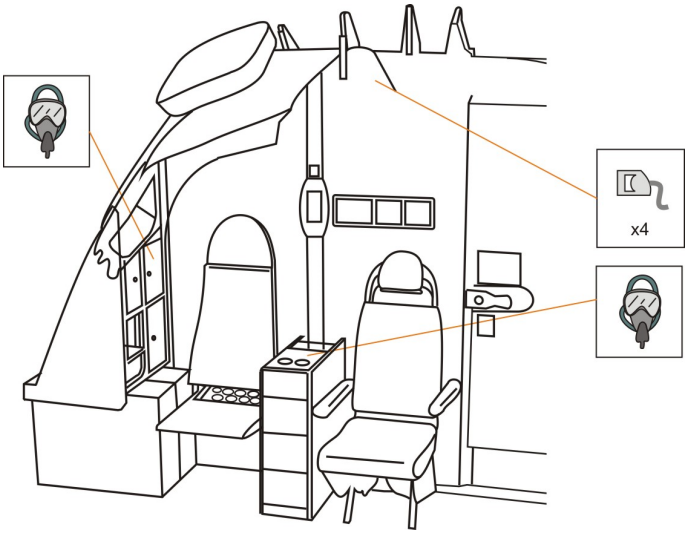
Cockpit-Fwd Area



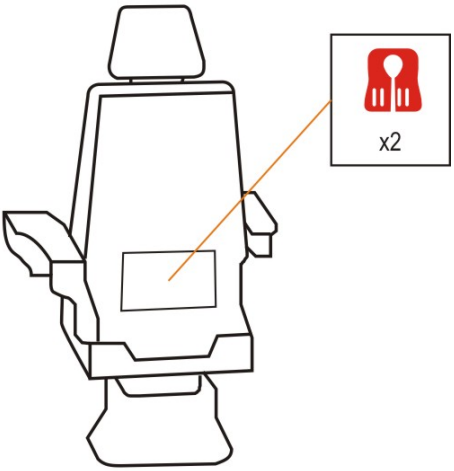
Cockpit-Aft Left Area



Cockpit-Aft Right Area

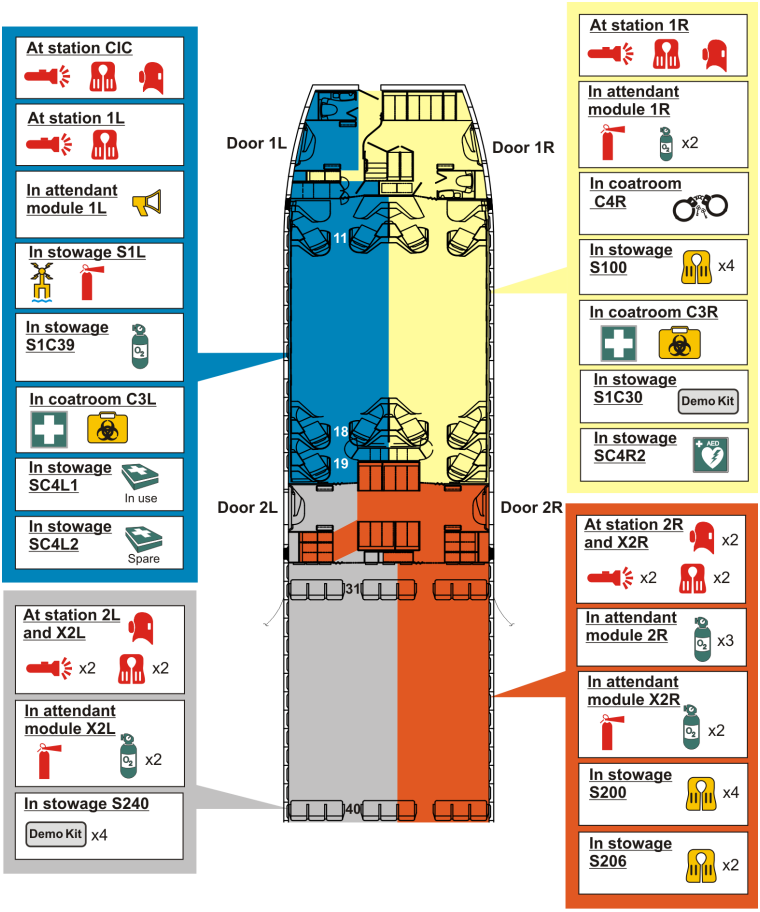


Captain and Co-pilot Seat

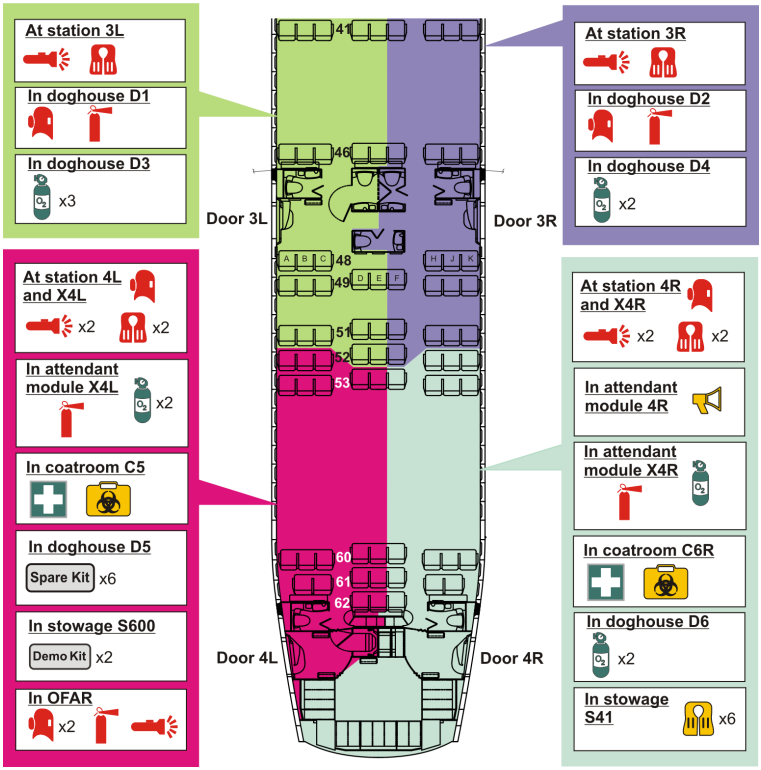


Emergency Equipment Locations—Passenger Cabin

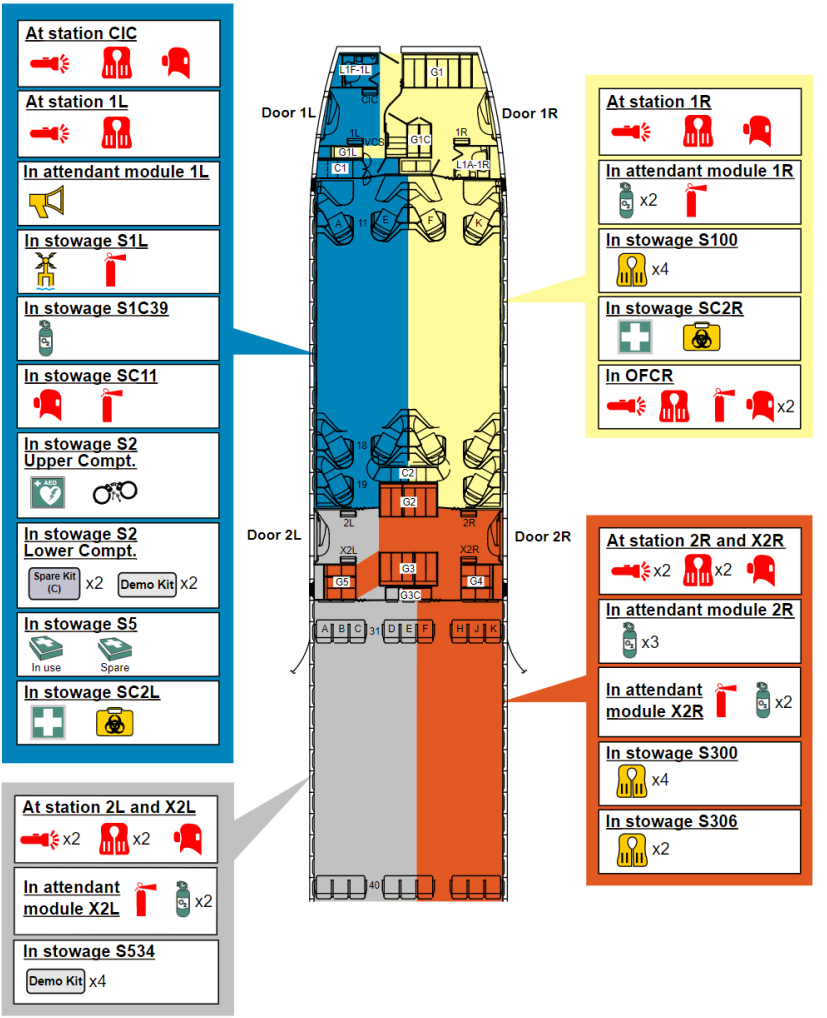
TQA to TQF



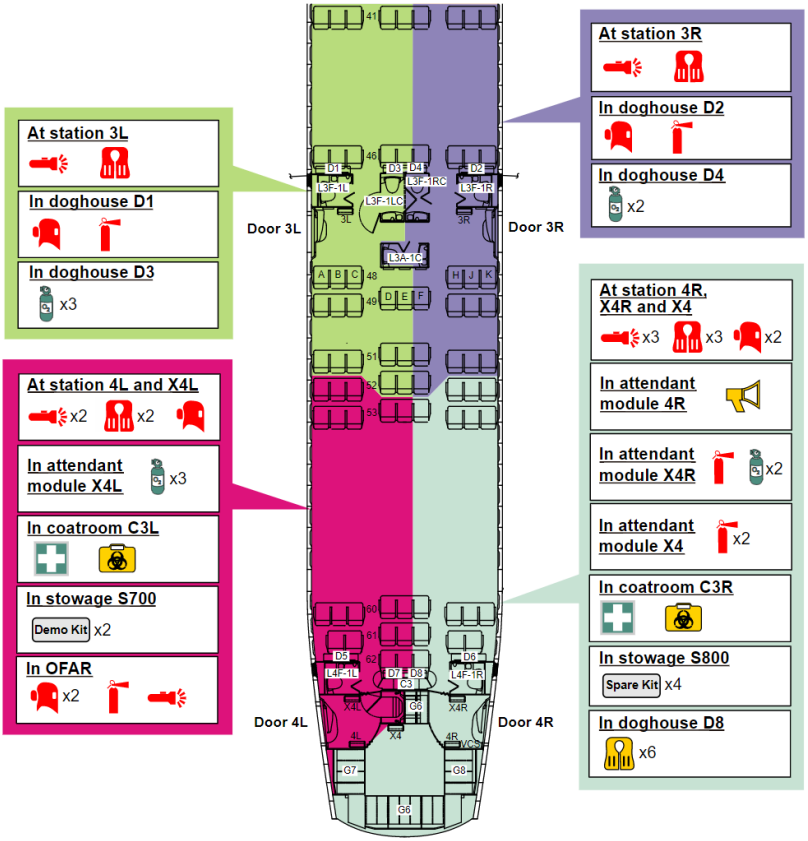
TQA to TQF


At station 3L
In doghouse D1
In doghouse D3
x3
At station 4L and X4L
x2
x2
In attendant module X4L
x2
In coatroom C5
In doghouse D5
Spare Kit
x6
In stowage S600
Demo Kit
x2
In OFAR
x2
Door 3L
Door 4L
41
46
48
49
51
52
53
60
61
62
At station 3R
In doghouse D2
In doghouse D4
x2
Door 3R
At station 4R and X4R
x2
x2
In attendant module 4R
In attendant module X4R
In coatroom C6R
In doghouse D6
x2
In stowage S41
x6
Door 4R

TWA,B


At station CIC
At station 1L
In attendant module 1L
In stowage S1L
In stowage S1C39
In stowage SC11
In stowage S2 Upper Compt.
In stowage S2 Lower Compt.
Spare Kit (C) x2
Demo Kit x2
In stowage S5
In use
Spare
In stowage SC2L
At station 2L and X2L
x2
x2
In attendant module X2L
x2
In stowage S534
Demo Kit x4
Door 1L
Door 1R
Door 2L
Door 2R
At station 1R
In attendant module 1R
x2
In stowage S100
x4
In stowage SC2R
In OFCR
x2
At station 2R and X2R
x2
x2
In attendant module 2R
x3
In attendant module X2R
x2
In stowage S300
x4
In stowage S306
x2

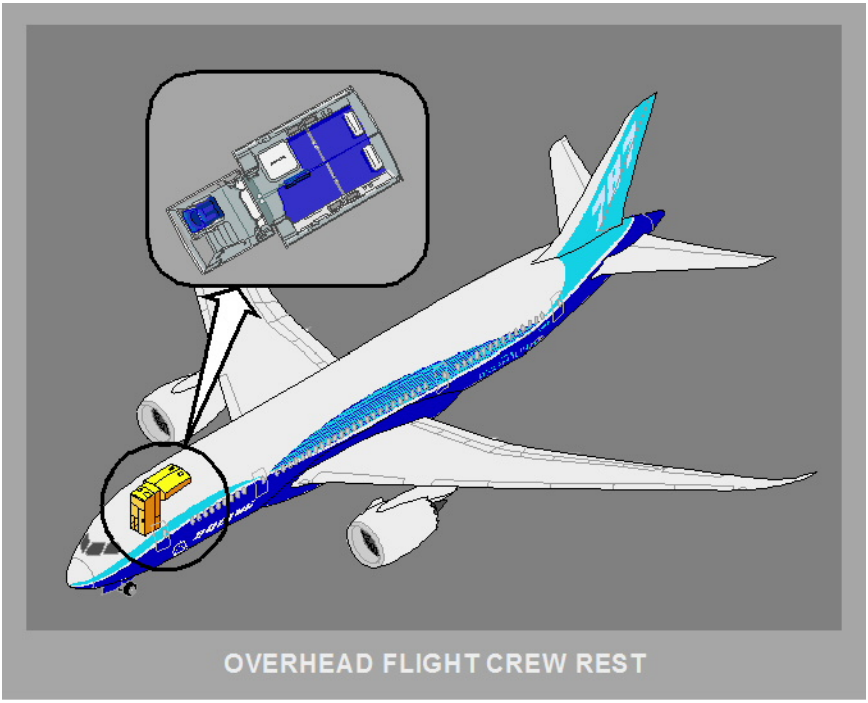
TWA,B


At station 3L
In doghouse D1
In doghouse D3
x3
At station 4L and X4L
x2
x2
In attendant module X4L
x3
In coatroom C3L
In stowage S700
Demo Kit
x2
In OFAR
x2
At station 3R
In doghouse D2
In doghouse D4
x2
At station 4R, X4R and X4
x3
x3
x2
In attendant module 4R
In attendant module X4R
x2
In attendant module X4
x2
In coatroom C3R
In stowage S800
Spare Kit
x4
In doghouse D8
x6
Door 3L
Door 3R
Door 4L
Door 4R

Overhead Flight Crew Rest

An overhead flight crew rest (OFCR) is located in the forward part of the airplane in the overhead area between door 1L and 1R. Access to the area is through an enclosure located in the passenger cabin near door 1L.

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



Occupancy

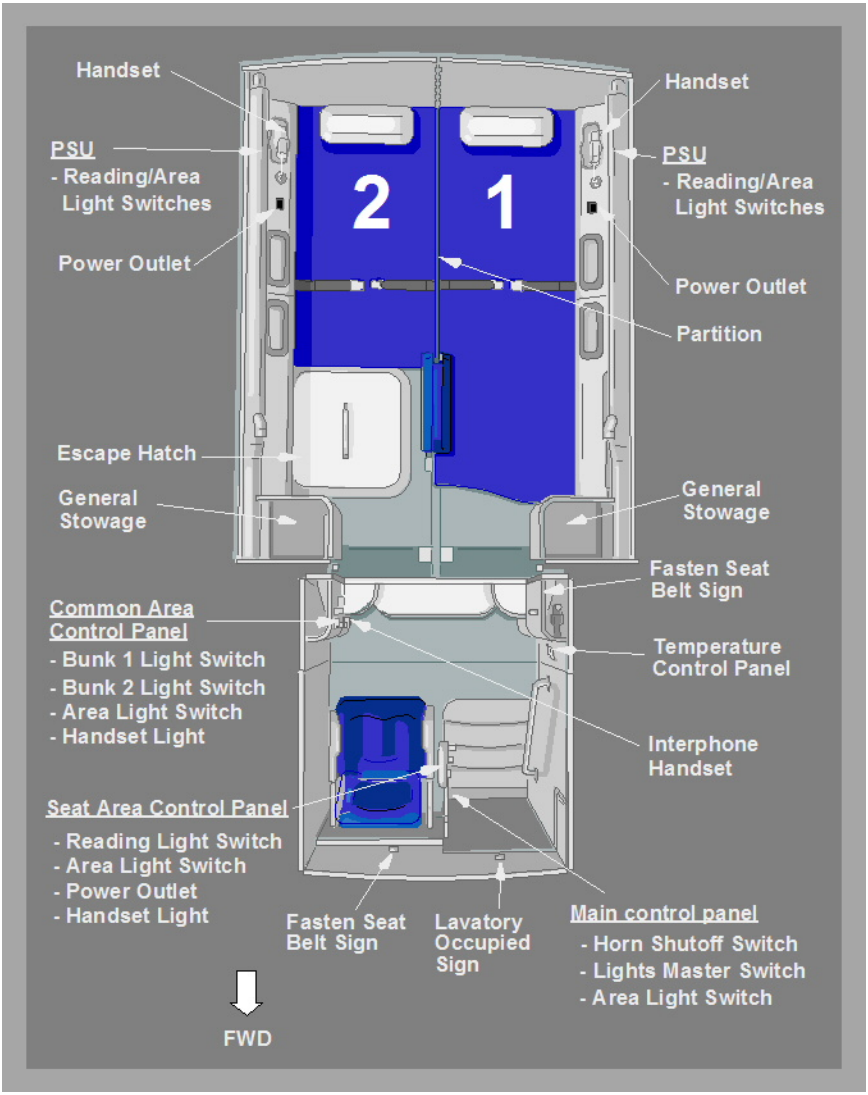
The overhead flight crew rest is to be occupied by flight crew members trained in the use of the crew rest evacuation routes, fire fighting and depressurization procedures.

Notes: 1. A placard is installed indicating any overhead flight crew rest occupancy restrictions.

2. The OFCR seat may be occupied during taxi, takeoff, or landing operations. The bunks and common area may not be occupied. The

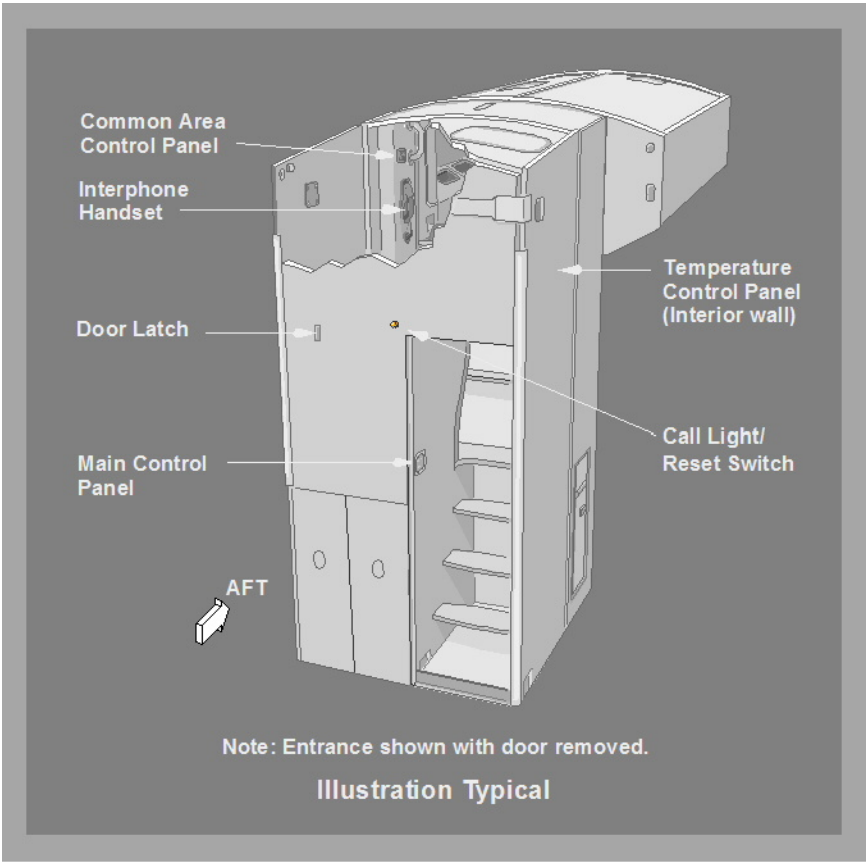
OFCR door must be latched open when occupied during taxi, takeoff or landing.

Layout



The overhead flight crew rest contains the following:

- an entrance and common area containing:
  - lights master switch
  - area lighting switches
  - horn shut off switch
  - temperature control panel
  - interphone handset
  - passenger information signs
  - emergency horn
  - smoke detector
  - flashlight
  - service power outlet
  - coat hooks, mirror, stowage
- a curtained off seat area containing:
  - 1 seat
  - control/lighting panel
  - PSU
  - smoke detector
  - emergency equipment
- a bunk area containing:
  - individually curtained-off sleeping bunks (2)
  - control/lighting panels (2)
  - PSUs (2)
  - interphone handsets (2)
  - smoke detectors (2)
  - emergency equipment
  - emergency egress hatch
  - stowage

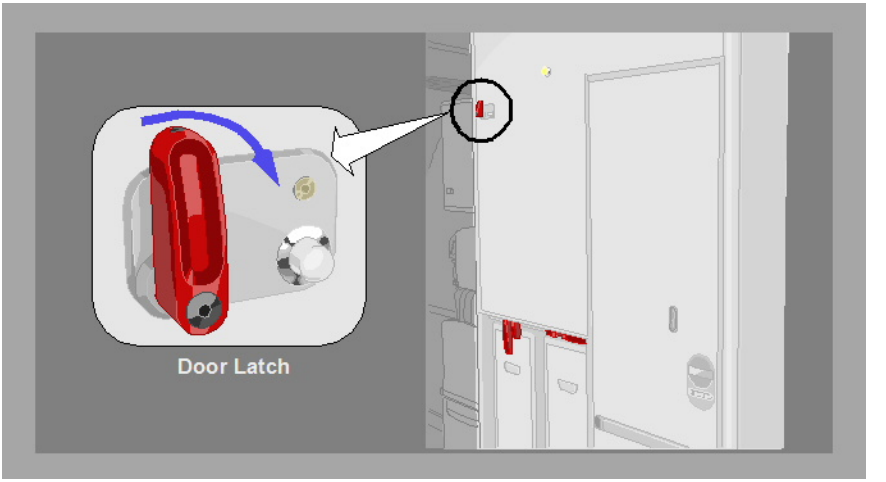


An amber call light/reset switch is mounted on the exterior wall above the entrance door. When smoke is detected in the crew rest area, the light flashes. The light illuminates steady when the attendant call button on a crew rest PCU has been pushed. Pushing the call light/reset switch resets the attendant call or smoke detection indications.

Conditioned air is used to provide temperature control and ventilation to the overhead flight crew rest. This air is regulated using the temperature control panel in the common area.

A humidification system for the OFCR is installed to supply moisture to the air and provide an enhanced level of comfort.

Entrance Enclosure



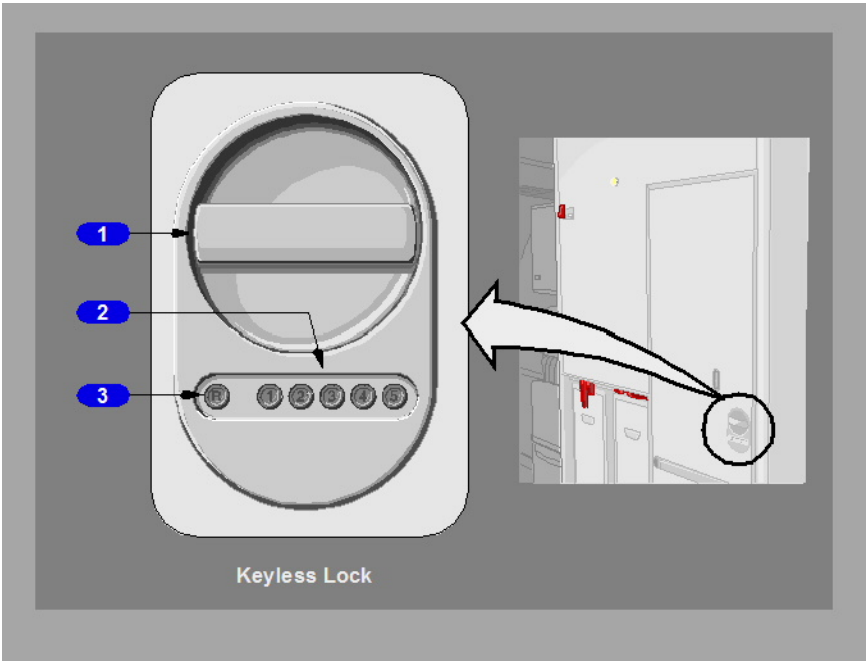
The entrance to the overhead flight crew rest is an enclosure located in the passenger cabin near door 1L and has the same external appearance as a lavatory, but is placarded for crew use and utilizes a keyless lock for security.

The door should remain closed and locked at all times, except where placarded otherwise. The door may be secured open with the quarter-turn door latch to keep open when occupied during taxi, takeoff or landing

The entrance enclosure contains lighting and a warning horn shutoff switch.

Entrance Enclosure Door Lock

A keyless door lock is installed at the entrance to the flight crew rest.



1 **Door Handle**

2 **5 Button Keypad**

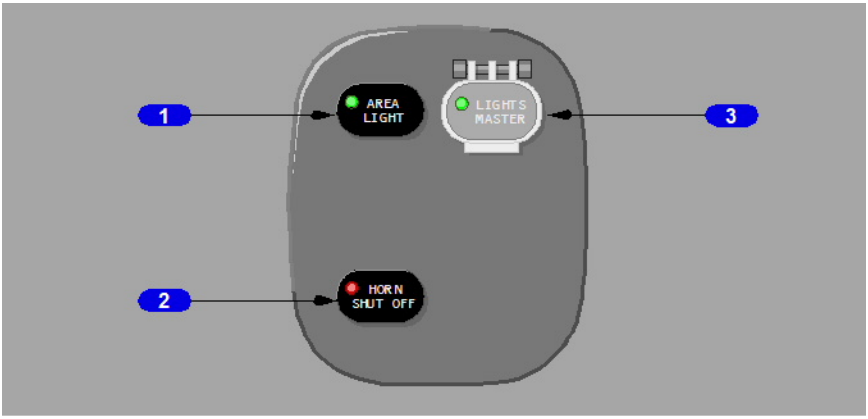
3 **Reset Button**

Door Lock Operation

To unlock the door, enter the airline-programmed code and rotate the door handle in either direction to retract the door bolt. When the door handle is released, the bolt automatically returns to the latched position allowing the door to be closed without retracting the bolt.

Main Control Panel

The OFCR main control panel is located inside the entrance enclosure at the bottom of the stairs.



1 AREA LIGHT switch

Push—

- turns entrance enclosure lights on dim (green light illuminates)
- second push turns entrance enclosure light off (green light extinguishes)

Note: If the LIGHTS MASTER switch is on, the AREA LIGHT switch cannot control the area lights.

2 HORN SHUT OFF Switch

Illuminated (red) during an airplane decompression or OFCR smoke detection.

3 LIGHTS MASTER Switch

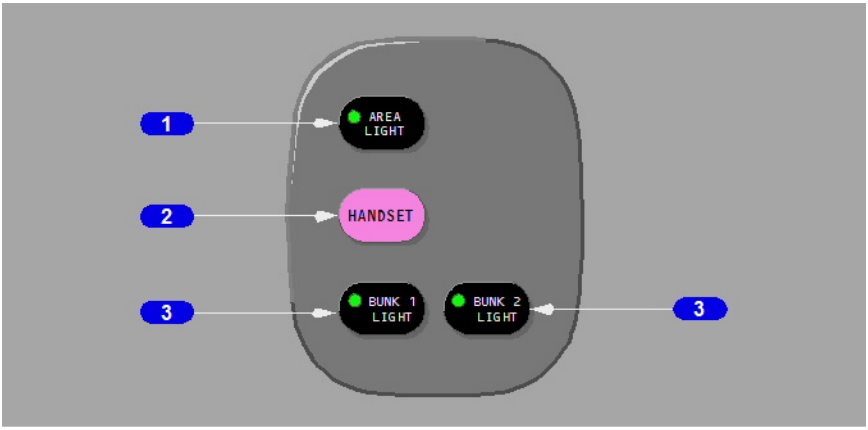
Guarded switch.

Push—

- overrides individual lighting controls and turns the entrance area, bunk area and seat area lights in the crew rest compartment on bright (green light illuminates)
- second push turns all the lights in the crew rest compartment off and returns control to the individual switches (green light extinguishes)

Common Area Control Panel

An area control panel is located on the common wall at the top of the stairs.



1 AREA LIGHT Switch

Push—

- turns entrance enclosure light on dim (green light illuminates)
- second push turns entrance enclosure lights off (green light extinguishes)

Note: If the LIGHTS MASTER switch is on, the AREA LIGHT switch cannot control the area lights.

2 HANDSET Light

Illuminated (magenta) – indicates an incoming cabin interphone call to the OFCR. Light extinguishes when a handset is removed from the cradle or the call is cancelled.

3 BUNK LIGHT Switches

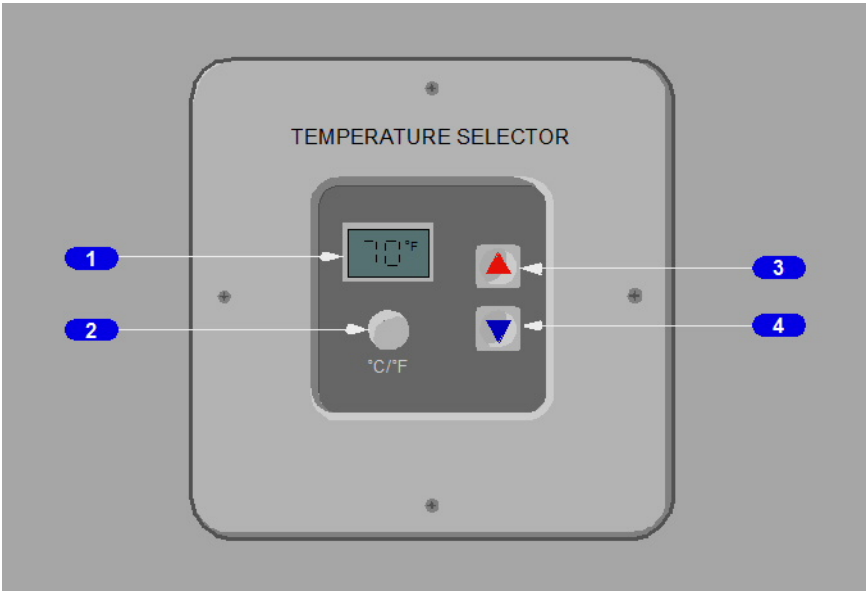
Push—

- turns associated bunk light on dim (green light illuminated)
- second push turns associated bunk light off (green light extinguished)

Temperature Control Panel

The temperature in the flight crew rest compartment is controlled by the temperature controller located on the wall in the entrance enclosure. The temperature can be set between 59º F (15º C) and 80º F (27º C) by selecting the warmer or cooler arrows on the panel. The seat and each bunk has an individual air flow outlet to help control individual temperatures in those areas.

Note: The flight crew rest compartment temperature can only be increased above the temperature in the aft cabin area. The system is not able to achieve the selected temperature under all operating conditions.



1 Temperature Display

Displays:

- current selected air temperature in deg F or deg C
- a momentary flashing selected temperature after warmer or cooler arrows are pushed

Note: If temperature display is continuously flashing, and not associated with a recent temperature setting change, the system has failed.

2 Units Selector

Push—toggles between deg F and deg C for display and temperature selection.

3 Warmer Arrow

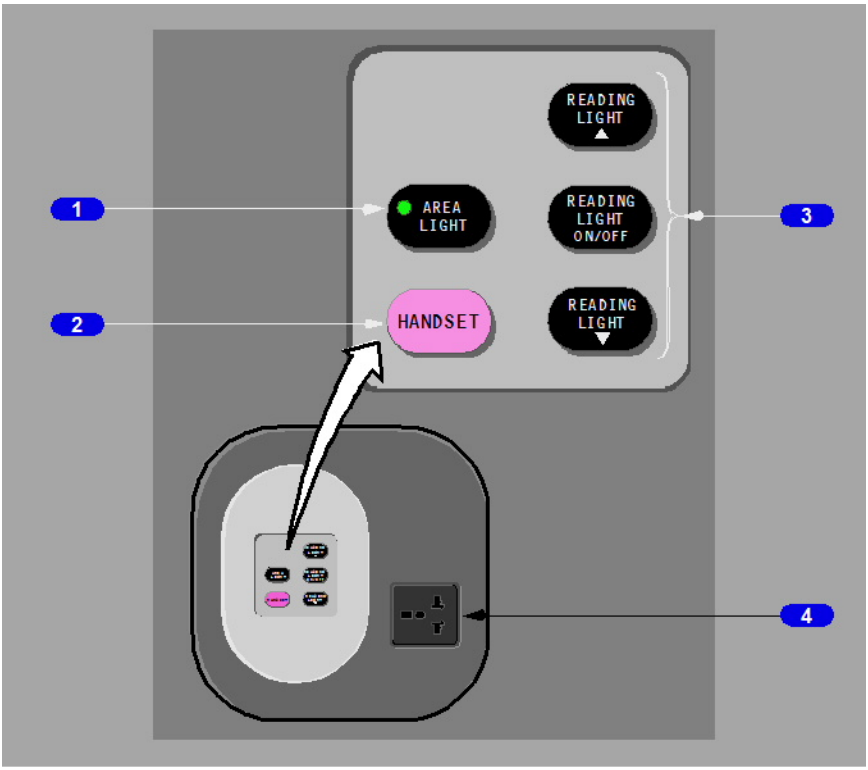
Push—to increase temperature setting for the overhead flight crew rest.

4 Cooler Arrow

Push—to decrease temperature setting for the overhead flight crew rest.

Seat Area Control Panel

The OFCR has a lighting control panel located to the right of the crew rest seat.



1 AREA LIGHT Switch

Push—

- turns seat area light on dim (green light illuminated)
- second push turns area light on bright (green light illuminated)
- third push turns area light off (green light extinguishes)

Note: The AREA LIGHT switch on the seat area control panel does not control the entrance area lights.

2 HANDSET Light

Illuminated (magenta) — indicates an incoming cabin interphone call to the OFCR. Light extinguishes when a handset is removed from the cradle or the call is cancelled.

3 READING LIGHT Switches

Push—

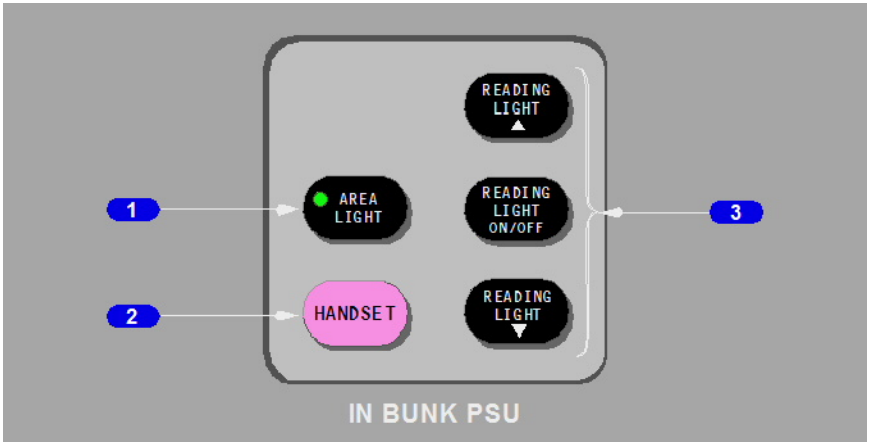
- READING LIGHT ON/OFF switch turns reading light ON or OFF (default setting is “dim”)
- upper READING LIGHT switch increases illumination to “bright”
- lower READING LIGHT switch decreases illumination to “dim”

4 PED Power Outlet

A 110-V AC, Personal Electronic Device (PED) power outlet.

Bunk Light Control Panel

The OFCR has a lighting control panel located in each bunk PSU.



1 Bunk AREA LIGHT Switch

Controls the bunk area lights which illuminate the header and footer of each individual bunk.

Push—

- turns bunk area lights on dim (green light illuminated)
- second push turns area lights on bright (green light illuminated)
- third push turns area lights off (green light extinguishes)

Note: The AREA LIGHT switch on the bunk lighting control panels does not control the entrance area lights.

2 HANDSET Light

Illuminated (magenta) — indicates an incoming cabin interphone call to the OFCR. Light extinguishes when a handset is removed from the cradle or the call is cancelled.

3 BUNK LIGHT Switches

Push—

- READING LIGHT ON/OFF switch turns reading light ON or OFF (default setting is “dim”)
- upper READING LIGHT switch increases illumination to “bright”
- lower READING LIGHT switch decreases illumination to “dim”

Oxygen System

The overhead flight crew rest oxygen system is considered part of the passenger cabin oxygen system and its operation is identical (see Oxygen Systems on page 1.40.10.).

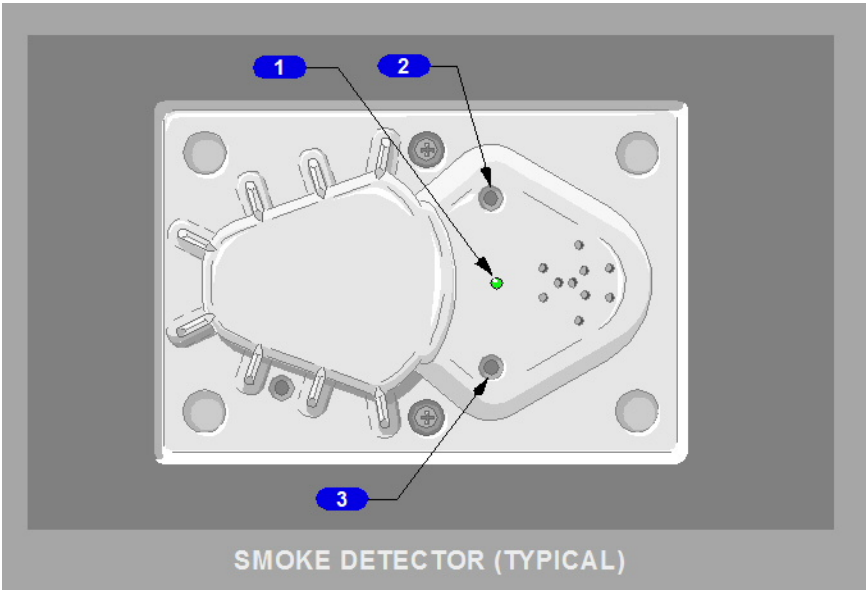
Note: When the oxygen masks deploy, the green oxygen indicator light in the common area illuminates.

Crew Rest Smoke Detection

Smoke detection is annunciated by a smoke alarm horn (pulsating) sounding in the main overhead flight crew rest and the entrance enclosure.

A total of four (4) smoke detectors are installed in the overhead flight crew rest. There is one smoke detector in the common area, one in the seat area, and one in each bunk area.

Smoke Detector



1 Status Indicator Light

Illuminated (green) —

- steady – smoke detector has power and is operating properly
- blinking – maintenance is necessary

Illuminated (red) —

- steady – smoke has been detected
- blinking – detector has failed

2 Self-Test Switch

Push—

- if pushed and immediately released, horn sounds for three seconds
- if pushed and held, horn sounds until the switch is released
- red indicator illuminates
- external alarms sound

Note: Switch is recessed in the smoke detector housing and requires a pen or other device to push.

3 Horn Cancel Switch

Push—

- the smoke detector horn is silenced
- the cabin chime is turned off
- a smoke alarm suppression cycle is initiated

Release—the horn cancellation remains active until the detector has not sensed smoke for a period of 30 seconds, at which time the detector resets.

Note: The horn cancel switch does not affect the status indicator light on the smoke detector.

Crew Rest Smoke Detection System Operation

If smoke is detected in the overhead flight crew rest:

- on the flight deck:
  - the master caution light illuminates
  - an aural caution alarm sounds
  - a SMOKE REST UPR DR 1 EICAS caution message is displayed
- in the flight crew rest area:
  - the smoke detector alarm indicator light illuminates
  - all area lights illuminate
  - the pulsating smoke detection system alarm horns sound in the overhead flight crew rest
  - the overhead flight crew rest air supply valves are closed and the area exhaust valves are opened
- at the entrance main control panel:
  - an alarm horn sounds
- in the passenger cabin:
  - the amber call light/reset switch above the entrance enclosure door flashes
  - a continuous chime sounds in the passenger cabin at door 1L, door 1 cross-aisle, door 1R, door 2L, and door 2R
  - the cabin attendant master call lights flash
  - a SMOKE DETECTED DR1 UPR REST message appears on the cabin attendant panels

Once the smoke clears, the red alarm indicator light extinguishes and the smoke detector is sensitive to smoke again. Continue to monitor the area until the red alarm indicator light extinguishes.

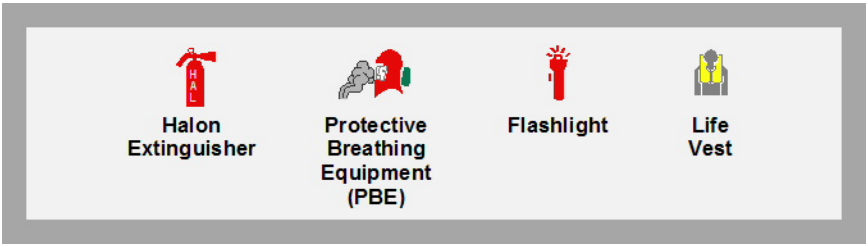
Note: When the smoke detector has been activated by smoke, lingering smoke in the detector sensor may cause reactivation. Blowing air into the detector sensor may clear lingering smoke.

Emergency Equipment

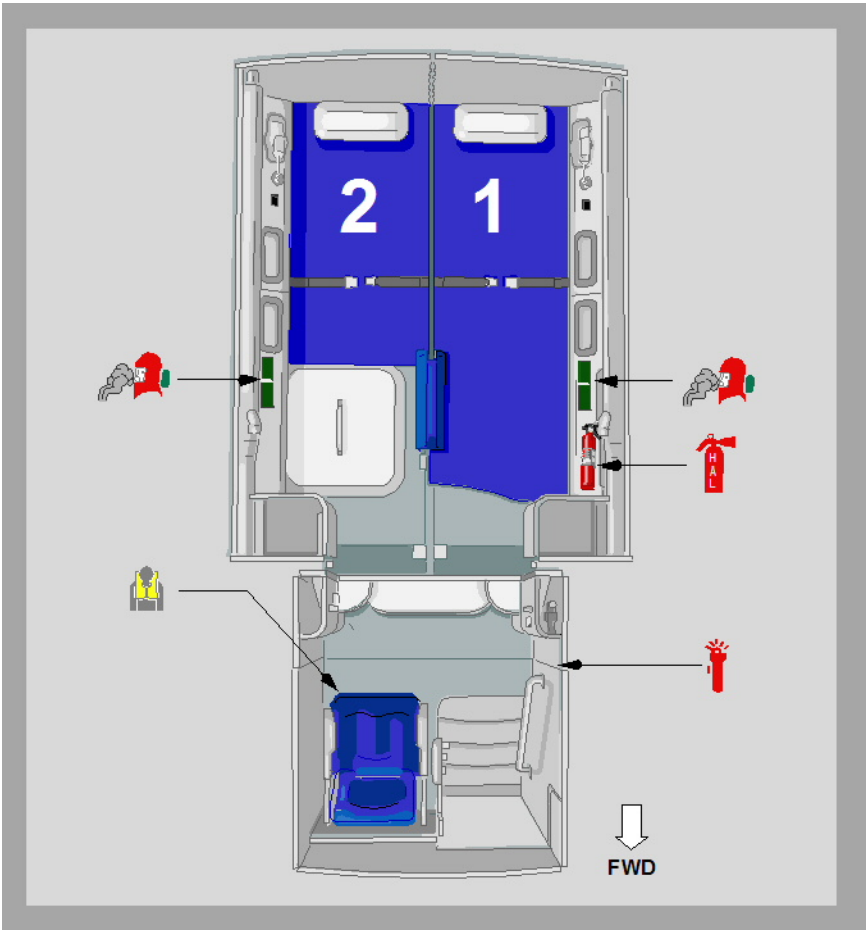
Overhead flight crew rest emergency equipment includes:

- Halon fire extinguisher (1)
- protective breathing equipment (PBE) (2)
- life vest (1)
- flashlight (1)

Emergency Equipment Sysbols



Emergency Equipment Location



OFCR Non-Normal Situation Guidelines

Decompression

If a cabin decompression occurs during cruise, a decompression (continuous) horn sounds in the main area and the entrance enclosure. The green oxygen indicator light also illuminates.

Overhead flight crew rest occupants should immediately move to an unoccupied position (if necessary), don one of the oxygen masks, and fasten the seat/bunk lap belt.

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

Evacuate the overhead flight crew rest when directed by the flight crew.

Note: Prior to evacuating the overhead flight crew rest, push the HORN SHUT OFF switch (located in the entrance area). This silences the decompression alarm horns in the overhead flight crew rest.

Crew Rest Area Fire Fighting

OFCR is occupied

If smoke is detected, at least one crew member in the crew rest:

- dons a smoke hood
- pushes the HORN SHUT OFF switch in the entrance area to silence the smoke detection system alarm horn and chimes, if required

  Notes:
  1. Pushing the HORN SHUT OFF switch also removes the cabin attendant panel alert pop-up window SMOKE DETECTED. A SMOKE DETECTED message is then shown in small text at the bottom of all cabin attendant panels.
  2. The flight deck Engine and Crew Alerting System (EICAS) message SMOKE REST UPR DR 1 remains displayed until the smoke detection system is reset.
- fights fire

  WARNINGS:
  1. **If the source of the smoke/fire can not be readily found, maintain access to the main entrance while continuing to search for source.**
  2. **If it becomes necessary to set the fire extinguisher down while searching for the fire source, ensure the extinguisher remains in contact with some part of the body for quick retrieval.**
- crew members not fighting the fire are to evacuate the upper crew rest area
  - ensure the entrance door is closed
  - establish communications with the flight deck
  - relocate additional emergency equipment to near the overhead crew rest area entrance
  - assist the crew member in the crew rest area, as required

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

OFCR is unoccupied

- ensure the entrance door is closed
- establish communications with the flight deck

- a crew member outside the overhead flight crew rest entrance pushes the amber reset light above the entrance enclosure door to silence smoke detection system alarm horn and chimes, if require

  Notes: 1. Pushing the reset switch also removes the cabin attendant panel alert pop-up window SMOKE DETECTED. A SMOKE DETECTED message is then shown in small text at the bottom of cabin attendant panels.

  2. The flight deck Engine and Crew Alerting System (EICAS) message SMOKE REST UPR DR 1 remains displayed until the smoke detection system is reset.

- at least one crew member:
  - obtains a fire extinguisher
  - dons a smoke hood
  - feels the door
  - if the door is hot:
    - keep the door closed
    - use a crash axe to chop a small hole in the upper part of the door just big enough to receive a fire extinguisher nozzle
    - discharge the fire extinguishing agent, preferably halon, into the hole
    - discharge the extinguisher completely
    - if needed, discharge the remaining extinguishers into the same hole to build up and maintain a high concentration of extinguishing agent
  - if the door is cool:
    - enters enclosure and closes door

      Note: Opening/closing of the door may require assistance of a second assistant if fire gloves are on.

    - puts on fire gloves (unless previously donned)
    - pushes the HORN SHUT OFF switch in the common area to silence the smoke detection system alarm horn and chimes, if required

      Note: The flight deck Engine and Crew Alerting System (EICAS) SMOKE REST UPR DR 1 message remains displayed until the smoke detection system is reset

    - fights fire
    - locates source of fire/smoke
    - discharge fire extinguisher at the base of the flames and/or any hotspots

WARNINGS:
1. **If the source of the smoke/fire can not be readily found, maintain access to the main entrance while continuing to search for source.**
2. **If it becomes necessary to set the fire extinguisher down while searching for the fire source, ensure the extinguisher remains in contact with some part of the body for quick retrieval.**

– crew members not fighting the fire assist as necessary
  - relocate additional emergency equipment near the overhead crew rest area entrance
  - assist the crew member in the crew rest area, as required

– after the smoke has been cleared from the crew rest area:
  - continue to monitor the overhead flight crew rest area
    - visually monitor the crew rest
    - use the cabin attendant panels as appropriate

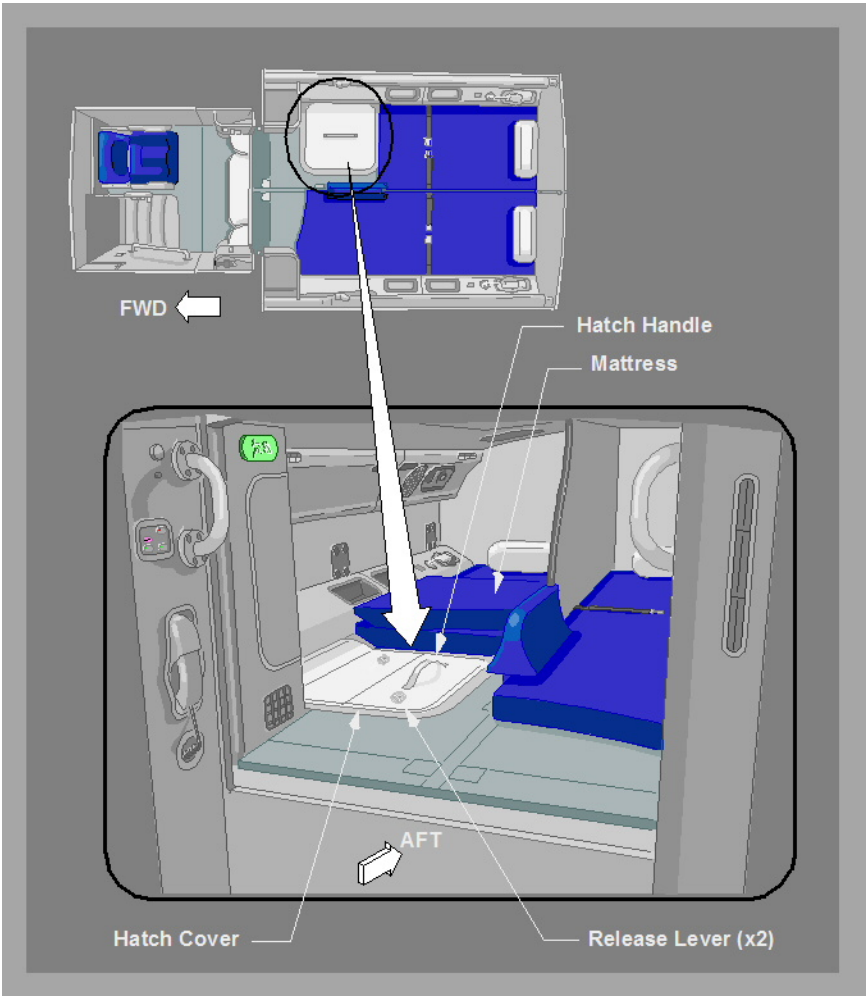
Note: The overhead crew rest area may be used if:
- the ignition source has been positively identified and extinguished
- all smoke has been cleared from the crew rest area

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

Evacuation

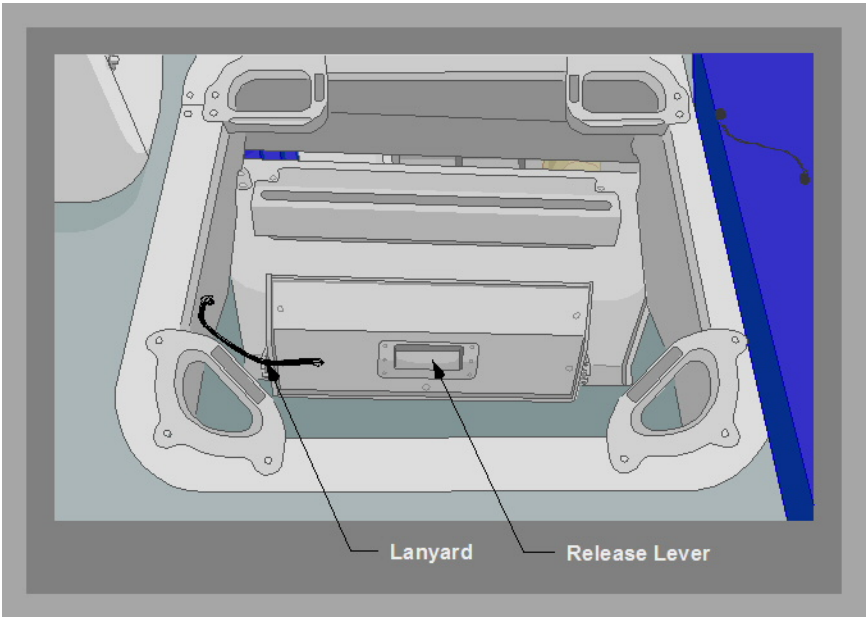
The primary evacuation route is down the entrance stairway through the entrance enclosure.

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

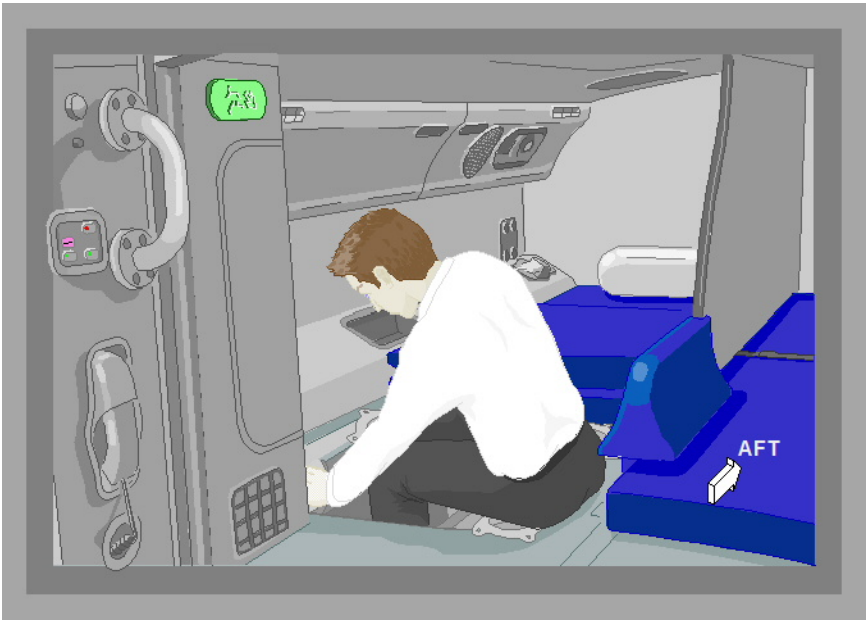


For egress:

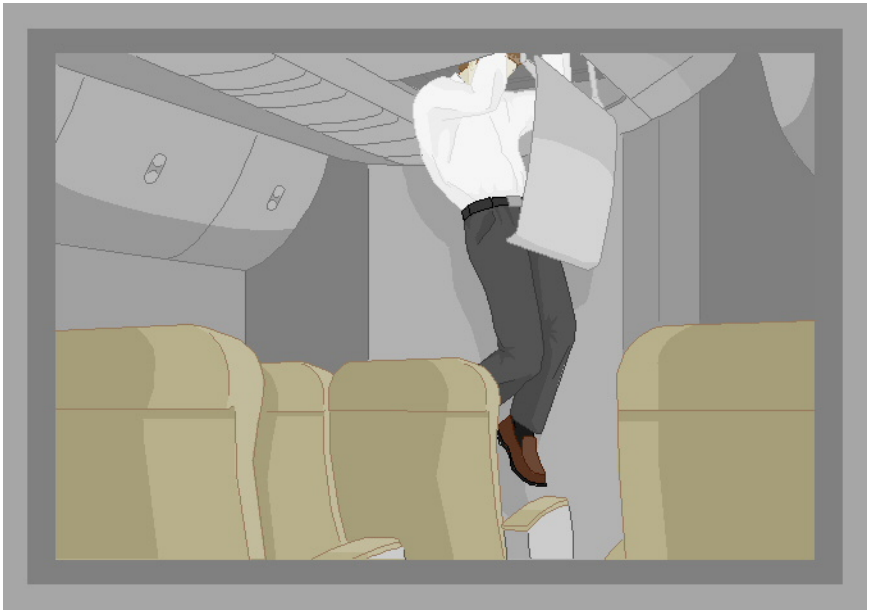
- lift and remove the mattress pad
  Note: Stow the mattress pad where it does not obstruct the emergency hatch.
- unlatch the cover using the two release levers
- pull up on hatch handle to open the cover
- stow the hatch cover where it does not interfere with evacuation through the emergency hatch.



- unlatch lower hatch
  - pull the lower hatch release lever
  - let the hatch drop a few inches
  - pull out lanyard and let hatch fall
- command passengers in immediate area to move clear of evacuation area



- sit on bench facing the right side of the airplane
- lower legs into hatch opening
- grasp the handholds keeping elbows tucked inward



- use the lower hatch to slide/swing down and drop to main deck
  - use the seat armrest to assist in maintaining balance as necessary

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

- close the lower hatch when evacuation is complete

WARNING: The lower evacuation hatch must be closed to help prevent the spread of smoke or fire.

Evacuating and Incapacitated Person Using the Main Stairway

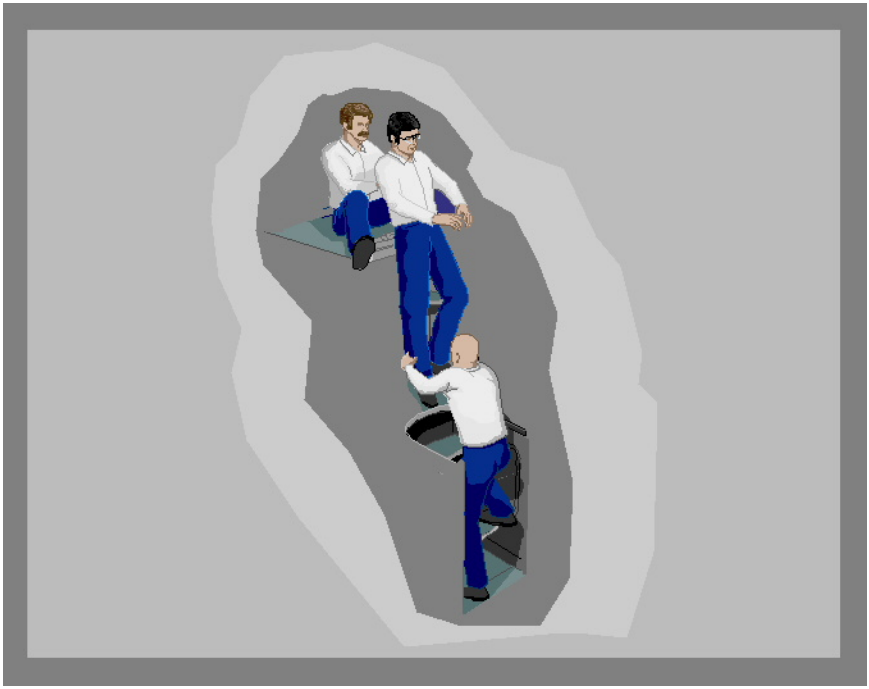
The upper assistant(s) in the crew rest should:

- obtain assistance as necessary



With the incapacitated person sitting on the edge at the top of the stairs,:

- the upper assistant(s) should:
  - position the incapacitated person with her/his legs extending down the stairs
  - sit behind the incapacitated person without supporting much of the incapacitated person's weight
  - prepare to transfer the incapacitated person to the lower assistant(s)



- the lower assistant(s) should:
  - request assistance (as required)
  - work the feet into the stairway
  - take as much weight as possible



- the upper assistant(s) should:
  - transfer grip to the back of the jacket or shirt (or under the shoulders) of the incapacitated person
    Note: Do not support much of the incapacitated person's weight.
  - proceed down the stairs
    Note: Protect incapacitated person’s head and neck as much as possible.
- the assistant(s) on the main deck should:
  - receive the incapacitated person
  - lower him/her to the floor while protecting the head and neck
  - close the area door

Evacuationg an Incapacitated Person Using the Emergency Hatch

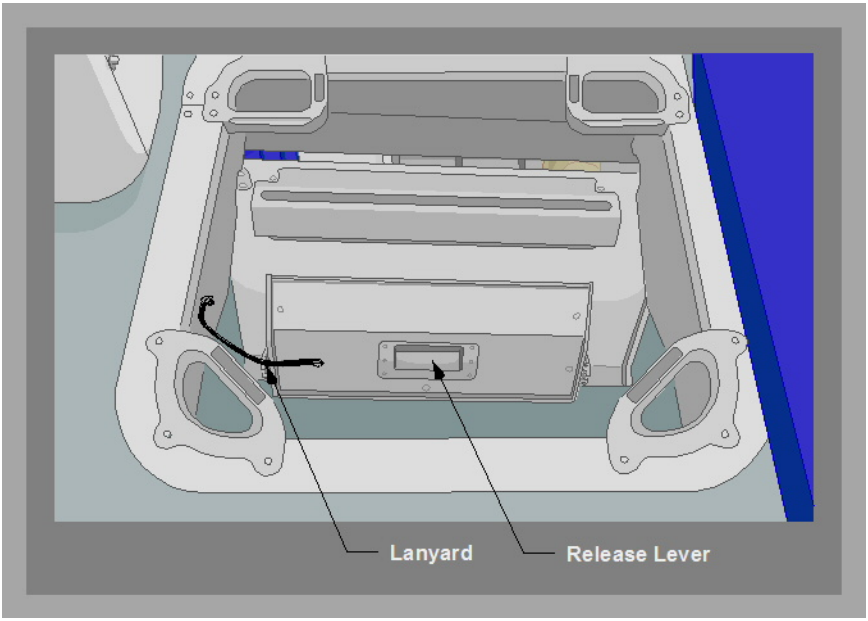
Prior to evacuation, the assistant(s) on the main deck should command passengers in the immediate area to move clear of evacuation area.

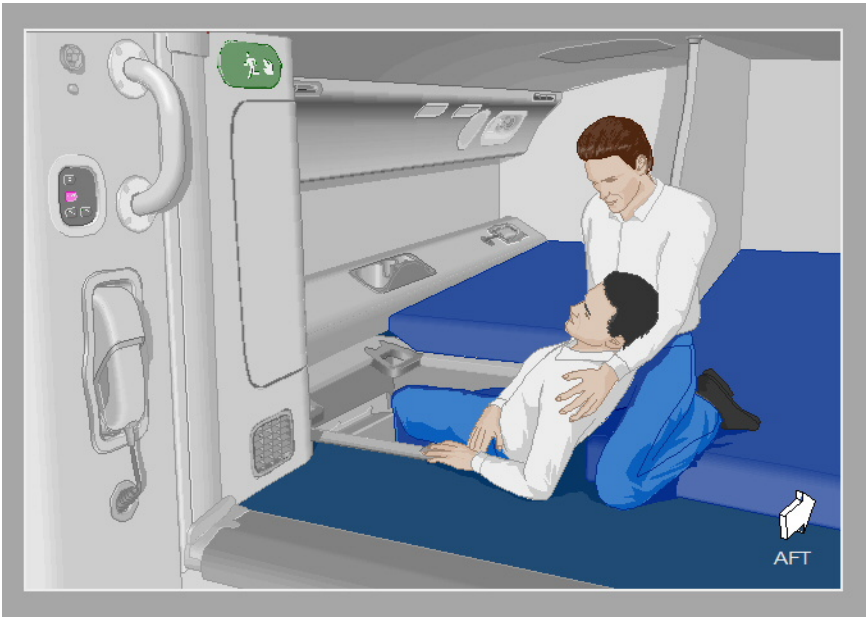
Displace the minimum number of passengers.

The assistant(s) in the crew rest should:

- obtain assistance as necessary
- lift and remove the mattress pad

  Note: Stow the mattress pad where it does not obstruct the emergency hatch.
- unlatch the cover using the two release levers
- pull up on hatch handle to open the cover
- stow the hatch cover where it does not interfere with evacuation through the emergency hatch
- unlatch lower hatch
  - pull the lower hatch release lever
  - let the hatch drop a few inches
  - pull out lanyard and let hatch fall





- place the incapacitated person across the rest area, face up

With one or more assistant(s) located below to receive the incapacitated person,

- the upper assistant(s) in the crew rest should:
  - place the incapacitated person's feet in the hatch opening
  - move to a position behind the incapacitated person
  - raise the incapacitated person to a sitting position
  - place hands under the incapacitated person's shoulders
  - slide the incapacitated person until the majority of the legs are in the hatch



- the upper assistant(s) should:
  - transfer hold of the incapacitated person from under the shoulders to the wrists
  - slowly lower the incapacitated person down through the hatch

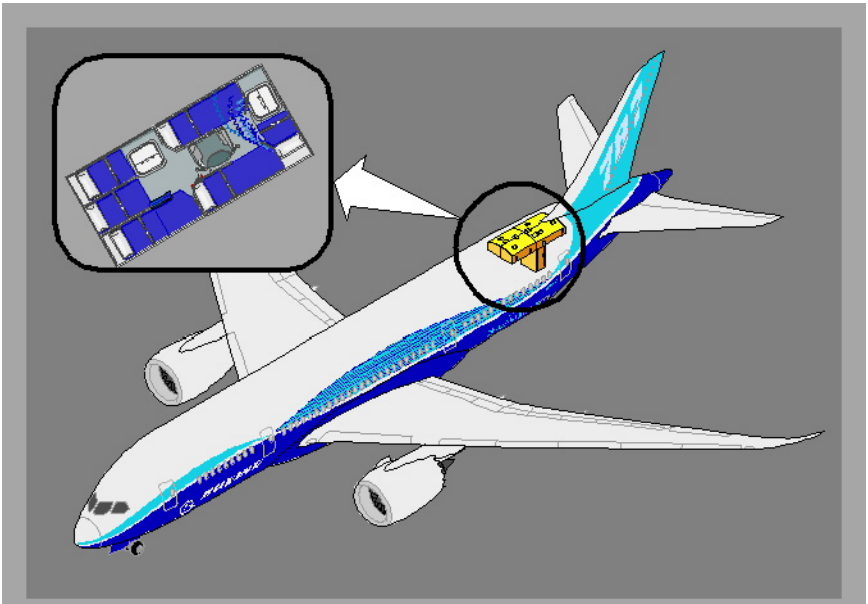


- the lower assistant(s) on the main deck shall:
  - receive the incapacitated person
  - lower him/her to the floor while protecting the head and neck
  - close the lower hatch

Overhead Flight Attendant Rest

An overhead flight attendant rest (OFAR) is located in the aft part of the airplane in the overhead area between door 4L and 4R. Access to the area is through an enclosure located in the passenger cabin near door 4L.

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

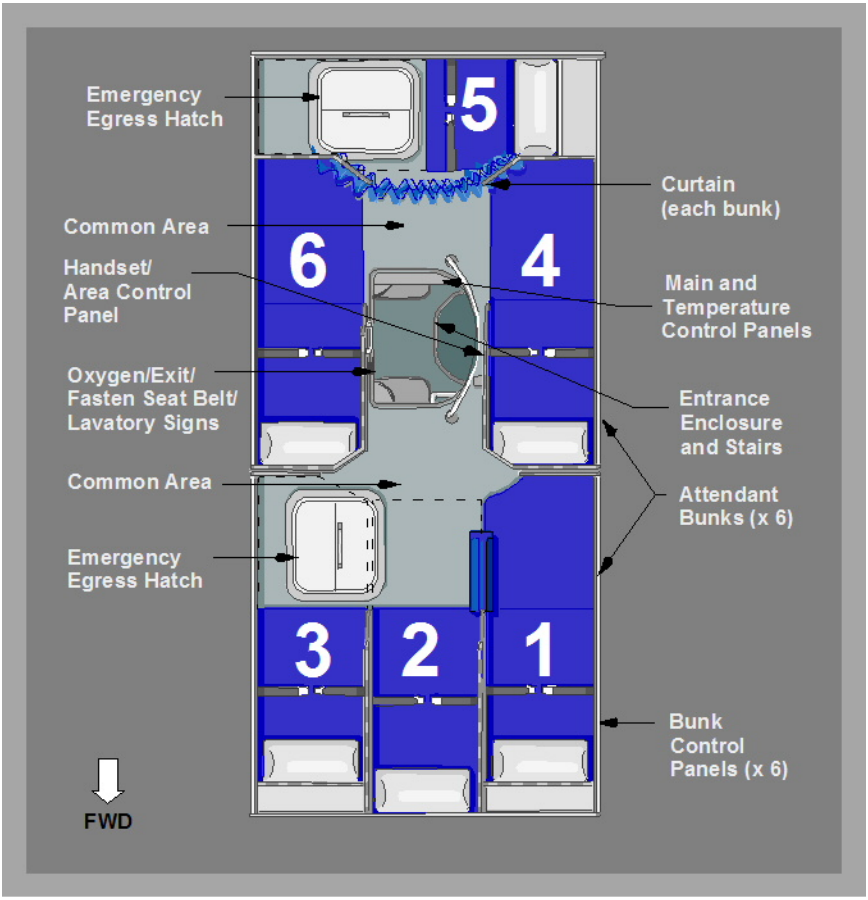


Occupancy

The overhead flight attendant rest is to be occupied by crew members trained in the use of the crew rest evacuation routes, fire fighting procedures and depressurization procedures.

Notes:
1. A placard is installed indicating any overhead flight attendant rest occupancy restrictions.
2. The overhead flight attendant rest is not to be occupied during taxi, takeoff or landing operations.
3. The OFAR has no ventilation below 15,000 ft altitude.

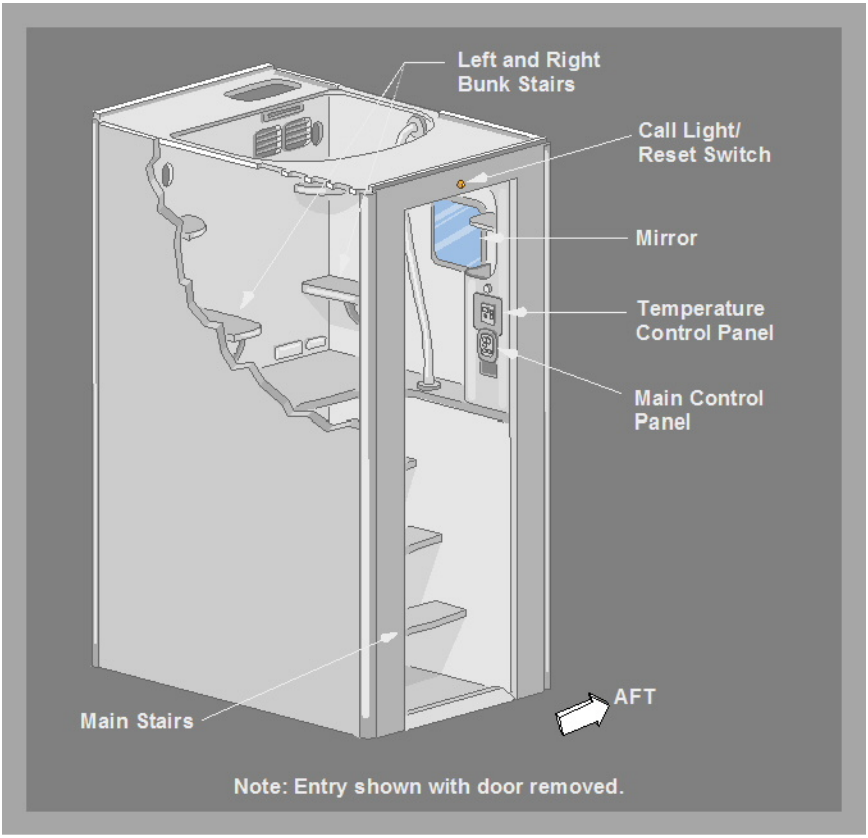
Layout



The overhead flight attendant rest contains the following:

- an entrance and common area containing:
  - lights master switch
  - area lighting switches
  - horn shut off switch
  - temperature control panel
  - interphone handset/light
  - passenger information signs
  - emergency horn
  - smoke detectors (2)
  - emergency equipment

  - coat hooks, mirror, stowage
- a bunk area containing:
  - individually curtained-off sleeping bunks (6)
  - control/lighting panels
  - handset indicator lights (6)
  - PSUs (6)
  - smoke detectors (6)
  - emergency equipment
  - emergency egress hatches (2)
  - power outlets (6)
  - stowage



An amber smoke alarm/call light is mounted on the exterior wall above the entrance door. When smoke is detected in the overhead flight attendant rest, the light flashes. The light illuminates steady when the attendant call button on

a crew rest PCU has been pushed. Pushing the call light/reset switch resets the attendant call or smoke detection indications.

Conditioned air is used to provide temperature control and ventilation to the overhead flight attendant rest. This air is regulated using the temperature control panel in the entrance enclosure.

A humidification system for the OFAR is installed to supply moisture to the air and provide an enhanced level of comfort.

Entrance Enclosure

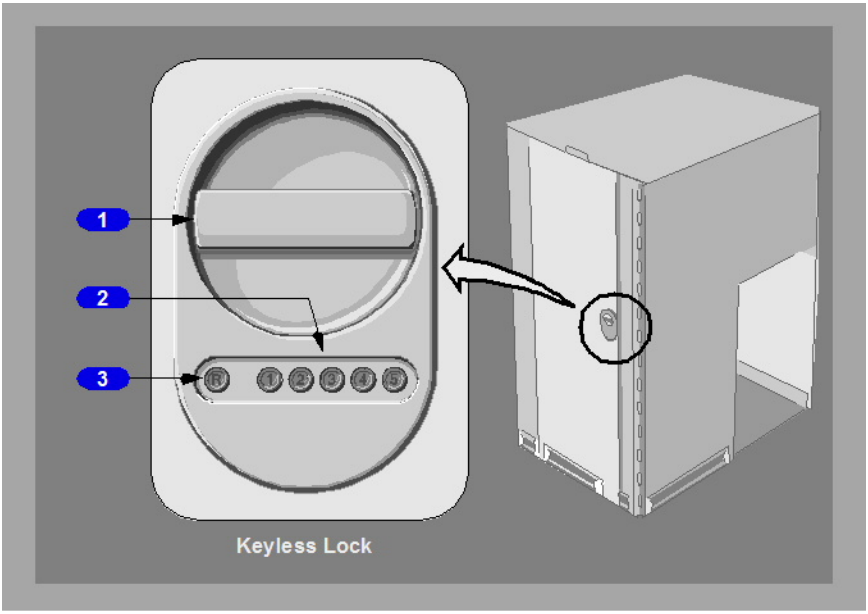
The entrance to the crew rest compartment is an enclosure located in the passenger cabin near door 4L and has the same external appearance as a lavatory, but is placarded for crew use and utilizes a keyless combination lock for security.

The door latch defaults to the locked position except during opening.

The entrance enclosure contains lighting and temperature controls, and a warning horn shutoff switch.

Entrance Enclosure Door Lock

A keyless door lock is installed at the entrance to the overhead flight attendant crew rest.



1 **Door Handle**

2 **5 Button Keypad**

3 **Reset Button**

Door Lock Operation

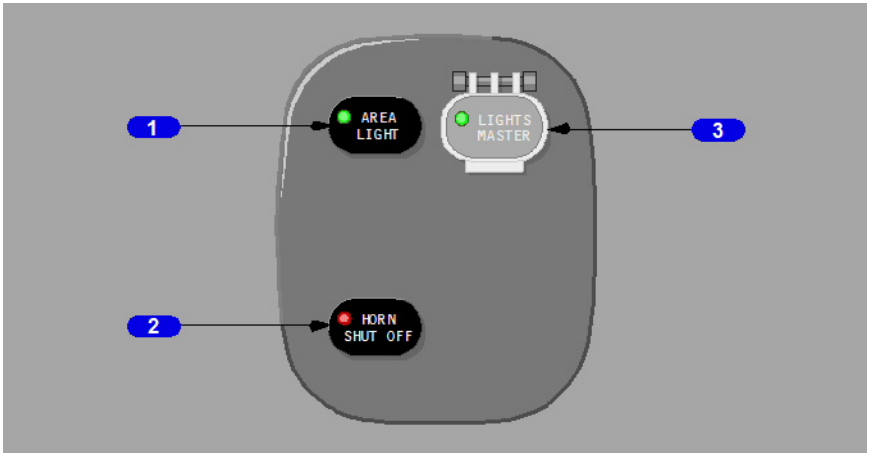
To unlock the door, enter the airline-programmed code and rotate the door handle in either direction to retract the door bolt. When the door handle is released, the bolt automatically returns to the latched position allowing the door to be closed without retracting the bolt.

Entrance Enclosure Control Panels

The overhead flight attendant rest main control and temperature control panels are located inside the entrance enclosure.

Main Control Panel

The OFAR main control panel is located inside the entrance enclosure at the bottom of the stairs.



1 **AREA LIGHT switch**

Push—

- turns entrance enclosure light on dim (green light illuminates)
- second push turns entrance enclosure light off (green light extinguishes)

Note: If the LIGHTS MASTER switch is on, the AREA LIGHT switch cannot control the area lights.

2 HORN SHUT OFF Switch

Illuminated (red) during an airplane decompression or rest compartment smoke detection.

Push – silences the decompression/smoke alert horn (light remains red) in the flight attendant crew rest area.

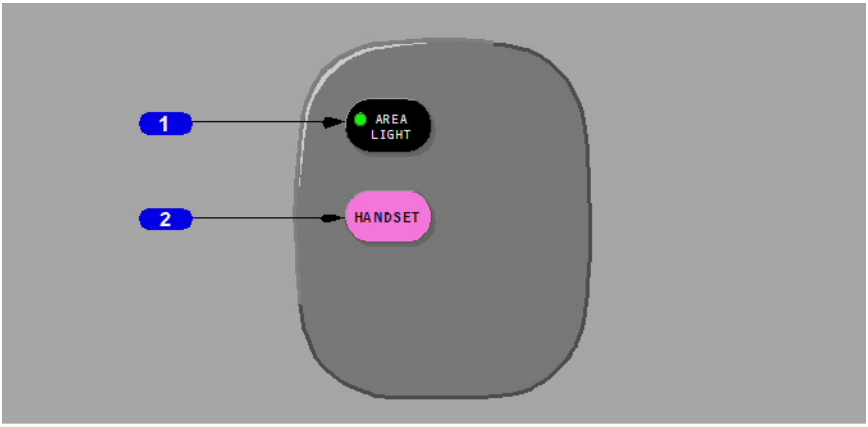
3 LIGHTS MASTER Switch

Push (guarded)—

- overrides individual lighting controls and turns the entrance area and bunk area lights in the crew rest compartment on bright (green light illuminates)
- second push turns all the lights in the crew rest compartment off and returns control to the individual switches (green light extinguishes)

Common Area Control Panel

An area control panel is located on the common wall at the top of the stairs below the cabin handset.



1 AREA LIGHT switch

Push—

- turns entrance enclosure light on dim (green light illuminates)
- second push turns entrance enclosure light off (green light extinguishes)

Note: If the LIGHTS MASTER switch is on, the AREA LIGHT switch cannot control the area lights.

2 HANDSET Light

Illuminated (magenta) – indicates an incoming cabin interphone call to the OFAR.

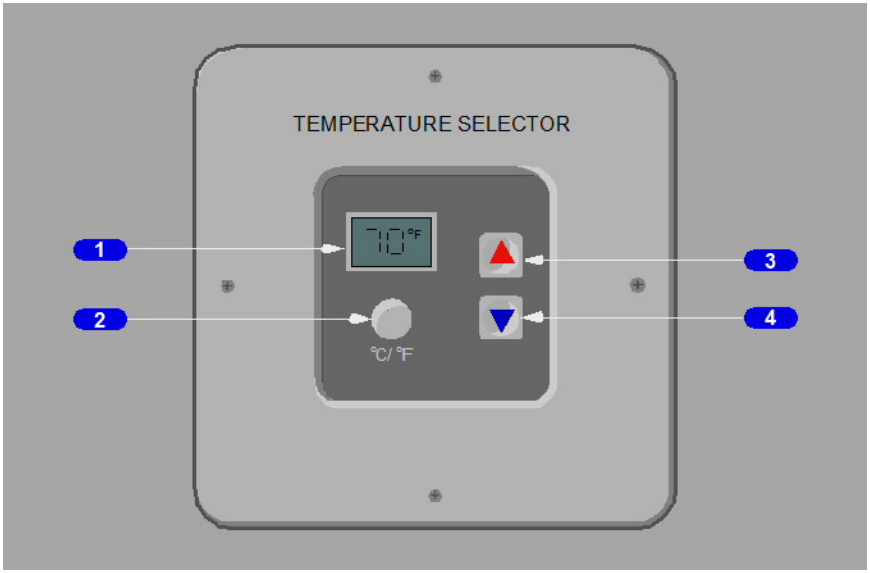
Light extinguishes when a handset is removed from the cradle or the call is canceled.

Temperature Control System

The temperature in the overhead flight attendant rest is controlled by the temperature controller located on the wall in the entrance enclosure. The temperature can be set between 59° F (15° C) and 80° F (27° C) by selecting the warmer or cooler arrows on the panel. Each bunk has an individual air flow outlet to help control individual temperatures in those areas.

Note: The crew rest compartment temperature can only be increased above the Cabin Zone D duct temperature. The system is not able to achieve the selected temperature under all operating conditions.

Temperature Control Panel



1 Temperature Display

Displays:

- current selected air temperature in deg F or deg C
- a momentary flashing selected temperature after warmer or cooler arrows are pushed

Note: If temperature display is continuously flashing, and not associated with a recent temperature setting change, the system has failed.

2 Units Selector

Push — toggles between deg F and deg C for display and temperature selection.

3 Warmer Arrow

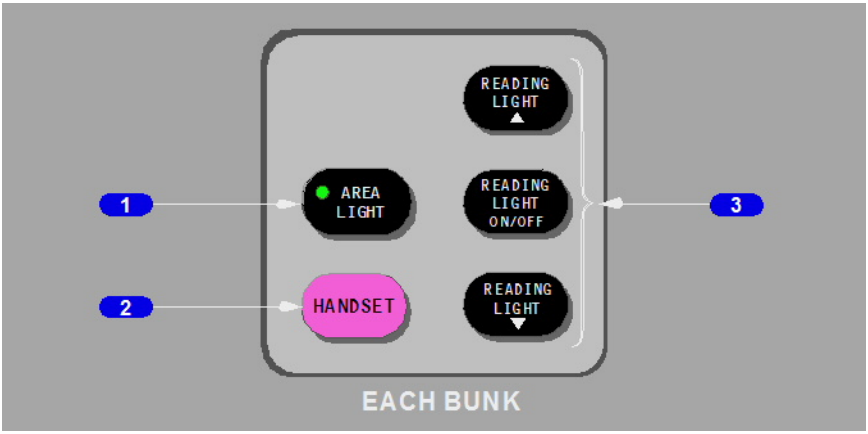
Push — to increase temperature setting for the overhead flight attendant rest.

4 Cooler Arrow

Push — to decrease temperature setting for the overhead flight attendant rest.

Bunk Lighting Control Panel

The OFAR has a lighting control panel located in the PSUs of bunks 1, 3, 4, and 6. Bunks 2 and 5 have a lighting control panel on the side wall at the head of the bunk.



1 Bunk AREA LIGHT Switch

Controls the bunk area lights which illuminate the header and footer of each individual bunk.

Push—

- turns bunk area lights on dim (green light illuminated)
- second push turns area lights on bright (green light illuminated)
- third push turns area lights off (green light extinguishes)

Note: The AREA LIGHT switch on the bunk lighting control panels does not control the entrance area lights.

2 HANDSET Light

Illuminated (magenta) – indicates an incoming cabin interphone call to the OFAR.

Light extinguishes when a handset is removed from the cradle or the call is cancelled.

3 READING LIGHT Switches

Push—

- READING LIGHT ON/OFF switch turns reading light ON or OFF (default setting is “dim”)
- upper READING LIGHT switch increases illumination to “bright”
- lower READING LIGHT decreases illumination to “dim”

Oxygen System

The overhead flight attendant rest oxygen system is considered part of the passenger cabin oxygen system and its operation is identical (see Passenger Cabin Oxygen System on page 1.40.18.).

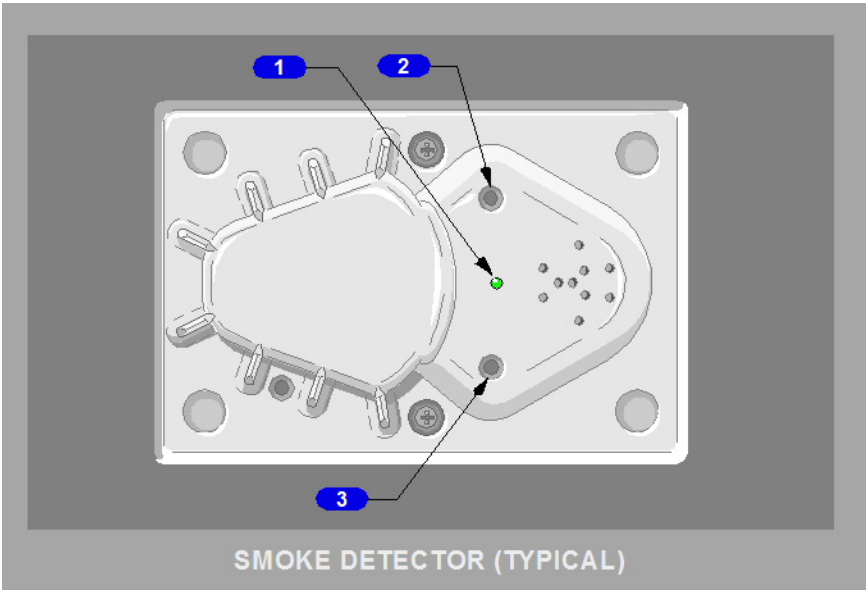
Note: When the oxygen masks deploy, the green oxygen indicator light in the common area illuminates.

Crew Rest Smoke Detection

Smoke detection is annunciated by a smoke alarm horn (pulsating) sounding in the main crew rest area and the entrance enclosure.

A total of eight (8) smoke detectors are installed in the overhead flight attendant rest. There are two smoke detectors in the common area and one in each bunk area.

Smoke Detector



1 Status Indicator Light

Illuminated (green)—

- steady – smoke detector has power and is operating properly
- blinking – maintenance is necessary

Illuminated (red)—

- steady – smoke has been detected
- blinking – detector has failed

2 Status Indicator Light

Push—

- if pushed and immediately released, horn sounds for three seconds
- if pushed and held, horn sounds until the switch is released
- red indicator illuminates
- external alarms sound

Note: Switch is recessed in the smoke detector housing and requires a pen or other device to push.

3 Horn Cancel Switch

Push—

- the smoke detector horn is silenced
- the cabin chime is turned off
- a smoke alarm suppression cycle is initiated

Release – the horn cancellation remains active until the detector has not sensed smoke for a period of 30 seconds, at which time the detector resets.

Note: The horn cancel switch does not affect the status indicator light on the smoke detector.

Crew Rest Smoke Detection System Operation

If smoke is detected in the overhead flight attendant rest:

- on the flight deck:
  - the master caution light illuminates
  - an aural caution alarm sounds
  - a SMOKE REST UPR DR 4 EICAS caution message is displayed
- in the crew rest area:
  - the smoke detector alarm indicator light illuminates
  - all area lights illuminate
  - the pulsating smoke detection system alarm horns sound
  - the air supply valves are closed and the area exhaust valves are opened
- at the entrance main control panel:
  - the pulsating smoke detection system alarm horn sounds
- in the passenger cabin:
  - the amber call light/reset switch above the entrance enclosure door flashes
  - a continuous chime sounds in the passenger cabin at door 3L, door 3 cross-aisle, door 3R, door 4L, and door 4R
  - the cabin attendant master call lights flash
  - a SMOKE DETECTED DR4 UPR REST message appears on the cabin attendant panels

Once the smoke clears, the red alarm indicator light extinguishes and the smoke detector is sensitive to smoke again. Continue to monitor the area until the red alarm indicator light extinguishes.

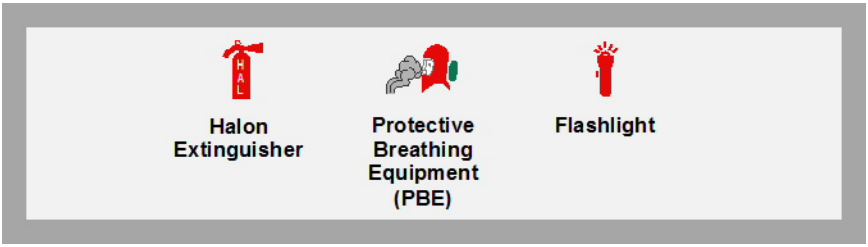
Note: When the smoke detector has been activated by smoke, lingering smoke in the detector sensor may cause reactivation. Blowing air into the detector sensor may clear lingering smoke.

Emergency Equipment

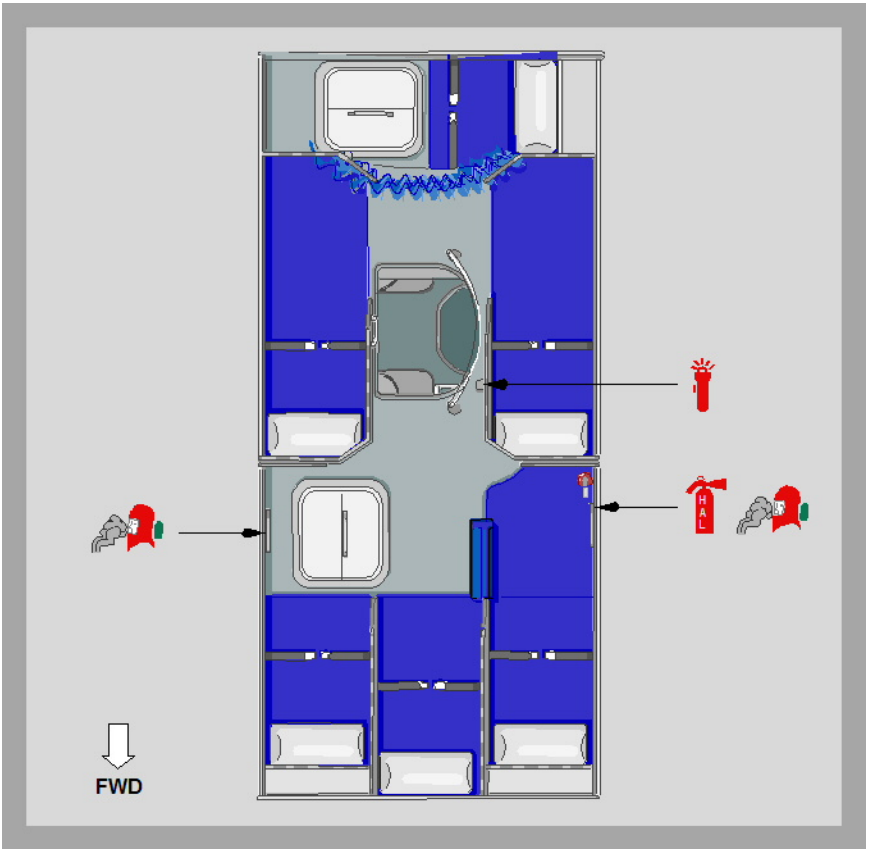
The overhead flight attendant rest emergency equipment includes:

- Halon fire extinguisher (1)
- protective breathing equipment (PBE) (2)
- flashlight (1)

Emergency Equipment Symbols



Emergency Equipment Location



OFAR Non-Normal Situation Guidelines

Decompression

If a cabin decompression occurs during cruise, a decompression (continuous) horn sounds in the main crew rest area and the entrance enclosure. The green oxygen indicator light also illuminates.

Overhead flight attendant rest occupants should immediately move to an unoccupied position (if necessary), don one of the oxygen masks, and fasten the bunk lap belt.

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

Evacuate the overhead flight attendant rest when directed by the flight crew.

Note: Prior to evacuating the overhead flight attendant rest, push the HORN SHUT OFF switch (located at the entrance on the main control panel). This silences the decompression alarm horns in the overhead flight attendant rest.

Crew Rest Area Fire Fighting

OFAR is occupied

If smoke is detected, at least one crew member in the crew rest:

- dons a smoke hood
- pushes the HORN SHUT OFF switch in the entrance area to silence the smoke detection system alarm horn and chimes, if required

  Notes: 1. Pushing the HORN SHUT OFF switch also removes the cabin services system alert pop-up window SMOKE DETECTED. A SMOKE DETECTED message is then shown in small text at the bottom of all displays.
  2. The flight deck Engine and Crew Alerting System (EICAS) message SMOKE REST UPR DR 4 remains displayed until the smoke detection system is reset.
- fights fire

  WARNINGS:
  1. **If the source of the smoke/fire can not be readily found, maintain access to the main entrance while continuing to search for source.**
  2. **If it becomes necessary to set the fire extinguisher down while searching for the fire source, ensure the extinguisher remains in contact with some part of the body for quick retrieval.**
- crew members not fighting the fire are to evacuate the upper crew rest area
  - ensure the entrance door is closed
  - establish communications with the flight deck
  - relocate additional emergency equipment to near the overhead crew rest area entrance
  - assist the crew member in the crew rest area, as required

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

OFAR is unoccupied

- ensure the entrance door is closed
- establish communications with the flight deck
- a crew member outside the overhead rest entrance pushes the amber reset light above the entrance enclosure door to silence smoke detection system alarm horn and chimes, if required

Notes: 1. Pushing the reset switch also removes the cabin services system alert pop-up window SMOKE DETECTED. A SMOKE DETECTED message is then shown in small text at the bottom of all displays.

2. The flight deck Engine and Crew Alerting System (EICAS) message SMOKE REST UPR DR 4 remains displayed until the smoke detection system is reset.

- at least one crew member:
  - obtains a fire extinguisher
  - dons a smoke hood
  - feels the door
  - if the door is hot:
    - keep the door closed
    - use a crash axe to chop a small hole in the upper part of the door just big enough to receive a fire extinguisher nozzle
    - discharge the fire extinguishing agent, preferably halon, into the hole
    - discharge the extinguisher completely
    - if needed, discharge the remaining extinguishers into the same hole to build up and maintain a high concentration of extinguishing agent
  - if the door is cool:
    - enters enclosure and closes door

      Note: Opening/closing of the door may require assistance of a second assistant if fire gloves are on.
    - puts on fire gloves (unless previously donned)
    - pushes the HORN SHUT OFF switch in the common area to silence the smoke detection system alarm horn and chimes, if required

      Note: The flight deck Engine and Crew Alerting System (EICAS) SMOKE REST UPR DR 4 message remains displayed until the smoke detection system is reset
    - fights fire
    - locates source of fire/smoke
    - discharge fire extinguisher at the base of the flames and/or any hotspots

WARNINGS: 1. If the source of the smoke/fire can not be readily found, maintain access to the main entrance while continuing to search for source.

2. If it becomes necessary to set the fire extinguisher down while searching for the fire source, ensure the extinguisher remains in contact with some part of the body for quick retrieval.

- crew members not fighting the fire assist as necessary
  - relocate additional emergency equipment near the overhead crew rest area entrance
  - assist the crew member in the crew rest area, as required
- after the smoke has been cleared from the crew rest area:
  - continue to monitor the overhead flight attendant rest area
    - visually monitor the crew rest
    - use the cabin attendant panels as appropriate

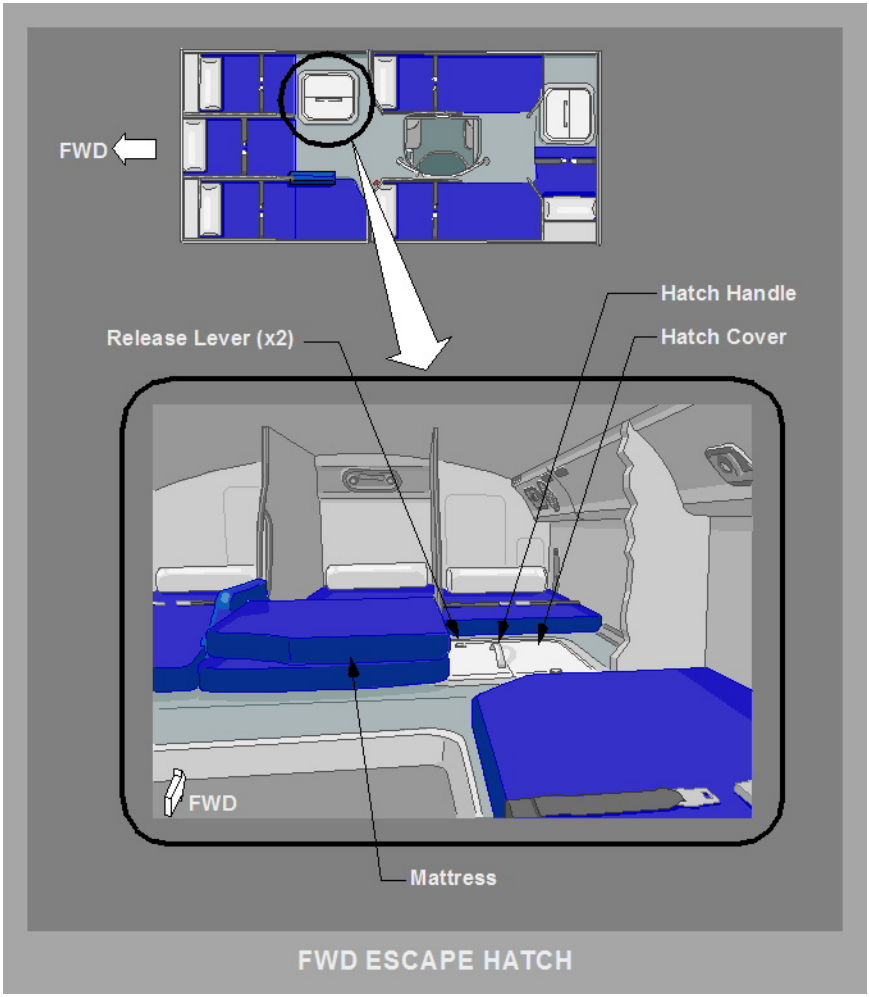
Note: The overhead crew rest area may be used if:
- the ignition source has been positively identified and extinguished
- all smoke has been cleared from the crew rest area

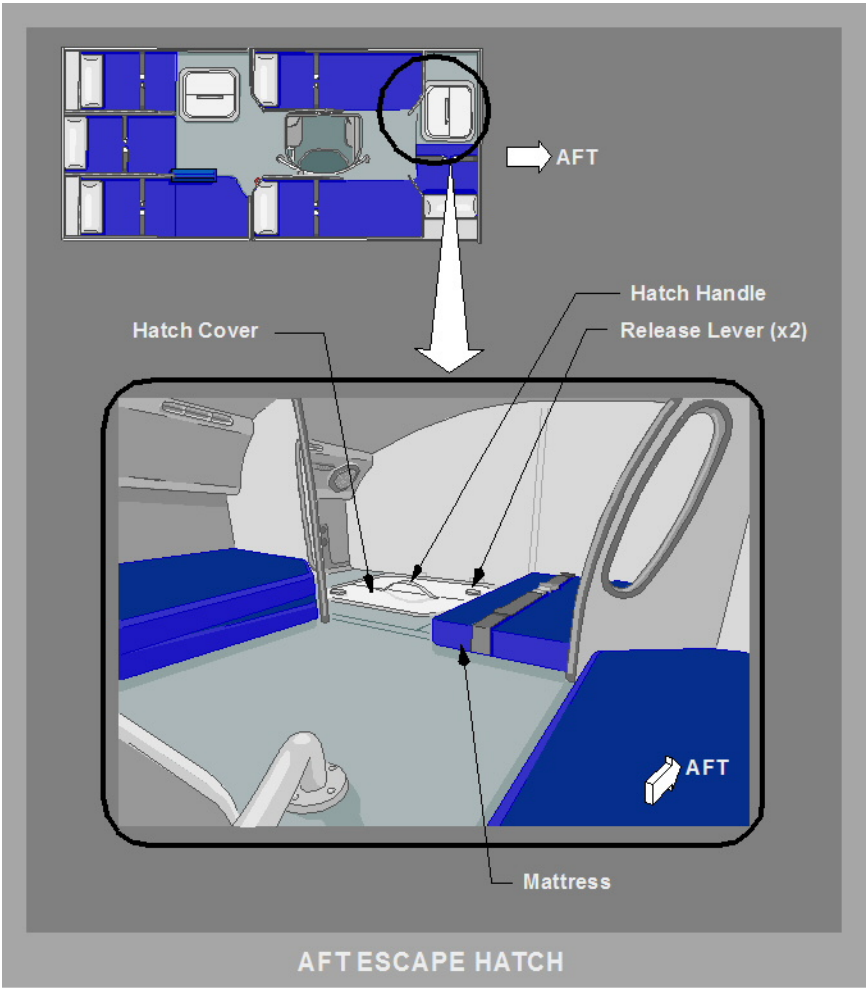
WARNING: If the emergency hatches were used for crew evacuation, the lower hatches must be closed to help prevent the spread of smoke or fire.

Evacuation from the Crew Rest Compartment

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

If the main entrance is unusable, evacuation is possible through the emergency hatches located at bunks 3 and 5.

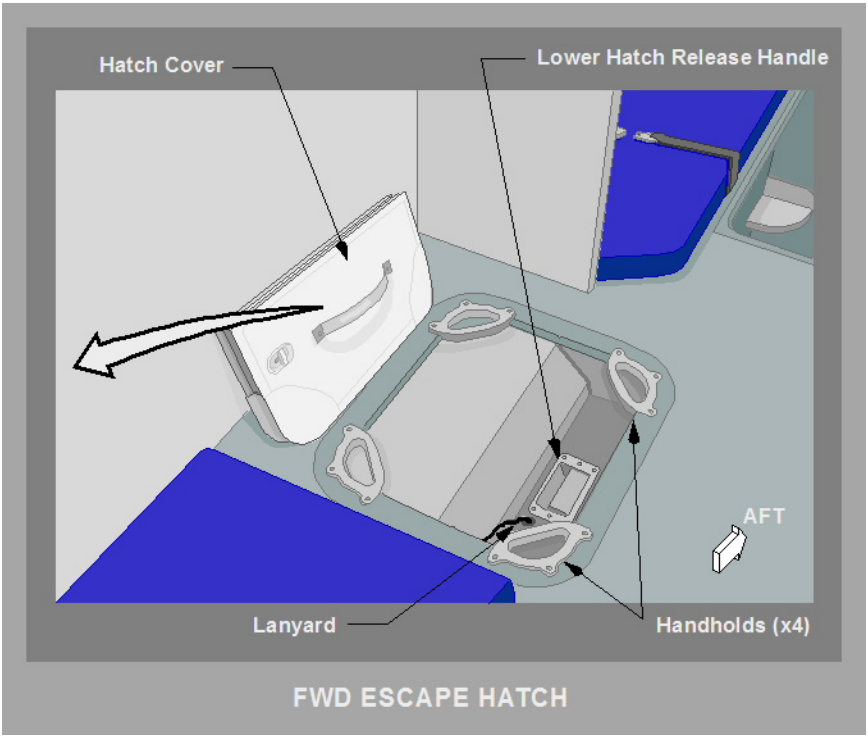

FWD
Release Lever (x2)
Hatch Handle
Hatch Cover
FWD
Mattress
FWD ESCAPE HATCH



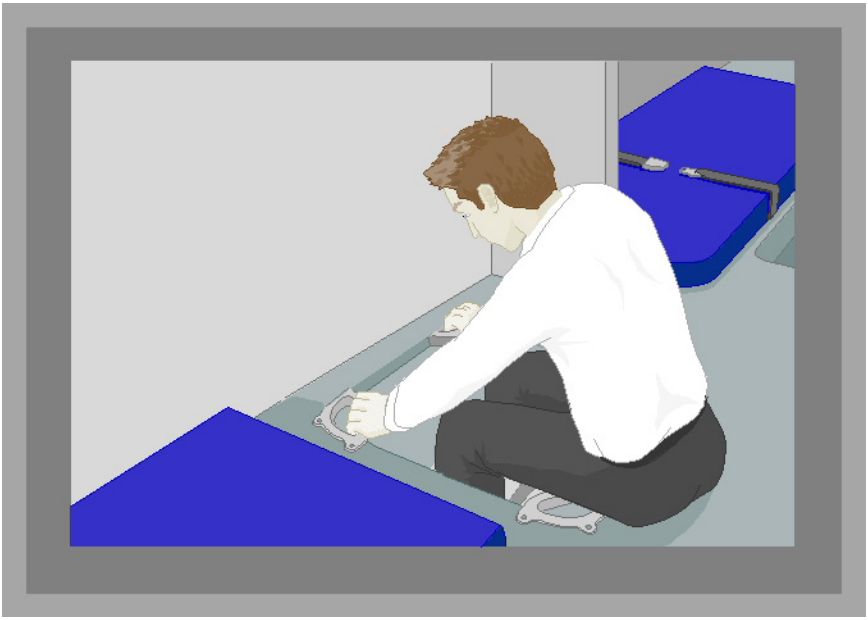
For egress from either emergency escape hatch:

- lift and remove the mattress pad

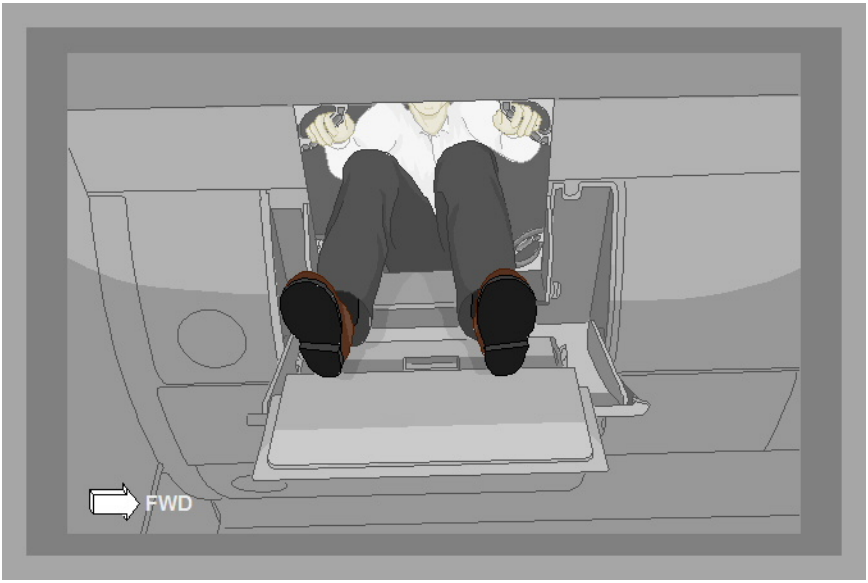
  Note: Stow the mattress pad where it does not obstruct the emergency hatch.



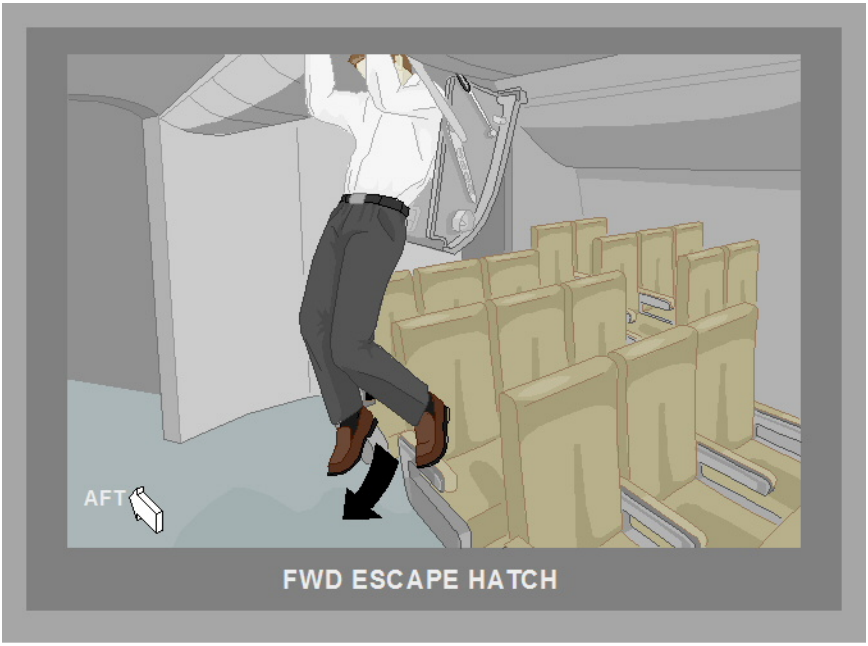
- unlatch the cover using the two release levers
- pull up on hatch handle to open the cover
- stow the hatch cover where it does not interfere with evacuation through the emergency hatch
- unlatch lower hatch
  - for the forward escape hatch:
    - pull the lower hatch release handle
    - let the hatch drop a few inches
    - pull out lanyard and let hatch fall
  - for the aft escape hatch:
    - push the lower hatch release lever
- command passengers in immediate area to move clear of evacuation area



- sit on bench facing the right side of the airplane
- lower legs into hatch opening



- grasp the handholds keeping elbows tucked inward





- use the lower hatch to slide/swing down and drop to main deck
  - use the seat armrest to assist in maintaining balance as necessary

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

- close the lower hatch when evacuation is complete

WARNING: The lower evacuation hatch must be closed to help prevent the spread of smoke or fire.

Evacuating an Incapacitated Using the Main Stairway

The upper assistant(s) should:

- obtain assistance as necessary

- place the incapacitated person on the floor, face up, with feet near the top of the stairs



With the incapacitated person sitting on the edge at the top of the stairs:

- the upper assistant(s) should:
  - move the incapacitated person so most of his/her legs are down the stairs
  - sit behind the incapacitated person without supporting much of the incapacitated person's weight
  - prepare to transfer the incapacitated person to the lower assistant(s).



- the lower assistant(s) should:
  - request assistance (as required)
  - work the feet into the stairway
  - take as much weight as possible.



- the upper assistant(s) should:
  - transfer grip to the back of the jacket or shirt (or under the shoulders) of the incapacitated person
    Note: Do not support much of the incapacitated person's weight.
  - proceed down the stairs.
    Note: Protect incapacitated person’s head and neck as much as possible.
- the lower assistant(s) should:
  - receive the incapacitated person
  - lower him/her to the floor while protecting the head and neck
  - close the area door.

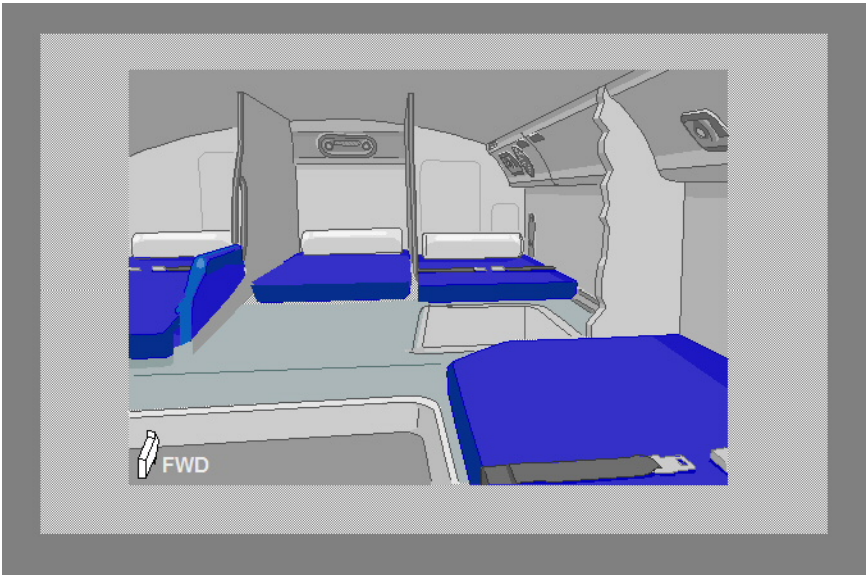
Evacuating an Incapacitated Person Using the Emergency Hatches

Prior to evacuation, the assistant(s) on the main deck should command passengers in the immediate area to move clear of evacuation area.

Note: Displace the minimum number of passengers.

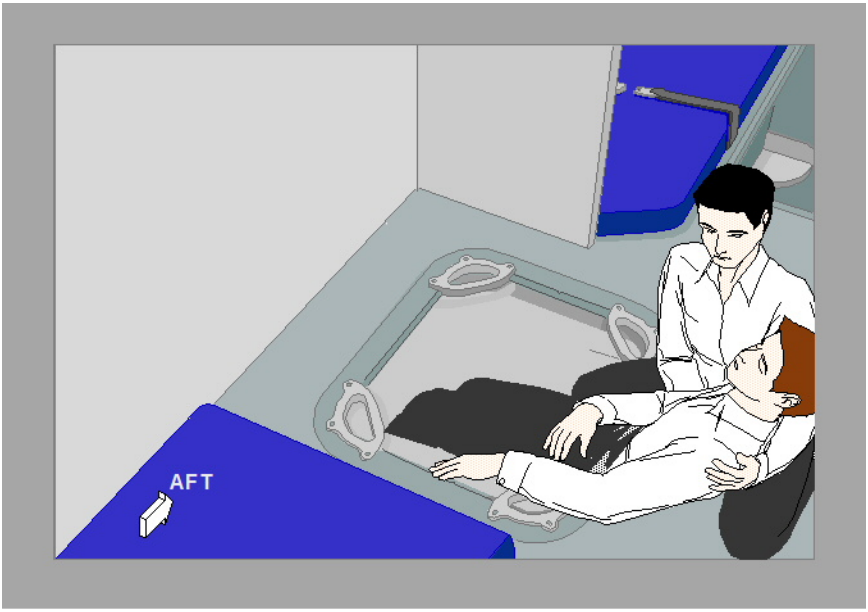
The assistant(s) in the crew rest should:

- obtain assistance as necessary
- lift and remove the mattress pads



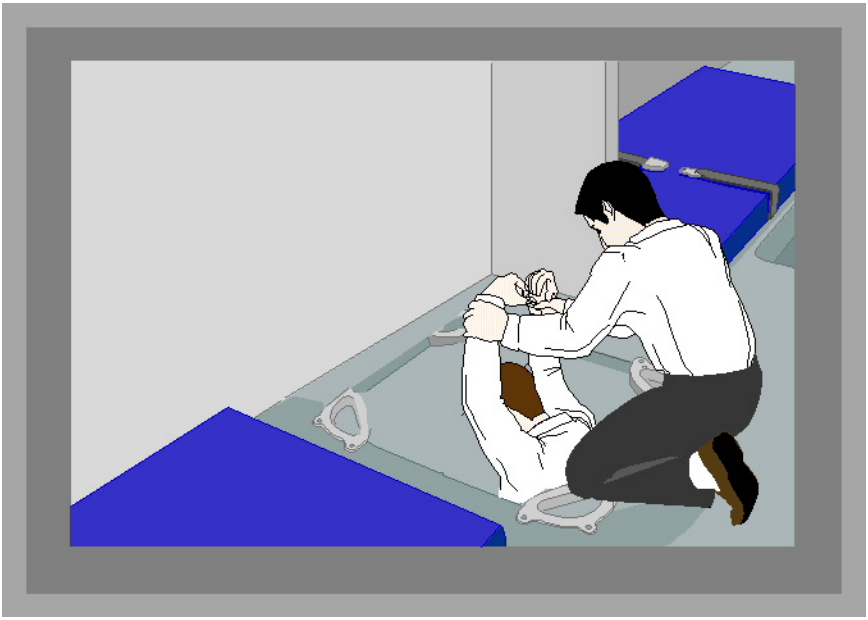
- unlatch and raise bunk escape hatch cover
- unlatch lower hatch
  - for the forward escape hatch:
  - pull the lower hatch release handle
  - let the hatch drop a few inches
  - pull out lanyard and let hatch fall
- for the aft escape hatch:
  - push the lower hatch release lever
- place the incapacitated person across the bunks, face up
  - feet should be placed near the hatch opening

With one or more assistant(s) located below to handle the incapacitated person,



- the upper assistant(s) in the crew rest should:
  - place the incapacitated person's feet in the hatch opening
  - move to a position behind the incapacitated person
  - raise the incapacitated person to a sitting position.
- placing hands under the incapacitated person's shoulders
  - slide the incapacitated person until the majority of the legs are in the hatch and weight transferred to hatch bench
- the main deck assistant(s) should:
  - hold the incapacitated person’s feet on the step

    Note: This helps support the incapacitate person while being lowered into the hatch.
- the upper assistant(s) should:
  - slowly lower the incapacitated person down through the hatch



- transfer incapacitated person's weight to hatch step as necessary





- the assistant(s) on the main deck shall:
  - receive the incapacitated person

    Note: The upper assistant should protect the incapacitated person's head and neck as much as possible while she/he is being lowered to main deck by the lower assistant(s).
  - close the upper and lower hatch.

Airplane General, Emergency Equipment, Doors, Windows EICAS Messages

The following EICAS messages can be displayed.

Doors and Windows

Message	Level	Aural	Condition
DOOR AFT, FWD CARGO	Caution	Beeper	The cargo door is not closed and secure.
DOOR BULK CARGO	Advisory		The bulk cargo door is not closed and secure.
DOOR AFT, FWD E/E ACCESS	Advisory		The electrical and electronic access door is not closed and secure.
DOOR ENTRY 1–4L, R	Advisory		An entry door is not closed and secure.
DOOR FD OVHD	Advisory		The flight deck overhead door is not closed and secure.
DOOR FWD ACCESS	Advisory		The forward access door is not closed and secure. TQA to TQF
DOORS	Advisory		Two or more doors are not closed and secure.
DOORS AUTO	Memo		All passenger doors are in the automatic mode.
DOORS AUTO/ MANUAL	Memo		Some passenger entry doors are in the automatic mode and some are in the manual mode.
DOORS MANUAL	Memo		All passenger doors are in the manual mode.
FD DOOR AUTO UNLOCK	Warning		The correct emergency access code is entered.
FD DOOR LOCK FAIL	Advisory		One or more of these occur: • the flight deck door power is off • the lock is failed.
FD DOOR OPEN	Advisory		The flight deck door is open.

Emergency Lights and Passenger Signs

Message	Level	Aural	Condition
EMER LIGHTS	Advisory		One of these occurs: • the emergency lights are on • the emergency lights switch is not ARMED.
SEATBELTS ON	Memo		The SEAT BELTS switch is in the ON position.

Oxygen System

Message	Level	Aural	Condition
CREW OXYGEN LOW	Advisory		Crew oxygen pressure is low.
PASS OXYGEN ON	Advisory		The passenger oxygen system is on.

Miscellaneous Emergency Equipment

Message	Level	Aural	Condition
ELT ON	Advisory		The emergency locator transmitter is on.
EVAC COMMAND	Warning	Evac Horn	The evacuation command signal is on.

Air Systems — Chapter 2
Table of Contents

Controls and Indicators 2.10

Air Conditioning System 2.10.1
Air Conditioning Panel 2.10.1
Shoulder and Foot Heaters 2.10.4
Cargo Temperature Control 2.10.5
Forward and Bulk Cargo Temperature Control 2.10.5
Pressurization System 2.10.6
Pressurization Panel 2.10.6
Pressurization System Indications 2.10.7
Equipment Cooling 2.10.8
Power Electronics Cooling System (PECS) Indications 2.10.8
Air Synoptic Display 2.10.10
Synoptic Indication Symbology 2.10.12

Air Conditioning System Description 2.20

Introduction 2.20.1
Air Conditioning Packs 2.20.1
Pack Ground Operation 2.20.1
Pack Non-Normal Operation 2.20.2
Standby Cooling Mode 2.20.2
Air Distribution 2.20.3
Alternate Ventilation System 2.20.4
Temperature Control 2.20.4
Crew Rest Area Temperature Control 2.20.5
Temperature Control With Loss of Trim Air 2.20.5
Shoulder and Foot Heaters 2.20.5
Cargo Temperature Control System 2.20.5
Forward Cargo Heat 2.20.5
Bulk Cargo Heat 2.20.5
Aft Cargo Heat 2.20.6

Air Conditioning System Schematic 2.20.7

Equipment Cooling, Equipment Ventilation, Lavatory and Galley Ventilation 2.20.9

Forward Equipment Cooling 2.20.9

Aft Equipment Cooling 2.20.10

Lavatory/Galley Ventilation System 2.20.11

Power Electronics Cooling System (PECS) 2.20.11

Integrated Cooling System 2.20.12

Miscellaneous Equipment Cooling System 2.20.12

Pressurization System Description 2.30

Introduction 2.30.1

Pressurization System Automatic Operation 2.30.1

Operation With Loss of Landing Altitude 2.30.2

Operation With Loss of Cabin Pressurization 2.30.2

Pressurization System Manual Operation 2.30.2

Bleed Air System Description 2.40

Introduction 2.40.1

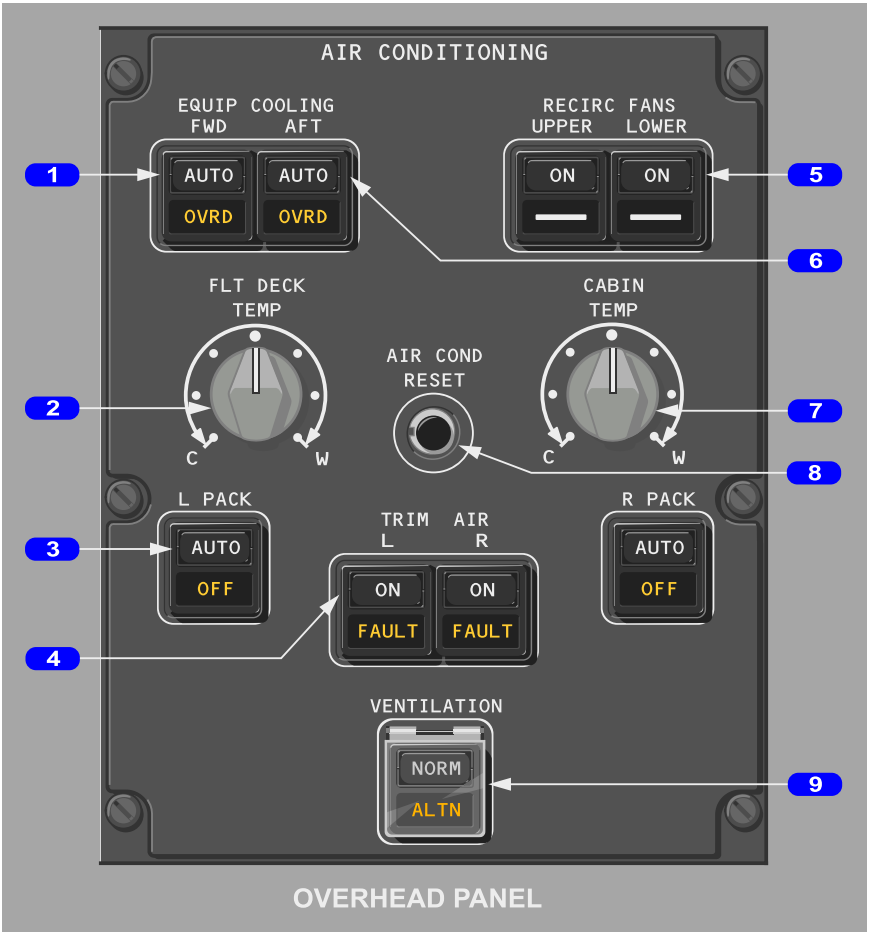
Engine Anti-ice Bleed Air Supply 2.40.1

EICAS Messages 2.50

Air Systems EICAS Messages 2.50.1

Air Conditioning System

Air Conditioning Panel



1 Forward Equipment Cooling (EQUIP COOLING FWD) Switch

AUTO—forward equipment cooling mode is controlled automatically.

Off (AUTO not visible)—

- both forward equipment cooling supply fans, flight deck supply fan and vent fan are commanded off
- both the smoke/override valve and the flight deck isolation valve are commanded open
- forward cargo heat becomes inoperative
- OVRD illuminates.

OVRD (illuminated amber)—SMOKE/OVRD mode is operating because:

- off is selected manually, or
- both forward equipment cooling supply fans fail, or
- the smoke/override mode is automatically selected by the smoke detection system.

2 Flight Deck Temperature (FLT DECK TEMP) Control

- selects the target flight deck temperature
- turning the control toward C or W sets the desired temperature between 18 deg. C and 29 deg. C. Mid position (12 o'clock) sets approximately 24 deg. C.

Note: During ground operations, the flight deck boost fan may be commanded on when the flight deck temperature switch is selected to the full C or to the full W setting. When the fan is on, flight deck air flow is increased and passenger cabin air flow is slightly reduced.

3 PACK Switches

AUTO—the pack is automatically controlled.

Off (AUTO not visible)—cabin air compressors are commanded off.

OFF (illuminated amber)—both associated cabin air compressors are not running:

- automatically during engine start, or
- automatically due to a pack or compressor outlet high temperature, or
- OFF is manually selected.

4 TRIM AIR Switches

ON—the trim air valve is commanded open.

Off (ON not visible)—

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

FAULT illuminated (amber)—

- the trim air valve is failed closed, or

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

5 Recirculation Fans (RECIRC FANS) Switches

ON—provides automatic operation of the associated recirculation fans.

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

An EICAS advisory message is displayed if either the upper or lower switches are placed in the off position.

6 Aft Equipment Cooling (EQUIP COOLING AFT) Switch

AUTO—aft equipment cooling mode is controlled automatically.

Off (AUTO not visible)—

- both aft equipment cooling supply fans and vent fan are commanded off
- override valve is commanded open
- aft cargo heat becomes inoperative
- OVRD illuminates.

OVRD (illuminated amber)—SMOKE/OVRD mode is operating because:

- off is selected manually
- both equipment cooling supply fans fail, or
- smoke/override mode is automatically selected by the smoke detection system.

7 Cabin Temperature (CABIN TEMP) Control

Provides automatic passenger cabin temperature control.

Turning the control toward C or W sets the passenger cabin master reference temperature between 18 deg. C and 29 deg. C.

8 Air Conditioning Reset (AIR COND RESET) Switch

Push—

- resets any air conditioning faults and attempts to restart normal operation
- resets any trim air valves held closed due to overheat, control failure, or valve failure
- attempts to reset a failed recirculation fan
- resets fault protection.

9 Alternate Ventilation (VENTILATION) Switch

NORM—environmental control system is configured for normal operation.

TQA to TQF ALTN (illuminated amber) — alternate ventilation valve is in the open position. When valve is open, no alternate ventilation flow occurs when airplane is pressurized normally.

TWA,B ALTN (illuminated amber) — the Forward and Aft Outflow Valves are automatically repositioned towards the ten and one o'clock positions respectively when airplane is below 13,000 ft altitude and not on ground.

Shoulder and Foot Heaters



1 SHOULDER HEATER Control

LOW—electric heater operates on low setting.

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

Note: Available in-flight only.

2 FOOT HEATER Control

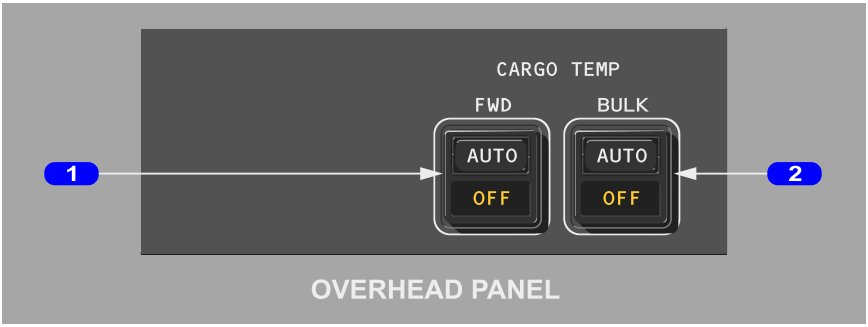
LOW—electric heater is off.

Turn—electric heater adds heat to the floor plate at variable temperature settings up to HIGH.

Note: Available on ground and in-flight when pack and recirculation fans are on.

Cargo Temperature Control

Forward and Bulk Cargo Temperature Control



1 FWD CARGO TEMP Switch

AUTO—forward cargo heat system targeting 21 deg. C.

Off (AUTO not visible)—forward cargo heat is commanded off.

OFF (illuminated amber)—

- FWD CARGO TEMP switch selected off
- forward cargo heater overheat.

2 BULK CARGO TEMP Switch

AUTO—bulk cargo heat system targeting 21 deg. C.

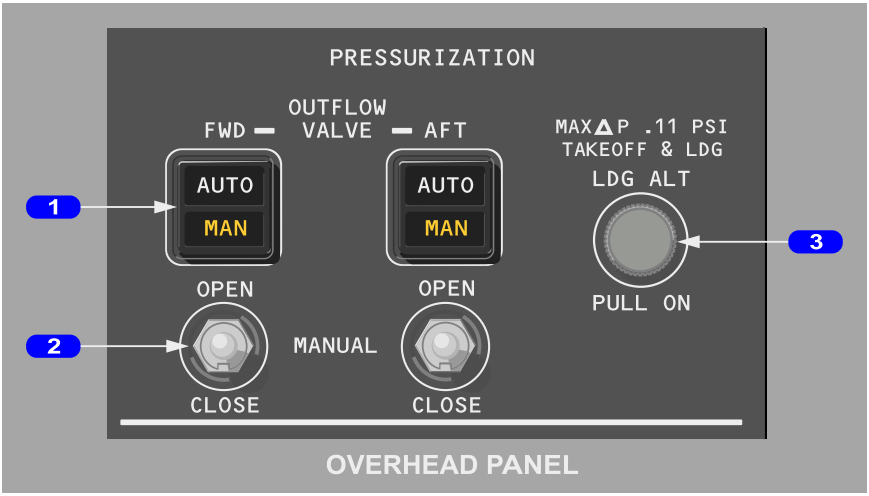
Off (AUTO not visible)—bulk cargo heat is commanded off.

OFF (illuminated amber)—

- BULK CARGO TEMP switch selected off
- bulk cargo heater overheat.

Pressurization System

Pressurization Panel



1 OUTFLOW VALVE (FWD/AFT) Switches

AUTO—outflow valve controlled automatically.

MAN (manual, illuminated amber)—

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

2 OUTFLOW VALVE MANUAL Switches

OPEN—moves the outflow valve toward open.

CLOSE—moves the outflow valve toward closed.

3 Landing Altitude (LDG ALT) Selector

Pull ON, then rotate—

- sets landing altitude manually
- landing altitude followed by MAN displayed on EICAS
- when turned slowly, landing altitude display changes in 100 foot increments. When turned quickly, display changes in 500 foot increments.

Push—

- landing altitude set automatically from FMS (see Approach on page 11.43.10.)

- landing altitude followed by AUTO displayed on EICAS.

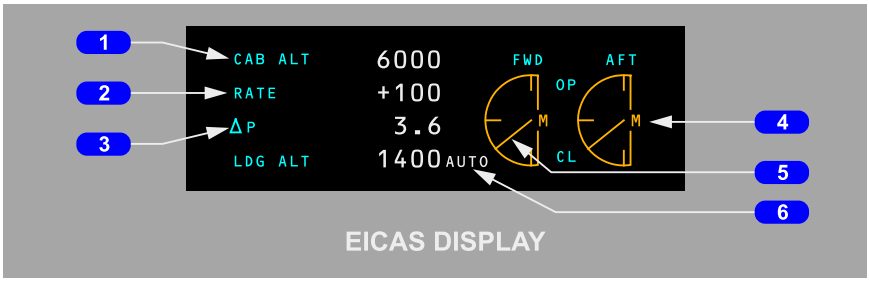
Pressurization System Indications

Pressurization system indications are displayed automatically when:

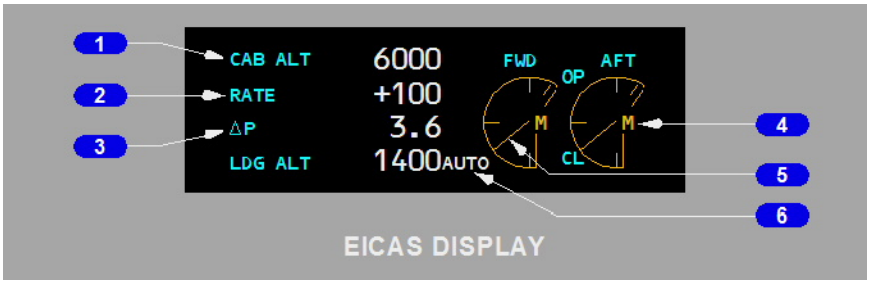
- landing altitude MAN
- either OUTFLOW VALVE switch in MAN
- cabin altitude is above normal range (amber or red)
- cabin differential pressure is above normal range (amber)
- cabin differential pressure is excessive (red)
- AIR synoptic selected on any MFD
- the following EICAS messages are displayed:
  - CABIN ALTITUDE
  - CABIN ALTITUDE AUTO
  - LANDING ALTITUDE
  - PACK L + R
  - OUTFLOW VALVE AFT
  - OUTFLOW VALVE FWD.
  - VENTILATION ALTN

TWA,B

TQA to TQF



TWA,B



1 Cabin Altitude

White—normal range.

Amber—above normal range.

Red—excessive cabin altitude.

2 Cabin Altitude Rate

+ (plus)—rate of climb.

–(minus)—rate of descent.

3 Cabin Differential Pressure

White—normal range.

Amber—above normal range.

Red—excessive cabin differential pressure.

4 Outflow Valve Control Source

M (manual) (amber)—manual control.

Blank—automatic control.

5 Outflow Valves Position

OP—open.

CL—closed.

Pointer varies position to reflect outflow valve position from open to closed.

6 Landing Altitude Selection

AUTO (white)—altitude set automatically from FMC.

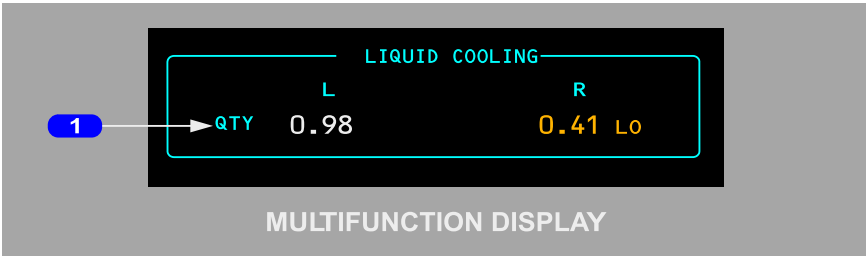
MAN (amber)—altitude set by landing altitude (LDG ALT) selector.

Equipment Cooling

Power Electronics Cooling System (PECS) Indications

PECS is the liquid cooling system for electronics. To view the status display, push a Systems (SYS) display switch, then select the status (STAT) synoptic key. (See Display Select Panel on page 10.10.51 for additional information.)

Status Display



1 Liquid Quantity Display

QTY—

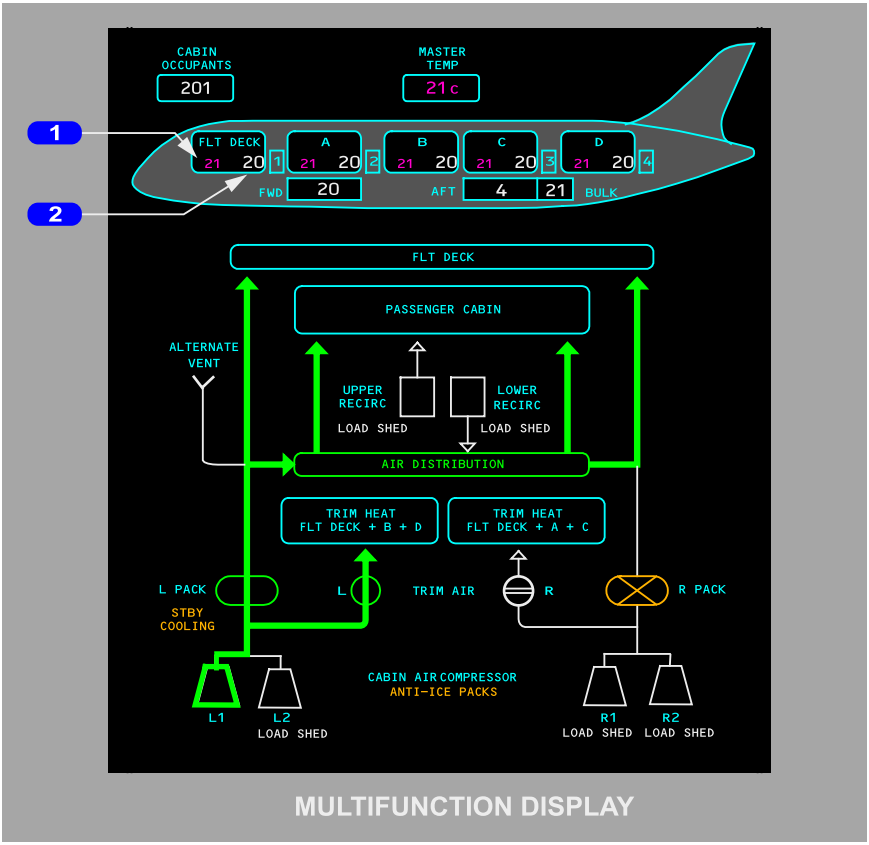
- displays the left and right system reservoir quantities as a percentage of the normal service level (1.00 is the normal service level)
- LO (amber)—displayed when the reservoir requires servicing
- RF (white)—displayed when reservoir servicing is recommended
- OF (white)—displayed when the reservoir is over-full.

Note: A single liquid cooling loop is displayed when only one forward external power source is connected and selected ON.

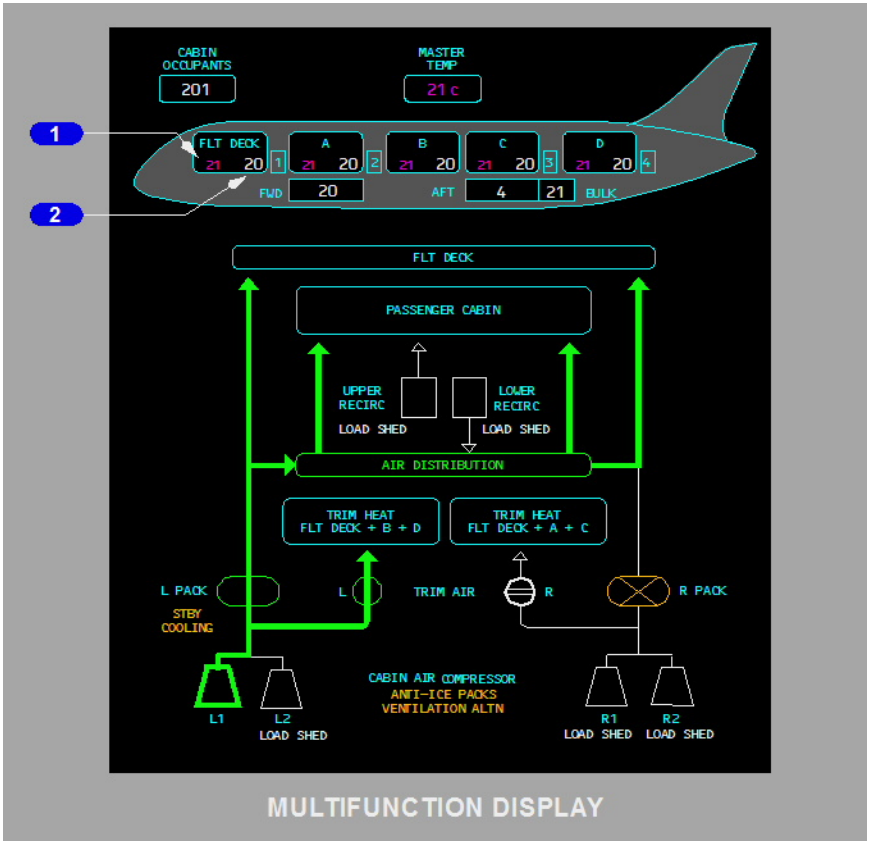
Air Synoptic Display

The air systems synoptic is displayed by pushing the systems (SYS) display switch on the display select panel, then selecting the air systems (AIR) synoptic key. (See Display Select Panel on page 10.10.51 for additional information.)

TQA to TQF



TWA,B



1 Selected Temperatures (magenta)

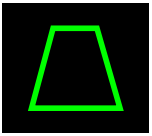
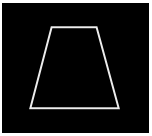
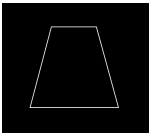
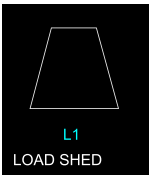
Selected by the FLT DECK TEMP and the CABIN TEMP controls.

2 Actual Temperatures (white)

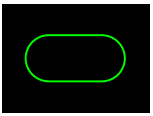
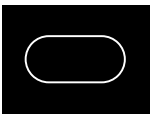
Actual temperature sensed on the flight deck or the passenger zone.

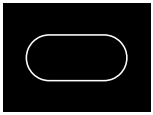
Synoptic Indication Symbology

Cabin Air Compressor Synoptic Indications

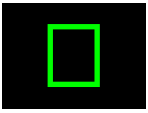
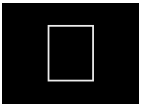
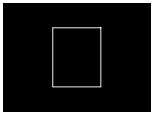
Symbol	Condition	Description
	Compressor on (green)	Associated compressor is running and developing flow.
	Compressor off (white)	Associated compressor is not developing flow.
	Compressor invalid (white, low intensity)	Signal from associated compressor is invalid or missing.
	Compressor load shed (white)	Associated compressor (L1,L2,R1,R2) has load shed.

Pack Synoptic Indications

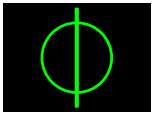
Symbol	Condition	Description
	Pack on (green)	Pack is running and developing conditioned airflow.
	Pack off (white)	Pack switch—OFF or both associated cabin air compressors are off and not PACK L(R) status message.

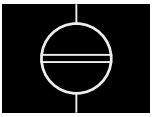
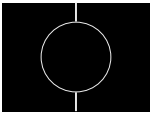
Symbol	Condition	Description
	Pack failed (amber)	Pack is not developing conditioned inflow when commanded to run. PACK switch—AUTO and PACK L(R) status message.
	Pack signal invalid (white, low intensity)	

Recirculation Fan Synoptic Indications

Symbol	Condition	Description
	Fan on (green)	Upper fan or one of two lower fans is developing flow.
	Fan off (white)	Upper fan or both lower fans are not running.
	Fan invalid on (white, low intensity)	

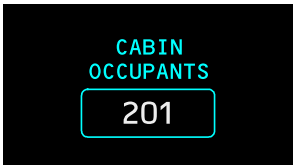
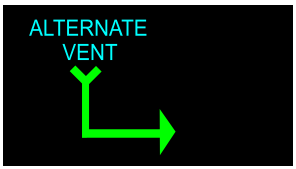
Trim Air Valve Synoptic Indications

Symbol	Condition	Description
	Valve open (green)	

Symbol	Condition	Description
	Valve closed (white)	
	Valve failed open (amber)	
	Valve failed closed (amber)	
	Valve invalid (white, low intensity)	

Miscellaneous Synoptic Indications

Symbol	Condition	Description
	Associated pack in standby cooling mode	EICAS advisory message PACK MODE L (R) displayed.
	Compressor inlet anti-ice failure	EICAS advisory message ANTI-ICE PACKS displayed.

Symbol	Condition	Description
	Number of cabin occupants as entered on the Cabin Attendant Panel	Blank if data missing or invalid.
	Ventilation system is in the alternate mode	Flight deck VENTILATION switch in ALTN position EICAS advisory message VENTILATION ALTN displayed.
	Ventilation system is in the alternate mode	Flight deck VENTILATION switch in ALTN position EICAS advisory message VENTILATION ALTN displayed.

TQA to TQF

TWA,B

Introduction

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

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

The system supplies ventilation for the passenger cabin:

- galleys
- lavatories.
- overhead crew rest compartments.

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

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

Note: Zones A and B contain sub-zones A1 and B1 that are not depicted on the air synoptic.

Air Conditioning Packs

Outside air is supplied to four electric cabin air compressors (CAC) through two dedicated inlets located in the wing to body fairings. During normal ground operations and landing phases of flight, deflector doors deploy in front of the CAC inlets to prevent debris from entering the CACs. These deflector doors may retract on the ground when ambient air temperature is below 2 deg. C or above 35 deg. C.

The air is then pressurized and flow-regulated by the CACs and supplied to two identical air conditioning packs. Two CACs are dedicated to each pack. A single CAC provides sufficient air to operate its associated pack in all operating modes. Packs are controlled by two identical pack control systems. If one system fails, pack control automatically switches to the other system.

Air flow to the packs is controlled by regulating the cabin air compressors. CAC output is increased automatically during high demand periods (to compensate for a failed pack), or is limited during electrical load shed conditions to ensure sufficient electrical power is available to other critical systems. During normal operation, outside airflow is controlled to ensure that a minimum ventilation rate is maintained.

Pack Ground Operation

Both air conditioning packs are normally selected to AUTO for ground operations. Each pack uses a ram fan to draw air through the ram air system for ground

operation cooling when sufficient main A/C Bus power is available. Normally, one CAC on each pack runs when using the APU as the power source.

Use of external power to power air conditioning packs is not recommended. A ground source of conditioned air can be used to supply conditioned air directly to the cabin distribution system.

CAUTION: Packs and lower recirculation fans must be selected off before and during use of external conditioned air.

During cold weather operations both CACs in each pack are commanded on.

TWA,B **Note:** Three CAC operation is automatically enabled two minutes after both engines are running.

For normal engine starts, all CACs are commanded off during initial start sequence with corresponding PACK L and PACK R messages inhibited. Packs do not restart until at least two minutes after the engine start sequence is initiated and the engine is running. If both engines are started together, and the two minute limit is met, packs restart immediately after the second engine is running.

Pack Non-Normal Operation

Pack control, fault detection, and overheat protection are all automatic. If an overheat or other significant pack fault is detected, the pack shuts down automatically and the EICAS advisory message PACK (L, R) is displayed. An attempt to restore pack operation may be made by pressing the AIR CONDITIONING RESET switch.

For an in-flight starter assisted engine start, only one CAC runs to maintain pack operation and maximize power available for the engine cross start.

During a go-around with one engine inoperative, if slat autogap is needed, both packs could temporarily load shed and the PACK L+R message may show momentarily. No crew action is required for the PACK L+R message in this condition.

Standby Cooling Mode

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

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

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

Air Distribution

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

The flight deck receives 100% conditioned outside air and the passenger cabin receives a mix of outside air and recirculated air. Some recirculated air is supplied to the flight deck if one pack is off and its associated lower recirculation fan is on.

Outside air flow is reduced during failure conditions and electrical load shed conditions to protect the electrical power distribution system and to ensure that sufficient electrical power is available to other critical airplane systems.

Cabin attendants can reduce outside airflow to the cabin based on the number of airplane occupants. This reduction is limited to ensure that a minimum air flow is always supplied to the cabin.

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

The lower recirculation ducts contain liquid-to-air heat exchangers capable of additional cabin cooling. Lower recirculation cooling reduces the power required from the CACs. Lower recirculation cooling is provided by the Integrated Cooling System (ICS) which is a common galley cooling system.

When upper and/or lower RECIRCULATION FAN switches are OFF, an EICAS advisory message RECIRC FAN UPR and/or LWR OFF is displayed. Turning the recirculation fans off does not increase the amount of fresh air to the passenger cabin, but results in a decreased airflow instead.

Note: If smoke is detected in the aft E/E equipment compartment, the lower recirculation fans are commanded off. (See Aft Equipment Cooling on page 2.20.10.) TWA,B

CAUTION: Recirculation fans must remain ON during hot weather operations unless a non-normal checklist directs to select them off.

A de-humidification system is located in the crown area of the passenger compartment. The system operates automatically when electrical power is available. It uses two zonal dryers (forward & aft) to remove moist air from the crown area. Fans recirculate dry air back to the crown area while moist air is exhausted below the cabin floor.

Alternate Ventilation System

TQA to TQF The Alternate Ventilation System (AVS) provides an alternate means of ventilating the cabin and flight deck in the event both packs are inoperative. The system consists of a flight deck switch and a dedicated flush inlet valve and duct that delivers outside air flow downstream of the left pack outlet. When the airplane is un-pressurized, placing the alternate ventilation system switch in the ALTN position opens a valve allowing fresh outside air to be drawn into the air distribution system.

TWA,B The Alternate Ventilation System (AVS) provides an alternate means of ventilating the cabin and flight deck in the event both packs are inoperative. The system uses both the FWD and AFT outflow valves. When the airplane is un-pressurized, placing the alternate ventilation system switch in ALTN positions the FWD and AFT outflow valves toward the ten and one o'clock positions respectively, allowing fresh outside air to be drawn into the air distribution system.

Temperature Control

Hot trim air from each pack is added to the pack conditioned air to control the temperature in each zone. Each trim air system supplies two cabin zone ducts and one flight deck zone duct.

Cabin zone temperatures are regulated by controlling pack outlet temperature and adding hot trim air to the zone supply ducts through the trim air valves to meet the target temperature of each of the seven temperature zones.

The CABIN TEMP selector sets a master reference temperature between 18 deg. C and 29 deg. C. The master reference temperature is increased or decreased automatically or manually to set target temperatures for each temperature zone.

The target temperatures of each passenger cabin temperature zone may be further modified plus or minus 3 deg. C, within the range of 18 deg. to 29 deg. C, using the cabin management system.

The flight deck temperature selector sets the flight deck temperature to between 18 deg. and 29 deg. C.

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

If the flight deck or cabin temperature selector setting is unavailable to the pack temperature controller, the pack outlet temperature is regulated to achieve either the last temperature set or an average cabin temperature of 24 deg. C.

Crew Rest Area Temperature Control

The Overhead Flight Crew Rest area temperature can be controlled manually by the heater controls in the compartments. (See Temperature Control Panel on page 1.46.8.)

The Overhead Flight Attendant Rest area temperature can be controlled manually by the heater controls in the compartment. (See Temperature Control System on page 1.47.7.)

Temperature Control With Loss of Trim Air

If the left or right trim air system is off, the cabin temperature controllers attempt to maintain all zones at the average target temperature. Flight deck temperature is maintained between 18 deg. and 29 deg. C.

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

Shoulder and Foot Heaters

Flight crew shoulder heat is provided by electric elements in the side window air diffusers and are available in-flight only.

Foot heaters have electric heating elements only and are available on ground and in-flight when pack and recirculation fans are on.

Cargo Temperature Control System

The forward and bulk cargo compartments have independent temperature control systems. The aft cargo compartment is heated but the compartment temperature is uncontrolled. An insulated curtain separates the aft and bulk cargo compartments.

Forward Cargo Heat

The forward cargo compartment is capable of carrying live animals. Ventilation and heat are provided by forward E/E cooling exhaust, in-line electric heaters and a forward cargo exhaust fan. Automatic ventilation ensures that odors do not go from the cargo compartment to the flight deck or passenger cabin.

With the FWD CARGO TEMP switch set to AUTO, the fwd cargo heater operates to maintain a target temperature of 21 deg. C. The EICAS advisory message CARGO HEAT FWD notifies the flight crew if a shutdown occurs or if a switch is off.

Bulk Cargo Heat

Bulk cargo compartment ventilation and heat are provided from cabin air passing through a supply fan and in-line electric heaters. In addition, there is

some residual heat from the aft E/E cooling exhaust entering from below the compartment floor.

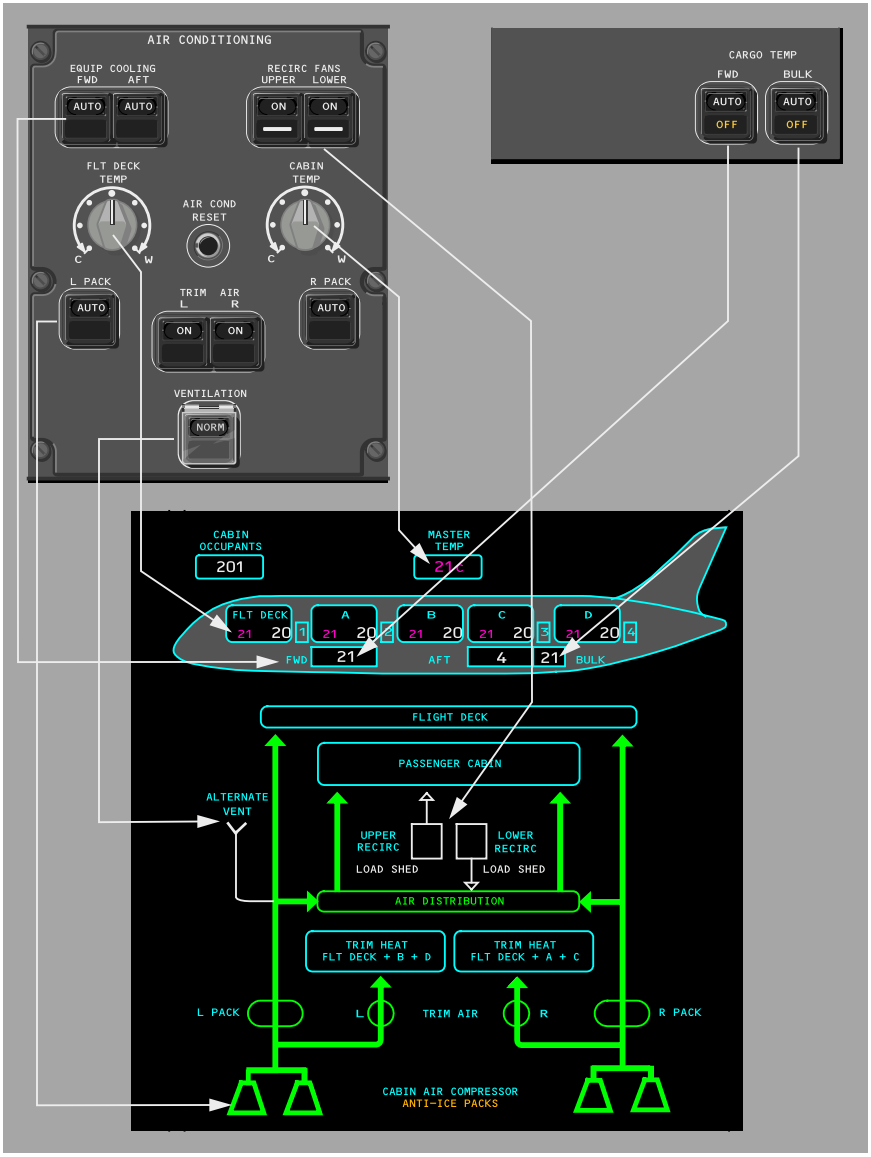
Selecting the AUTO setting on the BULK CARGO TEMP switch turns on the bulk ventilation fan to allow for live animal transport. The system has automatic overheat protection. When an automatic overheat shutdown occurs, cargo heat to the related compartment cannot be restored in flight. The EICAS advisory message CARGO HEAT BULK notifies the flight crew when the switch is off or a shutdown occurs.

Aft Cargo Heat

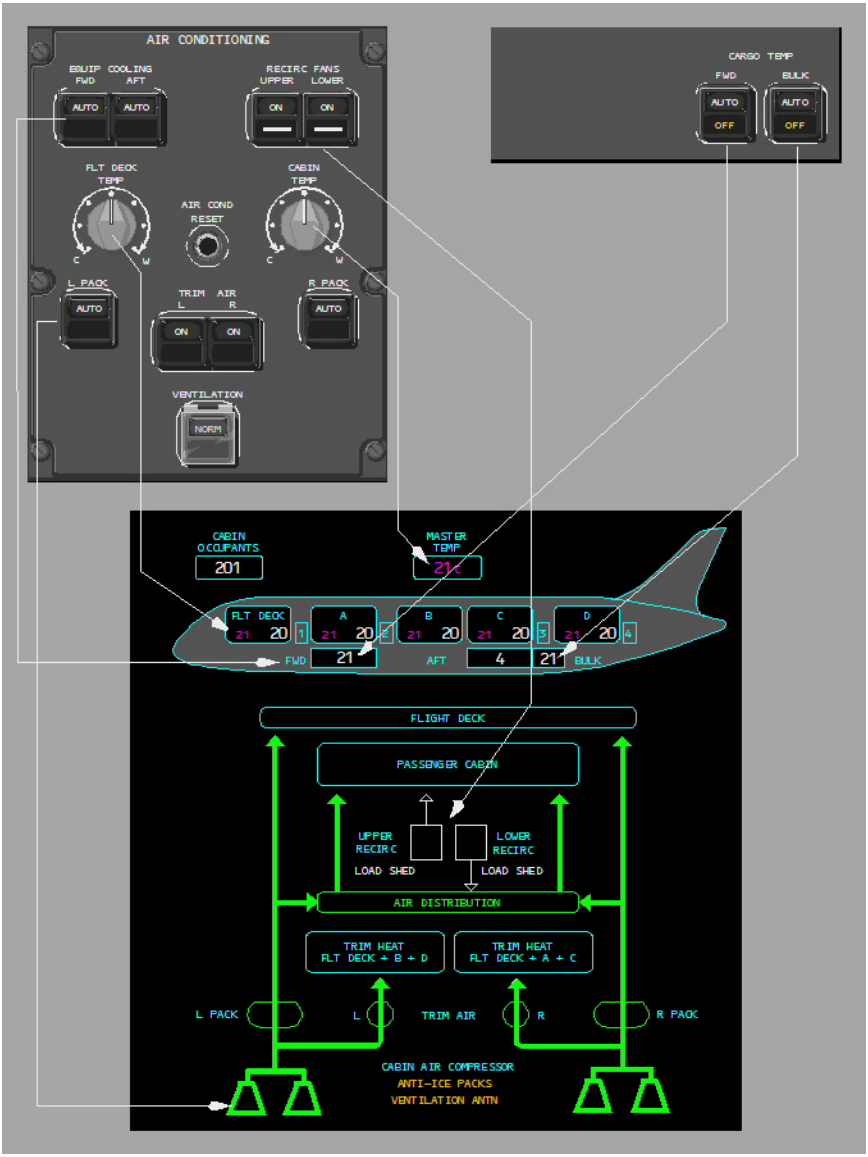
Aft cargo compartment ventilation and heat are provided from aft E/E cooling exhaust entering from below the compartment floor. In addition, there is some residual heat due to air leakage through the insulated curtain from the bulk cargo compartment.

Air Conditioning System Schematic

TQA to TQF



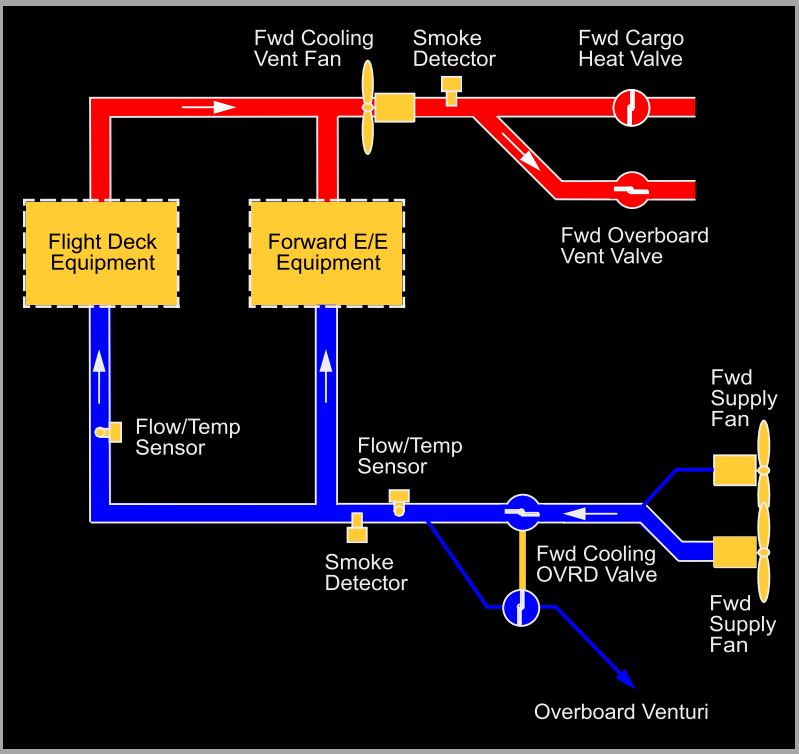
TWA,B


AIR CONDITIONING
EQUIP COOLING
FWD
AFT
AUTO
AUTO
RECIRC FANS
UPPER
LOWER
ON
ON
FLT DECK
TEMP
AIR COND
RESET
CABIN
TEMP
C
W
C
W
L PACK
AUTO
TRIM AIR
L
R
ON
ON
R PACK
AUTO
VENTILATION
NORM
CARGO TEMP
FWD
BULK
AUTO
AUTO
OFF
OFF
CABIN
OCCUPANTS
201
MASTER
TEMP
21
FLT DECK
21
20
1
A
21
20
2
B
21
20
3
C
21
20
4
D
21
20
FWD
21
AFT
4
21
BULK
FLIGHT DECK
PASSENGER CABIN
UPPER
RECIRC
LOAD SHED
LOWER
RECIRC
LOAD SHED
AIR DISTRIBUTION
TRIM HEAT
FLT DECK + B + D
TRIM HEAT
FLT DECK + A + C
L PACK
L
TRIM AIR
R
R PACK
CABIN AIR COMPRESSOR
ANTI-ICE PACKS
VENTILATION ANTN

Equipment Cooling, Equipment Ventilation, Lavatory and Galley Ventilation

Forward Equipment Cooling

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



FORWARD EQUIPMENT COOLING

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

The forward system reconfigures automatically to an override mode when:

- the FWD EQUIP COOLING switch is selected to OVRD, or

- in flight, both supply fans fail, or
- both flow sensors fail, or
- in flight, low airflow is detected, or
- in flight, excessive temperature is detected in the forward equipment cooling system, or
- smoke is detected in the forward equipment cooling system or the forward cargo area, or
- the FWD CARGO FIRE ARM switch is ARMED.

In the override mode, the forward cargo heat and overboard vent valves are closed, the vent fan and both supply fans are commanded off, and the forward equipment cooling override valve is commanded to the override position.

Cabin differential pressure draws air through the flight deck panels and the forward E/E equipment racks to create a reverse flow of air across the equipment, then exits through the override valve to an overboard venturi.

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

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

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

Aft Equipment Cooling

The aft equipment cooling system is similar in layout and functionality to the forward equipment cooling system. It provides cooling and ventilating air for the aft E/E equipment compartment and heating/ventilating air for aft cargo compartment.

The aft system uses internal fans and valves to direct cabin air to the aft equipment bay and ventilates the warm exhaust air to a dedicated overboard exhaust valve or aft cargo compartment. There are two cooling system supply fans, a primary and a backup. If the primary supply fan fails, the backup supply fan operates automatically.

The aft system reconfigures automatically to an override mode when:

- the AFT EQUIP COOLING switch is selected to OVRD, or
- in flight, both supply fans fail, or
- both flow sensors fail, or
- in flight, low airflow is detected, or
- in flight, excessive temperature is detected in the aft equipment cooling system, or
- the AFT CARGO FIRE ARM switch is ARMED, or

- smoke is detected in the aft equipment cooling system or aft equipment ventilation system.

Note: If smoke is detected in the aft E/E equipment compartment, the lower recirculation fans are commanded off. (See Air Distribution on page 2.20.3.) TWA,B

In the override mode, the aft cargo heat and overboard exhaust valves are closed, the vent fan and both supply fans are commanded off, and the aft equipment cooling override valve is commanded to the override position.

Cabin differential pressure draws air through the aft E/E equipment racks to create a reverse flow of air across the equipment, then exits through the override valve to an overboard venturi.

In flight, the AFT EQUIP COOLING switch in OVRD aids smoke evacuation from the passenger cabin.

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

The EQUIP OVBD VLV AFT message indicates that the aft equipment cooling overboard valve is failed in the open position. Pressurizing the airplane with this valve open leads to a large pressure differential between the cabin and equipment cooling duct. This causes duct failure and subsequent loss of cabin pressure through the equipment cooling overboard valve.

Lavatory/Galley Ventilation System

The lavatory/galley ventilation system provides ventilating air for the lavatories and galleys and smoke control for lavatories and optional crew rests. The system is also a secondary heat sink for the Power Electronics Cooling System (PECS), as well as a motive force to draw air across the cabin zone and bulk cargo zone temperature sensors.

Power Electronics Cooling System (PECS)

PECS is a liquid cooling system for the large motor power distribution system located in the aft E/E equipment compartment. It also provides liquid cooling to the supplemental cooling units and associated motor controllers of the Integrated Cooling System. The system consists of two independent liquid cooling loops. Each loop has a single pump package which contains two fully redundant pumps. (See Large Motor Power Distribution System on page 6.20.8 for additional information.)

Liquid quantities and status for each PECS (liquid cooling) loop are displayed on the STATUS page. PECS controls the liquid coolant supply temperature of each loop to 27 deg. C during normal operation. A single liquid cooling loop is displayed when only one forward external power source is connected and selected ON.

There is no flight deck control for the liquid cooling system. The system operation is completely automated and no crew action is required for either normal or non-normal modes of operation.

CAUTION: The Power Electronics Cooling System (PECS) requires a cool-down period following pack and hydraulic EMP shutdown to dissipate residual heat from the liquid cooled LRUs. This prevents damaging the units and degrading the coolant. (See Electrical Power Down on page SP.6.1 for additional information.)

Integrated Cooling System

The Integrated Cooling System (ICS) is a centralized refrigeration system that provides cooling to galley carts and assists with cooling recirculated cabin air. ICS is integrated with the air conditioning system and the liquid cooling system to manage airplane heat loads. There is no flight deck control for the ICS.

TQA to TQF

Miscellaneous Equipment Cooling System

The miscellaneous equipment cooling system provides cooling to equipment located in various areas of the airplane. This includes IFE equipment as well as other non-essential equipment located in the crown and areas of the lower lobe not cooled by other equipment cooling systems. Operation is fully automatic and powered on whenever the airplane is powered. Miscellaneous cooling system power can be removed using the IFE switch on flight deck overhead panel.

Introduction

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

Two outflow valves are installed: one forward and one aft. Normally, the outflow of cabin air is split equally between these two outflow valves. Cabin altitude and full ventilation rates can be maintained by either valve.

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

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

Pressurization System Automatic Operation

In flight, the Cabin Pressure Control System (CPCS) operates in a climb mode, a cruise mode, or a descent mode.

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

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

In climb mode, cabin altitude increases on a schedule related to the airplane climb rate and flight plan cruise altitude. When the FMC climb path has a planned level segment, it is included in the total time required for the airplane to reach the top of climb. Cabin altitude continues to increase during the planned level segment. For unplanned level segments or when VNAV is disengaged, cabin altitude remains constant as long as airplane altitude is not changing. 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 default cruise altitude is 43,000 feet.

In the cruise mode, the cabin altitude is normally at or below 6,000 feet. During some degraded operations the cabin may be commanded to climb to as high as 8,000 feet. This can occur if the air conditioning system is not achieving cabin temperature and ventilation rate targets, and would be more likely with an inoperative pack or CAC. The pressurization system enters descent mode after airplane descent has been initiated.

During descent, cabin altitude decreases to slightly below the FMC planned landing altitude. This ensures that the airplane lands pressurized. Landing altitude barometric pressure correction comes from the captain's altimeter setting.

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

For high altitude takeoffs, if the takeoff field elevation is higher than 8,000 feet, the cabin descends to the target altitude while the airplane is climbing.

For high altitude landings, if the destination airport elevation is greater than 8,000 feet, the cabin altitude climbs to 6,000 feet after takeoff and remains there during cruise. The cabin altitude then starts climbing to the destination airport elevation when appropriate.

Operation With Loss of Landing Altitude

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

Operation With Loss of Cabin Pressurization

If a depressurization event occurs, the outflow valves close to preserve cabin pressure. While the airplane is descending and cabin altitude is increasing, the outflow valves remain closed until the airplane reaches 15,000 feet or descends below the cabin altitude. At this point the outflow valves drive full open for the remainder of the flight.

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

Pressurization System Manual Operation

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

The system is manually operated by:

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

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

Landing altitude (normally provided by the FMC) can be manually set using the LANDING ALTITUDE selector. Landing field selection limits are 2,000 feet below sea level (-2,000) to 14,000 feet above sea level. Pulling the selector out to the detent removes the FMC landing altitude and displays pressurization system indications on the EICAS display. The knob is rotated clockwise to increase or

counterclockwise to decrease the landing altitude setting. Two rates of increase or decrease, low and high, are available in each direction from the starting position.

Introduction

Bleed air is supplied by the engines and is only used for engine core and inlet cowl anti–ice operations.

Engine Anti-ice Bleed Air Supply

Bleed air is supplied from a dedicated engine bleed port. Anti-ice valves are armed when the ENGINE ANTI-ICE selectors are placed to AUTO. These valves open when the ice detection system detects icing conditions or the selector is set to ON. Hot bleed air then flows to the engine core and inlet cowl to keep ice from forming. The anti-ice valves close when icing conditions are no longer detected or the selector is set to OFF.

(See Engine Anti-Ice System on page 3.20.1 for additional information.)

The engine anti-ice valves close automatically:

- during start
- for bleed air over temperature
- for bleed air overpressure
- when an engine fire switch is pulled
- when a bleed air leak is detected.

Air Systems EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
CABIN ALTITUDE	Warning	Siren	Cabin altitude is excessive.
CABIN ALTITUDE AUTO	Caution	Beeper	One of these occurs: • automatic pressurization control is failed • both outflow valve switches are in manual.
CABIN TEMPERATURE	Advisory		Flight deck or cabin temperature is excessively hot or cold. The temperature may cause incapacitation.
CARGO HEAT BULK, FWD	Advisory		Cargo heat is inoperative.
EQUIP CLG OVRD AFT	Advisory		The aft equipment cooling system is in override mode.
EQUIP CLG OVRD FWD	Advisory		The forward equipment cooling system is in override mode.
EQUIP COOLING AFT	Advisory		The aft equipment cooling system is inoperative.
EQUIP COOLING FWD	Advisory		The forward equipment cooling system is inoperative.
EQUIP OVBD VLV AFT	Advisory		The aft equipment cooling system overboard exhaust valve is failed in the open position.
EQUIP OVRD VLV AFT, FWD	Advisory		The equipment cooling system override valve is failed on the ground.
HIGH CABIN ALT MODE	Memo		The Cabin Altitude Warning limit is set higher than 10,000 feet due to a high takeoff or landing altitude.
LANDING ALTITUDE	Advisory		One of these occurs: • the FMC does not supply a landing altitude • the landing altitude selector is pulled.

Message	Level	Aural	Condition
LIQUID CLG QTY L, R	Advisory		The liquid cooling system quantity is low.
LIQUID COOLING L	Caution	Beeper	A left liquid cooling system fault occurs.
LIQUID COOLING R	Caution	Beeper	A right liquid cooling system fault occurs.
OUTFLOW VALVE AFT, FWD	Advisory		One of these occurs: • automatic control of the affected outflow valve is inoperative • the affected outflow valve switch is in manual.
PACK ALTITUDE LIMIT	Caution	Beeper	Airplane altitude is limited because two CACs are inoperative and the equipment cooling system is in the override mode, or three CACs are inoperative.
PACK L, R	Advisory		The pack is inoperative.
PACK L+R	Caution	Beeper	Both packs are inoperative.
PACK MODE L, R	Advisory		The pack is in the standby mode.
RECIRC FAN LWR, UPR OFF	Advisory		The recirculation fan switch is Off.
TRIM AIR L, R	Advisory		The trim air valve is closed.
VENTILATION ALTN	Advisory		The alternate ventilation system is on.

Anti-ice, Rain — Chapter 3
Table of Contents

Controls and Indicators 3.10

Anti-Ice Panel and Indications 3.10.1
- Anti-Ice Panel 3.10.1
- Anti-Ice Indications 3.10.2

Window Heat and Wiper/Washer Panels 3.10.3
- Window Heat Panel 3.10.3
- Wiper/Washer Panels 3.10.4

System Description 3.20

Introduction 3.20.1

Automatic Ice Detection System 3.20.1

Engine Anti-Ice System 3.20.1
- Engine Anti-Ice System Automatic Operation 3.20.1
- Engine Anti-Ice System Manual Operation 3.20.2
- Engine Anti-Ice Leak Detection System 3.20.2

Wing Anti-Ice System 3.20.2
- Wing Anti-Ice System Automatic Operation 3.20.2
- Wing Anti-Ice System Manual Operation 3.20.3

Engine and Wing Anti-Ice Effects on Maneuver Margin 3.20.3

Pack Inlet Anti-Ice System 3.20.3

Flight Deck Window Heat 3.20.3

Windshield Wipers/Washers 3.20.3

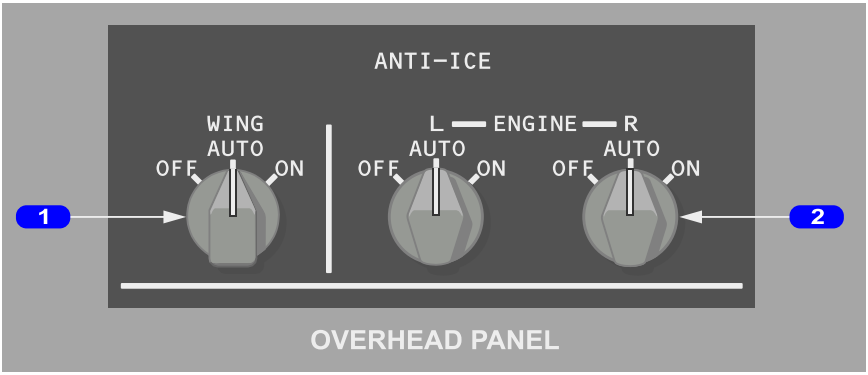
Probe Heat 3.20.4

EICAS Messages 3.30

Anti-Ice, Rain System EICAS Messages 3.30.1

Anti-Ice Panel and Indications

Anti-Ice Panel



1 WING ANTI-ICE Selector

OFF—

- wing ice protection system is not powered
- with flaps out of up, stick shaker logic returns to normal if no icing conditions have been detected for a certain time and TAT is greater than 10 deg. C.

Note: To enter the OFF position, switch must be pulled during rotation from AUTO to OFF.

AUTO—

- in flight, wing ice protection system is powered on and off automatically by the ice protection system
- with flaps out of up, stick shaker logic is set for icing conditions when icing conditions have been detected and TAT is 10 deg. C or less. Stick shaker logic returns to normal if no icing conditions have been detected for a certain time and TAT is greater than 10 deg. C.

ON—

- in flight, wing ice protection system is powered on and operates without input from automatic ice detection system (with TAT less than 25 deg. C)
- with flaps out of up, stick shaker logic is set for icing conditions.

Note: Stick shaker logic returns to normal when the airplane lands, regardless of switch position.

2 ENGINE ANTI-ICE Selectors

OFF—

- the engine anti-ice valves are commanded closed
- with flaps out of up, stick shaker logic returns to normal if no icing conditions have been detected for a certain time and TAT is greater than 10 deg. C.

AUTO—

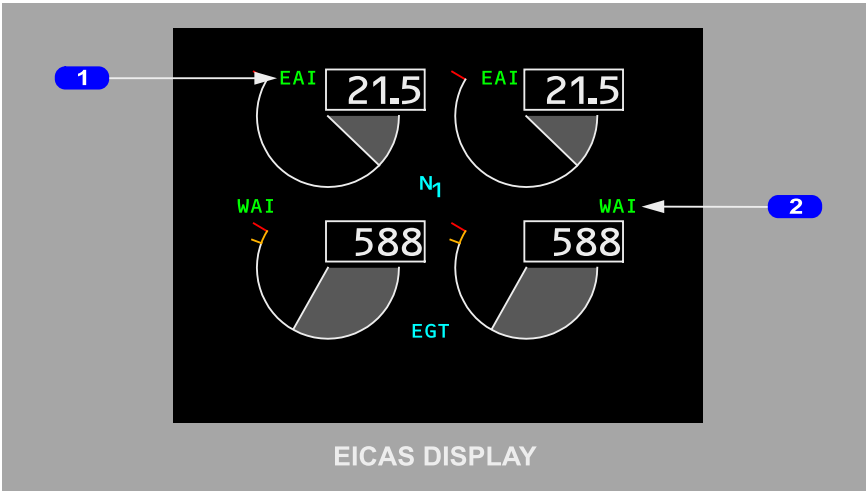
- in flight, the engine anti-ice valves are opened or closed automatically by the ice detection system
- with flaps out of up, stick shaker logic is set for icing conditions when icing conditions have been detected and TAT is 10 deg. C or less. Stick shaker logic returns to normal if no icing conditions have been detected for a certain time and TAT is greater than 10 deg. C.

ON—

- the engine anti-ice valves are commanded open
- with flaps out of up, stick shaker logic is set for icing conditions.

Note: Stick shaker logic returns to normal when the airplane lands, regardless of switch position.

Anti-Ice Indications



1 Engine Anti-ice Indication (EAI)

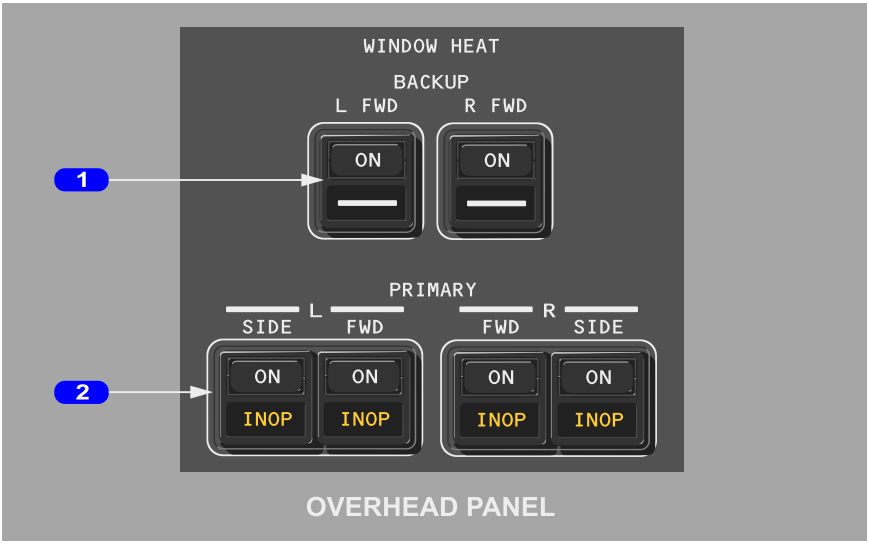
Displayed (green)—engine anti-ice system is on.

2 Wing Anti-Ice Indication (WAI)

Displayed (green)—wing anti-ice system is on.

Window Heat and Wiper/Washer Panels

Window Heat Panel



1 BACKUP WINDOW HEAT Switches

Off (ON not visible)—backup window heat anti-fogging system is off.

ON—backup window heat anti-fogging is commanded on for the selected windows if primary window heat system fails.

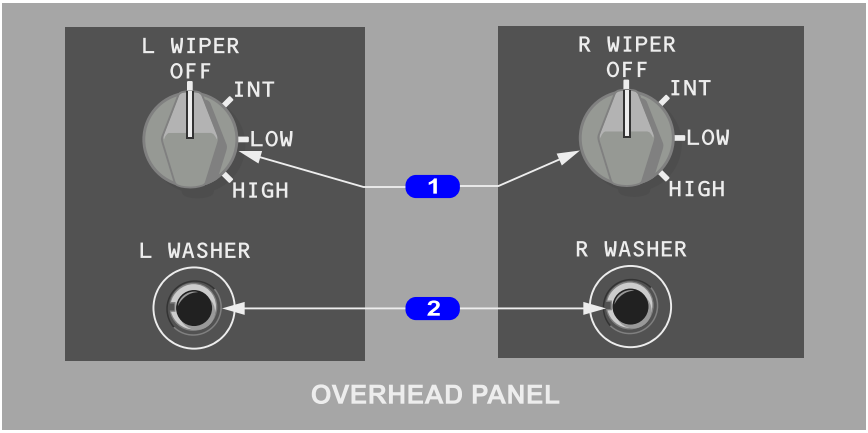
2 WINDOW HEAT Switches

ON—window heat is applied to the selected windows.

INOP (inoperative) illuminated (amber)—

- the switch is off, or
- an overheat is detected, or
- a system fault has occurred.

Wiper/Washer Panels



1 WIPER Selectors

OFF—the wiper is stowed vertically.

INT (intermittent)—the wiper operates intermittently.

LOW—the wiper operates at low speed.

HIGH—the wiper operates at high speed.

2 WASHER Switches

Push (momentary action)—fluid is sprayed on windshield until switch is released.

Introduction

The anti-ice and rain systems include:

- automatic ice detection
- engine anti-ice
- wing anti-ice
- pack inlet anti-ice
- flight deck window heat
- windshield wipers and washers
- probe heat.

Automatic Ice Detection System

The automatic ice detection system senses the existence of icing conditions and provides signals to control the engine, wing, and pack inlet anti-ice. The system has two icing condition detectors that measure liquid water content, and use TAT, other temperature sources, and other air data information to determine if icing conditions exist. Both detectors are heated electrically after engine start.

Automatic ice detection is inhibited on the ground below 75 knots.

Engine Anti-Ice System

The engine anti-ice system uses bleed air to provide engine core and cowl inlet ice protection. Engine anti-ice can be operated in flight or on the ground. The engine anti-ice indication EAI is displayed above the EICAS N1 indication when an engine anti-ice valve is open. The left and right engines have identical, independent anti-ice systems. This allows the remaining system to operate if one engine is shutdown.

Engine Anti-Ice System Automatic Operation

In flight, when the ENGINE ANTI-ICE selector is in AUTO, engine anti-ice system operation is automatic. When icing conditions are detected, the engine anti-ice valves open and bleed air is supplied to the engine core and inlet cowl.

When icing conditions are no longer detected, the engine anti-ice valves close and bleed air is no longer supplied to the engine core and inlet cowl.

Automatic operation of the engine anti-ice system is inhibited on the ground.

Note: The ice detection system uses a combination of temperature sources to determine total air temperature for engine anti-ice, and to command engine anti-ice on and off. This reference temperature may not be the same as the displayed TAT.

Engine Anti-Ice System Manual Operation

On the ground or in flight, when the ENGINE ANTI-ICE selector is ON, bleed air opens the engine anti-ice valves and is supplied to the engine core and inlet cowl.

The engine anti-ice valves close automatically:

- during start, or
- for bleed air overtemperature, or
- for bleed air overpressure, or
- when an engine fire switch is pulled, or
- when a bleed air leak is detected.

In addition to bleed air, the RR engine EEC automatically adjusts idle to prevent engine icing. (See EEC Idle Selection on page 7.20.9 for additional information.)

Engine Anti-Ice Leak Detection System

Each engine has an anti-ice system duct leak detection system. If an anti-ice duct leak is detected, the respective engine anti-ice valves close.

Wing Anti-Ice System

The electric wing anti-ice system powers thermal anti-icing mats on the leading edge slats on each wing. Wing anti-ice is inhibited on the ground below 75 knots. Wing anti-ice may be momentarily shed (30 seconds maximum) during high electrical loads, such as during flap retraction. To maintain aerodynamic stability, system logic controls symmetrical operation of left and right wing anti-ice. If one wing anti-ice thermal mat fails, the wing anti-ice system automatically de-powers the opposite thermal mat to prevent asymmetrical wing icing.

The wing anti-ice annunciation WAI is displayed below the EICAS N1 indication when wing anti-ice is powered.

Wing Anti-Ice System Automatic Operation

In flight with the WING ANTI-ICE selector in AUTO, wing anti-ice system operation is automatic. When icing conditions are detected, power is supplied to the thermal mats on the leading edge slats. When icing conditions are no longer detected, the system may enter a clean up cycle before power is removed. During the clean up cycle, the system continues to provide electrical power to the heated slats to clear any residual ice that may have accumulated during icing conditions. The WAI EICAS indication remains displayed until the clean up cycle is complete.

Automatic wing anti-ice operation is available in flight and on the ground above 75 knots airspeed.

Wing Anti-Ice System Manual Operation

In flight with the WING ANTI-ICE selector ON, the system is powered any time TAT is below 25 deg. C.

Engine and Wing Anti-Ice Effects on Maneuver Margin

With flaps out of up, engine or wing anti-ice use modifies stick shaker logic, increasing the stick shaker speed and minimum maneuvering speed. This reduces maneuver margin to stick shaker. Stick shaker logic returns to normal if no icing conditions have been detected for a certain time and TAT is greater than 10 deg. C, or when the airplane lands.

With flaps up, the use of engine or wing anti-ice has no effect on stick shaker speed and minimum maneuvering speed.

Pack Inlet Anti-Ice System

The pack inlet anti-ice system provides ice protection for both ram air inlets for the cabin air compressors. An electric heater on the leading edge of each inlet prevents ice formation and reduces ice formation in the duct during icing conditions.

Pack inlet anti-ice functions automatically with signals from the automatic ice detection system. Operation is inhibited on the ground and when TAT is above 10 deg. C.

Flight Deck Window Heat

All flight deck windows are electrically heated. The forward windows have exterior surface anti-icing, and interior surface antifogging protection. The side windows have interior surface antifogging protection only. With the PRIMARY L SIDE, L FWD, R FWD, and R SIDE window heat switches in the ON position, the primary system operates automatically.

With the BACKUP L FWD and R FWD switches in the ON position, a backup antifogging system for the forward windows operates automatically if the primary window heat system fails.

Windshield Wipers/Washers

The forward windows are equipped with independently controlled, three-speed wipers. When the WIPER selector in OFF, the respective wiper is off and stowed.

The Captains and First Officers windshields are equipped with a windshield washer system. Windshield washer switches command a continuous application of washer fluid while held ON.

Windshield scratching may occur if wipers are used on a dry windshield surface.

(See Windshield Wiper Use on page SP.3.1 for additional information.)

Probe Heat

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

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

Anti-Ice, Rain System EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
ANTI-ICE DET WING	Advisory		Automatic control of wing anti-ice is failed.
ANTI–ICE ENG L, R	Advisory		The engine anti-ice valve is closed when commanded open.
ANTI–ICE LEAK ENG L, R	Caution	Beeper	A bleed air leak occurs in the engine anti-ice duct.
ANTI–ICE LOSS ENG L, R	Advisory		Anti-ice bleed air for the engine is not available.
ANTI–ICE ON	Advisory		All of these occur: • an ANTI-ICE selector is ON • TAT is more than 10 deg. C • ice is not detected.
ANTI–ICE PACKS	Advisory		Both pack inlet anti-ice systems are failed.
ANTI–ICE WING	Caution		Wing anti-ice is degraded or failed.
HEAT PITOT C	Advisory		The center pitot probe heat is failed.
HEAT PITOT L	Advisory		The left pitot probe heat is failed.
HEAT PITOT L+C+R	Advisory		The left, center, and right pitot probe heat are failed.
HEAT PITOT R	Advisory		The right pitot probe heat is failed.
ICE DETECTORS	Advisory		The ice detectors are failed.
ICING ENG	Caution	Beeper	Ice is detected and an engine anti-ice selector is OFF.
WINDOW HEAT	Advisory		Two or more window heats are off.
WINDOW HEAT L, R FWD	Advisory		Primary window heat for the forward window is inoperative.
WINDOW HEAT L, R SIDE	Advisory		Primary window heat for the side window is inoperative.
WING ANTI–ICE OFF	Advisory		The wing anti-ice selector is OFF.

Automatic Flight — Chapter 4
Table of Contents

Controls and Indicators 4.10

Mode Control Panel (MCP) 4.10.1
- Autopilot Flight Director System Controls 4.10.1
- Autothrottle System Controls 4.10.3
- Autopilot Flight Director IAS/Mach Controls 4.10.4
- Autopilot Flight Director Roll and Pitch Controls 4.10.6
- Autopilot Flight Director Heading, Track, and Bank Angle Controls 4.10.9
- Autopilot Flight Director Vertical Speed (V/S) and Flight Path Angle (FPA) Controls 4.10.11
- Autopilot Flight Director Altitude Controls 4.10.12
- Autopilot Flight Director Approach Mode Controls 4.10.14

PFD and HUD Flight Mode Annunciations (FMAs) 4.10.16

Autopilot Disconnect Switch 4.10.19

Autothrottle Disconnect and TO/GA Switches 4.10.20

System Description 4.20

Introduction 4.20.1

Autopilot Flight Director System (AFDS) 4.20.1
- MCP Mode Selection 4.20.1
- Autopilot Engagement 4.20.2
- Autopilot Disengagement 4.20.2
- Autopilot and Flight Director Mode Degradations 4.20.3
- Flight Director Display 4.20.3
- Autopilot Flight Director System Schematic 4.20.4
- AFDS Status Annunciation 4.20.4
- AFDS Flight Mode Annunciations 4.20.5

Autothrottle System 4.20.9
- Manual Flight 4.20.9
- Automatic Activation 4.20.9
- Autothrottle Thrust Lever Operation 4.20.10

Autothrottle Disconnect 4.20.10
Automatic Flight Operations 4.20.11
Automatic Flight—Takeoff and Climb 4.20.11
HUD Takeoff 4.20.12
Automatic Flight Takeoff Profile 4.20.13
Automatic Flight—Cruise 4.20.14
Automatic Flight—Approach and Landing 4.20.14
Automatic Flight Approach Profiles 4.20.18
Automatic Flight—Go-Around 4.20.20
Automatic Flight Go-Around Profile 4.20.22
Automatic Flight Windshear Recovery 4.20.22
Flight Envelope Protection 4.20.23

EICAS Messages 4.30

Automatic Flight EICAS Messages 4.30.1

Mode Control Panel (MCP)



GLARESHIELD PANEL

Autopilot Flight Director System Controls



MODE CONTROL PANEL

1 Autopilot (A/P) Engage Switches

Push (either switch can engage the autopilot)—

- inhibited on the ground with the flaps out of up
- 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:
  - heading hold (HDG HOLD) or track hold (TRK HOLD) as the roll mode, and
  - vertical speed (V/S) or flight path angle (FPA) as the pitch mode.

2 Autopilot Engaged Light

Illuminated (white)—all operating autopilots are engaged.

3 Flight Director (F/D) Switches

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

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. The flight mode annunciation appears on both PFDs and HUDs. Positioning the second switch ON displays the flight direction steering indications on the second PFD and HUD
- in flight, with the autopilot disengaged and both flight director switches OFF, the first flight director switch positioned to ON activates the flight director in:
  - heading hold (HDG HOLD) or track hold (TRK HOLD) as the roll mode, and
  - vertical speed (V/S) or flight path angle (FPA) as the pitch mode
- in flight, with the autopilot engaged and both flight director switches OFF, the first flight director switch positioned to ON activates the flight director in the currently selected autopilot mode(s).

OFF—

- the 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.

4 Autopilot (A/P) DISENGAGE Bar

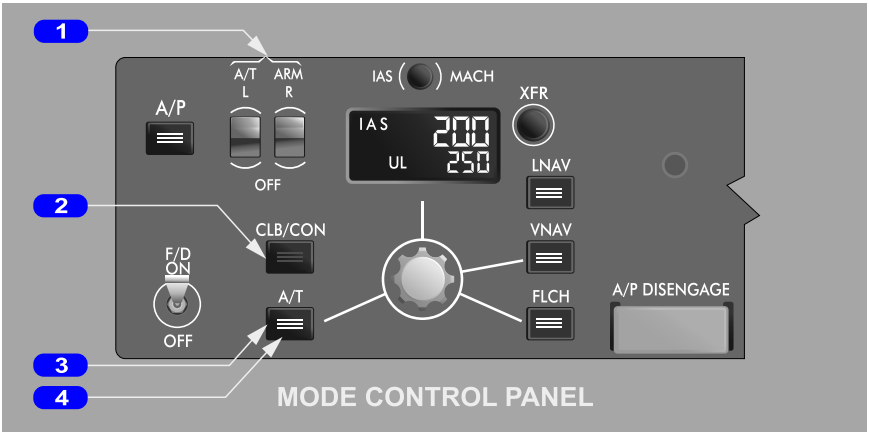
Pull down—

- with autopilot(s) engaged:
  - disengages all autopilots
  - displays the EICAS warning message AUTOPILOT DISC
  - sounds an aural warning
  - illuminates the master warning lights
- prevents autopilot engagement
- disables bank angle protection
- exposes the amber and black stripes.

Lift up—

- enables autopilot engagement
- enables bank angle protection
- hides the amber and black stripes.

Autothrottle System Controls



1 Autothrottle (A/T) ARM Switches

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

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

OFF—

- disconnects the selected autothrottle
- prevents selected autothrottle activation.

2 Climb/Continuous (CLB/CON) Thrust Switch

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

Push—

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

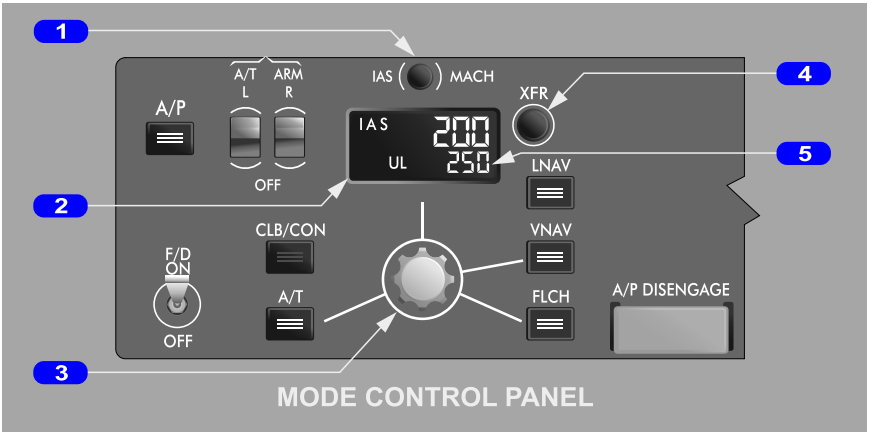
3 Autothrottle (A/T) Engage Switch

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

4 Autothrottle Engaged Light

Illuminated (white)—an autothrottle mode is activated.

Autopilot Flight Director IAS/Mach Controls



1 IAS/MACH Reference Switch

Push—

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

2 IAS/MACH Window

Upper line displays speed selected by the IAS/MACH selector and lower line displays uplinked ATC speed clearance.

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

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

The display range is:

- 100–399 KIAS
- .400–.950 Mach.

The selected speed displays as the PFD selected speed.

The selected speed displays as the range to target speed dot (green) on the VSD.

Upper line displays 200 knots and lower line is blank when power is first applied.

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

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

3 IAS/MACH Selector

Rotate—

- sets the speed on upper line of IAS/MACH window as the selected speed on both the PFD and HUD
- inoperative when the IAS/MACH window is blank.

Push—

- with VNAV active, alternately opens or closes the IAS/MACH window:
  - when the window is closed, the FMC computed target speed is active and displays on both the PFD and HUD
  - when the window is open, FMC speed–intervention is active and the IAS/MACH selector may be used to set the desired speed.

4 Uplink Transfer (XFR) Switch

Push—Transfers the IAS or Mach value from the lower line to the upper line. If upper line was blank/closed, it now opens to the uplinked ATC value. Lower line blanks after the transfer.

5 ATC Uplinked Speed Clearance

The ATC uplink function is always enabled. For immediate clearances, pushing the datalink ACCEPT switch displays the clearance IAS or Mach value in the lower line of the window. If the upper line was blank/closed, it remains unchanged. Pushing the datalink CNCL switch removes the clearance from the lower line.

For conditional clearances, pushing the ACCEPT switch automatically displays clearance IAS or Mach value in the lower line only after condition contained in the clearance is met.

Uplinked clearances are preceded by the letters "UL".

Autopilot Flight Director Roll and Pitch Controls



1 Lateral Navigation (LNAV) Switch

Push—

- arms, selects, or disarms LNAV as the roll mode
- displays LNAV as armed mode on PFD (in white) and HUD roll flight mode annunciator. The previous roll mode remains active
- LNAV activates when the airplane is above 50 feet radio altitude and:
  - within 2.5 NM of the active leg
  - when not within 2.5 NM of the active leg and on an intercept heading to the active leg, remains armed then activates when approaching the active leg
  - when active, displays LNAV in green on the PFD and HUD roll flight mode annunciations
- selection of LNAV with the airplane not on a heading to intercept the active leg, displays FMC INTERCEPT HDG EICAS advisory message
- selection of LNAV when an active FMC route is not available displays NO ACTIVE ROUTE in the CDU help window
- LNAV maintains current heading when:
  - passing the last active route waypoint
  - passing the last waypoint prior to a route discontinuity
  - passing the last route offset waypoint
  - activating the inactive route or activating an airway intercept and not within LNAV engagement criteria
- on go-around when valid missed approach path exists, LNAV activates automatically at 50 feet radio altitude with flight director only or 200 feet radio altitude with the autopilot engaged. If no missed approach path

is available, the roll bar blanks, the flight director guidance cue on the HUD blanks, and LNAV stays shown in the FMA. LNAV is deactivated by engaging any other roll mode or by disengaging the autopilot and turning both flight directors off.

LNAV is deactivated:

- by selecting heading hold (HDG HOLD) or track hold (TRK HOLD)
- by selecting heading select (HDG SEL) or track select (TRK SEL)
- with LOC or FAC capture
- when there is a dual or triple FMC failure (LNAV may be reselected if one FMC remains functional).

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

2 LNAV Light

Illuminated (white)—the LNAV mode is armed or active.

3 Vertical Navigation (VNAV) Switch

Push—

- arms, selects, or disarms VNAV as the pitch mode
- displays VNAV as armed mode on PFD (in white) and HUD pitch flight mode annunciation below 400 feet
- VNAV activates at 400 feet AGL
- VNAV SPD, VNAV PTH or VNAV ALT pitch mode displays in green (active) on the PFD and HUD pitch flight mode annunciation
- in the VNAV SPD pitch mode, the AFDS commands pitch to hold target airspeed. The autothrottle operates in the THR REF, THR, IDLE or HOLD mode, as required by the phase of flight
- in the VNAV PTH pitch mode, the AFDS commands pitch to maintain FMC target altitude or the VNAV path. The autothrottle maintains speed
- in the VNAV ALT pitch mode, the AFDS commands pitch to maintain the MCP selected altitude when that altitude is lower than the VNAV commanded altitude in climb or higher than the VNAV commanded altitude in descent
- when VNAV is selected and VNAV commands a descent with the MCP altitude window above the current airplane altitude, the autopilot maintains the altitude at which VNAV was selected. When on an instrument approach using VNAV, selecting the missed approach altitude does not interfere with the VNAV descent
- when VNAV is selected and VNAV commands a climb with the MCP altitude window below the current airplane altitude, the autopilot maintains the altitude at which VNAV is selected
- with the VNAV ALT pitch mode active, the autothrottle operates in the speed (SPD) mode

- with the VNAV PTH pitch mode active, the autothrottle operates in the following modes:
  - for climb or cruise—operates in the speed (SPD) mode
  - for descent—operates in the IDLE, HOLD, or speed (SPD) mode
- VNAV pitch guidance is available with one engine inoperative.

VNAV is deactivated:

- by selecting TO/GA, FLCH SPD, V/S, FPA, ALT, G/S or G/P pitch mode
- when there is a dual FMC failure
  Note: VNAV functionality still available. (See Vertical Navigation (VNAV) on page 11.31.21 for additional information.)
- when all three FMCs fail.

VNAV is disarmed by:

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

4 VNAV Light

Illuminated (white)—the VNAV mode is armed or active.

5 Flight Level Change (FLCH) Switch

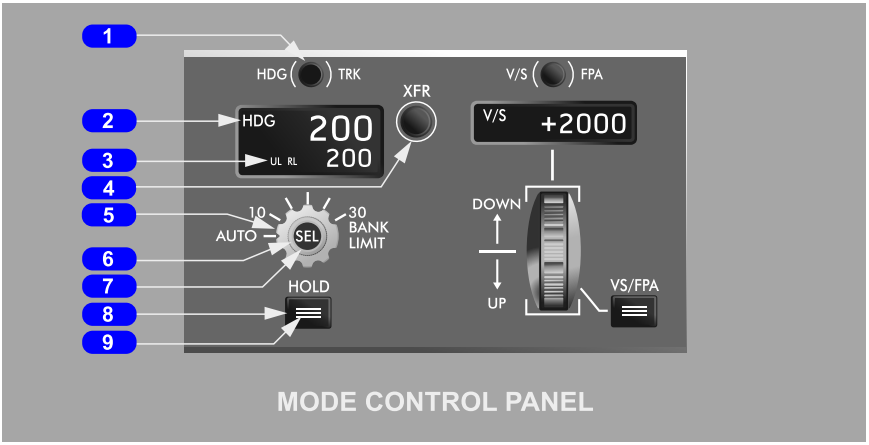
Push—

- selects FLCH SPD pitch mode
- FLCH SPD displays on the PFD and HUD pitch flight mode annunciation as the pitch mode
- when IAS/MACH window is blank, it opens to the FMC target speed, if valid. If not valid, the IAS/MACH window opens to the current speed
- when IAS/MACH window is open, it displays command speed
- AFDS pitch holds MCP selected speed. When the MCP selected altitude is captured, the pitch flight mode annunciation changes to ALT
- A/T operates in THR. When thrust is retarded to idle, HOLD displays during descent. When MCP selected altitude is captured, A/T mode changes to SPD
- for climbs between 1,000 feet and 12,000 feet of altitude change, the A/T advances the thrust levers to as high as the current thrust limit to provide an approximately 2 minute climb
- for descents between 2,000 feet and 16,000 feet of altitude change, the A/T retards the thrust levers to as low as idle to provide an approximately 2 minute descent. Smaller altitude changes will take less than 2 minutes
- with a higher altitude set in the altitude window, reference thrust limit changes to CLB when CRZ displays or to CON with an engine inoperative.

6 Flight Level Change Light

Illuminated (white)—the flight level change mode is active.

Autopilot Flight Director Heading, Track, and Bank Angle Controls



1 Heading/Track (HDG/TRK) Reference Switch

Push—alternately changes the upper line of the heading/track window, PFD, HUD, and ND selected heading/track references between heading and track. Also changes the PFD and HUD roll flight mode annunciations, when the HDG or TRK mode is active.

2 Heading/Track Window

Upper line displays the selected heading or track and lower line displays uplinked ATC heading or track target.

The selected heading or track displays on the PFD, HUD and ND.

If approach is armed, the heading/track in the MCP window automatically changes to the approach course at LOC or FAC capture.

Upper line displays 360º and lower line is blank when power is first applied.

3 ATC Uplinked Heading or Track

The ATC uplink function is enabled when the upper window and uplinked clearances are both heading values or both track values. When not both heading or track, pushing the heading/track reference switch displays the uplinked value. For immediate clearances, pushing the datalink ACCEPT switch displays the clearance heading or track value in the lower line of the window. Pushing the transfer (XFR) switch transfers the value from the lower line to the upper line. Pushing the datalink CNCL switch removes the clearance from the lower line.

For conditional clearances, pushing the ACCEPT switch displays the new heading or track value automatically in the lower line only after the clearance condition is met.

Uplinked clearances are preceded by the letters "UL". Clearances containing a turn direction are also displayed preceded by "L" or "R".

4 Uplink Transfer (XFR) Switch

Push—transfer the value from the lower line to the upper line. Lower line blanks after the transfer.

5 BANK LIMIT Selector (outer)

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

- AUTO—varies between 15º–25º, depending on TAS
- 10º, 15º, 20º, 25º or 30º—the selected value is the maximum, regardless of airspeed.

6 Heading/Track Selector (middle)

Rotate—

- sets heading or track in the heading/track window and on the PFDs, HUDs, and NDs
- with heading select (HDG SEL) or track select (TRK SEL) as the active roll mode, the aircraft will turn in the direction of knob rotation to achieve the selected heading or track.

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

Push—

- selects heading select (HDG SEL) or track select (TRK SEL) as the roll mode
- displays HDG SEL or TRK SEL on the PFD and HUD roll flight mode annunciator
- AFDS turns the aircraft in the direction of least heading change to achieve the selected heading or track
- bank is limited by the bank limit selector.

8 Heading/Track Hold (HOLD) Switch

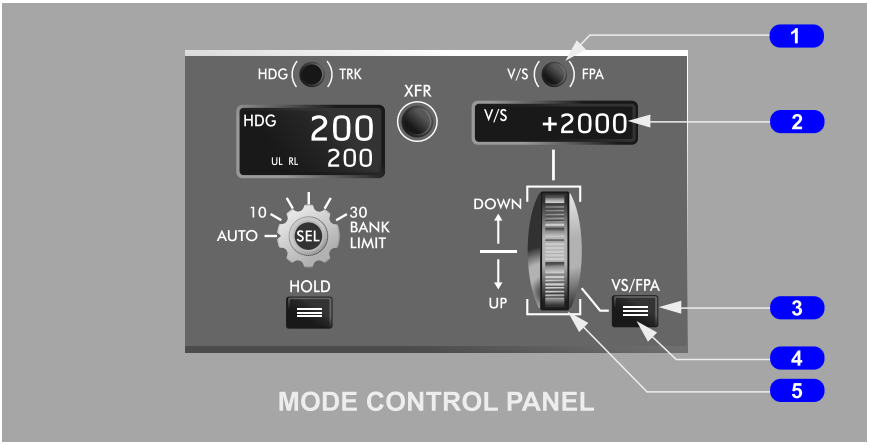
Push—

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

9 Heading/Track Hold Light

Illuminated (white)—the heading/track HOLD mode is active.

Autopilot Flight Director Vertical Speed (V/S) and Flight Path Angle (FPA) Controls



1 V/S-FPA Reference Switch

Push—alternately changes the vertical speed/flight path angle window and PFD references between vertical speed and flight path angle. Also changes the PFD/HUD pitch flight mode annunciation, if the V/S or FPA mode is active.

2 Vertical Speed/Flight Path Angle (V/S–FPA) Window

Displays the selected vertical speed in 100 fpm increments or the selected flight path angle in 0.1° increments.

The display range is:

- V/S: –8000 to +6000 fpm
- FPA: –9.9º to +9.9º.

Blank when the vertical speed (V/S) or flight path angle (FPA) pitch mode is not active. Display state can be pre-selected by pushing the V/S-FPA reference switch.

The selected vertical speed displays on the PFD vertical speed indication.

The selected flight path angle displays on the PFD attitude indicator.

3 V/S–FPA Switch

Push—

- engages V/S or FPA pitch mode
- displays V/S or FPA on the PFD and HUD pitch flight mode annunciation
- displays dashed line on the VSD indicating selected vertical speed as a target angle when V/S mode is selected
- displays the current vertical speed or flight path angle in the vertical speed/flight path angle window
- when the selected altitude is reached, the pitch mode changes to ALT
- AFDS commands pitch to maintain the vertical speed or flight path angle displayed in the vertical speed/flight path angle window
- when V/S or FPA is selected while in FLCH or VNAV, the autothrottle activates in speed (SPD) mode, when armed.

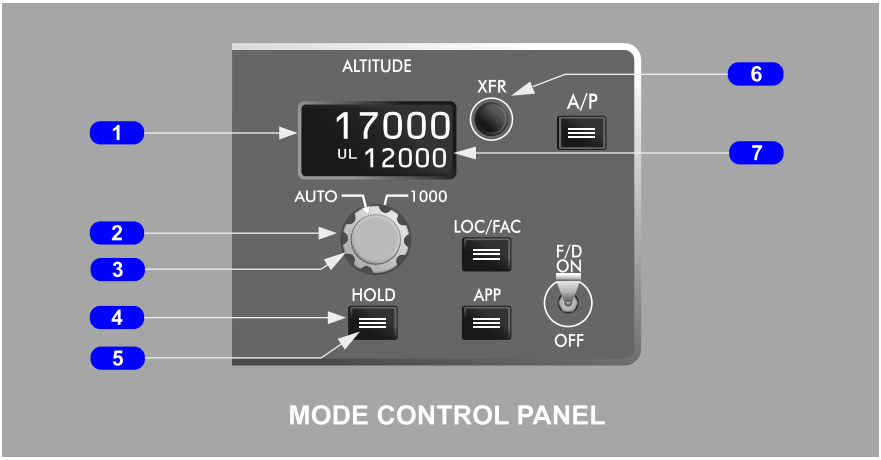
4 V/S–FPA Light

Illuminated (white)—the vertical speed/flight path angle mode is active.

5 V/S–FPA Selector

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

Autopilot Flight Director Altitude Controls



1 Altitude Window

Upper line displays the selected altitude and lower line displays an uplinked ATC altitude target.

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

The selected altitude displays on the PFD and HUD altitude tapes and the vertical situation display (VSD).

The altitude range is 0 to 50,000 feet.

Upper line displays 10,000 feet and lower line is blank when power is first applied.

Displayed altitude transmitted to ATC when Eurocontrol compliant transponder installed.

2 Altitude Increment Selector (outer)

AUTO—

- the altitude selector changes in 100 foot increments
- displays the selected BARO minimum as the selector passes through that altitude. If the BARO minimum is not a 10 foot increment, displays the next highest 10 foot increment
- when rotated rapidly, the displayed altitude changes at two to four times the normal rate.

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

3 Altitude Selector (inner)

Rotate—sets the altitude in the altitude window and on the PFD, HUD and VSD altitude indication displays.

Push—

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

4 Altitude HOLD Switch

Push—

- selects altitude (ALT) as the pitch mode
- ALT displays on the PFD and HUD pitch flight mode annunciation

- the AFDS commands pitch to maintain the altitude when the switch was pushed.

5 Altitude Hold Light

Illuminated (white)—the altitude hold mode is active.

6 Uplink Transfer (XFR) Switch

Push—transfer the value from the lower line to the upper line. Lower line blanks after the transfer.

7 ATC Uplinked Altitude

The ATC uplink function for altitude is always enabled. For immediate clearances, pushing the datalink ACCEPT switch displays the clearance altitude value in the lower line of the window. Pushing the transfer (XFR) switch transfers the value from the lower line to the upper line. Pushing the datalink CNCL switch removes the clearance from the lower line.

For conditional clearances, pushing the ACCEPT switch displays the new altitude value automatically in the lower line only after the clearance condition is met.

Uplinked clearances are preceded by the letters "UL".

Autopilot Flight Director Approach Mode Controls



MODE CONTROL PANEL

1 Localizer/Final Approach Course (LOC/FAC) Switch

Push—

- arms, disarms, or captures back course (B/CRS), final approach course (FAC) or localizer (LOC) as the roll mode

- displays B/CRS, FAC or LOC in white (armed) on the PFD and in green on the HUD roll flight mode annunciation before localizer or course capture
- displays B/CRS, FAC or LOC in green (active) on the PFD and in green on the HUD roll flight mode annunciation after localizer or course capture
- arms the AFDS to capture and track inbound on the front course or final approach course
- the capture point varies based on range and intercept angle
- capture can occur when an intercept track angle is within 120º of the localizer or final approach course.

The localizer/final approach course mode can be disarmed before capture by:

- pushing the LOC/FAC switch a second time, or
- selecting LNAV.

The localizer/final approach course mode can be deactivated after capture by:

- selecting a roll mode other than LNAV
- pushing a TO/GA switch
- pushing the APP switch
- disengaging the autopilot and turning both flight director switches off, or
- engaging an autopilot when in flight director only.

2 Localizer/Final Approach Course Light

Illuminated (white)—the localizer or final approach course mode is armed or active.

3 Approach (APP) Switch

Push—

- arms or captures roll mode (LOC, FAC, B/CRS) and pitch mode (G/S, G/P) for the approach selected in the FMC.
  - displays selected roll and pitch modes as armed on the PFD and HUD roll and pitch flight mode annunciations prior to capture
  - displays selected roll and pitch modes in green (engaged) on the PFD and HUD roll and pitch flight mode annunciations after capture.
- AFDS captures and tracks the roll mode (LOC, FAC, B/CRS) and the pitch mode (G/S, G/P) upon interception.
  - roll mode (LOC, FAC, B/CRS) captures when intercept track angle is within 120º of localizer or final approach course
  - pitch mode (G/S, G/P) captures when intercept track angle is within 80º of localizer or final approach course.

Glideslope can capture before localizer capture.

The approach mode can be disarmed or deactivated for any status of roll mode (LOC, FAC, B/CRS) and/or pitch mode (G/S, G/P) by disengaging the autopilot and turning both Flight Director switches OFF.

When both roll mode (LOC, FAC, B/CRS) and pitch mode (G/S, G/P) are armed, the approach mode can be disarmed by selecting APP, LOC, LNAV, or VNAV.

The approach mode deselects:

- by pushing APP when above 1,500 feet radio altitude
- with roll mode (LOC, FAC, B/CRS) captured and pitch mode (G/S, G/P) armed, by selecting heading select (HDG/TRK SEL) or heading hold (HDG/TRK HOLD)
- with glideslope captured and localizer armed, by selecting any other pitch mode except VNAV
- after roll mode (LOC, FAC, B/CRS) and pitch mode (G/S, G/P) captured, by selecting TO/GA.

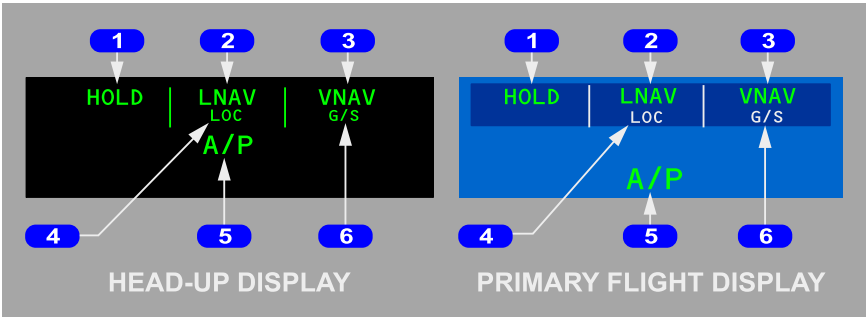
4 Approach Light

Illuminated (white)—the approach modes are armed or active.

PFD and HUD Flight Mode Annunciations (FMAs)

Notes:

1. When first engaged/activated, A/T, roll or pitch mode changes are emphasized for 10 seconds by a green box drawn around the mode.
2. A horizontal line displays through the affected ACTIVE pitch or roll mode when a flight mode fault is detected (amber on the PFD and green on the HUD).
3. NO AUTOLAND displays on the PFD and HUD if failures cause the system to degrade from a multi-channel engage status (LAND 3 or LAND 2) to a single channel status during an autoland. The mode change is emphasized for 10 seconds by a box (amber on the PFD and green on the HUD).
4. NO AUTOLAND also displays on the PFD and HUD if multi-channel approach selected but multi-channel engage status (LAND 3 or LAND 2) has not been annunciated by 300 feet AGL. Under these conditions, flare and rollout modes are not armed.



1 Autothrottle Modes (Active)

Displayed (green)—

- HOLD
- IDLE
- SPD
- THR
- THR REF.

Note: When only one autothrottle is connected and armed, the autothrottle mode annunciation is augmented by a "L-" or "R-" preceding the mode.

2 AFDS Roll Modes (Active)

Displayed (green)—

- B/CRS
- FAC
- HDG HOLD
- HDG SEL
- HUD TO/GA
- LNAV
- LOC
- ROLLOUT
- TO/GA
- TRK HOLD
- TRK SEL.

3 AFDS Pitch Modes (Active)

Displayed (green)—

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

4 AFDS Roll Modes (Armed)

Displayed (green on HUD, white on PFD)—

- B/CRS
- FAC
- LNAV
- LOC
- ROLLOUT.

5 Autoflight Status Annunciation

Displayed (green)—

- A/P
- FLT DIR
- LAND 3.

Displayed (green with white triangles)—



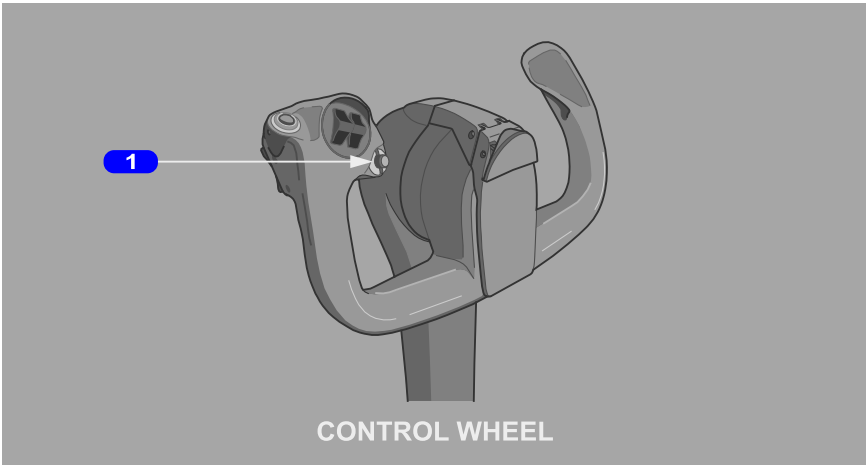
Displayed (green on HUD, amber on PFD)—NO AUTOLAND.

6 AFDS Pitch Modes (Armed)

Displayed (green on HUD, white on PFD)—

- FLARE
- G/P
- G/S
- VNAV.

Autopilot Disconnect Switch



1 Autopilot Disconnect Switches

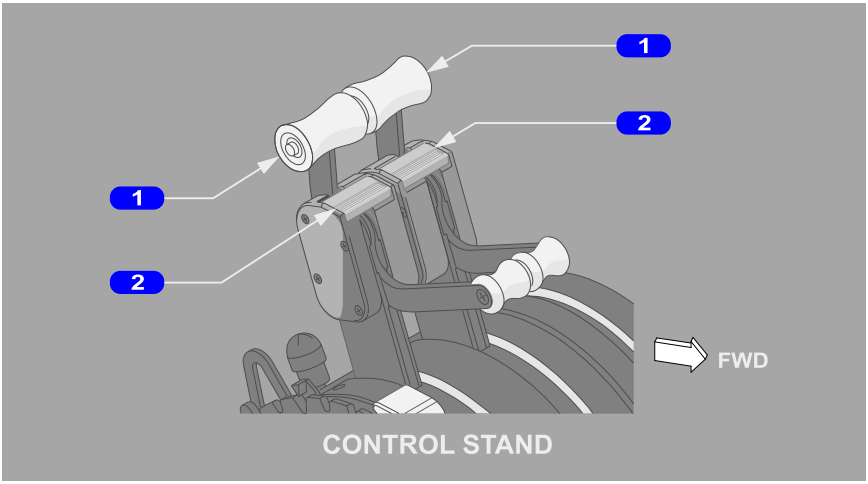
First push (either switch)—

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

Second push—resets:

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

Autothrottle Disconnect and TO/GA Switches



1 Autothrottle Disconnect Switches

Push (either switch)—

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

Second push—

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

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

On the ground:

Push—

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

In flight:

- push (after lift-off with takeoff thrust limit displayed)—
  - removes takeoff and climb derates and assumed temperature thrust reduction

  - activates autothrottle in THR REF mode
  - disarms AFDS modes
  - between 50 feet and 400 feet, selects TO/GA roll mode
  - above 400 feet, selects TO/GA roll and pitch modes.
- push (on approach with flaps out of up or glideslope/glidepath captured)—
  - activates autothrottle in THR mode with GA thrust limit displayed
  - disarms AFDS modes
  - selects TO/GA roll and pitch modes
  - 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 autothrottles 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 autothrottles 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 autothrottles in THR REF using GA reference thrust, selects TO/GA roll and pitch modes.

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 the 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 autoflight computing systems and the MCP.

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

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

Pilot MCP selections are sent to the autopilots. Autopilot commands are sent to the Primary Flight Computers (PFCs) to generate flight control surface commands. When autopilot(s) is engaged, pilot controls are back driven to provide visual and tactile indications of automatic commands. The PFCs send backdrive commands which control the backdrive actuators to move the column, wheel, and pedals. Autopilot rudder commands are added only during an autopilot approach and landing.

MCP Mode Selection

MCP switches select automatic flight control and flight director modes. A light on the switch illuminates to indicate the mode is armed or active. Mode activation is indicated by the PFD and HUD roll and pitch flight mode annunciations. Autothrottle modes are discussed later in this section.

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

- altitude hold (ALT)
- flight level change (FLCH SPD)
- flight path angle (FPA)
- heading hold (HDG HOLD)
- heading select (HDG SEL)
- track hold (TRK HOLD)
- track select (TRK SEL)

- vertical speed (V/S).

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

- glidepath (G/P) via APP switch
- glideslope (G/S) via APP switch
- lateral navigation (LNAV)
- localizer/final approach course (LOC/FAC)
- vertical navigation (VNAV).

All modes except G/S and G/P can be deselected by selecting another mode. All modes can be deselected by disengaging the autopilot and turning both flight directors off. After localizer and glideslope capture, the localizer and glideslope modes can be deactivated by disengaging the autopilot and turning both flight directors off, selecting the go-around mode, or if above 1,500 feet radio altitude, by reselecting APP (roll and pitch revert to default modes). The VNAV, LNAV, LOC, FAC, G/S and G/P modes can be disarmed by pushing the mode switch a second time (except when LNAV is automatically armed on go-around).

Desired target values can be selected on the MCP for:

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

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

Autopilot Engagement

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

Autopilot Disengagement

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

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

When an override force sufficient to move the control column, control wheel, or rudder pedals (LAND 2 or LAND 3 annunciated) is applied, the autopilot disengages and control transitions to manual inputs from the flight crew.

An automatic autopilot disengagement occurs for some failures detected by the autopilot. The EICAS warning message AUTOPILOT DISC displays if the

autopilot is manually or automatically disengaged. Depending on the system failure, it may be possible to re–engage an autopilot by pushing the autopilot engage switch.

Autopilot and Flight Director Mode Degradations

Autopilot

The autopilot system can detect the degradation of a specific autopilot mode. When an engaged mode degrades, the autopilot remains engaged in an attitude stabilizing mode based on inertial data. The condition is annunciated on the PFD and HUD by a line through the affected flight mode annunciation (amber line on the PFD) and the respective flight director bar is removed from the PFD and the flight guidance cue is removed from the HUD. The EICAS caution message AUTOPILOT displays to indicate the autopilot is operating in a degraded mode. When the degradation is no longer present the annunciations clear, the autopilot resumes using the mode, and a green box displays around the affected flight mode annunciation on the PFD and HUD for 10 seconds.

Flight Director

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

ILS Signal Interference Monitor

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

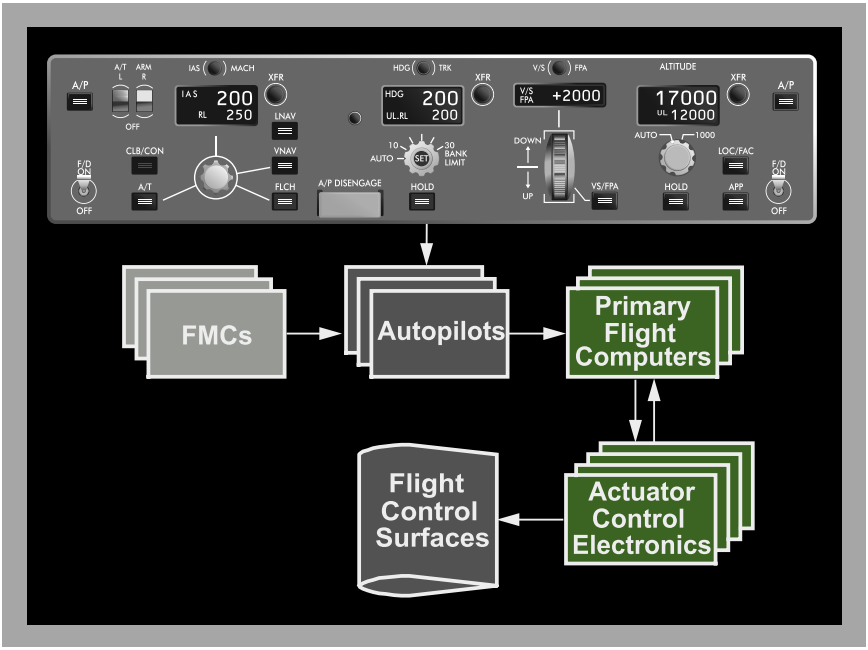
Flight Director Display

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

The steering indications also display when the related flight director switch is OFF and a TO/GA switch is pushed, if airspeed is greater than 80 knots and the flaps are out of up. In this case, the flight director display can be removed by cycling the respective flight director switch on, then off.

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

Autopilot Flight Director System Schematic



AFDS Status Annunciation

The following AFDS status annunciations display just above the PFD and HUD attitude display:

- A/P—autopilots are engaged
- FLT DIR—flight director is ON and autopilots are not engaged
- LAND 2—level of redundancy is such that a single fault cannot cause a significant deviation from the flight path (fail passive)
- LAND 3—autopilot system level of redundancy is such that a single fault cannot prevent the autopilot system from making an automatic landing (fail operational)
- NO AUTOLAND—AFDS is unable to make an automatic landing.

An EICAS message displays for any fault which limits the capability of the automatic landing system. Aural alerts for EICAS messages not affecting safety of flight are inhibited until after touchdown. Changes in autoland status below 200 feet, other than transition to NO AUTOLAND status, are inhibited.

AFDS Flight Mode Annunciations

The flight mode annunciations display just above the PFD and HUD AFDS status annunciations. The mode annunciations, from left to right, are:

- autothrottle
- roll
- pitch.

Active or captured modes display at the top of the flight mode annunciator boxes in large green letters. Armed modes (except for TO/GA in the air) display in smaller letters (white on the PFD) at the bottom of the flight mode annunciation boxes. Degradations of a specific mode while the autopilot is engaged annunciate by a line (amber on the PFD) through the mode annunciations. A green box displays around the mode annunciation for 10 seconds when a mode first becomes active, and when the line through a degraded mode is removed.

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 thrust levers manually
- SPD—Autothrottle maintains the command speed. Speed can be set using the MCP IAS/MACH selector or by the FMC, as displayed on the CDU CLIMB, CRUISE, or DESCENT page. The autothrottle does not exceed the operating speed limits or the thrust limits displayed on the EICAS.

Note: When only one autothrottle is connected and armed, the autothrottle mode annunciation is augmented by a "L-" or "R-" preceding the mode.

Roll Modes

Roll annunciations are:

LNAV—

- 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 ½ NM of the active leg
- On go-around, LNAV becomes active at 50 feet radio altitude with flight director only or 200 feet radio altitude with the autopilot engaged
- LNAV is deactivated by selecting any other roll mode or by disengaging the autopilot and turning both flight directors off.

HDG—

- HDG SEL (active)—Airplane turns to or maintains the heading set in the MCP heading/track window
- HDG HOLD (active)—AFDS holds present heading. When turning, the AFDS holds the heading reached after rolling wings level.

TRK—

- TRK SEL (active)—Airplane turns to or maintains the track set in the MCP heading/track window
- TRK HOLD (active)—AFDS holds present track. When turning, AFDS holds the track reached after rolling wings level.

LOC—

- LOC (armed)—AFDS captures localizer when within range and within 120º of localizer course
- LOC (active)—AFDS follows the localizer course.

FAC—

- FAC (armed)—AFDS captures the IAN final approach course
- FAC (active)—AFDS tracks the IAN final approach course along the inbound bearing.

B/CRS—

- B/CRS (armed)—AFDS captures the localizer final approach back course
- B/CRS (active)—AFDS tracks the localizer final approach course along the inbound back course bearing.

TO/GA—

- On the ground, TO/GA annunciates by positioning either flight director switch ON when both flight directors are OFF; or, by pushing either TO/GA switch with airspeed greater than 80 KIAS. 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 TO/GA roll mode maintains the existing ground track.

HUD TO/GA (Takeoff)

- On takeoff, HUD provides lateral guidance for takeoff roll and rejected takeoff using ILS or GLS signals. Selecting a HUD TAKEOFF departure in the FMC and turning either flight director ON sets HUD TO/GA as the active roll mode on the PFD and HUD
- HUD Takeoff requires the ILS or GLS to be auto tuned
- HUD guidance becomes active and cue appears when the airplane approaches the runway center line and airplane heading is within 45º of runway heading

Notes:
1. The lateral flight director bar on the PFD also moves with the guidance commands but is not certified for use during a HUD takeoff.
2. A HUD TO/GA takeoff based on an offset localizer course may provide guidance cues not aligned with the runway centerline and should not be used.
3. If HUD TO/GA is selected and the airplane is in a location where the selected localizer signal is blocked (for example, buildings between the selected runway and the airplane), the EICAS advisory message NO AUTOLAND can show until the airplane is in a location where a clear localizer signal can be received.

- When TO/GA mode is selected, the HUD symbology automatically changes to full mode symbology and the HUD symbology control switch is inhibited.

ROLLOUT—

- ROLLOUT (armed)—Displayed below 1,500 feet radio altitude and activates at touchdown with weight on the wheels
- 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; or, by pushing either TO/GA switch with airspeed greater than 80 knots. The flight director PFD pitch bar and HUD guidance cue indicates an initial pitch of 8º up. TO/GA pitch guidance becomes active at lift-off.

After lift-off, the AFDS commands a pitch attitude to maintain:

- a target speed of V2 plus 15 knots or the airspeed at rotation (pitch attitude greater than 2º) plus 15 knots, whichever is greater
- if current airspeed remains above the target speed for 5 seconds, the target airspeed is reset to the lesser of current airspeed or V2 plus 25 knots
- the IAS/MACH window speed if the IAS/MACH window speed is changed to a speed greater than the target speed.

Note: The AFDS uses the speed set in the IAS/MACH window for V2.

In flight, TO/GA is armed when flaps are out of up or glideslope is captured.

When a go-around is initiated, the commanded speed is the MCP IAS/MACH window or current airspeed, whichever is higher, to a maximum of the IAS/MACH window speed plus 25 knots. GA displays as the thrust limit on the primary EICAS engine display.

VNAV—

VNAV is armed by pushing the VNAV switch:

- VNAV light illuminates
- VNAV annunciates on the PFD pitch mode annunciation in small white characters below the current pitch mode
- VNAV annunciates on the HUD pitch mode annunciation in small green characters below the current pitch mode.

VNAV activates above 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 HUD and/or the CDU CLIMB or DESCENT pages. If speed intervention is selected, the MCP IAS/MACH selector is used to manually select the speed
- VNAV PTH (active)—AFDS maintains FMC altitude or descent path with pitch commands. If the MCP altitude window remains set to the current cruise altitude and the airplane is within two minutes of top of descent, the EICAS advisory message FMC MESSAGE displays and the CDU Help window opens with instructions to set a lower altitude before top of descent
- VNAV ALT (active)—When 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
- when an early descent is desired, FLCH, V/S, or FPA may be selected to descend below the VNAV descent path. If, during the descent, VNAV is armed and the airplane descent path subsequently intercepts the VNAV descent path, VNAV activates in VNAV PTH.

V/S (active)—Pushing the MCP VS/FPA switch, opens the vertical speed window to display the current vertical speed. Pitch commands maintain the rate of climb or descent set in the VS/FPA window.

FPA (active)—Pushing the MCP VS/FPA switch opens the flight path angle window to display the current flight path angle. Pitch commands maintain the flight path angle set in the VS/FPA window.

FLCH SPD (active)—Pushing the MCP FLCH switch opens IAS/MACH window (if blanked). Pitch commands maintain IAS/MACH window airspeed or Mach.

ALT (active)—Altitude hold mode is activated by:

- pushing the MCP altitude HOLD switch, or
- capturing the selected altitude from a V/S, FPA, or FLCH climb or descent.

G/S (active)—AFDS follows the ILS or GLS glideslope.

G/P (active)—AFDS follows the FMC glidepath.

FLARE (armed)—During autoland, FLARE displays below 1,500 feet RA.

FLARE (active)—During autoland, flare activates between 60 and 40 feet radio altitude. FLARE deactivates at touchdown and smoothly lowers the nosewheel 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 provides mode and speed selection. The CDUs enable FMC reference thrust limit selection. When VNAV is active, the FMC selects autothrottle modes and target thrust values. (See Vertical Navigation (VNAV) on page 11.31.21 for additional information.)

The autothrottle is either OFF, ARMED, or active. The autothrottle is off when the A/T arm switches are OFF. The autothrottle is armed when the A/T switches are ON and the autothrottle mode is blank. The autothrottle is active when the A/T arm switches are ON and there is an autothrottle mode shown. The active autothrottle modes are: IDLE, HOLD, THR, THR REF, and SPD.

Manual Flight

The autothrottle can be operated with flight directors OFF and the autopilot not engaged. When the autopilot is not engaged, but one or both flight directors are ON and the autothrottle is active, turning off both flight directors transitions the autothrottle to SPD. The autothrottle maintains the IAS/MACH window speed.

During a manual landing, when the active autothrottle mode is SPD, or the pitch mode is VNAV with the autothrottle active, thrust reduces to IDLE at 25 feet RA and the autothrottle mode transitions to IDLE.

Automatic Activation

The autothrottle can automatically activate to provide stall protection when armed and not active (A/T mode is blank).

With the autothrottle armed and not active, the autothrottle automatically activates when the pitch mode is ALT, V/S, FPA, VNAV ALT, VNAV PTH, G/S, G/P, or there is no active pitch mode, and:

- speed is less than an FMC calculated value for one second, and
- thrust is below reference thrust limit, and
- airplane barometric altitude is 400 feet above the airport on takeoff or airplane altitude is above 100 feet RA on approach

If speed decreases to near stick shaker activation, the autothrottle automatically activates in SPD mode and advances thrust to maintain minimum maneuvering speed (approximately the top of the amber band) or the speed set in the IAS/MACH window, whichever is greater.

Notes:
1. During a climb in VNAV SPD with the autothrottle armed and not active, the autothrottle automatically activates in THR REF mode and advances thrust toward the reference thrust limit.
2. During a descent in VNAV SPD with the autothrottle armed and not active, the autothrottle can automatically activate in HOLD mode and will not advance thrust levers to support stall protection.
3. The autothrottle will not automatically activate to support stall protection when the pitch mode is FLCH SPD or TO/GA.
4. The autothrottle will not support stall protection when the A/T mode is HOLD.

The EICAS advisory message AUTOTHROTTLE L or R displays when the respective autothrottle servo fails. If the autothrottle is active and only one autothrottle is armed, the PFD autothrottle flight mode annunciation displays L or R preceding the mode. For example, L SPD indicates only the left autothrottle is active in speed mode.

Autothrottle Thrust Lever Operation

The autothrottle system moves either or both thrust levers to provide speed or thrust control, depending on the active mode.

Thrust levers can be manually positioned without disconnecting the autothrottle. After manual positioning, the autothrottle system repositions thrust levers to comply with the active mode. The autothrottle system does not reposition thrust levers while in HOLD mode.

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

Autothrottle Disconnect

The autothrottle system can be disconnected manually by pushing either autothrottle disconnect switch, except during conditions that cause the autothrottle to automatically activate. The autothrottle can also be disconnected manually by positioning both A/T ARM switches to OFF, or individually by positioning the left or right A/T ARM switch to OFF. Positioning one or both A/T ARM switches to OFF prevents activation of all autothrottle modes for the affected autothrottle.

Autothrottle disconnect occurs automatically:

- if a fault in the active autothrottle mode is detected, or
- when either reverse thrust lever is raised to reverse idle, or
- if the thrust levers are overridden during a manual landing, after the autothrottle has begun to retard the thrust levers to idle, or

- when both engines are shut down, or
- when one engine is shut down.

The EICAS caution message AUTOTHROTTLE DISC displays and an aural alert sounds when the autothrottle is manually or automatically disconnected. The EICAS caution message and aural alert are inhibited if the disconnect occurs because of reverse thrust.

Automatic Flight Operations

Automatic Flight—Takeoff and Climb

Takeoff is a flight director only function of the takeoff/go-around (TO/GA) mode. The autopilot may be engaged after takeoff.

During preflight:

- with the autopilot disengaged and both flight director switches OFF, activation of TO/GA roll and pitch mode occurs when the first flight director switch is positioned ON
- PFD and HUD displays FLT DIR as AFDS status and TO/GA as the pitch and roll flight mode annunciations
- pitch command is set to approximately 8º up
- roll command is wings level.

During takeoff prior to lift–off:

- with speed less than 50 knots, pushing a TO/GA switch activates the autothrottle in thrust reference (THR REF) and advances thrust levers to the selected reference thrust limit. When the autothrottle is not active by 50 knots, it cannot be activated until above 400 feet
- at 80 knots, autothrottle annunciation changes to HOLD
- with speed greater than 80 knots, pushing a TO/GA switch disarms LNAV and VNAV.

At lift-off:

- pitch command target speed is V2 + 15 knots or the airspeed at rotation (pitch attitude greater than 2º) plus 15 knots, whichever is greater. If current airspeed remains above target speed for 5 seconds, target airspeed is reset to current airspeed (limited to a maximum of V2 + 25 knots)
- if an engine failure occurs on the ground, the pitch command target speed at lift-off is V2 or airspeed at lift-off, whichever is greater
- roll command maintains ground track.

After lift-off:

- when an engine failure occurs, the pitch command target speed is:
  - V2, if airspeed is below V2, or
  - existing speed, if airspeed is between V2 and V2 + 15, or
  - V2 + 15, if airspeed is above V2 + 15

- when a TO/GA switch is pushed:
  - removes takeoff and climb derates and assumed temperature thrust reduction
  - A/T in HOLD, A/T activates in THR REF
- at 50 feet radio altitude, LNAV activates, if armed. Roll commands bank to track the active route

  Note: If not using LNAV, automatic LNAV arming and activation occurs when a TO/GA switch is pushed after takeoff and the flaps are not up. To prevent this, do not load an instrument approach before departure.
- at 400 feet, VNAV activates, when armed. Pitch commands the current airspeed. The 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
- engine out acceleration and climb capability are functions of airplane thrust to weight ratio. If VNAV is not engaged at the engine out acceleration height, TO/GA pitch mode transitions from airspeed control to pitch control as required to manage the airplane energy. For extreme climb limited operation during flap retraction with one engine inoperative. TO/GA pitch mode may cycle periodically between airspeed control and pitch control
- when flaps are up, pitch commands an acceleration to VNAV climb speed. VNAV climb speed is the greater of:
  - flaps up maneuver speed, or
  - speed transition associated with origin airport
- at thrust reduction point (either an altitude or a flap position), FMC changes reference thrust limit to armed climb limit (CLB, CLB 1, or CLB 2).

The TO/GA mode is terminated by selecting any other pitch and roll mode or by activation of LNAV/VNAV.

HUD Takeoff

Using ILS or GLS signals, the HUD takeoff system provides lateral guidance on the HUD for takeoff roll and rejected takeoff. Selecting a HUD TAKEOFF departure in the FMC and turning on either flight director enables the guidance and sets HUD TO/GA as the active FMA roll mode. Once the airplane approaches the runway center line and airplane heading is within 45º of runway heading, guidance becomes active and the ground roll reference symbol and localizer deviation pointer appear. The ground roll reference symbol centers on the guidance cue once the airplane is centered on the runway.

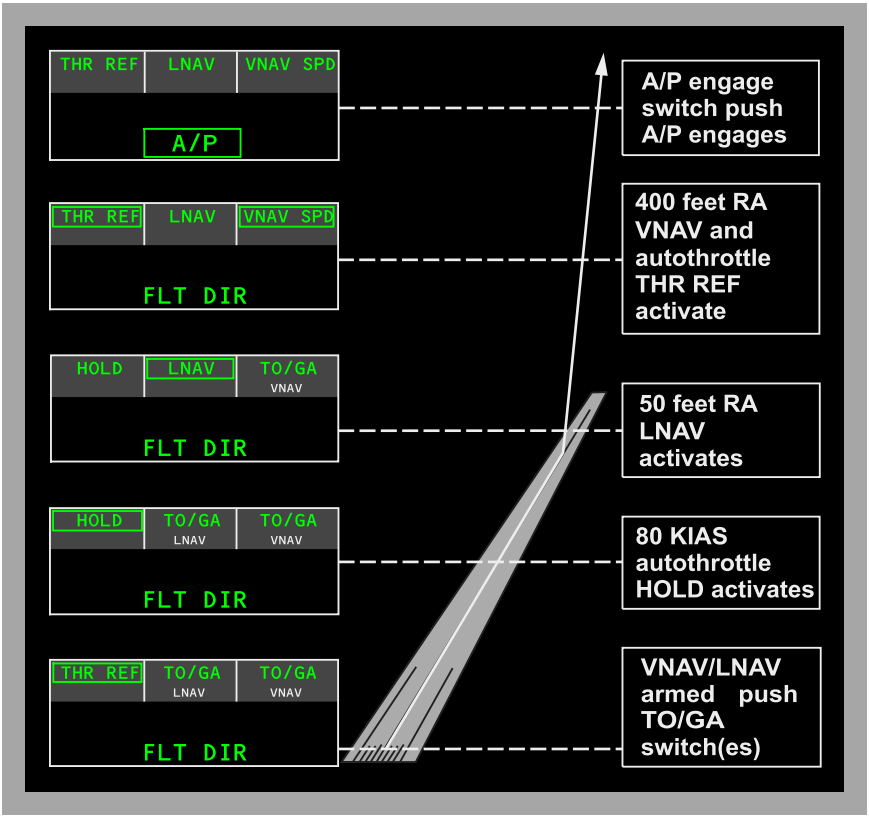
Notes: 1. The lateral flight director bar on the PFD also moves with the guidance commands, but is not certified for use during a HUD takeoff.

2. A HUD TO/GA takeoff based on an offset localizer course may provide guidance cues not aligned with the runway centerline and should not be used.
3. If HUD TO/GA is selected and the airplane is in a location where the selected localizer signal is blocked (for example, buildings between the selected runway and the airplane), the EICAS advisory message NO AUTOLAND can show until the airplane is in a location where a clear localizer signal can be received.

For additional information:

- See Primary Flight Display (PFD) on page 10.10.1
- See Ground Deviation Indications—HUD Takeoff on page 10.12.20.

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 FMS. Using LNAV and VNAV ensures the most economical operation.

Other roll modes available are:

- heading hold (HDG HOLD)
- heading select (HDG SEL)
- track hold (TRK HOLD)
- track select (TRK SEL).

Other pitch modes available are:

- altitude hold (ALT)
- flight level change (FLCH SPD)
- flight path angle (FPA)
- vertical speed (V/S).

Profile illustrations show the use of LNAV and VNAV.

Automatic Flight—Approach and Landing

The AFDS provides autopilot guidance for Instrument Landing System (ILS), GBAS Landing System (GLS) and approaches utilizing Integrated Approach Navigation (IAN).

ILS approaches are flown in the G/S and LOC modes with the approach path deviation data from the localizer and glideslope transmitters.

GLS approaches are also flown in the G/S and LOC modes, but the approach path deviation data is from the Ground-Based Augmentation System (GBAS).

Pushing the APP switch arms the pitch and roll modes after an approach procedure selection is made in the FMC. Either localizer or glideslope/glidepath can be captured first.

Pushing the LOC/FAC switch arms the AFDS to capture and maintain an approach lateral flight path using an ILS localizer beam or a lateral path provided by the FMC. Descent on the localizer or final approach course can be accomplished using VNAV, V/S, FLCH, or FPA pitch modes. The LOC or FAC mode cannot capture if the intercept angle exceeds 120º.

With a command speed of VREF + 5 knots and landing flaps, there is sufficient wind and gust protection available with the autothrottle active. The autothrottle adjusts thrust quickly when airspeed decreases below command speed. The autothrottle decreases thrust slowly when airspeed is more than command speed. In turbulence, thrust may be somewhat higher than necessary to maintain command speed. Average speed may be somewhat higher than command speed.

Integrated Approach Navigation (IAN)

Integrated Approach Navigation allows the use of consistent procedures for all types of instrument approaches. Any approach where the glidepath angle is defined in the navigation database can be flown using procedures, indications and alerts similar to those used for an ILS approach. The published glidepath angle can be found on the RTE LEGS page.

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 can come from the FMC or localizer.

The IAN FAC is constructed by the FMC inbound to and through the MAP on the final approach course. The FAC only provides guidance to the runway if the MAP is located on the runway approach end.

The IAN G/P is constructed on an angle that passes through altitude constraint at the MAP, and is the steeper of either the published angle, or the angle that clears the altitude constraint at the waypoint prior to the MAP.

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	FAC	G/P	G/S must be selected OFF.
VFR	FAC	G/P	
VOR	FAC	G/P	

IAN requires using the APP switch on the MCP to arm the roll and pitch modes as the airplane nears the final approach segment. Approaches are flown to published minimums utilizing 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 alert appears on the PFD and HUD if the autopilot remains engaged below 100 feet RA.

For additional information on autopilot engaged alerts:

- See Alerts Displayed on the PFD on page 15.10.8

- See Alerts Displayed on the HUD on page 15.10.9.

Note: IAN deviation scales and annunciations are displayed on the HUD but are not displayed on the ISFD.

For additional information on IAN:

- See Automatic Flight Approach Profiles on page 4.20.18
- See PFD Integrated Approach Navigation (IAN) Indications on page 10.10.16
- See Integrated Approach Navigation (IAN) Indications on page 10.30.7
- See Integrated Approach Navigation (IAN) on page 11.31.34
- See Approach Procedure on page NP.21.27.

Runway Alignment

Runway alignment is a submode of the approach mode. With crosswinds, the crab angle is reduced at touchdown. Runway alignment also compensates for a single engine approach.

For crosswinds requiring more than 10º of crab angle, runway alignment occurs at 500 feet AGL. A sideslip of 5º is established to reduce the crab angle. This configuration is maintained until touchdown. The airplane lands with a minimum of a 5º crab angle.

For crosswinds requiring a crab angle of between 5º and 10º, 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 5º. 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 5º, no runway alignment occurs until 200 feet AGL, where a sideslip is introduced to align the airplane with the runway.

If an engine fails prior to the approach, the AFDS introduces a sideslip at 500 feet AGL. This establishes a wings level configuration. If an engine fails during the approach, the wings level configuration is established when the engine failure is detected.

In the event of moderate or strong crosswinds from the side opposite the failed engine, no wings level sideslip is commanded, since the airplane is already banked into the wind.

Flare

The flare mode brings the airplane to a smooth automatic landing touchdown. The flare mode is not intended for single autopilot or flight director only operation.

Flare is armed when LAND 3 or LAND 2 is annunciated on the PFDs and HUDs. Below 350 feet radio altitude, the inboard spoilers are biased up incrementally. If the autopilot is subsequently disengaged, the spoiler bias is removed and a slight

forward column control force may be required to maintain trim. At approximately 50 feet radio altitude, the autopilots start the flare maneuver. FLARE replaces the pitch flight mode annunciation.

Note: If a TO/GA go-around is initiated with spoilers in the biased position, the spoiler bias is removed.

During flare:

- flight director roll and pitch bars retract from view
- between 25 and 50 feet radio altitude, the autothrottle begins retarding thrust levers to idle
- PFD and HUD autothrottle annunciation changes from SPD to IDLE
- at touchdown, the FLARE annunciation no longer displays, and the nose wheel is lowered to the runway.

Rollout

Rollout provides localizer centerline rollout guidance. Rollout arms when LAND 3 or LAND 2 annunciates.

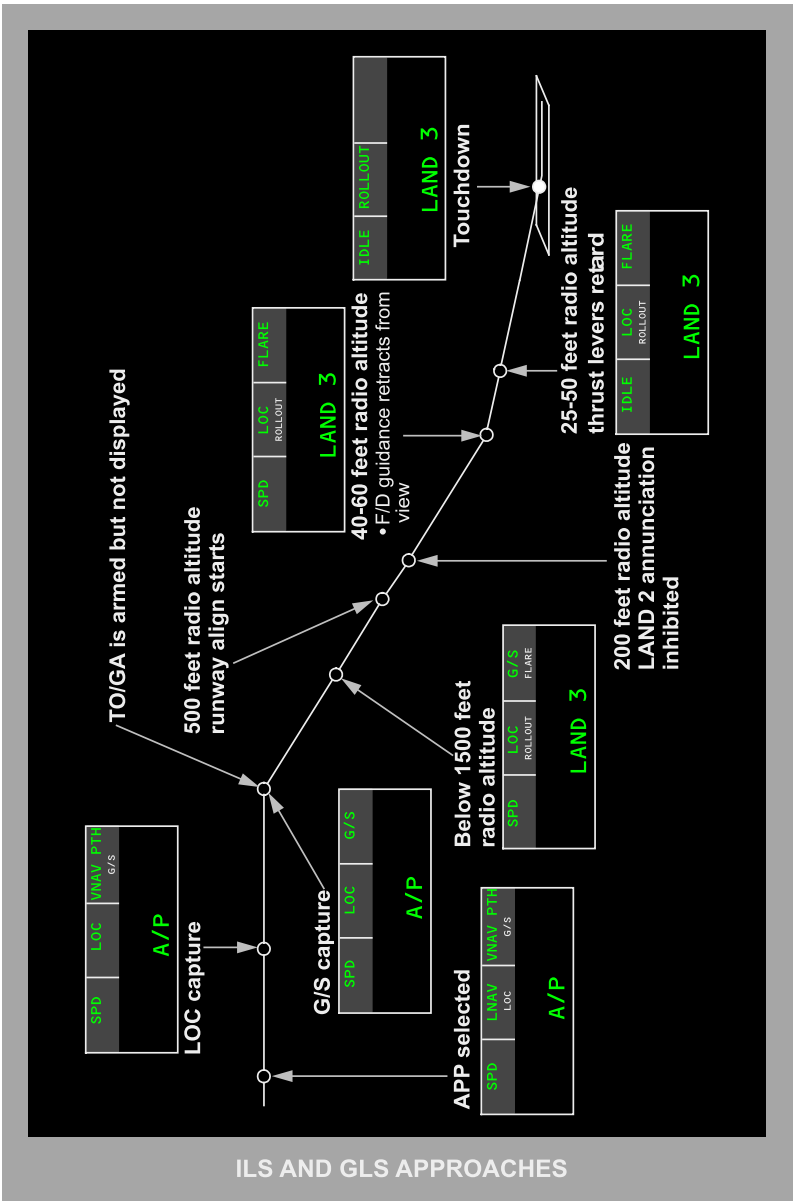
Rollout activates at touchdown with weight on the wheels. ROLLOUT replaces the roll mode annunciation.

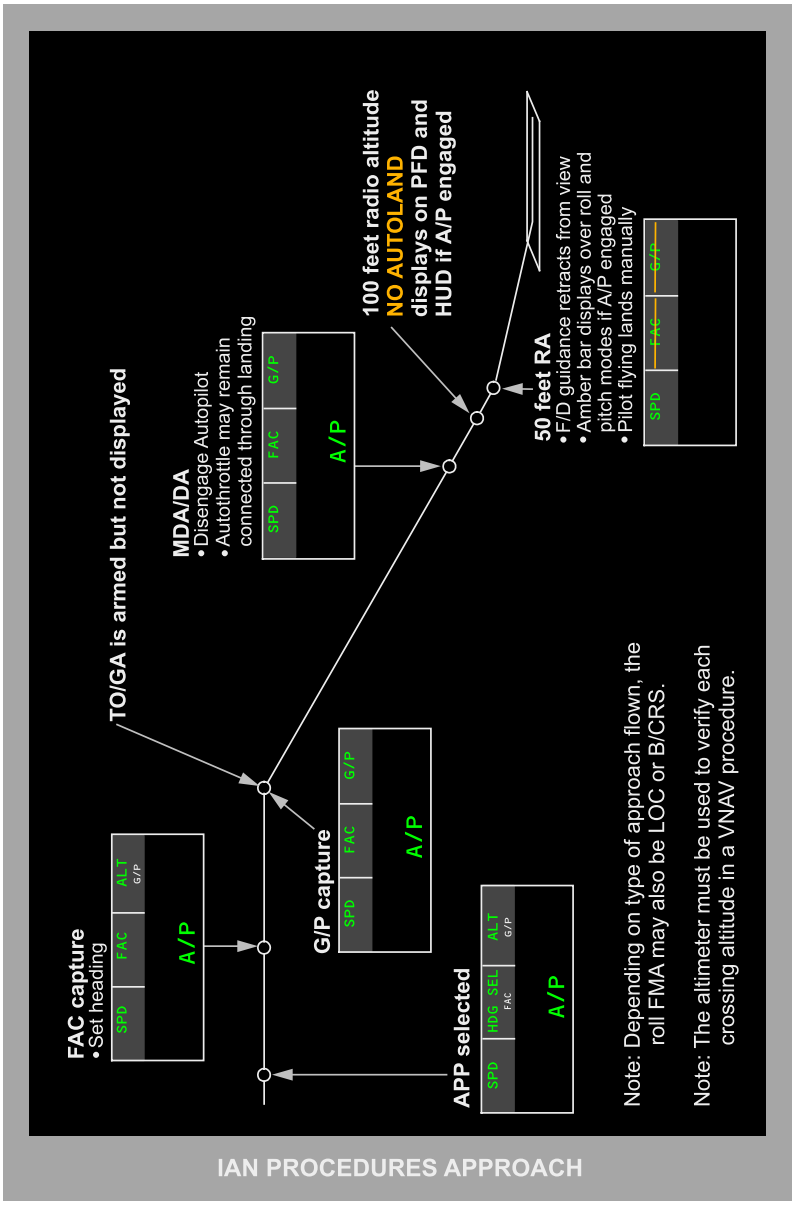
The autopilot controls rudder and nose wheel steering to track the localizer centerline.

During rollout, autothrottle IDLE mode remains active until the autothrottle disconnects with thrust levers in reverse.

Rollout guidance continues until the autopilots are disengaged.

Automatic Flight Approach Profiles




FAC capture
•Set heading
SPD
FAC
ALT
G/P
A/P
TO/GA is armed but not displayed
G/P capture
SPD
FAC
G/P
A/P
APP selected
SPD
HDG SEL
FAC
ALT
G/P
A/P
MDA/DA
•Disengage Autopilot
•Autothrottle may remain connected through landing
SPD
FAC
G/P
A/P
100 feet radio altitude
NO AUTOLAND
displays on PFD and HUD if A/P engaged
50 feet RA
•F/D guidance retracts from view
•Amber bar displays over roll and pitch modes if A/P engaged
•Pilot flying lands manually
SPD
FAC
G/P
Note: Depending on type of approach flown, the roll FMA may also be LOC or B/CRS.
Note: The altimeter must be used to verify each crossing altitude in a VNAV procedure.
IAN PROCEDURES APPROACH

Automatic Flight—Go-Around

TO/GA is armed when flaps are out of up or glideslope/glidepath is captured. The thrust limit changes to GA when flaps are out of up, flaps are extended to landing position, or glideslope/glidepath is captured. The reference thrust limit is locked in GA when flaps are in landing position or glideslope/glidepath 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, pushing 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.

The TO/GA switches are inhibited when on the ground and enabled again when in the air for a go-around or touch and go.

With the first push of either TO/GA switch:

- roll and pitch activate in TO/GA
- autothrottle activates in thrust (THR) to establish a minimum climb rate of 2,000 FPM
- the AFDS increases pitch to hold the selected speed as thrust increases
- when 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 an LNAV path 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: During go-around from a LAND 2 or LAND 3 approach, automatic LNAV activation causes disengagement of autopilot rudder control, but control is taken over by primary flight control system.

With the second push of either TO/GA switch, autothrottle activates in thrust reference (THR REF) at full go-around thrust.

With an LNAV path available, LNAV remains active following a second TO/GA push.

TO/GA level-off:

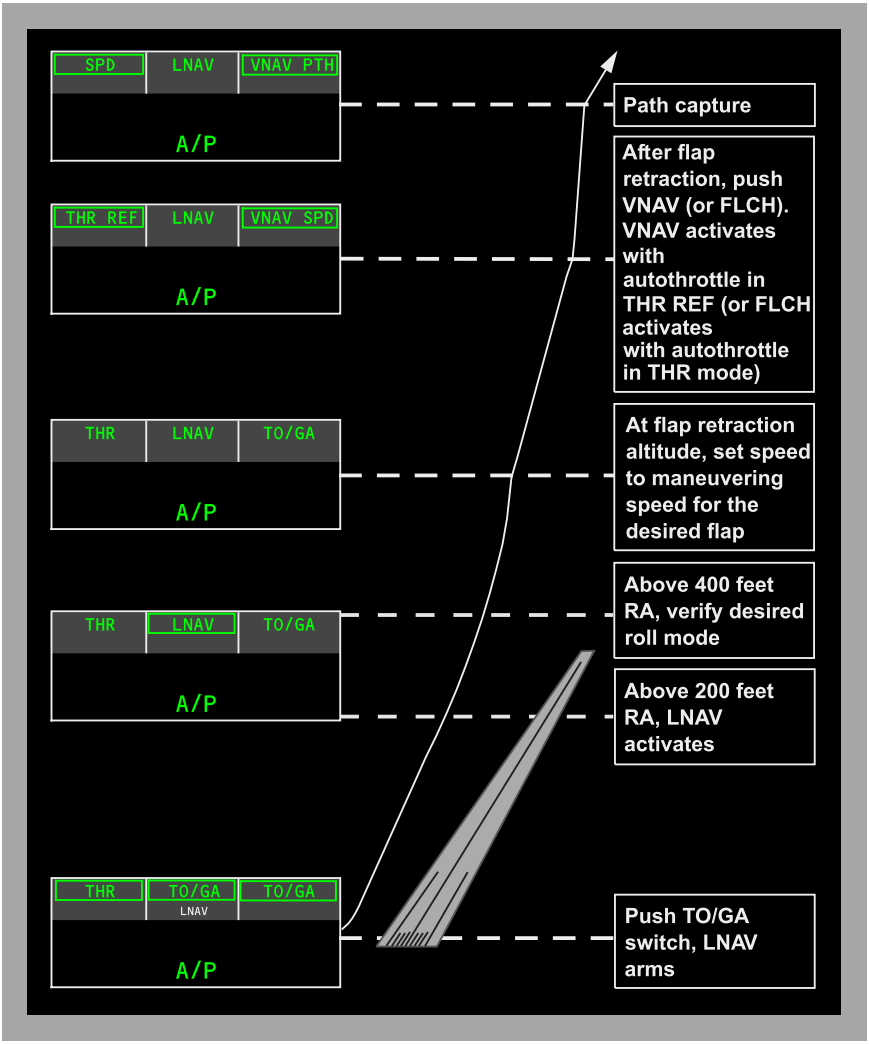
- at the set altitude, AFDS pitch mode changes to altitude hold (ALT)
- if altitude is captured or if V/S or FPA is active, MCP speed is automatically set to:
  - flap placard speed minus 5 knots, or
  - 250 knots if flaps are up, or
  - a speed value entered in the IAS/MACH window after TO/GA was pushed

- TO/GA remains the active roll mode until LNAV automatically activates or another roll mode is selected.

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.

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° or slightly below the pitch limit, whichever is lower.

As rate of climb increases, the AFDS transitions from pitch to airspeed control. The target airspeed is IAS/MACH window airspeed or current airspeed, whichever is greater when TO/GA is 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).

Flight Envelope Protection

In addition to primary flight control system protection, the autopilot and autothrottle systems prevent stall and overspeed. Overspeed protection is available with flaps up for all flight modes except G/S. With flaps out of up, flight envelope protection is only available in FLCH and TO/GA.

The EICAS caution message AUTOPILOT displays if the autopilot has begun flight envelope protection or if an amber line displays through the affected active roll or pitch flight mode annunciation.

When engaged, the autopilot limits bank angle to 30º, further assisting flight envelope protection.

(See Flight Envelope Protection on page 9.20.6 for additional information.)

Automatic Flight EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
AUTOPILOT	Caution	Beeper	One or more of these occur: • the autopilot is in a degraded mode other than the selected mode • the engaged roll mode is failed • the engaged pitch mode is failed • the autopilot is in flight envelope protection.
AUTOPILOT DISC	Warning	Siren	All autopilots are disconnected.
AUTOTHROTTLE DISC	Caution	Beeper	Both autothrottles are disconnected.
AUTOTHROTTLE L, R	Advisory		The autothrottle is inoperative.
A/P BACKDRIVE COLUMN	Caution	Beeper	The autopilot can no longer backdrive the control column to match the position of the elevator.
A/P BACKDRIVE PEDAL	Caution	Beeper	The autopilot can no longer backdrive the rudder pedals to match the position of the rudder during autoland approaches.
A/P BACKDRIVE WHEEL	Caution	Beeper	The autopilot can no longer backdrive the control wheel to match the position of the ailerons.
NO AUTOLAND	Caution Advisory	Beeper	The autoland system is not available. Message is a caution if fault occurs after LAND 3 or LAND 2 is annunciated, or approach has been selected but does not engage by 300 AGL. Message is an advisory if fault occurs before LAND 3 or LAND 2 is annunciated.
NO AUTOLAND GLS	Advisory		The autoland system is not available for a GLS approach.

Message	Level	Aural	Condition
NO AUTOLAND ILS	Advisory		The autoland system is not available for an ILS approach.
NO LAND 3	Caution Advisory	Beeper	The autoland system does not have redundancy for a triple channel autoland. Message is a caution if fault occurs after LAND 3 is annunciated. Message is an advisory if fault occurs before LAND 3 is annunciated.
T/O THRUST DISAGREE	Advisory		The thrust management takeoff thrust calculation disagrees with the EEC takeoff thrust calculation.

Communications Chapter 5
Table of Contents

Controls and Indicators 5.10

Audio Control Panel (ACP) 5.10.1

Radio System 5.10.4

Tuning and Control Panel (TCP) 5.10.4

TCP Page Components 5.10.6

Communication Indications 5.10.17

Miscellaneous Communication Controls 5.10.18

Headphone/Boom Microphone [Typical] 5.10.18

Oxygen Mask Microphone (Typical) 5.10.19

Control Wheel Microphone/Interphone Switch 5.10.20

Glareshield Microphone Switch (Typical) 5.10.20

Service Interphone Switch 5.10.21

Handset 5.10.22

Flight Deck Speaker/Boom Mic/Headphone Panel (Typical) 5.10.24

Observer Audio Selector 5.10.24

Datalink Accept/Cancel/Reject Switches (Typical) 5.10.25

Cockpit Voice Recorder System 5.10.26

Cockpit Voice Recorder Panel 5.10.26

Cockpit Voice Recorder Microphone 5.10.26

Printer Controls 5.10.27

Broadband Communication Switch 5.10.28

System Description 5.20

Introduction 5.20.1

Audio Control Panels (ACP) 5.20.1

Cockpit Voice Recorder (CVR) System 5.20.1

Tuning and Control Panels (TCP) 5.20.2

Communication Indications 5.20.2

Radio Communication Systems 5.20.2
VHF Communication System 5.20.2
HF Communication System 5.20.4
Data Mode 5.20.4
Stuck Mic Protection 5.20.5
Selective Calling (SELCAL) System 5.20.5
Satellite Communication (SATCOM) System 5.20.5
Broadband Connectivity System 5.20.6
Communication Crew Alerting System 5.20.6
Crew Alert Categories 5.20.6

Interphone Systems 5.30

Interphone Communication System 5.30.1
Flight Interphone System 5.30.1
Service Interphone System 5.30.1
Passenger Address System 5.30.2
Cabin Interphone System 5.30.2
Cabin Interphone Main Menu 5.30.3
Cabin Interphone Main Menu Page [Typical] 5.30.4
Cabin Interphone Directory Page [Typical] 5.30.5
Cabin Interphone Subdirectory Page [Typical] 5.30.6

MFD Communications Functions 5.40

MFD Communications Functions 5.40.1
Communications Menus 5.40.2
Communications Control and Input Functions 5.40.3
Command Key Locations 5.40.4
Command Key Functions 5.40.4
Text Entry 5.40.8
Menu Entry Fields 5.40.9
Help Window 5.40.9
Message List 5.40.12
Message Display Format 5.40.13

Exclusive and Nonexclusive Select Keys 5.40.15
Information Messages 5.40.15
ATC Messages 5.40.17
ATC Datalink 5.40.19
Crew Feedback 5.40.19
FMC Data Loading 5.40.19
Downlink Pages 5.40.20
ATC Menu 5.40.20
Level Request 5.40.23
Route Request 5.40.26
Speed Request 5.40.30
Clearance Request 5.40.32
Combination Downlink Request 5.40.34
When Can We Expect 5.40.36
Voice Contact Request 5.40.37
Free Text Message 5.40.38
ATC Logon/Status 5.40.39
ATC Reports 5.40.43
Emergency Report 5.40.43
ATC Requested Report 5.40.45
Armable Report 5.40.46
Conditional Clearances 5.40.46
Position Report 5.40.48
Monitoring Report 5.40.51
Flight Information 5.40.52
Flight Information Menu 5.40.52
Departure Clearance Request 5.40.53
Oceanic Clearance Request 5.40.54
ATIS Request 5.40.57
TWIP Request 5.40.59
Pushback Clearance Request 5.40.61
Expected Taxi Clearance Request 5.40.63

Company Menu (Typical) 5.40.65
Company Downlink Message Page (Typical) 5.40.66
Review Menu (Typical) 5.40.67
Review State Indicators 5.40.67
Manager Functions 5.40.69
Manager Menu 5.40.69
ACARS Manager 5.40.70
VHF Manager 5.40.71
VHF Manager Page 2/3 - VDL Mode A 5.40.73
VHF Manager Page 2/3 - VDL Mode 2 . . . . . 5.40.74
VHF Manager Page 3/3 . . . . . 5.40.75
HF Manager 5.40.76
SATCOM Manager 5.40.77
ADS Manager 5.40.78
System Information Manager 5.40.80
Automatic Messages Manager 5.40.81
Master Manager 5.40.82
Communications Audit 5.40.84
Manager Messages 5.40.85
New Messages 5.40.87
New Messages Menu (Typical) 5.40.87
New Message—No Response Required 5.40.88
New Message—Response Required 5.40.90

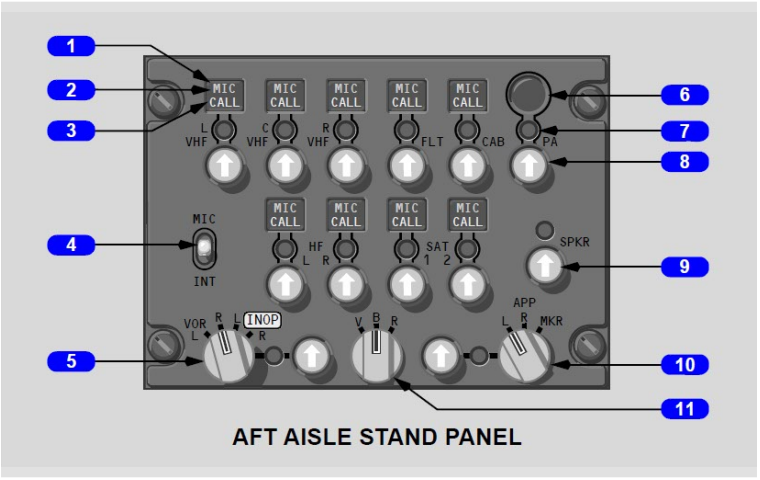
EICAS Messages 5.50

Communications EICAS Alert Messages 5.50.1
Datalink 5.50.1
Radios 5.50.1
SATCOM 5.50.1
EICAS Communication Messages 5.50.1
Crew Communications 5.50.2
Datalink 5.50.2
SATCOM 5.50.3

SELCAL 5.50.3

Audio Control Panel (ACP)

DELETION



AFT AISLE STAND PANEL

1 Transmitter Select Switches

Push—

- the MIC light illuminates
- normally, the MIC light for any other transmitter extinguishes
- selects the respective transmitter (radio or intercommunications) for transmission from this crew station
  - normally, only one switch is selected at a time for each crew station
  - CAB and SAT may be selected at the same time for cabin to SATCOM conferencing
- selects the receiver audio on, if not already manually selected on
- pushing the CAB transmitter select switch twice within one second places a priority call to a selected cabin station.

Second push—

- deselects the transmitter
- deselects receiver audio.

Note: Second push of the CAB select switch deselects the transmitter and receiver audio only after one second has elapsed from the first push.

2 MIC Lights

Illuminated (green)—indicates the transmitter is selected.

3 CALL Lights

Illuminated (white)—

- indicates a call on SELCAL, the flight interphone (FLT), the cabin interphone (CAB), or SATCOM (SAT)
- resets when the respective transmitter select switch is pushed or, if already pushed, by pressing a MIC/INTERPHONE switch (the SATCOM CALL light remains illuminated until the call ends)
- PA does not have a CALL light.

4 MIC/Interphone Switch

MIC—keys the boom microphone or oxygen mask on the selected radio transmitter or other system.

Center—off position (spring-loaded to center).

INT—keys the boom microphone or oxygen mask on the flight interphone.

5 VOR Receiver Selector

Selects the VOR receiver to be monitored:

- VOR L—left VOR and DME
- VOR R—right VOR and DME
- ADF L—(inop)
- ADF R—(inop).

6 PA Mic Switch

Push and hold—

- the MIC light for any other transmitter extinguishes
- keys passenger address announcement from this station to all PA areas.

7 Receiver Lights

Illuminated (green)—indicates the respective receiver volume control is manually selected on.

8 Receiver Volume Controls

Push—turns the respective receiver audio on or off.

Rotate—controls receiver volume.

Note: The CAB transmitter select switch has to be selected on an ACP in order to turn the CAB receiver audio on or off.

9 Speaker (SPKR) Volume Control

Push—turns the respective flight deck speaker on or off.

Rotate—controls flight deck speaker volume.

Note: Inoperative on first observer audio control panels.

10 Approach (APP) Receiver Selector

Selects the approach receiver to be monitored:

- APP L—left ILS/GLS and DME
- APP R—right ILS/GLS and DME
- MKR—marker beacon.

11 Navigation Filter Selector

Filters VOR, ILS, or DME audio:

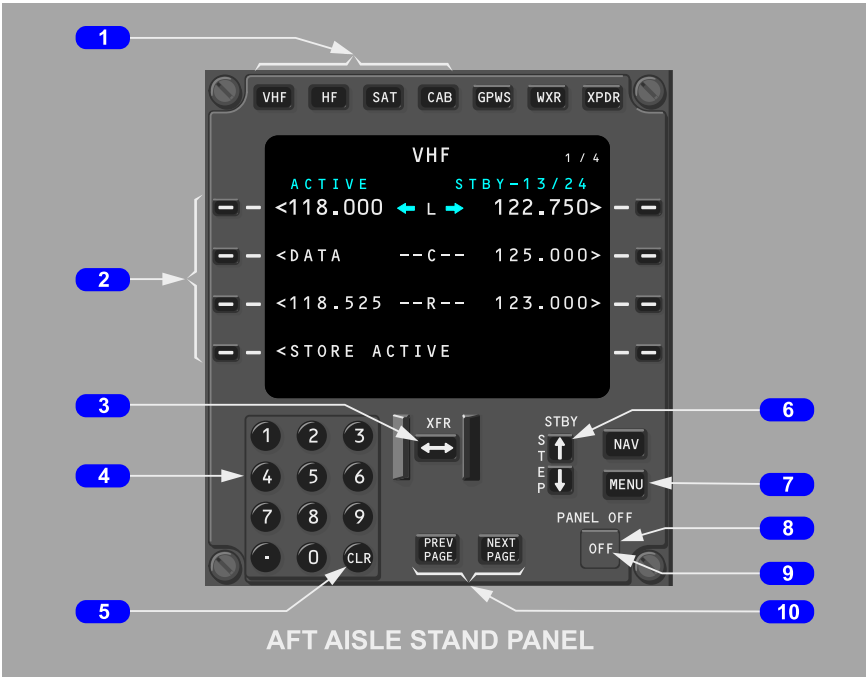
- V (voice)—only the voice audio is heard
- B (both)—both the voice and range audio are heard
- R (range)—range audio (navigation aid Morse code identifier) is heard.

Notes:

1. Marker beacon audio is available in all positions.
2. The Audio Control Panel is continuously completing BITE functions throughout the flight which may result in an uncommanded reset/ restart. In case of an uncommanded ACP restart, the ACP will blank intermittently taking approximately 5 seconds to complete and would set the ACP to the last configuration set prior to last aircraft power down. Therefore, the ACP has to be manually reconfigured to the setting before the uncommanded restart or to the desired configuration.

Radio System

Tuning and Control Panel (TCP)



1 Mode Select Keys

Push—Selects desired communication tuning mode page for display

- VHF—VHF Radio Key
- HF—HF Radio Key
- SAT—SATCOM Key
- CAB—Cabin Interphone Key.

2 Line Select Keys

Push—

- selects function line to be updated
- moves data from scratchpad to selected line.

3 Frequency Transfer (XFR) Switch

Push—

- transfers the STBY frequency or DATA to the ACTIVE frequency and tunes the selected radio to the new active frequency
- transfers the ACTIVE frequency or DATA to the STBY frequency.

4 Numeric Keypad

Push—puts selected character in scratchpad.

5 Clear (CLR) Key

Push—clears last scratchpad character or scratchpad message.

Push and hold—clears all scratchpad data

- displays CLEAR if on VHF, HF, CABIN INTERPHONE (main page) or ALTN NAV page
- displays CLEAR PAGE if CLEAR is already displayed on STORED VHF or HF frequency pages
- displays CLEAR ALL if CLEAR is already displayed on CABIN INTERPHONE (main page).

6 Standby (STBY) Frequency STEP Control

Active when a list (- N/X) number is displayed next to the STBY radio title.

Push (Up)—moves up in the stored frequency list for VHF and HF radios.

Push (Down)—

- moves down in the stored frequency list for VHF and HF radios
- DATA appears at the bottom of the list.

7 MENU Key

Push—selects the MENU page for display of

- SYS POWER (surveillance system power)
- ALERT/XPDR (transponder) CTL (control)
- SATCOM SYStem selection
- RADIO MISC.

8 Tuning & Control Panel OFF Switch

Push—removes associated TCP display and processor power.

9 Tuning & Control Panel OFF Light

Illuminated—associated TCP is off.

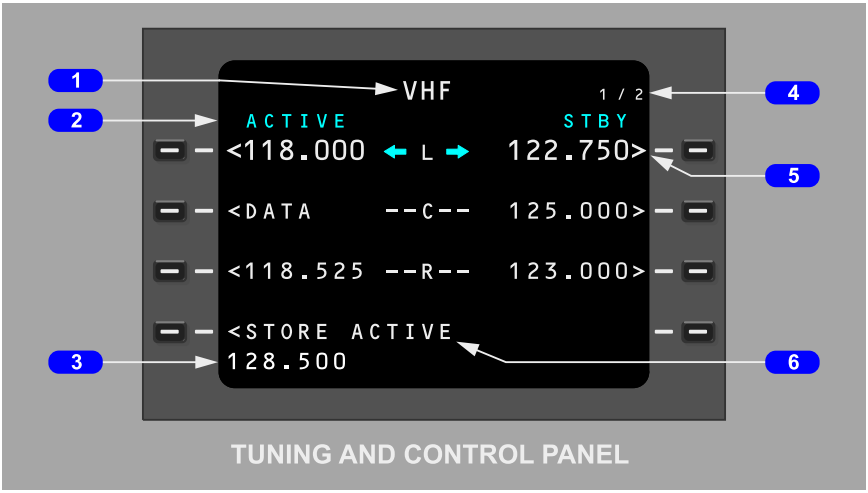
10 Previous (PREV)/NEXT PAGE Keys

PREV PAGE—displays previous page of multiple page displays.

NEXT PAGE—displays next page of multiple page displays.

TCP Page Components

VHF Operation



1 Page Title

Displays selected mode for data displayed on page.

2 Line Title

Displays title of data on line below.

3 Scratchpad

Displays—

- numeric entries from keypad
- line selected data
- system messages
- frequencies preceded by UL indicate an uplink.

Data (except CLEAR messages) is retained when switching between TCP modes for VHF and HF.

4 Page Number

Left number is page number. Right number is total number of related pages. Page number is blank when only one page exists.

5 Line

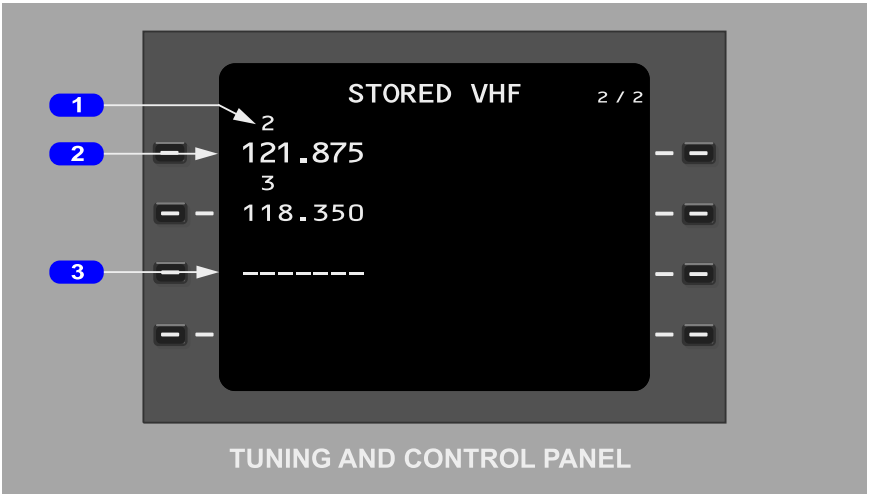
Displays—

- availability prompts
- frequency or DATA associated with line title
- associated radio (L, C, R)
- transfer arrows (XFR switch transfers active and standby frequencies)
- dashes in active and standby frequency windows indicate failed radio.

6 Store Active

Push—Stores active frequency on alternate frequency page.

VHF Page 2 Operation



1 List Number

Displays the number assigned to stored frequency below. The STBY frequency on page 1 is considered stored frequency number 1.

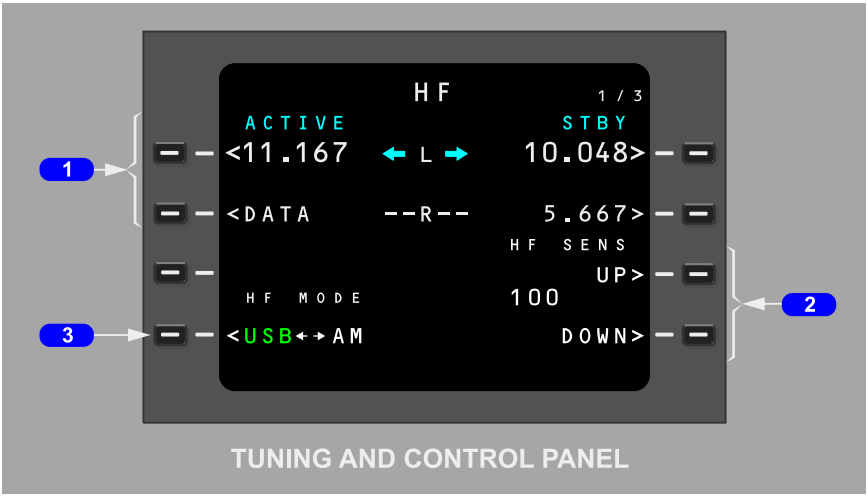
2 Frequency

Displays the stored frequency. A total of 24 frequencies may be stored on 3 STORED VHF pages.

3 Dash Prompts

Indicates that a new frequency can be added to the stored list. Up to 8 frequencies are stored on each page.

HF Operation



1 Dual HF Radios

Operation of HF radio selection and usage is identical to VHF radio operation.

2 HF Sensitivity Keys

Push—UP

- increases HF sensitivity in increments up to 100 or full volume
- holding key down slews sensitivity up to desired volume.

Push—DOWN

- decreases HF sensitivity in increments down to 0 or minimum volume
- holding key down slews sensitivity down to desired volume.

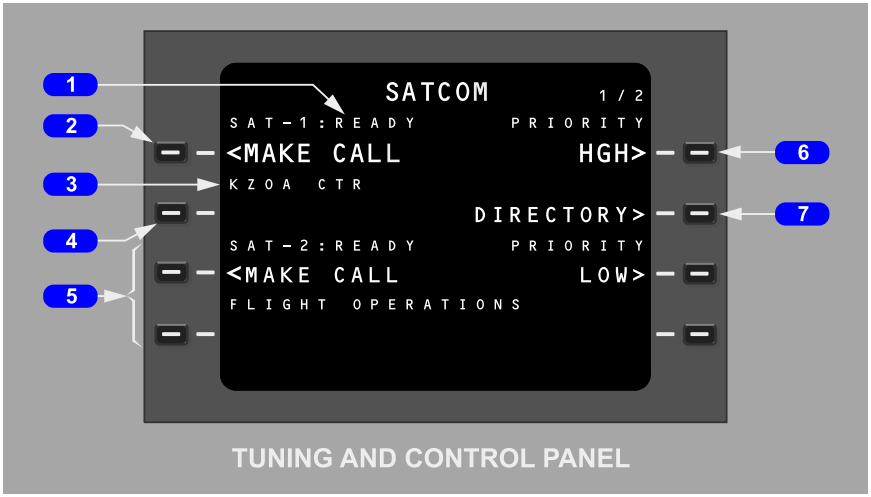
3 HF USB/AM Key

Push—Toggles between upper side band (USB) and amplitude modulation (AM) modes.

SATCOM Operation

SATCOM Main Menu

TQA to TQF



1 SATCOM Channel Status

Displays associated SATCOM channel (-1 or -2) status:

- READY—system ready to make call
- CABIN USE—system in use by cabin attendants
- DIALING—system is dialing or placing the call
- RINGING—call is ringing and waiting for ground station to answer
- ANSWERED—call has been picked up by ground station
- CALL FAIL—call failed to be received
- NOT READY—system is not ready to make a call
- GND CALL—there is an incoming call
- IN QUEUE—an incoming call has been placed in SATCOM queue.

2 SATCOM CALL Key

Push—MAKE CALL

- initiates a SATCOM call to the identifier/number listed below call key
- once call is in progress, prompt returns to END CALL.

Push—END CALL

- cancels the current call
- prompt returns to MAKE CALL.

Push—MANUAL ENTRY
- (displayed when any entry is made into the scratchpad)
- initiates a SATCOM call to the number entered in scratchpad
- once call is in progress, prompt returns to END CALL.

Push—PREEMPT
- (displayed when another call is in progress)
- overrides call in progress and initiates selected call
- once call is in progress, prompt returns to END CALL.

Push—CLR STATUS
- clears the CALL FAIL channel status message
- prompt returns to MAKE CALL.

Push—ANSWER
- answers incoming call
- once call is in progress, prompt returns to END CALL.

3 SATCOM Phone Number Identifier

Displays
- identifier station name to be called from directory
- in manual dial mode, displays phone number of station entered from scratchpad
- when last use was an incoming call, line is blank.

4 SATCOM Response Key

Push—REJECT
- rejects incoming call
- prompt returns to blank.

Push—QUEUE CALL
- (displayed when another call is in progress)
- places incoming call into SATCOM call queue
- channel status shows IN QUEUE
- prompt returns to END QUEUE.

Push—END QUEUE
- cancels call in SATCOM queue
- prompt returns to blank.

5 SATCOM Channel 2

Second SATCOM voice channel operates identical to channel 1.

6 SATCOM Call Priority Key

Push—toggles through call priorities

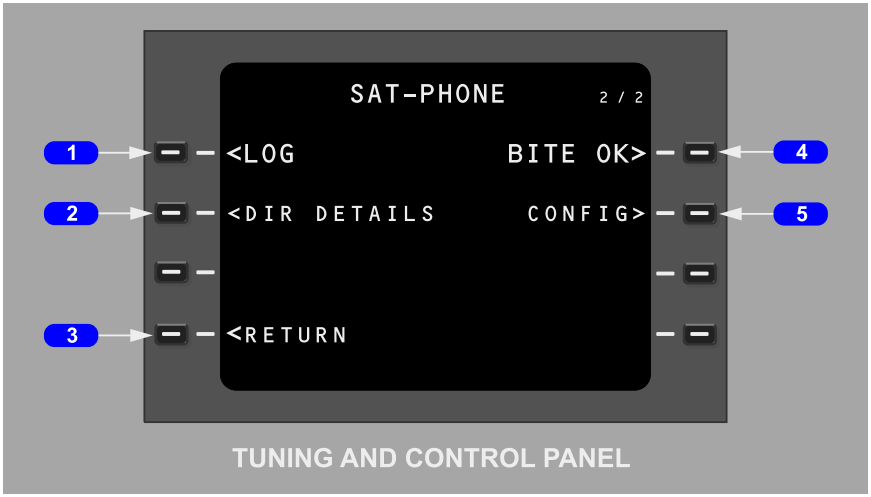
- EMG—emergency call
- HGH—high priority call
- LOW—low priority call.

7 SATCOM DIRECTORY Key

Push—Displays directory of available SATCOM phone numbers by geographic region.

SATCOM Page 2/2

TQA to TQF



1 SATCOM LOG Key

Push—displays the SATCOM LOG page (controls connection to satellite).

2 SATCOM DIRectory Details Key

Push—displays the directory details page (a list of phone number identifiers).

3 SATCOM RETURN Key

Push—returns display to main SATCOM page.

4 SATCOM BITE OK Key

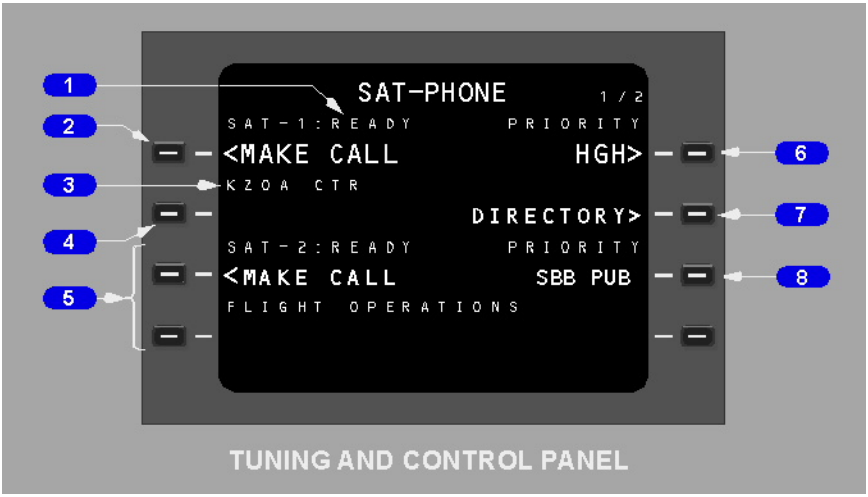
Push—displays BITE page (maintenance use only).

5 SATCOM CONFIG Key

Push—displays controls for SATCOM configuration (maintenance use only).

TWA,B

SATCOM Main Menu



1 SATCOM Channel Status

Displays associated SATCOM channel (-1 or -2) status:

- READY — system ready to make call
- DIALING — system is dialing or placing the call
- RINGING — call is ringing and waiting for ground station to answer
- ANSWERED — call has been picked up by ground station
- NOT READY — system is not ready to make a call
- GND CALL — there is an incoming call

2 SATCOM CALL Key

Push — MAKE CALL

- initiates a SATCOM call to the identifier / number listed below call key
- once call is in progress, prompt returns to END CALL

Push — END CALL

- cancels the current call
- prompt returns to MAKE CALL

Push — MANUAL ENTRY

- (displayed when any entry is made into the scratchpad)
- initiates a SATCOM call to the number entered in scratchpad

- once call is in progress, prompt returns to END CALL

DELETION

Push — CLR STATUS

- clears the CALL FAIL channel status message
- prompt returns to MAKE CALL

Push — ANSWER

- answers incoming call
- once call is in progress, prompt returns to END CALL

3 SATCOM Phone Number Identifier

Displays

- identifier station name to be called from directory
- in manual dial mode, displays phone number of station entered from scratchpad
- when last use was an incoming call, line is blank

4 SATCOM Response Key

Push — REJECT

- (displayed when there is an incoming call, and MIC has not been selected on the Audio Control Panel)
- rejects incoming call
- prompt returns to blank

5 SATCOM Channel 2

The second SATCOM voice channel operates identical to channel 1, with additional provisions for IP data communications.

Note: SAT-2 is a SwiftBroadBand (SBB) channel only. Operational status is dependent upon provider subscription.

6 SATCOM Call Priority Key

Push — toggles through call priorities

- EMG — emergency call
- HGH — high priority call
- LOW — low priority call
- PUB — public correspondence/non-safety

7 SATCOM DIRECTORY Key

Push — Displays directory of available SATCOM phone numbers by geographic region.

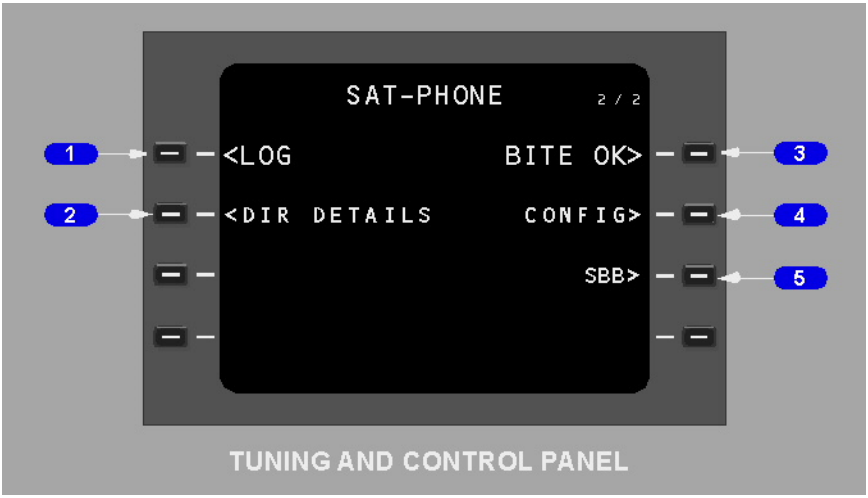
8 SATCOM Call Priority Key

- SBB PUB — public correspondence/non-safety

Note: SBB communications are limited to PUB priority only.

TWA,B

SATCOM Page 2/2



1 SATCOM LOG Key

Push — displays the SATCOM LOG page (controls connection to satellite).

2 SATCOM DIRectory Details Key

Push — displays the directory details page (a list of phone number identifiers).

3 SATCOM BITE OK/FAIL Key

Push — displays BITE page (maintenance use only).

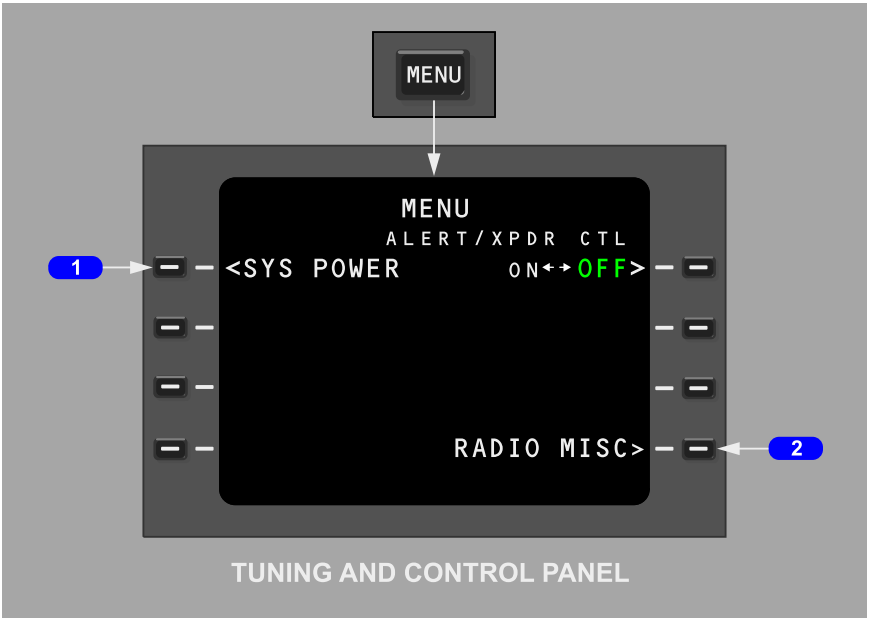
4 SATCOM CONFIG Key

Push — displays controls for SATCOM configuration (maintenance use only).

5 SATCOM SBB Key

Push — displays SBB status.

Menu Page



1 SYS POWER Key

Push—displays SYS POWER page.

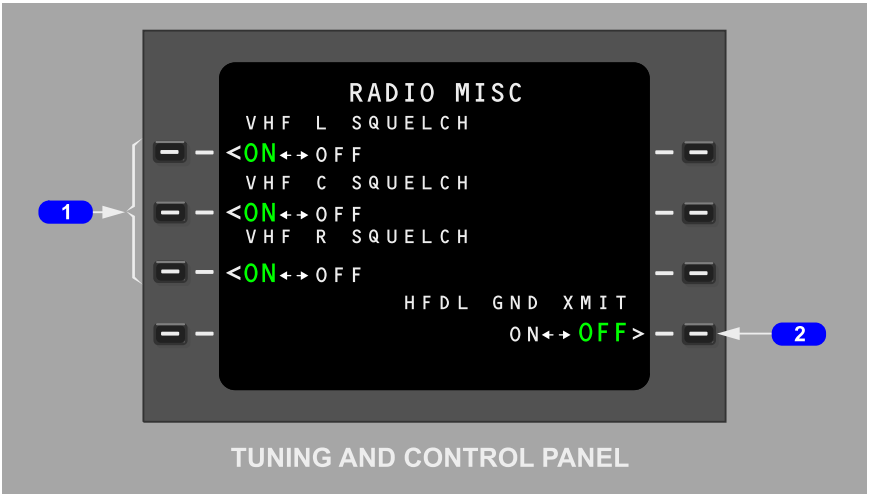
For additional information:

- Weather Radar—(see Tuning and Control Panel (TCP) on page 11.10.19.)
- Transponder—(see Tuning and Control Panel (TCP) on page 11.10.14.)

2 RADIO MISC Key

Push—displays RADIO MISC page.

RADIO MISC Page



1 VHF SQUELCH Key

Push—

- toggles VHF squelch between ON and OFF
- when squelch is OFF, displays memo message VHF SQUELCH OFF.

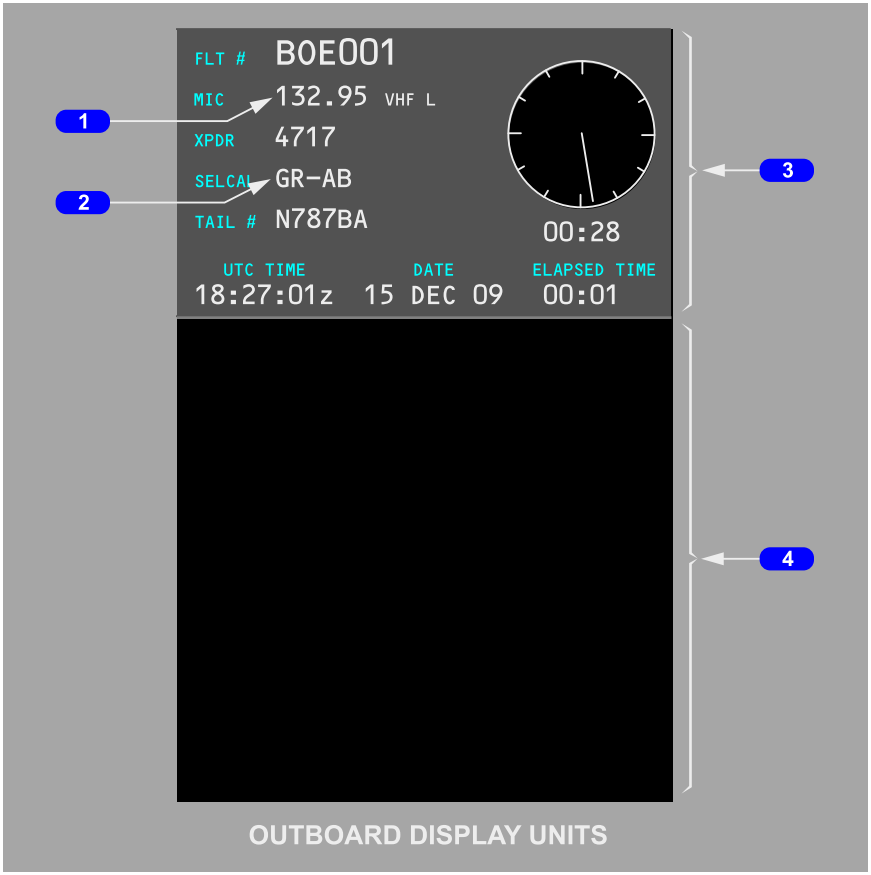
2 HF Datalink Ground Transmit (HFDL GND XMIT) Key

Push—

- toggles HF datalink between ON and OFF for ground transmit
- when selected ON, displays memo message HFDL GND XMIT.

Communication Indications

(See Auxiliary (AUX) Display on page 10.10.63 for additional information.)



1 MIC (microphone) Indicator Display

Displays (white)—

- selected onside radio VHF or HF mic source frequency
- onside radio ACP selected mic source
  - VHF L, C, or R when a VHF switch is selected
  - FLT when the FLT switch is selected
  - CAB when the CAB switch is selected
  - HF L or HF R when a HF switch is selected
  - SAT 1 or SAT 2 when a SAT switch is selected

- DATA when onside radio is used for datalink operation.

Displays (green)—

- keyed onside radio VHF or HF mic source frequency
- onside radio ACP selected mic source
  - when (above listed) mic source is keyed
  - PA when the PA mic switch is pushed
- FLT when the control wheel MIC/INT switch is selected to INT
- DATA when onside radio is transmitting/receiving datalink information.

2 SELCAL Indicator Display

Displays assigned airplane SELCAL number.

3 Flight Data Block

4 ATC Data Block

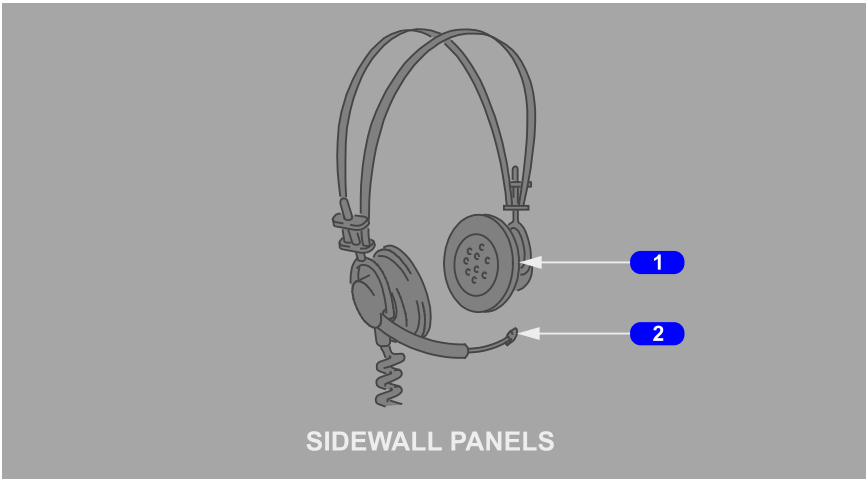
Displays:

- ATC/FIS messages (Uplinks, D-ATIS, Clearances, TWIP, etc.)
- COMM system messages.

(See ATC Messages on page 5.40.17 for additional information.)

Miscellaneous Communication Controls

Headphone/Boom Microphone [Typical]



1 Headphone

Used to monitor audio from the respective audio control panel.

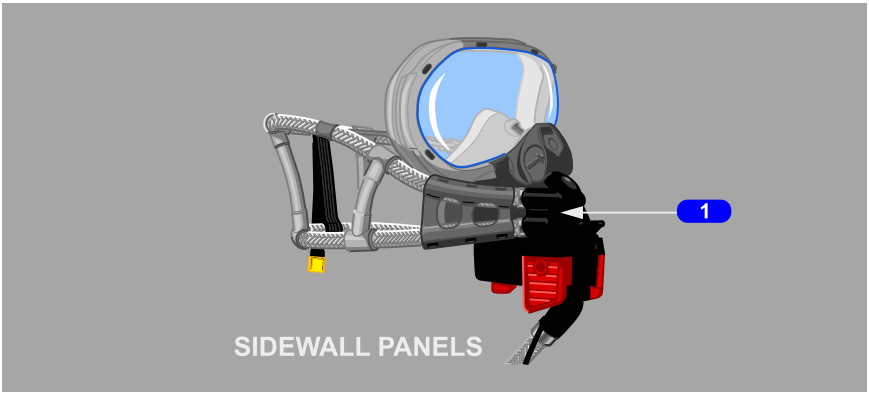
Audio volume is adjusted using audio control panel controls for the associated station.

Available at all flight deck stations.

2 Boom Mic

Activation of a control wheel, glareshield, audio control panel mic/interphone switch or PA mic switch transmits on the system selected for use at that station.

Oxygen Mask Microphone (Typical)

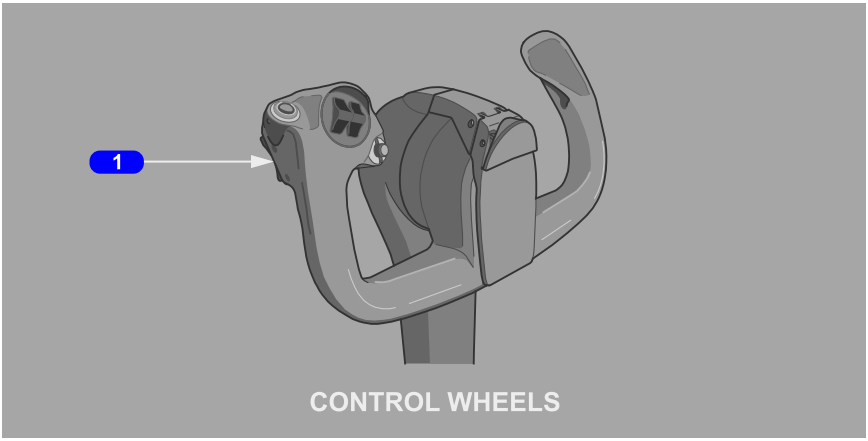


1 Oxygen Mask Microphone

Enabled when the oxygen mask doors are open. The boom microphone is disabled.

Activation of a control wheel, glareshield or audio control panel mic/interphone switch transmits on the system selected for use at that station.

Control Wheel Microphone/Interphone Switch



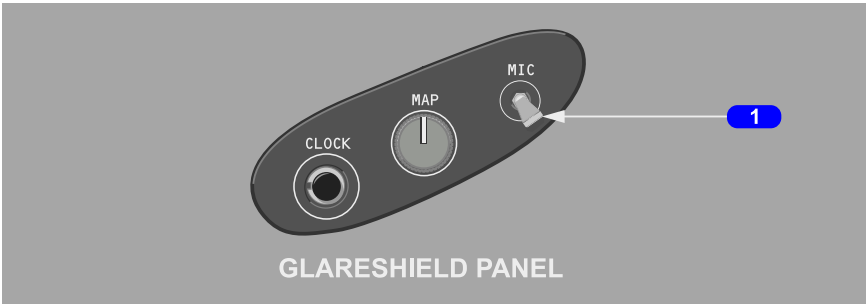
1 Control Wheel Mic/Interphone Switch

MIC—allows oxygen mask or boom microphone transmission on selected transmitter. Spring-loaded to center.

CENTER—off position.

INT—allows oxygen mask or boom microphone transmission on the flight interphone system. Latched in position.

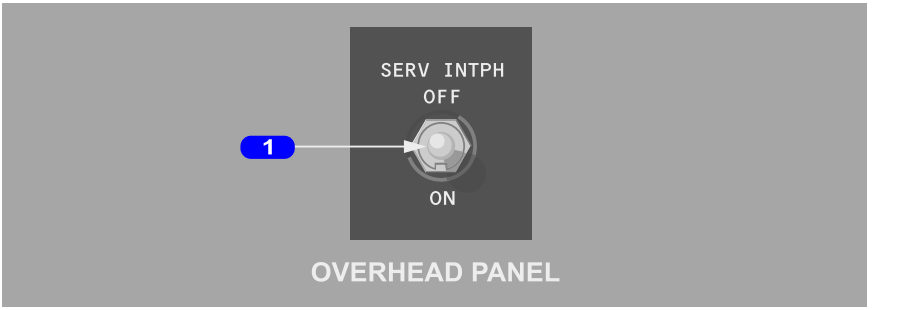
Glareshield Microphone Switch (Typical)



1 Glareshield Mic Switch

Push—allows oxygen mask or boom microphone transmission on the selected transmitter.

Service Interphone Switch

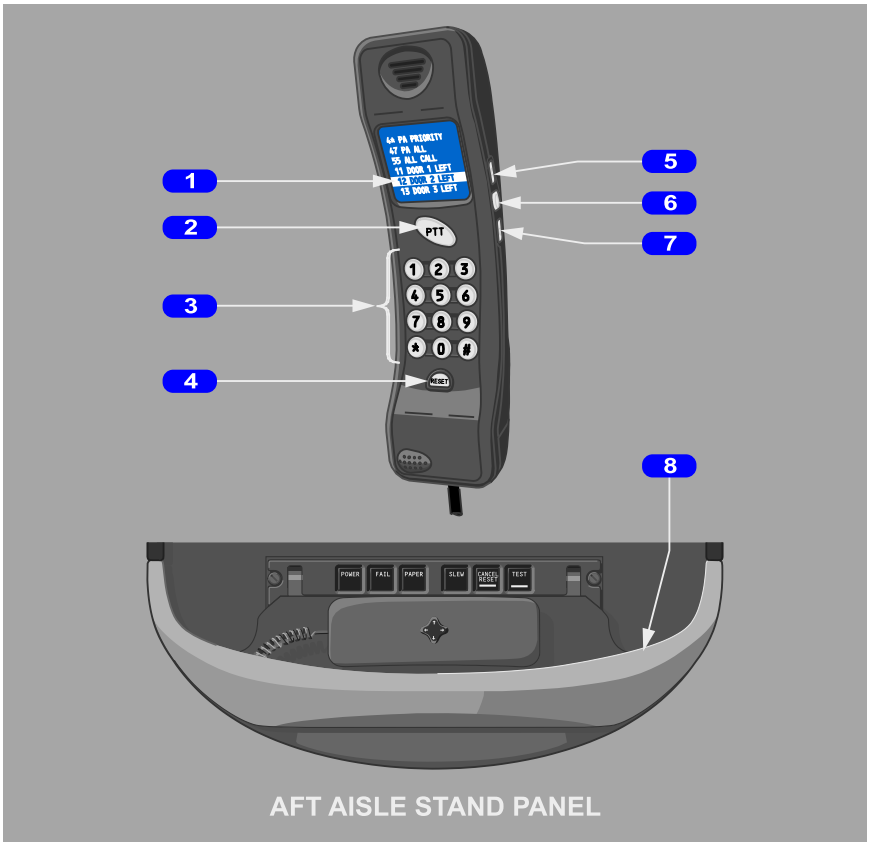


1 Service Interphone Switch

OFF—allows independent operation of the service and flight interphone systems.

ON—connects the service and flight interphone systems.

Handset



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 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 TCP 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.

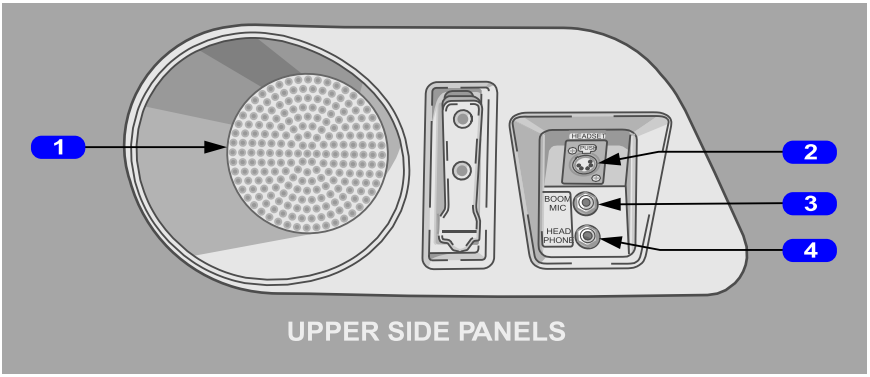
7 Handset Dial Code Step Down Switch

Push—moves down and highlights dial code from a list of predetermined crew station(s) and PA areas.

8 Printer Cover Release Lever

Push—releases printer cover and handset cradle for access to printer paper door.

Flight Deck Speaker/Boom Mic/Headphone Panel (Typical)



1 Flight Deck Speaker

Controlled by the speaker volume control on the respective audio control panel.

2 Headset Jack

Accepts a flight crew headset plug.

3 Boom Mic Jack

Accepts a flight crew boom mic plug.

4 Headphone Jack

Accepts a flight crew headphone plug.

Observer Audio Selector



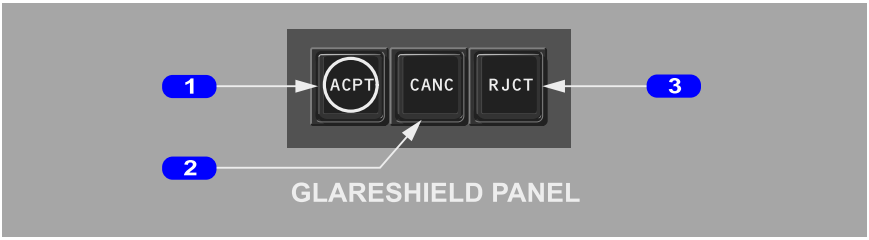
1 Observer (OBS) AUDIO Selector

Captain (CAPT)—connects the captain's hand microphone, headphone, boom microphone/headset, oxygen mask microphone, speaker, and mic/interphone switches to the first observer audio control panel.

Normal (NORM)—the first observer audio control panel is connected to the first observer's hand microphone, headphone, boom microphone/headset and oxygen mask microphone.

First Officer (F/O)—connects the first officer's hand microphone, headphone, boom microphone/headset, oxygen mask microphone, speaker, and mic/interphone switches to the first observer audio control panel.

Datalink Accept/Cancel/Reject Switches (Typical)



1 Accept (ACPT) Switch

Push—

- a positive response to a displayed message is downlinked to the origin of the displayed message
- functions the same as selecting an MFD communications display ACCEPT command key.

2 Cancel (CANC) Switch

Push—

- the message is removed from the display
- functions the same as selecting an MFD communications display CANCEL command key.

3 Reject (RJCT) Switch

Push—

- a negative response to the displayed message is downlinked to the origin of the displayed message
- functions the same as selecting an MFD communications display REJECT command key.

Cockpit Voice Recorder System

Cockpit Voice Recorder Panel



1 Cockpit Voice Recorder TEST Switch

Push and hold for three seconds (on the ground and engines off)—

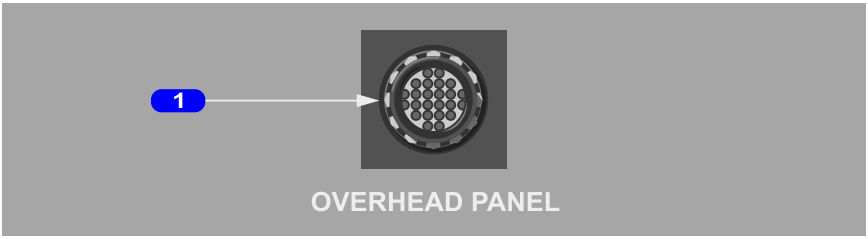
- tests area microphone CVR channel
- a test tone is heard from flight deck speakers
- an EICAS status message is displayed if test fails.

Note: Test may fail if crew is speaking when test is initiated. If necessary, repeat test without speaking for three (3) seconds after the test tone is heard.

2 Cockpit Voice Recorder ERASE Switch

Push and hold for two seconds (on the ground and engines off)—erases voice recorder.

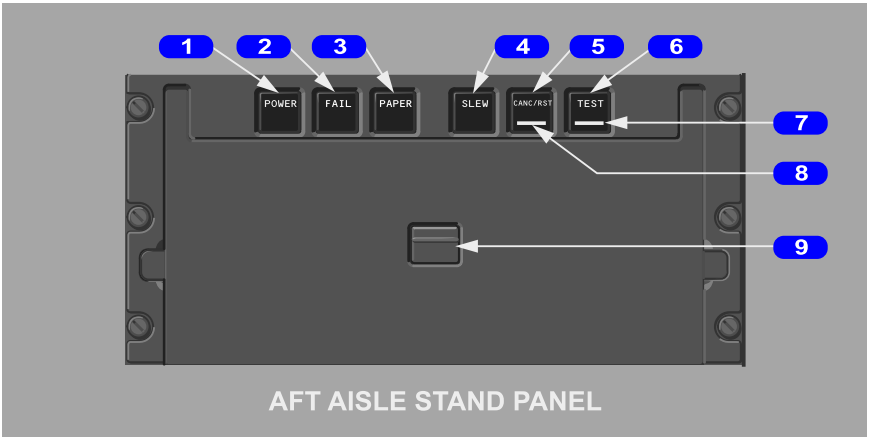
Cockpit Voice Recorder Microphone



1 Cockpit Voice Recorder Microphone

Area microphone for the voice recorder.

Printer Controls



1 Printer POWER Switch

Push—applies power to printer.

White band around switch—power is not applied to printer.

2 Printer FAIL Light

Illuminated (white)—the printer is failed.

3 Printer PAPER Light

Illuminated (white)—

- printer is out of paper, or
- paper loading door is open.

Note: With both FAIL and PAPER lights illuminated, printer is overheated.

4 Printer SLEW Switch

Push and hold—advances the printer paper.

5 Printer CANC/RST Switch

Push—cancels current printing cycle.

Push and hold—resets the printer if it stops operating.

6 Printer TEST Switch

Push—

- tests the printer and printer lights

- prints a test pattern.

7 Printer TEST Light

Illuminated (white)—

- a printer test is in progress, or
- a printer reset is in progress.

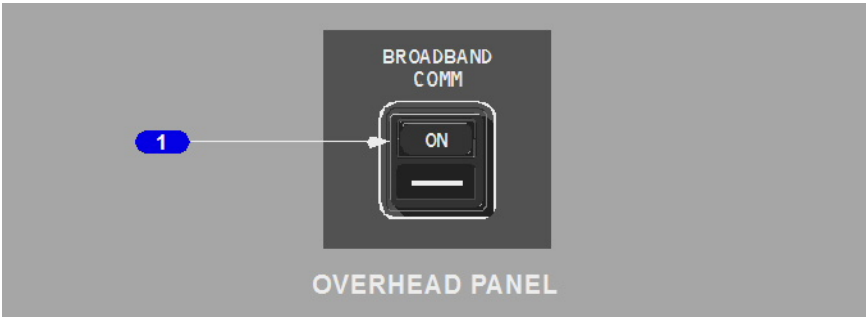
8 Printer RESET Light

Illuminated (white)—a printer reset is in progress.

9 Printer Paper Door Lever

Push—opens printer paper door.

Broadband Communication Switch



1 BROADBAND Communication (COMM) Switch

OFF—disables the broadband communication system.

ON—enables the broadband communication system.

Introduction

The communication systems include:

- cockpit voice recorder system
- radio communication system
- SELCAL system
- SATCOM system
- communication crew alerting system
- interphone communication system (see Interphone Communication System on page 5.30.1 for additional information.)
- data communication system. (See MFD Communications Functions on page 5.40.1 for additional information.)

The communication systems are controlled using the:

- audio control panels
- tuning and control panels (TCP) (see Cabin Interphone System on page 5.30.2 for additional information.)
- control display unit (CDU) communications pages (see Company Datalink on page 11.34.1 for additional information.)
- multifunction display (MFD) communications pages. (See MFD Communications Functions on page 5.40.1 for additional information.)

Audio Control Panels (ACP)

The audio control panels (ACP) are used to manage the radio and interphone communication systems. Navigation receiver audio can also be monitored. The captain, first officer, and first observer audio control panels are installed on the aft aisle stand.

Microphones are keyed by pushing the desired audio control panel transmitter select switch and using the MIC (microphone) position of a control wheel or audio control panel microphone/interphone switch, a glareshield MIC switch, or a hand microphone push-to-talk switch. Systems are monitored using headphones or speakers. An oxygen mask microphone is enabled and the boom microphone is disabled when the oxygen mask stowage doors are open. The oxygen mask microphone is disabled and the boom microphone is enabled when the left oxygen mask stowage box door is closed and the RESET/TEST lever is pushed.

Cockpit Voice Recorder (CVR) System

The cockpit voice recorder (CVR) records any 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

crewmember boom, oxygen mask, and hand microphones, independent of microphone/interphone switch positions. All inputs are recorded continuously.

Tuning and Control Panels (TCP)

The tuning and control panels (TCP) are used to tune and control the VHF, HF, SATCOM, cabin interphone, and other airplane systems. The panels are designated left, center, and right, and are normally associated with the respective VHF and HF radios.

Each TCP has a light sensor to automatically control display lighting. Lighting levels for all TCPs can be adjusted using aisle stand panel or master brightness controls.

Communication Indications

The TCP enables the flight crew to share a display between multiple communication control functions. Therefore, each flight data block provides onside microphone source, frequency, SELCAL and transponder code settings for continuous pilot reference.

Radio Communication Systems

The radio communication systems consist of the very high frequency (VHF) communication system, the high frequency (HF) communication system, the satellite communication (SATCOM) system, and the selective calling (SELCAL) system.

VHF Communication System

Three independent VHF voice/data radios, designated VHF L (left), VHF C (center), and VHF R (right) are installed. Any VHF radio can be controlled by any TCP. The audio control panels are used to control voice transmission and receiver monitoring.

When a VHF radio is tuned to frequency 121.5, all flight crew automatically monitor the radio. The receiver lights on all audio control panels illuminate.

VHF L is configured for voice communication only and VHF C is normally used for data communication. VHF C and VHF R can be used for both voice or data communication. However, only one VHF radio can operate in the data mode at a time.

When ------- - X - ------- is displayed on the TCP, the affected radio (X) is inoperative.

In event of electrical power loss, the left VHF radio and left TCP continue to operate on standby power.

VHF Page Displays

Four VHF page displays are used to tune the left, center and right VHF radios. The main VHF page (1/X) is always displayed when the VHF mode select key is pushed. The main display controls the active and standby frequency selection for all three radios. The selected radio for each TCP is indicated by ACTIVE and STBY titles above large white text of the radio name (L, C, R) and the current frequencies assigned. Pushing another active or standby line select key changes the radio to be tuned.

For the selected radio, the frequency transfer switch moves the pretuned, standby frequency to become the active, tuned frequency. The previously active frequency then becomes the standby frequency.

New frequencies are entered into the scratchpad. Entering the decimal and/or following zeros for this new frequency are optional. The decimal is inserted automatically when the line select key is pushed. Scratchpad frequencies can be entered into either the active or standby windows. If an invalid frequency is entered, an INVALID ENTRY scratchpad message is displayed. Pushing the clear key erases the INVALID ENTRY message and displays the previous scratchpad entry.

Stored frequencies

VHF pages 2, 3, and 4 can contain up to eight stored frequencies for all three radios (24 total). These frequencies can be entered manually into the TCP by the flight crew.

Stored frequencies are accessed from the main VHF page by using the standby frequency step control. Selecting UP or DN scrolls through the stored frequencies for the active radio in the standby window. Once the desired frequency is displayed in STBY, pushing the frequency transfer switch makes it active.

Frequencies stored during flight (VHF pages 2, 3, and 4) may be manually deleted using the CLR key. Frequencies not manually deleted are automatically deleted from the TCP after flight is completed.

ATC Uplink

If an ATC uplink containing a VHF frequency is accepted, the uplink frequency is displayed in the scratchpad preceded by a UL indicator. Line selecting this frequency into the active, standby or a stored position clears the scratchpad. It also turns the uplink frequency green in the uplink data block.

It is possible for one clearance to contain both a radio frequency and a transponder code. In this case the radio frequency appears in the scratch pad only when the appropriate page is displayed on the TCP. VHF frequencies appear when VHF page 1 is displayed, HF frequencies appear when the HF page 1 is displayed and transponder codes appear when the transponder page is displayed on the TCP.

HF Communication System

There are two independent HF communication radios, designated HF L (left) and HF R (right). Each HF radio can be tuned by any TCP from the main HF page. Managing HF frequencies on the TCP is identical to VHF mode operation. Up to three pages of stored HF frequencies (24 total) can be stored in the TCP.

Frequencies stored during flight (HF pages 2, and 3) may be manually deleted using the CLR key. Frequencies not manually deleted are automatically deleted from the TCP after flight is completed.

The HF radios operate in one of two modes, upper side band (USB) or amplitude modulation (AM). The USB/AM key on the main HF page is used to toggle between these two modes. In addition, the HF sensitivity is controlled by the HF sensitivity keys. Pushing the sensitivity UP or DOWN keys increment HF sensitivity between maximum (100) and minimum (0) volume.

The audio control panels are used to control voice transmission and receiver monitoring.

When an HF transmitter is keyed after a frequency change, the antenna tunes while a continuous or intermittent tone may be heard through the audio system. A tone lasting longer than 7 seconds indicates failure of the system to tune. Data is stored in memory for the last 100 tuned frequencies. Stored frequencies may tune quickly and a tone may not be noticeable.

Both HF radios use a common antenna. When either HF radio is transmitting, the antenna is disconnected from the other HF radio, and it cannot be used to transmit or receive. However, both HF radios can receive simultaneously if neither is being used for transmitting.

TQA,B If smoke is detected in the aft cargo compartment:

- power is removed from the HF radios
- dashes are displayed on the TCP HF radio line.

Data Mode

The data mode can be selected and deselected by pushing the frequency transfer switch when the word DATA is displayed on the active radio line (VHF or HF).

When a standby frequency is transferred to the active DATA window, DATA is now displayed in the standby window. If a new frequency is selected in the standby window when DATA is displayed, DATA is replaced by the new frequency. Data can be returned to the standby window by stepping through the list of standby frequencies until DATA appears.

When a VHF or HF radio is in the data mode, it is not available for voice communications. A radio can be returned to the voice communication mode by transferring a voice frequency into the ACTIVE frequency window.

Notes: 1. VHF or HF radios set to DATA automatically revert to voice mode after being load shed and re-energized (e.g. VHF when switching to ground handling power, or HF after engine start).

2. HF datalink transmissions are inhibited on the ground.

Stuck Mic Protection

In the event a VHF or HF radio transmits for more than 30 seconds, the EICAS advisory message RADIO TRANSMIT CAPT, F/O, or OBS is displayed. The message is removed when the transmission stops.

On the ground, any VHF radio that transmits for more than approximately 35 seconds is automatically disabled. Several seconds before disablement, an intermittent tone can be heard through the audio system for that radio. That radio is enabled when the microphone switch for that radio is released.

Selective Calling (SELCAL) System

The SELCAL system monitors the three VHF radios and the two HF radios. When the system receives a call from a ground station, the crew is alerted through the communication crew alerting system.

Satellite Communication (SATCOM) System

The SATCOM system provides both data and voice communications. The system is managed by the Satellite Receiver/Transmitter (SRT). Flight deck voice calls are controlled using the TCPs and audio control panels. TQA to TQF

The SATCOM system provides both data and voice communications. The system is managed by the Satellite Data Unit (SDU). Flight deck voice calls are controlled using the TCPs and audio control panels. TWA,B

The SATCOM control pages are displayed by selecting SAT on the TCP. Directories of airline-defined numbers are line-selectable or numbers may be manually entered if function is enabled by the operator.

The SATCOM main menu pages allow the flight crew to initiate, answer and terminate calls, monitor call status, and access lower-level pages. Control functions are active when displayed with a caret (< or >).

Incoming SATCOM calls are annunciated by a SELCAL chime and illumination of a CALL light on the audio control panel. Pressing the respective transmitter select switch connects the call to the pilot headset/hand mic. Flight crews can facilitate audio conferencing between the cabin and ground by selecting both the CAB and SAT transmitter select switches on. (See Cabin/SATCOM Conferencing on page SP.5.1 for additional information.)

SATCOM calls are terminated when the CALL light extinguishes (ground party hang-up or pilot ends call).

The EICAS communication message SATCOM CALL displays when a SATCOM message requires flight crew attention. Servicing the message clears the EICAS message.

TQA to TQF The Rockwell SRT-2100 SATCOM system (as installed) provides three priority levels:

- Emergency (EMG)—emergency and distress calls (activates ground station alarm)
- Operational high (HGH)—regulatory and flight safety calls
- Operational low (LOW)—non-safety related service calls.

TWA,B The Rockwell SDU-2200B SATCOM system (as installed) provides four priority levels:

- Emergency (EMG) - emergency and distress calls (activates ground station alarm)
- High (HGH) - regulatory and flight safety calls
- Low (LOW) - non-safety related service calls
- Public (PUB) - non-safety related public correspondence.

Note: SBB communications are limited to PUB priority only.

DELETION

Broadband Connectivity System

A dedicated satellite communications system provides passengers with real-time, high-speed internet connectivity inflight. Passengers and cabin crew access the system with compatible personal electronic devices (PEDs) using the cabin wireless access points (WAP).

Communication Crew Alerting System

The communication crew alerting system provides aural and visual alerts for normal operations requiring crew awareness that may require crew action. Visual alerts are presented as EICAS messages preceded by a bullet symbol (•). The aural alert is a high–low chime. The following table shows communication crew alert categories and the respective aural and visual alerts for each category. (See Communications EICAS Alert Messages on page 5.50.1 for additional information.)

Crew Alert Categories

Communication Crew Alert Category	Aural Alert	Visual Alert	Comments
High	High–low chime	Communication EICAS alert	None currently implemented. Reserved for future use.

Communication Crew Alert Category	Aural Alert	Visual Alert	Comments
Medium	High–low chime	Communication EICAS alert	Message awareness required. Crew action may be required.
Low	None	Communication EICAS alert	Crew action may be required.

Interphone Communication System

The interphone communication system includes the:

- flight interphone system
- cabin interphone system
- service interphone system
- passenger address (PA) system.

The flight interphone, service interphone, and passenger address systems are normally operated through the audio select panel. The cabin interphone is operated through the TCP or the flight deck handset.

Flight Interphone System

The flight interphone system provides communications between flight deck crew members. The flight interphone system also provides communications between the flight deck and ground crew through a flight interphone jack on the nose landing gear.

The system is used by selecting the INT (interphone) position of a control wheel or audio control panel mic/interphone switch. The interphone can also be used by selecting the FLT transmitter selector on an audio control panel and then selecting one of the following microphone switches:

- MIC position of a control wheel switch
- MIC position of an audio control panel mic/interphone switch
- a hand microphone push-to-talk switch
- a glareshield MIC switch.

Note: Voice level from the flight deck speakers decreases when selecting the MIC/INT switch on the ACP or control wheel, the PTT switch on the hand microphone, or the MIC switch on the glareshield.

Crew alerting of a ground crew initiated call is provided by an aural alert chime, the GROUND CALL EICAS communications alert message, and a CALL light illuminated on the audio control panel transmitter select switch.

Service Interphone System

The service interphone system provides voice communications between ground crew stations at various locations around the airplane. The system can be connected to the flight interphone system through the service interphone switch on the overhead panel.

Passenger Address System

The passenger address (PA) system is used by the flight crew to make cabin announcements. Pushing a PA mic switch on an audio control panel provides direct access to all PA areas.

The system is monitored by pushing the PA receiver volume control on an audio control panel. The PA system can also be selected through the cabin interphone system or the flight deck handset.

Cabin PA announcement priorities are:

- flight deck announcements from an audio control panel
- priority (all area) announcements
- normal announcements from flight attendant or flight deck handsets.

Cabin Interphone System

The cabin interphone system provides voice communications between the flight deck and the flight attendant stations. Boom microphones, oxygen mask microphones, and hand microphones are used by selecting the CAB (cabin) transmitter select switch on an audio control panel and pushing the mic/interphone switch to the MIC position. A cabin interphone station(s) must be selected and a call initiated from the TCP CABIN INTERPHONE page to alert the desired station to pick up the call.

EICAS communications alert messages and chimes alert the pilots to incoming cabin calls. Normal priority calls from the cabin display the CABIN CALL EICAS message. Normal priority calls made to the flight deck while another call is in progress results in a busy signal at the handset, the calling station being displayed in the call queue, and the CABIN CALL memo message being set in EICAS. The call queue and memo messages are cleared when communication is established between that calling station and the flight deck. Priority calls from the cabin display the CABIN ALERT EICAS message. Priority calls automatically disconnect lower priority cabin interphone calls. Priority calls placed while a priority call is in progress are automatically connected as a conference call.

The cabin interphone call queue, speed dial numbers, and directories are accessed from the TCP CABIN INTERPHONE page menu.

Calls are initiated by:

- line selecting one of three predefined SPEED DIAL locations on the CABIN INTERPHONE page, or
- accessing the DIRECTORY menu, selecting the appropriate subdirectory and then selecting the desired call location(s), or
- manually entering a valid two digit dial code in the scratchpad and selecting MAKE CALL.

Pushing the audio control panel CAB (cabin) transmitter select switch twice within one second places a priority call to an airline–designated call location. If the

cabin station is already 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.

Note: CAB and SAT may be selected at the same time for cabin to SATCOM conferencing. (See Cabin/SATCOM Conferencing on page SP.5.1 for additional information.)

Calls can be ended by selecting the CABIN INTERPHONE page prompt END CALL or de–selecting the CAB transmitter selector on the audio control panel. The call also ends if the other party terminates the call.

Calls can also be answered or placed using the flight deck handset. 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.

Cabin Interphone Main Menu

The cabin interphone menu allows the pilots to make or end calls. Calls are made 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 MAKE CALL prompt. A list of the two digit station codes is located on the handset.

The directory of stations is created by the customer airline and is not shown here. The following depict typical main menu pages and selected options.

Speed Dial

The speed dial menu provides a quick means to call up to three predefined stations or groups of stations. A single push initiates the selected call.

Call Queue

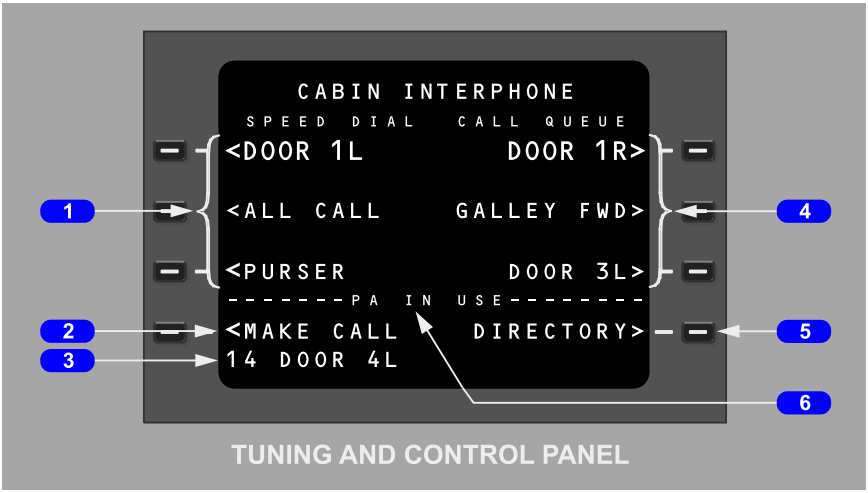
When the flight deck is involved in a call, additional incoming calls are displayed in the queue. Up to three calls can be displayed in order of the priority assigned as follows:

- 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 three 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]



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 MAKE CALL/END CALL

MAKE CALL:

A two–digit dial code may be manually entered with the TCP keyboard. If the dial code is valid, the dial code, dial code label, and MAKE CALL are displayed. If the dial code is invalid, INVALID ENTRY is displayed in the scratchpad.

Push—initiates a call to the selected station.

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 by/from the cabin crew, or
- both the PA and video entertainment systems are in use by/from the cabin crew.

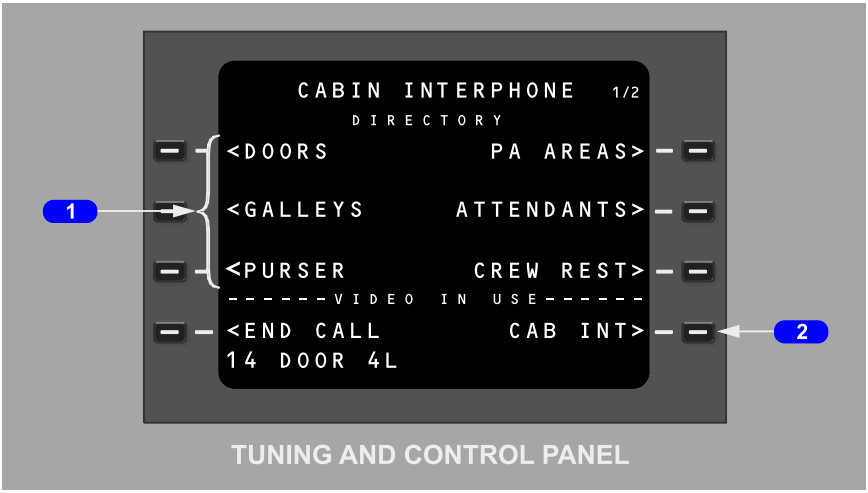
VIDEO IN USE—a portion of the video entertainment system is in use.

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. TCP cabin interphone directory pages and individual directory entries are predefined by the airline. Each directory label is the name of a subdirectory where the dial code labels of the individual stations or functions are listed.

Selection of the specific location(s) is accomplished on the subdirectory page.



1 Directories

Up to 12 subdirectories can be predefined.

Push—displays the appropriate subdirectory page.

2 CAB INT

Push—returns the display to the cabin interphone main menu page.

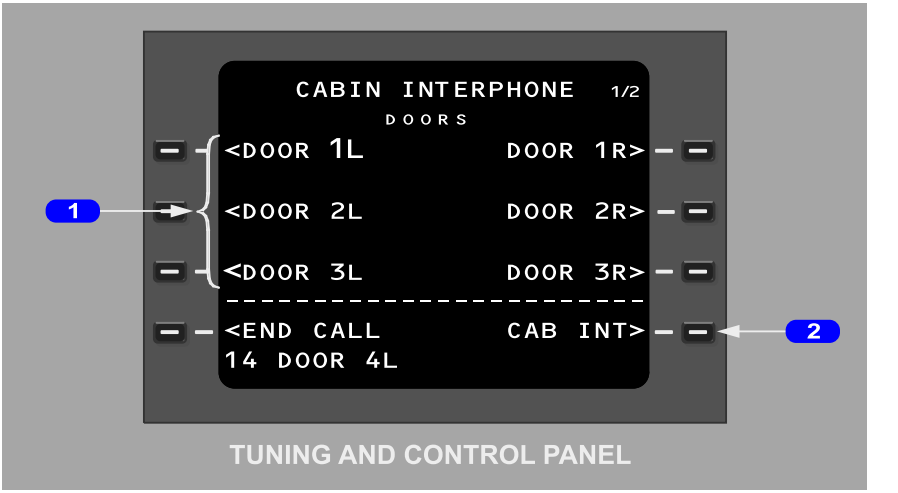
Cabin Interphone Subdirectory Page [Typical]

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.



TUNING AND CONTROL PANEL

1 Dial Code Labels

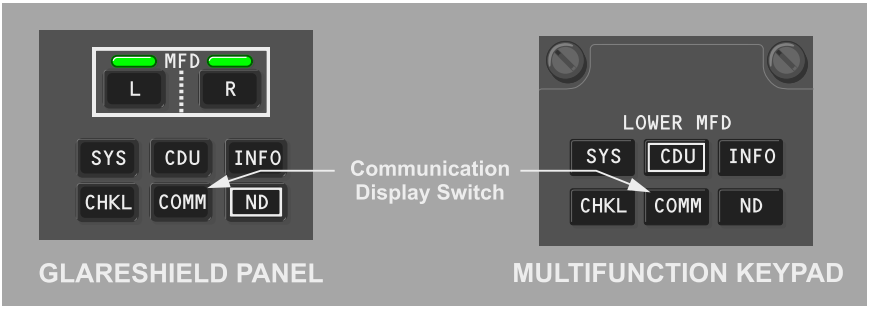
Push—initiates a call to the appropriate station(s).

2 CAB INT

Push—returns the display to the cabin interphone main menu page.

MFD Communications Functions

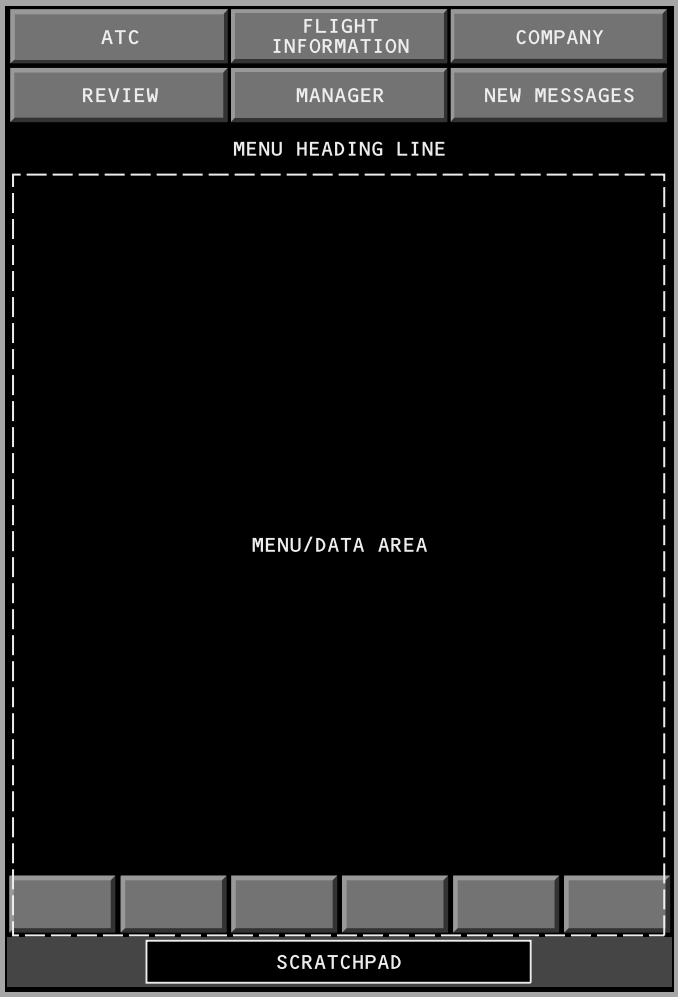
The MFD communications functions are used to control datalink features. Datalink messages not processed by the FMC are received, accepted, rejected, reviewed, composed, sent, and printed using communications functions on the MFD. Datalink communications can be established with participating ATC and company locations. ACARS and datalink radio management functions are provided through communications management menus.



The communication (COMM) display switch displays the communications main menu on the selected multifunction display (MFD). Communications functions are selected using the cursor control device or cursor control selector. Message text entry is accomplished by entering data into the COMM scratchpad and transferring it to the appropriate area. Messages can be printed on the flight deck printer. Incoming ATC and FIS message traffic is annunciated by an EICAS •ATC communication message and displayed in the ATC Data Block on both auxiliary displays as well as the Comm MFD. Company messages are annunciated by a EICAS •COMM communication message and only displayed on the Comm MFD.

Illustrations shown in this section depict the COMM menu with all features enabled. ATC datalink requires appropriate airplane and ATC capability.

Communications Menus



MULTIFUNCTION DISPLAY

Note: Shown with no menu functions active.

Company communications functions can be customized by airlines. Descriptions and illustrations provided in this section are examples of a typical installation

with all communications functions active (depending on airline configuration or function availability, some functions may be inhibited).

Selectable menu items (active functions) have white text on a gray background. Inhibited items have cyan text on a black background with a cyan border. Inhibited items cannot be selected. The background color for a selected top level function is green.

Selecting ATC, FLIGHT INFORMATION, COMPANY, REVIEW, MANAGER, or NEW MESSAGES selection:

- places the appropriate title in the menu heading line
- displays the subordinate menu selections for that function in the menu/data area.

Subordinate menu items which lead to subsequent subordinate menu(s) are followed by three dots (…). Making a selection from the subordinate menu places the title of that function in the menu heading and displays a new subordinate menu or data below. Making a selection from the subordinate menu displays the appropriate title, the menu heading, and the data below.

ATC provides ATC logon/status functions and downlink messages to ATC, where available.

FLIGHT INFORMATION provides downlink messages that allow Departure Clearance, Oceanic Clearance, Automatic Terminal Information Service (ATIS), Pushback Clearance, Terminal Weather Information for Pilots (TWIP), and Expected Taxi Clearance requests.

COMPANY provides for downlink messages to airline facilities and related operational datalink functions.

REVIEW displays a list of all transmitted messages, received messages not requiring a response that have been viewed, or received messages with the response already sent. REVIEW is inhibited if there are no listed messages.

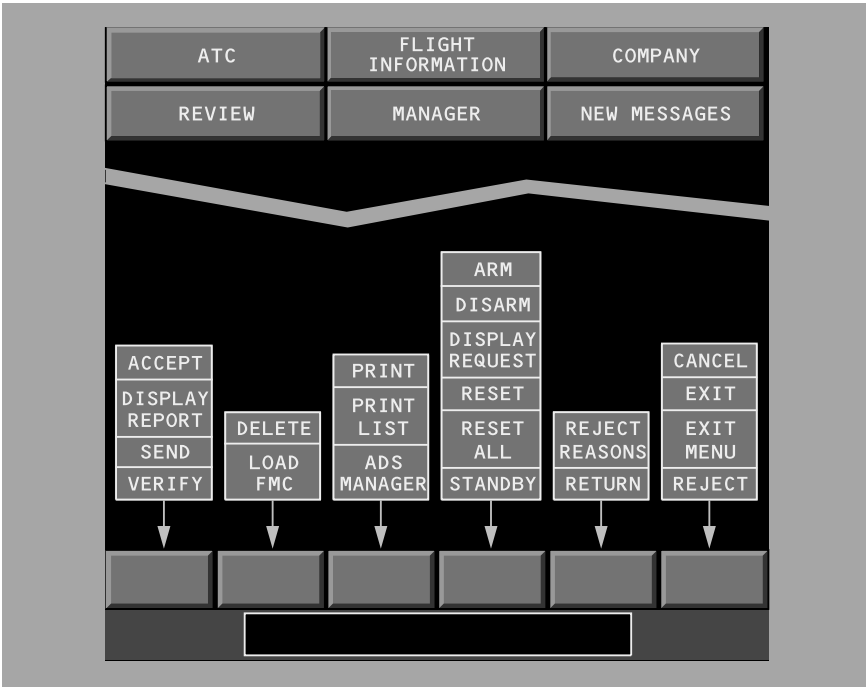
MANAGER provides the controls for datalink and communications systems in general.

NEW MESSAGES displays a list of uplinked messages that have not been displayed or responded to. NEW MESSAGES is inhibited when there are no new messages.

Communications Control and Input Functions

Communications menus, controls, and data input methods are similar for ATC, FLIGHT INFORMATION, and COMPANY functions. Basic functions are explained here.

Command Key Locations



Communications command keys are displayed at the bottom of communications pages. Command keys change as appropriate for pages displayed. Each key has a label which changes based on the page displayed and the possible action. Only one label is displayed in a single location for a specific condition on the page.

Command Key Functions

The following table describes the key functions and labels for all ATC, FLIGHT INFORMATION, and COMPANY functions.

Command key label	Displayed/Inhibited	Key function
ACCEPT (uplink messages)	Displayed when: • message requires an accept/reject response, and • all message pages have been displayed.	Select: • message acceptance downlinked to message sender • ACCEPT & REJECT keys removed

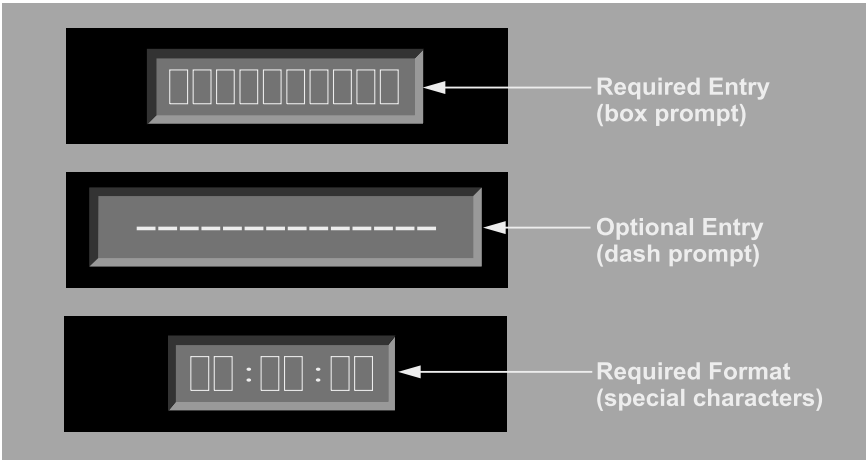
Command key label	Displayed/Inhibited	Key function
	Inhibited for first 2 seconds of message display.	• message status displayed in info box • CANCEL command key displayed.
ADS MANAGER	Displayed when ATC LOGON/ STATUS page is displayed.	Displays ADS MANAGER page.
ARM (ATC downlink reports)	Displayed when an armable report is not ARMED: • REPORT LEAVING • REPORT MAINTAINING • REPORT PASSING • REPORT REACHING. • REPORT REACHING BLOCK	Select: • arms the report for automatic downlink to ATC when report conditions are met • key function changes to DISARM • report status changes from OPEN to ARMED.
CANCEL	Displayed when: • uplink message is displayed which does not require an accept or reject response, or • an uplink message is displayed which has been accepted, rejected, or • review message is displayed. Inhibited for first 2 seconds of message display.	Message is removed.
DELETE (ATC reports and Conditional Clearances)	Displayed when a downlink report page is open for entry.	Select: • deletes the report without sending • displays the COMM menu.
DISARM (ATC reports)	Displayed when an armable report is ARMED: • REPORT LEAVING • REPORT MAINTAINING • REPORT PASSING • REPORT REACHING. • REPORT REACHING BLOCK	Select: • disarms automatic report downlink to ATC • key function changes to ARM • Report status changes from ARMED to OPEN.

Command key label	Displayed/Inhibited	Key function
DISPLAY REPORT	Displayed after accepting an uplink message which contains a report.	Displays the downlink report attached to an uplinked message.
DISPLAY REQUEST	Displayed after accepting an ATC uplink message which contains a request.	Downlink request which required an ATC response is displayed.
EXIT	Displayed when: • a downlink message is displayed, or • a manager page is displayed.	COMM main menu is displayed.
EXIT MENU	Displayed when menu is displayed.	COMM main menu is displayed.
LOAD FMC (ATC uplink)	Displayed when uplinked ATC message contains data which can be loaded into the FMC. Inhibited when active route is in a MOD condition.	Select: • FMC data is transferred into the active route, and • FMC modification is started.
PRINT	Displayed when: • displayed message can be printed, and • printer is available. Inhibited when printer is not available.	Message is sequenced for printing.
PRINT LIST	Displayed when: • new message list page is displayed, or • review list page is displayed • ATC REPORTS • CONDITIONAL CLEARANCES. Inhibited when printer is not available.	All messages in the list are sequenced for printing.
REJECT (uplink messages)	Displayed when: • message requires an accept/reject response, and • all message pages have been displayed.	Select: • message rejection downlinked to message sender • ACCEPT, REJECT, STANDBY and REJECT

Command key label	Displayed/Inhibited	Key function
	Inhibited for first 2 seconds of message display.	REASONS command keys removed • CANCEL command key displayed • message status displayed in info box, and • message cleared from the display 5 seconds after status changes to REJECTED.
REJECT REASONS (ATC reject downlink)	Displayed when an uplink message requires an accept or reject response.	Displays REJECT REASON page.
RESET (downlink pages)	Displayed when downlink page is displayed.	Message parameters are reset to their default values.
RESET ALL (ATC downlink pages)	Displayed when ATC VERIFY REQUEST page is displayed.	Select: • all request parameters on the VERIFY REQUEST are set to reset/default values • ATC combined request pages are reset, or • COMM main menu is displayed.
RETURN	Displayed when: • a review message is displayed, or • a downlink message is displayed, or • a VERIFY REQUEST page is displayed, or • a manager page is displayed.	Previous list page, request page, or menu is displayed.
SEND (downlink messages)	Displayed when: • required data complete, and • all company message pages have been displayed. Inhibited when transmission queue is full.	Select: • message transmission initiated • message status displayed in info box, and • message cleared from the display 5 seconds after status changes to SENT.

Command key label	Displayed/Inhibited	Key function
STANDBY (ATC uplink messages)	Displayed when: • uplinked message is received which requires an accept/reject response, and • STANDBY has not been previously selected for this message.	Standby response is sent.
VERIFY	Displayed when data is entered on more than one of the following ATC pages: • ALTITUDE REQUEST • ROUTE REQUEST • SPEED REQUEST.	Displays VERIFY REQUEST page.

Text Entry



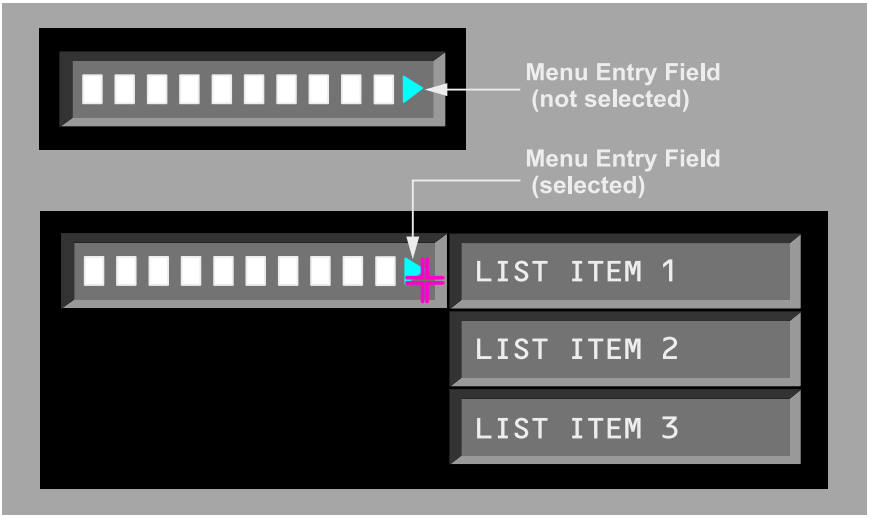
Downlink message pages provide text entry fields. Scratchpad entries transfer to selected entry fields when a cursor select switch is pushed. Scratchpad entries blank when successfully transferred. Scratchpad entries remain and an INVALID ENTRY message is displayed in the help window when the entry is not valid.

An entry field resets to a default value when a blank scratchpad is transferred. An entry field blanks when a space is transferred. An entry field resets to the default entry prompt when DELETE is transferred.

Box and dash prompts indicate the maximum number of characters allowed.

Some entry fields have format requirements. Entry prompts display the required entry format, with special characters separating entry boxes. The required data is entered without the special characters or spaces. Scratchpad data is transferred to entry boxes after being checked for proper format. Invalid data or format prevents transfer and displays INVALID ENTRY in the help window.

Menu Entry Fields



Menu entry fields are used to make text entry selections from a list. Menu entry fields distinguish mandatory versus optional entry in the same manner as CDU entry field.

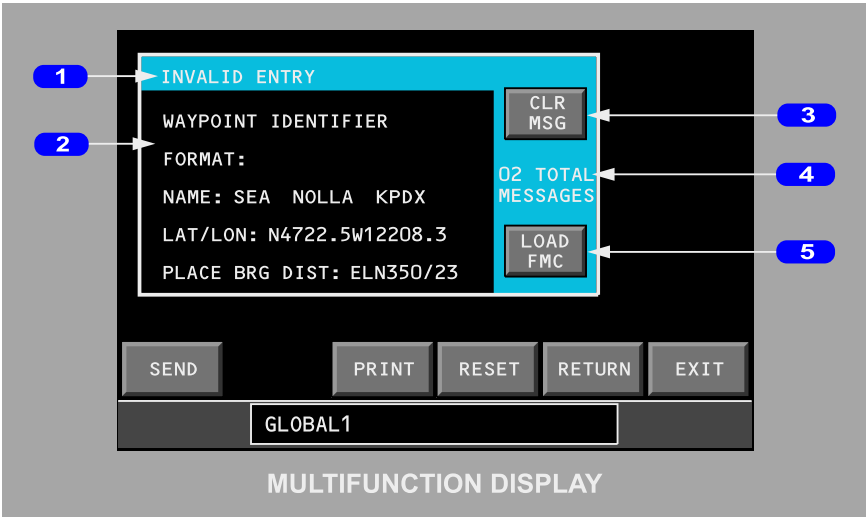
The menu entry field is distinguished from other entry fields by the pointer to the right of the field.

When initially selected, a list of menu items is displayed to the side of the pointer. If an item from the list is then selected using the cursor and cursor select switch, that item is transferred to the entry field. If the menu prompt is selected again and the scratchpad contains a valid value, that scratchpad value is transferred to the entry field. Actions for invalid values, an empty scratchpad, space characters, and the delete key are the same as for CDU entry fields. When the entry field is selected with text already inserted, the menu list is removed from the display.

Help Window

A help window is provided in both COMM and CDU displays at the bottom of the MFD to assist in resolving data entry errors and to display FMC information messages. Some help window messages clear automatically when the condition

is removed. Others, such as COMM MASTER SWITCH must be manually cleared using the CLR MSG key.



1 Help Window Title

Displays help window message title.

2 Help Window Text

Displays text message information to:

- help correct data entry errors
- provide FMC alerting messages
- provide FMC communications messages.

3 Clear Message (CLR MSG) Key

Push—

- removes help window for current message from display
- displays next help message (if one exists).

4 TOTAL MESSAGES

Displays total number of messages in help window queue.

5 LOAD FMC Key

Displays when loadable ATC RTE CLEARANCE UPLINK message is received.

Push—

- clears ATC message

- enters modified route into FMC for execution
- displays next help message (if one exists).

COMM Help Messages

COMM help messages are described in the following table.

Condition	Help Window Title	Help Window Text
An entry box is selected and the scratchpad value is not valid.	INVALID ENTRY	(Specific to type of entry)
Entry cannot be found in the navigation database.	NOT IN DATABASE	(Specific to entry)
Entered waypoint is not on active route.	NOT ON ROUTE	WAYPOINT MUST BE IN ACTIVE ROUTE
An attempt to send a downlink message is unsuccessful.	NO SEND	UNSUCCESSFUL MESSAGE TRANSMISSION RETRY OR CONTACT ON VOICE
ACCEPT response is not successfully transmitted or an ACCEPT response is not required.	NO ACCEPT	UNSUCCESSFUL ACCEPT MESSAGE RESPOND BY VOICE
REJECT response is not successfully transmitted or a REJECT response is not required.	NO REJECT	UNSUCCESSFUL REJECT MESSAGE RESPOND BY VOICE
An attempt to send a message to the flight deck printer is unsuccessful.	NO PRINT	UNSUCCESSFUL PRINT CHECK PRINTER
ATC uplink times out, or ATC connection is lost, or handoff to a new ATC center occurs before responding.	ABORTED	UPLINK ABORTED BEFORE FLIGHT CREW RESPONSE CONTACT ATC BY VOICE IF RESPONSE REQUIRED

Condition	Help Window Title	Help Window Text
Company messages are lost due to a switch of the master COMM function.	COMM MASTER SWITCH	COMPANY MESSAGE LOG LOST
Message exceeds the maximum number of stored downlink message.	MESSAGE LIMIT EXCEEDED	DOWNLINK MESSAGE STORAGE IS FULL CONFIRM DATALINK STATUS BEFORE SENDING MESSAGES
An ATC message element is selected when the maximum number is already selected.	MESSAGE LIMIT EXCEEDED	CANNOT SELECT ADDITIONAL MESSAGE ELEMENTS
Clearance cannot be loaded because a flight plan modification is in progress.	UNABLE TO LOAD	FLIGHT PLAN MODIFICATION IN PROGRESS EXECUTE OR ERASE MOD TO LOAD CLEARANCE
Clearance cannot be loaded because there is no active route.	UNABLE TO LOAD	NO ACTIVE ROUTE ACTIVATE RTE 1 OR RTE 2
Clearance cannot be loaded because it contains unloadable elements.	UNABLE TO LOAD	UNABLE TO LOAD CLEARANCE ATC CLEARANCE CONTAINS INVALID DATA CONTACT ATC
Entry of an incorrect password for a password-protected page.	INCORRECT PASSWORD	ENTER CORRECT PASSWORD

DELETION

DELETION

DELETION

DELETION

CDU Help Messages

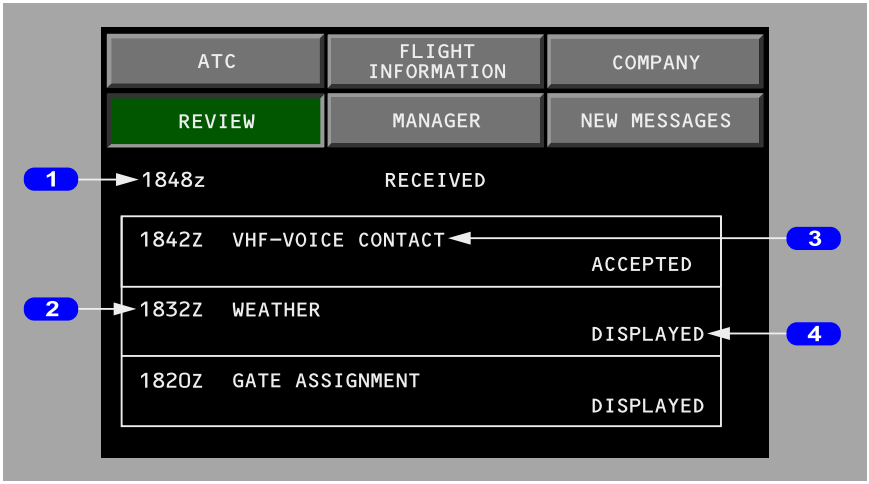
(See FMC Communications Messages on page 11.60.11 for additional information.)

Message List

Message titles and related information can be displayed in a list. The illustration shows the REVIEW message list. A similar list is available for NEW MESSAGES.

The NEW MESSAGES list is sorted with ATC messages first, FLIGHT INFORMATION next and COMPANY messages at the end. Each of these groups is sorted by the time of receipt with the most current message at the top. ATC uplink messages have an ATC label to the right of the data block. The message remains in the list until it is accepted, rejected, or displayed. Messages requiring an accept/reject remain in the list until the accept/reject response is accomplished.

Selecting an item from the list with the cursor and pushing the cursor select switch displays the message page. Lists are also used to view new messages.



1 Current Time

Displays current time.

2 Message Time

For new messages—time the message is received.

For review messages—time the message is received or sent.

3 Message Title

Displays message title information.

4 Message Status

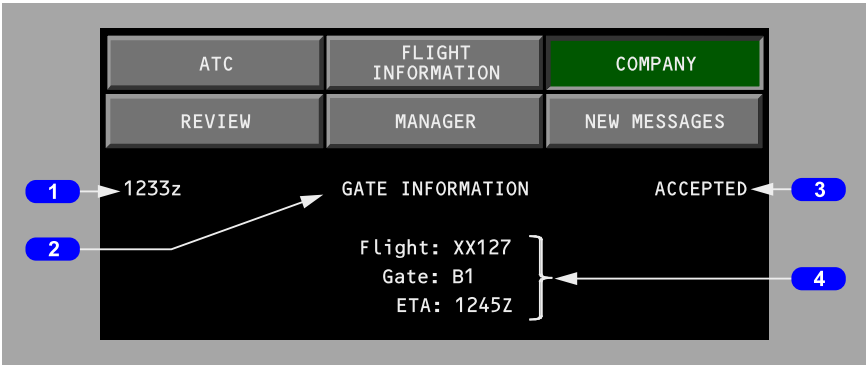
Only displayed for review list boxes.

The appropriate status indicator is displayed.

Message Display Format

A typical message display format is shown. Messages selected from a list are displayed in this format.

Note: Selection of a main menu item exits the message page.



1 Message Time

For downlink messages—current time.

For new messages—time the message is received.

For review messages—time the message is received or sent.

2 Message Title

Displays message title information.

3 Review State

Only displayed for review messages.

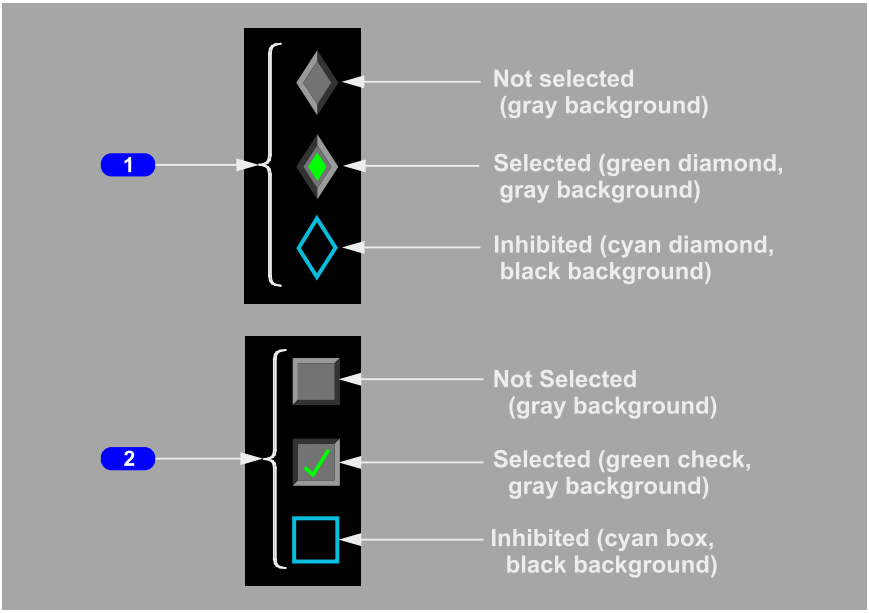
The appropriate state indicator is displayed.

4 Message Content

Located between the title and the keys.

Exclusive and Nonexclusive Select Keys

Communications pages can contain select keys to activate features. Pushing the cursor select switch when the key is highlighted makes the selection. A second selection of a nonexclusive key toggles to the deselected state.



1 Exclusive Select Key

The diamond–shaped exclusive select keys are used to select a single feature from a group. Selecting a key activates the feature and all other exclusive select keys in that group are deselected. The keys are displayed in their selected or default condition. If selection is required, the SEND key is not displayed until a selection is made.

2 Nonexclusive Select Key

The square–shaped nonexclusive select keys are used to select multiple features. Selecting a key activates the feature. The keys are displayed in their previously selected or default condition. If selection is required, the SEND key is not displayed until a selection is made.

Information Messages

Messages are displayed in an information box at the bottom of the MFD and relate to message status. The information box covers the command keys.

Information messages, such as SENT, are cleared by selecting EXIT INFO. Some information messages automatically disappear.



1 Information Message Text

The text starts at the left of the box.

2 EXIT INFO Key

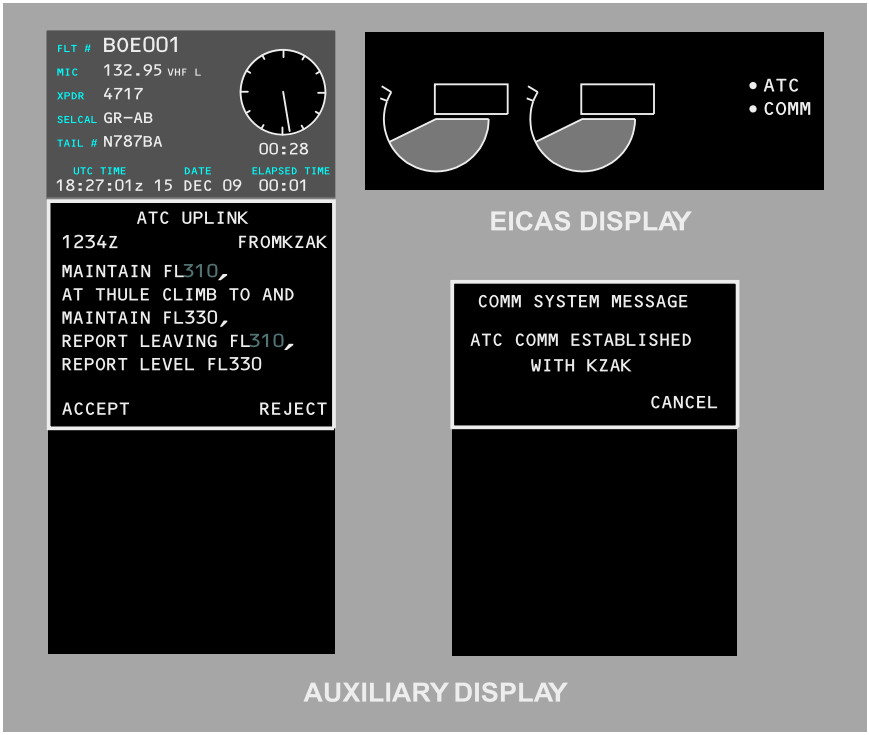
Select—removes the information box for the displayed message from the display.

Communications Information Messages

Communications information messages are described in the following table.

Information Message Status	Condition
ACCEPTED	ACCEPT response successfully sent.
ACCEPTING	ACCEPT response is being sent.
CONNECTING	ATC logon is in progress.
LOADED	ATC uplink message successfully loaded.
MESSAGE TO PRINTER	Printer indicates that print job successfully printed.
PRINTING	Print job is being sent to printer.
REJECTED	REJECT response successfully sent.
REJECTING	REJECT response is being sent.
SENDING	The downlink message is being sent.
SENT	The downlink message is successfully sent.

ATC Messages



ATC and Flight Information Uplinks

Arriving ATC and Flight Information uplink messages are annunciated by an EICAS •ATC communications message, an aural chime. The message text is displayed in the ATC Data Block. The message text can also be displayed using the NEW MESSAGE menu selection.

Company Uplinks

Arriving company uplink messages are annunciated by an optional EICAS •COMM communications message, optional EICAS •PRINTER communications message, and/or an optional aural chime. The message text can be displayed using the NEW MESSAGE menu selection.

COMM System Messages

COMM system messages are ATC related messages generated by the communication system. COMM system messages are annunciated by an EICAS

•ATC communications message, an aural chime. The message text is displayed in the ATC Data Block.

COMM system messages are described in the following table.

COMM System Message Text	Condition
RE-LOGON TO ATC COMM	Failure to extablish ATC datalink connection
ATC COMM ESTABLISHED WITH [center]	Establishment of ATC datalink connection
ATC DATALINK LOST	Loss of ATC datalink connection
LEAVING [altitude] SENT TO [center]	LEAVING report sent (FANS only)
REACHING [altitude] SENT TO [center]	REACHING report sent (FANS only)
REACHING BLOCK [altitude] TO [altitude] SENT TO [center]	REACHING BLOCK report sent (FANS only)
MAINTAINING [altitude] SENT TO [center]	MAINTAINING report sent (FANS only)
PASSING [position] SENT TO [center]	PASSING report sent (FANS only)
CONDITIONAL CLEARANCE CONDITION MET	The condition in a conditional ATC clearance has been satisfied (FANS only)
CLEARANCE CONDITION NOT MET	Conditional ATC clearance executed prior to satisfying condition (FANS only)
CONDITIONAL CLEARANCE NOT IN ROUTE	The position in a conditional ATC clearance cannot be found by FMF (FANS only)
INVALID ATC UPLINK	Invalid ATC uplink received

Accept/Reject/Cancel

ATC messages requiring an accept or reject response display those options on the ATC Data Block. The MFD message page displays ACCEPT, STANDBY, REJECT REASONS, and REJECT keys at the bottom. Select ACCEPT or REJECT to respond to the uplink message. The REJECT REASONS key can be selected to inform ATC why the message is being rejected.

Company messages can only be accepted or rejected on the message page.

After making a selection, the status changes to ACCEPTING/REJECTING while the response is transmitting. When the communications network sends a response indicating that the message was received, the message status changes to ACCEPTED/REJECTED. After a message has been accepted or rejected, a CANCEL key is displayed at the bottom of the page. Selecting CANCEL clears the message from the display. Rejected messages are automatically removed 5 seconds after the message status changes to REJECTED.

The ACCEPT, CANCEL, and REJECT buttons on the glareshield perform the same function as the same keys on the MFD.

ATC Datalink

ATC datalink communicates with participating air traffic control centers, reducing the need for VHF and HF voice communications. Airplane situation reports, route changes, speed and vertical clearances, and voice contact requests can be sent or received as appropriate. The COMM display ATC menu selection allows display of downlink message pages.

Uplink and downlink messages are stored. All messages are assigned the time of receipt/transmission and are printable.

ATC datalink requires manual logon to a participating ATC facility. Once logged on, transfer to adjacent ATC facilities is normally automatic.

Crew Feedback

ATC uplinks containing clearance data that the crew can set on the MCP, TCP or EFIS control panel have a crew feedback display function. When the message is displayed on the ATC Data Block or the message page, the data values change from white to green when properly set by the crew. Data which provides feedback is:

- MCP speed
- MCP heading
- MCP altitude
- barometer setting
- transponder code
- VHF frequency
- HF frequency.

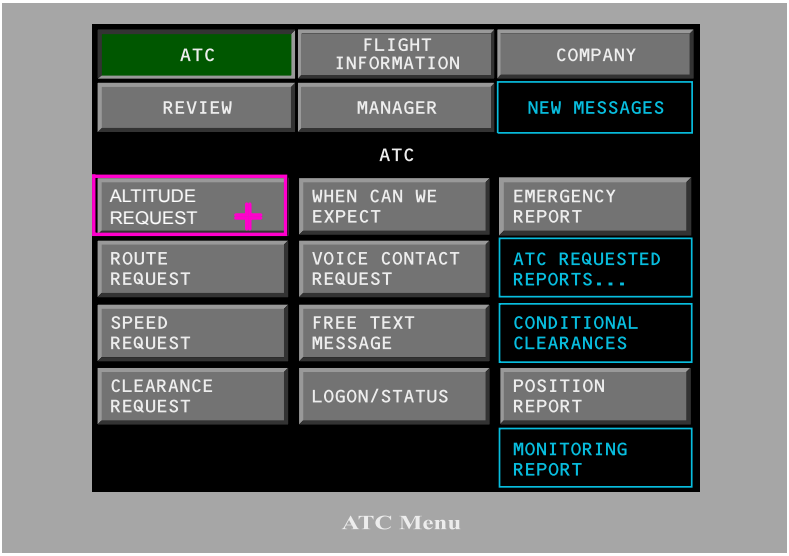
FMC Data Loading

Some ATC uplinks contain data for loading into the FMC. Display of the LOAD FMC command key indicates that FMC data is available for loading. Selecting LOAD FMC transfers data to the FMC and creates an FMC modification.

Both MFD information messages and help window messages provide indications of loading progress.

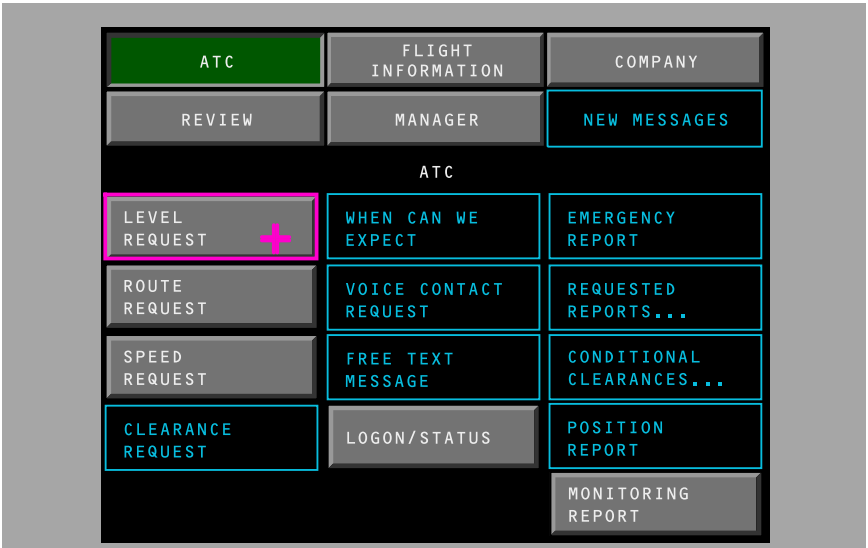
Downlink Pages

ATC Menu



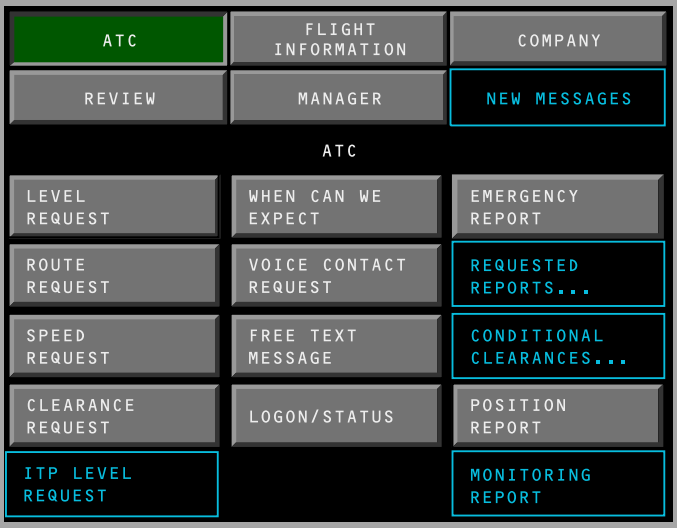
ATC Menu

TQA,B,C,D



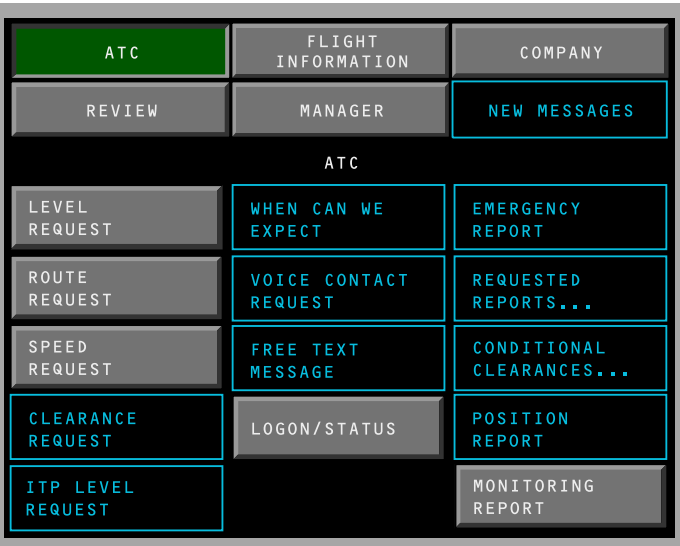
ATC Menu - ATN Connection Established

TQE,F,TWA,B



ATC Menu (BPv2.5)

TQE,F,TWA,B



ATC Menu (BPv2.5) - ATN Connection Eatablished

The ATC menu provides access to ATC downlink pages.

The ATC REQUESTED REPORTS menu selection is inhibited (cyan) when no reports are requested by ATC.

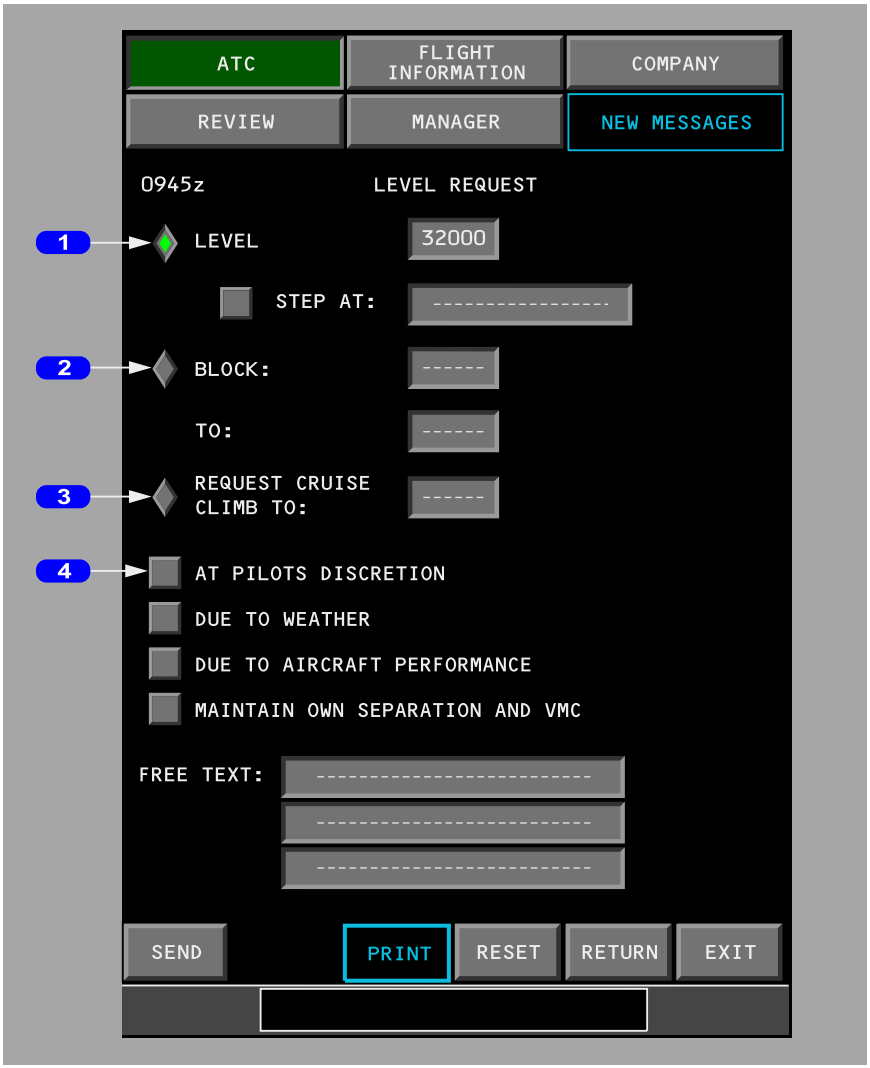
The CONDITIONAL CLEARANCES menu selection is inhibited (cyan) unless a conditional clearance is accepted by the flight crew.

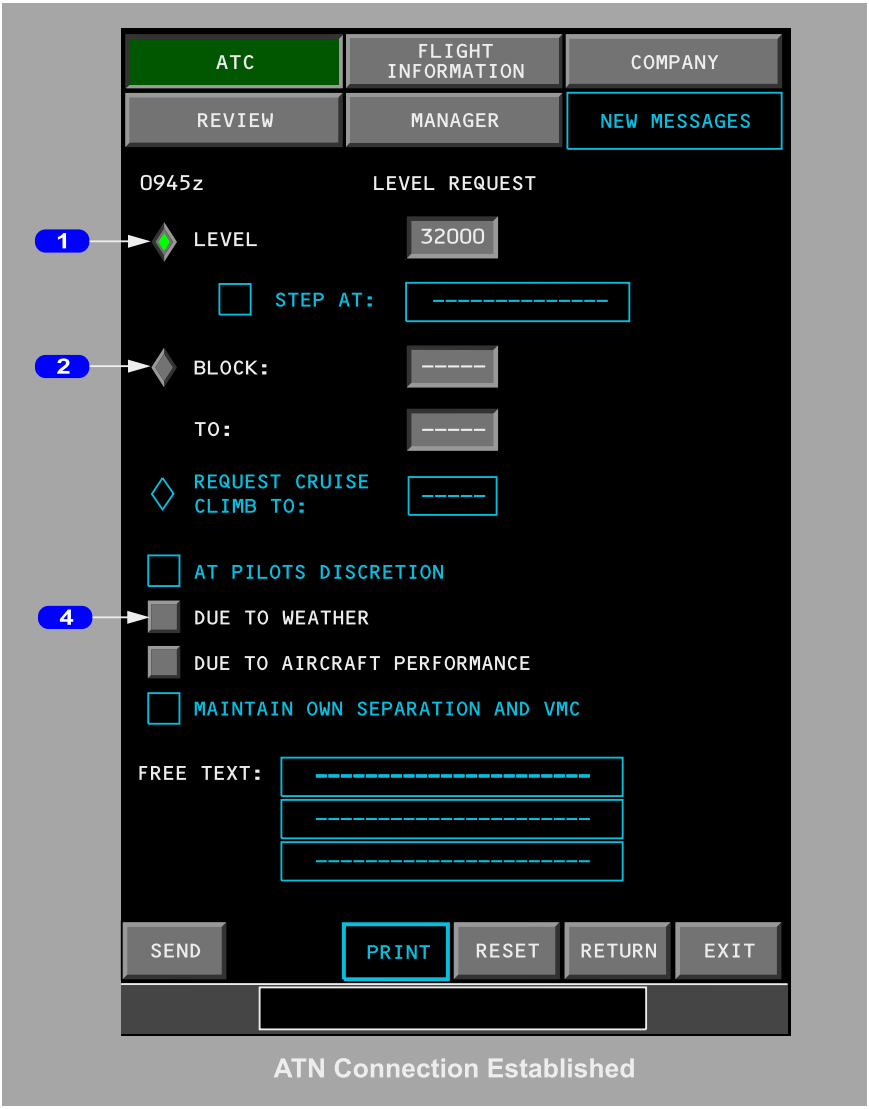
Some ATC menu selections and request messages are inhibited (cyan) when an ATN (Aeronautical Telecommunication Network) datalink connection is established.

Note: This menu is not repeated when describing individual pages.

Level Request

The LEVEL REQUEST page allows selection of a level, a block level, or a cruise climb.





1 LEVEL

The requested altitude or flight level is entered into the dash prompt and the SEND key becomes active.

Pushing the SEND key requests a normal climb at climb power unless otherwise requested, or a normal descent.

Additional climb or descent options are:

- STEP AT—allows entering a time or position for the start of the climb or descent.

STEP AT is inhibited when the LEVEL value is less than 150 feet from current airplane altitude. Flight level entries are any valid FMC altitude or flight level. Time entries are in four digit, hours and minutes, optionally followed by a Z. Position entries are any valid FMC waypoint in the active route.

2 BLOCK

BLOCK is the beginning of a block altitude. TO is the end of the altitude block. Altitude entries are any valid FMC altitude.

The SEND key becomes active with an entry.

3 REQUEST CRUISE CLIMB TO

Begin a cruise climb from present position.

Assumes a minimum rate climb based on fuel burnoff.

Note: LEVEL should be used for a normal VNAV cruise climb.

The SEND key becomes active with this selection.

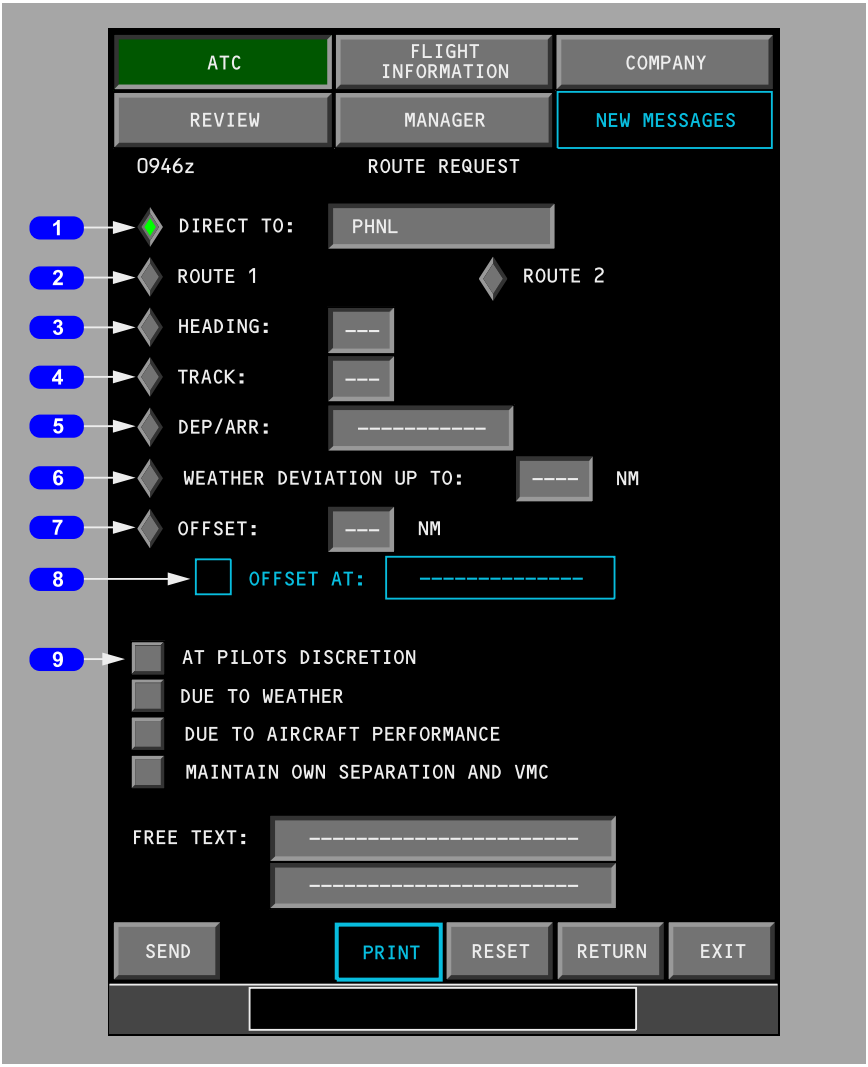
4 ADDITIONAL REQUEST INFORMATION

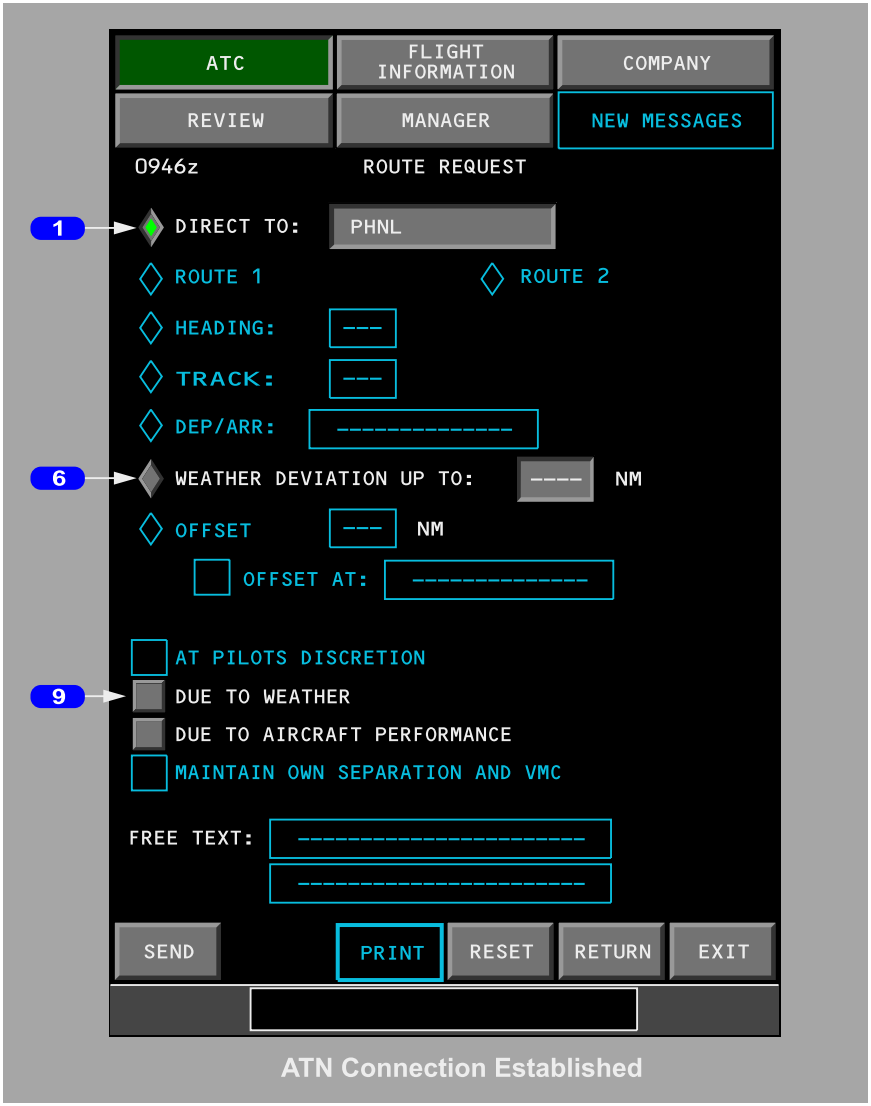
One or more reasons for a request are optionally selected.

Up to three lines of free text can be included.

Route Request

The ROUTE REQUEST page allows selection of a direct to waypoint, new route, heading or track, departure and transition, arrival and transition, weather deviation, or a route offset.





1 DIRECT TO

Enter any valid FMC waypoint. The SEND key becomes active with this selection.

2 ROUTE

Selects FMC route 1 or 2. Sends the selected route, including any modifications. The SEND key becomes active with this selection.

3 HEADING

Enter desired heading. When displays are referenced to true north, a TRU label is displayed right of the heading. The SEND key becomes active with this selection.

4 TRACK

Enter desired ground track. When displays are referenced to true north, a TRU label is displayed right of the ground track. The SEND key becomes active with this selection.

5 Departure (DEP)/Arrival (ARR)

Enter one of the following:

- departure
- arrival
- departure and transition
- arrival and transition.

Default entries are:

- departure procedure/transition selected for the selected route
- the arrival procedure/transition selected for the active route when the airplane is in the air and an arrival procedure/transition has been selected
- the approach procedure/transition selected for the active route when the airplane is in the air and an arrival procedure/transition is not selected.

The SEND key becomes active when one of the check boxes is selected.

6 WEATHER DEVIATION UP TO

Enter desired offset in nautical miles. Valid entries are L (left) or R (right) NNN (NNN is any number from 1 to 128). Entries can be made without L or R to allow for offsets to either side of the route. The SEND key becomes active with this selection.

7 OFFSET

Enter desired FMC route offset in nautical miles. Valid entries are L (left) or R (right) XX (XX is any number from 1 to 99). Entries can be made without L or R to allow for offsets to either side of the route. The SEND key becomes active with this selection.

8 OFFSET AT

Enter a time or position to begin the offset. Time entries are in four digit, hours and minutes. Position entries are any valid FMC waypoint in the active route.

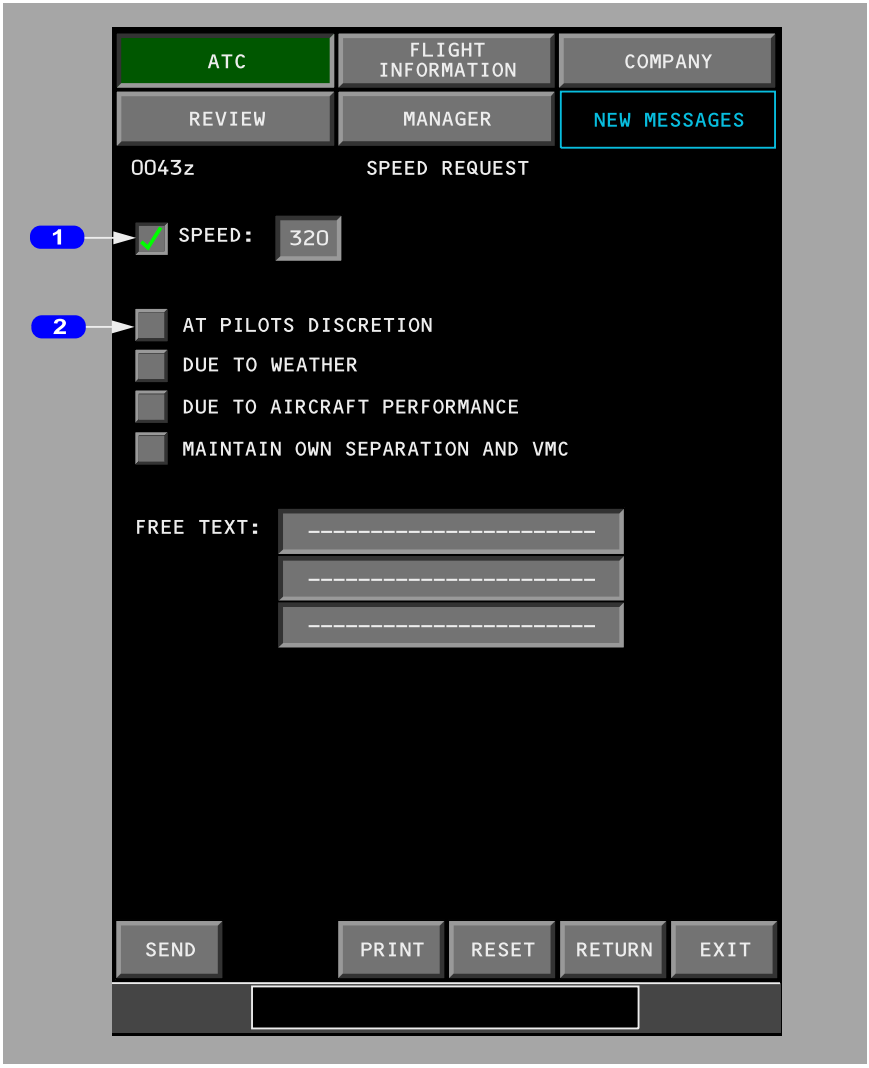
9 ROUTE REQUEST REASON

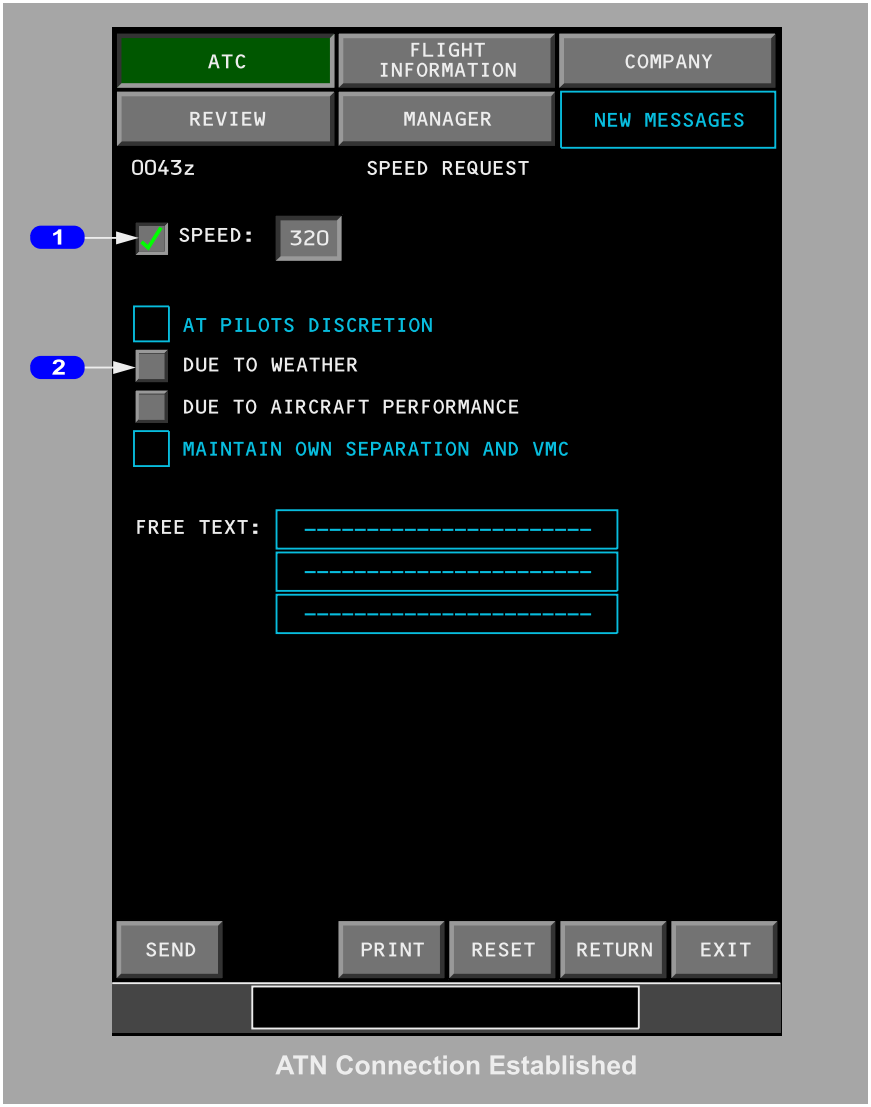
One or more reasons for a request are optionally selected.

Up to two lines of free text can be included.

Speed Request

The SPEED REQUEST page allows selection of speed.





1 SPEED

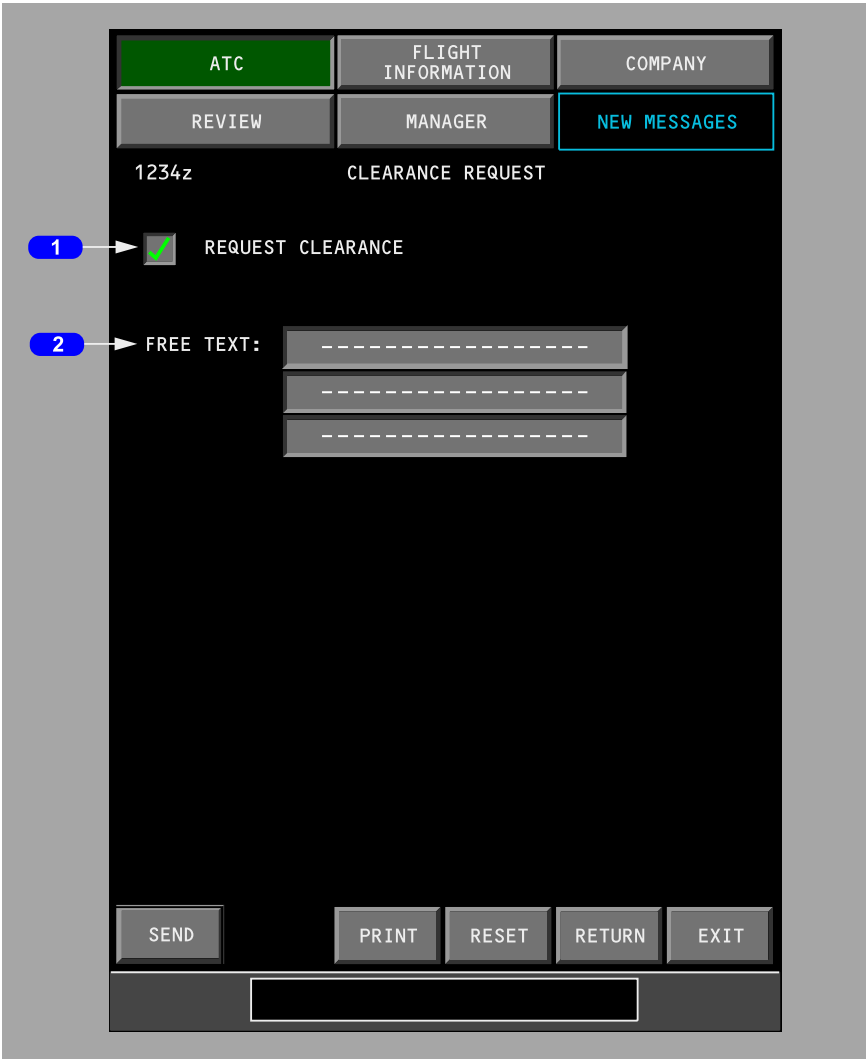
Enter any valid FMC speed or Mach number. IAS entries are rounded to the nearest 10 knots. The SEND key becomes active with this entry.

2 SPEED REQUEST REASON

One or more reasons for a request are optionally selected.

Up to three lines of free text can be included.

Clearance Request



1 CLEARANCE REQUEST

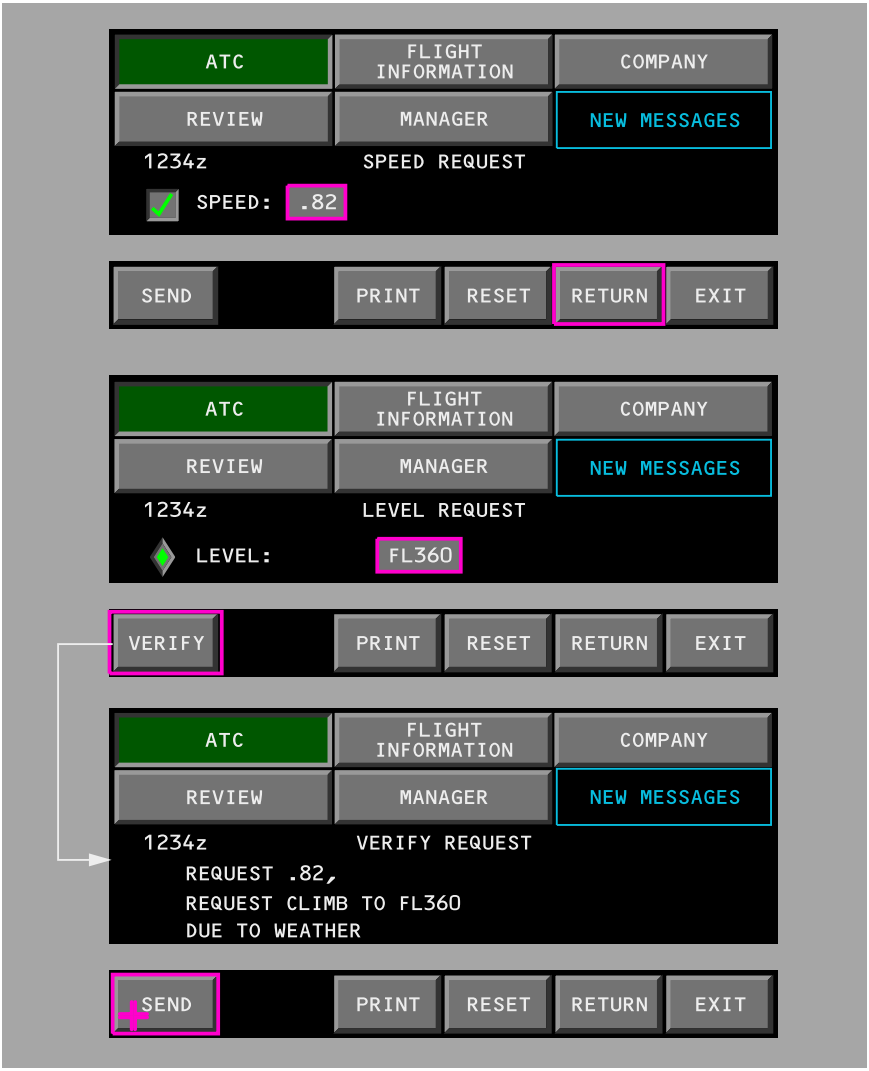
Informs ATC that the crew is ready for a clearance, such as predeparture or pushback.

The SEND key becomes active with this entry.

2 CLEARANCE REQUEST REASON

Up to three lines of free text can be included.

Combination Downlink Request



Requests from the level, speed, and route pages can be combined into one downlink request. Each request is individually selected and filled out. Select subsequent request pages by selecting RETURN, and selecting additional downlink pages from the ATC main menu. When data is entered into the second request page, the SEND key changes to VERIFY.

The SEND key is active on the VERIFY REQUEST page. A combined request is limited to five elements. Selecting a sixth request element displays the MESSAGE LIMIT EXCEEDED information message.

The verify page provides a display of the combined request elements. Each element is displayed on separate lines. Elements requiring revision before sending are revised on their respective request page. Selecting SEND transmits the combined downlink message to ATC.

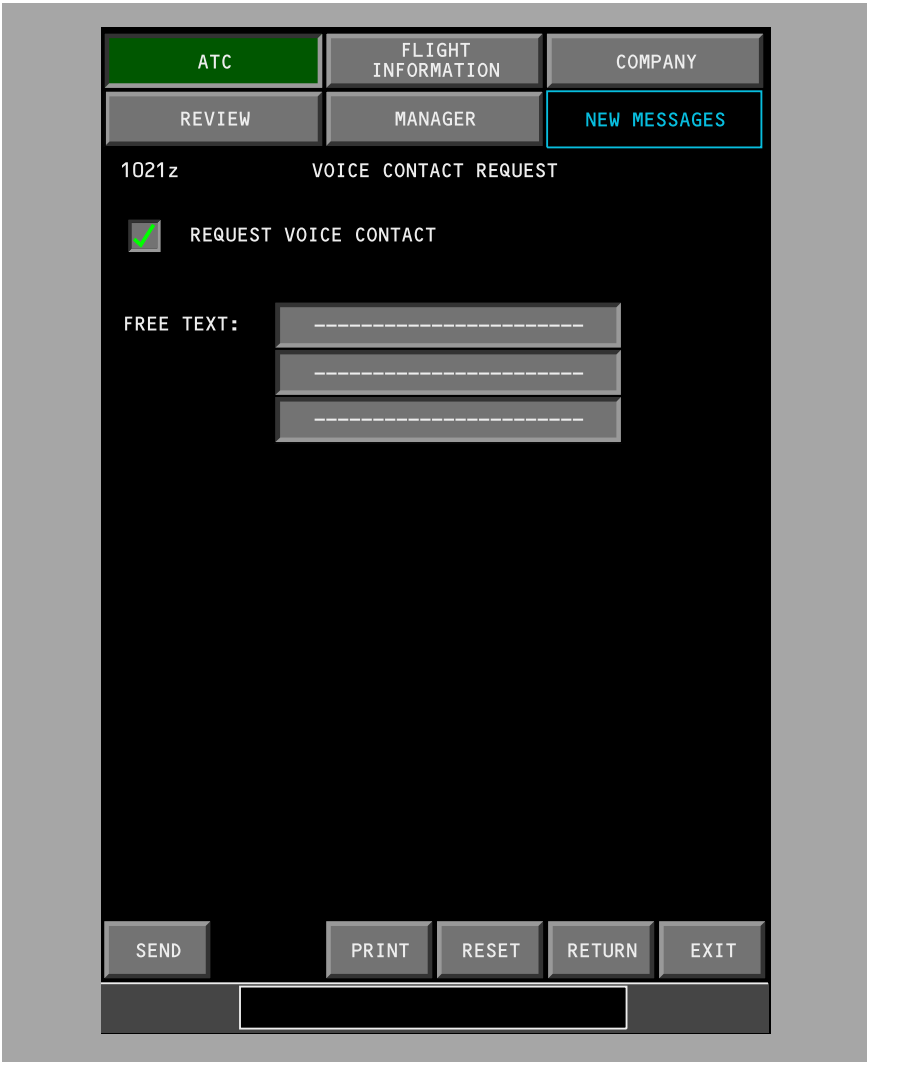
The example shows a combined level and speed request where the speed request was created first.

When Can We Expect



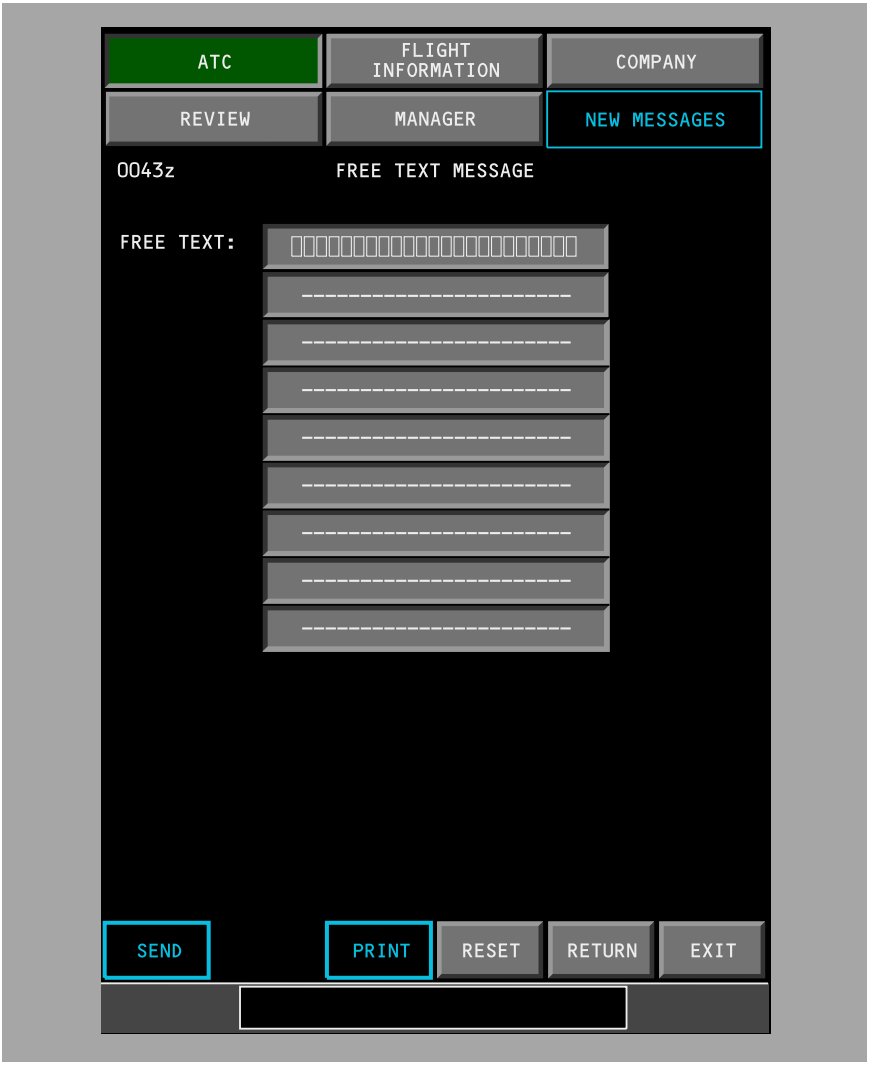
Making selections asks ATC the time or location the crew can expect clearance for the requested items. Level, speed, and cruise climb entry rules are the same as on the LEVEL REQUEST and SPEED REQUEST pages. Up to three lines of free text can be included. The SEND key becomes active when a check box is selected.

Voice Contact Request



Making selection asks ATC for a voice contact. Up to three lines of free text can be included. The SEND key becomes active when the request for voice contact box is selected.

Free Text Message

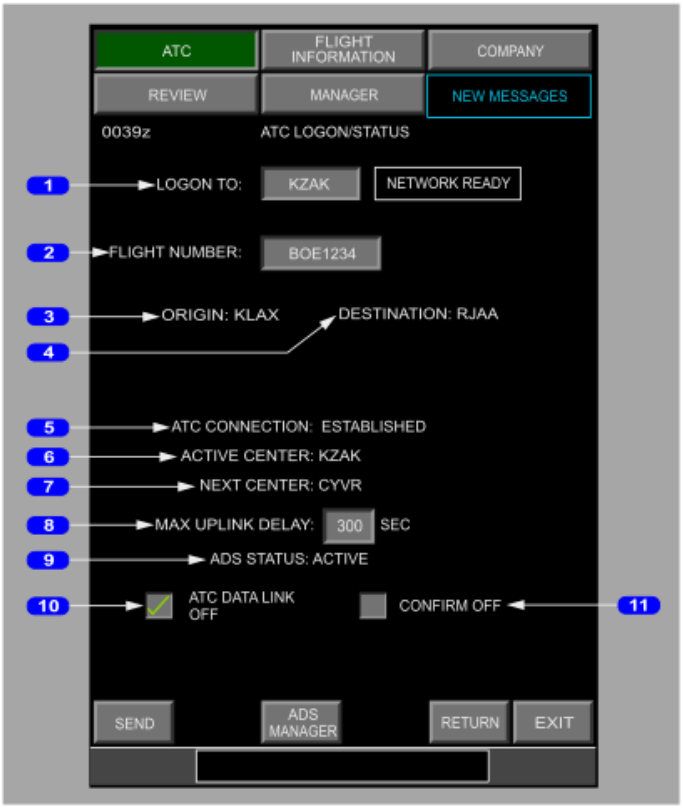


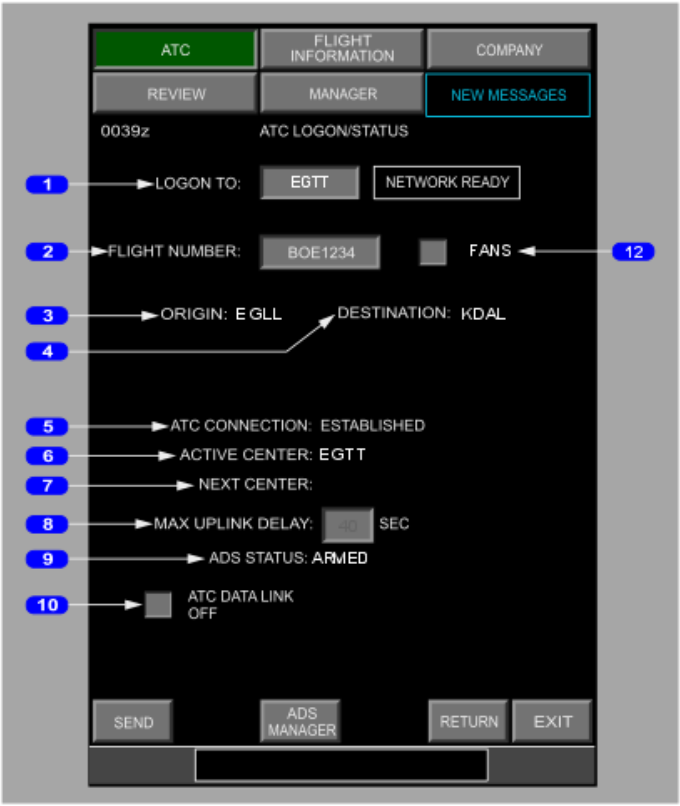
Making selection communicates to ATC other requests or information. Up to nine lines of free text can be included. The SEND key becomes active when characters are entered in the first line of free text.

ATC Logon/Status

The ATC LOGON/STATUS page allows logon to the desired ATC facility for establishment of a datalink connection and displays ATC datalink connection status information.

The SEND key is displayed after all logon entries are completed. Selecting the SEND key displays a SENDING status message during logon transmission followed by a CONNECTING status message when the logon is successfully transmitted. Five seconds after the logon status changes to CONNECTING, the page is exited.





1 LOGON TO

Box prompts are initially displayed. Enter the ICAO four letter identifier for the desired ATC center. The display changes to dashed prompts after establishing an ATC connection.

When an ATN identifier is entered, network status displays as:

- NETWORK READY:
  - VHF data link mode 2 available, or
  - FANS select key selected and an ACARS connection established.
- NETWORK NOT READY:
  - VHF data link mode 2 not available, or
  - FANS select key selected and an ACARS connection not established.

When a non-ATN (FANS) identifier is entered, network status displays as:

- NETWORK READY—an ACARS connection is established, or
- NETWORK NOT READY—an ACARS connection not established.

2 FLIGHT NUMBER

Normally displays the flight number entered on the FMC route page. When the flight number is not available, box prompts are displayed. Flight number entry on this page is copied to the FMC route page. Changing this entry after establishing an ATC connection cancels the ATC connection.

3 ORIGIN

Displays origin airport identifier.

4 DESTINATION

Displays destination airport identifier.

5 ATC CONNECTION

Displays the status of the ATC connection, ESTABLISHED or NOT ESTABLISHED.

6 ACTIVE CENTER

Displays the identifier of the ATC facility with which a connection is established.

7 NEXT CENTER

Displays the ATC facility identifier to which an automatic handoff transfers the connection.

8 MAX UPLINK DELAY

Elapsed time in seconds from transmission to receipt of an ATC uplink message that triggers a late message annunciation. The words “UPLINK DELAY EXCEEDED” precede any late ATC uplink message. The elapsed time is enabled/disabled by the CMF Airline Modifiable Information (AMI) file, which also determines its default value. Valid entries are from 0 to 999 seconds (0 being inactive). Reverts to default value configured in CMF AMI at:

- power-up
- datalink system reset
- ATC connection terminated
- “DELETE” entry
- non-ATN (FANS) identifier entry into the LOGON TO field.

With an ATN connection established, displays “40” in cyan and inhibits manual entry. Uplink messages having an elapsed transmission time of 40 seconds or more do not display to the flight crew and an error message is sent to ATC.

9 ADS STATUS

Displays status of ADS connection, ARMED, ACTIVE, or OFF.

10 ATC DATA LINK OFF

Displays when an ATC connection is established.

Selecting ATC DATA LINK OFF displays the CONFIRM OFF selection.

11 CONFIRM OFF

Selecting CONFIRM OFF sends the termination request:

- the COMM system message ATC DATALINK LOST is displayed in the auxiliary display ATC Data Block when the connection is terminated
- once an ATC connection is terminated or lost, the logon entries revert to the default values.

12 FANS Box

Displays when an ATN center identifier is entered into the LOGON TO field and is deselected by default. If the flight crew desires to establish an ATN ATC connection with an ATN center, then this box should remain deselected. If the flight crew desires to establish a FANS ATC connection with an ATN center that is also a FANS center, then this box should be selected.

Loss of ATC Connection

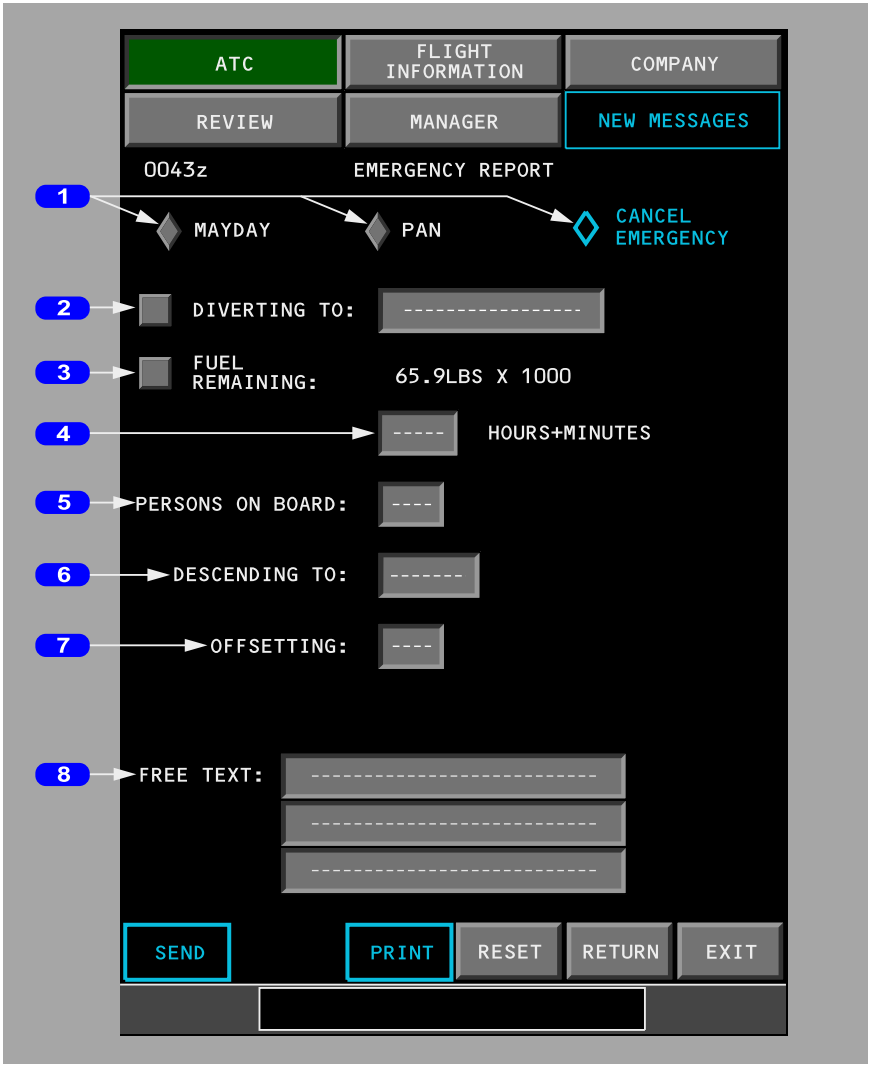
If the EICAS advisory message DATALINK LOST is displayed for 16 minutes, the ATC connection is automatically lost and the COMM system message ATC DATALINK LOST is displayed.

Once an ATC connection is terminated or lost, the logon entries revert to the default values.

ATC Reports

Emergency Report

This page informs ATC of an emergency. Sending this report places Automatic Dependant Surveillance (ADS) into the emergency mode.



1 MAYDAY, PAN, CANCEL EMERGENCY

Select MAYDAY or PAN emergency. The SEND key becomes active. CANCEL EMERGENCY informs ATC that a previous emergency is now canceled and returns ADS to the normal mode. CANCEL EMERGENCY is inhibited until MAYDAY or PAN downlink is sent.

2 DIVERTING TO

Defaults to the destination airport from the active route. Enter any valid FMC position. If the entry is a position in the active FMC route, then VIA ROUTE 1 or VIA ROUTE 2 as appropriate is also displayed. If the entry is not a position in the active FMC route, then VIA DIRECT is also displayed.

3 FUEL REMAINING

Displays the FMC fuel remaining from the PROGRESS page.

4 FUEL REMAINING—HOURS + MINUTES

Defaults to time provided from the FMC. Manually enter fuel remaining in hours and minutes. Use two numeric characters for hours followed by two numeric characters for minutes.

5 PERSONS ON BOARD

Manual entry of number of persons on board is required. Enter up to three numeric characters.

6 DESCENDING TO

Enter the altitude for an immediate descent. The default value is the MCP altitude when it is more that 150 feet below current altitude.

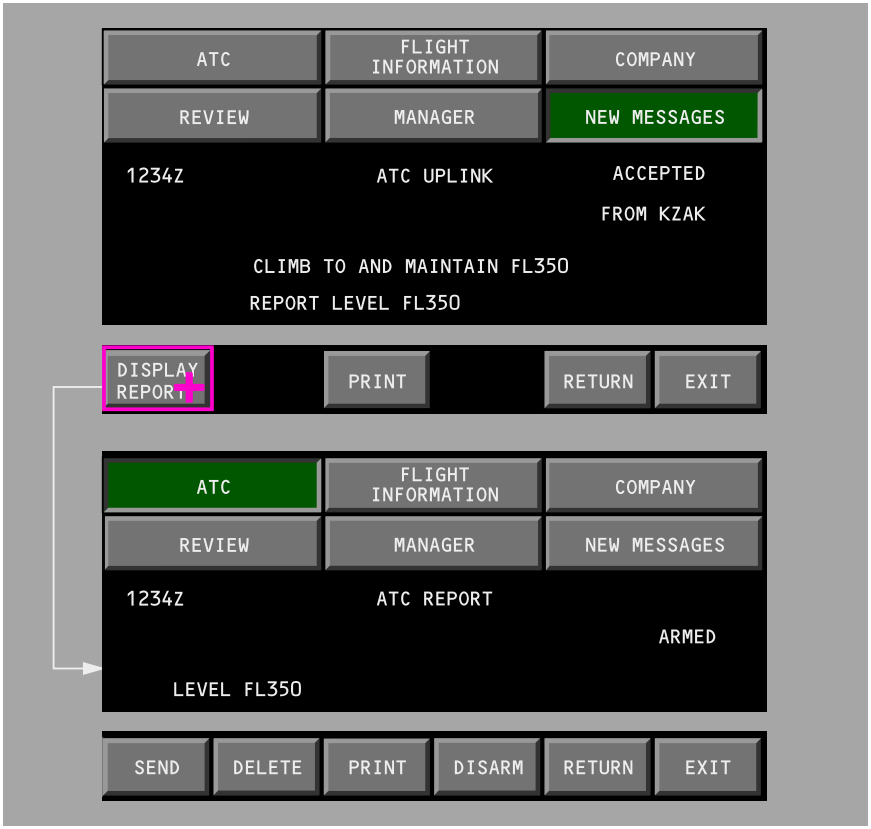
7 OFFSETTING

Enter any valid FMC route offset value.

8 FREE TEXT

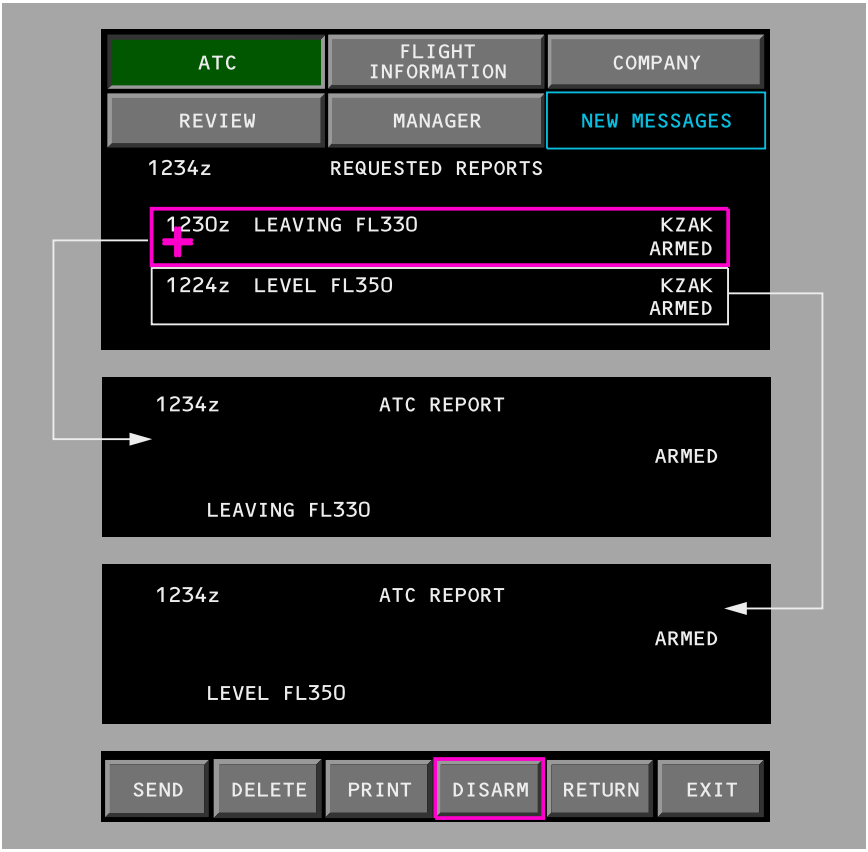
Up to three lines of free text can be included.

ATC Requested Report



ATC uplink messages can contain a request for a report. When the uplink is accepted, the DISPLAY REPORT key is displayed. Selecting DISPLAY REPORT displays the ATC requested report. A displayed report can be sent. Some reports can be armed for automatic transmission when conditions are met.

Armable Report

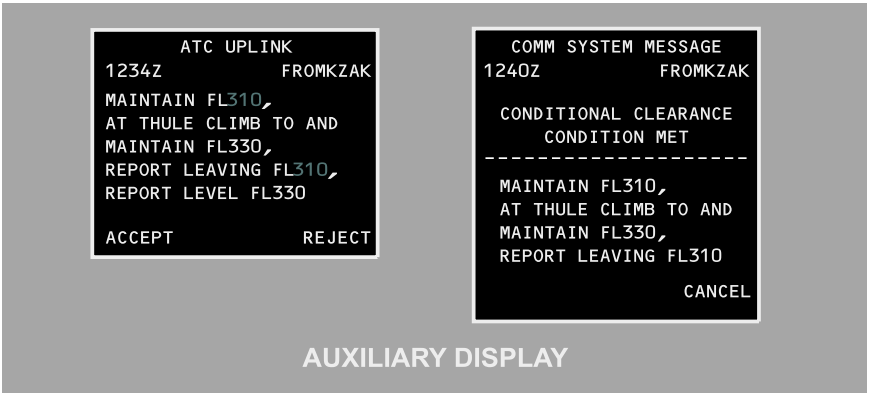


All reports requested by ATC can be displayed using the ATC REQUESTED REPORT menu selection. The LEAVING, LEVEL, PASSING, REACHING, and REACHING BLOCK reports are armed for automatic transmission on ACCEPT. When a report is armed, the ARM command key changes to DISARM. When a report is automatically transmitted, a COMM system message confirms the report was sent.

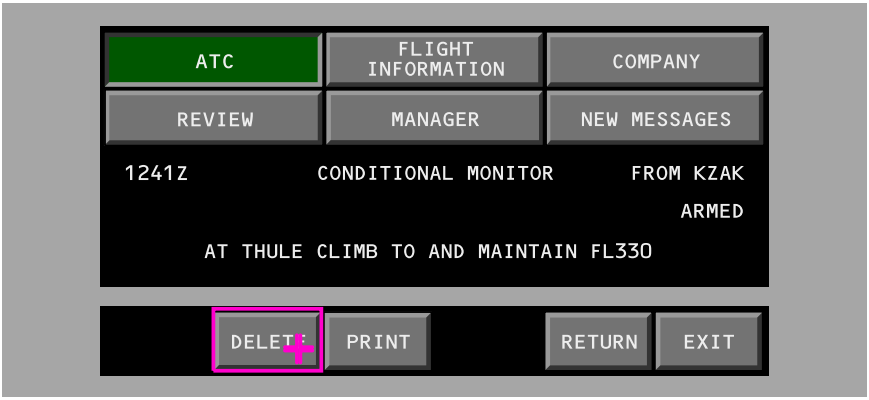
Conditional Clearances

Conditional clearances are ATC directions for route modification at some future location, time or altitude. The CONDITIONAL CLEARANCES item on the ATC menu is normally non-selectable. It becomes selectable when a conditional clearance is accepted by the flight crew. The communications management system then monitors the clearance parameters and notifies the flight crew with a

COMM SYSTEM MESSAGE when either the condition has been met, or the crew has taken an action to execute the clearance before the condition has been met.



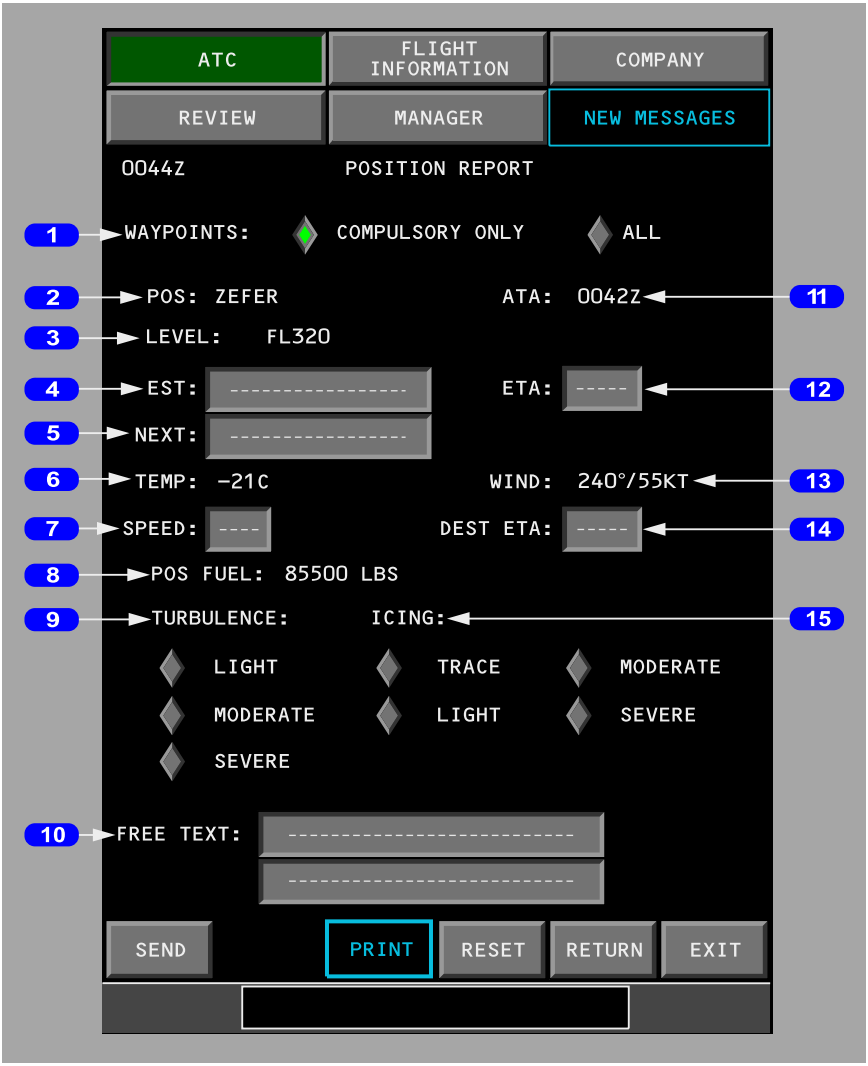
When a conditional clearance monitor function must be cancelled (e.g. a new clearance is received by voice that supersedes the conditional clearance) the crew can select CONDITIONAL CLEARANCES from the ATC menu and then choose DELETE on the CONDITIONAL MONITOR page.



Note: Deleting a conditional clearance does not disarm or delete any other ATC requested reports contained in the clearance. Each individual ATC report must be disarmed or deleted manually.

Position Report

Use the POSITION REPORT page to manually send a position report.



1 WAYPOINTS

COMPULSORY ONLY—displays on this page only ATC compulsory reporting waypoints as defined in the FMC NAV database for the active route as shown on the FMC LEGS page.

ALL—displays on this page all waypoints for the active route as shown on the FMC LEGS page.

2 Position (POS)

Displays the last sequenced FMC waypoint. Displays all asterisks (*) when no FMC data is available.

3 LEVEL

Displays flight level at the last sequenced FMC waypoint.

4 EST

Displays the next FMC waypoint. Accepts entry of other waypoints in the active route as shown on the FMC LEGS page.

5 NEXT

Displays the next FMC waypoint following EST waypoint. Accepts entry of other waypoints in the active route as shown on the FMC LEGS page.

6 Temperature (TEMP)

Displays current static air temperature. Displays all asterisks (*) when no FMC data is available.

7 SPEED

Displays the current FMC speed. Accepts valid speed entry. Displays all asterisks (*) when no FMC data is available.

8 Position (POS) FUEL

Displays FMC calculated fuel remaining at the POS waypoint. Displays all asterisks (*) when no FMC data is available.

9 TURBULENCE

Select LIGHT, MODERATE or SEVERE to report current turbulence condition.

10 FREE TEXT

Up to two lines of free text can be included.

11 ATA

Displays actual time of arrival at the last sequenced FMC waypoint. Displays all asterisks (*) when no FMC data is available.

12 ETA

Displays estimated time of arrival for the next FMC waypoint. Accepts valid time entry.

13 WIND

Displays current wind bearing and speed. Displays all asterisks (*) when no FMC data is available.

14 Destination (DEST) ETA

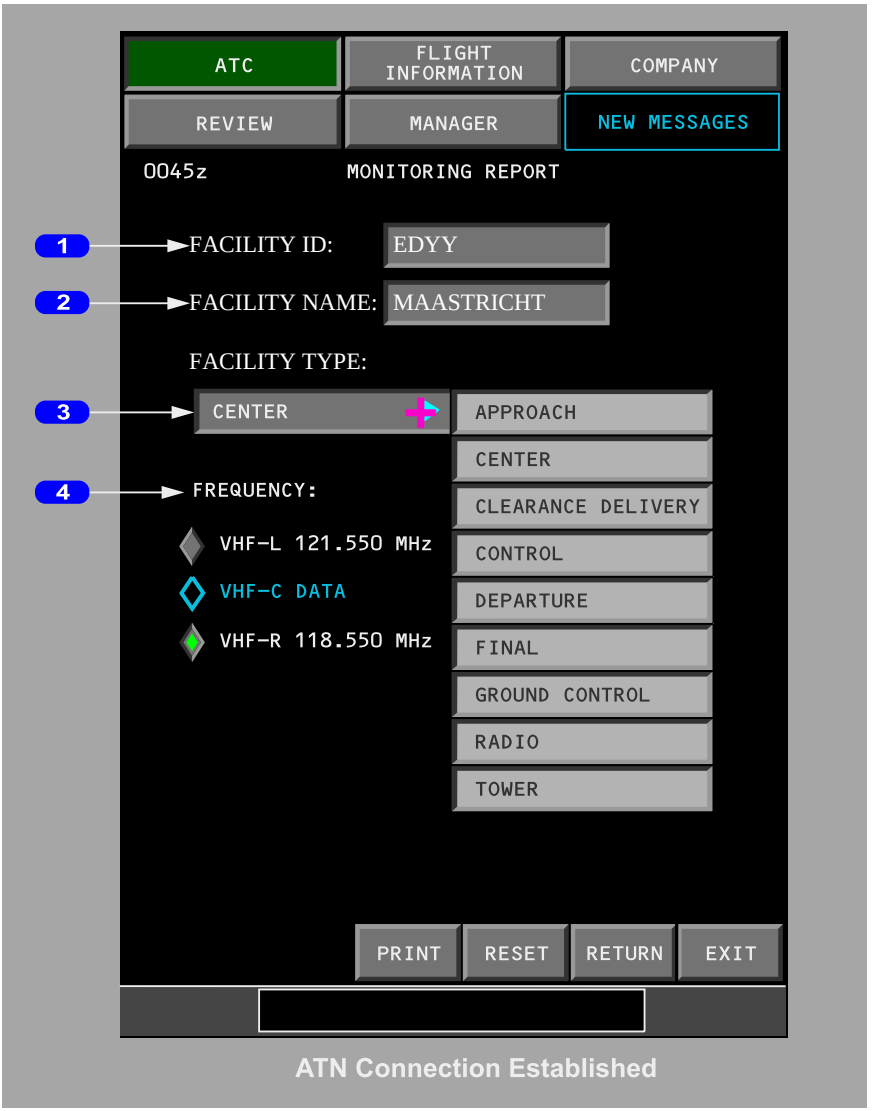
Displays estimated time of arrival for the last FMC waypoint. Accepts a valid time entry. Displays all asterisks (*) when no FMC data is available.

15 ICING

Select TRACE, LIGHT, MODERATE or SEVERE to report current icing condition.

Monitoring Report

This page informs ATC what voice frequency is being monitored for ATC communication purposes.



1 FACILITY ID

Displays the ATC facility identifier that is contained in the most recent monitor instruction received from ATC. Displays box prompts and requires manual entry of ATC facility identifier if no previous monitor instruction has been received.

2 FACILITY NAME

Displays the ATC facility name that is contained in the most recent monitor instruction received from ATC. Displays box prompts and requires manual entry of ATC facility name if no previous monitor instruction has been received.

3 FACILITY TYPE

Displays a pull down list for selection of the ATC facility type:

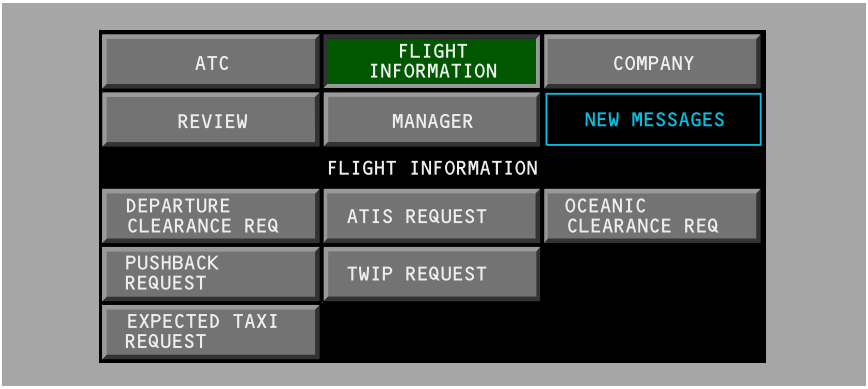
- Approach
- Center
- Clearance Delivery
- Control
- Departure
- Final
- Ground Control
- Radio
- Tower.

4 FREQUENCY

Select radio and frequency flight crew is monitoring for ATC communications.

Flight Information

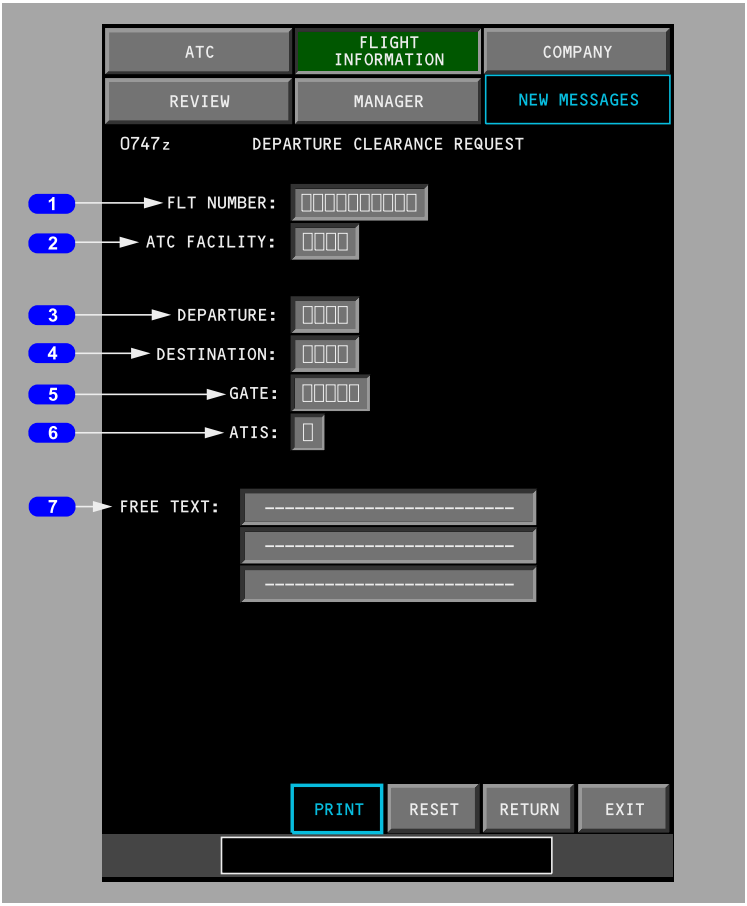
Flight Information Menu



The Flight Information menu provides access to FLIGHT INFORMATION downlink pages.

Departure Clearance Request

The DEPARTURE CLEARANCE REQUEST page allows downlink request to obtain clearance via datalink in a more timely manner with reduced risk of incorrect voice transmission. The clearance may be viewed on the ATC Data Block, Comm MFD or printed.



1 FLIGHT NUMBER

Flight number defaults to FMC flight number, if entered.

When boxes display, valid entry is flight number up to 10 characters.

Note: Entering a new flight number terminates the current ATC connection.

2 ATC FACILITY

Valid entry is a 4 letter ATC facility identifier.

3 DEPARTURE

Departure airport defaults to FMC origin.

Valid entry is a 4 letter ICAO airport identifier.

4 DESTINATION

Destination airport defaults to FMC destination.

Valid entry is a 4 letter ICAO airport identifier.

5 GATE

Valid entry is a gate number at the reference airport, POS INIT page.

6 ATIS

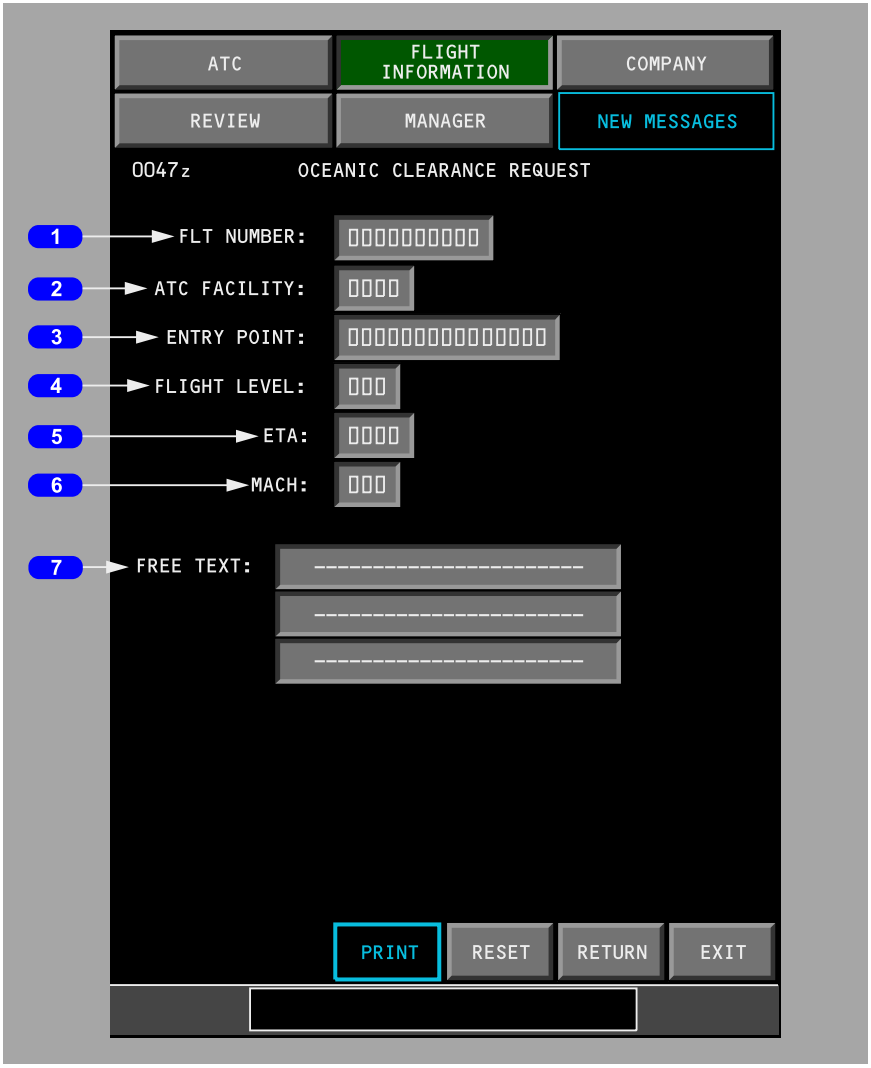
Valid entry is any character A through Z.

7 FREE TEXT

Up to three lines of free text can be included.

Oceanic Clearance Request

The OCEANIC CLEARANCE REQUEST page allows downlink request to obtain oceanic clearance via datalink in a more timely manner with reduced risk of incorrect voice transmission. The clearance information may be viewed on the ATC Data Block, MFD or printed.



1 FLIGHT NUMBER

Flight number defaults to FMC flight number, if entered.

When boxes display, valid entry is flight number up to 10 characters.

Note: Entering a new flight number terminates the current ATC connection.

2 ATC FACILITY

Valid entry is a 4 letter ATC facility identifier.

3 ENTRY POINT

Valid entry must be in the active route of flight:

- at least 3 characters and up to 15 characters in length
- entries of 7 or more characters are decoded as a latitude/longitude
- tenths of a minute of latitude or longitude may not display.

4 FLIGHT LEVEL

Valid entry is a 3 character flight level; for example, 350.

5 ETA

If an ENTRY POINT has been entered, it is a waypoint in the active route, and an ETA has not been entered; the ETA box defaults to the predicted ETA at the waypoint.

Valid entry is any time in the range 0000 to 2359.

6 MACH

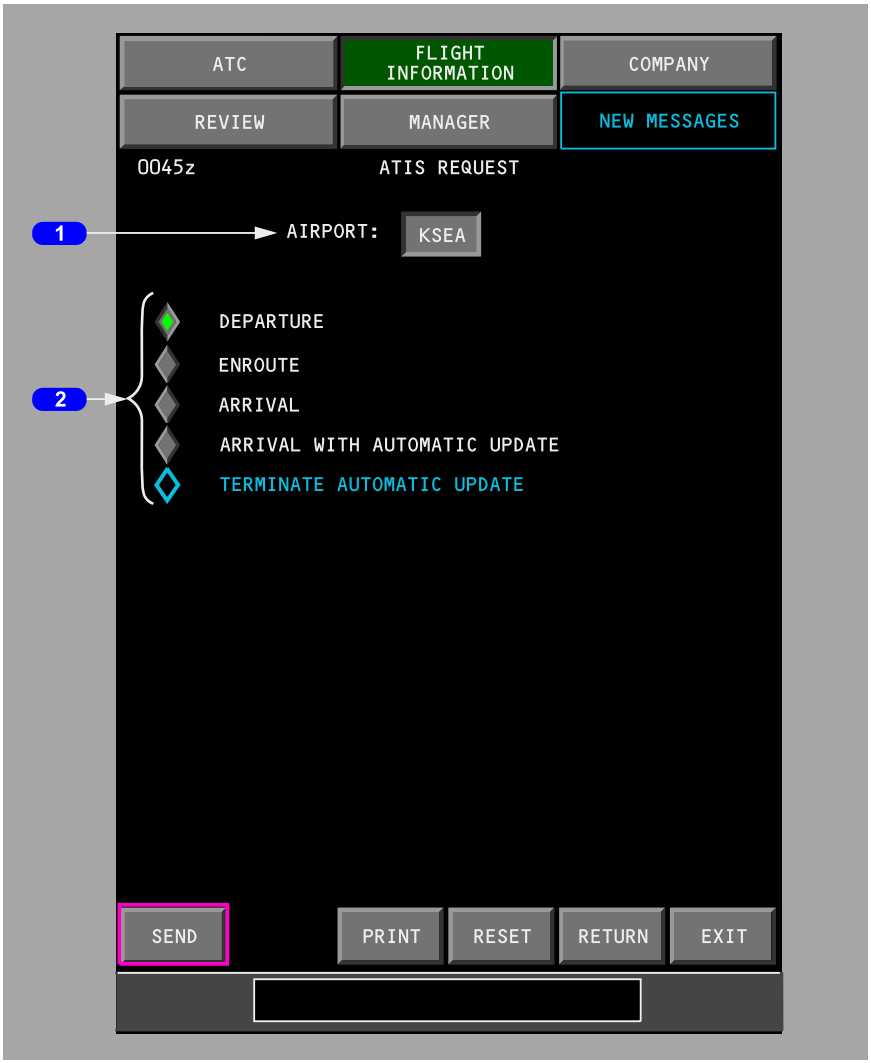
Valid entry is any Mach number between 0.4 and 0.92. Entry of leading zero and decimal point is not required.

7 FREE TEXT

Up to three lines of free text can be included.

ATIS Request

The ATIS REQUEST page allows downlink request for digital ATIS information without using voice radio. ATIS information may be viewed on the ATC Data Block, MFD or printed.



1 AIRPORT

Valid entry is a 4 letter ICAO airport identifier.

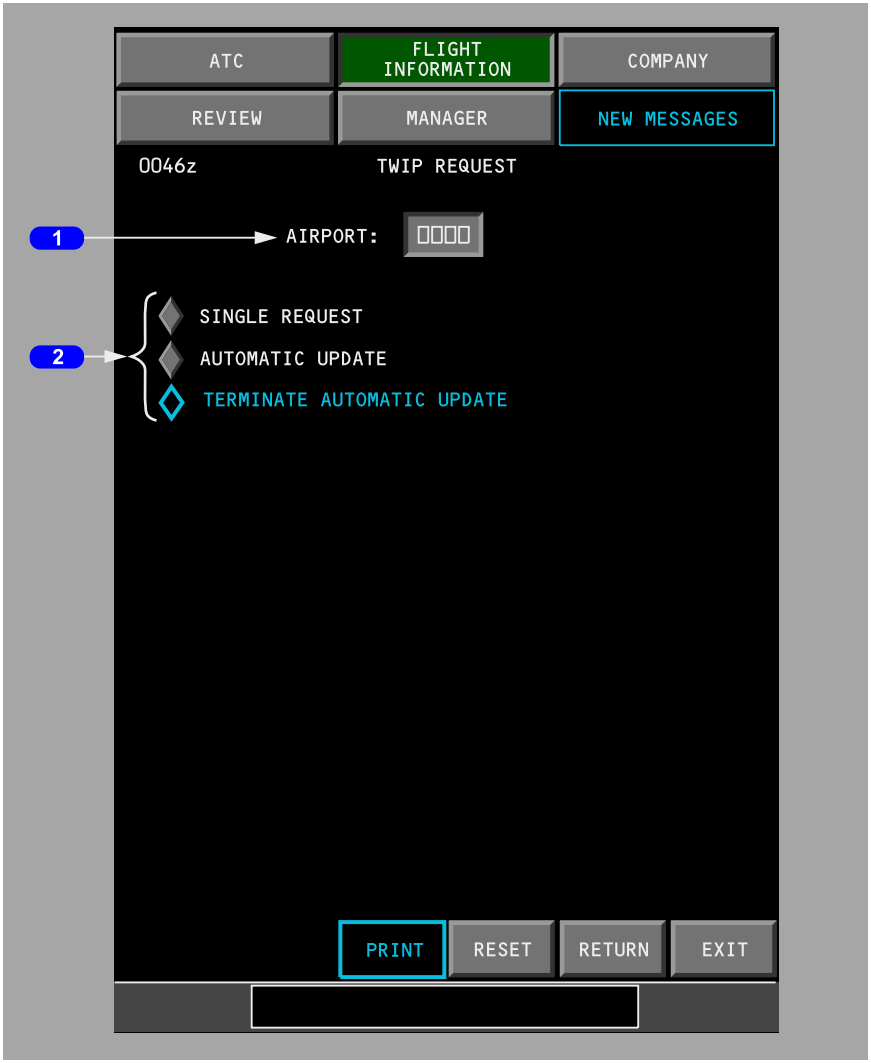
If a departure airport exists in the active route and the airplane is on the ground, the default entry is the departure airport. If the destination airport exists in the active route and the airplane is in flight, the default entry is the destination airport.

2 ATIS SELECTOR GROUP

The default is none selected. Only one selection can be made at a time. If ENROUTE selected, updating is automatic. TERMINATE AUTOMATIC UPDATE is inhibited unless an automatic update has been requested. The SEND key becomes active with selection. Pushing the SEND key requests the selected information. Automatic updating is terminated at the end of flight.

TWIP Request

The Terminal Weather Information for Pilots (TWIP) REQUEST page allows downlink request for digital weather information without using voice radio. TWIP information may be viewed on the ATC Data Block, MFD or printed.



1 AIRPORT

Valid entry is a 4 letter ICAO airport identifier.

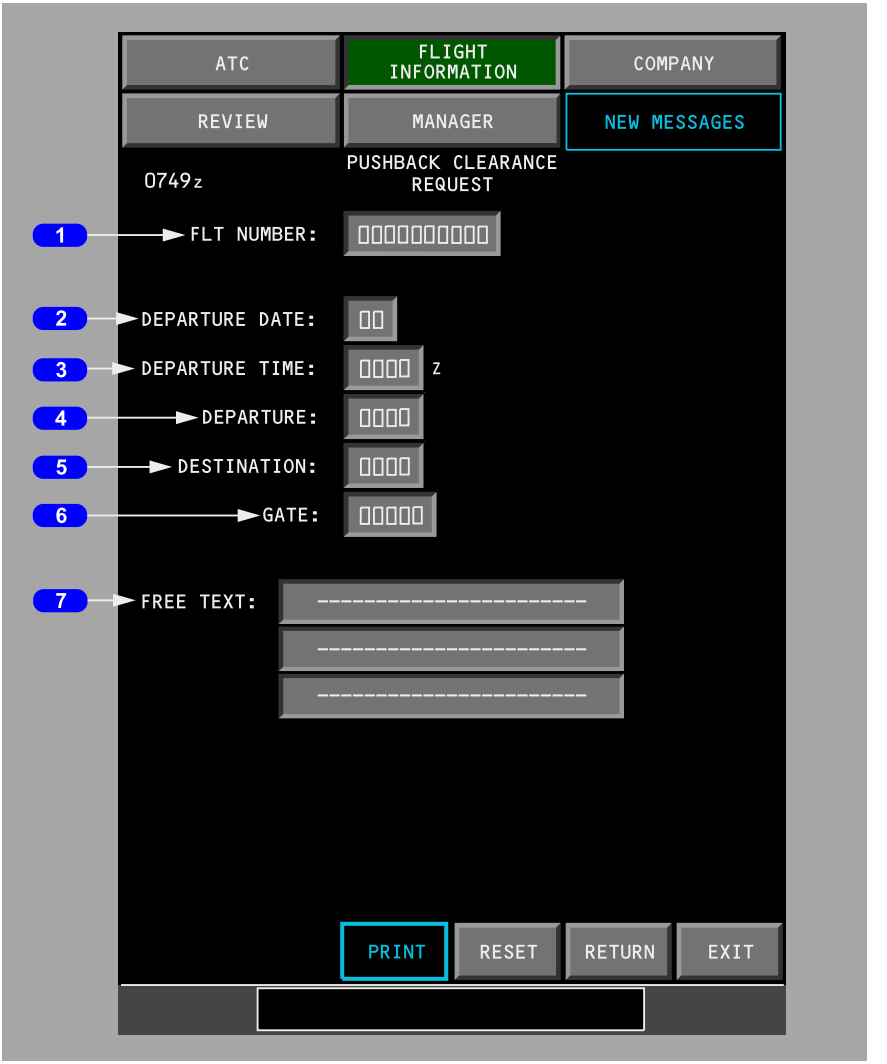
If a departure airport exists in the active route and the airplane is on the ground, the default entry is the departure airport. If the destination airport exists in the active route and the airplane is in flight, the default entry is the destination airport.

2 TWIP SELECTOR GROUP

The default is none selected. Only one selection can be made at a time. TERMINATE AUTOMATIC UPDATE is inhibited unless an automatic update has been requested. The SEND key becomes active with selection. Pushing the SEND key requests the selected information. Automatic updating is terminated at the end of flight.

Pushback Clearance Request

The PUSHBACK CLEARANCE REQUEST page allows downlink request for pushback information without using voice radio. Pushback information may be viewed on the ATC Data Block, MFD or printed.



1 FLIGHT NUMBER

Flight number defaults to FMC flight number, if entered.

When boxes display, valid entry is flight number up to 10 characters.

Note: Entering a new flight number terminates the current ATC connection.

2 DEPARTURE DATE

Enter day of the month of scheduled departure, any number between 1 and 31.

3 DEPARTURE TIME

Enter any valid UTC departure time in HHMM format.

4 DEPARTURE

Defaults to the departure airport in the active FMS route.

Valid entry is a 4 letter ICAO airport identifier.

5 DESTINATION

Defaults to the destination airport in the active FMS route.

Valid entry is a 4 letter ICAO airport identifier.

6 GATE

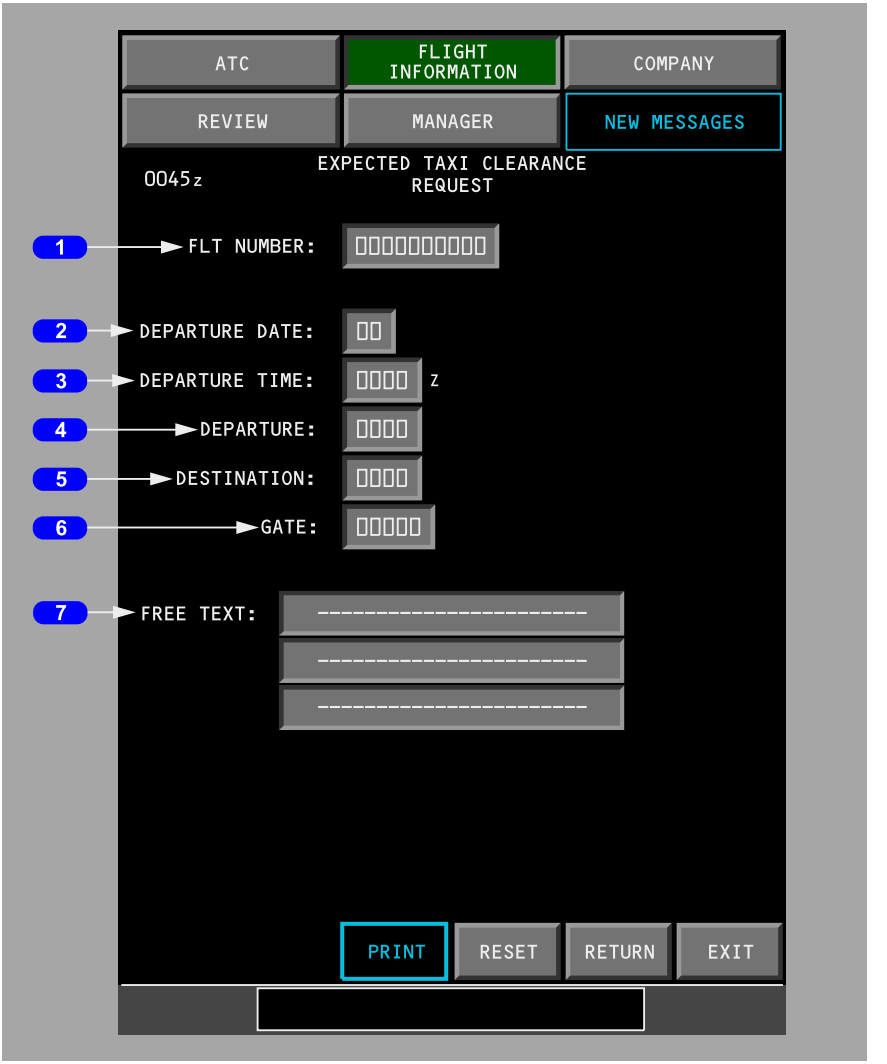
Allows entry of up to five alphanumeric characters.

7 FREE TEXT

Up to three lines of free text can be included.

Expected Taxi Clearance Request

The EXPECTED TAXI CLEARANCE REQUEST page allows downlink request for expected taxi information without using voice radio. Expected taxi information may be viewed on the ATC Data Block, MFD or printed.



1 FLIGHT NUMBER

Flight number defaults to FMC flight number, if entered.

When boxes display, valid entry is flight number up to 10 characters.

Note: Entering a new flight number terminates the current ATC connection.

2 DEPARTURE DATE

Enter day of the month of scheduled departure, any number between 1 and 31.

3 DEPARTURE TIME

Enter any valid UTC departure time in HHMM format.

4 DEPARTURE

Defaults to the departure airport in the active FMS route.

Valid entry is a 4 letter ICAO airport identifier.

5 DESTINATION

Defaults to the destination airport in the active FMS route.

Valid entry is a 4 letter ICAO airport identifier.

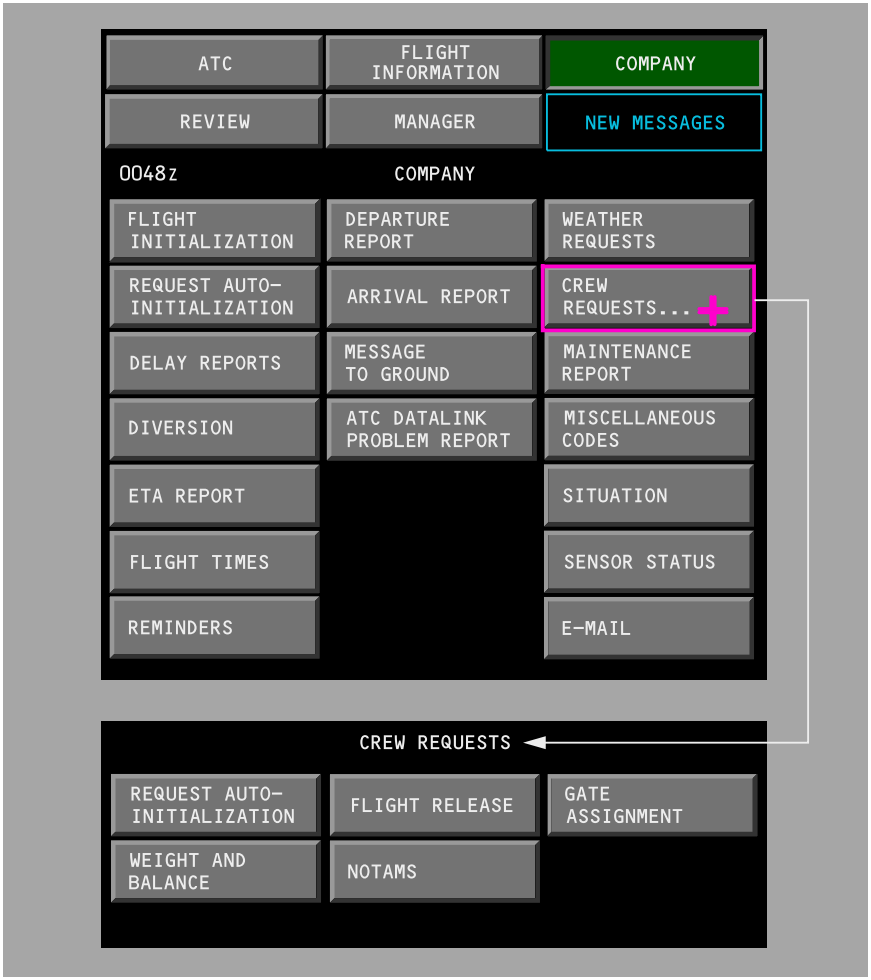
6 GATE

Allows entry of up to five alphanumeric characters.

7 FREE TEXT

Up to three lines of free text can be included.

Company Menu (Typical)



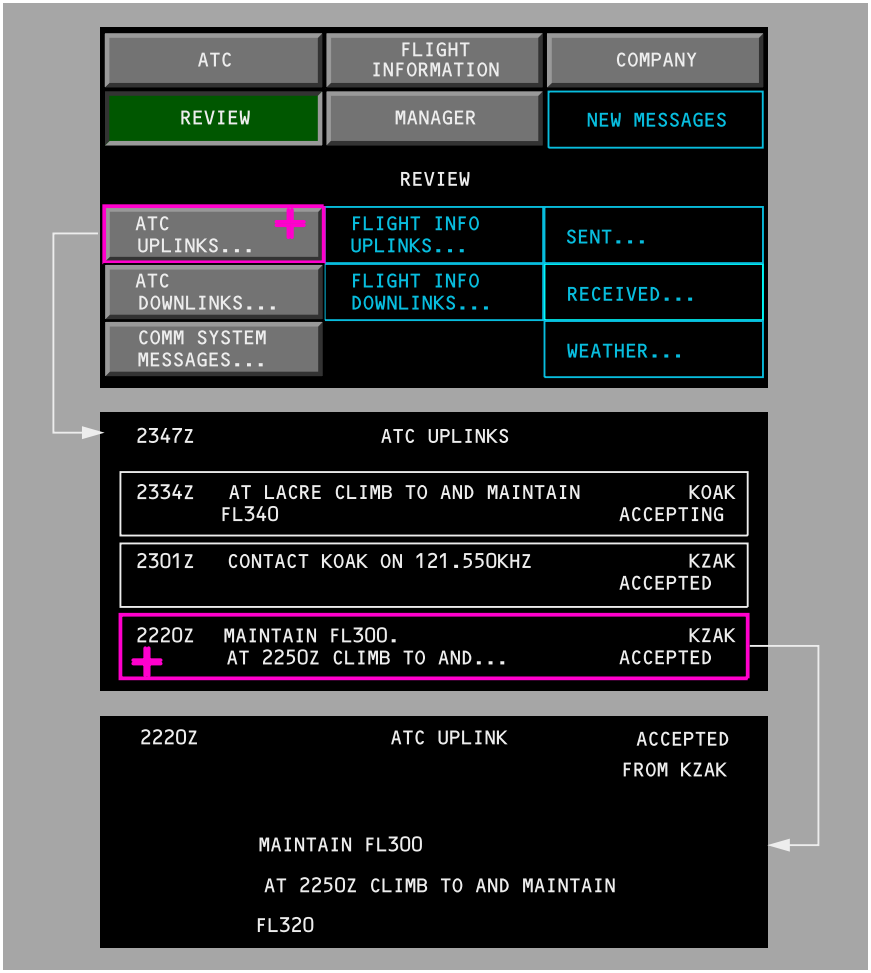
Company downlink menus are accessed by selecting the COMPANY function. Actual menu and page layout is determined by the airline. An example of a typical menu and report page are provided to show common features.

Company Downlink Message Page (Typical)



This typical COMPANY report page shows exclusive selections, required entry, and optional menu selections.

Review Menu (Typical)



Review messages are accessed by selecting the REVIEW menu. Both uplink and downlink messages are displayed in review lists. The review menu is inhibited (cyan) if there are no review messages in that category.

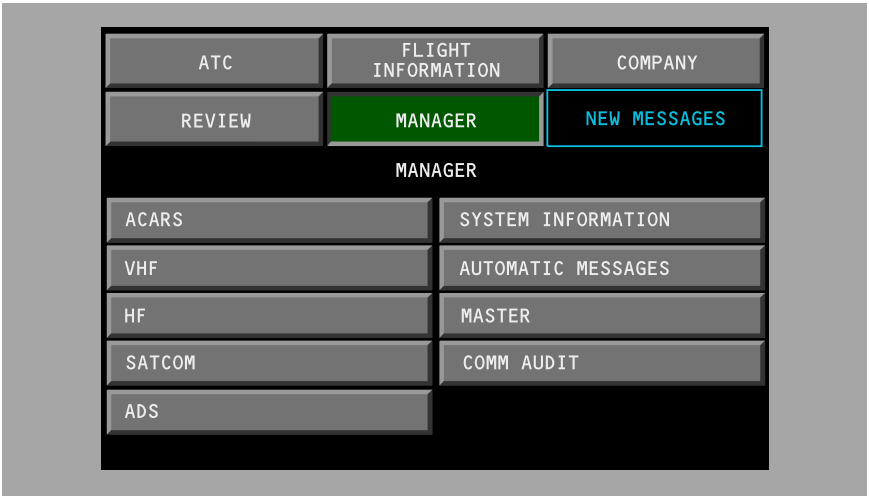
Review State Indicators

Each review message list field and each review message displays the last state of the referenced message. Only one state can apply to a message at a time.

State Indicator	Condition
ABORTED	ATC datalink connection lost before sending response to uplink message or completing a downlink message.
ACCEPTING	The received message was displayed and an ACCEPT response was initiated.
ACCEPTED	The received message was displayed, an ACCEPT response was initiated, and the service provider has acknowledged receipt of the response.
DISPLAYED	The received message was displayed (no accept/reject response was required).
NO ACCEPT	The received message was displayed, an ACCEPT response was initiated, but the service provider did not acknowledge receipt of the response.
NO REJECT	The received message was displayed, an REJECT response was initiated, but the service provider did not acknowledge receipt of the response.
NO SEND	The downlink message was initiated to be sent and the service provider did not acknowledge receipt of the message.
REJECTING	The received message was displayed and a REJECT response was initiated.
REJECTED	The received message was displayed, an REJECT response was initiated, and the service provider has acknowledged receipt of the response.
RESP RCVD	ATC uplink message received in response to a downlink request.
SENDING	The downlink message was initiated to be sent.
SENT	The downlink message was initiated to be sent and the service provider has acknowledged receipt of the message.

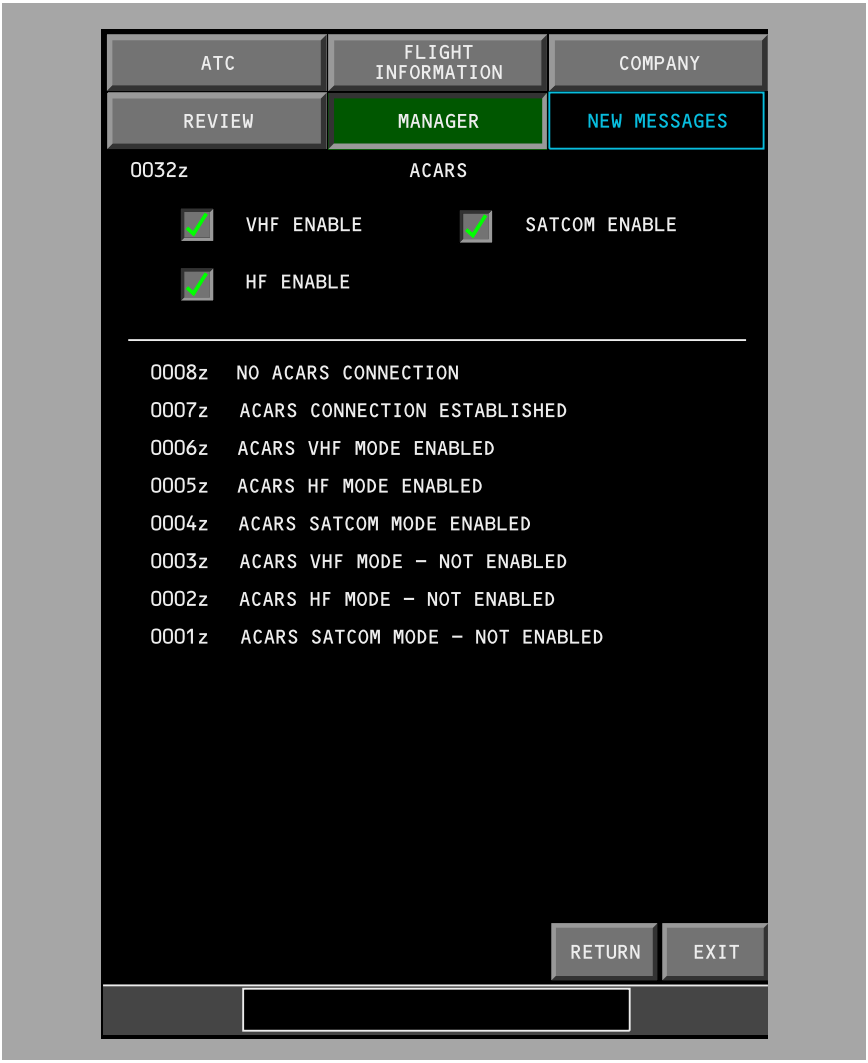
Manager Functions

Manager Menu



The MANAGER menu page provides access to the manager functions.

ACARS Manager

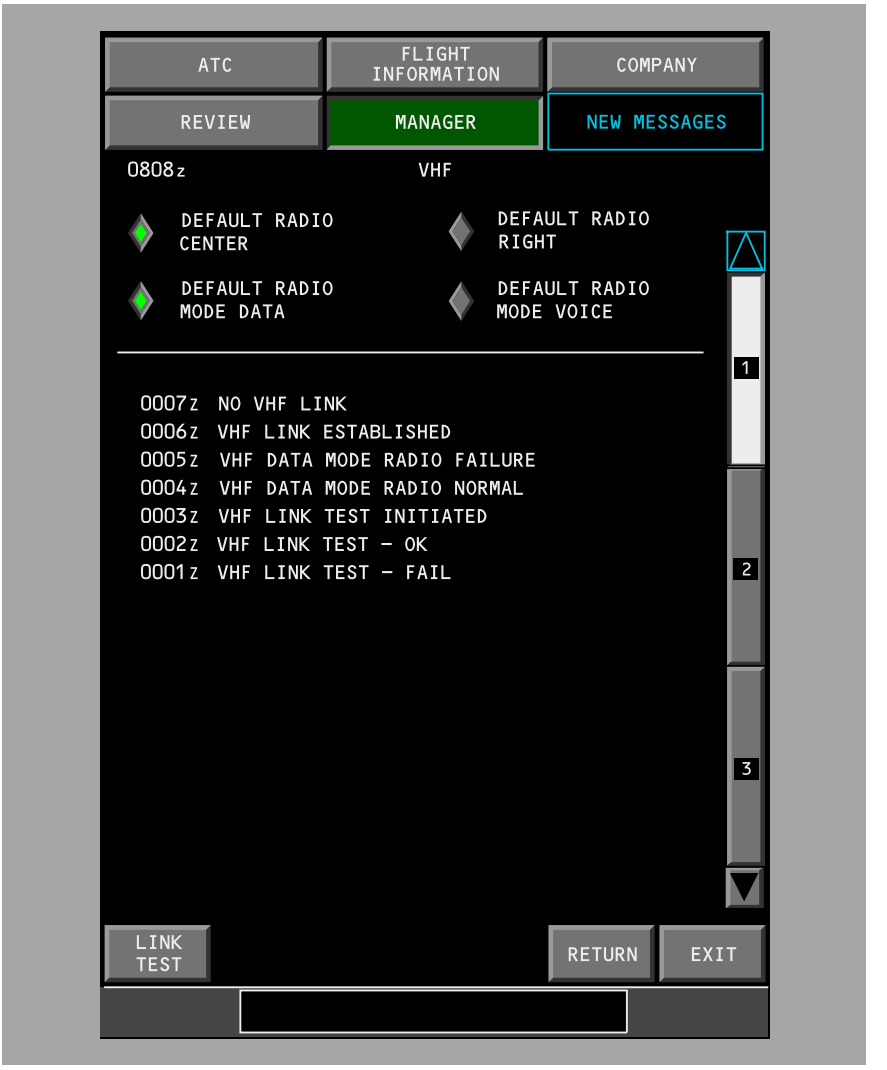


This page allows the operator to select/deselect VHF, SATCOM, or HF transmission of data. ACARS is set with all three selections enabled at power-up or data communication system reset. Normally, this permits ACARS to automatically use VHF, SATCOM (if VHF is unavailable), or HF (if VHF and SATCOM are unavailable). If one or more boxes is deselected, those systems

lose the capability to send downlink messages, but can still receive and display uplink messages.

The lower portion of the ACARS page displays system status messages.

VHF Manager



The VHF manager page provides the capability to select the default radio and to configure the default radio to the voice or data mode. Manager messages related to the VHF system are also presented on this page.

If the DEFAULT RADIO CENTER key is selected, the center VHF radio becomes the default radio. If the DEFAULT RADIO RIGHT key is selected, the right VHF radio becomes the default radio.

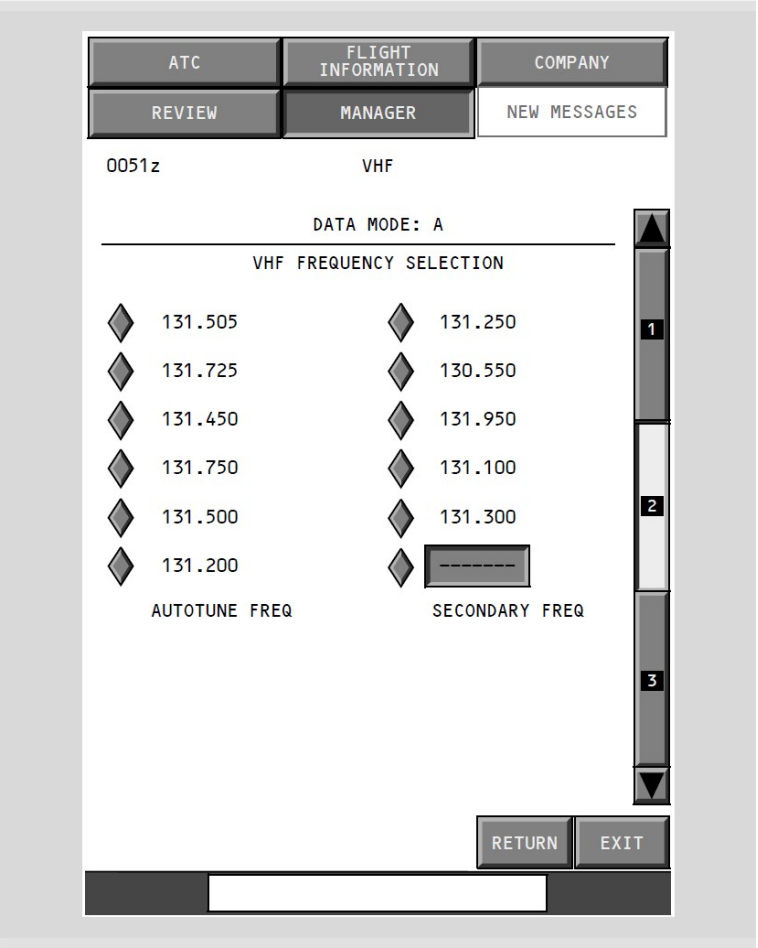
If the DEFAULT RADIO MODE DATA key is selected, the default radio is set to the data mode. If the DEFAULT RADIO MODE VOICE key is selected, the default radio is set to the voice mode.

The lower portion of the VHF page displays system status messages.

Note: On startup, the center VHF radio defaults to data mode. The default radio can also be set to the data or voice mode via the TCP. Only one VHF radio can be set in data mode at a time.

VHF Manager Page 2/3 - VDL Mode A

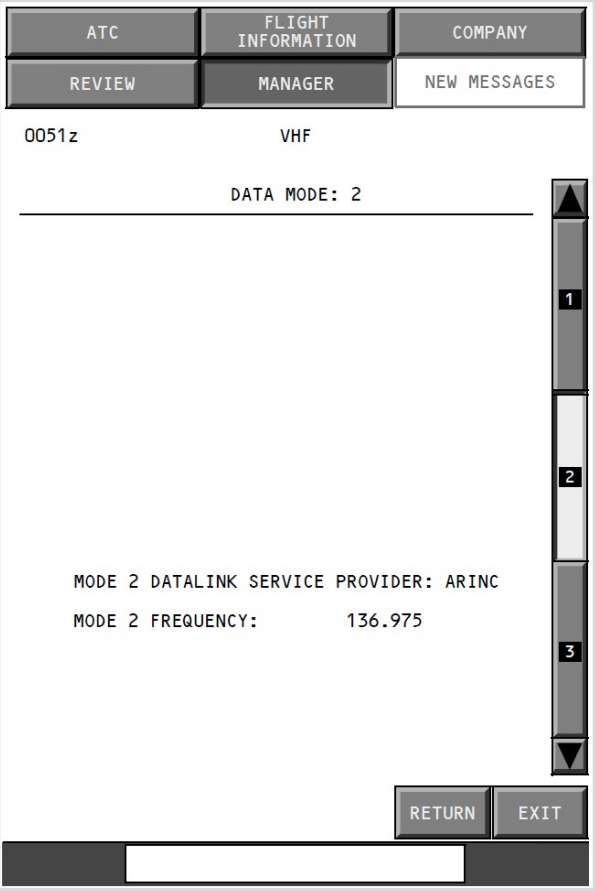
DELETION



If a VHF Digital Link (VDL) Mode A connection is established, then VHF manager page 2/3 displays DATA MODE: A and allows selection and entry of VDL Mode A frequencies. VDL Mode A frequencies are normally selected on an automatic basis, but a displayed frequency may be manually selected or a frequency may be manually entered in the SECONDARY FREQ field. If no VDL Mode A or VDL Mode 2 connection is established, then VHF manager page 2/3 displays DATA MODE:

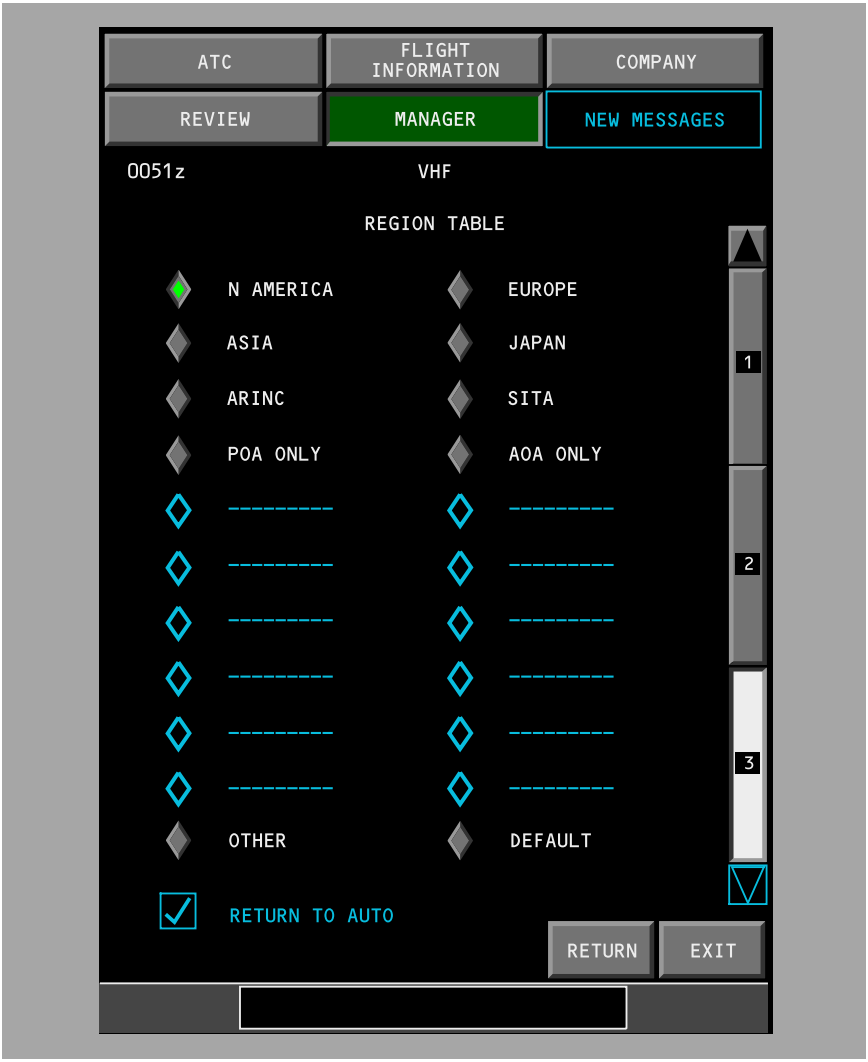
DELETION

VHF Manager Page 2/3 - VDL Mode 2



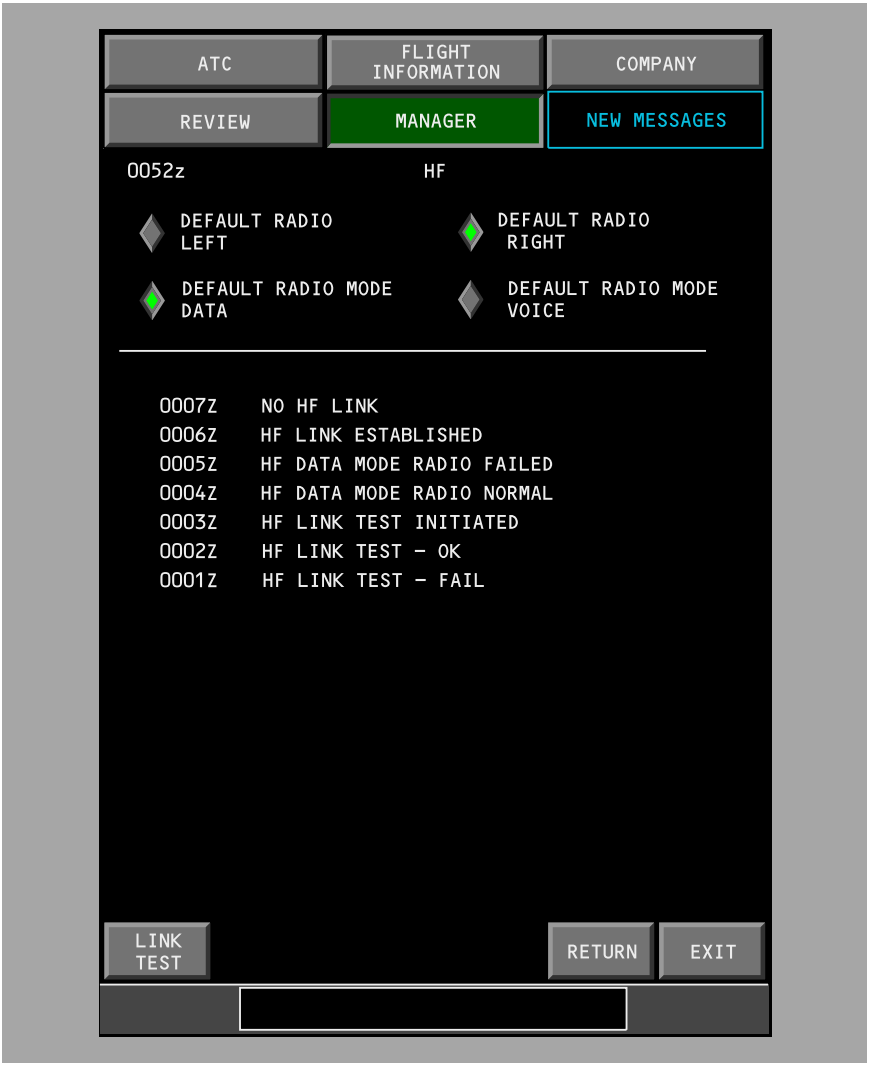
If a VDL Mode 2 connection is established, then VHF manager page 2/3 displays DATA MODE: 2 and indicates the VDL Mode 2 service provider (for example, ARINC or SITA) and the automatically selected VDL Mode 2 frequency. Manual selection or entry of the VDL Mode 2 service provider and frequency is not allowed. If no VDL Mode A or VDL Mode 2 connection is established, the VHF manager page 2/3 displays DATA MODE:

VHF Manager Page 3/3



The VHF manager page 3/3 provides override capability of the automatically selected datalink region based on airplane position. When a manual selection is made, the RETURN TO AUTO selection becomes available. Selecting RETURN TO AUTO returns control of region selection back to CMF.

HF Manager



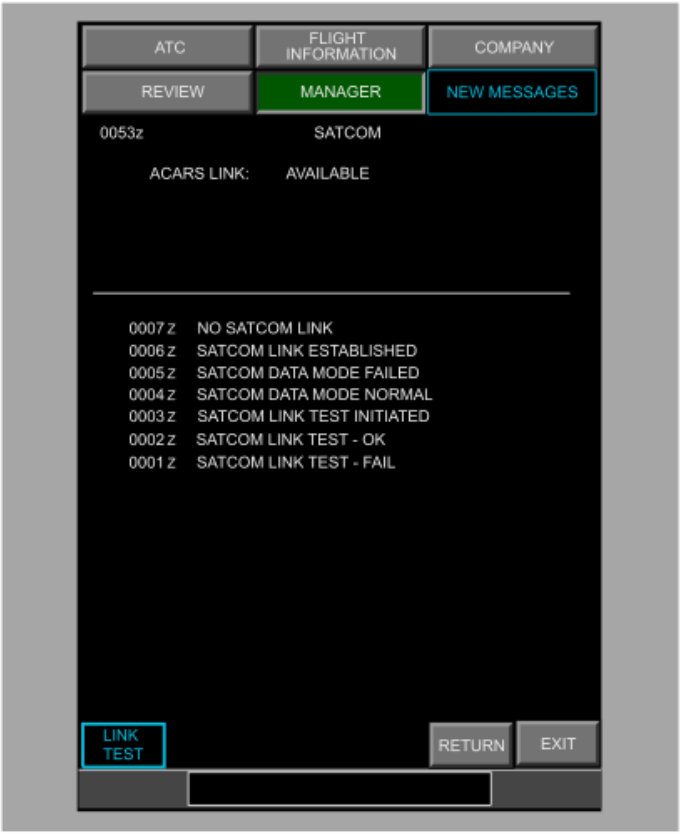
If the DEFAULT RADIO LEFT is selected, the left HF radio becomes the default radio. If the DEFAULT RADIO RIGHT is selected, the right HF radio becomes the default radio.

If the DEFAULT RADIO MODE: DATA is selected, the default HF radio is set to data mode. If the DEFAULT RADIO MODE: VOICE is selected, the default HF radio is set to voice mode.

The lower portion of the HF page displays system status messages.

Note: On startup, both HF radios default to voice mode. The default HF radio can also be set to the data or voice mode via the TCP. Only one HF radio can be set in data mode at a time.

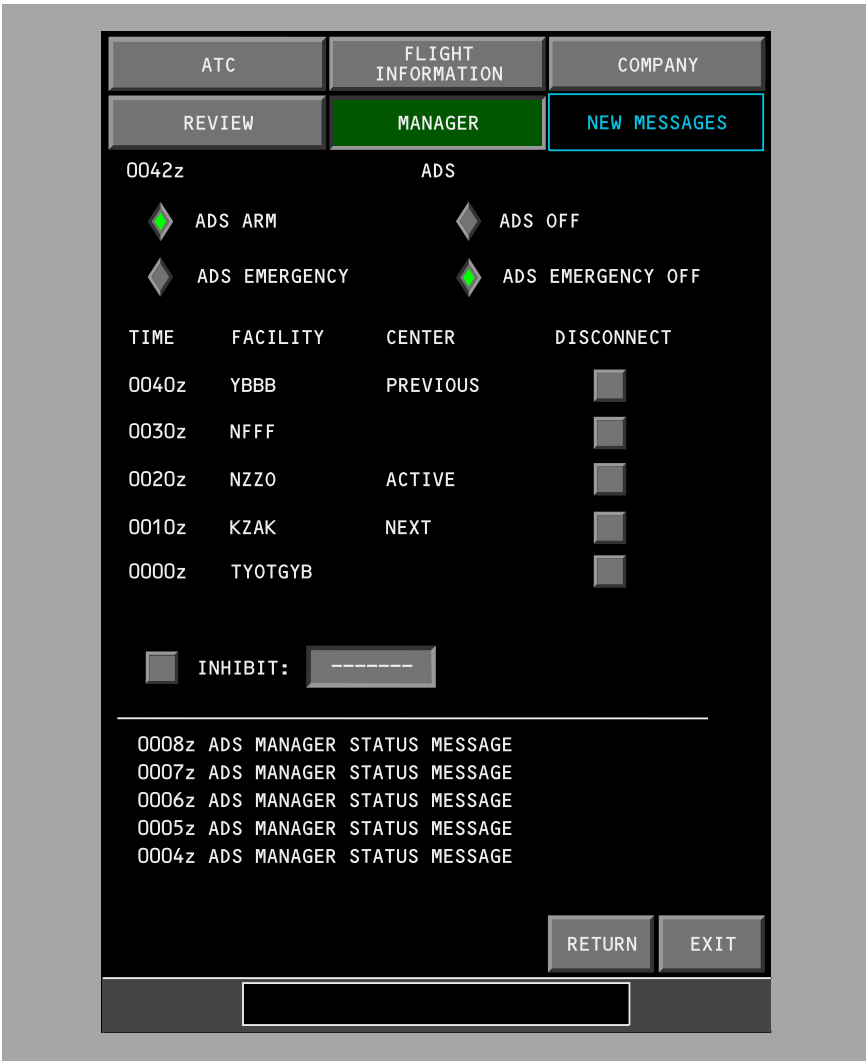
SATCOM Manager



The SATCOM manager page displays manager messages related to the SATCOM system.

The lower portion of the SATCOM page displays system status messages.

ADS Manager



When Automatic Dependant Surveillance (ADS) is armed, AUTOMATIC position report messages can be requested by ATC and/or COMPANY.

The ADS page controls the following airplane ADS functions:

- ADS ARM—allows airplane ADS functions
- ADS OFF—inhibits airplane ADS functions

- ADS EMERGENCY—sends an alert to ATC indicating an emergency situation (resets to ADS EMERGENCY OFF at power-up)
- ADS EMERGENCY OFF—cancels emergency indication to ATC.

A list of ADS center (facility) connection status is displayed on the ADS page:

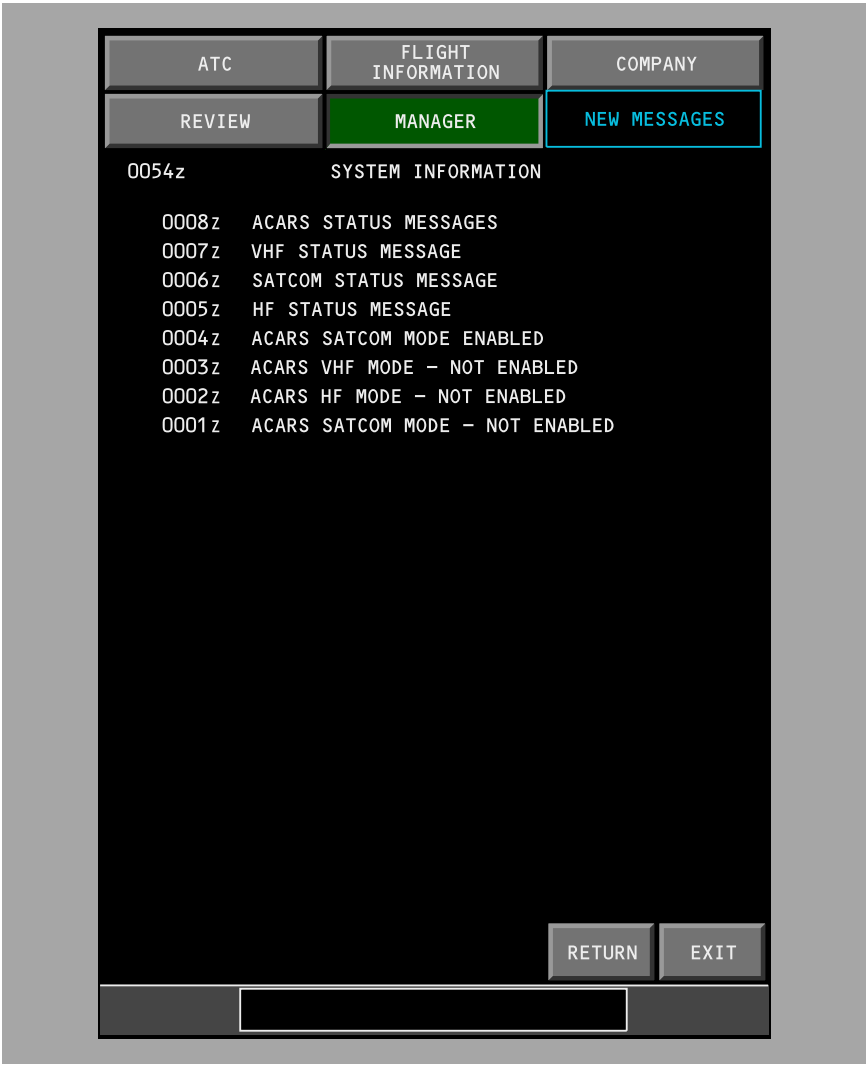
- a 4 character ICAO identifier if a previous connection was established
- a 7 character ACARS address if a previous connection was not established
- the airplane can be in contact with up to 5 different facilities at one time.

A select key is available to terminate any active air traffic service provider (ATSP) facility ADS connection. Selecting the adjacent DISCONNECT key causes a disconnect message to be sent to the associated ground station.

A select key is also available to INHIBIT/ENABLE an ATSP from establishing an ADS contact with the airplane. Entering the ICAO identifier of the ATSP into the data box and selecting INHIBIT prohibits an ADS connection from that facility. Entering the identifier of an inhibited ATSP and selecting the ENABLE box allows a connection to be made with that facility. Only one ATSP can be inhibited at a time.

The lower portion of the ADS page displays system status messages.

System Information Manager



The system information manager page displays manager messages for all applicable systems.

Automatic Messages Manager

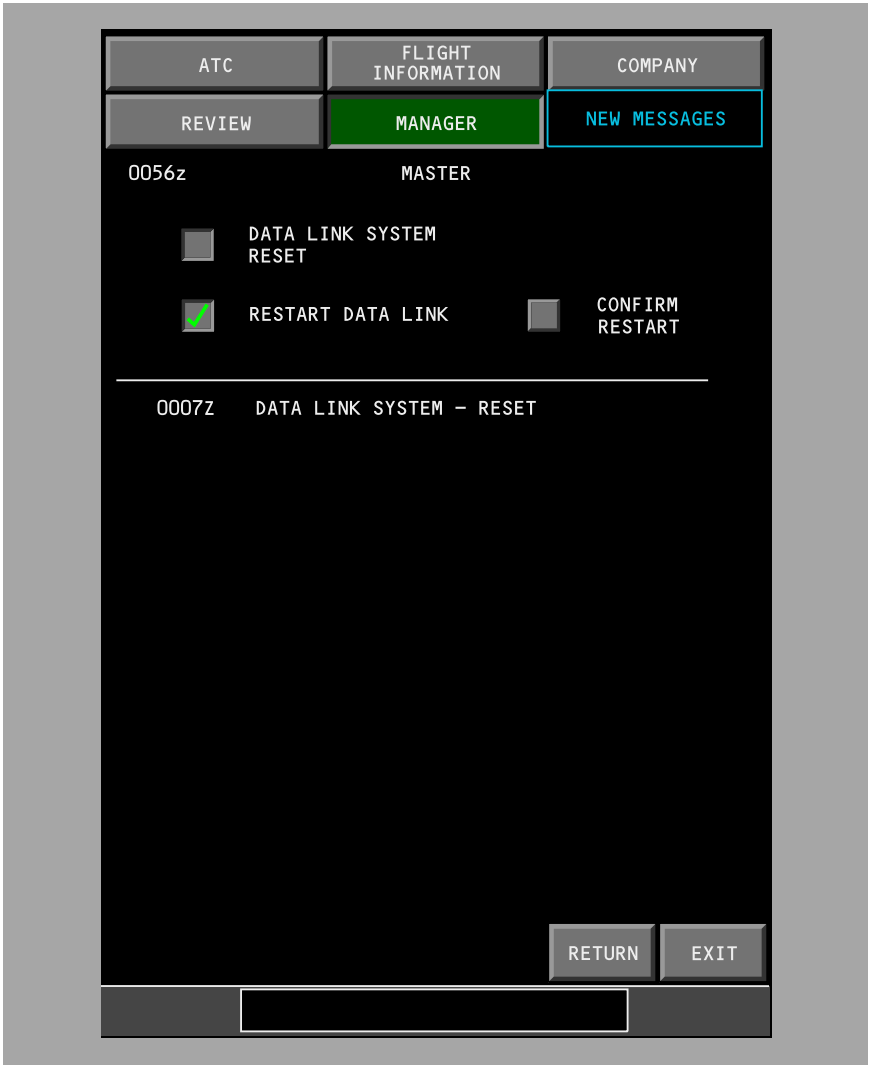


The AUTO MESSAGES OFF selection inhibits automatic sending of flight operations related messages. Manager messages related to the automatic messages capability are also presented on this page.

When the AUTOMATIC MESSAGES OFF key is selected, the CONFIRM OFF key is displayed. Selecting the CONFIRM OFF key turns off the capability to automatically send flight operations related messages.

The lower portion of the AUTOMATIC MESSAGES page displays system status messages.

Master Manager



The master manager page provides the capability to reset or restart the data communication system. Manager messages related to the master features are also presented on this page. The lower portion of the MASTER page displays system status messages.

System Reset

When the DATALINK SYSTEM RESET key is selected, the CONFIRM RESET key is displayed. If the CONFIRM RESET key is selected, the following occurs:

- ATC connection is reset to not established on the ground
- review messages are deleted
- the center VHF radio is selected as the default
- the VHF default radio is set to data mode on the ground or voice mode in the air
- the right HF radio is selected as the default and set to voice mode
- VHF, HF, and SATCOM datalink is set to enable
- automatic messages are set to ON
- downlink message parameters are initialized
- ADS EMERGENCY is reset to ADS EMERGENCY OFF
- two seconds after selection, the CONFIRM RESET key is removed from the display and the DATALINK SYSTEM RESET key is displayed as not selected.

This reset does not occur at power-up.

The data communication system may automatically reset (AMI option) after each flight. If selected, reset occurs approximately 10 minutes after the last engine is shut down, and with any entry door open.

Datalink capability for the flight management system, OMS, and EICAS related maintenance functions, and cabin functions are not reset with this feature.

System Restart

If datalink functions become unresponsive or the DATALINK LOST (EICAS) advisory message is displayed when at least one link (SATCOM, VHF or HF) should be operational, a system RESTART may be attempted.

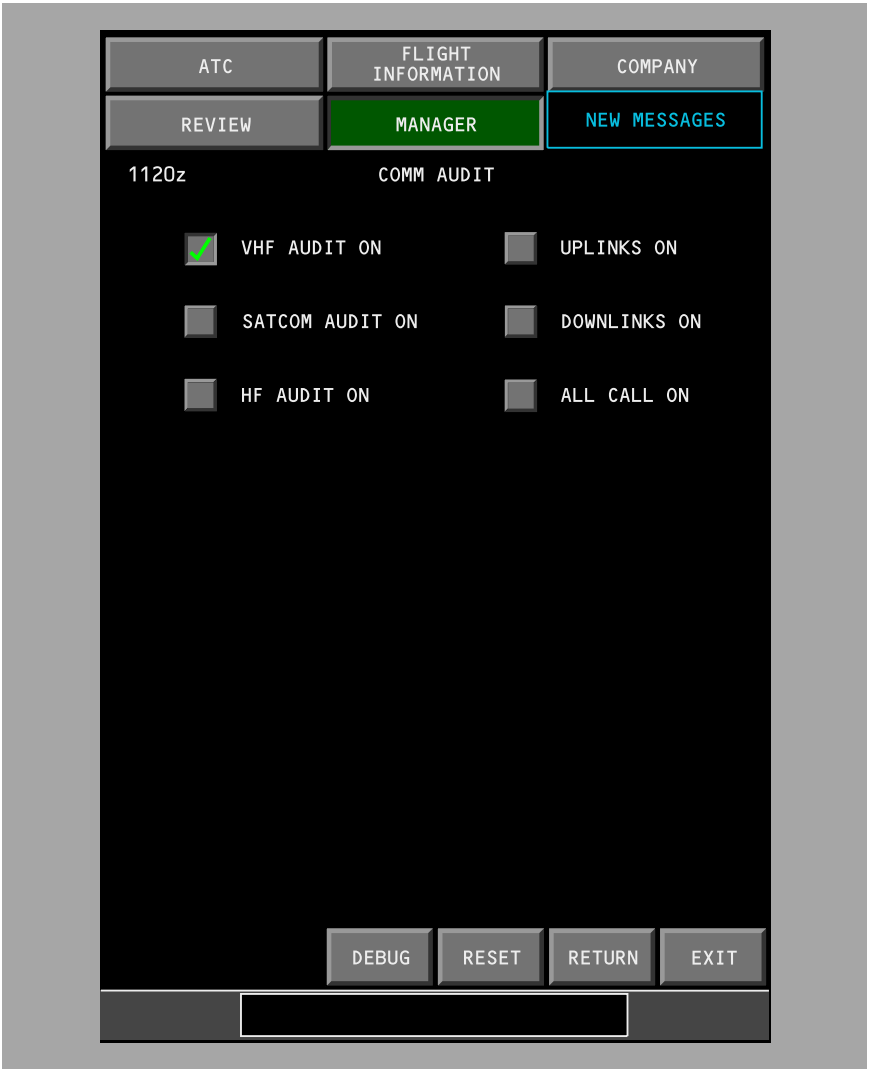
When the RESTART DATA LINK key is selected, the CONFIRM RESTART key is displayed. If the CONFIRM RESTART key is selected, the following occurs:

- the COMM page blanks, then returns to the main menu
- data communication changes operation to an identical standby function
- normal datalink operation is restored
- ATC, FIS and flight crew entered data are retained
- the COMM help message COMM MASTER SWITCH - COMPANY MESSAGES LOG LOST displays
- the DATALINK LOST message blanks.

Note: When a second datalink system restart is selected, ATC, FIS and flight crew entered data are also lost.

Datalink capability for the flight management system, OMS, and EICAS related maintenance functions, and cabin functions are not reset with this feature.

Communications Audit



The communications audit page is for maintenance use only. It allows communication data to be collected on the mass storage device relating to a reported airplane problem.

Manager Messages

Manager messages are displayed in reverse chronological order (the newest message is nearest the top of the display). The time of occurrence is displayed with each message and the ATC center associated with the message (if applicable). The manager messages are listed in the following table.

Function	Manager Message
ACARS	ACARS CONNECTION ESTABLISHED
	NO ACARS CONNECTION
	ACARS VHF MODE
	ACARS VHF MODE—NOT ENABLED
	ACARS SATCOM MODE
	ACARS SATCOM MODE—NOT ENABLED
	ACARS HF MODE
	ACARS HF MODE—NOT ENABLED
ADS	CONNECTION ESTABLISHED
	CONNECTION LOST
	ALL ADS CONNECTIONS LOST
	CONNECTION INHIBITED
	CONNECTION ENABLE
	MANUAL TERMINATION
	WAYPOINT REPORT
VHF	VHF LINK ESTABLISHED
	NO VHF LINK
	VHF DATA MODE RADIO FAILURE
	VHF DATA MODE RADIO NORMAL
	VHF LINK TEST INITIATED
	VHF LINK TEST—OK
	VHF LINK TEST—FAIL
SATCOM	SATCOM LINK ESTABLISHED
	NO SATCOM LINK
	SATCOM DATA MODE FAILED

Function	Manager Message
	SATCOM DATA MODE NORMAL
	SATCOM LINK TEST INITIATED
	SATCOM LINK TEST—OK
	SATCOM LINK TEST—FAIL
AUTOMATIC MESSAGES	AUTOMATIC MESSAGES—ON
	AUTOMATIC MESSAGES—OFF
MASTER	DATA LINK SYSTEM—RESET
HF	HF LINK ESTABLISHED
	NO HF LINK
	HF DATA MODE RADIO FAILURE
	HF DATA MODE RADIO NORMAL
	HF LINK TEST INITIATED
	HF LINK TEST—OK
	HF LINK TEST—FAIL

New Messages

New Messages Menu (Typical)

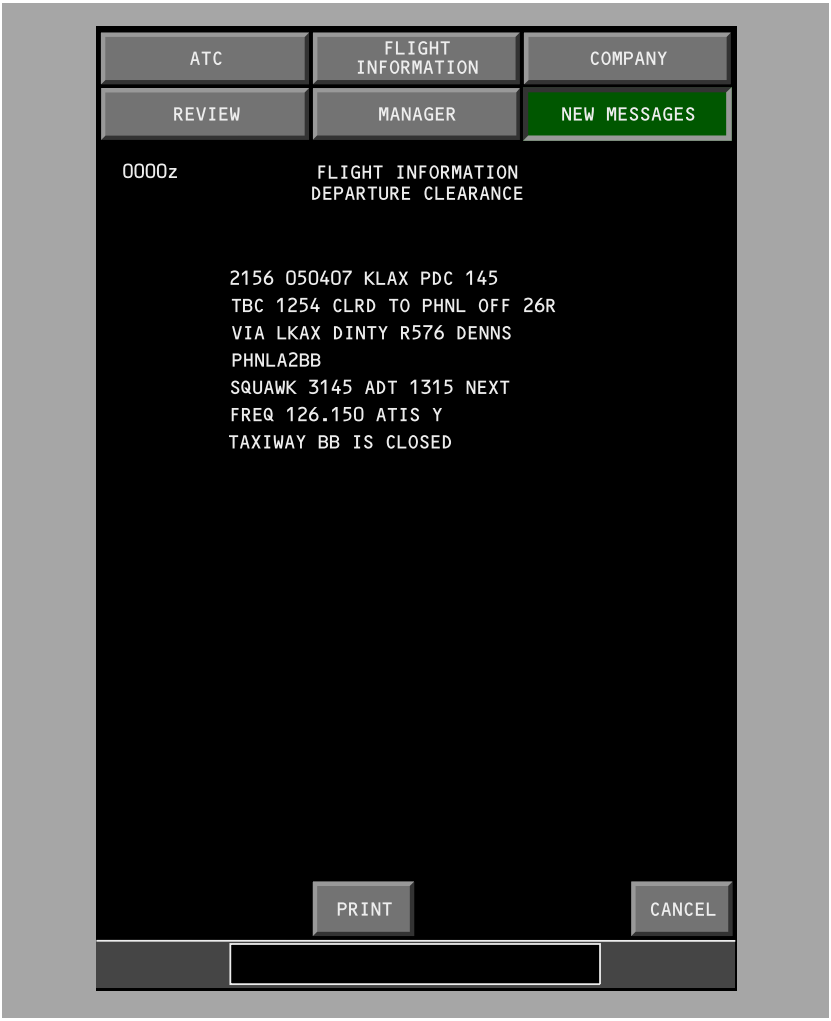


New messages can be accessed by selecting the NEW MESSAGES menu, which displays list boxes for all pending messages. A message is displayed by selecting the appropriate message line.

New uplink messages are displayed with ATC messages above Flight Information messages, which are displayed above Company messages. Within ATC, Flight Information and Company groups, messages are listed by the time they are received. The newest message is at the top of the group. Messages are removed from the list when displayed or an accept/reject response is sent.

New ATC uplinks which respond to downlink requests display a key which displays the original downlink request.

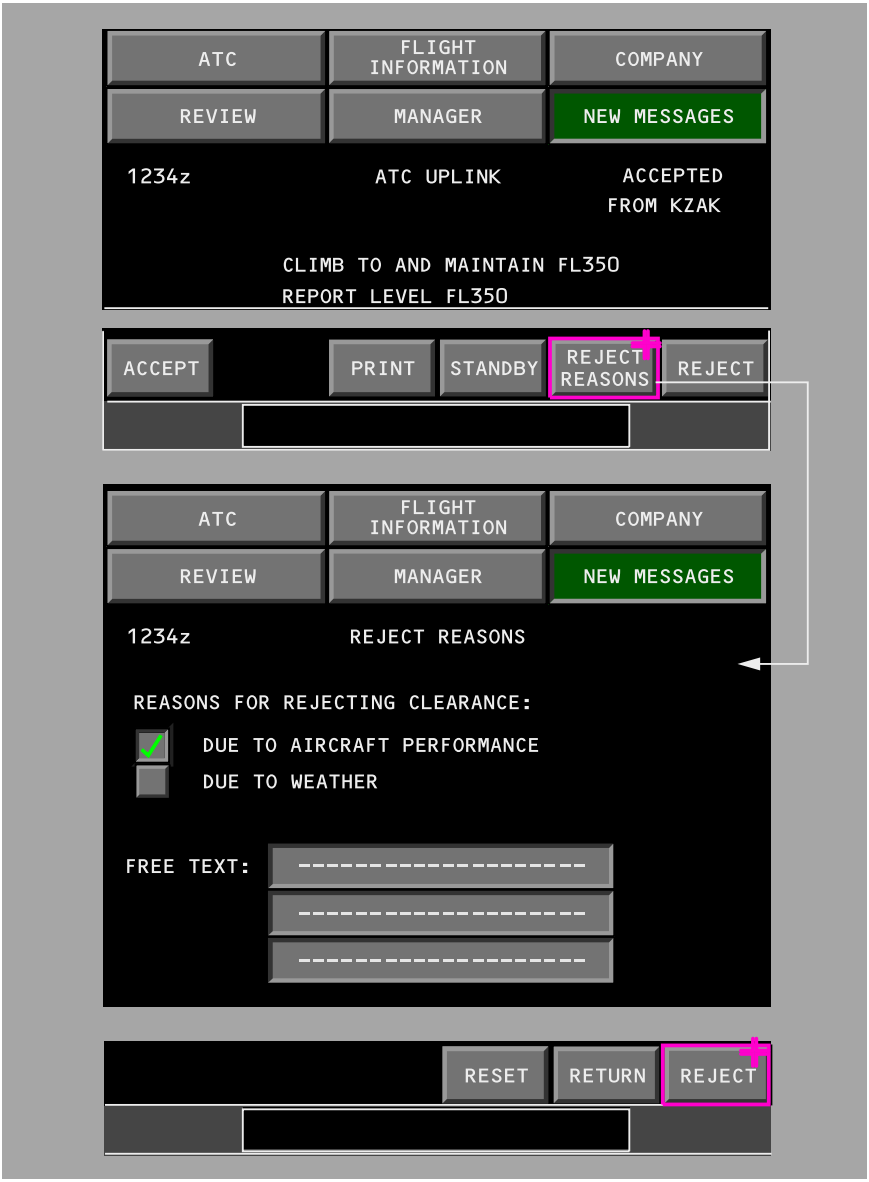
New Message—No Response Required



Received messages remain in the new messages list until after they are displayed. If an ACCEPT or REJECT response is required, the message remains in the list until accepted or rejected.

The display above shows a received message that does not require a response. The ACCEPT and REJECT keys are not displayed for this message. The message can be cleared by selecting the CANCEL key on the MFD or pushing the CANCEL switch on the glareshield.

New Message—Response Required



The display above shows a received message that requires a response. The ACCEPT and REJECT keys are both displayed for this message. The message clears after either the ACCEPT or REJECT key is selected.

Communications EICAS Alert Messages

The following EICAS alert messages can be displayed.

Datalink

Message	Level	Aural	Condition
DATALINK LOST	Advisory		The ACARS datalink is temporarily lost.
DATALINK SYS	Advisory		The datalink system is failed.
HF DATALINK	Advisory		The HF datalink is failed.
HF DATALINK OFF	Memo		The HF datalink is off.
HFDL GND XMIT	Memo		The HF datalink mode is on, on the ground.
SATCOM DATALINK OFF	Memo		The SATCOM datalink is off.
VHF DATALINK	Advisory		The VHF datalink is failed.
VHF DATALINK OFF	Memo		The VHF datalink is off.

Radios

Message	Level	Aural	Condition
RADIO TRANSMIT CAPT, F/O, OBS	Advisory		A microphone switch is on and causes a radio to transmit for 30 seconds or more.
VHF SQUELCH OFF	Memo		The VHF radio squelch is off.

SATCOM

Message	Level	Aural	Condition
SATCOM	Advisory		The SATCOM system is failed.
SATCOM DATALINK	Advisory		The SATCOM datalink is failed.
SATVOICE LOST	Advisory		SATCOM voice communication is temporarily lost.

EICAS Communication Messages

The following EICAS communication messages can be displayed.

Crew Communications

EICAS Communication Message	Level	Condition	Crew Action
•CABIN ALERT	Medium	Pilot alert received over cabin interphone.	Respond to the alert.
•CABIN CALL	Medium	Pilot call received over cabin interphone.	Respond to the call.
•CABIN READY	Medium	CABIN READY received over cabin interphone.	Crew awareness. Automatically removed after one minute.
•FD DOOR CALL	Medium	Doorbell command entered at FDAS keypad.	Respond to the call.
•GROUND CALL	Medium	Pilot call received over flight interphone from nose wheel well.	Respond to the call.

Datalink

EICAS Communication Message	Level	Condition	Crew Action
•COMM	Medium/ low	A datalink message has been received.	Push COMM switch on the display select panel. View the message title and text in the help window.
•COMM BUSY	Medium	Communications system pending datalink message queue is full.	Respond to current pending datalink messages.
•FMC	Medium	An FMC related datalink message has been received.	Push CDU switch on the display select panel. View the message title and text in the help window.
•PRINTER (with datalink installed)	Medium/ low	A datalink message has been received and sent to the printer.	Review the printed message.
•ATC	Medium	An ATC datalink message has been	Push COMM switch on the display select

EICAS Communication Message	Level	Condition	Crew Action
		received or an armed report has been sent.	panel. View the message title and text in the help window.

SATCOM

EICAS Communication Message	Level	Condition	Crew Action
•SATCOM CALL	Medium/ low	Voice call received over SATCOM.	Respond to call.

SELCAL

EICAS Communication Message	Level	Condition	Crew Action
•SELCAL	Medium	SELCAL received or any SATCOM voice call received.	Respond to the call.

Electrical — Chapter 6
Table of Contents

Controls and Indicators 6.10

Electrical Panel 6.10.1

Towing Power Panel 6.10.4

Electrical Synoptic Display 6.10.6

Synoptic Indication Symbology 6.10.7

Circuit Breaker Indication and Control (CBIC) 6.10.14

CBIC Indication Symbology 6.10.15

System Description 6.20

Introduction 6.20.1

Electrical System Power Sources 6.20.1

Engine Starter/Generators 6.20.1

APU Starter/Generators 6.20.2

External Power 6.20.2

Ram Air Turbine (RAT) Generator 6.20.3

Battery Power 6.20.4

Permanent Magnet Generators 6.20.4

Permanent Magnet Alternators 6.20.5

Electrical Power Distribution and Conversion 6.20.5

Power Flow and Load Distribution 6.20.6

Electrical Load Management 6.20.8

Modes of Operation 6.20.8

Load Inhibit and Load Shedding 6.20.12

IFE/PASS SEATS and CABIN/UTILITY Power Switches 6.20.12

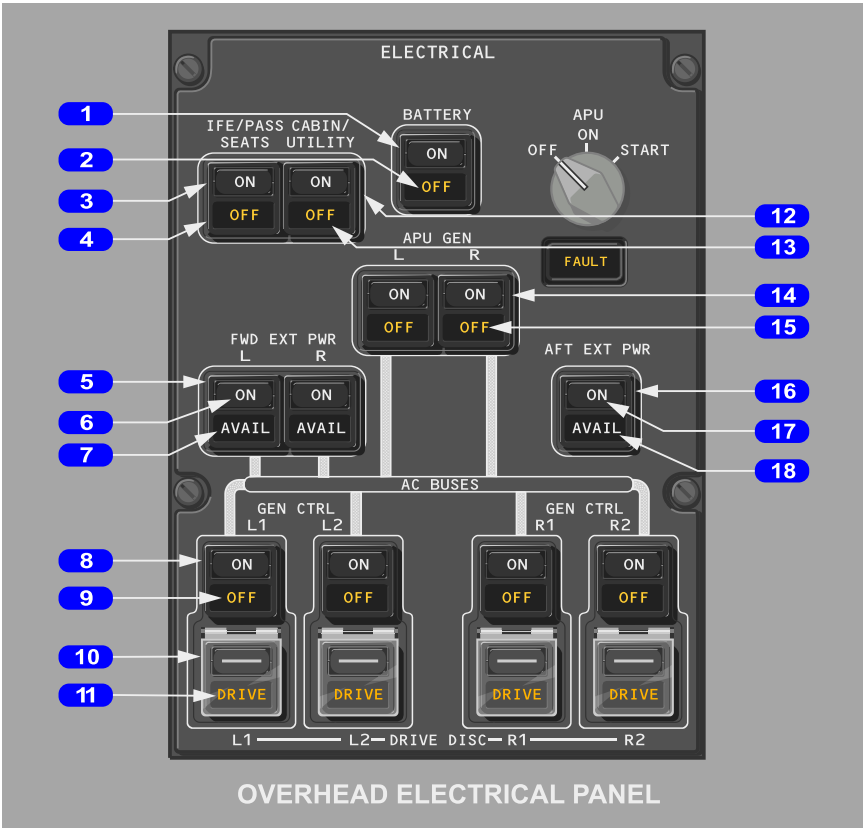
Circuit Breaker Indication and Control (CBIC) 6.20.12

EICAS Messages 6.30

Electrical EICAS Messages 6.30.1

Cabin System 6.30.1

Electrical Panel



1 BATTERY Switch

ON—

- initiates L CCR start-up sequence
- (after L CCR start-up complete) energizes the “On-Ground Battery Only” mode.

OFF—

- (after delay of up to 2 minutes) de-energizes the “On-Ground Battery Only” mode
- de-energizes the L CCR.

For additional information:

- See Common Core System on page 1.40.1
- See On-Ground Battery Only mode on page 6.20.9.

2 Battery OFF Light

Illuminated (amber)—the BATTERY switch is OFF.

3 IFE/PASS SEATS Power Switch

ON—energizes in-flight entertainment system, passenger seat systems, video surveillance cameras, and flight deck personal electronic device power outlets.

OFF—de-energizes in-flight entertainment system, passenger seat systems, video surveillance cameras, and flight deck personal electronic device power outlets.

4 IFE/PASS SEATS OFF Light

Illuminated (amber)—the IFE/PASS SEATS power switch is OFF.

5 Forward External Power (FWD EXT PWR) Switches

Push—(if AVAIL light illuminated) closes forward external power contactor.

Push—(if ON light illuminated) opens forward external power contactor.

6 Forward External Power ON Lights

Illuminated (white)—forward external power is selected ON.

(See External Power On mode on page 6.20.10 for additional information.)

7 Forward External Power AVAIL Lights

Illuminated (white)—

- forward external power is plugged in and power quality is acceptable
- extinguishes when the ON light illuminates.

(See Ground Handling mode on page 6.20.10 for additional information.)

8 Generator Control (GEN CTRL) Switches

ON—

- arms generator control breaker (allows it to close automatically when power is available)
- closes generator field.

OFF—

- opens generator control breaker
- opens generator field
- resets fault protection systems.

9 Generator OFF Lights

Illuminated (amber)—the generator control breaker is open.

10 Generator Drive Disconnect (DRIVE DISC) Switches

Push—disconnects generator drive from engine.

Requires maintenance action on the ground to reconnect generator drive.

11 Generator DRIVE Lights

Illuminated (with the engine running) (amber)—a generator drive malfunction has occurred.

12 CABIN/UTILITY Power Switch

ON—energizes galleys, most cabin lights, and other non-essential cabin utility loads.

OFF—de-energizes galleys, most cabin lights, and other non-essential cabin utility loads.

13 CABIN/UTILITY Power OFF Light

Illuminated (amber)—CABIN/UTILITY power switch is selected OFF.

14 APU Generator (APU GEN) Switches

ON—

- arms generator control breaker (allows it to close automatically when power is available)
- closes generator field.

OFF—

- opens generator control breaker
- opens generator field
- resets fault protection systems.

15 APU Generator OFF Lights

Illuminated (amber)—

- the APU generator control breaker is open
- the APU GEN switch is selected OFF.

16 AFT External Power (AFT EXT PWR) Switch

Push—(if AVAIL light illuminated) closes aft external power contactor.

Push—(if ON light illuminated) opens aft external power contactor.

17 AFT External Power ON Light

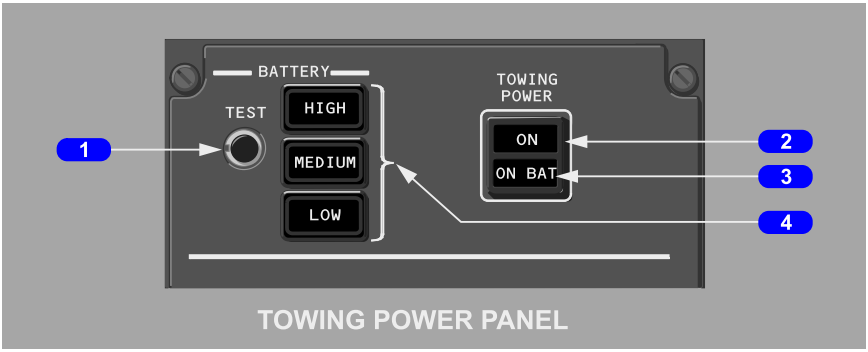
Illuminated (white)—aft external power is powering the large motor power system for right engine start.

18 AFT External Power AVAIL Light

Illuminated (white)—

- aft external power is plugged in and power quality is acceptable
- extinguishes when the ON light illuminates.

Towing Power Panel



TOWING POWER PANEL

1 Towing Battery Test Switch

Push—applicable towing battery charge light illuminates, indicating the current state of charge of the batteries (HIGH, MEDIUM, LOW).

2 TOWING POWER Switch

ON—selects the main and APU batteries for energizing the “Towing Power” mode. Applicable towing battery charge light illuminates. (See Towing Power mode on page 6.20.9 for additional information.)

OFF—De-energizes the “Towing Power” mode.

3 ON BAT Light

Illuminated (white)—the battery TOWING POWER switch is ON.

4 Towing Battery Charge Lights

Illuminated (white)—pushing the towing battery TEST switch illuminates one of the following battery state of charge indicators:

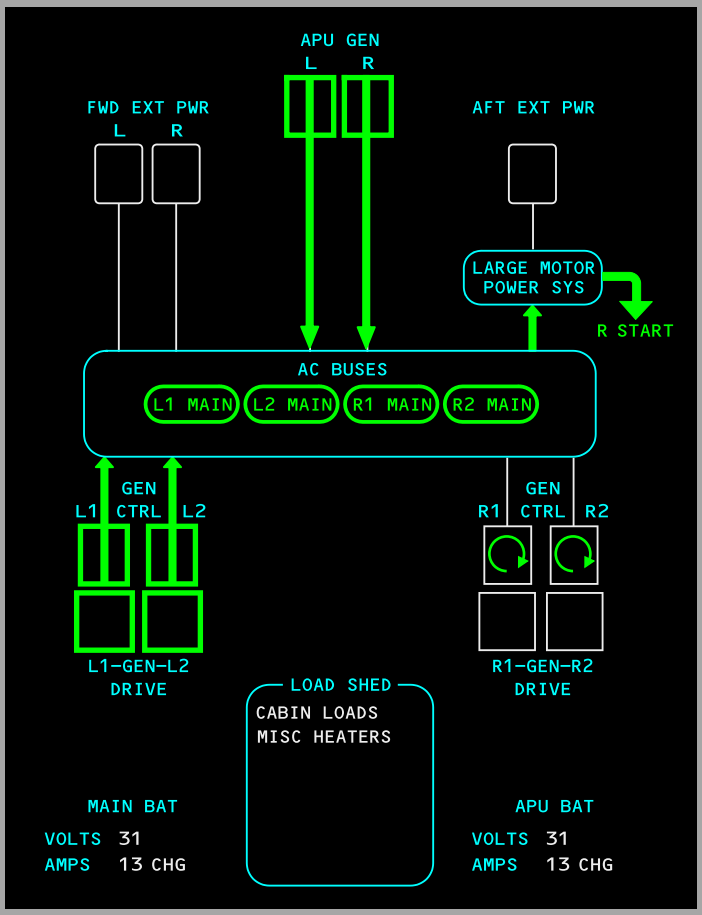
- HIGH—a minimum of 60 minutes remains before battery charge is depleted

- MEDIUM—a minimum of 30 minutes remains before battery charge is depleted
- LOW—a minimum of 15 minutes remains before battery charge is depleted.

Note: Minimum times assume steady state towing (no braking) before batteries are depleted. If heavy braking occurs, actual time remaining may fall below the minimum times listed.

Electrical Synoptic Display

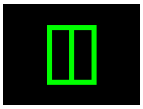
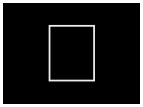
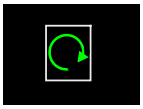
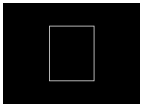
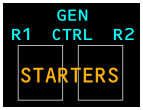
The electrical synoptic is shown by pushing the systems (SYS) display switch, then selecting the electrical (ELEC) synoptic key. (See Display Select Panel on page 10.10.51 for additional information.)



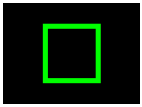
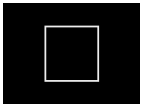
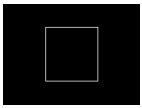
ELECTRICAL SYNOPTIC DISPLAY
(Typical engine start using APU power)

Synoptic Indication Symbology

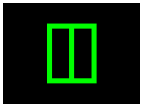
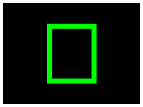
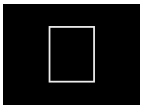
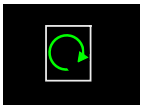
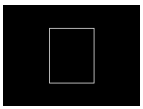
Engine Generator Synoptic Indications

Symbol	Condition	Description
	Engine generator on (green)	Engine is running, and • engine GEN CTRL switch is ON • engine generator is powering buses.
	Engine generator off (white)	Engine is not running, or engine GEN CTRL switch is OFF with engine running. If GEN CTRL switch is OFF with engine running, EICAS advisory message ELEC GEN OFF L1, L2, R1, R2 is shown.
	Engine starter on (white box with green arrow)	An engine start is in progress. Start power indication (green arrow) from Large Motor Power System symbol also shows at this time.
	Engine generator failed (amber)	Engine is running, and • GEN CTRL switch is ON • engine generator failure has occurred • engine generator is not powering buses • OFF light on GEN CTRL switch illuminates • EICAS advisory message ELEC GEN OFF L1, L2, R1, R2 shows.
	Engine generator data invalid (white, low intensity)	Engine generator condition unknown.
	Both (L1, L2 or R1,R2) Starters inoperative (amber)	If both starters on respective engine fail: • STARTERS message appears across both starter symbols • EICAS advisory message ENG STARTERS L, R shows.

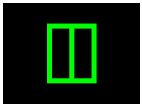
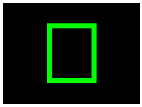
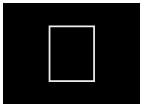
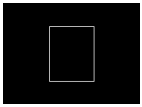
Engine Generator Drive Synoptic Indications

Symbol	Condition	Description
	Engine generator drive on (green)	Engine is running and drive is connected.
	Engine generator drive off (white)	Engine is not running.
	Engine generator drive disconnected (amber)	Engine is running and drive is disconnected.
	Engine generator drive data invalid (white, low intensity)	Engine generator drive condition unknown.
	Engine generator drive fault (amber)	If an engine generator drive malfunction occurs: • DRIVE (amber) appears next to (L1,L2,R1, or R2) engine generator drive symbol • respective engine generator drive requires disconnect • DRIVE light on generator drive disconnect switch illuminates • EICAS advisory message ELEC GEN DRIVE L, R shows. **Note:** DRIVE fault symbol and engine generator drive disconnected symbol appear together when drive is disconnected.

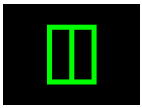
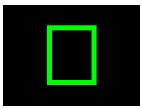
APU Generator Synoptic Indications

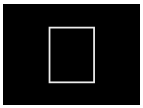
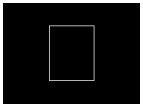
Symbol	Condition	Description
	APU generator on (green)	APU is running, and • APU GEN switch is ON • APU generator is powering buses.
	APU generator available (green)	APU is running, and • APU GEN switch is ON • APU generator is available for power • APU generator is not powering buses.
	APU generator off (white)	APU is not running, or APU GEN switch is OFF with APU running. If APU GEN switch is OFF with APU running, EICAS advisory message ELEC GEN OFF APU L,R also shows.
	APU starter on (white box with green arrow)	An APU start is in progress. Start Power Indication (green arrow) from Large Motor Power System symbol also shows at this time.
	APU generator failed (amber)	APU is running, and • APU GEN switch is ON • APU generator failure has occurred • APU generator is not powering buses • OFF light on APU GEN switch illuminates • EICAS advisory message ELEC GEN OFF APU L,R shows.
	APU generator data invalid (white, low intensity)	APU generator condition unknown.

Forward External Power Synoptic Indications

Symbol	Condition	Description
	Forward external power on (green)	Forward external power: • switch has been selected • is powering the buses • ON light illuminates in power switch.
	Forward external power available (green)	Forward external power: • is plugged in, power quality is acceptable • switch has not been selected • AVAIL light illuminates in power switch.
	Forward external power off (white)	Forward external power is not available.
	Forward external power data invalid (white, low intensity)	Forward external power condition unknown.

Aft External Power Synoptic Indications

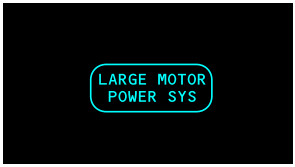
Symbol	Condition	Description
	Aft external power on (green)	Aft external power: • switch has been selected • is powering the motor controllers (for right engine start) • ON light illuminates in power switch.
	Aft external power available (green)	Aft external power: • is plugged in, power quality is acceptable • switch has not been selected • AVAIL light illuminates in power switch.

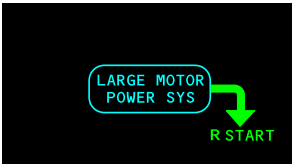
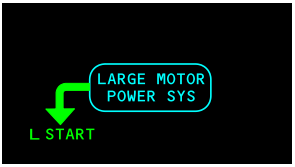
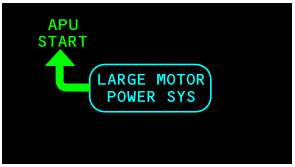
Symbol	Condition	Description
	Aft external power off (white)	Aft external power is not available.
	Aft external power data invalid (white, low intensity)	Aft external power condition unknown.

Main Bus Synoptic Indications

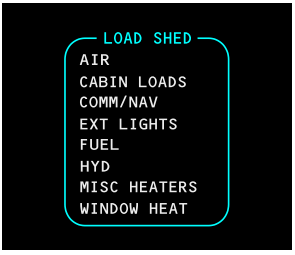
Symbol	Condition	Description
	Bus on (green)	L1,L2,R1,R2 bus is powered.
	Bus off (amber)	L1,L2,R1,R2 bus is not powered. **Note:** If the bus is unpowered because of a fault, EICAS caution message ELEC AC BUS L1,L2,R1,R2 shows.
	Bus data invalid (white, low intensity)	Bus condition unknown.

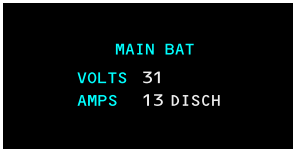
Large Motor Power System and Start Power Synoptic Indications

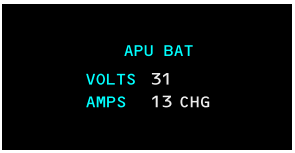
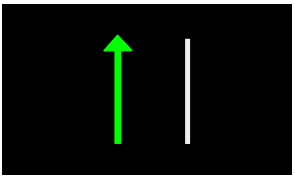
Symbol	Condition	Description
	Large Motor Power System (no power flowing to or from symbol)	Symbol represents all of the high power electrical motors. Power flow lines (green straight arrows) from aft external and main AC buses depict power flow to system when applicable. Power flow lines (90 degree green arrows) from the system

Symbol	Condition	Description
		shows during APU and engine start.
	Start Power Indication shows right engine start in progress (green arrow)	Both right engine starter on symbols show at this time.
	Start Power Indication shows left engine start in progress (green arrow)	Both left engine starter on symbols show at this time.
	Start Power Indication shows APU start in progress (green arrow)	Either the left or right APU starter on symbols show at this time.

Miscellaneous Synoptic Indications

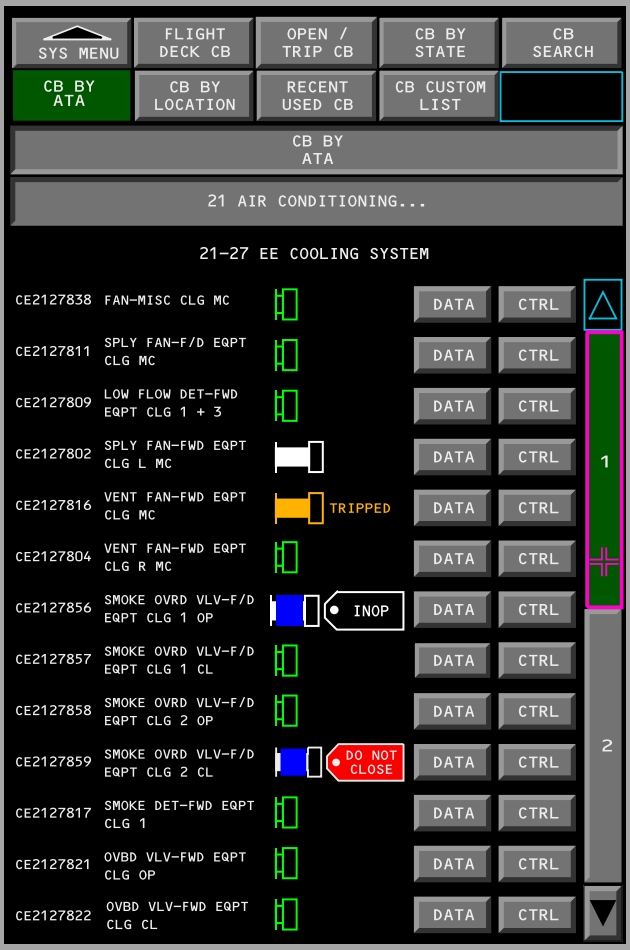
Symbol	Condition	Description
	Load Shed Message List (white text)	The most recent system impacted by load shed is listed at the top. AIR—LOAD SHED shows on AIR synoptic. (See Air Synoptic Display on page 2.10.10.) CABIN LOADS—Power to one or more cabin systems have been reduced or shed: galley, galley floor heater(s), chiller, cabin lighting, IFE, door area heater(s). COMM/NAV—One or more communication or navigation loads have shed: VHF, TCP,

Symbol	Condition	Description
		HF, SATCOM, DME, flight interphone. EXT LIGHTS—One or more exterior lights have shed: beacon, strobe, wing landing, nose landing gear, taxi, navigation (position), logo, runway turnoff. FUEL—LOAD SHED shows on FUEL synoptic. (See Fuel Synoptic Indications on page 12.10.7.) HYD—LOAD SHED shows on HYD synoptic. (See Hydraulic Synoptic Display on page 13.10.4.) MISC HEATERS—One or more heaters have shed. WINDOW HEAT—Flight deck window heat has shed.
	Main Battery Indications	VOLTS (white value)—battery charge in volts. If voltage level is low, the MAIN BATTERY LOW EICAS advisory message shows. AMPS (white value)—battery rate of charge or discharge in amps. CHG (white)—battery is charging. DISCH (white)—battery is discharging. If DISCH is indicated, the MAIN BATTERY DISCH EICAS advisory message shows.

Symbol	Condition	Description
	APU battery indications	VOLTS (white value)—battery charge in volts. AMPS (white value)—battery rate of charge or discharge in amps. CHG (white)—battery is charging. DISCH (white)—battery is discharging.
	Flow lines (green with arrow end or white solid)	Green flow lines with directional arrow show if power is flowing. White solid flow lines show if power is not flowing.

Circuit Breaker Indication and Control (CBIC)

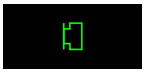
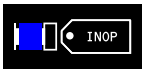
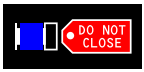
CBIC provides indication and control for Electronic Circuit Breakers (ECB), and indication only for Thermal Circuit Breakers (TCB). CBIC is shown on the multifunction display by pushing the systems (SYS) display switch on the display select panel, then selecting the CB key. (See Display Select Panel on page 10.10.51 for additional information.)



CBIC DISPLAY

CBIC Indication Symbology

Individual circuit breaker operational status is represented by a symbol on the CBIC display.

Symbol	Condition	Description
	ECB or TCB closed (green)	Circuit is powered. **Note:** The same symbol depicts a closed ECB or TCB. TCBs state can be monitored, but can not be controlled by CBIC.
	ECB open (white)	Circuit is not powered.
	TCB open (white)	Circuit is not powered. **Note:** TCBs state can be monitored, but can not be controlled by CBIC.
	ECB tripped (amber)	ECB is tripped due to a fault. Circuit is open and not powered.
	ECB collared and tagged INOP (white tag, cyan lock collar)	ECB is open and collared for dispatch. Circuit is not powered.
	ECB collared and tagged DO NOT CLOSE (red tag, cyan lock collar)	ECB is open and collared for maintenance purposes. Circuit is not powered.
	ECB or TCB condition unknown (amber)	The circuit status can not be determined.

Introduction

The 787 airplane electrical system generates, distributes, and manages airplane electrical power. System operation is automatic. In addition to traditional electrically powered systems, the 787 electrical system powers engine start, pressurization, wing ice protection, stabilizer trim, and wheel brake systems. The system primarily uses 115 Vac and 28 Vdc power, with a limited number of systems optimized with 235 Vac.

Electrical System Power Sources

The electrical power sources are:

- four variable frequency engine starter/generators
- two variable frequency APU starter/generators
- three external AC power receptacles
- one Ram Air Turbine (RAT)
- one main battery
- one APU battery
- three flight control Permanent Magnet Generators
- two EEC Permanent Magnet Alternators.

The power sources remain isolated from each other throughout the generation and distribution channels. During power transfers, a brief power interruption may occur as buses are energized from a new power source.

Engine Starter/Generators

The engine starter/generators function as electrically powered starter motors for engine start, and as engine driven generators once the engines are running.

Each engine has two 235 Vac variable frequency starter/generators. L1 and L2 are mounted on the left engine. R1 and R2 are mounted on the right engine. They are directly connected to the engine gearboxes, producing variable frequency power proportional to engine rotor speed.

Electrical power for engine start can be provided by external power, APU generated power, or the opposite engine's generated power. The electrical system automatically selects both starter/generators to engage in order to provide optimal torque for engine start.

After start, the starter/generators function as generators to energize their respective main AC buses, also designated L1, L2, R1, and R2. Generator status is shown by generator switch indications, MFD electrical synoptic, and the EICAS message system.

Each generator has a drive disconnect mechanism that allows the generator to be mechanically disconnected from the engine. Depending on the fault condition, the generator drive is either automatically disconnected, or requires crew action to be disconnected. The generator DRIVE light, generator DRIVE synoptic indication, and EICAS advisory message ELEC GEN DRIVE shows when a condition is detected that requires the flight crew to disconnect the generator drive. The generator can then be disconnected from the engine by pushing the respective generator drive disconnect (DRIVE DISC) switch. The drive cannot be reconnected by the flight crew.

APU Starter/Generators

Auxiliary Power Unit (APU) starter/generators function as electrically powered starter motors for APU start, and as generators once the APU is running. The APU generators can provide electrical power for ground operations and supplemental power during flight. Additionally, normal engine start is accomplished using electrical power supplied by the APU.

The APU has two 235 Vac variable frequency starter/generators, designated left (L) and right (R). The generators are directly connected to the APU gearbox, producing variable frequency power proportional to APU speed.

Electrical power for APU start can be provided by forward external power, APU battery, or engine generated power. The electrical system automatically selects a single starter/generator to provide sufficient torque for APU start. For APU starts with the APU battery as the power source (no engine running and forward external power not ON), the right starter/generator is always used. Either the left or right starter/generator is used for APU start if an engine is running or forward external power is selected ON.

On the ground, both APU generators are available to energize the airplane's 235 Vac electrical buses; L1, L2, R1, and R2. In flight, one or both APU generators provide power depending on the electrical load requirements of the airplane. Generator status is shown by generator switch indications, MFD electrical synoptic, and the EICAS message system.

There are three Common Motor Start Controllers (CMSC) available to drive the two APU Starter Generators. Two CMSC give priority to the main engine start and the third CMSC gives priority to the hydraulic electric motor pump over the APU start. If demand pumps are turned on during APU start, the start may be aborted due to the CMSC being prioritized away from the APU start. Simlarly, if an engine is shut down during an APU start, the start may be aborted due to a power interrupt to the CMSC performing the start.

External Power

The 115 Vac external power system consists of both a forward and aft system, with their corresponding receptacles, controls, and indications.

The forward system provides the power for general ground operations. It has two (L, R) power receptacles located on the left forward fuselage of the airplane. Connecting one or both power sources to the receptacles illuminates the AVAIL light(s) in the power switch(es), and energizes “Ground Handling” mode. Only one connection is required to power this mode. If two sources are connected, the first source connected is the one that is used. (See Ground Handling mode on page 6.20.10 for additional information.)

Selecting the external power switch(es) to ON energizes the “External Power On” mode and extinguishes the AVAIL light(s). Two connections are recommended in this mode to power the maximum number of electrical loads and minimize load shedding.

If the APU is not available, engine start may be accomplished using external power. At a minimum, two 90 kVA rated forward external power sources are required. In this configuration, either engine may be started first. Only a single VFSG is used during start, resulting in increased engine start times. Load shedding occurs, especially during engine start. Connecting the two forward and one aft receptacles only reduces load shedding, and does not decrease engine start time.

The aft external power system can assist the forward system when starting the right engine first. The aft receptacle is located on the airplane fuselage aft of the left wing. To receive the benefit of the aft power source (reduced load shedding), both forward power sources must also be connected, and the right engine must be started first. (See Ground Power Engine Start on page SP.7.1 for additional information.)

Ram Air Turbine (RAT) Generator

A Ram Air Turbine (RAT) serves as an emergency source of electrical and hydraulic power. It has no operating time limits, airspeeds, or altitudes.

In flight, the RAT deploys automatically if any of the following occur:

- both engines have failed
- all three hydraulic system pressures are low
- loss of all electrical power to captain’s and first officer’s flight instruments
- loss of all four EMPs and faults in the flight control system occur on approach
- loss of all four EMPs and an engine fails on takeoff or landing.

The RAT can be deployed manually if necessary by pushing the RAM AIR TURBINE switch on the hydraulic panel.

For additional information:

- Electrical—see In-Air Rat Only mode (Standby Power) on page 6.20.11
- Hydraulics—see Hydraulic Panel on page 13.10.1
- Hydraulics—see Ram Air Turbine (RAT) on page 13.20.3.

Battery Power

The airplane has one main battery, and one APU battery. The main battery power switch is located on the overhead electrical panel. The APU battery functions automatically, and has no flight deck power switch. Operating indications for the main and APU batteries are provided on the electrical synoptic.

The main battery provides power for:

- airplane power-up
- APU start (assists APU battery)
- refueling operations
- towing operations
- electric braking (as power source)
- captain's flight instruments (after a power failure, energizes essential instruments until RAT deployment).

(See Modes of Operation on page 6.20.8 for additional information.)

The APU battery provides power on the ground for:

- APU start
- navigation lights (when Towing Power mode is active).

(See Modes of Operation on page 6.20.8 for additional information.)

Both batteries have protection systems that monitor for faults to ensure that overcharging does not occur. If a fault is detected, the protection system stops battery charging and, if necessary, isolates the battery electrically.

If either battery experiences a severe failure and overheats, a sealed enclosure ensures the resulting heat and gases are contained so they pose no hazard to the airplane or its occupants. If the heat and gases reach a level normally associated with a cell failure, a burst disk on the enclosure activates, venting gases directly overboard through a vent tube opening in the fuselage.

The main battery vent opening is located aft of the forward E/E door, near the airplane centerline. A brief odor may be present in the flight deck just prior to the main battery burst disk activation.

The APU battery vent opening is located aft of the access door to the aft E/E compartment, near the airplane centerline.

Permanent Magnet Generators

Three engine driven Permanent Magnet Generators (PMG) are the primary source of power for the flight control electronics. These power sources are independent from the main airplane electrical system, and are also independent from each other.

A secondary source for flight control power is provided by the airplane's 28 Vdc bus distribution system, and the main battery. In addition, a backup system is

provided by dedicated batteries to assure positive flight control operation during temporary power interruptions.

Permanent Magnet Alternators

Two engine driven Permanent Magnet Alternators (PMA) (one per engine) are the primary source of power for the EEC. PMAs are independent from the main airplane electrical system, and are also independent from each other.

A secondary source for EEC power is provided by the airplane's 115v AC bus distribution system. During engine start, initial EEC power is provided by the airplane until the PMA is able to provide power. The airplane also serves as a backup EEC power source if a PMA is inoperative.

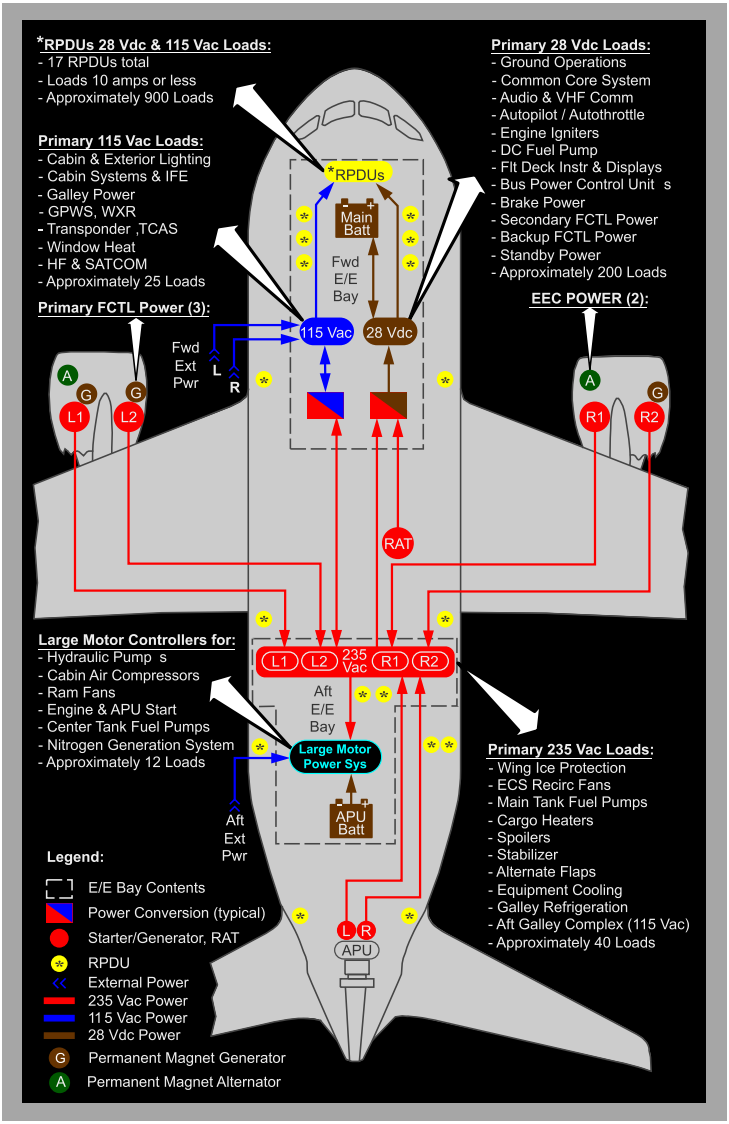
Electrical Power Distribution and Conversion

The electrical system uses two distinct power distribution methods: primary and remote. The primary power distribution method energizes higher amperage loads directly from bus power panels located in the forward and aft E/E bays. The remote distribution method energizes lower amperage loads through a decentralized network of 17 Remote Power Distribution Units (RPDUs) located throughout the airplane.

A limited number of high voltage 235 Vac electrical loads are energized from the aft E/E bay. The majority of airplane electrical loads are 115 Vac and 28 Vdc, energized by the forward E/E bay power panels and RPDUs.

The forward and aft E/E bays also contain the main and APU batteries, respectively. In addition, they contain power conversion devices which change power from one voltage or current type (AC/DC) to another, and system controllers that direct power to the various airplane buses and systems.

Power Flow and Load Distribution



Main 235 Vac Bus Distribution System

There are four main 235 Vac buses, designated L1, L2, R1, and R2. These primary power system buses are located in the aft E/E bay power panels. They

distribute power directly to a limited number of high voltage AC airplane systems. In addition, they distribute power to all other airplane bus systems through power conversion devices. These buses can be energized by several different sources, depending on source availability and the operation being conducted.

On the ground, with only forward external power selected ON (no engine or APU generator power), the 235 Vac buses are energized by the 115 Vac distribution system through power conversion devices. If the APU or an engine(s) is subsequently started, it energizes the four main 235 Vac buses, and external power transitions from ON to AVAIL.

On the ground, with only the APU power available (no external power or engine generator power), each APU generator energizes two of the four main 235 Vac buses.

With one engine running (no APU or external power), that engine's two related 235 Vac buses are energized directly. The other two 235 Vac buses are energized by the two powered buses.

With one engine and the APU running, that engine's two related 235 Vac buses are energized directly. The other two 235 Vac buses are energized by the APU generators.

With both engines running, each main 235 Vac bus is energized directly from its related engine generator. If any engine generator is not available, its related main bus is energized by another main 235 Vac bus.

Operating indications are provided by the electrical synoptic and EICAS message systems. The EICAS caution message ELEC AC BUS (L1, L2, R1, R2) shows when a main 235 Vac bus is inoperative.

115 Vac Bus Distribution System

There are multiple 115 Vac buses. To distribute power, the 115 Vac system uses both primary power system buses located in the forward E/E bay, and RPDUs located throughout the airplane. The higher amperage (greater than 10 amps) loads are distributed directly by the bus system. The lower amperage (10 amps or less) loads are distributed by the RPDUs.

On the ground, with only forward external power selected ON (no engine or APU generator power), the 115 Vac system is energized directly. It then energizes the 235 Vac bus system through power conversion devices.

With an engine(s) and/or APU running (external power OFF), the main 235 Vac buses energize the 115 Vac system through power conversion devices. If forward external power is then selected ON, it energizes the 115 Vac system directly.

28 Vdc Bus Distribution System

There are multiple 28 Vdc buses. To distribute power, the 28 Vdc system uses both primary power system buses located in the forward E/E bay, and RPDUs located throughout the airplane. The higher amperage (greater than 10 amps)

loads are distributed directly by the bus system. The lower amperage (10 amps or less) loads are distributed by the RPDUs.

The 235 Vac system provides power to the 28 Vdc system through power conversion devices.

Four electrical brake power supply units regulate power for the exclusive use of the airplane electric brake system. Each of the four power supplies receive two separate 28 Vdc inputs. One from the 28 Vdc bus system, and one from the main battery. The 28 Vdc bus system is the primary power source, and the main battery provides the backup power source. (See Electric Brake System on page 14.20.3 for additional information.)

Large Motor Power Distribution System

The airplane's use of variable frequency power requires large motor loads to be energized by motor controllers, which conditions that power for use. A dedicated large motor power distribution system in the aft E/E bay power panels energizes the motor controllers.

The main 235 Vac distribution system energizes the large motor power system through power conversion devices. In addition, portions of the large motor power system are energized by the APU battery and aft external power through power conversion devices. The APU battery energizes only the motor controller required to perform an APU battery start. The aft external power system energizes only the motor controller required to perform a right engine start using external power as the sole power source.

The Power Electronics Cooling System (PECS) dissipates heat created by these high voltage motor controllers. PECS is energized if one or both engines or the APU is running, or if forward external power is connected and selected ON.

For additional information:

- Air Systems—see Power Electronics Cooling System (PECS) on page 2.20.11
- Supplementary Procedures—see Electrical Power Down on page SP.6.1.

Electrical Load Management

The 787 electrical system dynamically manages electrical loads. Using electronic controllers, the system can automatically cycle on or off loads for efficient use of available airplane power.

The Bus Power Control Unit (BPCU) provides flight deck control/indication, power transfer functions, and overall load management and protection. In the event of a BPCU failure, a second BPCU assumes all functions.

Modes of Operation

By using electronic controllers to selectively energize individual loads on different buses, the airplane can operate a group of loads together as an electrical operating mode.

Note: The lists of loads energized by the following modes contain high priority equipment for the type of operation being conducted. These lists are considered a general guideline, and are not intended to be all-inclusive. Some of these loads may be shed depending on power availability.

These modes are defined as follows:

Towing Power mode

Towing Power mode is active when the TOWING POWER switch is selected to ON (with the main BATTERY switch OFF). The main and APU batteries energize only the equipment essential for towing operations. (See Towing Power Panel on page 6.10.4 for additional information.) Significant loads energized by this mode include:

- captain's ACP
- captain's flight interphone
- flight deck dome lights
- aisle stand flood lights
- navigation lights
- brakes.

Note: Radio communication systems are not energized in the towing power mode.

On-Ground Battery Only mode

On-Ground Battery Only mode is active when the BATTERY switch is selected to ON while the airplane is on the ground, and there are no other power sources connected. This mode is to support the airplane power-up sequence. Significant loads energized by this mode include:

- captain's inboard DU
- lower DU
- MCP
- APU start capability
- wing fueling panel
- captain’s/first officer's ACP
- captain’s/first officer's flight interphone
- VHF L
- TCP L
- DSP L
- MFK L

- CCD L
- AHRU L, R
- FMC
- CCR L
- ground crew call horn
- engine/APU fire detection
- miscellaneous lighting
- brakes.

Note: Some overhead panel indicator lights are inoperative in On-Ground Battery Only mode.

Ground Handling mode

Ground Handling mode is active when the first forward external power receptacle is connected (not selected ON), and there are no other power sources. Significant loads energized by this mode include:

- lower DU
- APU start capability
- MFK L
- CCD L
- CCR L, R
- equipment cooling fans
- engine/APU fire detection
- cargo compartment lighting
- cargo door actuation systems
- cargo handling systems
- cargo loading lights
- service compartment lights
- wing fueling panel
- battery chargers.

Note: Ground Handling mode has priority over On-Ground Battery Only mode, and initializes regardless of BATTERY switch position.

Ground Service mode

Ground Service mode is active when the GROUND SERVICE switch on the master attendant switch panel is selected ON while in Ground Handling Mode. In addition to loads energized by Ground Handling mode, other significant loads energized by this mode include:

- cabin systems (limited operation)
- cabin lighting (limited operation)
- flight deck dome lighting.

External Power On mode

External Power On mode is active when at least one forward external power receptacle is connected and selected ON with the APU and engine generators off.

Significant loads energized by this mode with only one forward external power source connected and selected ON include:

- flight deck equipment, controls, and indications
- cabin systems (limited operation)
- cabin lighting (limited operation)
- PECS (single loop only).

Additional loads energized by this mode with two forward external power sources connected and selected ON include:

- NGS (limited operation)
- hydraulics (limited operation)
- IFE (limited operation)
- cabin systems (basic operation)
- cabin lighting (basic operation)
- PECS (both loops).

Note: Packs and cargo heat are inoperative in External Power On mode.

In-Air Rat Only mode (Standby Power)

In-Air Rat Only mode is active if loss of all electrical power to captain's and first officer's flight instruments occurs in flight. The RAT energizes the captain's flight instruments and other essential equipment for flight controls, navigation, and communication. The main battery provides standby power until RAT deployment. Significant loads energized by this mode include:

- captain's inboard DU
- captain's outboard DU
- lower DU
- DSP L
- ISFD
- ECL
- MFK L
- CCD L
- captain's/first officer's ACP
- captain's/first officer's flight interphone
- VHF L
- TCP L
- MCP
- autoflight system (limited operation)

- autopilot (limited operation)
- FMC (limited operation)
- IRU L, R
- AHRU L, R
- INR L, R
- PFC
- CCR L
- center pitot heat
- engine/APU fire detection
- miscellaneous lighting.

Note: Inoperative items on standby power include: TAT, autothrottle, LNAV/VNAV, FMC predictions, FMC thrust limits, TAP, flaps, slats, stabilizer trim, thrust reversers, auto speedbrakes, packs, Head-Up displays, HF radios, SATCOM system, TCAS, GPWS, transponder, weather radar, external lighting, WIPS, and window heat.

In-Air Battery Only mode (Standby Power)

In-Air Battery Only mode energizes the same equipment as the “In-Air RAT Only” mode with the exception of center pitot heat.

Load Inhibit and Load Shedding

There are two types of automatic load reduction that can occur to maintain power for essential systems:

- load inhibit—loads are inhibited at predefined operational phases. This is because the affected system is not required, or additional power is temporarily needed by another system
- load shed—loads are shed in the order of priority to stay within the capacity of the available power sources.

The electrical synoptic shows a list of airplane systems affected by load shedding. The affected system synoptic (AIR, FUEL, & HYD) also indicate equipment (in white) that is inhibited or shed. Additionally, loads that are shed show “LOAD SHED” text next to the affected equipment symbol.

IFE/PASS SEATS and CABIN/UTILITY Power Switches

Electrical power to some non-essential loads can be controlled from the flight deck overhead electrical panel. Two switches are provided for de-energizing these loads if necessary. The IFE/PASS SEATS switch controls In-Flight Entertainment (IFE) system, passenger seat systems, video surveillance cameras, and flight deck personal electronic device power outlets. The CABIN/UTILITY switch controls galleys, most cabin lights, and other non-essential cabin utility loads.

Circuit Breaker Indication and Control (CBIC)

CBIC provides indication and control for Electronic Circuit Breakers (ECB), and indication-only for Thermal Circuit Breakers (TCB). CBIC can be viewed on any MFD, and operated using a CCD and MFK. Circuit breaker operational status is depicted by a symbol. (See CBIC Indication Symbology on page 6.10.15 for additional information.)

The circuit breaker (CB) list can be sorted by the following categories using the CBIC menu soft keys at the top of the display:

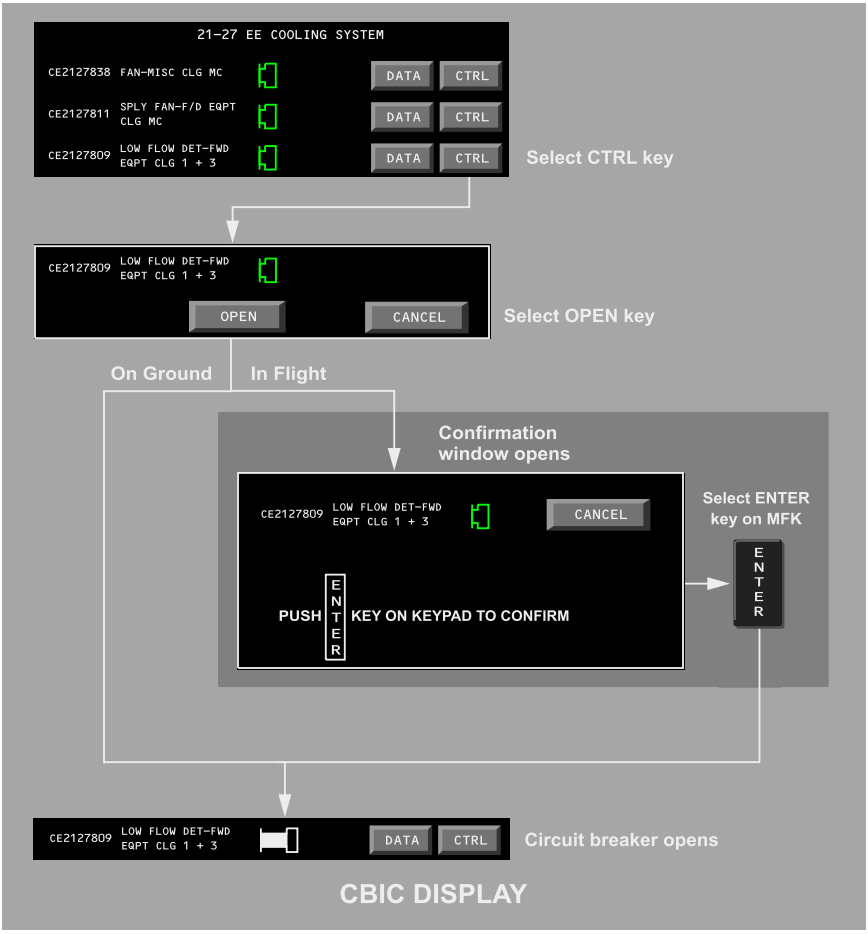
- Flight Deck CB
- Open/Trip CB
- CB by State
- CB Search
- CB by ATA
- CB by location
- Recent Used CB
- CB Custom List.

CBIC operation

Circuit breakers can be opened or closed using CBIC on the ground and in flight.

Note: Flight crew cycling (pulling and resetting) of circuit breakers to clear a non-normal condition is not recommended unless directed by maintenance or a non-normal checklist. In flight, flight crew reset of a tripped circuit breaker is not recommended. (Non-Normal Checklist Operation in QRH Chapter CI, Section 2, for additional information.)

Opening a circuit breaker



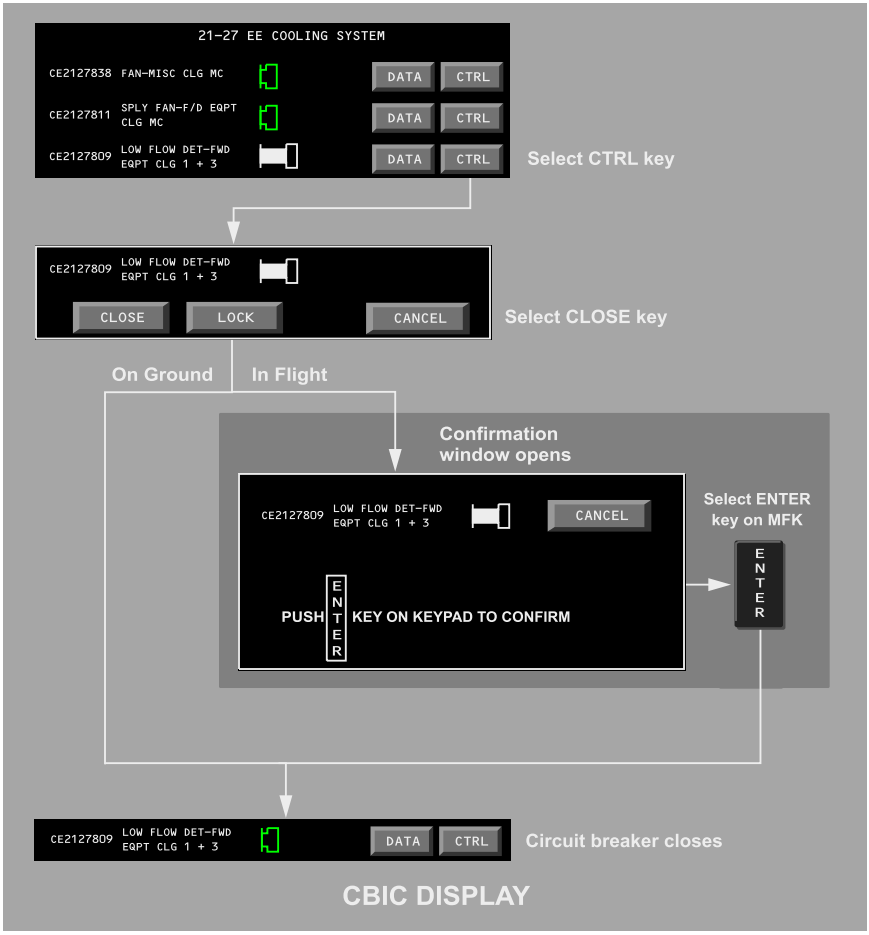
On the ground, perform the following steps:

- select CTRL soft key (displays control menu)
- select OPEN soft key (opens circuit breaker and closes control menu).

In flight, perform the following steps:

- select CTRL soft key (displays control menu)
- select OPEN soft key (displays confirmation window)
- select ENTER key on multifunction keypad (opens circuit breaker and closes confirmation window).

Closing a circuit breaker



On the ground, perform the following steps:

- select CTRL soft key (displays control menu)
- select CLOSE soft key (closes circuit breaker and closes control menu).

In flight, perform the following steps:

- select CTRL soft key (displays control menu)
- select CLOSE soft key (displays confirmation window)
- select ENTER key on multifunction keypad (closes circuit breaker andcloses confirmation window).

Electrical EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
APU BATTERY	Advisory		The APU battery is failed.
ELEC AC BUS L1	Caution	Beeper	The L1 AC bus is not energized.
ELEC AC BUS L2	Caution	Beeper	The L2 AC bus is not energized.
ELEC AC BUS R1	Caution	Beeper	The R1 AC bus is not energized.
ELEC AC BUS R2	Caution	Beeper	The R2 AC bus is not energized.
ELEC BATTERY OFF	Advisory		The battery switch is Off.
ELEC GEN DRIVE L1, L2, R1, R2	Advisory		A generator drive fault occurs.
ELEC GEN OFF APU L, R	Advisory		The APU generator control breaker is open.
ELEC GEN OFF L1, L2, R1, R2	Advisory		The generator control breaker is open.
ELEC STANDBY SYS	Advisory		A standby power system failure occurs.
MAIN BATTERY DISCH	Advisory		One of these occurs: • the main battery is discharging • the hot battery bus is not energized.
MAIN BATTERY LOW	Advisory		The main battery charge is low.
MAIN BATTERY	Advisory		The main battery is failed.

Cabin System

Message	Level	Aural	Condition
ELEC CABIN/UTIL OFF	Advisory		The cabin/utility power switch is off.
ELEC IFE/SEATS OFF	Advisory		The IFE/passenger seats power switch is off.

Engines, APU — Chapter 7
Table of Contents

Controls and Indicators 7.10

EICAS Display 7.10.1
Mode Indications 7.10.2
TPR Indications 7.10.2
TPR Indications (Alternate Mode) 7.10.4
N1 Indications 7.10.4
N1 Indications (Hard Alternate Mode) 7.10.5
EGT Indications 7.10.6
In–Flight Start Envelope 7.10.7
Cross Start Indications 7.10.8
Secondary Engine Indications 7.10.9
N2 Indications 7.10.10
Starting Mode and Idle Target Indication 7.10.10
N3 Indications 7.10.11
Fuel Flow Indications 7.10.12
Oil Pressure Indications 7.10.12
Oil Temperature Indications 7.10.13
Oil Quantity Indications 7.10.13
Engine Vibration Indications 7.10.14
Engine Controls 7.10.15
Thrust Levers 7.10.15
Fuel Control Switches 7.10.16
Engine Control Panel 7.10.17
Auxiliary Power Unit (APU) 7.10.18
APU Controls 7.10.18
APU Indications 7.10.19

Engine System Description 7.20

Introduction 7.20.1
Engine Intermix 7.20.1

Engine Indications 7.20.1
Primary Engine Indications 7.20.2
Secondary Engine Indications 7.20.2
Display Format 7.20.2
Electronic Engine Control (EEC) 7.20.3
EEC Normal Mode 7.20.4
EEC Alternate Mode 7.20.4
Overspeed Protection 7.20.6
Secondary Air System (SAS) 7.20.6
Thrust Control Malfunction Accommodation 7.20.7
Thrust Asymmetry Protection (TAP) 7.20.7
EEC Idle Selection 7.20.9
Engine Start and Ignition System 7.20.9
Autostart 7.20.10
In–Flight Start 7.20.11
Engine Ignition 7.20.11
Auto–Relight 7.20.12
Engine Start and Ignition System Schematic 7.20.12
Engine Fuel System 7.20.13
Engine Fuel System Schematic 7.20.14
Engine Oil System 7.20.14
Engine Oil System Schematic 7.20.15
Thrust Reverser System 7.20.15
Thrust Reverser Schematic 7.20.17
Airborne Vibration Monitoring System 7.20.18
Engine Failure Alert System 7.20.18

APU System Description 7.30

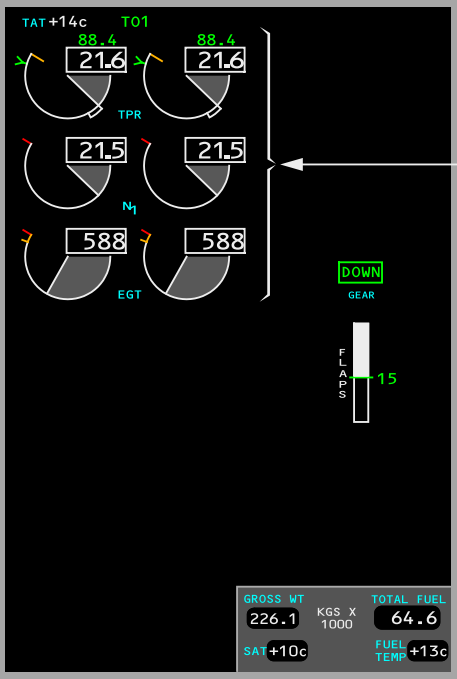
Introduction 7.30.1
APU Location 7.30.1
APU Operation 7.30.2
APU Start 7.30.2

APU Automatic Start 7.30.3
APU Shutdown 7.30.3
APU Operating Modes 7.30.3

EICAS Messages 7.40

Engines, APU EICAS Messages 7.40.1
APU 7.40.1
Engine 7.40.1

EICAS Display



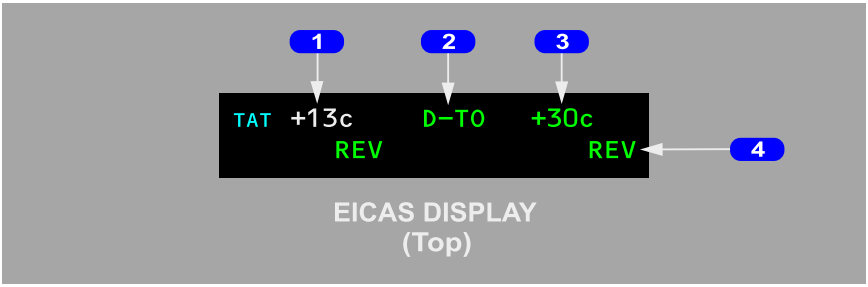
CAPTAIN / FIRST OFFICER INBOARD DISPLAY

1 Primary Engine Indications

Displayed full time on the EICAS display:

- TPR
- N1
- EGT.

Mode Indications



1 Total Air Temperature (TAT)

Displayed (white)—TAT (deg. C).

2 Thrust Reference Mode

Displayed (green)—selected FMS thrust reference mode:

- TO—maximum rated takeoff thrust
- TO 1—derate one takeoff thrust
- TO 2—derate two takeoff thrust
- D–TO—assumed temperature derated takeoff thrust
- D–TO 1—derate one assumed temperature derated takeoff thrust
- D–TO 2—derate two assumed temperature derated takeoff thrust
- CLB—maximum rated climb thrust
- CLB 1—derate one climb thrust
- CLB 2—derate two climb thrust
- CON—maximum rated continuous thrust
- CRZ—maximum rated cruise thrust
- G/A—maximum go-around thrust.

3 Assumed Temperature

Displayed (green)—selected assumed temperature (deg. C) for reduced thrust takeoff.

4 Thrust Reverser Indication

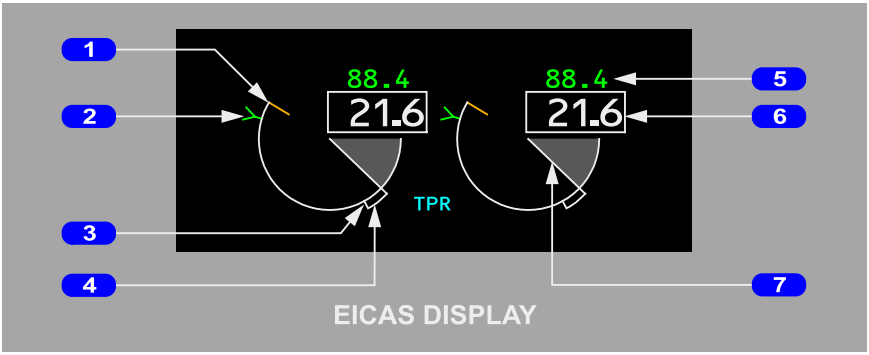
Displayed REV (amber)—reverser in transit.

Displayed REV (green)—reverser fully deployed.

TPR Indications

Notes: 1. During tailwind conditions, slight TPR fluctuations may occur prior to 30 knots forward airspeed.

2. When reverse thrust is activated, the following indications are not displayed:
   - maximum TPR line
   - commanded TPR
   - reference/target TPR indication
   - reference TPR.



1 Maximum TPR Line

Displayed (amber).

2 Reference/Target TPR Indication

Displayed (green)—reference TPR limit.

Displayed (magenta)—target FMC commanded TPR when VNAV is active and:

- autothrottle connected in THR or THR REF mode, or
- autothrottle disconnected.

3 Commanded TPR

Displayed (white).

4 Commanded TPR Sector

Displayed:

- (white)—a momentary difference between engine TPR and TPR commanded by thrust lever position
- (amber filled)—a difference between engine TPR and commanded TPR exists and engine TPR is not closing toward commanded TPR. EICAS alert message ENG THRUST (L or R) is displayed.

5 Reference TPR

Displayed (green).

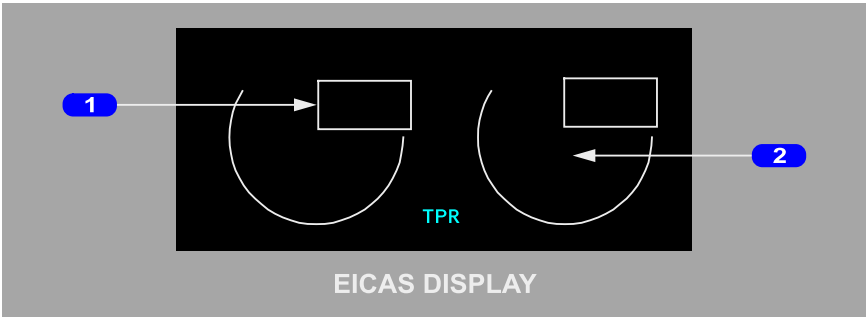
6 Actual TPR

Displayed (white).

7 Actual TPR Indication

Displayed (white).

TPR Indications (Alternate Mode)



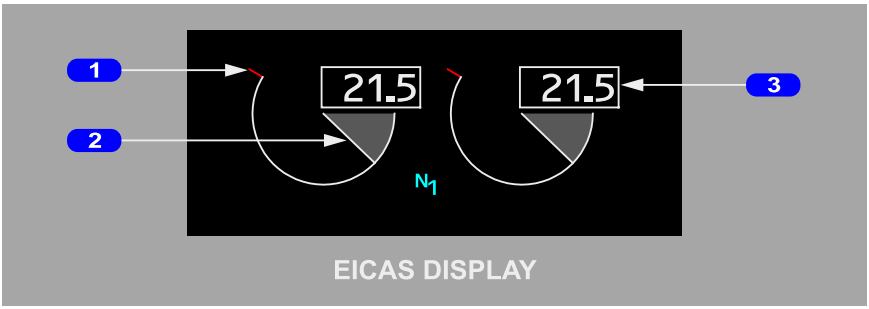
1 Actual TPR

Displayed (blank).

2 Actual TPR Indication

Displayed (blank).

N1 Indications



1 N1 Red Line

Displayed (red)—N1 RPM operating limit.

2 N1 Indication

N1 RPM, displayed:

- (white)—normal operating range
- displayed (red)—operating limit reached.

3 N1

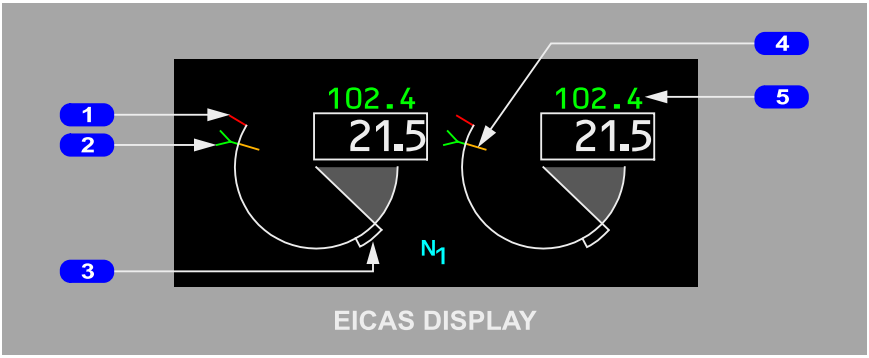
Digital N1 RPM (%), displayed:

- (white)—normal operating range
- displayed (red)—operating limit reached.

N1 Indications (Hard Alternate Mode)

Note: When reverse thrust is activated, the following indications are not displayed:

- maximum N1 line
- commanded N1
- reference/target N1 indication
- reference N1.



1 N1 Red Line

Displayed (red).

2 Reference/Target N1 Indication

Displayed (green)—reference N1 limit.

Displayed (magenta)—target FMC commanded N1 when VNAV is active and:

- autothrottle connected in THR or THR REF mode, or

- autothrottle disconnected.

3 Commanded N1 Sector

Displays momentary difference between engine N1 and N1 commanded by thrust lever position.

Displayed:

- (white)—a momentary difference between engine N1 and N1 commanded by thrust lever position
- (amber filled)—a difference between engine N1 and commanded N1 exists and engine N1 is not closing toward commanded N1. EICAS alert message ENG THRUST (L or R) is displayed.

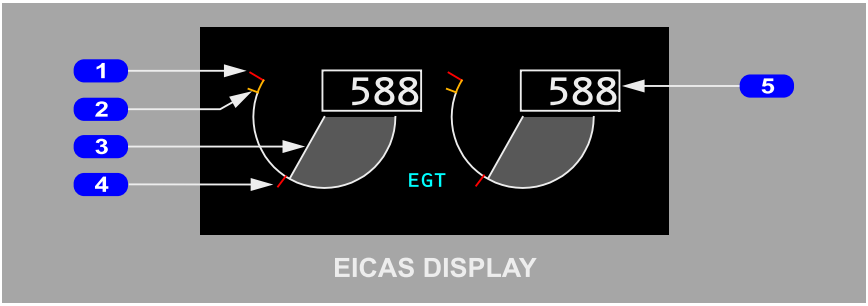
4 Maximum N1 Line

Displayed (amber).

5 Reference N1

Displayed (green)—thrust reference calibrated for N1.

EGT Indications



1 EGT Red Line

Displayed (red)—maximum takeoff EGT limit.

2 EGT Amber Band

Displayed (amber)—maximum continuous EGT limit.

3 EGT Indication

Displayed:

- (white)—normal operating range
- (amber)—maximum continuous limit reached
- (red)—maximum start or takeoff limit reached.

4 EGT Start Limit Line

Displayed (red) when the engine fire switch is in and:

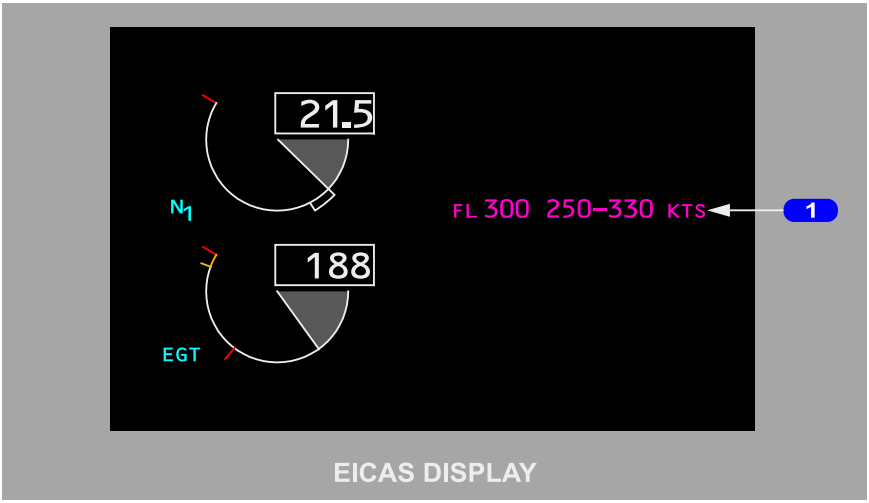
- the FUEL CONTROL switch is in CUTOFF, or
- the N2 RPM is below idle.

5 EGT

EGT (deg. C), displayed:

- (white)—normal operating range
- (amber)—maximum continuous limit reached
- (red)—maximum start or takeoff limit reached.

In–Flight Start Envelope

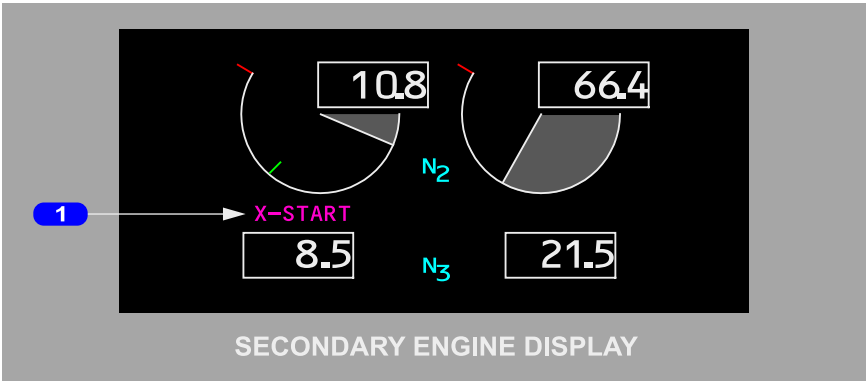


1 In-Flight Start Envelope

Displayed (magenta) – airspeed range necessary 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:

- the FUEL CONTROL switch is in CUTOFF, or
- the engine N2 RPM is below idle.

Cross Start Indications

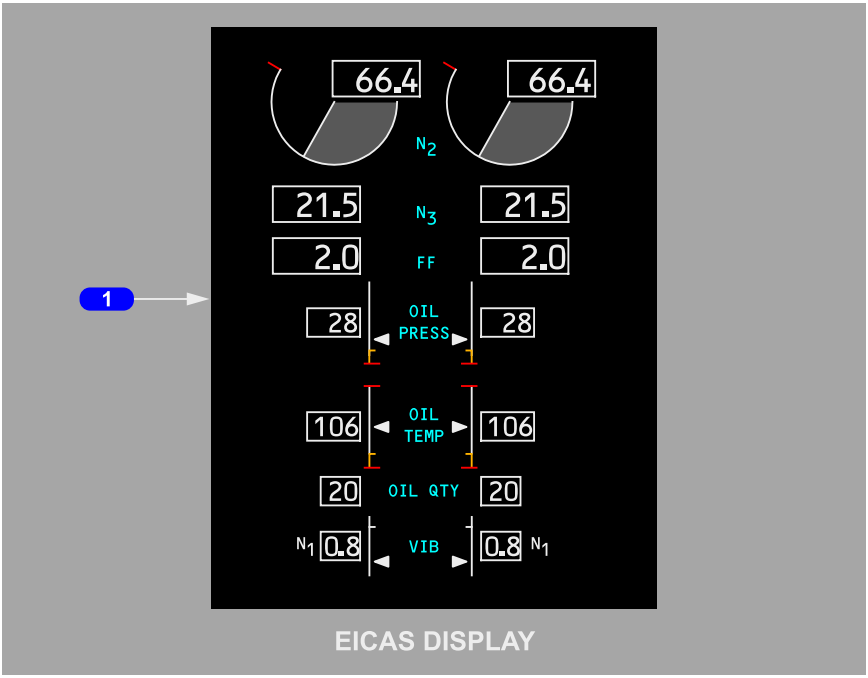


1 CROSS START Indication

Displays X-START (magenta) when current altitude and/or airspeed are outside the windmilling start envelope. Starter assist is recommended for an in-flight start.

Secondary Engine Indications

(See Display Select Panel on page 10.10.51 for additional information.)

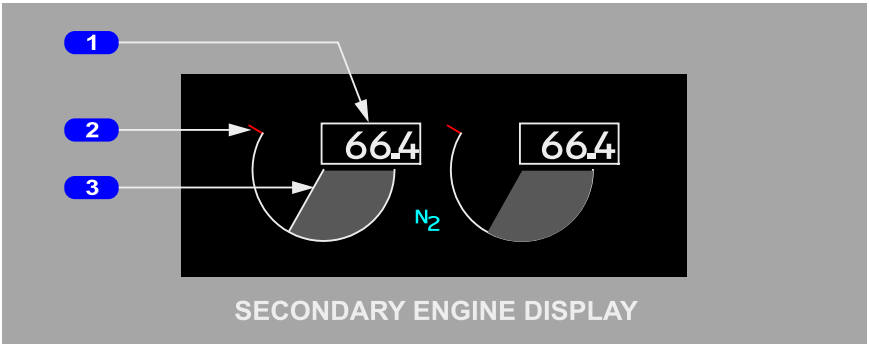


1 Secondary Engine Display

Displays:

- N2 RPM
- N3 RPM
- fuel flow (FF)
- oil pressure
- oil temperature
- oil quantity
- vibration.

N2 Indications



1 N2

N2 RPM (%), displayed:

- (white)—normal operating range
- (red)—operating limit reached.

2 N2 Red Line

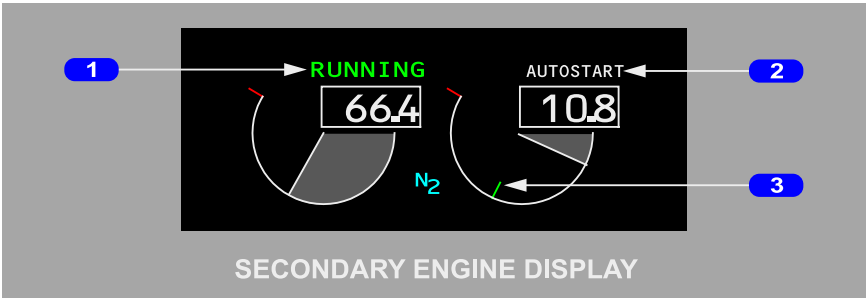
N2 RPM operating limit, displayed (red).

3 N2 Indication

N2 RPM, displayed:

- (white)—normal operating range
- (red)—operating limit reached.

Starting Mode and Idle Target Indication



1 RUNNING Indication

Displayed (green)—

- fuel control switch is in the RUN position, and
- engine is at or above idle.

The RUNNING indication blanks 30 seconds after engine reaches idle.

2 Starting Mode

AUTOSTART (white)—EEC is in autostart mode.

The AUTOSTART indication blanks when the system is no longer attempting an engine start.

AUTORELIGHT (white)—EEC is in auto-relight mode.

The AUTORELIGHT indication blanks when the system is no longer attempting an engine relight.

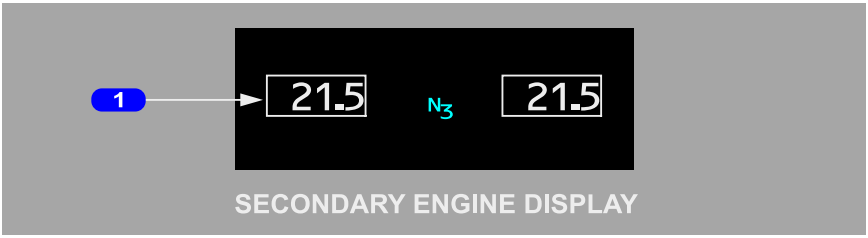
3 Idle Target Indication

Indicates approximate RPM where the engine can maintain self-sustained running operation.

Displayed (green)—

- fuel control switch is in the RUN position, and
- engine is below idle.

N3 Indications

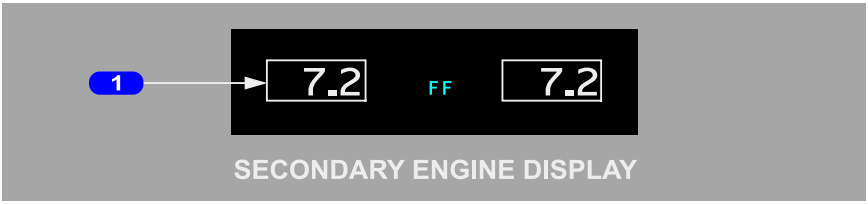


1 N3

N3 RPM (%), displayed:

- (white)—normal operating range
- (red)—operating limit reached.

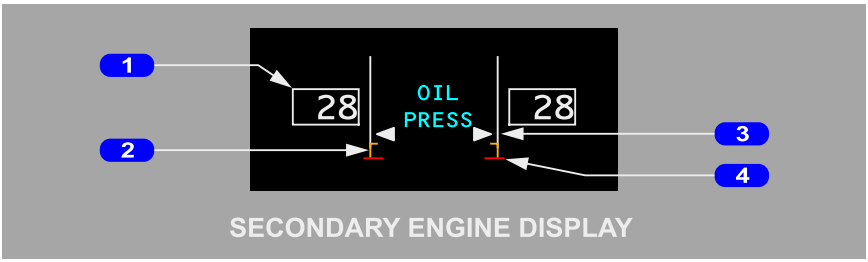
Fuel Flow Indications



1 Fuel Flow

Displayed (white)—fuel flow to the engine (kilograms per hour × 1000).

Oil Pressure Indications



1 Oil Pressure

Engine oil pressure (psi), displayed:

- (white)—normal operating range
- (amber)—caution range reached
- (red)—operating limit reached.

2 Oil Pressure Amber Band

Displayed (amber)—oil pressure caution range.

3 Oil Pressure Pointer

Engine oil pressure, displayed:

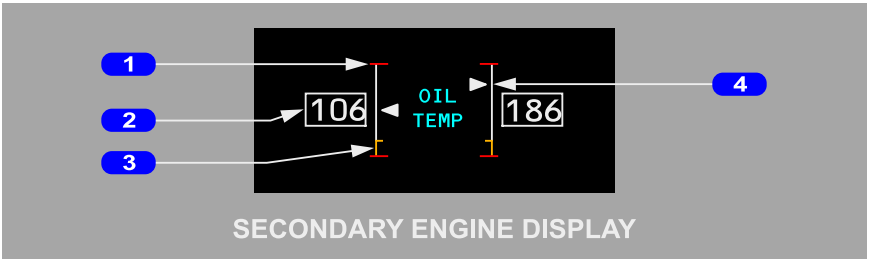
- (white)—normal operating range
- (amber)—caution range reached
- (red)—operating limit reached.

4 Oil Pressure Red Line

Displayed (red)—oil pressure operating limit.

Vertical position of oil pressure red line will vary with N2 RPM.

Oil Temperature Indications



1 Oil Temperature Red Line

Displayed (red)—oil temperature operating limit.

2 Oil Temperature

Engine oil temperature (deg. C), displayed:

- (white)—normal operating range
- (amber)—caution range reached
- (red)—operating limit reached.

3 Oil Temperature Amber Band

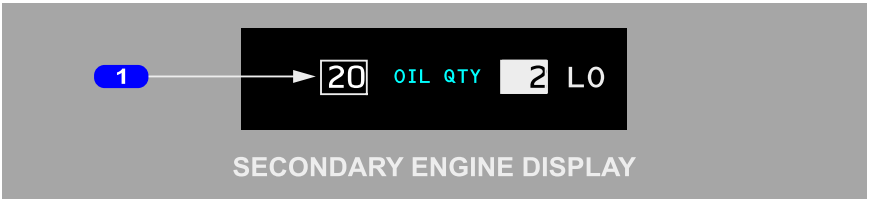
Displayed (amber)—oil temperature caution range.

4 Oil Temperature Pointer

Engine oil temperature, displayed:

- (white)—normal operating range
- (amber)—caution range reached
- (red)—operating limit reached.

Oil Quantity Indications



1 Oil Quantity

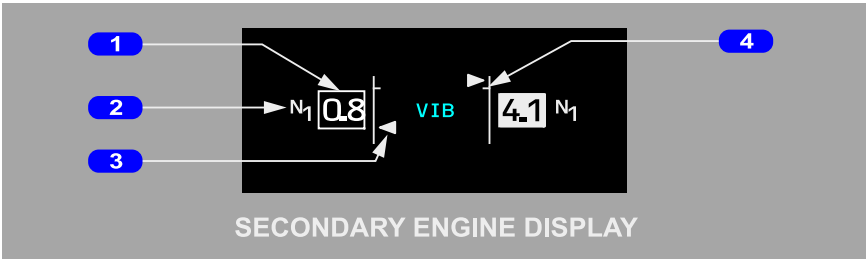
Usable oil quantity (liters).

Displayed:

- (white)—normal quantity
- (black numbers on white background)—low quantity.

Note: LO—displayed (white) when quantity is low.

Engine Vibration Indications



1 Engine Vibration

Engine vibration, displayed:

- (white)—normal operating range
- (black numbers on a white background)—high vibration.

2 Vibration Source

Identifies the vibration source being displayed.

Displayed (white)—vibration source with the highest vibration:

- N1 rotor vibration
- N2 rotor vibration
- N3 rotor vibration
- BB (broad band) vibration.

If the vibration source BB is displayed, the source is unknown and average vibration is displayed.

3 Engine Vibration Pointer

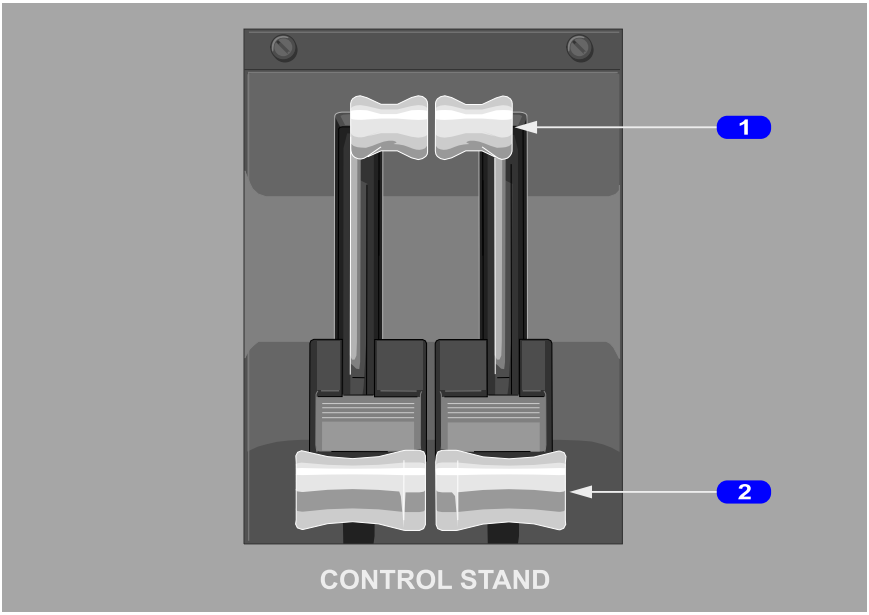
Displayed (white)—indicates engine vibration level.

4 Engine Vibration High Band

Displayed (white)—vibration level at which automatic display of secondary engine indications occurs.

Engine Controls

Thrust Levers



1 Reverse Thrust Levers

Controls engine reverse thrust.

Reverse thrust can only be selected when the forward thrust levers are closed.

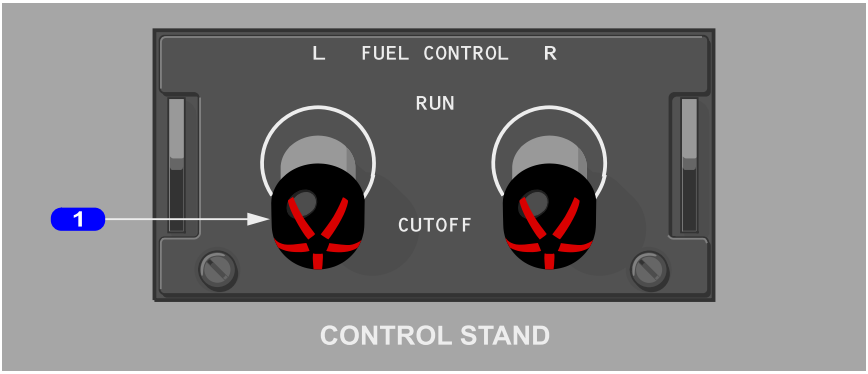
Actuates the automatic speedbrakes. (See Spoiler Speedbrake Operation on page 9.20.18 for additional information.)

2 Forward Thrust Levers

Controls engine forward thrust.

The thrust levers can only be advanced if the reverse thrust levers are down.

Fuel Control Switches



1 FUEL CONTROL Switch

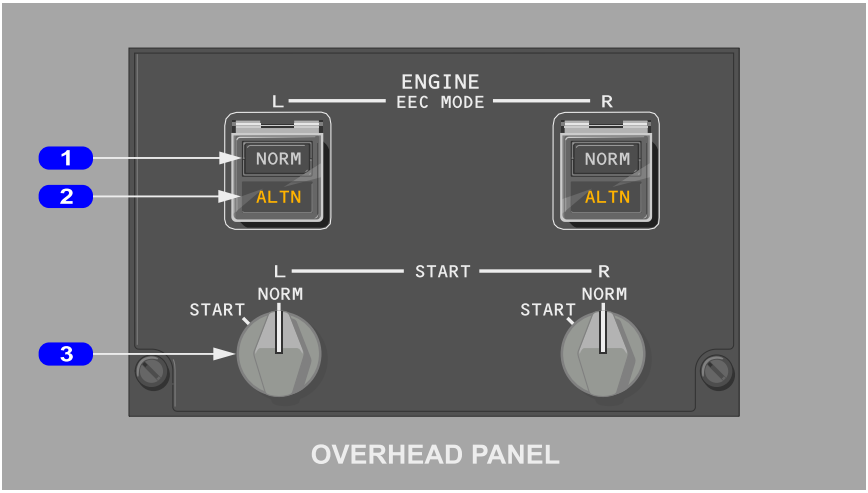
RUN—

- opens the spar fuel valve
- arms the engine fuel valve (the EEC opens the valve when required)
- arms the selected igniters (the EEC turns the ignitors on when required).

CUTOFF—

- closes the engine fuel valve (and spar fuel valve if start switch not in START)
- removes igniter power
- unlocks the engine fire switch.

Engine Control Panel



1 Electronic Engine Control (EEC) Mode Switch

NORM—

- selects the normal engine control mode for engine control
- the EEC sets thrust using TPR as the controlling parameter.

Off (ALTN visible)—

- selects the alternate engine control mode for engine control
- thrust is set using N1 RPM as the controlling parameter.

2 Electronic Engine Control (EEC) Alternate (ALTN) Light

Illuminated (amber)—the alternate engine control mode is either automatically or manually selected.

3 START Selector

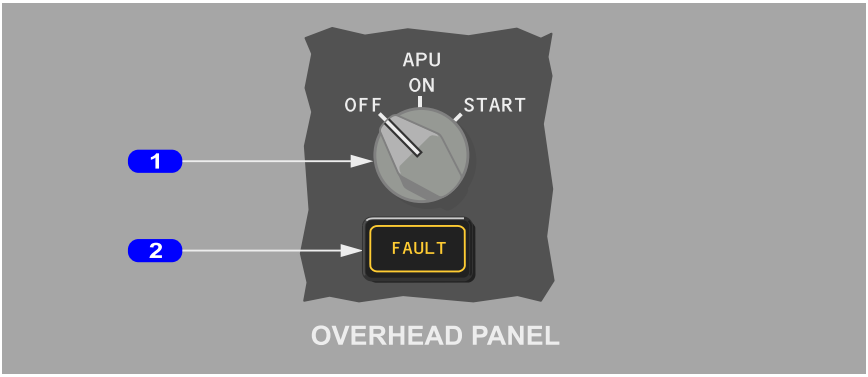
START—

- initiates engine start by commanding the fuel spar valve to open and the starter motors to energize
- releases to NORM at completion of start.

NORM—the starter motor is de-energized.

Auxiliary Power Unit (APU)

APU Controls



1 APU Selector

OFF—
- initiates normal shutdown
- resets auto shutdown fault logic.

ON (APU operating position)—
- opens the APU fuel spar valve and inlet door
- activates AC or DC fuel pump
- powers the APU controller.

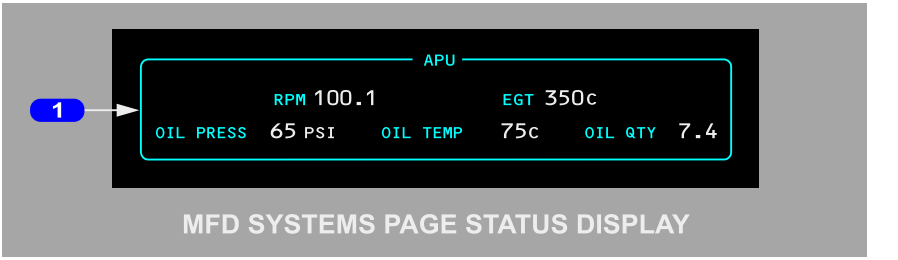
START (momentary position, spring–loaded to ON)—
- initiates automatic start sequence.

Note: If the common core system is not running, the APU controller delays start until the required common core applications are available.

2 APU FAULT Light

Illuminated (amber):
- APU fault and/or fire is detected
- APU shutdown due to fault and/or fire
- momentarily during APU controller self–test.

APU Indications



1 APU Status Display

RPM—APU rotation speed (% RPM).

EGT—APU exhaust gas temperature (deg. C).

OIL PRESS—APU oil pressure (PSI).

OIL TEMP—APU oil temperature (deg. C).

OIL QTY—APU oil quantity (liters).

Introduction

The airplane is powered by two Rolls Royce Trent 1000AE engines. The engines are rated at 64,100 pounds of takeoff thrust each. TQA to TQF

The airplane is powered by two Rolls Royce Trent 1000D engines. The engines are rated at 70,200 pounds of takeoff thrust each. TWA,B

Note: This thrust rating is a minimum engine thrust known as Boeing Equivalent Thrust (BET), useful as a takeoff reference under certain conditions rather than the thrust rating at static conditions listed on the Type Certificate Data Sheet (TCDS).

The engines are three-rotor axial flow turbofans of high compression and bypass ratio. The N1 rotor consists of the fan and a low pressure turbine section on a common shaft. The N2 rotor consists of an intermediate pressure compressor section and an intermediate pressure turbine section on a common shaft. The N3 rotor consists of a high pressure compressor section and a high pressure turbine section on a common shaft. The N1, N2, and N3 rotors are mechanically independent from each other. The N2 rotor drives the engine accessory gearbox.

Each engine is controlled by an EEC. The EECs monitor autothrottle and flight crew inputs through the thrust levers to automatically control the engines.

Each engine has individual flight deck controls. Thrust is set by positioning the thrust levers. The thrust levers are positioned automatically by the autothrottle system or manually by the flight crew. (See Autothrottle System on page 4.20.9 for additional information.)

Engine indications are displayed on the EICAS display.

Engine Intermix

Both engines are set to operate at the same thrust rating. Replacement engine thrust rating is increased or decreased to match the thrust rating of the installed engine configuration. An EGT red line (maximum takeoff EGT limit) difference between engines may be indicated, but these indications are normal.

Engine Indications

Primary and secondary engine indications are provided only on the EICAS display. The EICAS is normally displayed on the inboard MFD window of the left or right inboard display unit. (See Display Selection and Control on page 10.20.1 for additional information.)

If engine data is not available, the associated engine indication blanks. There is no EICAS message relating to the loss of engine data.

Primary Engine Indications

TPR, N1, and EGT are the primary engine indications. The primary engine indications are displayed full-time on the EICAS display.

Secondary Engine Indications

The secondary engine indications are:

- N2
- N3
- fuel flow
- oil pressure
- oil temperature
- oil quantity
- engine vibration.

Secondary engine indications are displayed on EICAS below the primary engine indications. The secondary engine indications can be displayed by pushing either secondary engine display switch (ENG on the display select panel). The secondary engine indications are automatically displayed when:

- the displays initially receive electrical power
- a FUEL CONTROL switch is moved to CUTOFF in flight
- an engine fire switch is pulled in flight
- a secondary engine parameter is exceeded
- engine N2 RPM is below idle in flight
- a start selector is in the START position
- FUEL FLOW ENG L/R Advisory is shown.

When secondary engine parameters are automatically displayed on EICAS due to any of the above conditions, they cannot be cleared until the condition is no longer present. After the condition is resolved, the secondary engine parameters can be cleared by pushing the engine (ENG) display switch.

Display Format

Primary engine indications and the N2 indications are both digital readouts and round dial/moving pointer indications. The digital readouts display numerical values while the moving pointers indicate relative value.

Oil pressure, oil temperature, and vibration indications are both digital readouts and vertical indication/moving pointers. N3, fuel flow, and oil quantity are digital readouts only. All digital readouts are enclosed by boxes. The dial and vertical indications display the normal operating range, caution range, and operating limits (as applicable).

Normal operating range is displayed on a dial or vertical indication in white.

The oil temperature and oil pressure vertical indication have caution ranges displayed by amber bands. If oil temperature reaches the caution range, the

digital readout, digital readout box, and pointer change color to amber. An indication changes color back to white when it returns to the normal operating range.

N1, N2, EGT, oil pressure, and oil temperature indications have operating limits indicated by red lines. If one of these indications reaches the red line, the digital readout, dial, box, and pointer change color to red for that indication. Oil temperature and oil pressure indication changes color back to white when it returns to the normal operating range.

If an N1, N2, N3, or EGT red line is exceeded, the box enclosing the digital readout remains red after the exceeded limit returns to the normal range. The red box color can be canceled to white or recalled to red by pushing the cancel/recall switch on the display select panel.

The maximum TPR limit is indicated by an amber line at the top of the TPR dial. The TPR indication does not change color when maximum TPR is reached. The reference/target TPR indication displays the FMS reference or target TPR. The commanded TPR indication displays the EEC calculated TPR commanded by thrust lever position.

The EGT indication has a maximum continuous limit represented by an amber band. The maximum continuous limit does not apply during takeoff or go–around. If EGT reaches the maximum continuous limit, the digital indication, box, pointer, and dial all change color to amber. EGT indications are inhibited from changing to amber during takeoff or go–around for five minutes. The EGT indication is often in the amber band during takeoff and go-around; this is acceptable. The inhibit is extended to ten minutes for single–engine operation. The EGT indication has a maximum takeoff limit displayed by a red line. If EGT reaches the maximum takeoff limit, the digital indication, box, pointer and dial, all change color to red.

For low oil quantity, the oil quantity digital readout changes to black text on a white background. The white text LO is displayed adjacent to the readout.

For high engine vibration, the vibration digital readout changes to black text on a white background.

Electronic Engine Control (EEC)

Each EEC has full authority over engine operation. The EEC uses thrust lever inputs to automatically control forward and reverse thrust. The EEC has two control modes: normal and alternate. In the normal mode, the EEC uses TPR as the parameter for setting thrust. In the alternate mode, the EEC uses N1 RPM as the controlling parameter.

During engine start, initial EEC power is supplied by the airplane until a Permanent Magnet Alternator (PMA) is able to provide sufficient power. The airplane also serves as an alternate EEC power source whenever a PMA is unavailable.

EEC Normal Mode

In the normal mode, the EEC sets thrust by controlling TPR based on thrust lever position. TPR is commanded by positioning the thrust levers either automatically with the autothrottles, or manually by the flight crew.

Maximum TPR represents the maximum rated thrust available from the engine. The EEC continuously computes maximum TPR.

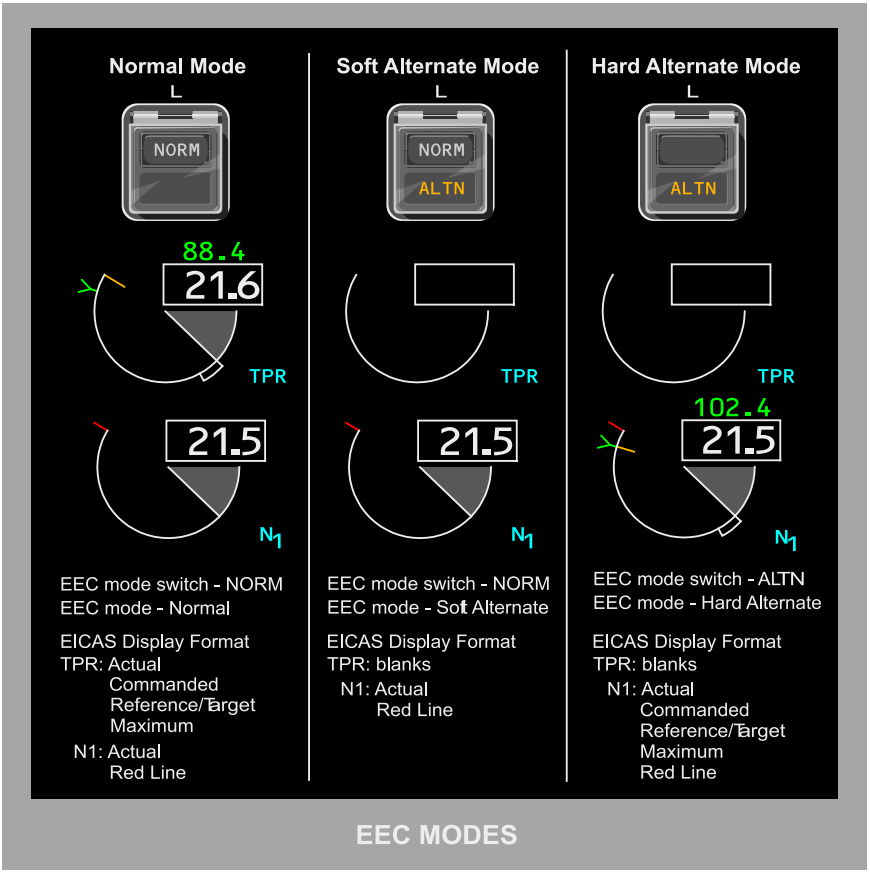
Maximum rated thrust is available in any phase of flight by moving the thrust levers to the full forward positions.

EEC Alternate Mode

If the required signals are not available to operate in the normal mode, the EEC automatically uses the alternate mode. In the alternate mode, the EEC schedules N1 as a function of thrust lever position. The alternate mode provides soft and hard levels of control:

- Soft—When the EEC automatically switches an engine to the alternate mode and the EEC mode switch remains in NORM, the EEC is in the soft alternate mode (the switch position is NORM, the EEC mode is alternate) at a fixed thrust lever position, thrust does not change
- Hard – When ALTN is manually selected on an EEC mode switch, that engine is switched to the hard alternate mode (the switch position is ALTN, the EEC mode is alternate). Reference and target N1, and maximum and commanded N1 values are displayed on the N1 indication during the hard alternate mode. Thrust may change to set the commanded N1 when ALTN is manually selected.

For the normal, soft alternate, and hard alternate modes, the following TPR and N1 information is displayed.



EEC MODES

Automatic reversion or manual selection to the alternate mode is indicated by the EICAS advisory message ENG EEC MODE (L, R) and illumination of the EEC ALTN light on the associated EEC mode switch. Selecting the alternate mode on both engines eliminates thrust lever stagger at equal thrust settings, or asymmetric thrust when the thrust levers are operated together.

The autothrottles remain connected whenever the EEC automatically switches to the alternate mode. The alternate mode N1 reference/target values are computed by the FMC.

Note: Autothrottles remain connected in the soft or hard alternate mode.

The alternate mode schedule (N1 schedule) provides equal or greater thrust than the normal mode for the same thrust lever position.

Thrust protection is not provided in the alternate mode and maximum rated thrust is reached at a thrust lever position less than full forward. As a result, thrust overboost can occur at full forward thrust lever positions. The EICAS caution message ENG LIMIT PROT (L, R) is displayed if the thrust lever position commands an N1 greater than the maximum rated thrust (maximum N1). N1 and N2 red line protection is still available in the alternate control mode.

Overspeed Protection

The EEC monitors N1, N2, and N3 rotor speeds and commands reduced fuel flow if any rotor speed approaches its redline limit. The EICAS advisory message ENG RPM LIMITED (L or R) is displayed when RPM limiting is in effect. If the redline limit is exceeded, the EICAS caution message ENG LIMIT EXCEED (L or R) is displayed.

Overspeed protection is provided on N1 and N2 shafts (N3 is indirectly protected by the N1 and N2 protection). If RPM limiting fails and an overspeed condition persists, the EEC commands fuel shut off to shutdown the engine. The EICAS caution message ENG FAIL (L or R) is displayed with an aural beeper once the engine falls below idle speed.

If the EECs are in alternate mode, advancing the thrust levers full forward provides some overboost and should be considered only during emergency situations when all other available actions have been taken and terrain contact is imminent.

Secondary Air System (SAS)

The engines are equipped with a secondary air system to provide cooling and sealing airflow to the intermediate pressure turbine. A secondary air system valve (SASV) regulates intermediate pressure stage-8 and high pressure stage-3 bleed air to provide the necessary airflow. The system is monitored and controlled by the EEC.

At idle, failure of the SASV in the closed position could result in the ingestion of turbine annulus gasses into the SAS. To prevent this, the EEC commands increased idle speed which provides sufficient pressure in the SAS to prevent gas ingestion. On the ground below 80 KIAS the EICAS advisory message ENG CONTROL (L or R) is displayed.

Should the SASV fail in the open position, the temperature in the SAS rises rapidly and could result in overheated engine bearings. The aircrew is alerted to this condition when:

- the EICAS warning message ENG THRUST HIGH (L or R) is displayed accompanied by an audible siren, and/or
- the EICAS advisory message ENG SEC AIR VLV (L or R) is displayed.

In addition to the EICAS messages, one or more of the following occurs:

- the maximum thrust indication (amber tick mark) is reduced on the TPR (normal mode) or N1 (alternate mode) gauge

- above 400 feet AGL, engine thrust is automatically reduced to a safe thrust limit (additional manual thrust reduction may be required per non-normal procedure)
- above 400 feet AGL, an amber filled thrust command arc appears on the TPR (normal mode) or N1 (alternate mode) gauge.

Note: If the EEC determines that a failed SASV is working normally, the EEC removes all protections and full thrust is again available.

Thrust Control Malfunction Accommodation

Thrust Control Malfunction Accommodation is an EEC function that provides protection against idle thrust asymmetry conditions while on the ground.

The EEC commands shutdown of the affected engine when the:

- airplane is on the ground, and
- thrust lever is at idle, and
- engine is above idle speed and not decelerating normally.

The EICAS caution message ENG FAIL (L or R) is displayed with an aural beeper once the engine falls below idle speed.

Thrust Asymmetry Protection (TAP)

TAP is an automatic feature that provides protection against asymmetric thrust during takeoff or go-around by limiting thrust on the higher thrust engine. TAP enhances safety by:

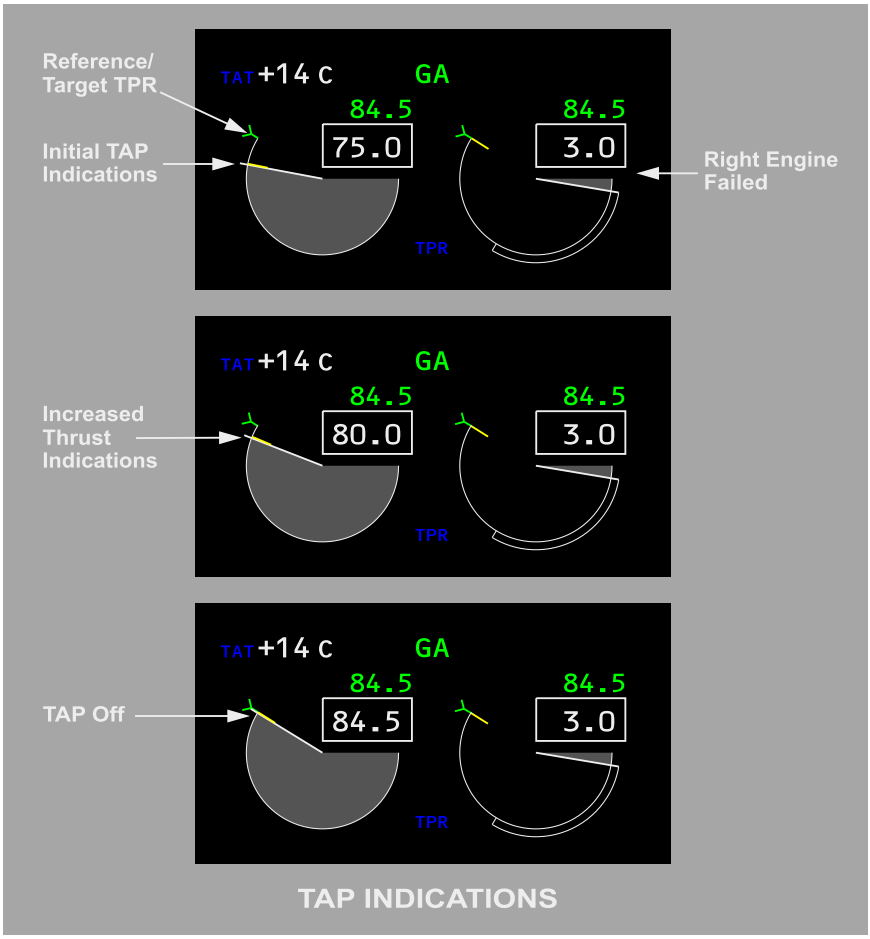
- allowing a decrease in approach speed at light gross weights, and
- providing engine-out control capability for speeds above stick shaker, and
- allowing full rated thrust to be available for all-engine operation at all weights and airspeeds.

For an engine-out condition, TAP reduces thrust on the operating engine to ensure there is sufficient rudder for directional control. TAP reduces thrust when the airspeed decreases below approximately V2 on a takeoff or below approximately VREF on a go-around. Once speed is increased above V2/VREF, TAP increases thrust. The TAP function does not affect thrust for engine out operations flown at or above V2/VREF, with the exception of a light weight go-around at weights less than 152,273 kilograms where TAP reduces thrust slightly at VREF on the go-around.

TAP does not affect certified takeoff performance. For airspeeds where TAP does limit thrust, climb gradient is higher with TAP limiting thrust than it would be if TAP did not limit thrust. This occurs because additional thrust asymmetry creates more airplane drag than the thrust that was added. Therefore, if TAP becomes active due to a speed reduction below V2, any reduction in climb gradient from that scheduled for the takeoff is due to mismanaged speed and not due to TAP.

TAP is only available when the flight controls are operating in normal mode, and the EEC is in normal or alternate modes.

In the following example, the right engine has failed and TAP is actively reducing thrust on the left engine. As TAP reduces thrust, the maximum and commanded TPR tics move down to the reduced TAP thrust value, and the actual TPR indication follows. The reference/target TPR indication and the thrust levers do not move. As TAP increases thrust back to normal, the maximum and commanded TPR tics on the left engine move up until they again match the reference/target TPR indication.



TAP INDICATIONS

The EICAS advisory message THRUST ASYM PROT is displayed if the TAP function is inoperative.

For additional information on TAP:

- See Alerts Displayed on the PFD on page 15.10.8
- See Alerts Displayed on the HUD on page 15.10.9
- See Thrust Asymmetry Minimum Speed (TAMS) on page 15.20.10.

EEC Idle Selection

The EEC selects minimum idle, approach idle, icing idle, and ice crystal idle automatically. Minimum idle is a lower thrust than approach idle. Minimum idle is selected for ground operation and most phases of flight.

Approach idle is selected in flight when:

- the flaps are commanded to 25 or greater, or
- the landing gear is selected DOWN.

Approach idle decreases acceleration time for go-around. Approach idle is maintained until after touchdown when the EEC selects minimum idle.

Icing idle is selected when:

- engine anti-ice on.

Ice crystal idle is selected in flight when:

- OAT is between ISA and ISA +29 deg. C and altitude is between 35,000 feet and 5,000 feet.

Note: Small temporary ice crystal idle differences in flight are normal. These are a result of minor differences between left and right engine calculated total air temperature.

Engine Start and Ignition System

The engines can only be started using the autostart system.

The electrical system powers two starter motors mechanically connected to the N2 shaft via the accessory gearbox. During engine starts, power to run the starters is drawn from the airplane's electrical system. There are two power sources that can provide starter power; the APU and the forward external power. Normally, APU power is used to drive the engine starters.

Simultaneous engine start is only allowed when the APU is running and both APU starter generators are operational. If both engines are commanded to start with an inadequate power configuration, the second start command is ignored.

Load shed always occurs during engine start. Shed systems appear on their respective synoptic with the majority appearing on the electrical synoptic.

The START selectors control the starter motors. Ignition and fuel flow are controlled through the FUEL CONTROL switches.

The EEC monitors the start and commands starter cutout when the engine reaches idle speed. The START selector then releases to the NORM position.

In the event both starters on the respective engine fail, STARTERS displays across the respective starter symbols on the electrical synoptic. The EICAS advisory message ENG STARTERS L, R also is displayed. (See Synoptic Indication Symbology on page 6.10.7 for additional information.)

A maximum start limit line (red) is displayed on the EGT indication when the FUEL CONTROL switch is moved to CUTOFF or the engine is not running and the respective fire switch is not pulled. It remains displayed after the FUEL CONTROL switch is moved to RUN until the engine is stable at idle. The EGT indication changes color to red if the EGT start limit is reached.

Autostart

Autostart allows the EEC to control fuel and ignition. The autostart sequence is initiated by rotating the START selector to START and moving the FUEL CONTROL switch to RUN. For in-flight windmill starts the autostart sequence is initiated by moving the FUEL CONTROL switch to RUN.

The START selector applies electrical power to the starter motors to begin dry motoring the engine. Moving the START selector to START or the FUEL CONTROL switch to RUN opens the spar fuel valve. The proper sequencing of fuel and ignition is controlled by the autostart system. With the FUEL CONTROL switch positioned to RUN, the EEC opens the engine fuel valve and energizes the ignitor(s) at the appropriate N3 RPM.

During autostart, the EEC monitors EGT, N2 RPM, N3 RPM, and other engine parameters until the engine reaches idle speed.

During ground starts, the autostart system monitors engine parameters and aborts the start for any of the following:

- loss of both starters
- no N1 rotation.

If one of the above conditions is detected the EEC aborts the autostart sequence without motoring and does not make a second attempt. The starters are de-energized and the START selector returns to the NORM position. The EICAS caution message ENG AUTOSTART (L or R) displays.

During ground starts, the autostart system monitors engine parameters and attempts to correct the start for any of the following:

- compressor stall
- hot start
- hung start
- loss of one starter
- no EGT rise
- start time exceeds the starter duty cycle timer.

If one of the above conditions is detected the EEC turns off fuel and ignition and motors the engine for 20 to 30 seconds (depending on the detected condition)

before making a second start attempt. The second attempt uses a reduced fuel schedule and both igniters are enabled. On the ground, if the second attempt fails, the EEC cancels the autostart. Fuel and ignition are shut off and the engine is motored to clear residual fuel. The starters are de-energized and the START selector returns to the NORM position. The EICAS caution message ENG AUTOSTART (L or R) displays. There is a limit of 2 start attempts per start sequence while on the ground. In the air, the EEC does not limit the start attempts.

Note: For in-flight starts, the autostart system temporarily discontinues the start by cutting fuel if the takeoff EGT redline limit is reached, or if a no light-off or a hung start is detected. If one of these conditions is detected, autostart windmill motors the engine for 30 seconds before making another attempt. The starters are re-engaged on the following start attempt. Autostart takes corrective action if some start problems are detected, but does not abort the start. During the second or subsequent start attempts autostart re–introduces fuel and ignition when the EGT falls below 200 deg. C.

In–Flight Start

In-flight start envelope information is displayed on the EICAS display when an engine is not running in flight (N2 RPM below idle RPM) or when an engine is shut down in flight and the respective engine fire switch is not pulled. The in-flight start envelope indicates the airspeed range necessary to ensure an in-flight start at the current flight level. If the current flight level is above the maximum start altitude, the maximum start altitude and respective airspeed range are displayed.

Secondary engine indications are automatically displayed in flight when an engine is not running (N2 RPM is below idle with corresponding FUEL CONTROL switch in RUN) or when a FUEL CONTROL switch is moved to CUTOFF. A starter assist indication (X-START) is displayed below the N2 indication if airspeed is below that recommended for a windmilling start.

For in–flight starts, autostart makes continuous start attempts until the engine either starts or the pilot aborts the start attempt by positioning the FUEL CONTROL switch to CUTOFF (and positioning the START switch to NORM if it was a starter assisted attempt).

During a windmilling in–flight start, the EEC monitors engine parameters to provide the best fuel schedule to ensure the shortest possible start time.

(Engine In–Flight Start, QRH, Non Normal Checklists Chapter 7, for the in–flight engine start procedure.)

Engine Ignition

Each engine has two igniters. The EEC automatically selects the appropriate igniter(s) for successive engine ground starts. Dual igniters are always used for in-flight starts.

Aircraft supplied DC power is the normal power source for ignition. Standby power provides a backup power source for energizing the igniters.

Auto–Relight

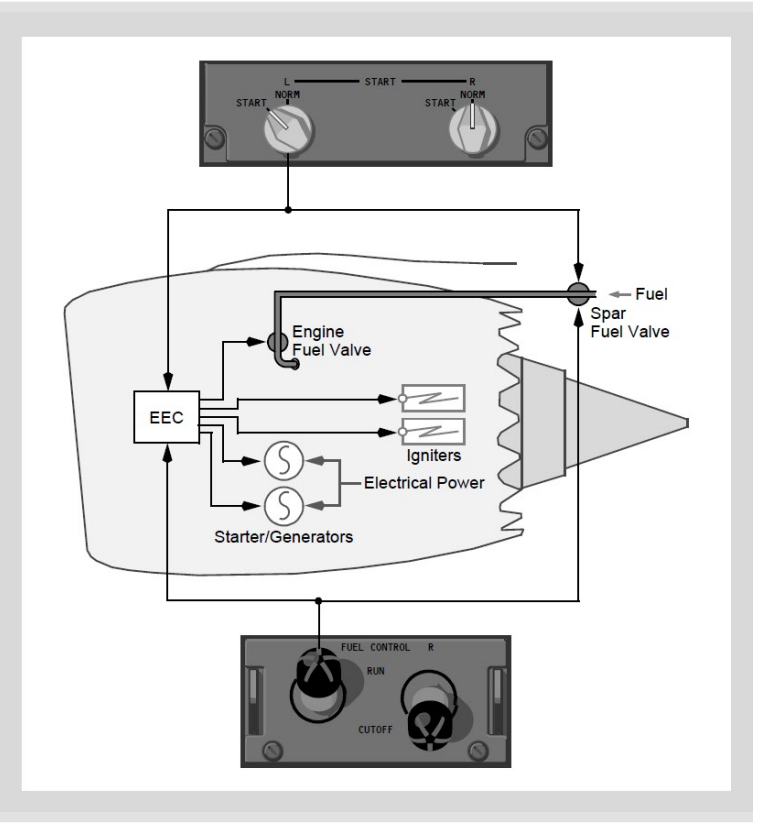
Engine auto-relight protection is provided for flameout and sub-idle stall recovery. There is no manual continuous ignition selection or automatic continuous ignition function. The auto-relight function is activated whenever a flameout is detected, or an engine is at or below idle with the FUEL CONTROL switch in RUN.

When the auto-relight function is activated, the EEC commands both igniters in the respective engine to on in an attempt to recover the engine. The igniters are switched off when the engine again reaches idle.

The EEC also provides protection against flameout during periods of excessive rain/hail ingestion. When a flameout is detected, the EEC energizes both igniters.

Engine Start and Ignition System Schematic

DELETION



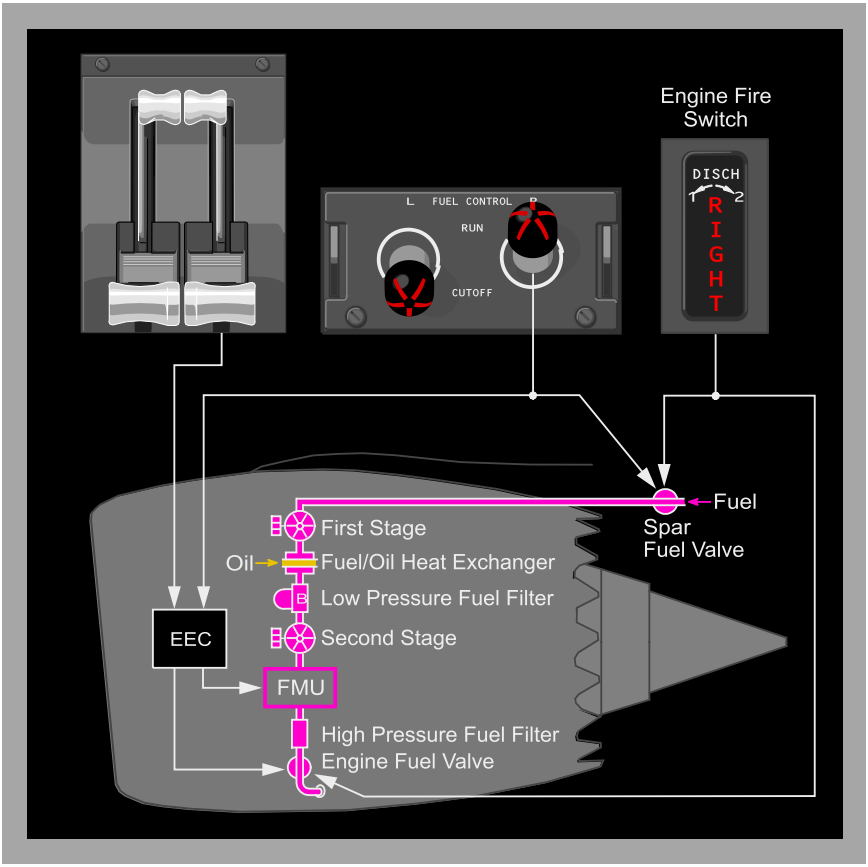
Engine Fuel System

Fuel is supplied by pumps located in the fuel tanks. The fuel flows through a spar valve located in the main tank. It then passes through the first stage engine fuel pump where additional pressure is added. It flows through a fuel/oil heat exchanger where it is preheated. A fuel filter removes contaminants. The second stage of the engine fuel pump adds more pressure before the fuel reaches the fuel metering unit. The fuel metering unit adjusts fuel flow to meet thrust requirements. Leaving the FMU, the fuel flows through a high pressure filter and then through the engine fuel valve into the engine.

The spar and engine fuel valves allow fuel flow to the engine when both valves are open. The spar valve opens when the engine fire switch is IN and either the START selector is in START or the FUEL CONTROL switch is in RUN. The engine fuel valve opens when the engine fire switch is IN and the FUEL CONTROL switch is in RUN. Both valves close when the engine fire switch is OUT, or the FUEL CONTROL switch is in CUTOFF and the START selector is in NORM.

Fuel flow is measured after passing through the engine fuel valve. Fuel flow is displayed on the secondary engine display. Fuel flow information is also provided to the FMS.

Engine Fuel System Schematic



Engine Oil System

The oil system provides pressurized oil to lubricate and cool the engine main bearings, gearbox and accessory drives. The oil system also provides automatic fuel heating for fuel system icing protection.

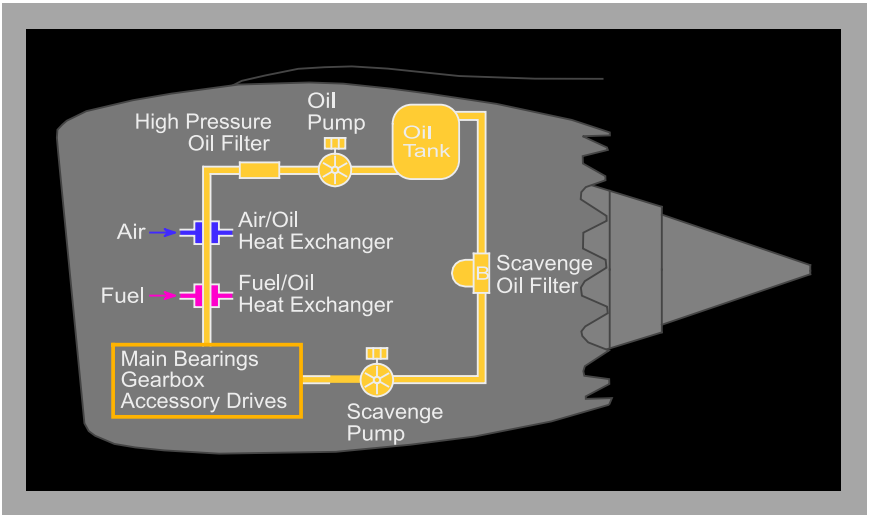
Oil is pressurized by an engine-driven oil pump. From the pump, the oil flows through a high pressure oil filter. An air/oil surface cooler heat exchanger provides oil cooling under conditions of low fuel flow or high fuel temperatures. The engine oil is then cooled primarily by a fuel/oil heat exchanger before being delivered to the various engine components. A scavenge pump returns oil to the tank after passing through a scavenge filter.

Oil pressure, temperature, and quantity are displayed on the engine display. Oil pressure is measured prior to entering the engine by dual oil pressure transmitters (there is no discrete low pressure switch). The EICAS caution message ENG OIL PRESS (L or R) is displayed if pressure decreases below the operating limit.

Oil temperature is measured after leaving the engine by dual oil temperature transmitters. The EICAS advisory message ENG OIL TEMP (L or R) is displayed when oil temperature reaches the red line limit.

There is no minimum oil quantity limit (no amber or red line limit); however, a low oil quantity causes automatic display of the secondary engine display and reverses the display indication to show black numbers on a white background. There are no operating limitations for the engine oil quantity; therefore, there are no flight crew procedures based solely on a response to low oil quantity.

Engine Oil System Schematic



Thrust Reverser System

Each engine has a hydraulically actuated fan air thrust reverser. Reverse thrust is available only on the ground.

The reverse thrust levers can be raised only when the forward thrust levers are in the idle position. When the reverse thrust levers are raised, the EEC opens the reverser isolation valve. The EEC inhibits reverser isolation valve actuation and reverser deployment unless the airplane is on the ground with the engine running. The EECs also control thrust limits during reverser operation.

There is a physical interlock located in the aisle stand to prevent movement of the reverse thrust lever beyond the reverse idle position until the cowl is partially deployed. The interlock provides tactile feedback to the pilot that the thrust reverser is or is not deployed.

When the reverse thrust levers are pulled aft to the interlock position:

- the autothrottle disengages
- the auto speedbrakes deploy.

When the reverser system is activated:

- the reverser translating sleeves hydraulically move aft
- the fan flow blocker doors rotate into place to direct fan air through stationary cascade guide vanes
- the reverser indication REV is displayed in amber above each digital TPR indication (REV is displayed in amber when the reverser is in transit).

When the interlock releases:

- the reverse thrust levers can be raised to the maximum reverse thrust position
- the REV indication changes to green when the reverser is fully deployed.

Pushing the reverse thrust levers to the full down position retracts the reversers to the stowed and locked position. The thrust levers cannot be moved forward until the reverse thrust levers are fully down.

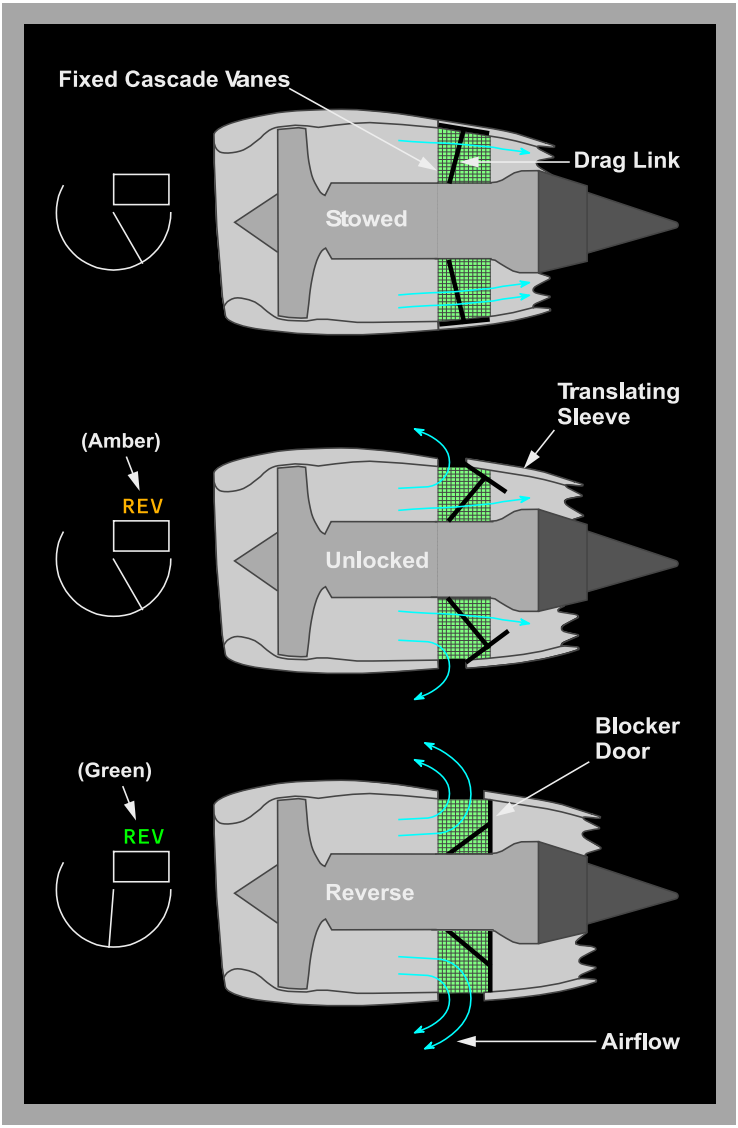
The EICAS advisory message ENG REV LIMITED (L or R) is displayed if the reverser cannot deploy when commanded, or can deploy only with reverse thrust limited to idle. Not all conditions limiting or preventing reverse thrust can be detected before reverse thrust selection. For these conditions, the reverse thrust levers cannot be moved beyond the interlock position.

The EICAS advisory message ENG REVERSER (L or R) is displayed on the ground to indicate a reverser system fault.

The EICAS caution message ENG REV AIR/GND is displayed when the air/ground logic that prevents in-flight thrust reverser deployment has failed.

The EICAS caution message ENG REV COMMANDED (L or R) is displayed when the left or right reverse thrust lever is not in the down position in flight.

Thrust Reverser Schematic



Airborne Vibration Monitoring System

The engine monitor unit tracks engine vibration levels. The vibration indications are displayed on the secondary engine display. The vibration source indication (N1, N2, N3, or BB) is also displayed. If the vibration monitoring system cannot determine the source, BB (broadband) is displayed for the affected engine. Broadband vibration is the average vibration detected.

The airborne vibration monitoring feature is primarily intended to track rotor imbalance, but is also a useful tool for isolating and determining corrective action for engine anomalies. There is no certified vibration limit, but when a vibration value of 4 units is reached, the secondary engine parameters are automatically displayed and the digital vibration readout is displayed in reverse (black digits on white background). Since there are no operating limits, there are no specific flight crew actions (or procedures) based solely on vibration indication. High N1 vibration would most likely be accompanied by tactile vibration where as high N2 or N3 vibration may not be felt. N1, N2 and N3 high vibrations may be accompanied by anomalies in other engine parameters and usually respond to thrust lever adjustment.

Engine Failure Alert System

The engine failure alert system provides alerts when actual engine performance is less than commanded engine performance during a part of the takeoff and for other phases of flight.

A red ENG FAIL is displayed on both PFDs, and ENG FAIL is displayed on both HUDs if actual thrust is less than commanded thrust during takeoff with airspeed between 65 knots and 6 knots prior to V1. The PFD and HUD displays are accompanied by the voice annunciation “Engine Fail,” and the Master WARNING lights illuminating.

The EICAS caution message ENG FAIL (L or R) is displayed if an engine unexpectedly decelerates to less than idle speed. The message remains displayed until the engine recovers or the fuel control switch is moved to CUTOFF.

The EICAS caution message ENG THRUST (L or R) is displayed if:

- the engine is producing less than commanded thrust, and actual thrust is not satisfactorily increasing towards the commanded thrust, or
- the engine is producing more than commanded thrust, and actual thrust is not satisfactorily decreasing towards the commanded thrust
- and, the current airspeed is greater than 6 knots prior to V1.

The EICAS caution message ENG THRUST (L or R) is accompanied by:

- the thrust command arc is filled amber, and
- the Master CAUTION light and beeper aural.

Introduction

The auxiliary power unit (APU) is a self–contained gas turbine engine located in the airplane tailcone.

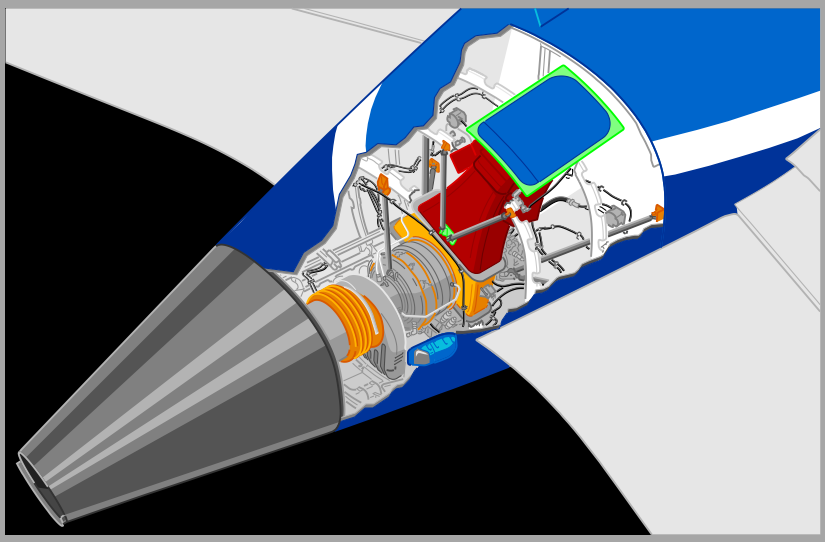
The APU can be started and operated to the airplane maximum certified altitude.

The APU supplies electrical power which is available throughout the airplane operating envelope.

For additional information:

- Electrical—see Controls and Indicators on page 6.10.1
- Electrical—see System Description on page 6.20.1
- See APU Fire Protection on page 8.20.4
- See APU Fuel Feed on page 12.20.6.

APU Location



TAILCONE

APU Operation

APU Start

The APU is started by either the left or right APU starter.

Either starter can be powered by forward external power or an engine generator.

The APU battery powers the APU controller (APUC), air inlet door, and the right starter if required. The main airplane battery powers the APU fuel shutoff valve, DC fuel pump, and fire detection system.

Rotating the APU selector to START begins the automatic start sequence.

Note: If starting the APU from an unpowered airplane (battery switch recently moved to ON), the APUC waits until the common core system (CCS) applications are available before proceeding with the start. The CCS fire detection and fuel management applications are necessary to start the APU and are available when the CDU page is visible on the lower display unit.

The APUC commands the air inlet door to open.

APU fuel is supplied from the left fuel manifold by any operating AC fuel pump, or by the DC fuel pump in the left main tank. With AC power available and the APU selector in the ON position, the left aft fuel pump is commanded on regardless of flight deck switch position.

If AC power is not available or no AC pump pressurizes the left fuel manifold, the DC pump in the left main tank provides APU fuel. The DC pump continues to run until either the APU is shut down or an AC pump supplies fuel pressure. The APU is designed to be started with no pumps operating when on the ground or in-flight up to 14,000 feet.

When the APU air inlet door reaches the full open position, and the required CCS programs are running, the starter engages. Starter selection is automatic. On battery power, only the right starter is used. After the APU reaches the proper speed, APUC commands ignition and fuel. When the APU reaches starter cutout speed (approximately 50% rpm), the starter disengages and ignition is turned off.

When the APU is running (95% of target speed + 2 seconds), the EICAS memo message APU RUNNING is displayed and the APU is ready to power the airplane.

If the start fails, the APU shuts down automatically. The EICAS advisory message APU SHUTDOWN is displayed. Moving the APU selector from ON to OFF clears the message and resets the shutdown system to enable a restart attempt.

The APU battery is designed to support two consecutive start attempts. If the APU fails to start after the second attempt, a 5 minute cooling period must be observed before a third attempt is made.

APU Automatic Start

In flight, if three or more engine generators go offline, the APU automatically starts, regardless of APU selector position. When the automatic start condition is no longer valid, the APU can be shut down by positioning the selector to ON, then OFF. When the automatic start condition is valid, the APU can only be shut down by pulling the APU fire switch.

APU Shutdown

When the APU selector is rotated to OFF, the APUC initiates a normal shutdown sequence. The APU continues running in a two minute cooldown cycle. The EICAS memo message APU COOLDOWN is displayed. At any time during the cooldown period, the APU may be returned to its running condition by placing the APU selector back to ON. When the cooldown period finishes, an APU overspeed condition is simulated to test the overspeed and fuel shutoff protection. This shuts off fuel and the APU shuts down. The APUC then commands the APU spar valve to close and the CCS fuel management application turns off fuel pumps as applicable. At 15% rpm, the APUC commands the air inlet door to close and the normal shutdown sequence is complete.

APU Operating Modes

The APU has attended and unattended operating modes. The attended mode operates when either engine is starting or running, or when the airplane is in flight. The unattended mode operates in all other configurations on the ground.

APU Attended Mode

In the attended mode, any of the following faults cause the APU to shut down immediately:

- APU fire/inlet overtemperature
- overspeed/loss of overspeed protection
- APU controller failure
- speed droop
- APU start failure (no rotation, or no acceleration, or no light-off)
- Air inlet door failed closed.

There is no cooldown period. The EICAS advisory message, APU SHUTDOWN, displays.

For the following faults, the APU continues to operate and the EICAS caution message APU LIMIT displays:

- high EGT
- high oil temperature
- low oil pressure.

There is no cooldown period when the APU is manually shut down after the APU LIMIT message is displayed.

APU Unattended Mode

In the unattended mode, any of the following faults cause the APU to shutdown immediately:

- APU fire/inlet overtemperature
- overspeed/loss of overspeed protection
- high EGT/loss of EGT signal
- low oil pressure
- high oil temperature
- APU starter/generator oil filter approaching bypass
- Air inlet door failed closed
- APU controller failure
- speed droop
- APU starting failure (no rotation, or no acceleration, or no light-off).

There is no cooldown period. The EICAS advisory message, APU SHUTDOWN, displays.

Engines, APU EICAS Messages

The following EICAS messages can be displayed.

APU

Message	Level	Aural	Condition
APU COOLDOWN	Memo		The APU is running in the cooldown mode.
APU LIMIT	Caution	Beeper	An APU limit exceedance occurs.
APU RUNNING	Memo		The APU is running.
APU SHUTDOWN	Advisory		An APU automatic shutdown occurs.

Engine

Control

Message	Level	Aural	Condition
ENG CONTROL L, R	Advisory		An EEC system fault occurs.
ENG CORE ANTI-ICE L, R	Advisory		An engine core anti-ice fault occurs.
ENG EEC MODE L, R	Advisory		An EEC is in the alternate control mode.
ENG FAIL L, R	Caution	Beeper	Engine speed is below idle.
ENG LIMIT EXCEED L, R	Caution		An engine limit exceedance occurs.
ENG LIMIT PROT L, R	Caution	Beeper	The EEC is in the alternate mode and commanded N1 exceeds maximum N1.
ENG REV AIR/GND	Caution	Beeper	The air/ground thrust reverser logic is failed.
ENG REV COMMANDED L, R	Caution	Beeper	The reverse thrust lever is not in the down position in flight.
ENG REV LIMITED L, R	Advisory		The engine reverser operation is limited.
ENG REVERSER L, R	Advisory		A fault occurs in the thrust reverser system.

Message	Level	Aural	Condition
ENG RPM LIMITED L, R	Advisory		Engine control is limiting engine thrust to prevent N1, N2, or N3 from exceeding the RPM operating limit.
ENG SEC AIR VLV L, R	Advisory		The engine secondary air system valve is failed in the open position.
ENG SHUTDOWN	Caution		Both engines were shut down by the fuel control switches or the engine fire switches.
ENG SHUTDOWN L, R	Caution		The engine was shut down by the fuel control switch or the engine fire switch.
ENG SURGE L, R	Caution	Beeper	An engine surge or stall that requires crew action is detected.
ENG THRUST L, R	Caution	Beeper	One of these occurs: • the thrust is more than the commanded thrust • the thrust is less than the commanded thrust.
ENG THRUST HIGH L, R	Warning	Siren	The engine thrust limit is decreased and the commanded thrust exceeds the limit.
ENG TURB DAMAGE L, R	Caution	Beeper	The engine is failed due to turbine shaft damage.
THRUST ASYM PROT	Advisory		Thrust asymmetry protection is inoperative.

Start

Message	Level	Aural	Condition
ENG AUTOSTART L, R	Caution	Beeper	Autostart did not start the engine.
ENG START CUTOUT L, R	Advisory		The start selector stays in START when commanded to NORM.
ENG STARTERS L, R	Advisory		Both starters on the engine are inoperative.

Fuel

Message	Level	Aural	Condition
ENG FUEL FILTER L, R	Advisory		Fuel contamination can cause fuel to bypass the engine fuel filter.
ENG FUEL FILTER L +R	Caution		Fuel contamination can cause fuel to bypass the engine fuel filters on both engines.
ENG FUEL VALVE L, R	Advisory		One or more of these occur: • the engine fuel valve is not in the commanded position • the fuel spar valve is not inthe commanded position.

Oil

Message	Level	Aural	Condition
ENG OIL PRESS L, R	Caution	Beeper	The engine oil pressure is low.
ENG OIL TEMP L, R	Advisory		The engine oil temperature is high.

Fire Protection — Chapter 8
Table of Contents

Controls and Indicators 8.10

Engine Fire Protection 8.10.1
Engine Fire Panel 8.10.1
Fuel Control Switches 8.10.2
APU and Cargo Fire Panel 8.10.3
APU Ground Control Fire Protection Panel 8.10.5

System Description 8.20

Introduction 8.20.1
Engine Fire Protection 8.20.1
Engine Fire and Overheat Detection 8.20.1
Engine Fire Extinguishing 8.20.3
APU Fire Protection 8.20.4
APU Fire Detection 8.20.4
APU Fire Extinguishing 8.20.4
Main Wheel Well Fire Protection 8.20.4
Main Wheel Well Fire and Overheat Detection 8.20.5
Main Wheel Well Overheat Warning 8.20.5
Main Wheel Well Fire Warning 8.20.5
Cargo Compartment Fire Protection 8.20.5
Cargo Compartment Smoke Detection 8.20.5
Cargo Compartment Fire Warning 8.20.6
Cargo Compartment Fire Extinguishing 8.20.6
Crew Rest Compartment Fire Protection 8.20.6
Overhead Flight Crew Rest Compartment Smoke Detection 8.20.6
Overhead Flight Attendant Rest Compartment Smoke Detection 8.20.6
Lavatory Fire Protection 8.20.7
Lavatory Fire Detection 8.20.7

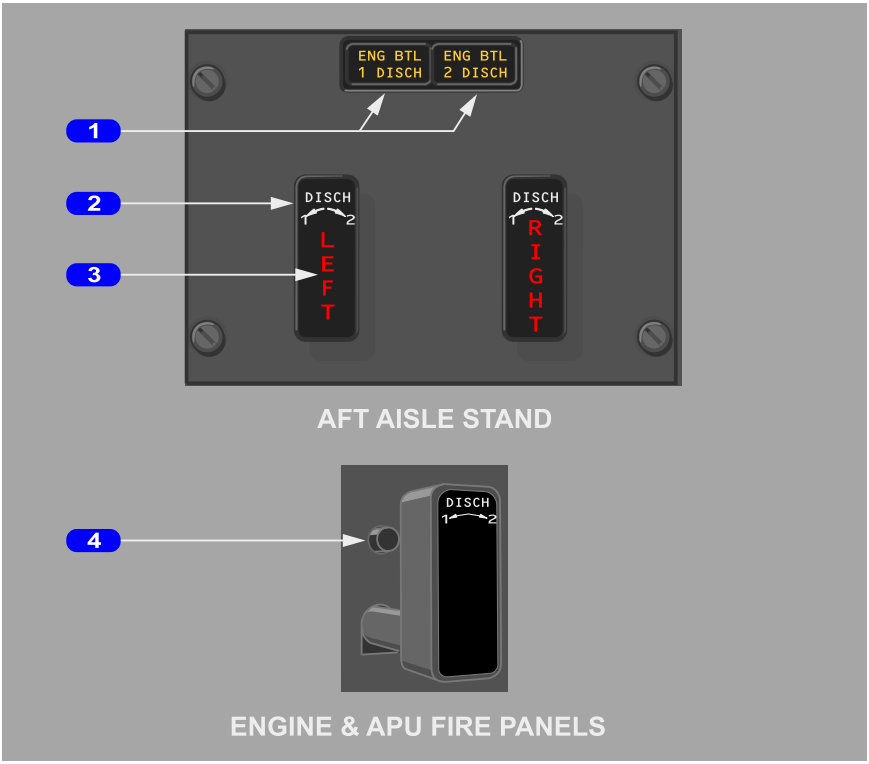
Lavatory Fire Extinguishing 8.20.7
Fire and Overheat Detection System Fault Test 8.20.7
Fire and Overheat Detection System Automatic Fault Test . . . 8.20.7
Fire and Overheat Detection System Manual Fault Test 8.20.7

EICAS Messages 8.30

Fire Protection EICAS Messages 8.30.1
Airplane System EICAS Messages 8.30.1
Cabin System EICAS Messages 8.30.1
System Test Messages 8.30.2

Engine Fire Protection

Engine Fire Panel



1 Engine Bottle Discharged (ENG BTL DISCH) Lights

Illuminated (amber)—the extinguisher bottle is discharged or has low pressure.

2 Engine Fire Switches

In (normal position, mechanically locked)—unlocks automatically for a fire warning, or when the FUEL CONTROL switch is in CUTOFF.

Out—

- arms both engine fire extinguishers
- closes the associated engine and spar fuel valves

- closes the associated engine anti-ice valves
- trips the associated engine generators off
- shuts off hydraulic fluid to the associated engine–driven hydraulic pump
- depressurizes the associated engine–driven hydraulic pump
- removes power to the thrust reverser isolation valve.

Rotate to position 1 or 2—discharges the selected fire extinguisher into the engine.

3 Engine Fire Warning Lights

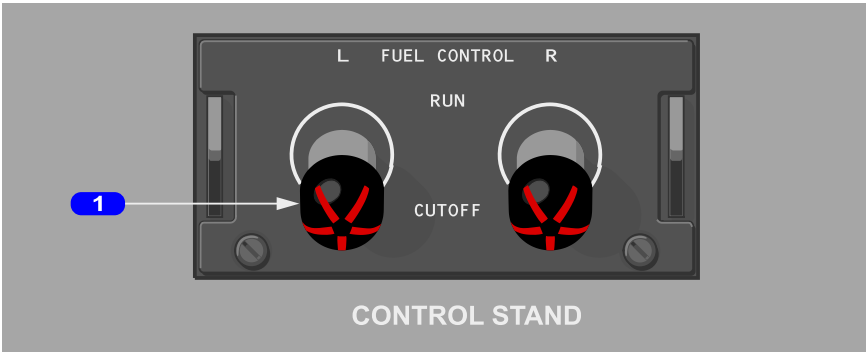
Illuminated (red)—

- an engine fire is detected, or
- the FIRE/OVERHEAT TEST switch is pushed.

4 Engine and APU Fire Override Switches

Push—unlocks the fire switch.

Fuel Control Switches

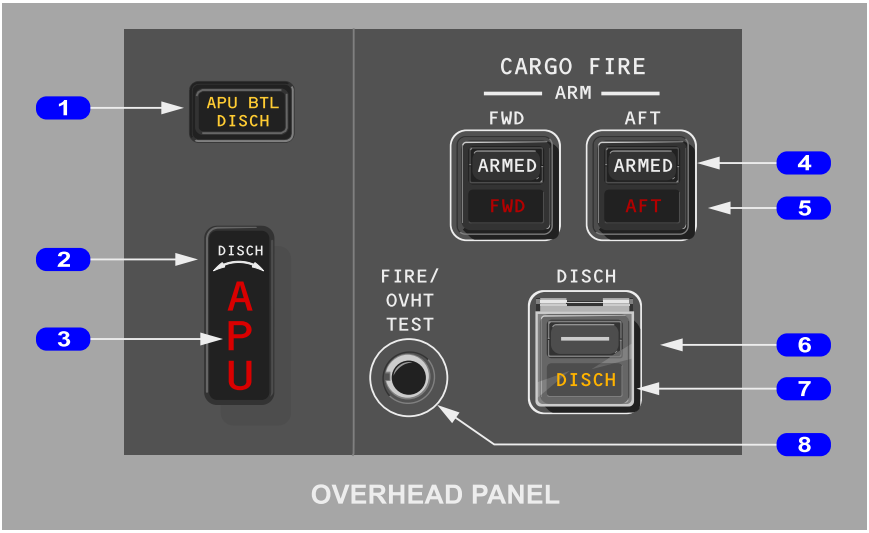


1 FUEL CONTROL Switch Fire Warning Lights

Illuminated (red)—

- an associated engine fire is detected, or
- the FIRE/OVERHEAT TEST switch is pushed.

APU and Cargo Fire Panel



1 APU Bottle Discharge (APU BTL DISCH) Light

Illuminated (amber)—the extinguisher bottle is discharged or has low pressure.

2 APU Fire Switch

In—normal position, mechanically locked; unlocks automatically for a fire warning.

Out—

- arms the APU fire extinguisher bottle
- closes the APU fuel valve
- closes the APU air inlet door
- trips the APU generator field and generator breaker
- shuts down the APU (if automatic shutdown does not occur).

Rotate—either direction discharges the APU fire extinguisher into the APU compartment.

3 APU Fire Warning Light

Illuminated (red)—

- an APU fire is detected, or
- the FIRE/OVERHEAT TEST switch is pushed.

The APU automatically shuts down for a detected fire.

4 CARGO FIRE ARM Switches

ARMED—

- arms all cargo fire extinguisher bottles
- arms the selected compartment extinguisher valve
- turns off both lower recirculation fans
- shuts down cargo heat
- commands the packs to provide the minimum air flow required to provide pressurization
- shuts down the bulk cargo compartment ventilation system operation (aft cargo fire only)
- shuts down the lavatory/galley vent fan (aft cargo fire only)
- puts associated (fwd or aft) equipment cooling system into the override mode
- turns off miscellaneous equipment cooling fan (forward cargo fire only)
- shuts off in-flight entertainment equipment (IFE) cooling
- turns off Nitrogen Generation System (NGS)
- shuts off door 4 galley chiller units (aft cargo fire only)
- outflow valves move to 50/50 flow split for air flow stability
- turns off zonal dryer fans.

Off (blank)—normal position.

5 CARGO FIRE Warning Lights

Illuminated (red)—

- associated cargo compartment smoke is detected, or
- the FIRE/OVERHEAT TEST switch is pushed.

6 CARGO FIRE Discharge (DISCH) Switch

Push—discharges the fire extinguisher bottles into the ARMED cargo compartment.

Note: The bulk cargo compartment is included in the AFT cargo fire extinguishing system.

7 CARGO FIRE Discharge (DISCH) Light

Illuminated (amber)—the fire extinguishers have discharged.

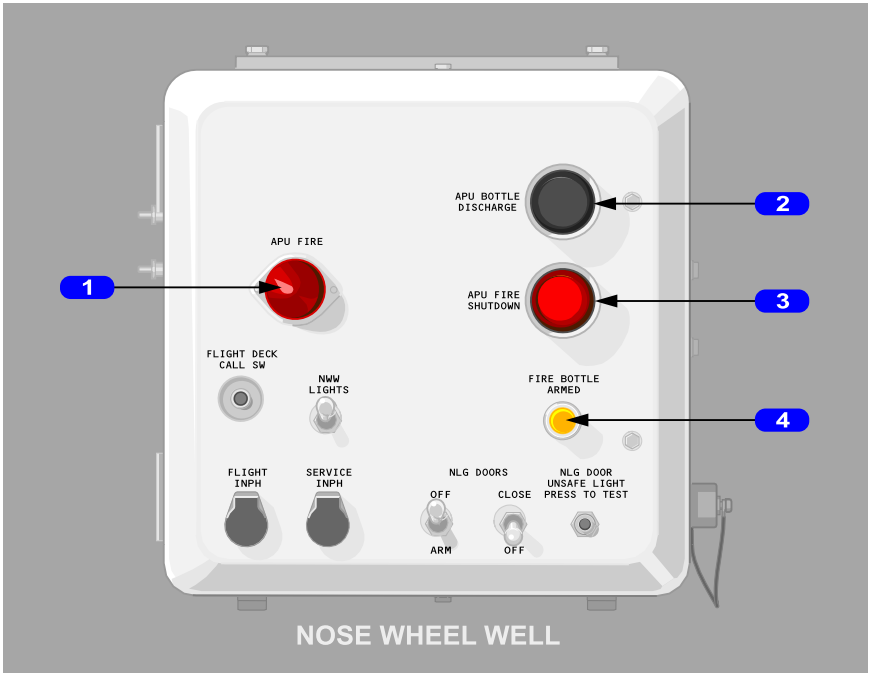
8 FIRE / Overheat (OVHT) TEST Switch

Push and hold—

- sends fire/overheat test signals to the engine, APU, wheel well, and cargo compartment fire detector systems

- tests flight deck fire and overheat indications. (See Fire and Overheat Detection System Manual Fault Test on page 8.20.7.)

APU Ground Control Fire Protection Panel



1 APU FIRE Light

Illuminated (red)—

- an APU fire is detected, or
- a fire/overheat test is in progress.

The APU automatically shuts down for a detected fire.

2 APU BOTTLE DISCHARGE Switch

Push—discharges the APU fire extinguisher into the APU compartment.

3 APU FIRE SHUTDOWN Switch

Push (red)

- shuts down the APU
- arms the APU fire extinguisher.

4 APU FIRE BOTTLE ARMED Light

Illuminated (amber)—the APU fire extinguisher is armed.

Introduction

There are fire detection and extinguishing systems for the:

- APU
- cargo compartments
- engines
- lavatories.

The engines also have overheat detection systems.

The main gear wheel wells have a fire detection system, but no fire extinguishing system.

The overhead flight crew rest compartment has a fire detection system, but no fire extinguishing system.

The overhead flight attendant rest compartment has a fire detection system, but no fire extinguishing system.

For additional information:

- See Equipment Cooling, Equipment Ventilation, Lavatory and Galley Ventilation on page 2.20.9
- See Engine Anti-Ice Leak Detection System on page 3.20.2.

Engine Fire Protection

Engine fire protection consists of these systems:

- engine fire and overheat detection
- engine fire extinguishing.

Engine Fire and Overheat Detection

There are multiple dual-channel detector assemblies in each engine nacelle. Each detector channel provides both fire and overheat detection. Normally, at least one element on each channel must detect a fire or overheat condition to cause an engine fire warning or overheat caution.

If a fault is detected in one channel, the remaining channel element automatically switches to single channel operation. If the operating channel senses a fire or overheat, the system provides the appropriate fire warning or overheat caution.

If both main engine detector elements on a single assembly are faulted, no fire or overheat detection is provided. The EICAS advisory message DET FIRE ENG (L or R) is displayed if the engine fire detection system fails.

Turbine overheat detection is provided in addition to engine fire and engine overheat detection. A turbine overheat event is annunciated with the same flight deck indications as an engine overheat (OVERHEAT ENG L, R).

Engine Fire Warning

The indications of an engine fire are:

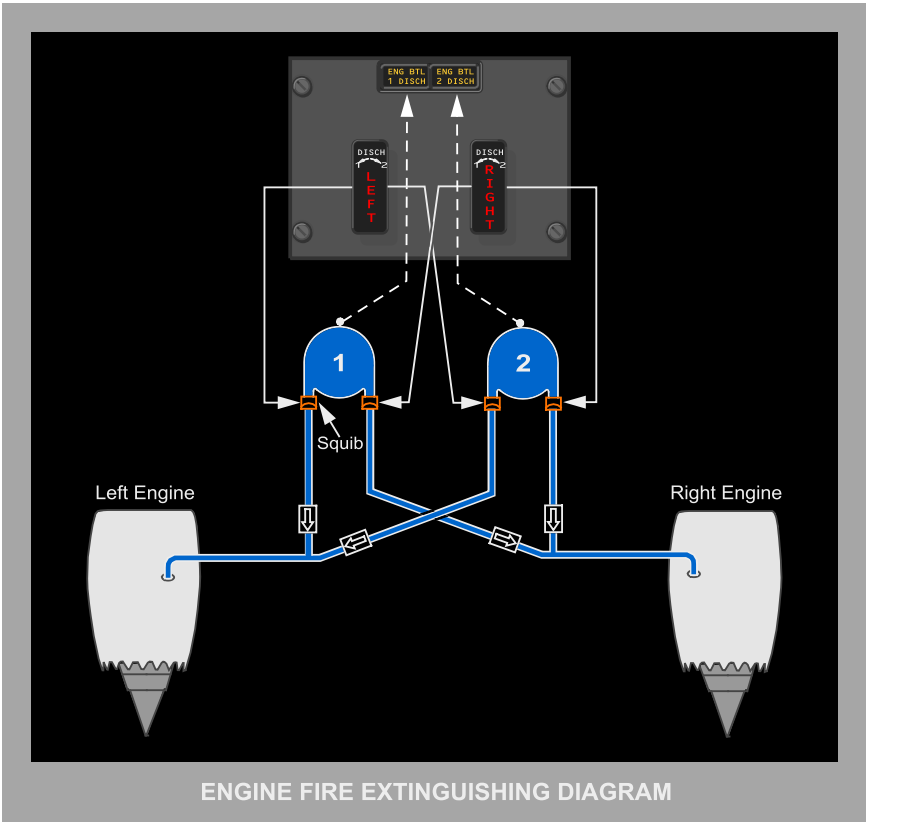
- the fire bell sounds
- the master WARNING lights illuminate
- the EICAS warning message FIRE ENG (L or R) is displayed
- the engine fire switch LEFT or RIGHT fire warning light illuminates
- the engine fire switch unlocks
- the engine FUEL CONTROL (L or R) switch fire warning light illuminates.

Engine Overheat Caution

The indications of an engine overheat are:

- the caution beeper sounds
- the master CAUTION lights illuminate
- the EICAS caution message OVERHEAT ENG (L or R) is displayed.

Engine Fire Extinguishing



ENGINE FIRE EXTINGUISHING DIAGRAM

There are two fire extinguisher bottles. Either or both bottles can be discharged into either engine.

When the engine fire switch is pulled out, rotating the fire switch in either direction discharges a single extinguisher bottle into the associated engine. Rotating the engine fire switch in the other direction discharges the remaining extinguisher bottle into the same engine.

If an extinguisher bottle is discharged or has low pressure:

- the ENG BTL (1 or 2) DISCH light illuminates
- the EICAS advisory message BOTTLE (1 or 2) DISCH ENG shows.

APU Fire Protection

APU fire protection consists of these systems:

- APU fire detection
- APU fire extinguishing.

APU Fire Detection

The APU compartment has dual fire detector loops. There is no APU overheat detection.

Normally, both loops must detect a fire to produce a fire warning. An APU fire warning automatically shuts down the APU.

If a fault is detected in one loop, the system automatically switches to single loop operation. If the operating loop detects a fire, an APU fire warning occurs and the APU shuts down.

The EICAS advisory message DET FIRE APU is displayed if the APU fire detection system fails.

APU Fire Warning

The indications of an APU fire warning are:

- the fire bell sounds
- the master WARNING lights illuminate
- the EICAS warning message FIRE APU is displayed
- the APU fire switch fire warning light illuminates
- the APU fire switch unlocks.

APU Fire Extinguishing

There is one APU fire extinguisher bottle. When the APU fire switch is pulled out, rotating the switch in either direction discharges the extinguisher bottle into the APU compartment. If the bottle is discharged or has low pressure:

- the APU BTL DISCH light illuminates
- the EICAS advisory message BOTTLE DISCH APU is displayed.

An APU fire signal causes the APU to shutdown immediately. The APU extinguisher bottle is automatically discharged after a 15 second delay to allow time for the fuel valve to close.

On the ground with both engines off an APU fire signal from either APU fire detector loop causes APU shutdown and extinguisher bottle discharge.

Main Wheel Well Fire Protection

The main wheel well has fire and overheat detection. There is no fire extinguishing system. The nose wheel well does not have a fire or overheat detection system.

Main Wheel Well Fire and Overheat Detection

The main wheel well fire and overheat detection system consists of dual detector channels.

Main Wheel Well Overheat Warning

The indications for a main wheel well overheat are:

- the caution beeper sounds
- the master CAUTION lights illuminate
- the EICAS caution message OVERHEAT WHEEL WELL is displayed.

Main Wheel Well Fire Warning

The indications for a main wheel well fire are:

- the fire bell sounds
- the master WARNING lights illuminate
- the EICAS warning message FIRE WHEEL WELL is displayed.

Cargo Compartment Fire Protection

Cargo compartment fire protection consists of these systems:

- cargo compartment smoke detection
- cargo compartment fire extinguishing.

Note: The bulk cargo compartment is included in the AFT cargo fire detection and extinguishing systems.

Cargo Compartment Smoke Detection

The forward and aft cargo compartments each have smoke detectors. Fourteen detectors are installed in the forward cargo compartment. Eight detectors are installed in the aft (six detectors) / bulk (two detectors) cargo compartment. TQA to TQF

The forward and aft cargo compartments each have smoke detectors. Eighteen detectors are installed in the forward cargo compartment. Eleven detectors are installed in the aft (nine detectors) / bulk (two detectors) cargo compartments. TWA,B

Normally, two smoke detectors in the same cargo compartment must detect a fire or overheat condition at the same time to cause a cargo fire warning. If one detector fails in a compartment, a single smoke detector detecting a fire or overheat condition causes a fire warning.

Note: With one detector inoperative, a single detector may indicate a false alarm. TQA to TQF

If smoke is detected in the aft cargo compartment, power is removed from the HF radios. TQA,B

Whenever cargo compartment smoke detection is inoperative, the EICAS advisory message DET FIRE CARGO (FWD or AFT) is displayed.

Cargo Compartment Fire Warning

The indications of a cargo compartment fire are:

- the fire bell sounds
- the master WARNING lights illuminate
- the EICAS warning message FIRE CARGO (FWD or AFT) is displayed
- the CARGO FIRE (FWD or AFT) fire warning light illuminates.

Cargo Compartment Fire Extinguishing

Five fire extinguisher bottles are installed for cargo compartment fire extinguishing. Pushing the FWD or AFT CARGO FIRE ARM switch (ARMED visible) arms the extinguishers.

Cargo fire suppression is provided for 180-minute ETOPS operation.

In flight, a fire warning from the cargo fire detection system causes the immediate total discharge of two extinguisher bottles into the affected compartment. After a 15 minute time delay, the remaining three extinguisher bottles discharge at a reduced flow rate into the affected compartment. If the airplane lands within the 15 minute time delay, only one of the remaining bottles discharges at the reduced rate on touchdown.

In flight, pushing the CARGO FIRE DISCHARGE switch also activates the extinguishing system.

On the ground, if a CARGO FIRE DISCHARGE switch is pushed, three extinguisher bottles discharge simultaneously into the selected compartment, with the third bottle discharging at a reduced flow rate.

When cargo fire extinguisher bottle discharge is initiated and the first two extinguisher bottles begin to discharge:

- the CARGO FIRE DISCHARGE switch light illuminates
- the EICAS advisory message BOTTLE DISCH CARGO is displayed.

Crew Rest Compartment Fire Protection

Overhead Flight Crew Rest Compartment Smoke Detection

Smoke detectors are installed in the overhead flight crew rest compartment. The EICAS caution message SMOKE REST UPR DR 1 indicates smoke in the compartment.

Overhead Flight Attendant Rest Compartment Smoke Detection

Smoke detectors are installed in the overhead flight attendant rest compartment. The EICAS caution message SMOKE REST UPR DR 4 indicates smoke in the compartment.

Lavatory Fire Protection

Lavatory fire protection consists of these systems:

- lavatory fire detection
- lavatory waste container fire extinguishing.

Lavatory Fire Detection

Each lavatory has a single smoke detector. If smoke is detected, an aural alert sounds in the lavatory and in the cabin. In addition, the lavatory call light flashes and the master call light at the associated attendant station illuminates. The EICAS advisory message SMOKE LAVATORY is displayed.

Lavatory Fire Extinguishing

Each lavatory has one fire extinguisher bottle. The bottle discharges through two nozzles into the waste container. Extinguisher operation is automatic. There is no flight deck indication.

Fire and Overheat Detection System Fault Test

The fire and overheat detection system has automatic and manual fault testing.

Fire and Overheat Detection System Automatic Fault Test

Fire and overheat detection system testing is automatic. The engine and APU systems continuously monitor the fire/overheat detector loops for faults. The cargo and wheel well systems continuously monitor for any system faults.

If a fault is detected, the system automatically reconfigures for single loop operation. Complete system failures are indicated by an EICAS advisory message for the failed system:

- DET FIRE ENG (L or R)
- DET FIRE APU
- DET FIRE CARGO (FWD or AFT).

Fire and Overheat Detection System Manual Fault Test

The fire and overheat detection systems can be tested manually by pushing and holding the FIRE/OVERHEAT TEST switch.

The indications for a manual fire and overheat detection system test are:

- the fire bell sounds
- the nose wheel well crew call horn sounds (on the ground)
- the EICAS warning message FIRE TEST IN PROG is displayed
- these lights illuminate:
  - the master WARNING lights
  - the LEFT and RIGHT engine fire warning lights
  - the APU fire warning light

- the nose wheel well APU fire warning light
- the FWD and AFT CARGO FIRE warning lights
- the LEFT and RIGHT FUEL CONTROL switch fire warning lights.

When the test is complete, the EICAS warning message FIRE TEST PASS or FIRE TEST FAIL replaces the FIRE TEST IN PROG message; the switch can be released. The appropriate system EICAS messages are displayed with the FIRE TEST FAIL message:

- DET FIRE ENG (L or R)
- DET FIRE APU
- DET FIRE CARGO (FWD or AFT)
- DET FIRE WHEEL WELL.

All test messages clear when the test switch is released. If the switch is released with the FIRE TEST IN PROG message displayed, the test ends without completing.

Fire Protection EICAS Messages

The following EICAS messages can be displayed.

Airplane System EICAS Messages

Message	Level	Aural	Condition
BOTTLE 1, 2 DISCH ENG	Advisory		The engine fire extinguisher bottle pressure is low.
BOTTLE DISCH APU	Advisory		The APU fire extinguisher bottle pressure is low.
BOTTLE DISCH CARGO	Advisory		Both rapid discharge cargo fire extinguisher bottle pressures are low.
DET FIRE APU	Advisory		APU fire detection is failed.
DET FIRE CARGO AFT, FWD	Advisory		Cargo compartment smoke detection is failed.
DET FIRE ENG L, R	Advisory		An engine fire detection system fault occurs.
FIRE APU	Warning	Fire Bell	Fire is detected in the APU.
FIRE CARGO AFT	Warning	Fire Bell	Smoke is detected in the aft cargo compartment.
FIRE CARGO FWD	Warning	Fire Bell	Smoke is detected in the forward cargo compartment.
FIRE ENG L, R	Warning	Fire Bell	Fire is detected in the engine.
FIRE WHEEL WELL	Warning	Fire Bell	Fire is detected in a main wheel well.
OVERHEAT ENG L, R	Caution	Beeper	An overheat is detected in the engine.
OVERHEAT WHEEL WELL	Caution	Beeper	An overheat is detected in either the left or right wheel well.

Cabin System EICAS Messages

Cabin

Message	Level	Aural	Condition
SMOKE EQUIP CLG AFT	Caution	Beeper	Smoke is detected in the aft equipment cooling system.

Message	Level	Aural	Condition
SMOKE EQUIP CLG FWD	Caution	Beeper	Smoke is detected in the forward equipment cooling system.
SMOKE EQUIP CLG MISC	Caution	Beeper	Smoke is detected in the miscellaneous equipment cooling system.
SMOKE LAVATORY	Advisory		Smoke is detected in one or more lavatories.

Crew Rest Area

Message	Level	Aural	Condition
SMOKE REST UPR DR1	Caution	Beeper	Smoke is detected in the Overhead Flight Crew Rest area.
SMOKE REST UPR DR4	Caution	Beeper	Smoke is detected in the Overhead Flight Attendant Rest area.

System Test Messages

The following messages are associated with the manually initiated fire test.

Message	Level	Aural	Condition
DET FIRE WHEEL WELL	Advisory		Wheel well fire detection system is failed.
FIRE TEST FAIL	Warning		One or more fire/overheat detection systems have failed to successfully complete the manually initiated fire/overheat test.
FIRE TEST IN PROG	Warning	Fire Bell	A manually initiated fire/overheat detection system test is in progress.
FIRE TEST PASS	Warning		A manually initiated test of the fire/overheat detection system has been completed.

Flight Controls — Chapter 9
Table of Contents

Controls and Indicators 9.10

Primary Flight Computers Control 9.10.1

Pitch and Stabilizer Trim Systems 9.10.2

Control Wheel and Column 9.10.2

Stabilizer Trim System 9.10.3

Rudder Trim Control 9.10.5

Rudder/Brake Pedals 9.10.6

Speedbrake Lever 9.10.6

Flap System 9.10.8

Flap Controls 9.10.8

Flap Limit Placard 9.10.10

Normal Flap Position Indication 9.10.11

Flap Load Relief Indication 9.10.12

Expanded Flap and Slat Position Indication 9.10.12

Flight Control Synoptic Displays 9.10.13

Normal Flight Control Synoptic 9.10.14

Non–Normal Flight Control Synoptic 9.10.16

Flight Control Surfaces Controls 9.10.18

System Description 9.20

Introduction 9.20.1

Pilot Controls 9.20.1

Unique Failure Considerations 9.20.2

Flight Control Surfaces 9.20.2

Flight Control Surfaces Lock 9.20.3

Flight Control Surface Locations 9.20.3

Actuator Control Electronics (ACE)/Hydraulic Power Distribution 9.20.4

Primary Flight Control System Modes 9.20.5

Flight Control System Normal Mode 9.20.5

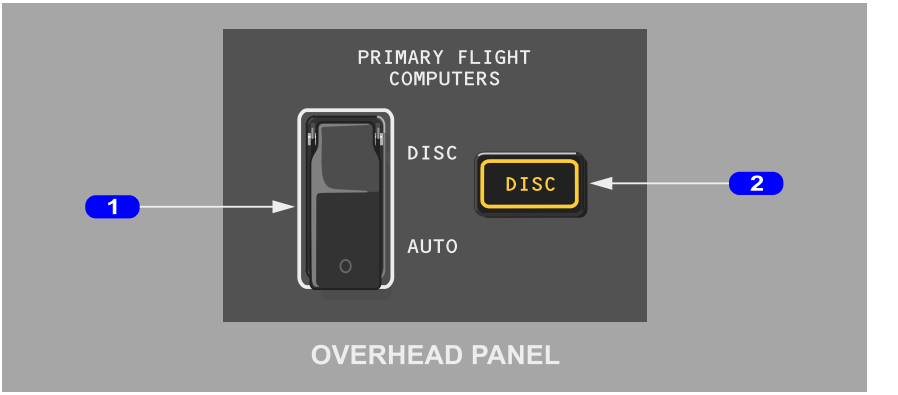
Flight Envelope Protection 9.20.6
Flight Control System Secondary Mode 9.20.7
Flight Control System Direct Mode 9.20.8
Normal Mode Pitch Control 9.20.9
Primary Pitch Trim Control 9.20.10
Alternate Pitch Trim 9.20.10
Pitch Envelope Protection 9.20.11
Elevator Variable Feel 9.20.11
Tail Strike Protection 9.20.11
Secondary and Direct Mode Pitch Control 9.20.12
Stabilizer Operation 9.20.12
Stabilizer Shutdown 9.20.12
Column Cutout 9.20.13
Stabilizer Position Indication and Green Band Monitor 9.20.13
Hybrid Laminar Flow Control (HLFC) 9.20.14
Normal Mode Roll Control 9.20.14
Bank Angle Protection 9.20.14
Secondary and Direct Mode Roll Control 9.20.15
Normal Mode Yaw Control 9.20.15
Asymmetry Compensation 9.20.15
Wheel to Rudder Cross–Tie 9.20.16
Yaw Damping 9.20.16
Gust Suppression 9.20.16
Rudder Trim 9.20.17
Secondary and Direct Mode Yaw Control 9.20.18
Spoilers 9.20.18
Spoiler Speedbrake Operation 9.20.18
Autodrag 9.20.19
Landing Attitude Modifier (LAM) 9.20.19
Flaps and Slats 9.20.20
Flap and Slat Sequencing 9.20.20
Flap and Slat Modes 9.20.21

Flap/Slat Load Relief 9.20.21
Slat Autogap and Slat Pregap 9.20.22
Cruise Flaps 9.20.23
Flap and Slat Asymmetry Detection 9.20.23
Uncommanded Flap or Slat Motion 9.20.23
Flap or Slat Disagree 9.20.23
Flap Indications 9.20.24

EICAS Messages 9.30

Flight Control System EICAS Messages 9.30.1

Primary Flight Computers Control



1 PRIMARY FLIGHT COMPUTERS Disconnect Switch

DISC—

- disconnects the primary flight computers (PFCs) from the flight control system
- puts the flight control system in the direct mode
- AUTO can be reselected to attempt restoration of secondary or normal mode operation.

AUTO—

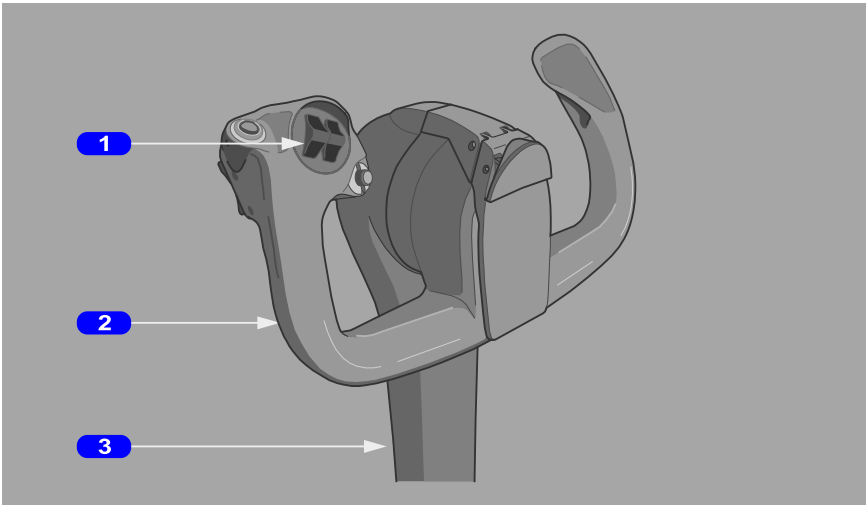
- the flight control system operates in the normal mode
- system faults automatically cause the system to switch to the secondary or direct modes.

2 PRIMARY FLIGHT COMPUTERS Disconnect (DISC) Light

Illuminated (amber)—the primary flight computers are disconnected either automatically or manually and the system is in the direct mode.

Pitch and Stabilizer Trim Systems

Control Wheel and Column



1 Pitch Trim Switches

Spring-loaded to neutral.

Push (both switches)—

- on the ground, directly moves the stabilizer
- in the air in normal mode, changes the trim reference airspeed
- in the air in the secondary and direct modes, directly moves the stabilizer.

2 Control Wheel

Rotate—deflects the ailerons, flaperons, and spoilers in the desired direction.

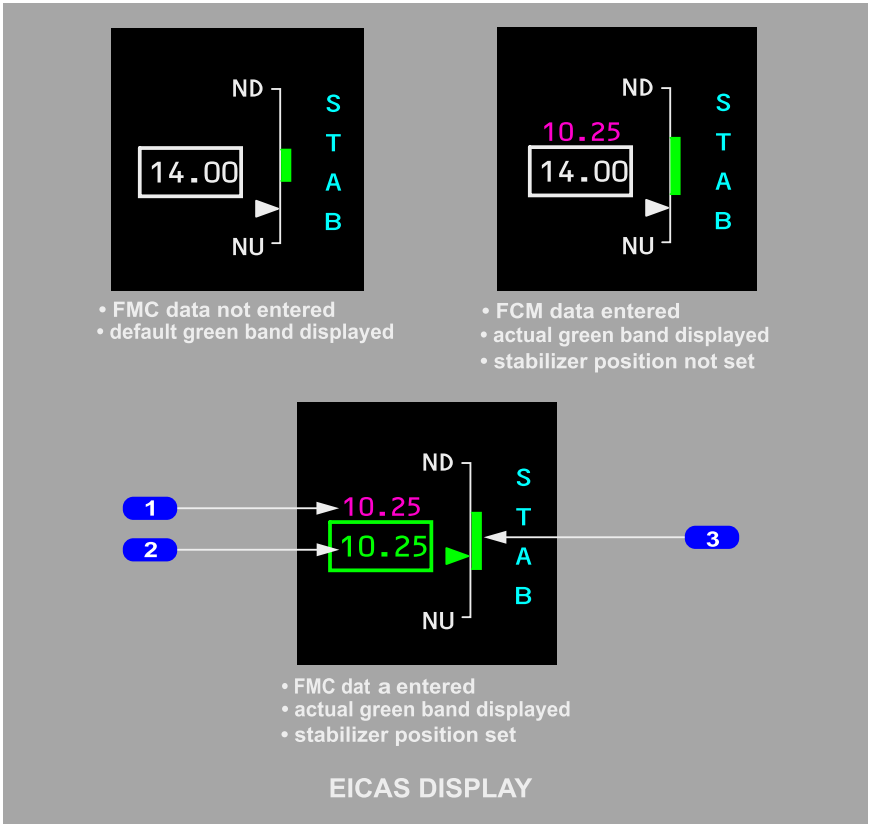
3 Control Column

Push/pull—commands the airplane to pitch in the desired direction:

- in the normal mode, deflects the elevator and horizontal stabilizer
- in the secondary and direct modes, deflects the elevator.

Does not move with pitch trim operation.

Stabilizer Trim System



1 FMC Stabilizer Takeoff Setting

Displays (magenta) the FMC calculated stabilizer takeoff setting in units of trim.

When FMC data is not present or is invalid, the digital readout is not displayed.

2 Stabilizer (STAB) Position Indicator

Displays actual stabilizer position in 0.25 increments from 0.25 to 16.75 units of trim flaps down on the ground, and 1.50 to 16.75 units flaps up and in the air. Corresponding pointer position is displayed on the ND/NU (nose down/nose up) scale.

Box, digital readout and pointer display white anytime the trim pointer is outside the green band.

Box, digital readout and pointer display green when FMC performance data is entered and trim pointer is within the green band.

When the stabilizer signal is not present or is invalid, the digital readout and pointer are not displayed on the stabilizer position indicator.

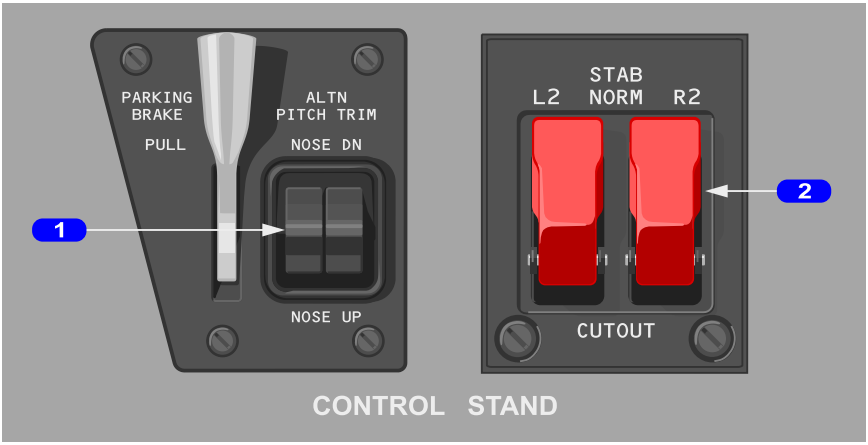
When the stabilizer trim is inoperative, the digital readout is replaced with an "X". The box, the "X" and the pointer display amber. The pointer remains on the scale at the last known trim position.

3 Takeoff Trim Green Band

The green band indicates the allowable takeoff trim range, based on gross weight and CG information from the FMC.

A default green band is displayed from 4 to 9 units of trim prior to performance data being entered into the FMC.

When the green band signal is not present or is invalid, the green band is not displayed.



1 Alternate (ALTN) PITCH TRIM Switches

Spring-loaded to neutral.

Push (both switches)—

- on the ground, directly moves the stabilizer
- in the air in normal mode, changes the trim reference airspeed
- in the air in the secondary and direct modes, directly moves the stabilizer.

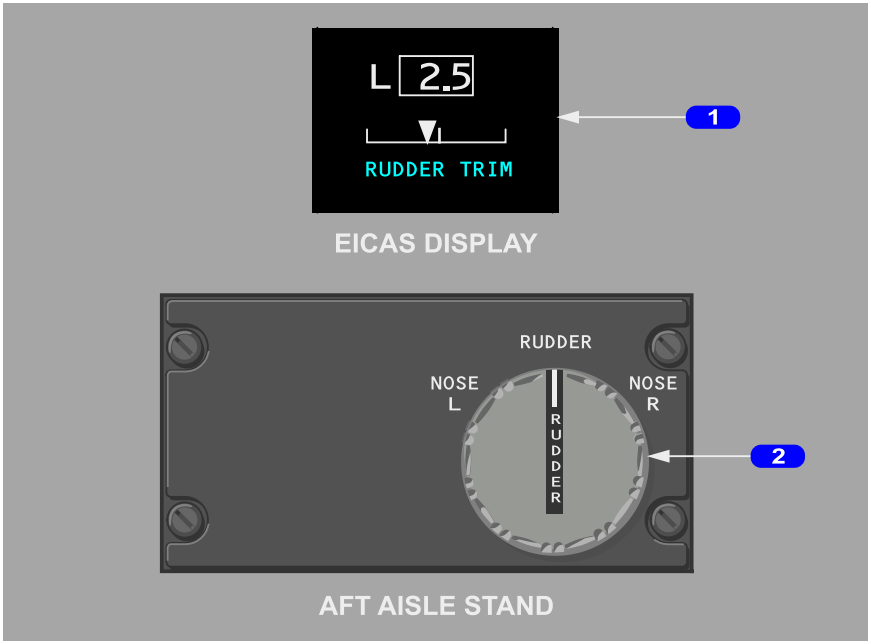
2 Stabilizer (STAB) Cutout Switches

NORM—

- electrical power is supplied to the related stabilizer control unit
  - L2—the related left 235 Vac bus
  - R2—the related right 235 Vac bus
- if unscheduled stabilizer motion is detected, electrical power to the related stabilizer control unit is automatically shut off.

CUTOUT—shuts off electrical power to the related stabilizer control unit.

Rudder Trim Control



1 RUDDER TRIM Indicator

Digital readout displays rudder position in 0.2 increments from 0.0 to 1.0 unit and in 0.5 increments between 1.0 and 17.0 units of trim. An L or R is displayed to the left or right of the box for any non-zero rudder trim. Corresponding pointer position is displayed on the line scale below.

When the rudder signal is not present or is invalid, the digital readout, left/right indication and pointer are not displayed on the rudder position indicator.

When the rudder trim is inoperative, the digital readout is replaced with an "X". The box, the "X" and the pointer display amber. The pointer remains on the scale at the last known trim position.

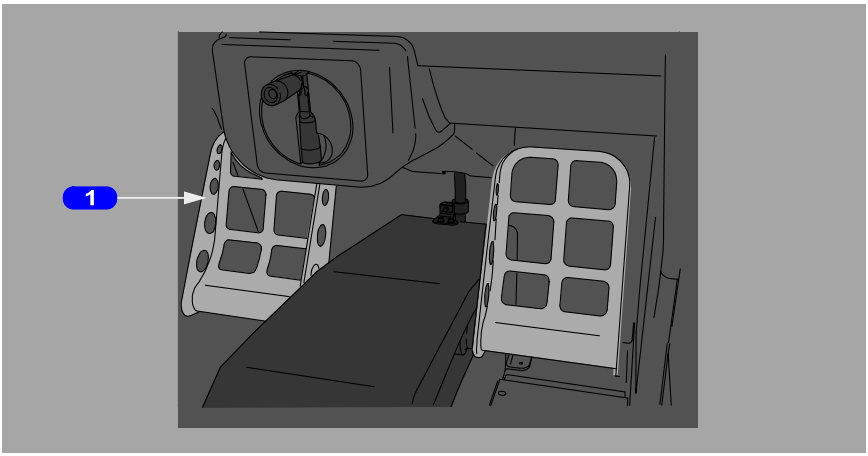
2 RUDDER Trim Selector

Spring-loaded to neutral.

Rotate—

- trims the rudder in the desired direction
- in either direction the trim runs at low speed with the knob rotated to the detent, and high speed with the knob rotated past the detent
- the rudder pedals move with rudder trim operation.

Rudder/Brake Pedals



1 Rudder Pedals

Push—deflects the rudder in the desired direction.

For additional information:

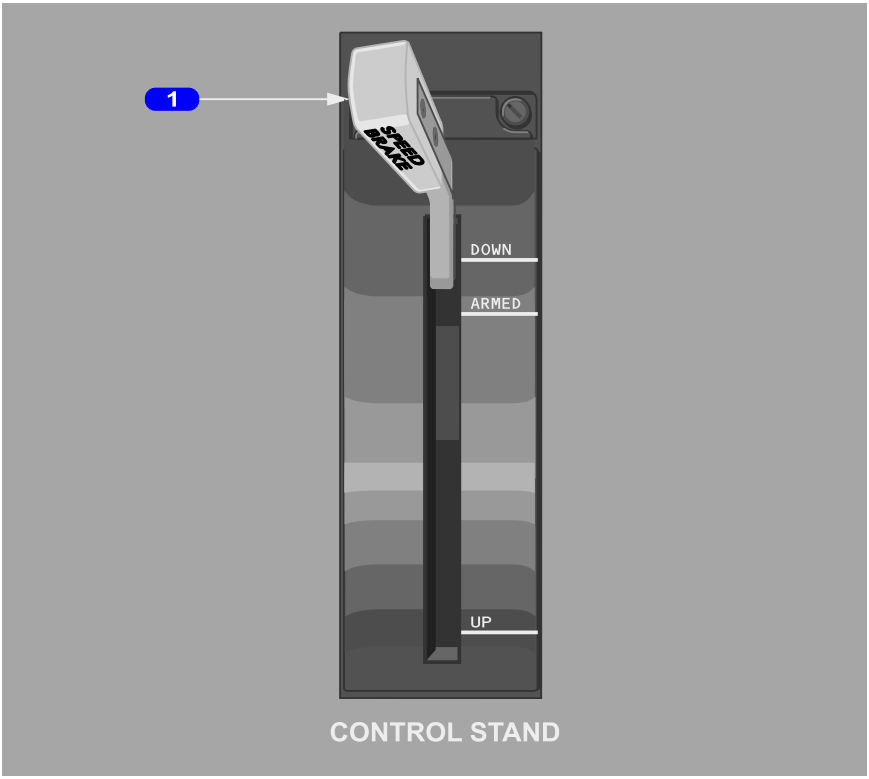
- See Brake System on page 14.20.3
- See Nosewheel Steering on page 14.20.3.

Speedbrake Lever

On the ground:

- the speedbrake lever moves to DOWN and all spoiler panels retract if either thrust lever is advanced to the takeoff thrust position

- the speedbrake lever moves to UP and all spoiler panels extend if both reverse thrust levers are raised to the reverse idle detent.



1 Speedbrake Lever

DOWN (detent)—all spoiler panels are retracted.

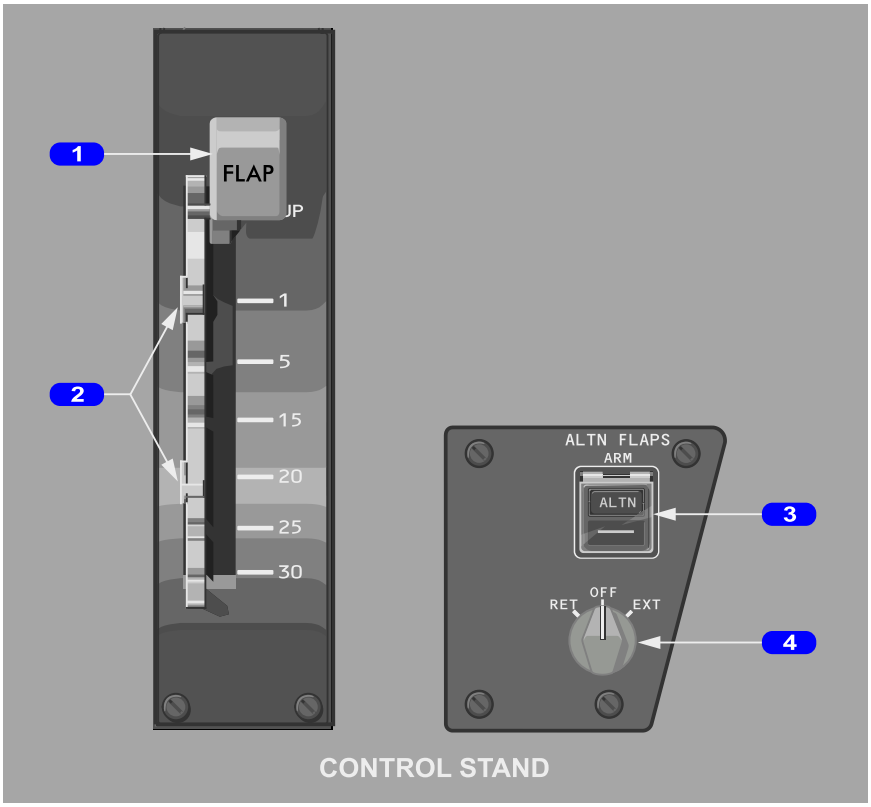
ARMED—the auto speedbrake system is armed.

UP—the required spoiler panels extend to their maximum in-flight or on-ground position (intermediate positions can be selected).

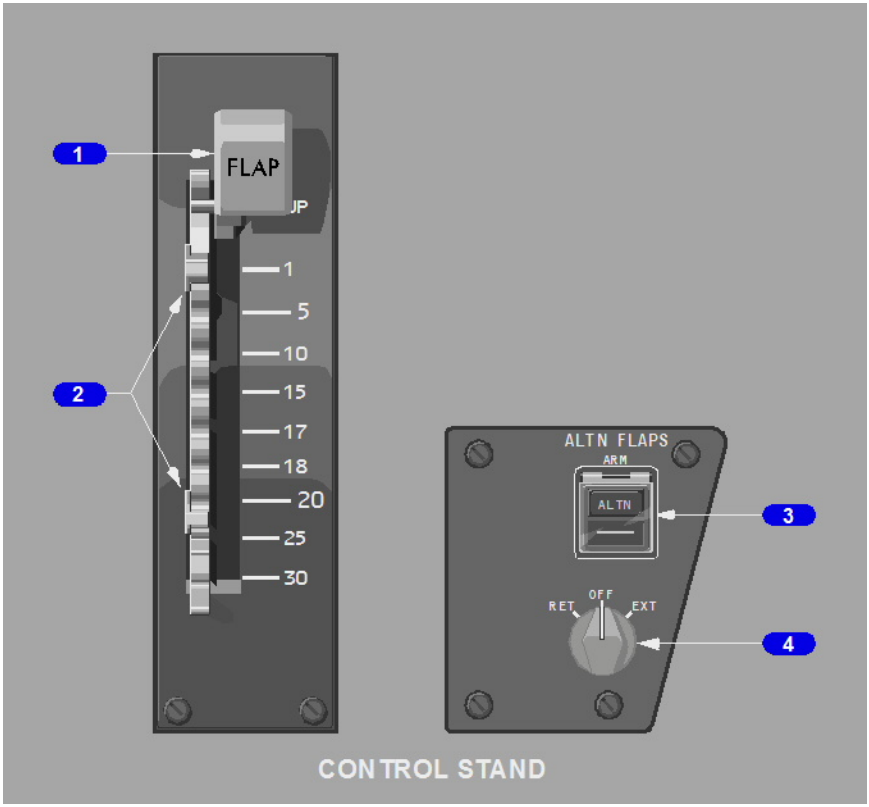
Flap System

Flap Controls

TQA to TQF



TWA,B



1 Flap Lever

Primary mode—positions the slats and flaps hydraulically.

Secondary mode—positions the slats and flaps hydraulically and/or electrically when the primary mode fails.

2 Flap Gates

1—prevents inadvertent retraction of the slats.

20—prevents inadvertent retraction of the flaps past the go-around position.

3 Alternate Flaps Arm (ALTN FLAPS ARM) Switch

Push (ALTN displayed)—

- arms the alternate flap control mode
- arms the alternate flaps selector
- disables primary and secondary flap/slat mode operation

- asymmetry/skew and uncommanded motion protection, slat autogap, and flap/slat load relief are not available
- the flap lever is inoperative.

4 Alternate Flaps Selector

RET—retraction is accomplished electrically and sequenced so that full flap retraction occurs before the slats begin to retract.

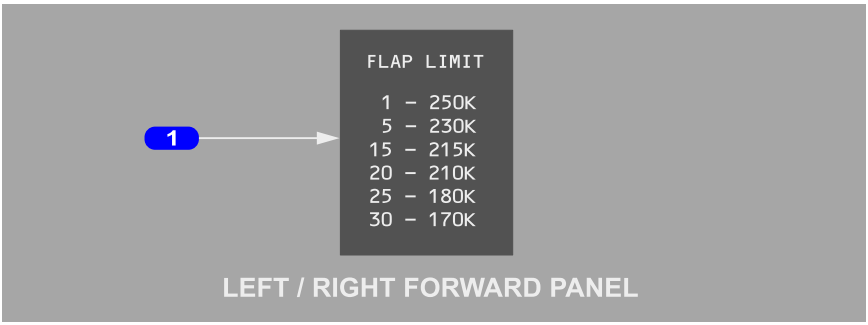
OFF—alternate flaps are deactivated.

EXT—

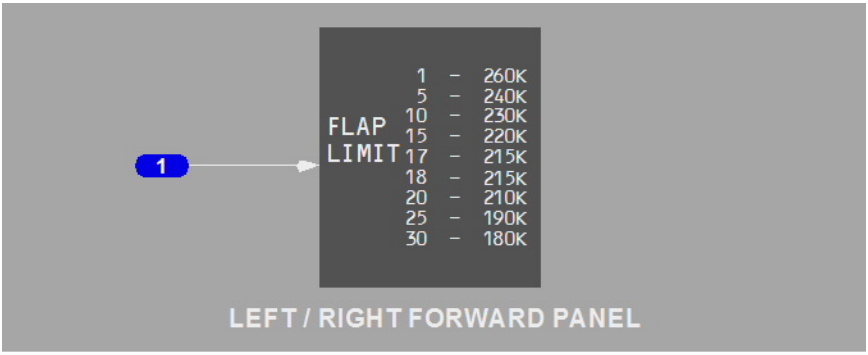
- the slats and flaps are electrically extended
- maximum extension is flaps 20, with the slats at the midrange position.

Flap Limit Placard

TQA to TQF



TWA,B



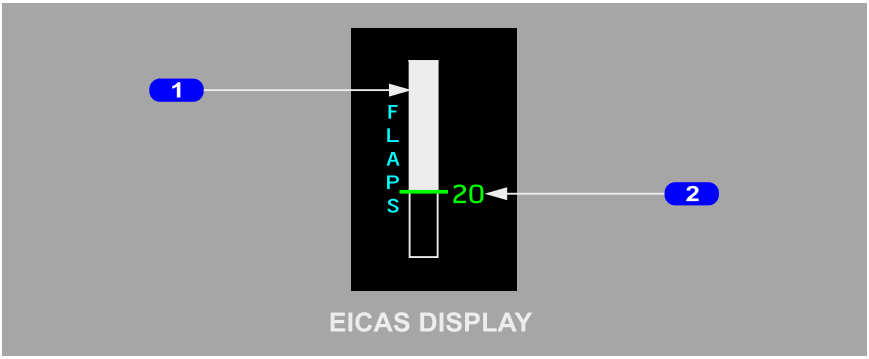
1 Flap Limit Placard

Flaps extended speed limits.

Normal Flap Position Indication

Displays combined flap and slat positions when all surfaces are operating normally and control is in the primary (hydraulic) mode. The indicator shows continuous motion.

The flap position indication is removed 10 seconds after slat retraction.



1 Flap Position (white)

UP—the slats and flaps are retracted.

1—the slats extend to the midrange position.

5, 15, and 20— TQA to TQF

- the slats remain in the midrange position
- the flaps extend to the commanded position.

5, 10, 15, 17, 18, and 20— TWA,B

- the slats remain in the midrange position
- the flaps extend to the commanded position.

25—the slats extend to the fully extended position. The flaps do not move.

30—the flaps extend to the commanded position.

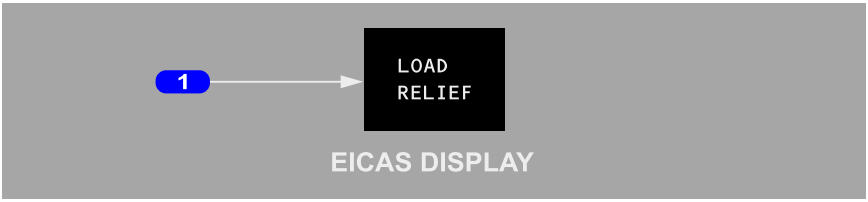
2 Flap Lever Position (line and number)

The line and number change color.

Magenta—the slats or flaps are in transit to the commanded position.

Green—the slats or flaps are in the commanded position.

Flap Load Relief Indication



1 Flap LOAD RELIEF Indication

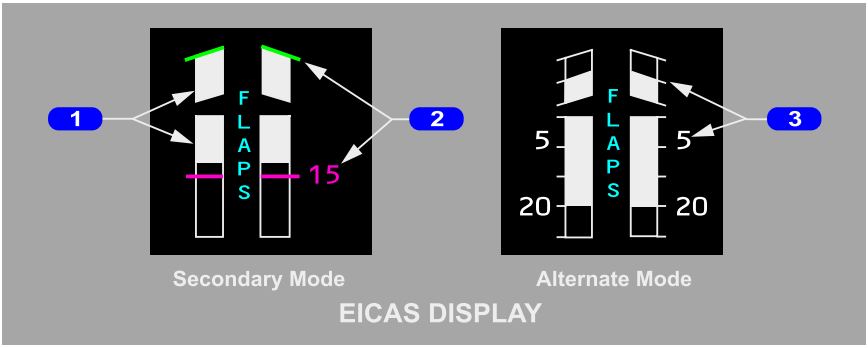
Displayed (white)—flap load relief is retracting the flaps, or inhibiting extension, as required to prevent air load damage due to excessive airspeed.

Expanded Flap and Slat Position Indication

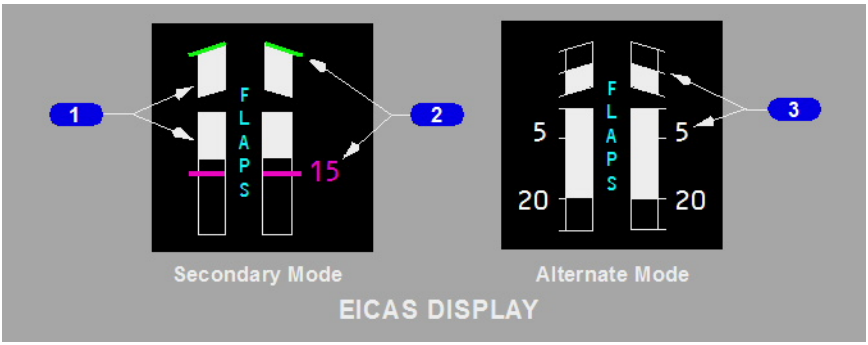
If any flap/slat is non–normal or if control is in the secondary mode, slat and flap positions are shown independently. Each wing is also shown separately.

Indicator motion is continuous between flap detents.

TQA to TQF



TWA,B



1 Expanded Flap and Slat Position Indications

The slat indication fills up (forward) for extension.

The flap indication fills down (aft) for extension.

Indication colors of outline and fill are:

- white when operating in secondary mode
- amber when the respective FLAPS DRIVE or SLATS DRIVE EICAS caution message is displayed.

Loss of position information is shown as a white outline with no fill and no flap lever position indication.

2 Flap Lever Position (line and number)

Magenta—the slats or flaps are in transit to the commanded position.

Green—the slats or flaps are in the commanded position.

The numbers are shown next to the flap position indicator only.

3 Alternate Flap and Slat Position Indications (white)

In the alternate mode, extension is limited to slats midrange and flaps 20.

Displayed automatically when the alternate control mode is armed.

Slats—displays the position of the slats.

Flaps—displays the position of the flaps.

Flap position index marks—reference flaps UP, 5, 15, and 20. TQA to TQF

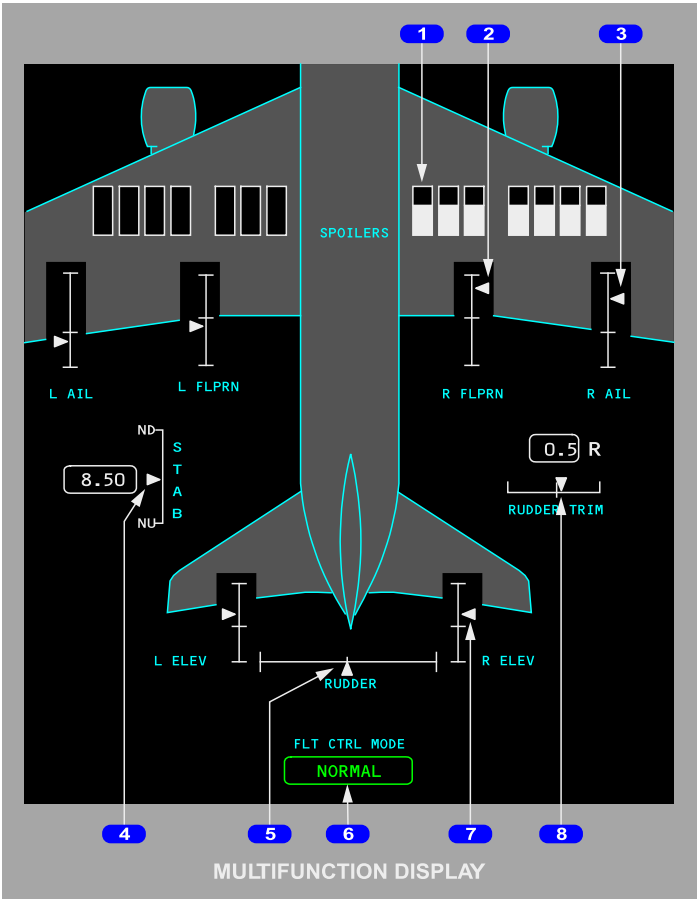
Flap position index marks – reference flaps UP, 5, and 20. TWA,B

Loss of position information is indicated as a white outline with no fill and no position index marks or numbers.

Flight Control Synoptic Displays

The flight controls synoptic is displayed by pushing the systems (SYS) display switch, then selecting the FCTL synoptic key from the menu page.

Normal Flight Control Synoptic



1. Spoiler Position
2. Flaperon Position
3. Aileron Position
4. Stabilizer Position
5. Rudder Position
6. Primary Flight Control System Mode

7 Elevator Position

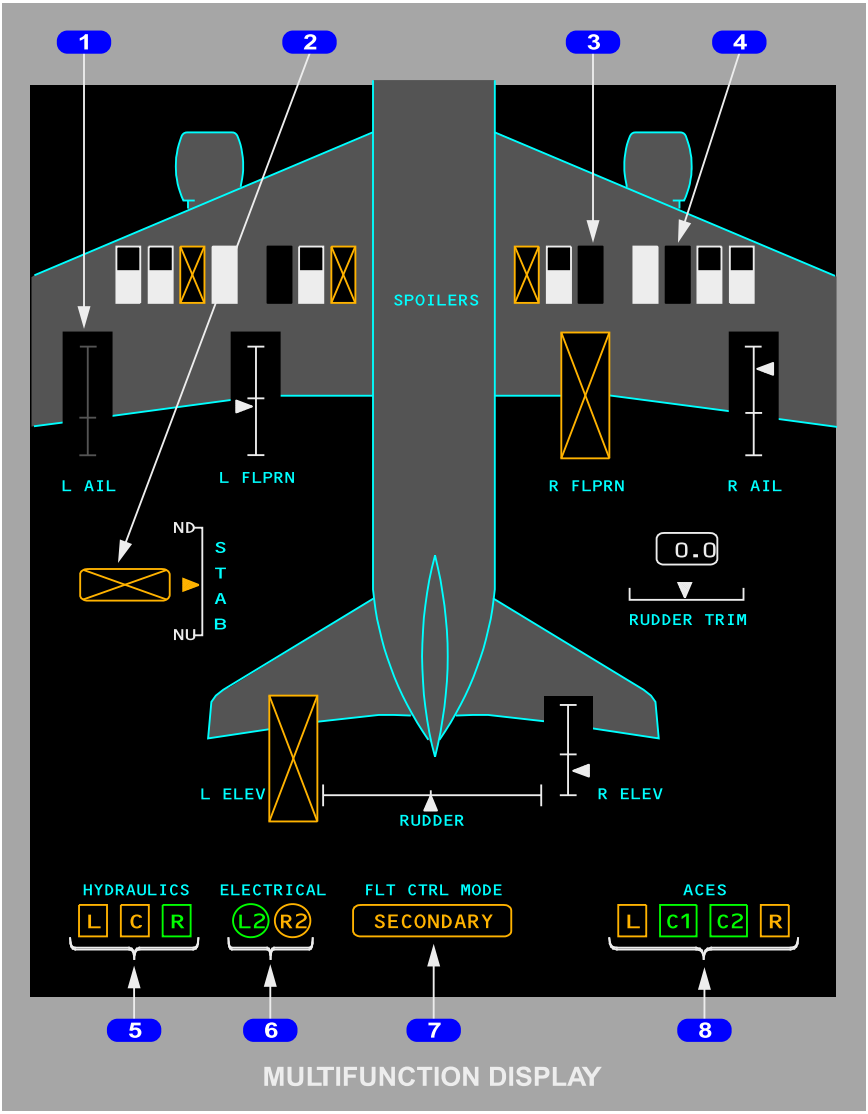
8 Rudder Trim Position and Direction

L—Left

R—Right

No direction is shown when rudder trim is centered.

Non–Normal Flight Control Synoptic



1 Unknown Aileron Position

Unknown aileron position is indicated by a gray scale and no pointer.

2 Failed Control Surface or Trim Function

Failed control surfaces and trim functions are indicated by an amber border with an “X” inside.

3 Unknown or Failed Electric Spoiler Condition

Unknown position or failed electric spoilers are indicated by a blanked spoiler display for the affected spoiler.

4 Unknown Spoiler Condition

Unknown spoiler condition is indicated by a blanked spoiler display for the affected spoiler.

5 Hydraulic System Indications

Green—the associated hydraulic system is functioning normally.

Amber—the associated hydraulic system has failed.

6 Electrical Systems Indications

Green—the associated electrical system is functioning normally.

Amber—the associated electrical system has failed.

7 Flight Control Mode SECONDARY or DIRECT Indications

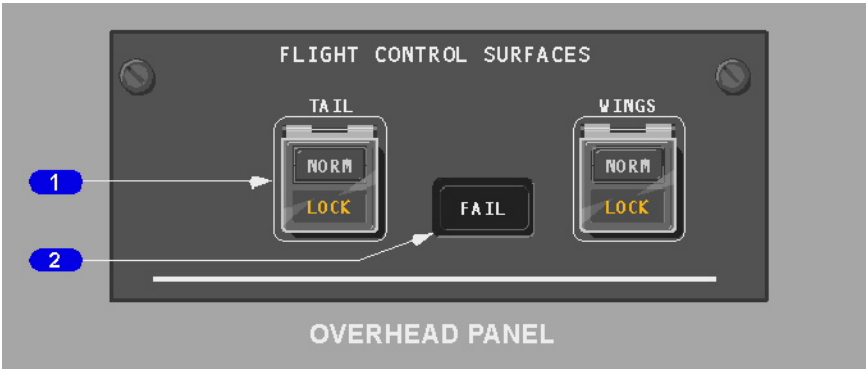
When flight controls revert to secondary or direct modes the FLT CTRL MODE indication displays an amber SECONDARY or DIRECT to indicate which mode is in use.

8 Actuator Control Electronic Indications

Green—the associated ACE is functioning normally.

Amber—the associated ACE has failed.

Flight Control Surfaces Controls



1 FLIGHT CONTROL SURFACES Lock Switches (TAIL and WINGS)

NORM—the respective flight control surfaces are unlocked.

LOCK (illuminated amber)—

- the respective flight control surfaces are electronically locked
- EICAS advisory message FLT CONTROL LOCKED is displayed.

2 Flight Control Surfaces Lock FAIL Light

Illuminated (white)—a flight control surfaces lock switch is selected and any of the respective flight control surfaces are not locked.

Introduction

The primary flight control system uses conventional control wheel, column, and pedal inputs from the pilot to electronically command the flight control surfaces. The system provides conventional control feel and pitch responses to speed and trim changes. The system's electronic components provide enhanced handling qualities and reduce pilot workload.

The primary flight control system is highly redundant, with three operating modes: normal mode, secondary mode, and direct mode.

Pilot Controls

The pilot controls consist of:

- alternate flap switches
- alternate pitch trim switches
- control wheel pitch trim switches
- rudder trim selector
- stabilizer cutout switches
- the flap lever
- the speedbrake lever
- two control columns
- two control wheels
- two pairs of rudder pedals.

The columns, wheels, and rudder pedals are connected through jam override mechanisms. If a jam occurs in a column, wheel, or rudder pedals the pilots can maintain control by applying force to the other column, wheel, or rudder pedals to overcome the jam.

The speedbrake lever allows manual or automatic symmetric actuation of the spoilers.

The EICAS caution message FLIGHT CONTROLS is displayed if:

- multiple ACE and/or hydraulic system failures cause the loss of a significant number of control surfaces, or
- other significant flight control system faults are detected.

The ACEs can transmit pilot control inputs directly to the control surfaces, or they can send the pilot inputs to the PFCs. When the ACEs are sending pilot inputs to the PFCs, the ACEs receive control commands back from the PFCs and use the commands to position the flight control surfaces.

The PFCs use information from other airplane systems (such as air data, inertial data, flap and slat position, engine thrust, and radio altitude) to compute

control surface commands for enhanced handling qualities. See Primary Flight Control System Modes on page 9.20.5 for a description of these handling quality enhancements.

The autopilot sends commands to the PFCs, which then produce control surface commands. (See Autopilot Flight Director System (AFDS) on page 4.20.1 for additional information.)

Unique Failure Considerations

In the unlikely event of the loss of all hydraulic power, the electrically actuated stabilizer and two spoiler pairs allow pilot control of pitch and roll using the primary pitch trim switches, alternate pitch trim switches, and the control wheel.

If there is a complete loss of flight control signaling, direct wiring from the flight deck to the stabilizer and a spoiler pair allow pilot control of pitch using the alternate pitch trim switches and roll using the control wheel.

Flight Control Surfaces

Pitch control is provided by:

- two elevators
- a movable horizontal stabilizer.

Roll control is provided by:

- two flaperons
- two ailerons
- fourteen spoilers.

Yaw control is provided by a single rudder.

The two elevators and horizontal stabilizer work together to provide pitch control.

The flaperons and ailerons provide roll control, assisted by asymmetric spoilers.

The flaperons are located between the inboard and outboard flaps on both wings. In the normal mode, they are used for roll control with the flaps either retracted or extended. The flaperons also droop with the trailing edge flaps to improve slow speed performance.

The ailerons are located outboard of the outboard flaps on each wing. The ailerons and spoilers droop with the trailing edge flaps to improve slow speed performance.

The ailerons are locked out during high speed flight where the flaperons and spoilers provide sufficient roll control. During low speed flight, the ailerons operate to augment roll control.

Yaw control is provided by a single rudder. During takeoff, the rudder becomes aerodynamically effective at approximately 60 knots.

Flaps and slats provide high lift for takeoff, approach, and landing.

Symmetric spoilers are used as speedbrakes.

Flight Control Surfaces Lock

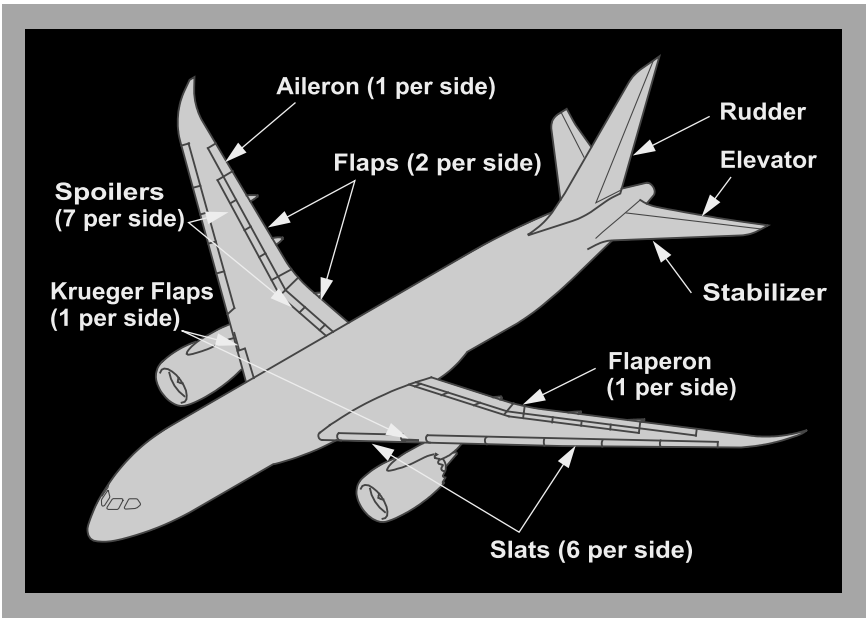
There are two FLIGHT CONTROL SURFACES lock switches located on the overhead panel for locking out the flight control surfaces on the tail and wings. The flight control lock switches are for use by maintenance personnel to prevent surface movement when working on or in the area of the control surfaces.

WARNING: To avoid injury to personnel or damage to the airplane, always verify the areas near the flight control surfaces are clear prior to moving a switch from LOCK to NORM.

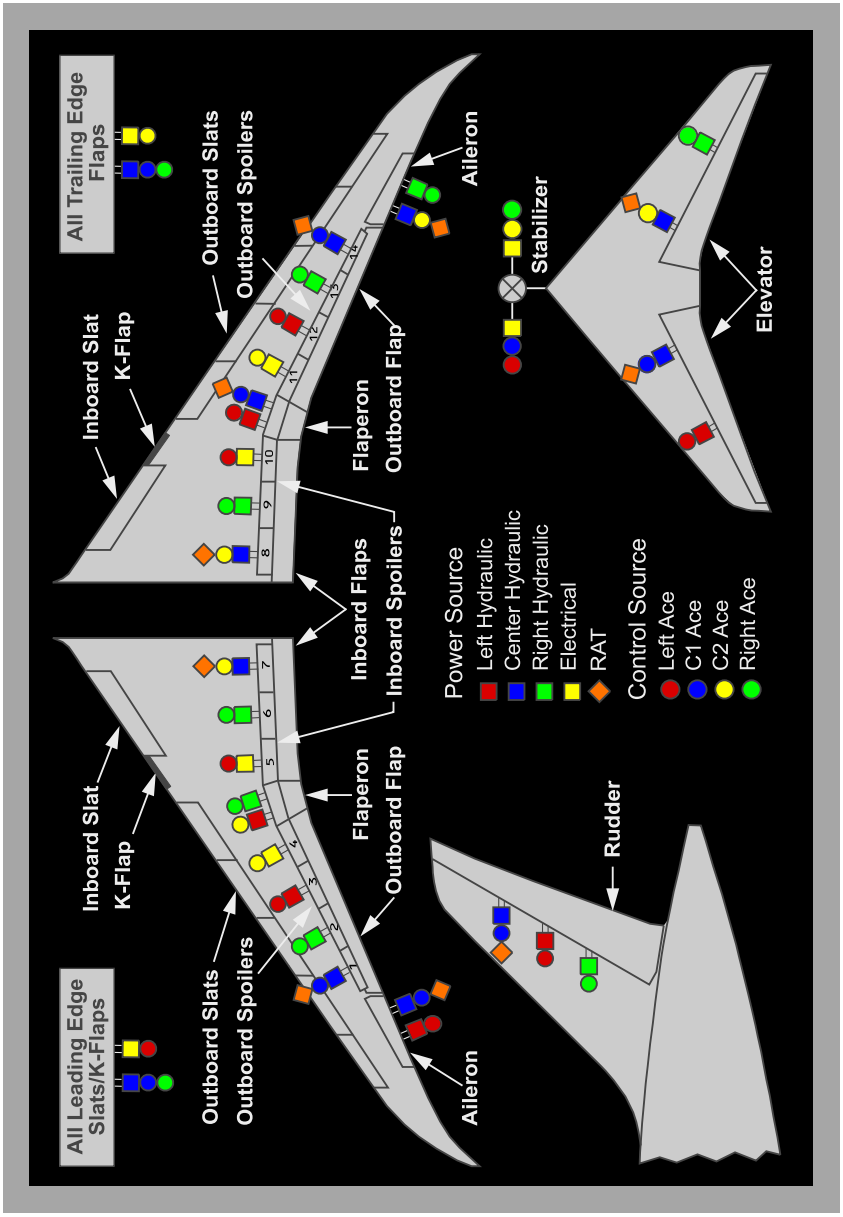
To alert the flight crew of a locked condition, the EICAS advisory message FLT CONTROL LOCKED is displayed when a lock switch is in the LOCK position. In addition, the flight control surfaces automatically unlock when groundspeed exceeds 40 knots.

The flight control lock FAIL light is illuminated when a lock switch is in the LOCK position and any of the associated surfaces do not lock.

Flight Control Surface Locations



Actuator Control Electronics (ACE)/Hydraulic Power Distribution



Primary Flight Control System Modes

There are three primary flight control system modes (flap and slat system modes are described later in this section):

- normal
- secondary
- direct.

All the modes use the same pilot controls and flight control surfaces.

Flight Control System Normal Mode

In the normal mode during manual flight (autopilot disengaged), four ACEs receive pilot control inputs and send these signals to three PFCs. The PFCs verify these signals and information from other airplane systems to compute enhanced control surface commands. These commands are sent back to the ACEs, then to the flight control surface actuators. (See Flight Controls on page L.10.5 for additional information.)

When the autopilot is engaged, the autopilot system sends control surface commands to the PFCs. The PFCs generate control surface commands which are sent to the ACEs and then to the control surface actuators. The autopilot backdrives the pilot controls to provide awareness of what the autopilot is doing. If the pilot overrides the autopilot with control inputs, the autopilot disconnects and the flight control system uses the pilot control inputs. The autopilot is only available during normal mode operation. (See Autopilot Flight Director System (AFDS) on page 4.20.1 for additional information.)

After landing with flaps and speed brakes retracted and groundspeed less than 30 knots, a series of flight control self-tests are run. The first series of tests require hydraulic power to be on, and take approximately 90 seconds to complete. These tests start when the flaps are retracted and also require that hydraulic power not be interrupted or flight controls moved to avoid interrupting these tests. If the engines are shutdown before the flaps are retracted, these tests are not accomplished.

After the first series of tests are complete, and all hydraulic systems are depressurized, a second series of flight control self-tests are run. These tests take approximately 55 seconds, require that hydraulics remain unpowered, and that the flaps or speedbrakes not be moved during the tests.

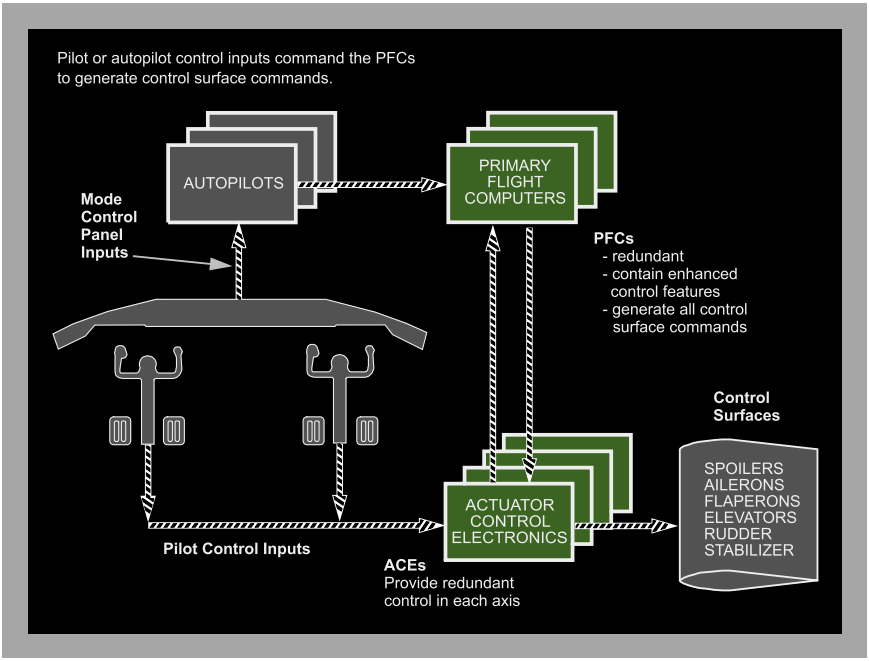
After the second series of tests are complete, and both engines are shut down and PMG power is off, a third series of self-tests are run. These tests take approximately 90 seconds to complete.

If certain tests in any of the three series are skipped or interrupted, or, if the hydraulic power-on tests are accomplished without the hydraulic power-off tests being accomplished on two consecutive flights (e.g. training), then a fault condition may be set with a correlated FC SYS maintenance memo or

EICAS status message. These fault conditions may affect dispatch and require maintenance tests to be run.

While each series of tests are running, various EICAS alert and status messages display, and various failures display on the flight controls synoptic page. When the self-tests are complete, the EICAS alert and status messages are removed, and the synoptic display returns to normal.

Normal Mode



Flight Envelope Protection

The primary flight control system provides flight envelope protection when operating in normal mode during manual flight. Flight envelope protection reduces the possibility of inadvertently exceeding the flight envelope by providing crew awareness of envelope margins through tactile, aural, and visual cues. Envelope protection does not reduce pilot control authority.

The protection functions are described later in this section and include:

- bank angle protection
- overspeed protection
- stall protection.

For additional information:

- See Flight Envelope Protection on page 4.20.23
- See Aurals, Master WARNING/CAUTION Switches and Lights on page 15.20.4
- See Airspeed Alerts on page 15.20.10.

Flight Control System Secondary Mode

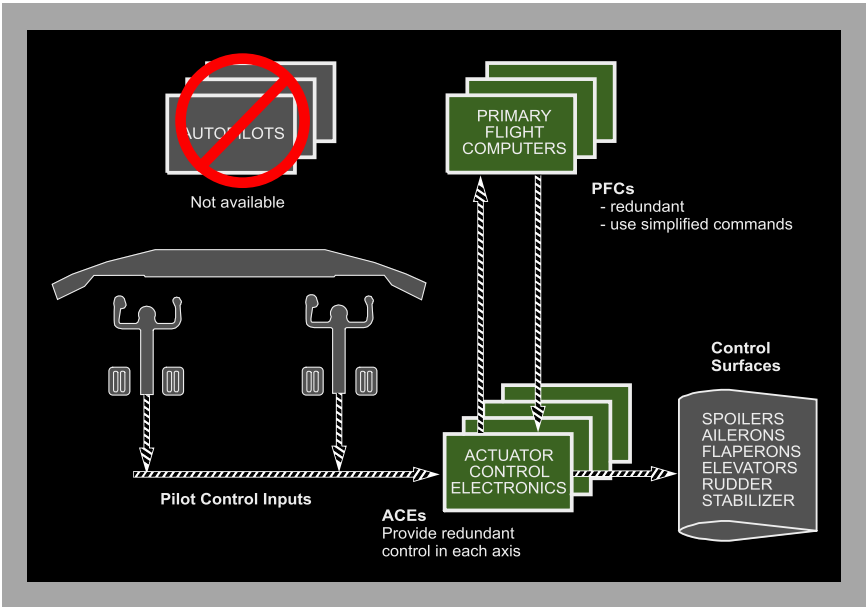
The PFCs automatically revert to secondary mode when inertial or air data is insufficient to support normal mode or when all slat and flap position data is unavailable. The ACEs continue to receive and process pilot control inputs, and send these signals to the three PFCs. The PFCs use simplified computations to generate flight control surface commands. These simplified commands are sent back to the ACEs, where they are sent to the control surface actuators. All flight control surfaces remain operable. The elevator and rudder are more sensitive at some airspeeds and yaw damping is degraded.

In the secondary mode, the following functions are not available:

- autopilot
- auto speedbrakes
- envelope protection
- gust suppression
- pitch compensation
- roll/yaw asymmetry compensation
- tail strike protection.

The EICAS caution message FLIGHT CONTROL MODE is displayed when the primary flight control system is in the secondary mode. The secondary mode cannot be manually selected.

Secondary Mode



Flight Control System Direct Mode

The ACEs automatically transition to the direct mode when they detect the failure of all three PFCs or lose communication with the PFCs. The direct mode can also be manually selected by moving the PRIMARY FLIGHT COMPUTERS disconnect switch to DISC.

In the direct mode, the PFCs no longer generate control surface commands. Pilot inputs received by the ACEs are sent directly to the control surface actuators.

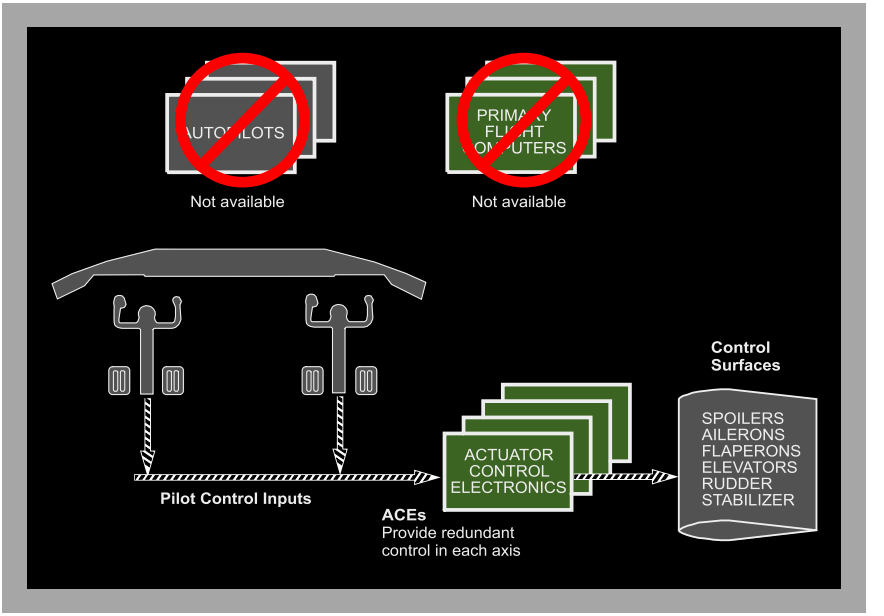
The direct mode provides full airplane control for continued safe flight and landing. The airplane handling qualities are almost the same as the secondary mode. All flight control surfaces remain operable and yaw damping is degraded. The EICAS caution message PRI FLIGHT COMPUTERS is displayed when the system is in the direct mode.

In the direct mode, the following functions are not available:

- autopilot
- auto speedbrakes
- envelope protection
- gust suppression
- pitch compensation
- roll/yaw asymmetry compensation

- tail strike protection.

Direct Mode



Normal Mode Pitch Control

In the normal mode, the airplane pitch control characteristics are similar to conventional airplanes. The control column input commands the PFCs to generate a pitch maneuver where the rate is dependent on column displacement. The PFCs automatically position the elevator and stabilizer to generate the commanded maneuver. The PFCs constantly monitor airplane response to pilot commands and reposition the elevator and stabilizer accordingly.

The PFCs provide pitch compensation by utilizing control surface commands to minimize airplane pitch responses to thrust changes, configuration changes (gear, flap, speedbrake), turbulence, and turns up to 30° of bank. The PFCs automatically control pitch to maintain a relatively constant flight path. This eliminates the need for the pilot to make control column inputs to compensate for these factors. For turns up to 30° of bank, the pilot does not need to add additional column back pressure to maintain altitude. For turns of more than 30° of bank, the pilot does need to add column back pressure.

As airspeed changes, the PFCs provide conventional pitch control characteristics by requiring the pilot to make control column inputs or trim changes to maintain a constant flight path.

Primary Pitch Trim Control

Primary pitch trim is controlled by the dual pitch trim switches on each control wheel. Both switches must be moved to command trim changes. The primary pitch trim switches are inhibited when the autopilot is engaged. Pitch trim does not move the control column.

In the normal mode, primary pitch trim operates differently on the ground than it does in flight. On the ground, the stabilizer is directly positioned when the pilot uses the pitch trim switches. In flight, the pitch trim switches do not position the stabilizer directly, but make inputs to the PFCs to change the trim reference speed. The trim reference speed is the speed at which the airplane would eventually stabilize if there were no control column inputs. Once the control column forces are trimmed to zero, the airplane maintains a constant speed with no column inputs. Thrust changes result in a relatively constant indicated airspeed climb or descent, with no trim inputs needed unless airspeed changes.

When pilot trim inputs are made, the PFCs automatically move the elevators to achieve the trim change, then moves the stabilizer to streamline the elevator. Stabilizer motion may also automatically occur to streamline the stabilizer and elevator for thrust and configuration changes.

In the secondary or direct modes, primary pitch trim operates the same on the ground and in flight; the stabilizer is directly positioned when the pilot uses the primary pitch trim switches.

Alternate Pitch Trim

Alternate pitch trim is controlled by the dual pitch trim switches located on the control stand. Both switches must be moved to command trim changes. The switches are linked electrically to the horizontal stabilizer trim actuator and then mechanically to the stabilizer. Alternate pitch trim commands have priority over primary pitch trim commands in all flight control modes. Alternate pitch trim switches are inhibited when the autopilot is engaged. Pitch trim does not move the control column.

In the normal mode, alternate pitch trim operates differently on the ground than it does in flight. On the ground, the stabilizer is directly positioned when the pilot uses the alternate pitch trim switches. In flight, the alternate pitch trim switches make changes to the trim reference speed. This is the same normal operation as the primary pitch trim switches (see Primary Pitch Trim Control on page 9.20.10 for details).

In the secondary or direct modes, alternate pitch trim operates the same on the ground and in flight; the stabilizer is directly positioned when the pilot uses the alternate pitch trim switches.

Pitch Envelope Protection

The pitch envelope protection functions include:

- overspeed protection
- stall protection.

Overspeed Protection

Overspeed protection reduces the likelihood of inadvertently exceeding VMO or MMO by providing enhanced crew awareness of the approach to an overspeed condition.

Overspeed protection limits the speed to which the airplane can be trimmed. At VMO/MMO, the trim reference speed is limited by inhibiting trim in the nose down direction. The pilot must apply continuous forward column pressure, at twice the normal force, to maintain airspeed above VMO/MMO.

Stall Protection

Stall protection reduces the likelihood of inadvertently exceeding the stall angle of attack by providing enhanced crew awareness of the approach to a stall or to a stalled condition.

Stall protection limits the speed to which the airplane can be trimmed. The trim reference speed is limited by inhibiting trim in the nose up direction when the airplane slows to a speed where maneuver margin is limited. This trim inhibit speed is approximately the minimum maneuvering speed (top of the amber band) at lower altitudes, and can be 10 to 20 kts lower than the top of the amber band at higher altitudes. The pilot must apply continuous aft column pressure, at higher than normal force, to maintain airspeed below the minimum maneuvering speed.

For additional information on PFD flight mode annunciations, mode control panel and autothrottle operation:

- See AFDS Flight Mode Annunciations on page 4.20.5
- See Autothrottle System on page 4.20.9
- See MCP Mode Selection on page 4.20.1.

Elevator Variable Feel

The PFCs calculate feel commands based on airspeed. In general, control column forces increase:

- as airspeed increases for a given column displacement, or
- as column displacement increases.

Tail Strike Protection

During takeoff or landing, the PFCs calculate if a tail strike is imminent and decrease elevator deflection, if required, to reduce the potential for tail contact with the ground. Activation of tail strike protection does not provide feedback to the control column. Protection does not degrade takeoff performance and

is compatible with the autoland system. The pilot can override the tail strike protection, if necessary, with continued column input.

Secondary and Direct Mode Pitch Control

Airplane pitch control in the secondary and direct flight control modes differs from normal mode. The flight control system continues to receive and process pilot control inputs using simplified computations to generate flight control surface commands. The control columns command a proportional elevator deflection instead of a maneuver command. Secondary and direct modes do not provide automatic pitch compensation for:

- flap and speedbrake configuration changes
- gear configuration changes
- thrust changes
- turns to 30° bank angle
- turbulence.

In secondary and direct modes, the elevator variable feel system provides feel force levels based on flap position instead of a continuous variation with airspeed. With the flaps up, the feel forces provide maneuver force levels that discourage over control in the pitch axis at high speeds. With the flaps out of up, the feel forces decrease to provide force levels appropriate for approach and landing.

In the secondary and direct modes there is no trim reference speed. Both the primary and alternate pitch trim switches move the stabilizer directly.

Stabilizer Operation

Stabilizer position commands are processed through two independent channels within the flight control system. The commands come from the primary or alternate pitch trim switches and move the stabilizer using an electric control unit powered by the L2 and R2 AC buses.

Stabilizer Shutdown

If uncommanded stabilizer motion is sensed, the stabilizer channel that caused the motion is automatically shut down. If a channel is inoperative due to automatic shutdown or failure, the EICAS advisory message STABILIZER L2 or STABILIZER R2 is displayed. The stabilizer remains operative through the remaining channel. If the affected channel can not be isolated, both channels are shut down.

If both stabilizer channels automatically shut down or fail, the EICAS warning message STABILIZER is displayed. This warning is also displayed if automatic shutdown fails to stop the uncommanded motion.

The L2 and R2 stabilizer cutout switches, located on the aisle stand, control electric power to the independent stabilizer channels. Placing both switches

in the CUTOUT position disables stabilizer operation and the EICAS advisory message STABILIZER CUTOUT is displayed. With both switches in the CUTOUT position the STABILIZER warning message is not displayed.

Note: If both stabilizer channels are automatically shut down, placing both stabilizer cutout switches in the CUTOUT position will not clear the STABILIZER warning message and will not display the STABILIZER CUTOUT advisory message.

In the normal mode, when the stabilizer is manually shut down or has failed, pitch trim is still available through the elevators. Pitch trim commands from the primary or alternate pitch trim switches change the trim reference speed. The elevators then trim the airplane but the stabilizer does not move.

Column Cutout

The column cutout function is designed to stop the effects of uncommanded pitch trim input from jammed or failed pitch trim switches. If a nose up or nose down pitch trim command from either the primary or alternate trim switches is opposed by either control column for more than 2 seconds, the column cutout function disables the specific pitch trim switch commands until the switch input indicates no trim input. If the column cutout function remains active for more than 20 seconds, i.e. the trim switch remains jammed or failed, the STABILIZER L2/R2 EICAS advisory is displayed, and the uncommanded input is removed by system shutdown.

Column cutout is only available in the normal and secondary modes and is not active while on the ground to allow trimming nose down stabilizer with aft column input during a touch-and-go.

Stabilizer Position Indication and Green Band Monitor

Stabilizer position is displayed on EICAS and on the flight controls synoptic. The EICAS stabilizer position indication includes a takeoff green band. The indication on the synoptic is constantly displayed. The EICAS indication is displayed on the ground at power-up and blanks when either of the following conditions are satisfied:

- gear up for 10 seconds, or
- 60 seconds after liftoff.

The EICAS stabilizer position indication automatically displays if any of the following conditions are satisfied:

- after landing and any pair of pitch trim switches are used, or
- after landing and groundspeed is less than 40 knots, or
- in the air and any of the following EICAS messages are active:
  - FLIGHT CONTROL MODE
  - PITCH DOWN AUTHORITY
  - PITCH UP AUTHORITY

- PRI FLIGHT COMPUTERS
- STABILIZER
- STABILIZER CUTOUT.

The stabilizer green band monitor is part of the crew alerting function and helps confirm that the green band displayed on the stabilizer position indicator is correct for the actual takeoff weight and CG, based on the gross weight and CG entries in the FMC. Two nose gear pressure transducers provide actual airplane gross weight and CG information. The nose gear pressure data is used to determine two separate sets of validation limits (one for each transducer). The FMC calculated stabilizer green band is then compared to the validation limits from the transducers. The EICAS advisory message STAB GREENBAND is displayed if:

- computed green band disagrees with pressure transducer data, or
- the two transducer values are not within the set tolerance, or
- either transducer has failed.

Hybrid Laminar Flow Control (HLFC)

TWA,B The vertical stabilizer has a Hybrid Laminar Flow Control (HLFC) system installed to reduce aerodynamic drag. Two external door assemblies, that can be seen near the root of vertical stabilizer, automatically provide negative pressure to the leading edges in flight to reduce airplane drag. There are no crew procedures or monitoring requirements for this system and no alert messages specific to this function for any failure mode.

Normal Mode Roll Control

In the normal mode, airplane roll control characteristics are similar to conventional airplanes. Unlike conventional airplanes, the control wheel does not directly position the lateral surfaces in flight, it instead commands a roll maneuver with the rate dependent on wheel displacement. The flight control system automatically positions the ailerons, flaperons, and spoilers to generate the commanded maneuver. It constantly monitors airplane response to pilot inputs and repositions the lateral surfaces to carry out these commands. Control wheel forces increase as control displacement increases. Control wheel forces do not change with airspeed changes. Airplane roll response to turbulence is minimized by automatic control surface commands. The ailerons are locked out at high speeds. Aileron trim is incorporated into the flight control laws and no pilot input is required.

Bank Angle Protection

Bank angle protection reduces the likelihood of exceeding the bank angle boundary due to external disturbances, system failures, or inappropriate pilot action.

Bank angle protection provides roll control wheel inputs when airplane bank angle exceeds the bank angle protection boundary of approximately 35°. If the boundary is exceeded, the control wheel force rolls the airplane back within 30° of bank. This roll command can be overridden by the pilot. Maximum control wheel deflection always commands maximum roll authority. The autopilot disengage bar disables bank angle protection.

Excessive bank angles are indicated on the PFD bank indicator. The indicator changes color to amber at bank angles exceeding 35°.

For additional information:

- See PFD Attitude Indications on page 10.10.7
- See Lateral Navigation (LNAV) on page 11.31.13.

Secondary and Direct Mode Roll Control

Airplane roll control in the secondary and direct flight control modes differs from normal mode. The flight control system continues to receive and process pilot control inputs using simplified computations to generate flight control surface commands. Roll envelope bank angle protection is not available in the secondary or direct modes.

Normal Mode Yaw Control

In the normal mode, airplane yaw control characteristics are similar to conventional airplanes. Unlike conventional airplanes, the rudder pedals do not directly position the rudder surface in flight, they instead command a sideslip maneuver with the airplane sideslip angle dependent on pedal displacement. The flight control system automatically positions the rudder to generate the commanded maneuver. It constantly monitors airplane response to pilot inputs and repositions the rudder to carry out these commands. Airplane sideslip response to turbulence is minimized by automatic control surface commands.

Pedal forces increase as pedal displacement increases. Pedal forces do not change with airspeed changes. The rudder ratio changer automatically reduces the sideslip command (for a given pedal input) as airspeed increases. Sufficient rudder authority is provided at all airspeeds to maintain airplane control in engine failure conditions, and during takeoffs and landings in crosswinds.

Asymmetry Compensation

During reverse thrust asymmetry conditions, or during takeoffs in crosswind or gusty conditions, the flight control system attempts to maintain a zero yaw rate by automatically adding rudder corrections. Under these conditions the rudder pedals do not move. The pilot may need to provide additional inputs using rudder and/or control wheel movement to maintain directional control.

On the ground above 60 knots groundspeed, the flight control system attempts to maintain a yaw rate near zero by commanding rudder to counter the majority

of the yawing moment due to an engine failure. The capability to counter a thrust asymmetry is an inherent part of the flight control system. The pilot can still recognize the initial onset of an engine failure through the airplane yaw cue, since the flight controls do not counter all of the yawing moment. Also, the rudder pedals move to give feedback to the pilot that the system is working to counter a thrust asymmetry.

In flight, when a roll or yaw asymmetry condition exists for any reason (not only thrust related), the flight control system initially attempts to maintain zero roll rate and sideslip. An automatic rudder input counters the yawing moment and an automatic lateral control input counters the rolling moment. After the initial inputs, the system off loads any steady state lateral control input to the rudder, resulting in a small sideslip. The rudder pedals move to give the pilot awareness of the automatic function and the resulting rudder trim indication is automatically shown on the EICAS display.

This off load increases sideslip on the airplane, therefore the off load has limits based on the severity of the asymmetry. For large asymmetry conditions a greater sideslip is permitted, but some automatic lateral control input may remain after the off load stops. For large asymmetries the EICAS caution message ROLL/YAW ASYMMETRY is displayed.

For severe asymmetric conditions where the initial automatic lateral control input is very large, the EICAS caution message ROLL LEFT/RIGHT AUTHORITY, is displayed to inform the crew of the limited roll control available.

Automatic lateral and rudder inputs are only available in the normal flight control mode and can be overridden by manual control wheel or rudder pedal inputs.

Wheel to Rudder Cross–Tie

The wheel to rudder cross–tie function is available in the secondary and direct modes. This function reduces maximum sideslip and vertical fin loads.

In the normal mode, wheel to rudder cross-tie is not required, the flight control system automatically controls sideslip and fin loads.

Yaw Damping

In the normal mode, the roll/yaw control laws provide turn coordination and Dutch roll damping.

Gust Suppression

Vertical gust suppression enhances ride quality in the presence of vertical gusts and turbulence. It utilizes symmetric deflection of the flaperons and elevators to alleviate gust acceleration. This function is active only with the autopilot engaged in Altitude Hold or VNAV level flight modes.

Lateral gust suppression improves ride quality and can reduce pilot work load on approach by automatic application of discrete yaw commands in response to lateral gusts and turbulence.

Operation of vertical and lateral gust suppression does not result in control wheel, control column, or rudder pedal movement.

Vertical and lateral gust suppression are only available in the normal mode.

Rudder Trim

Manual rudder trim operation is provided in all three flight control modes by a rudder trim selector located on the aft aisle stand. Two rudder trim rates are available. A low rate is commanded with the selector rotated to the detent, and a high rate is commanded when rotated past the detent. Manual trim inputs are automatically zeroed during takeoff roll, when groundspeed exceeds 30 knots and further manual trim inputs are inhibited until in the air. Manual rudder trim is also inhibited with the autopilot yaw engaged (LAND 3) on approach. To provide pilot awareness, the pedals move to reflect the amount of manual rudder trim applied.

Automatic rudder trim is provided in the normal flight control mode. For pilot awareness of any asymmetric condition on the ground or in the air, the system automatically moves the rudder pedals to reflect the rudder position being commanded. This trim position is also shown on the rudder trim indicator and the flight control synoptic. If the rudder deflection is minimal, the rudder trim remains centered. This prevents running the trim for normal situations such as to coordinate a turn.

On landing, automatic and manual rudder trim inputs are zeroed so they do not provide a yaw command when the airplane transitions from the air mode (sideslip maneuver) to the ground mode (yaw maneuver).

Rudder trim is displayed on EICAS and the flight controls synoptic. The indication on the synoptic is constantly displayed. The EICAS indication blanks when either of the following conditions are satisfied:

- gear up for 10 seconds, or
- 60 seconds after liftoff.

The EICAS rudder trim indication automatically displays if any of the following conditions are satisfied:

- after landing and groundspeed is less than 40 knots, or
- in the air and any of the following EICAS messages are active:
  - ENG FAIL L (or R)
  - ENG SHUTDOWN L (or R)
  - ENG THRUST L (or R)
  - FLIGHT CONTROL MODE
  - PRI FLIGHT COMPUTERS.

Secondary and Direct Mode Yaw Control

Airplane yaw control in the secondary and direct flight control modes differs from normal mode. The flight control system continues to receive and process pilot control inputs and uses simplified computations to generate flight control surface commands. The rudder pedals command a proportional rudder deflection instead of a maneuver command. Pedal feel forces are unchanged from normal mode and rudder response is slightly different.

In secondary and direct modes, the rudder ratio changer is based on flap position. With flaps up, the rudder response to pedal inputs is less than the response when the flaps are not up.

In the secondary and direct modes:

- asymmetry compensation is inoperative
- flight envelope protection is inoperative
- gust suppression is inoperative
- yaw damping is degraded.

Spoilers

There are 7 sets of spoilers, 4 outboard and 3 inboard of the flaperons, on the upper surface of each wing. The spoilers are numbered from left to right, 1 through 14. Spoilers on opposing wings are symmetrically paired.

Spoiler panels are used as speedbrakes to increase drag and reduce lift, both in flight and on the ground. The spoilers also supplement roll control in response to control wheel commands.

All three hydraulic systems supply 5 pairs of spoilers. Each hydraulic system is dedicated to a different set of spoiler pairs to provide isolation and maintain symmetric operation in the event of hydraulic system failure. The remaining two spoiler pairs are individually powered by two electrical buses.

The flight control system automatically biases the spoilers up during engine start and taxi to prevent spoiler trailing edges from contacting the flaps.

Failure of one or two spoiler panels in the air, or failure of one not down and locked spoiler panel on the ground, causes the EICAS advisory message SPOILERS to display. Failure of three or more spoiler panels causes the EICAS advisory message SPOILER PAIRS to display.

Spoiler Speedbrake Operation

The 14 spoiler panels are used as speedbrakes.

The speedbrake spoilers are controlled by the speedbrake lever located on the control stand. The speedbrake lever has three marked positions:

- DOWN
- ARMED

- UP.

The speedbrake lever can be placed in intermediate positions between ARMED and UP.

In the ARMED position, the spoilers extend and the speedbrake lever is driven aft to the UP position on landing when the main gear trucks untilt and both thrust levers are not in the takeoff range.

When the speedbrake lever is not in the ARMED position, the spoilers still automatically extend and the speedbrake lever is driven to the UP position when either of the following conditions occur:

- on the ground with groundspeed above 85 knots, either thrust lever was previously in the takeoff range, then both thrust levers are moved to the idle range (rejected takeoff), or
- on the ground and both thrust reverse levers are moved to the reverse idle detent.

The spoilers automatically retract and the speedbrake lever is driven forward to the DOWN position, when any of the following conditions occur:

- on the ground, when either thrust lever is moved to the takeoff range, or
- on the ground, if there is a transition to in the air, or
- in the air, when either thrust lever is beyond 90% full travel.

Automatic speedbrakes are only available in the normal mode.

Autodrag

The autodrag function operates by deflecting the ailerons upward and raising the two most outboard spoilers, while maintaining airspeed, to assist in glideslope/glidepath capture when the airplane is on or above the vertical path. Autodrag functions only in landing configuration; flaps 25 or 30 and the thrust levers are at idle. Spoiler and aileron movement is shown on the flight control synoptic. The autodrag surface deflection is gradually removed below 500 feet AGL so flare and touchdown are not affected. The function is active during automatic or manual approaches.

Autodrag is only available in the normal mode.

Landing Attitude Modifier (LAM)

Landing Attitude Modifier (LAM) is an automatic function used to increase pitch attitude and increase the nose gear height when landing flaps are selected at higher speeds. LAM increases pitch attitude by partially raising selected lateral control surfaces. This reduces the lift produced by the wing, requiring the airplane to fly at a higher pitch attitude. When LAM is active, some airframe buffet may occur. There are no crew procedures or monitoring requirements for this system and no alert messages specific to this function for any failure mode.

Flaps and Slats

The flaps and slats are high lift devices that increase wing lift and decrease stall speed during takeoff, approach, and landing.

The airplane has an inboard and an outboard flap on the trailing edge of each wing, and one inboard and five outboard slats on the leading edge. A two-position Krueger flap provides a seal between the inboard slat and the engine nacelle on each wing.

TQA to TQF In the flaps 1 position, only the slats move. Flaps 5, 15, and 20 are takeoff flap positions. Flaps 25 and 30 are landing flaps positions. Flaps 20 is used for some non–normal landing conditions.

TWA,B In the flaps 1 position, only the slats move. Flaps 5, 10, 15, 17, 18, and 20 are takeoff flap positions. Flaps 25 and 30 are landing flaps positions. Flaps 20 is used for some non–normal landing conditions.

To protect against inadvertent deployment during cruise, flap and slat extension from the UP position is inhibited when speed is more than 260 KIAS or altitude is above approximately 20,000 feet. This inhibit is only available in primary and secondary flap and slat modes.

Flap and Slat Sequencing

TQA to TQF When the flap lever is in the UP detent, all flaps and slats are commanded to the retracted position. Moving the flap lever aft allows selection of flap detent positions 1, 5, 15, 20, 25 and 30. The flaps and slats sequence so that the slats extend first and retract last.

TWA,B When the flap lever is in the UP detent, all flaps and slats are commanded to the retracted position. Moving the flap lever aft allows selection of flap detent positions 1, 5, 10, 15, 17, 18, 20, 25 and 30. The flaps and slats sequence so that the slats extend first and retract last.

Note: On the ground, all three hydraulic systems must be pressurized before flaps will move to avoid contact with an unpowered (drooping) spoiler.

Starting from flaps UP, selection of flaps 1 commands the slats to move to the middle position. The flaps remain retracted.

TQA to TQF Selection of the flaps 5, 15, and 20 positions commands the flaps to move to the position selected. The slats remain in the middle position.

TWA,B Selection of the flaps 5, 10, 15, 17, 18, and 20 positions commands the flaps to move to the position selected. The slats remain in the middle position.

Selection of flaps 25 commands the slats to move to the fully extended position. The flaps do not move.

Selection of flaps 30 commands the flaps to extend to the primary landing position.

During retraction, flap and slat sequencing is reversed.

The mechanical gate at the flaps 20 detent prevents inadvertent retraction of the flaps past the go-around flap setting. The mechanical gate at flaps 1 prevents inadvertent retraction of the slats past the middle position.

Flap and Slat Modes

There are three modes of flap and slat operation:

- primary
- secondary
- alternate.

In the primary mode, the flaps and slats are controlled together and positioned using center hydraulic system motors. Autogap and flap load relief operate in the primary mode.

The secondary mode is automatically selected when any of the following conditions occur:

- center hydraulic system failed, or
- control surfaces travel at less than 50% of the normal hydraulic rate, or
- flap or slat disagree is detected, or
- flap or slat primary control failure, or
- primary mode fails to move the flaps or slats to the selected position, or
- uncommanded flap or slat motion is detected.

In the secondary mode the slats and flaps are controlled separately and can be positioned by hydraulic or electric motors. For example, if the slats hydraulic control fails, the flaps are still driven hydraulically but the slats are now powered electrically. Pilot control is through the flap lever but operation in secondary mode is limited to flaps 20 by non-normal procedures.

The three-position alternate flaps selector extends and retracts the flaps and slats. The flaps and slats extend simultaneously, but slat retraction is inhibited until the flaps are up. Alternate mode flap and slat extension is limited to the slats middle position and flaps 20. Asymmetry and uncommanded motion protection, slat autogap and pregap, and flap and slat load relief are not available in alternate mode.

The alternate mode must be manually selected. Slat and flap operation time in the secondary and alternate modes is greatly increased.

Flap/Slat Load Relief

In the primary mode, the flap load relief system protects the flaps from excessive air loads. If flap airspeed placard limits are exceeded with the flaps in the 15 through 30 position, LOAD RELIEF is displayed and the flaps automatically retract to a safe position appropriate to the airspeed. Load relief retraction is limited to flaps 5.

When airspeed is reduced, the flaps automatically re-extend as airspeed allows. Re-extension is limited to the commanded flap position.

TQA to TQF If a flap overspeed exists, load relief prevents flap extension beyond the 5, 15, or 20/25 positions until airspeed is sufficiently reduced. Flap load relief is available only in the primary mode. The EICAS flap display indicates an in-transit flap condition and shows actual flap position. The flap lever does not move during flap load relief operation. Load relief for slats is not required in the primary or alternate modes.

TWA,B If a flap overspeed exists, load relief prevents flap extension beyond the 5, 15, 17, 18, or 20/25 positions until airspeed is sufficiently reduced. Flap load relief is available only in the primary mode. The EICAS flap display indicates an in–transit flap condition and shows actual flap position. The flap lever does not move during flap load relief operation. Load relief for slats is not required in the primary or alternate modes.

TQA to TQF Slat load relief is available in the secondary mode. If airspeed exceeds 225 KIAS with the slats fully extended, they retract to the middle position and LOAD RELIEF is displayed. For all lever positions except Up, the slats are driven to their extend position when the airspeed is below 225 KIAS.

TWA,B Slat load relief is available in the secondary mode. If airspeed exceeds 240 KIAS with the slats fully extended, they retract to the middle position and LOAD RELIEF is displayed. For all lever positions except Up, the slats are driven to their extend position when the airspeed is below 240 KIAS.

Slat Autogap and Slat Pregap

TQA to TQF The slat autogap function is only available in primary mode when the slats are in the middle position and the airspeed is below 225 KIAS. At a high angle of attack, autogap fully extends the slats to increase the wing camber, thus increasing the lift and margin to stall. The slats return to the middle position after the angle of attack decreases. The autogap trip threshold is a function of AOA, airspeed and flap position.

TWA,B The slat autogap function is only available in primary mode when the slats are in the middle position and the airspeed is below 240 KIAS. At a high angle of attack, autogap fully extends the slats to increase the wing camber, thus increasing the lift and margin to stall. The slats return to the middle position after the angle of attack decreases. The autogap trip threshold is a function of AOA, airspeed and flap position.

TQA to TQF In the secondary mode the system is too slow to respond to an autogap request, so a pregap function exists. The slats automatically move to the fully extended position from the middle position when the flap lever is not UP and airspeed is less than 225 KIAS. The slats remain in the extended position until the flap lever is in the UP position or airspeed is above 225 KIAS.

In the secondary mode the system is too slow to respond to an autogap request, so a pregap function exists. The slats automatically move to the fully extended position from the middle position when the flap lever is not UP and airspeed is less than 240 KIAS. The slats remain in the extended position until the flap lever is in the UP position or airspeed is above 240 KIAS. TWA,B

Cruise Flaps

Cruise flaps is an automated function that improves the airplane's cruise performance by symmetrically moving the flaps, ailerons, flaperons, and spoilers based on airplane parameters such as weight, airspeed and altitude. Cruise flaps optimizes performance in cruise by varying the camber of the wing and thus reducing drag. Control surface movements are minor and no pilot interaction is required. The EICAS advisory message CRUISE FLAPS SYS is displayed if the system fails with the flaps in an increased drag condition.

Cruise flaps are only available in the normal mode, above 25,000 feet, between 0.54 and 0.87 Mach.

Flap and Slat Asymmetry Detection

In primary and secondary modes the flap and slat systems are designed to shutdown when a skew condition or asymmetric deployment is detected. When the system is shutdown, the corresponding EICAS caution message FLAPS DRIVE and/or SLATS DRIVE is annunciated.

Uncommanded Flap or Slat Motion

Uncommanded motion is detected when the flaps or slats:

- move away from the commanded position, or
- continue to move after reaching a commanded position, or
- move in a direction opposite to that commanded.

If the flap or slat is operating in the primary mode, uncommanded motion first causes an automatic transfer to the secondary mode. The EICAS caution message FLAPS PRIMARY FAIL and/or SLATS PRIMARY FAIL is displayed. If motion continues, the system shuts down. The EICAS caution message FLAPS DRIVE and/or SLATS DRIVE is displayed.

Flap or Slat Disagree

A disagree is detected when the flaps or slats do not move or move too slowly after a commanded input. If the flap or slat is operating in the primary mode, and the rate of motion is less than half the normal rate, an automatic transfer to the secondary mode occurs. The EICAS caution message FLAPS PRIMARY FAIL and/or SLATS PRIMARY FAIL is displayed. If motion continues at less than half the normal rate, the system shuts down. The EICAS caution message FLAPS DRIVE and/or SLATS DRIVE is displayed.

Flap Indications

Flap position indications are displayed on the primary EICAS display. In primary mode a single vertical indicator displays combined flap and slat position. The position commanded by the flap lever is also displayed. Ten seconds after all flaps and slats are up, the entire indication is no longer displayed. A loss of position sensing removes the tape fill and flap lever position indications.

If flap/slat control is in the secondary or alternate mode, or if any non–normal condition is detected, an expanded flap indication is displayed automatically. The position of the left and right flaps and slats are separately indicated. In the alternate mode, the position commanded by the flap lever is replaced by flap position index marks at all flap and slat positions, and numbers at flaps 5 and flaps 20. The index marks are used as a guide to position the flaps to the desired setting.

Flight Control System EICAS Messages

The following EICAS messages can be displayed.

Note: Configuration (CONFIG) warning messages are described in Chapter 15, Warning Systems.

Message	Level	Aural	Condition
AUTO SPEEDBRAKE	Advisory		An automatic speedbrake fault occurs.
CRUISE FLAPS SYS	Advisory		The cruise flaps system is not in the correct position.
FLAPS DRIVE	Caution	Beeper	The flap drive mechanism is failed.
FLAPS PRIMARY FAIL	Caution	Beeper	The flaps primary mode is failed.
FLAP/SLAT CONTROL	Caution	Beeper	The flap/slat electronics units are failed.
FLIGHT CONTROL MODE	Caution	Beeper	The flight control system is in the secondary mode.
FLIGHT CONTROLS	Caution	Beeper	One or more of these occur: • two or more flight control surfaces are inoperative • other faults in the flight control system are detected.
FLT CONTROLS LOCKED	Advisory		One or both Flight Control Surfaces switches are in the Off position.
PITCH DOWN AUTHORITY	Caution	Beeper	Pitch down authority is restricted.
PITCH UP AUTHORITY	Caution	Beeper	Pitch up and flare authority are restricted.
PRI FLIGHT COMPUTERS	Caution	Beeper	The flight control system is operating in the direct mode.
ROLL LEFT AUTHORITY	Caution	Beeper	The pilot has limited roll control to the left because the ailerons or rudder are near full travel.
ROLL RIGHT AUTHORITY	Caution	Beeper	The pilot has limited roll control to the right because the ailerons or rudder are near full travel.
ROLL/YAW ASYMMETRY	Caution	Beeper	An airplane roll or yaw asymmetry occurs.

Message	Level	Aural	Condition
SLATS DRIVE	Caution	Beeper	The slat drive mechanism is failed.
SLATS PRIMARY FAIL	Caution	Beeper	The slats primary mode is failed.
SPEEDBRAKE EXTENDED	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 • a thrust lever is not at idle.
SPEEDBRAKES ARMED	Memo		The speedbrakes are armed.
SPOILER DRAG	Advisory		Some spoilers are not stowed because center hydraulic system pressure is low.
SPOILER PAIRS	Advisory		More than two spoiler panels are failed.
SPOILERS	Advisory		One or two spoiler panels are failed.
STAB GREENBAND	Advisory		The nose gear pressure sensor disagrees with the computed stabilizer greenband.
STABILIZER	Warning	Siren	One of these occurs: • stabilizer movement without a signal to trim • the stabilizer is failed.
STABILIZER CUTOUT	Advisory		Both stabilizer cutout switches are in CUTOUT.
STABILIZER L2	Advisory		The left stabilizer control path is failed.
STABILIZER R2	Advisory		The right stabilizer control path is failed.
STALL PROTECTION	Advisory		A stall protection fault occurs.

Flight Instruments, Displays — Chapter 10
Table of Contents

Controls and Indicators 10.10

Primary Flight Display (PFD) 10.10.1
PFD Indications 10.10.1
PFD Airspeed Indications 10.10.3
PFD Reference Speeds 10.10.4
PFD Attitude Indications 10.10.7
PFD Steering Indications 10.10.8
PFD Radio Altitude Indications 10.10.9
PFD Rising Runway Indications 10.10.10
PFD Navigation Performance Indications 10.10.10
PFD Instrument Landing System Indications 10.10.12
PFD Expanded Localizer Indications 10.10.15
PFD Integrated Approach Navigation (IAN) Indications 10.10.16
PFD Altitude Indications 10.10.19
PFD Landing Altitude/Minimums Indications 10.10.21
PFD Barometric Indications 10.10.22
PFD Vertical Speed Indications 10.10.24
PFD Heading/Track Indications 10.10.24
PFD Reversion Mode 10.10.26
PFD Messages 10.10.26
PFD Failure Flags 10.10.28
Navigation Display (ND) 10.10.28
ND Map Mode 10.10.29
ND Weather Radar System Display Indications 10.10.31
ND Plan Mode 10.10.32
Vertical Situation Display (VSD) 10.10.32
Airport Map Display 10.10.38
MFD Messages 10.10.39
ND Failure Indications and Flags 10.10.40
ND Failure Messages 10.10.40

ND Failure Flags 10.10.41
VSD 10.10.41
EFIS Control Panels 10.10.41
EFIS Control Panel—PFD Controls 10.10.42
EFIS Control Panel—ND Controls 10.10.43
Map Keys and Information Selections 10.10.45
Instrument Source Select Panels 10.10.49
Heading Reference 10.10.50
Heading Reference Controls 10.10.50
Display Select Panel 10.10.51
Multifunction Keypad (MFK) 10.10.53
Cursor Control Device (CCD) 10.10.55
Display Brightness Controls 10.10.57
Forward Panel Brightness Controls 10.10.57
Lower Display Brightness Controls 10.10.58
Standby Flight Instruments 10.10.58
Integrated Standby Flight Display (ISFD) 10.10.59
Standby Magnetic Compass 10.10.62
Auxiliary (AUX) Display 10.10.63
Clock 10.10.64
EFIS Control Panels and Display Select (DSP)—Systems MFD Alternate Control 10.10.65
Systems MFD Control Selection 10.10.66

Head-Up Display System—Displays 10.12

Head-Up Display (HUD) 10.12.1
Full Symbology Mode 10.12.1
Decluttered Symbology Mode 10.12.2
HUD Airspeed Indications 10.12.3
HUD Reference Speeds 10.12.4
HUD Attitude Indications 10.12.5
HUD Steering Indications 10.12.6

HUD Radio Altitude Indications 10.12.8
HUD Navigation Performance Indications 10.12.8
HUD Instrument Landing System Indications 10.12.11
HUD Expanded Localizer Indications 10.12.12
HUD Altitude Indications 10.12.13
HUD Landing Altitude/Minimums Indications 10.12.14
HUD Barometric Indications 10.12.15
HUD Heading/Track Indications 10.12.16
HUD Messages 10.12.18
HUD Failure Flags 10.12.18
HUD-Unique Indications and Symbology 10.12.19
TO/GA Reference Line 10.12.20
Ground Deviation Indications—HUD Takeoff 10.12.20
Flight Path Vector Symbol with Guidance Cue 10.12.21
Speed Error Tape and Flight Path Acceleration 10.12.22
Slip/Skid Indication 10.12.23
Wind Speed, Wind Direction, and Digital Heading 10.12.23
Pitch Scale Chevrons and Pitch Scale Compression 10.12.24
Unusual Attitude 10.12.25
Runway Edge Lines and Glideslope Reference Line 10.12.26
Ground Deceleration Scale 10.12.27
HUD Controls 10.12.28
Combiner 10.12.28
Combiner Locking Lever 10.12.29
Symbology Control Switch 10.12.29
HUD Brightness Control 10.12.30

System Description 10.20

Introduction 10.20.1
Display Selection and Control 10.20.1
Multifunction Display Management (MDM) 10.20.1
EFIS Control Panels 10.20.2
Display Select Panel 10.20.2

Multifunction Keypad (MFK) 10.20.3
Display Brightness Control 10.20.3
PFD/MFD Source Selector 10.20.3
Instrument Display Source Selection 10.20.3
Display Selection and Control Examples 10.20.4
Cursor Location Control 10.20.12
Cursor Control Device (CCD) 10.20.13
Multifunction Keypad (MFK) 10.20.14
EFIS Control Panel 10.20.14
Standby Flight Instruments 10.20.14
Integrated Standby Flight Display (ISFD) 10.20.14
Standby Magnetic Compass 10.20.14
Radio Altimeter (RA) 10.20.15
Auxiliary (AUX) Display 10.20.15
Clocks 10.20.15
Display System Information Sources 10.20.16
Inertial Reference System (IRS) 10.20.16
Air Data Reference System (ADRS) 10.20.16

Head-Up Display System Description 10.22

Introduction 10.22.1
HUD Components 10.22.1
Overhead Unit 10.22.1
HUD Controls 10.22.1
Combiner 10.22.2
Combiner Display Symbology 10.22.2
HUD-Unique Indications and Symbology 10.22.2

Primary Flight Displays (PFDs) 10.30

Introduction 10.30.1
Airspeed 10.30.2
Altitude 10.30.2

Vertical Speed 10.30.3
Attitude 10.30.3
Steering Indications 10.30.3
Radio Altitude 10.30.4
Navigation Performance Indications 10.30.4
Instrument Landing System (ILS) Indications 10.30.7
Integrated Approach Navigation (IAN) Indications 10.30.7
Approach Minimums 10.30.7
Heading/Track Indications 10.30.7
Engine Fail, GPWS and PWS Alerts 10.30.8
Typical PFD Displays 10.30.8
PFD Takeoff Display 10.30.8
PFD Climb Display 10.30.9
PFD Cruise Display 10.30.10
PFD Descent Display 10.30.11
PFD Approach Display 10.30.12
PFD Landing Display 10.30.13

Navigation Displays (NDs) 10.40

Introduction 10.40.1
Map Mode 10.40.1
Navigation Data Points 10.40.1
Plan Mode 10.40.1
ND Information 10.40.2
Heading 10.40.2
Track 10.40.2
Traffic 10.40.2
Weather Radar 10.40.2
Airport Map 10.40.2
Vertical Situation Display (VSD) 10.40.2
Failure Flags and Messages 10.40.3

Typical ND Map Displays 10.40.4
ND Expanded Map Displays 10.40.4
ND Symbology 10.40.8

Electronic Checklist Displays 10.50

Normal Checklist 10.50.1
Non-Normal Checklist Queue 10.50.3
Non-Normal Checklist 10.50.4
Checklist Timer 10.50.6
Operational Notes and Additional Information 10.50.7
Operational Notes Page 10.50.8
Conditional Line Item 10.50.10
Closed Loop 10.50.10
Open Loop 10.50.11
Deferred Line Items 10.50.12
Non-Normal Checklist 10.50.12
Normal Checklist 10.50.13
Inhibit Checklist Line Item 10.50.14
Checklist Override 10.50.15
Checklists Menu Page 10.50.17
Resets Menu Page 10.50.19

Electronic Checklist Description 10.60

Introduction 10.60.1
Electronic Checklist Operation 10.60.1
Checklist Pages 10.60.1
Checklist Status 10.60.2
Checklist Line Items 10.60.2
Action Items 10.60.2
Operational Notes 10.60.3
Conditional Line Items 10.60.3
Inhibit Checklist Line Items 10.60.4

Deferred Line Items 10.60.5
Timers 10.60.5
Additional Information 10.60.5
Precautionary Text 10.60.5
Checklist Menu Operation 10.60.6
Normal Menu 10.60.6
Non-Normal Menu 10.60.6
Resets Page 10.60.6
Dual Database 10.60.6
Checklist Priority 10.60.7
Normal Checklists 10.60.7
Normal Checklist Access 10.60.7
Normal Checklist Completion 10.60.7
Incomplete Normal Checklist Alerting 10.60.8
Non-Normal Checklists 10.60.8
Non-Normal Checklist Access and Checklist Icon 10.60.8
Non-Normal Unannunciated Checklists 10.60.9
Non-Normal Checklist Completion 10.60.9
Hidden Non-Normal Checklist Alerting 10.60.9
Checklist Resets 10.60.10
Normal Checklist Automatic Reset Conditions 10.60.10
Normal Checklist Manual Resets 10.60.10
Non-Normal Checklist Manual Resets 10.60.10
Manual Reset All 10.60.11
Overrides 10.60.11
Electronic Checklist Inoperative 10.60.11

Electronic Flight Bag—Controls and Displays 10.70

Introduction 10.70.1
Display Unit 10.70.1
Display Description 10.70.4
MAIN MENU Page 10.70.6

IDENT Page 10.70.9
SYSTEM Page 10.70.11
EFB Virtual Keyboard Display 10.70.12

Electronic Flight Bag—Operation and Applications 10.80

EFB MAIN MENU Page 10.80.1
SYSTEM Page 10.80.1
EFB Messages Table 10.80.1
Initializing a Flight 10.80.2
Closing a Flight 10.80.2
EFB Document Browser 10.80.3
Overview 10.80.3
Typical EDB Menus 10.80.4
Viewing Documents or Content 10.80.5
Selecting a Document from the Document Library 10.80.6
Selecting a Document from the History List 10.80.10
Selecting Document Content Using Bookmarks 10.80.10
Navigating Through a Document 10.80.12
Changing the Display of a Document 10.80.12
Searching for Information within Documents 10.80.13
Viewing Large Tables 10.80.19
Printing a Document on the Flight Deck Printer 10.80.20
Understanding Document Conventions 10.80.20
Troubleshooting 10.80.20
Typical Enroute Moving Map 10.80.21
Overview 10.80.21
Starting the Application 10.80.21
Selecting an Application Mode 10.80.21
Navigation Mode (NAV) Page 10.80.22
Plan Route Mode (ROUTE) Page 10.80.25
Creating or Modifying Routes 10.80.27
Enroute Data Search 10.80.28

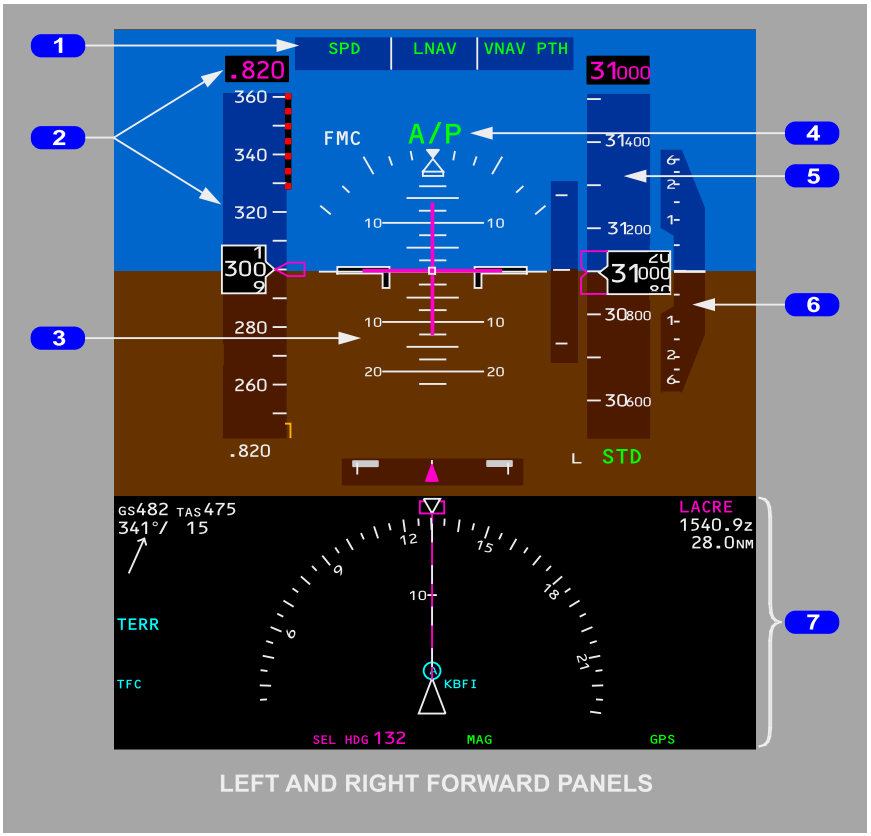
Regional Notes 10.80.30
Reference Notes 10.80.31
Typical Onboard Performance Tool 10.80.32
Overview 10.80.32
Pre-loaded Data and Pilot Inputs 10.80.32
Calculating Takeoff Performance 10.80.36
Calculating Landing Performance 10.80.41
Send and Copy Performance Data 10.80.44
Reviewing Airport Data 10.80.47
Adding/Deleting a Temporary Airport 10.80.49
Entering NOTAM Information 10.80.51
Accommodating MEL or CDL Issues 10.80.53
eRouteManual 10.80.55
Overview 10.80.55
EN ROUTE CHARTS 10.80.55
TERMINAL CHARTS 10.80.55
Video Surveillance (Typical) 10.80.55
Selecting an Image 10.80.56
Manipulating the Display 10.80.56
VIDEO SURVEILLANCE Main Page 10.80.57
VIDEO SURVEILLANCE Show Menu Page 10.80.59
Troubleshooting 10.80.60
PILOT UTILITIES 10.80.60

EICAS Messages 10.90

Flight Instrument and Display EICAS Messages 10.90.1

Primary Flight Display (PFD)

PFD Indications



LEFT AND RIGHT FORWARD PANELS

1 Flight Mode Annunciations

(See PFD and HUD Flight Mode Annunciations (FMAs) on page 4.10.16 for additional information.)

2 Airspeed/Mach Indications

Displays air data reference system (ADRS) airspeed information and other airspeed related information.

3 Attitude, Steering, and Miscellaneous Indications

Displays Inertial Reference System (IRS) attitude information.

4 Autopilot, Flight Director System Status

(See PFD and HUD Flight Mode Annunciations (FMAs) on page 4.10.16 for additional information.)

5 Altitude Indications

Displays ADRS altitude and other altitude–related information.

6 Vertical Speed Indication

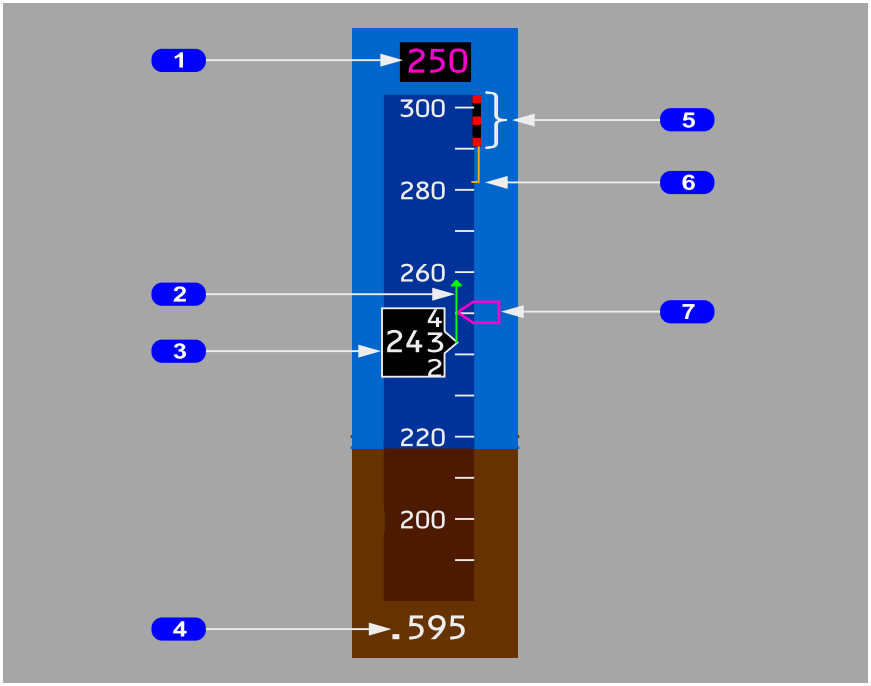
Displays ADRS vertical speed and other vertical speed information.

7 Mini-map

Displays current IRS heading, track and other heading information.

Displays the flight plan with associated information. (See ND Symbology on page 10.40.8 for additional information.)

PFD Airspeed Indications



1 Selected Speed

Displays the airspeed/Mach selected in the mode control panel MCP IAS/MACH window. (See Autopilot Flight Director IAS/Mach Controls on page 4.10.4 for additional information.)

Displays the FMC–computed airspeed/Mach when the MCP IAS/MACH window is blank.

2 Speed Trend Vector

Indicates predicted airspeed in ten seconds based on current acceleration or deceleration.

3 Current Airspeed

Indicates current ADRS airspeed.

The box around the current airspeed indication turns amber when airspeed is below minimum maneuvering speed.

4 Current Mach

Displays current ADRS Mach.

5 Maximum Speed

Bottom of the bar indicates maximum airspeed as limited by the lowest of the following:

- Vmo/Mmo, or
- landing gear placard speed, or
- flap placard speed.

6 Maximum Maneuvering Speed

Bottom of the amber bar indicates the maximum maneuvering speed. This airspeed provides 1.3 g maneuver capability to high speed buffet (or an alternative approved maneuver capability as preset by maintenance). May be displayed when operating at high altitude at relatively high gross weights.

Note: 1.3 g maneuver capability occurs at 40º of bank in level flight.

7 Selected Speed Bug

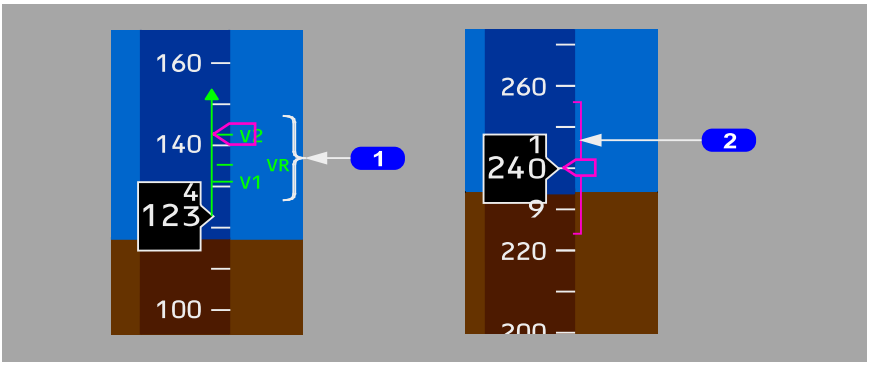
Points to the airspeed/Mach selected in the MCP IAS/MACH window.

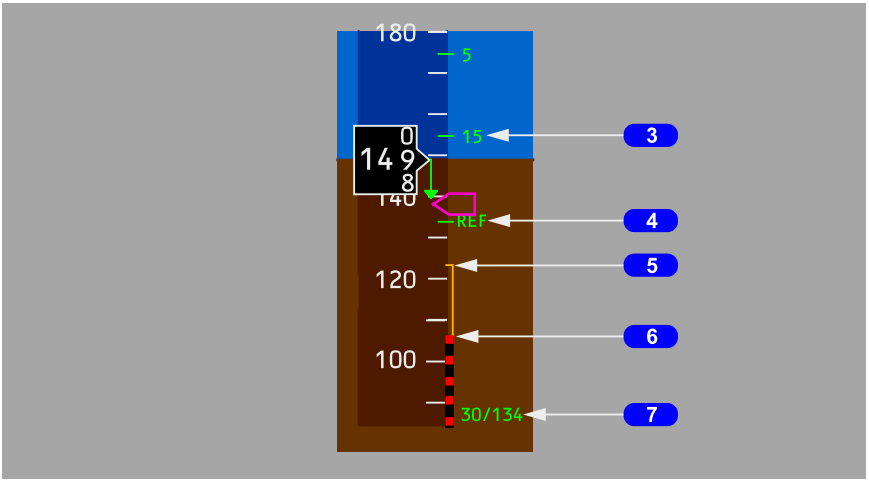
Points to FMC-computed airspeed when the MCP IAS/MACH window is blank.

The bug is five knots in height.

When the selected speed is off scale, the bug is parked at the top or bottom of the tape, with only one half the bug visible.

PFD Reference Speeds





1 Takeoff Reference Speeds

Displays the takeoff reference speeds V1, VR (displays R if VR is within 4 knots of V1 or V2), and V2, selected on the CDU:

- displayed for takeoff
- NO V SPD is displayed if V speeds are not selected on the CDU
- V1 is displayed at the top of the airspeed indication when selected and if the value is off the scale
- V1 and VR are removed at lift-off
- V2 is removed on climb-out:
  - when flap retraction begins, or
  - after 10 minutes have passed without flap lever movement, or
  - after VREF has been selected (for a turn-back).

(See Takeoff Reference Page 1/2 on page 11.40.40 for additional information.)

2 VNAV Speed Band

Indicates speed range for VNAV path (VNAV PTH):

- upper limit is speed at which VNAV changes from VNAV PTH to VNAV SPD
- lower limit is speed at which autothrottle adds thrust above FMC-computed descent thrust.

Displayed after top of descent with flaps up.

3 Flap Maneuvering Speeds

Indicates flap maneuvering speed for flap retraction or extension.

Not displayed above approximately 20,000 feet altitude.

4 Landing Reference Speed

Displays the VREF speed as selected on the CDU. (See Approach Reference Page on page 11.43.19 for additional information.)

VREF speed is displayed at the bottom of the airspeed indication when the value is off the scale.

5 Minimum Maneuvering Speed

Top of amber bar indicates minimum maneuvering speed. This airspeed provides:

- 1.3 g maneuver capability to stick shaker below approximately 20,000 ft
- 1.3 g maneuver capability to low speed buffet (or an alternative approved maneuver capability as preset by maintenance) above approximately 20,000 ft.

Displayed with first flap retraction after takeoff.

Note: 1.3 g maneuver capability occurs at 40º of bank in level flight.

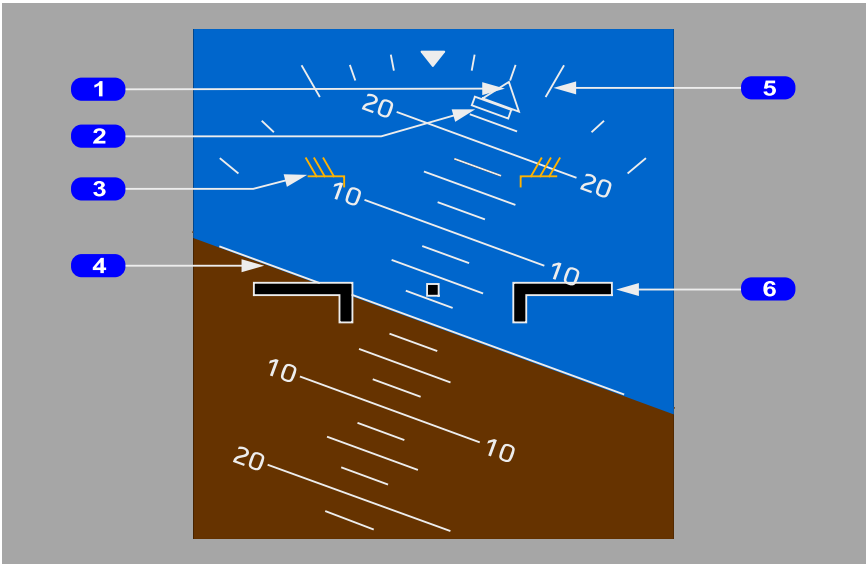
6 Minimum Speed

Indicates the airspeed where stick shaker activates.

7 Landing Flap and VREF Speed

Displays landing flap position and landing reference speed.

PFD Attitude Indications



1 Bank Pointer

Indicates bank angle in reference to the bank angle scale.

Indicates direction toward wings level.

Fills and turns amber if bank angle is 35º or more.

2 Slip/Skid Indication

Displaces beneath the bank pointer to indicate slip or skid.

Fills white at full scale deflection.

Turns amber if bank angle is 35º or more; fills amber if the slip/skid indication is also at full deflection.

3 Pitch Limit Indication

Indicates pitch limit (stick shaker activation point for the existing flight conditions).

Limited to a maximum of +30º.

Displayed when the flaps are not up, or at slow speeds with the flaps up.

4 Horizon Line and Pitch Scale

Indicates the IRS horizon relative to the airplane symbol.

Pitch scale is in 2.5º increments.

5 Bank Scale

Fixed reference for the bank pointer.

Scale marks are at 0º, 10º, 20º, 30º, 45º, and 60º.

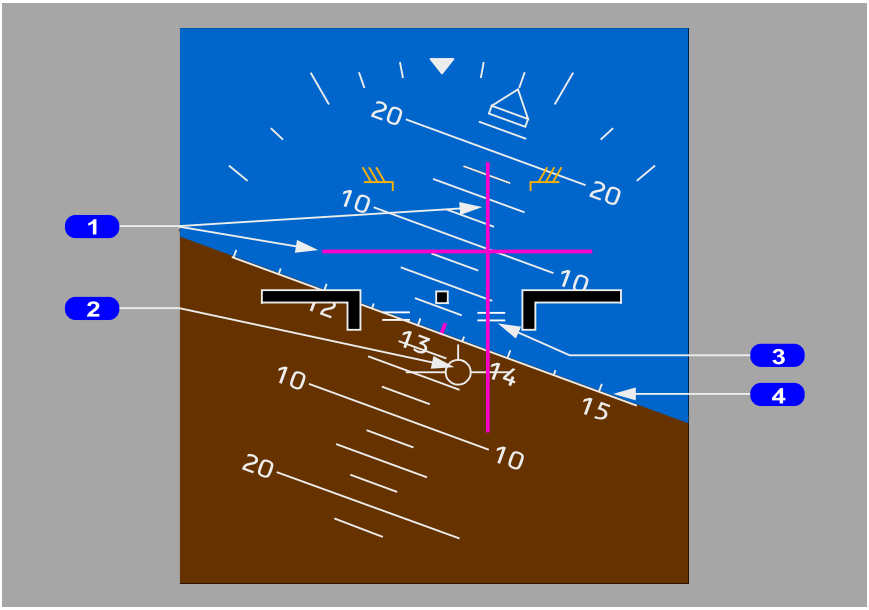
6 Airplane Symbol

Indicates airplane attitude with reference to the IRS horizon.

PFD Steering Indications

For additional information:

- See TCAS PFD Vertical Guidance on page 15.10.18
- See Alerts Displayed on the PFD on page 15.10.8.



1 Flight Director Pitch and Roll Bars

Indicates flight director pitch and roll steering commands. (See Autopilot Flight Director Roll and Pitch Controls on page 4.10.6 for additional information.)

2 Flight Path Vector (FPV)

Displays flight path angle and drift angle if:

- FPV is selected on the EFIS control panel, or

- FPA (flight path angle) is selected on the MCP.

Flight path angle is displayed relative to the horizon line.

Drift angle is represented by the perpendicular distance from the centerline of the pitch scale to the FPV symbol.

3 Selected Flight Path Angle (FPA)

Indicates the selected flight path angle when FPA is selected on the MCP.

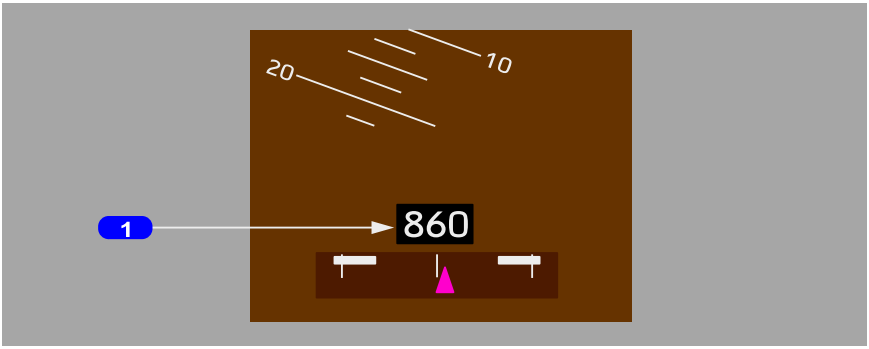
4 Horizon Line Heading Scale

Displays when:

- FPV is selected on the EFIS control panel, or
- FPA (flight path angle) is selected on the MCP, and
- current bank angle is less than 50º, and
- absolute pitch angle is less than 20º.

A magenta bug is displayed which reflects the MCP selected heading/track value.

PFD Radio Altitude Indications



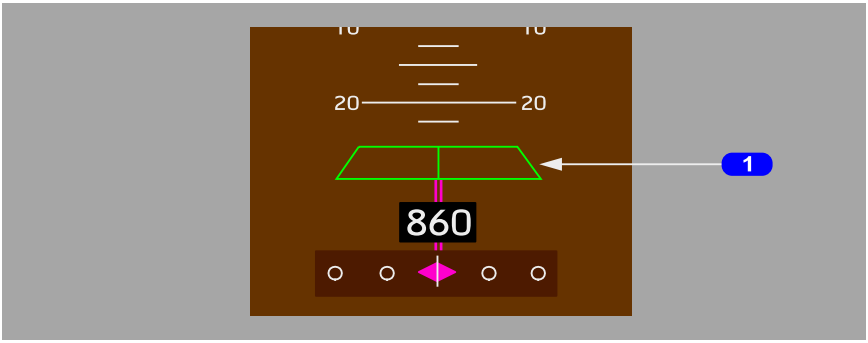
1 Radio Altitude

Displays radio altitude below 2,500 feet AGL.

The display box is highlighted in white for 10 seconds when passing below 2,500 feet.

Turns amber when below radio altitude minimums.

PFD Rising Runway Indications



1 Rising Runway

Displayed below 2,500 feet altitude when the localizer pointer is in view for both front and back courses.

Moves toward the airplane symbol below 200 feet radio altitude.

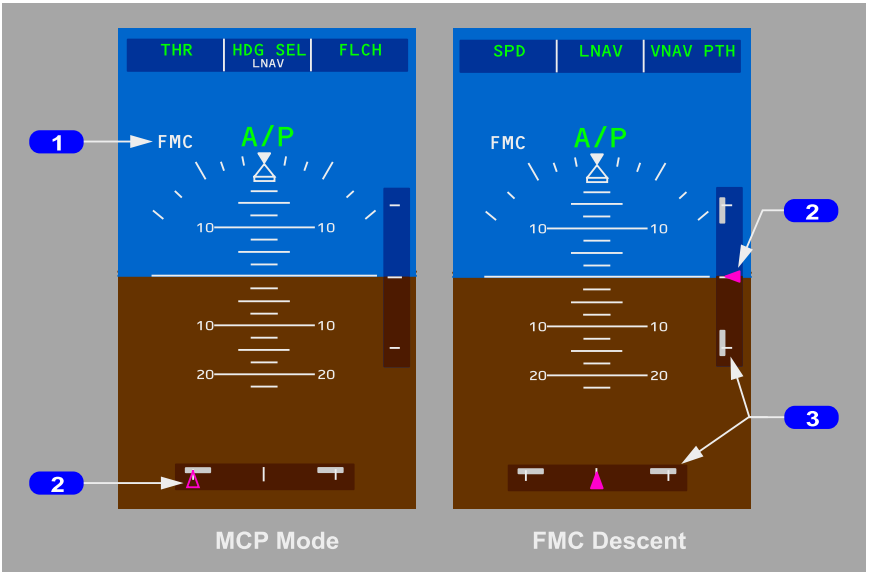
The stem of the rising runway symbol flashes when localizer deviations cause the diamond to flash.

PFD Navigation Performance Indications

Actual Navigation Performance (ANP) and Required Navigation Performance (RNP) indications are displayed when:

- LNAV is armed or active
- VNAV is active

- TO/GA roll mode is active.



1 Navigation Source Reference

Displays the source of navigation performance for the navigation scales.

2 Navigation Performance Scale (NPS) Deviation Pointer

Indicates the navigation path relative to the airplane position:

- 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 or ANP bars meet in the middle of the deviation scale.

3 Deviation Scales and Bars

Lateral and Vertical scales:

- outer white tic marks represent RNP. Center white tic mark represents airplane position
- the part of each bar extending from an outer tic mark toward the center tic mark represents ANP
- area between bars indicates margin available to remain within RNP criteria
- if ANP value increases (navigation system performance decreases), the bars become longer, extending toward the center white tic mark

- bars show on vertical scale only during FMC descent phase of flight.

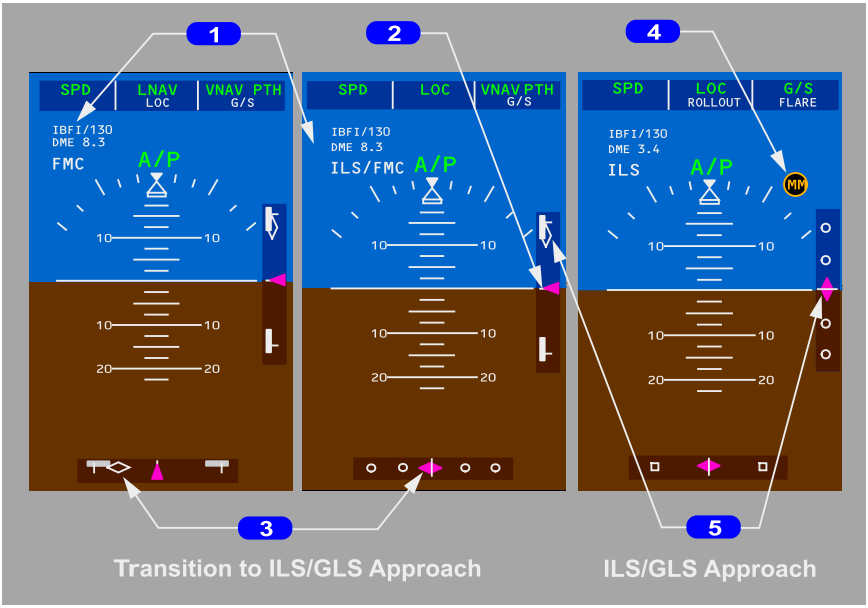
If ANP equals or exceeds RNP:

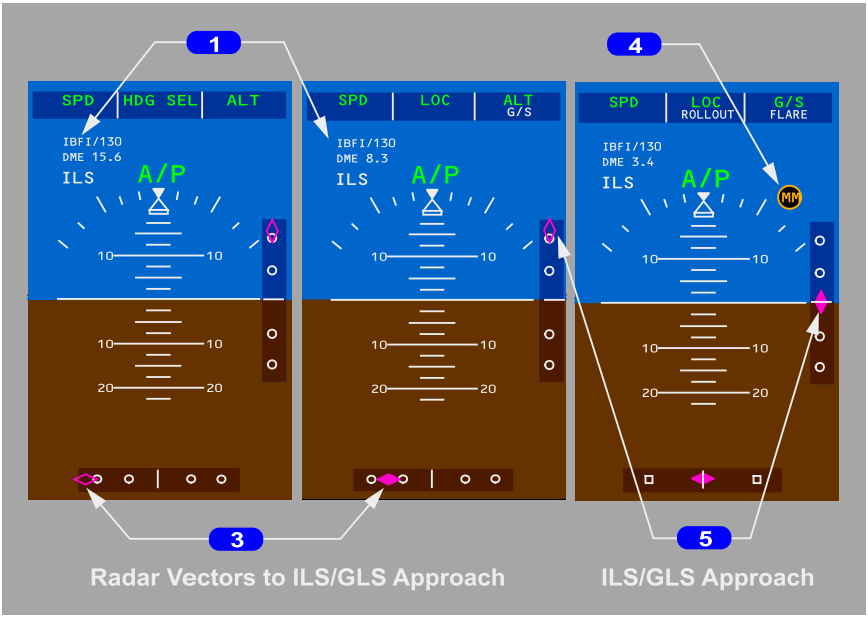
- the white bars meet in the middle
- after 5 seconds, the bars and scale turn amber indicating RNP operations can no longer be maintained
- the NAV UNABLE RNP EICAS message is displayed (Lateral scale only).

If pointer migrates into bar area for more than 5 seconds:

- scale and ANP bars turn amber
- pointer flashes for 10 seconds.

PFD Instrument Landing System Indications





1 Approach Reference and Navigation Source

Displays—

- selected ILS/GLS identifier or frequency, approach front course
- ILS/GLS DME distance
- navigation source annunciation.

The navigation source annunciation on the third line is completely independent of the approach data on the first two lines. It identifies the source of navigation performance for the deviation scales. Possible combinations for source annunciation are:

Horizontal Scale	Vertical Scale	Scale Source Text
NPS	NPS	FMC
ILS Localizer	NPS	ILS/FMC
GLS Localizer	NPS	GPS/FMC
ILS Localizer	ILS Glideslope	ILS
GLS Localizer	GLS Glideslope	GLS
NPS	GLS Glideslope	FMC/GPS
NPS	ILS Glideslope	FMC/ILS

ILS/GLS approach reference data appears when an appropriate approach has been selected to the active route and

- manually tuned
- auto-tuned and the airplane is
  - < 150 NM from the destination airport
  - < 50 NM from Top of Descent
  - FMC is in descent mode.

If the tuned ILS/GLS frequencies disagree, the frequency turns amber with an amber horizontal line through it.

If the approach courses in the ILS/GLS receivers disagree, the course turns amber with an amber horizontal line through it.

2 NPS Deviation Pointer

Indicates the navigation path relative to the airplane position.

3 Localizer Pointer and Scale

The pointer indicates the localizer relative to the airplane position and is:

- unfilled white diamond for LOC if NPS are shown
- unfilled magenta diamond for LOC if NPS are not shown
- in view when the localizer signal is received
- filled magenta diamond when within 2 1/2 dots from the center.

The scale is in view after the frequency is tuned if NPS are not shown. If either LNAV or VNAV is active, or LNAV is armed, the NPS indications remain in view until localizer capture.

At low radio altitudes, with the autopilot engaged or flight director on, the scale turns amber and the pointer flashes to indicate excessive localizer deviation.

At low altitudes, with LNAV active and LOC armed, the localizer scale turns amber and the pointer flashes if the localizer is not captured.

4 Marker Beacon Indication

The marker beacon indication appears flashing when over one of the marker beacon transmitters:

- IM—an airway or inner marker beacon
- MM—a middle marker beacon
- OM—an outer marker beacon.

The indication flashes in cadence with the beacon identifier.

5 Glideslope Pointer and Scale

The pointer indicates the glideslope relative to the airplane position and is:

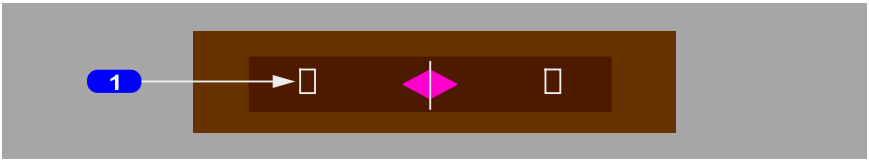
- unfilled white diamond for glideslope if NPS are shown

- unfilled magenta diamond for glideslope if NPS are not shown
- in view when the glideslope signal is received
- filled magenta diamond when within 2 1/2 dots from the center.

The scale is in view after the frequency is tuned if NPS are not shown. If either LNAV or VNAV is active, or LNAV is armed, the NPS indications remain in view until glideslope capture.

At low radio altitudes, with the autopilot engaged or flight director on, the scale turns amber and the pointer flashes to indicate excessive glideslope deviation.

PFD Expanded Localizer Indications

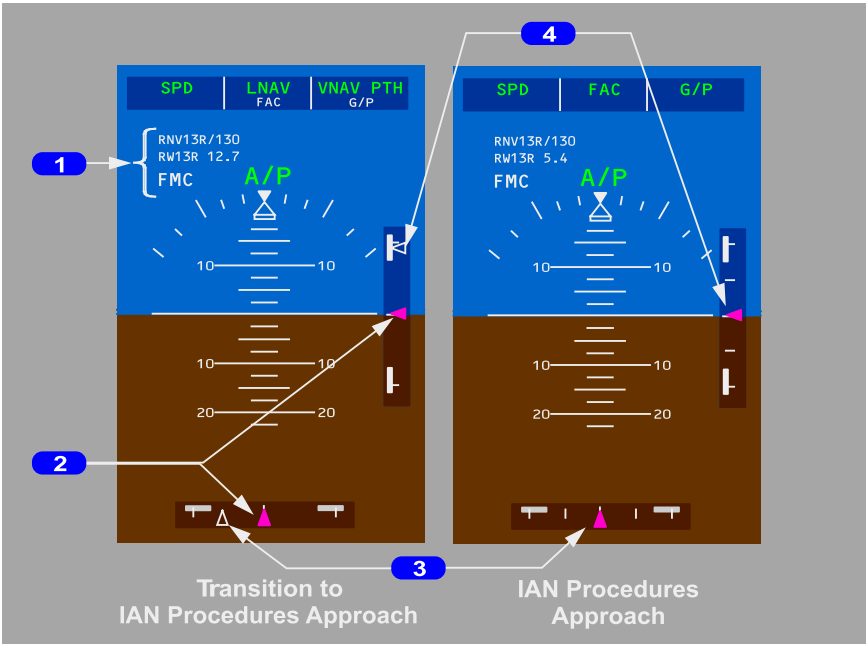


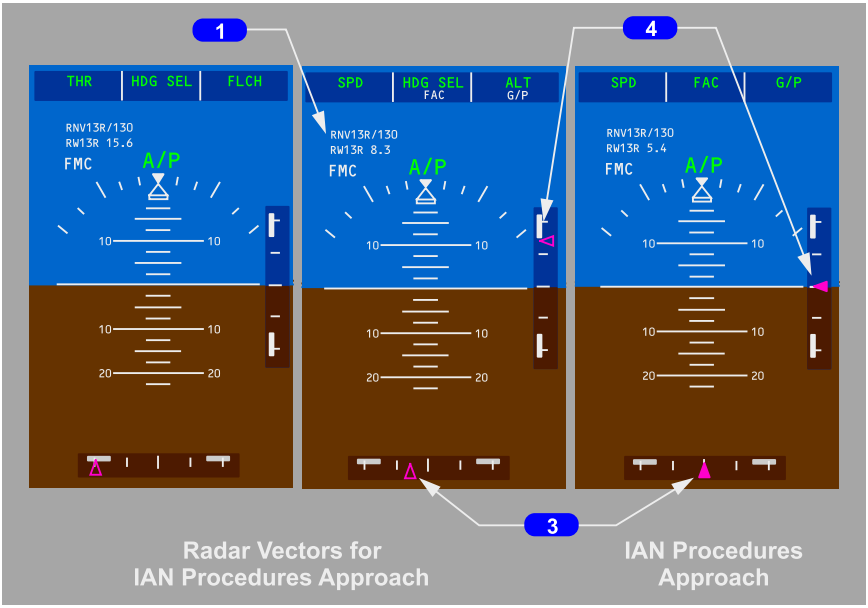
1 Expanded Localizer Scale

Displays when the autopilot is in LOC mode and the airplane is close to the runway center line. Provides a more sensitive display.

A rectangle equals 1/2 dot deviation.

PFD Integrated Approach Navigation (IAN) Indications





1 Approach Reference and Navigation Source

Displays—

- type of approach, runway, approach front course
- missed approach waypoint name, distance to that waypoint
- source annunciation.

The source annunciation on the third line is completely independent of the approach data on the first two lines. It identifies the source of navigation performance for the deviation scales. Possible combinations for source annunciation are:

Horizontal Scale	Vertical Scale	Scale Source Text
NPS	NPS	FMC
Final Approach Course	NPS	FMC
ILS Localizer	NPS	ILS/FMC
GLS Localizer	NPS	GPS/FMC
NPS	Glidepath	FMC
Final Approach Course	Glidepath	FMC
ILS Localizer	Glidepath	ILS/FMC

Horizontal Scale	Vertical Scale	Scale Source Text
GLS Localizer	Glidepath	GPS/FMC

Approach reference data appears when the appropriate approach has been selected to the active route and the airplane is

- < 150 NM from the destination airport
- < 50 NM from Top of Descent
- FMC is in descent mode.

2 NPS Deviation Pointer

Indicates the navigation path relative to the airplane position.

3 Final Approach Course Pointer and Scale

The pointer:

- indicates the final approach course relative to the airplane position
- unfilled white triangle for FAC if LNAV is active
- unfilled magenta triangle for FAC if LNAV is not active
- is in view when
  - < 25 NM from missed approach point
  - airplane position is within 60º of FAC
- filled magenta triangle when captured.

The scale:

- has additional tic marks at 1/2 RNP
- appears at the same time as the approach reference data if navigation performance scales are not shown
- appears when capture occurs if either LNAV or VNAV is active, or LNAV is armed.

Note: The deviation scales are proportional to RNP. They do not become more sensitive as ILS/GLS scales do.

With the autopilot engaged or flight director on, the scale turns amber and the pointer flashes to indicate excessive final approach course 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.

4 Glidepath Pointer and Scale

The pointer:

- indicates glidepath position relative to the airplane position
- unfilled white triangle if VNAV is active
- unfilled magenta triangle if VNAV is not active

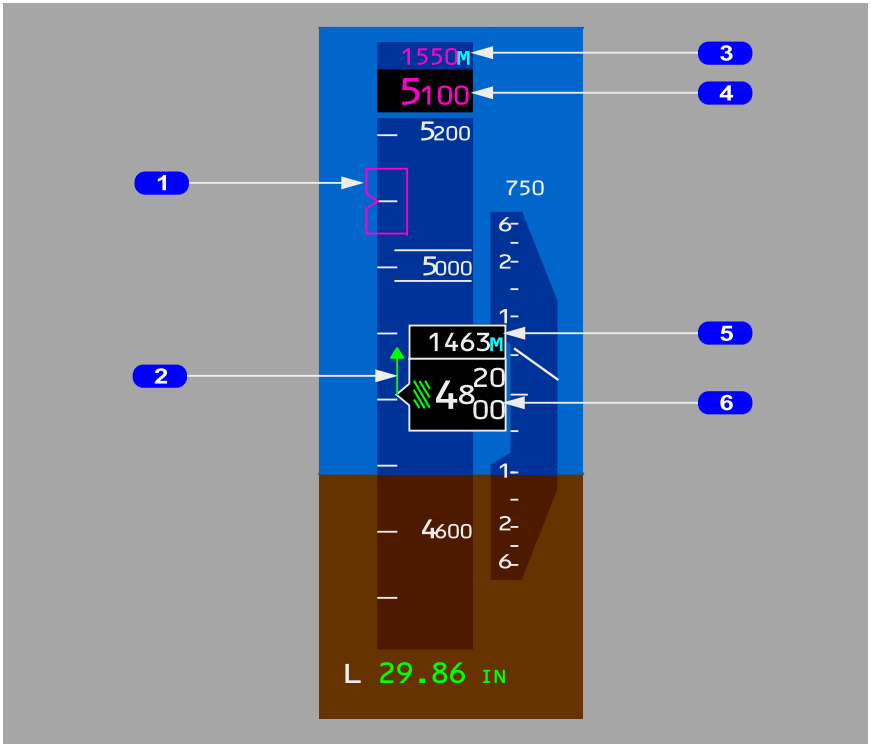
- is in view when
  - < 6,000 feet above field elevation
  - < 25 NM from missed approach point
  - airplane position is within 60° of FAC
  - airplane track is within 90° of FAC
- filled magenta triangle when captured.

The scale:

- has additional tic marks at 1/2 RNP
- appears at the same time as the approach reference data if navigation performance scales are not shown
- appears when capture occurs if either LNAV or VNAV is active, or LNAV is armed.

With the autopilot engaged or flight director on, the scale turns amber and the pointer flashes to indicate excessive glidepath deviation.

PFD Altitude Indications



1 Selected Altitude Bug

Indicates the altitude set in the MCP altitude window.

When the selected altitude is off scale, the bug is parked at the top or bottom of the tape, with only one half the bug visible.

2 Altitude Trend Vector

Indicates expected altitude six seconds ahead in time based on the current vertical speed.

3 Selected Altitude—Meters

Displayed when MTRS is selected on the EFIS control panel MTRS switch.

Indicates selected altitude in meters (selected in feet in the MCP altitude window).

Displays in 10 meter increments.

4 Selected Altitude

Displays the altitude set in the MCP altitude window.

The selected altitude box is highlighted in white between 900 feet and 200 feet prior to reaching the selected altitude.

5 Current Altitude—Meters

Displayed when MTRS is selected on the EFIS control panel MTRS switch.

Displays altitude in meters.

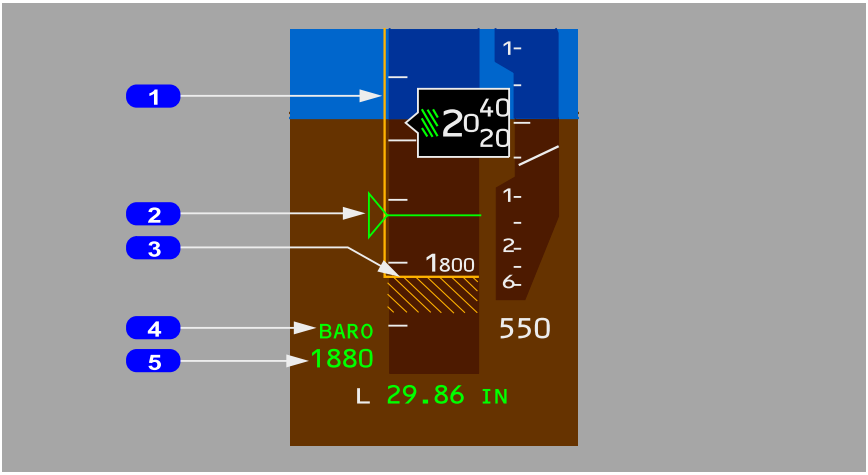
6 Current Altitude

Indicates current ADRS altitude.

Current altitude box—

- highlighted white between 900 feet and 200 feet prior to reaching the selected altitude
- highlighted amber when deviating beyond 200 feet from selected altitude. If deviation continues beyond 900 feet, amber highlight is removed.

PFD Landing Altitude/Minimums Indications



1 Landing Altitude Reference Bar

Indicates the height above touchdown.

White bar—500 to 1,000 feet above landing altitude.

Amber bar—0 to 500 feet above landing altitude.

2 BARO Minimums Pointer

When BARO minimums are displayed, the number is also represented as a triangular bug and line on the altitude scale.

Turns steady amber when the airplane descends below baro minimums.

When RA minimums are displayed after BARO minimums are selected, the bug remains on the altitude scale.

3 Landing Altitude Indication

The crosshatched area indicates the FMC landing altitude for the destination runway or airport.

Indicates the landing altitude for the departure runway or airport until 400 NM or one–half the distance to the destination, whichever occurs first.

4 Minimums Reference

Displays BARO when the EFIS control panel MINS reference selector is set to BARO.

Displays RADIO when the EFIS control panel MINS reference selector is set to RADIO.

Turns amber and flashes for 3 seconds when the airplane descends below selected minimum altitude.

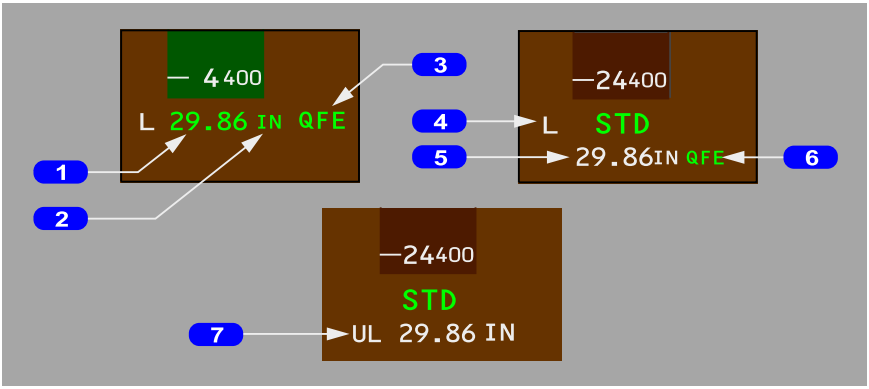
5 Minimums

Displays the approach minimums altitude set using the EFIS control panel MINS selector:

- BARO minimums are feet MSL
- RADIO minimums are radio altitude feet AGL.

Turns amber and flashes for 3 seconds when the airplane descends below selected minimum altitude.

PFD Barometric Indications



1 Barometric Setting

Indicates the barometric setting selected on the EFIS control panel barometric selector.

STD is displayed when STD is selected on the EFIS control panel barometric STD switch.

The display is boxed and changes to amber if a barometric setting is set and altitude climbs above the transition altitude, or if STD is set and altitude descends below the transition flight level.

2 Barometric Reference

Indicates the barometric setting units selected on the EFIS control panel barometric reference selector:

- IN is inches of mercury

- HPA is Hectopascals.

3 QFE Altitude Reference

Indicates QFE altitude reference selected on the CDU APPROACH REF page.

When selected, QFE is boxed for 10 seconds.

The altitude tape is shaded green during QFE operation.

When QNH is selected, the green shading is removed; QNH is displayed for 10 seconds, then blanks.

4 Autopilot/Flight Director Barometric Source

L or R indicates that the left or right EFIS control panel is the barometric setting reference for the autopilot or flight director (the same indication is displayed on both PFDs).

Displayed when a flight director switch is ON or the autopilot is engaged:

- F/D—one turned on and one not on determines L or R
- F/D—both on—L is displayed
- A/P—first one pushed on determines L or R.

5 Preselected Barometric Setting

A barometric setting can be preselected when STD is displayed.

The preset barometric setting is selected on the EFIS control panel barometric selector and is displayed below STD.

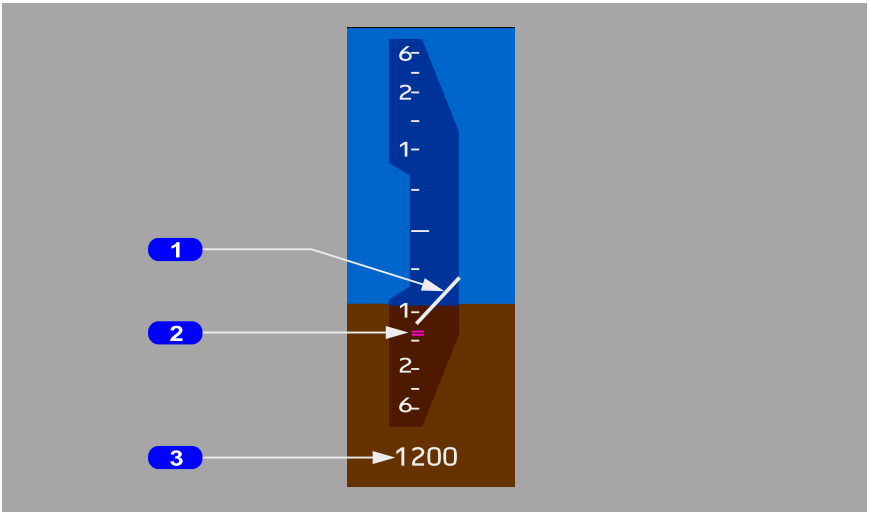
6 QFE

When STD is selected, a small QFE appears when QFE is selected.

7 Uplinked Barometric Setting

The annunciation UL is displayed to the left of the barometric preselect field when a barometric setting uplink is accepted.

PFD Vertical Speed Indications



1 Vertical Speed Pointer

Indicates current vertical speed.

2 Selected Vertical Speed Bug

Indicates the speed selected in the MCP vertical speed window with the V/S pitch mode active.

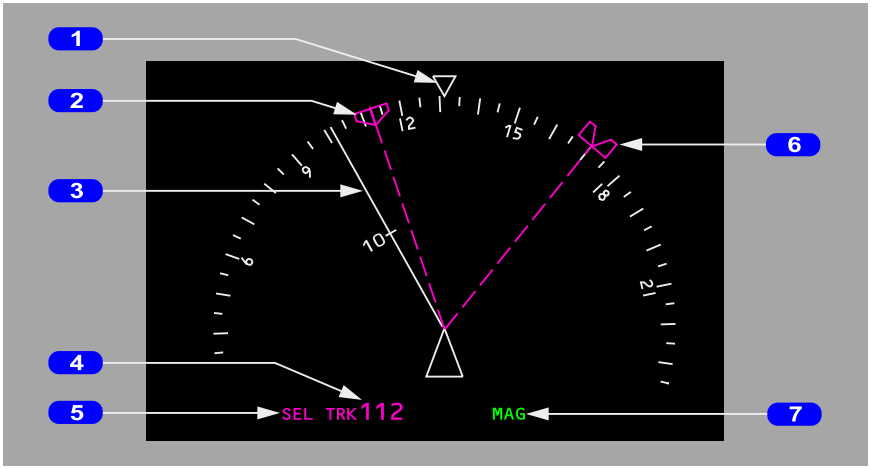
3 Vertical Speed

Displays vertical speed when greater than 400 feet per minute.

The display is located above the vertical speed indication when climbing and below when descending.

PFD Heading/Track Indications

Note: The selected track bug and selected heading bug are not displayed at the same time.



1 Current Heading Pointer

Indicates current heading.

2 Selected Track Bug (MCP Selection)

The selected track bug is displayed on the inside of the compass rose.

If selected track exceeds display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the track.

3 Track Line

Indicates the current track.

4 Selected Heading/Track (MCP Selection)

Digital display of the selected heading or track bug.

5 Selected Heading/Track Reference (MCP Selection)

When HDG (heading) is selected, SEL HDG is displayed.

When TRK (track) is selected, SEL TRK is displayed.

6 Selected Heading Bug (MCP Selection)

The selected heading bug is displayed on the outside of the compass rose.

If selected heading exceeds display range, the bug parks on the side of the compass rose in the direction of the shorter turn to the heading.

7 Heading/Track Reference

Displays the automatic or manually selected heading/track reference:

- MAG (magnetic north)
- TRU (true north).

PFD Reversion Mode

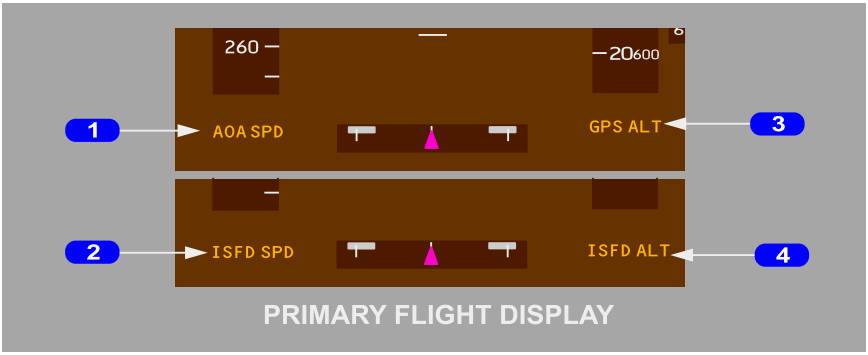
Note: The PFD is shown in reversion mode for some display failures. The PFD with mini-map is cropped to fit within an MFD window (one half of a Display Unit). All PFD symbology remains in the same relative position referenced to the airplane symbol center.



PFD Messages

Notes: 1. Upper and lower amber band indications are not displayed when the AOA SPD or ISFD SPD message is displayed.

2. The Mach indication is not displayed when the AOA SPD or ISFD SPD message is displayed.
3. The baro setting below the altitude tape is not displayed when the ADRS altitude is not valid.
4. GPS ALT derived altitude displays cannot be used to accurately maintain ATC assigned altitudes.



1 AOA SPD

A backup airspeed based on AOA and inertial data.

Displayed when:

- the ADRS airspeed is not available, or
- the on-side AIR DATA/ATT selector has been placed in the ALTN position.

2 ISFD SPD

A backup airspeed based on single source data from the center pitot air data module and the center static air data module.

Displayed if both the ADRS airspeed and AOA SPD are unavailable.

3 GPS ALT

A backup altitude based on data from GPS L or GPS R.

Displayed when:

- the ADRS altitude is not available, or
- the on-side AIR DATA/ATT selector has been placed in the ALTN position.

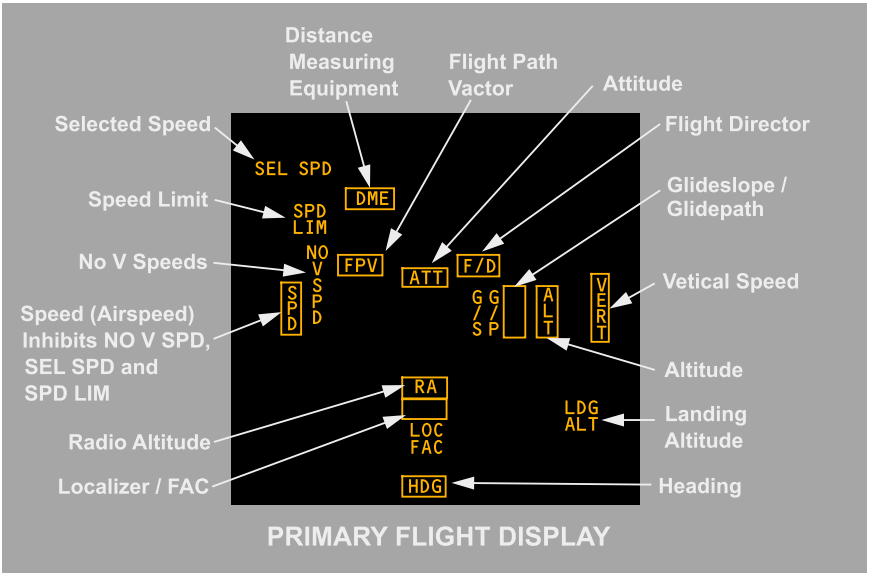
4 ISFD ALT

A backup altitude based on single source data from the center static air data module.

Displayed if both the ADRS altitude and GPS ALT are unavailable.

PFD Failure Flags

Note: PFD failure flags replace the appropriate display to indicate source system failure, or lack of computed information.



Navigation Display (ND)

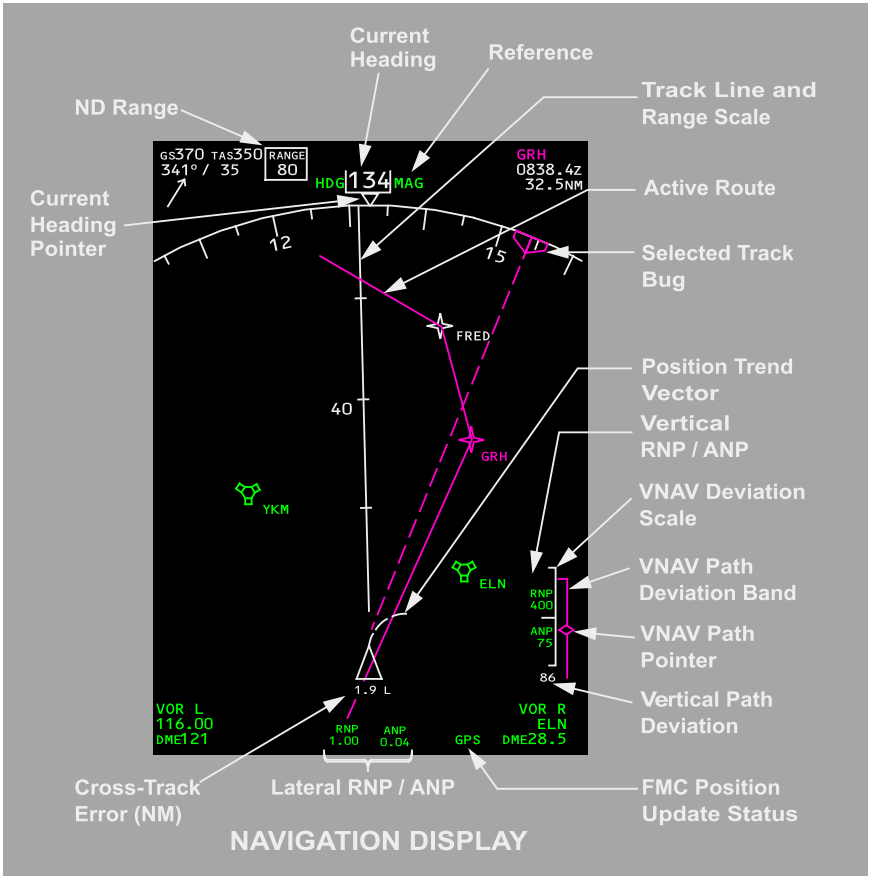
(See ND Symbology on page 10.40.8 for additional information.)

Note: A normal-display ND is shown on one half of a display unit (DU). A full-display ND is shown on an entire DU.

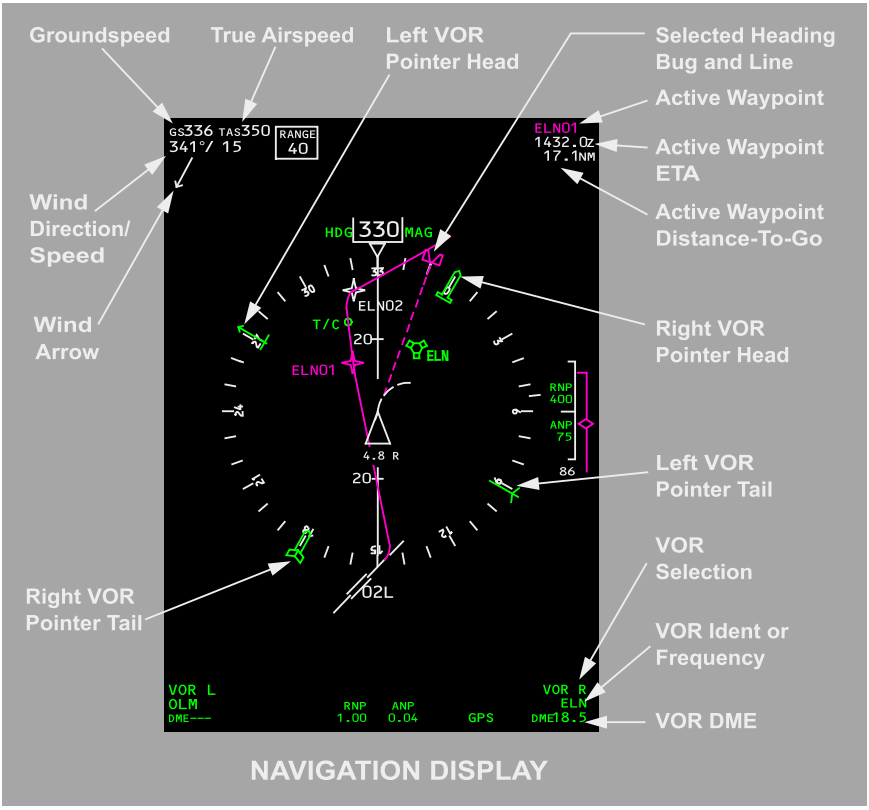
(See Display Selection and Control Examples on page 10.20.4 for additional information.)

ND Map Mode

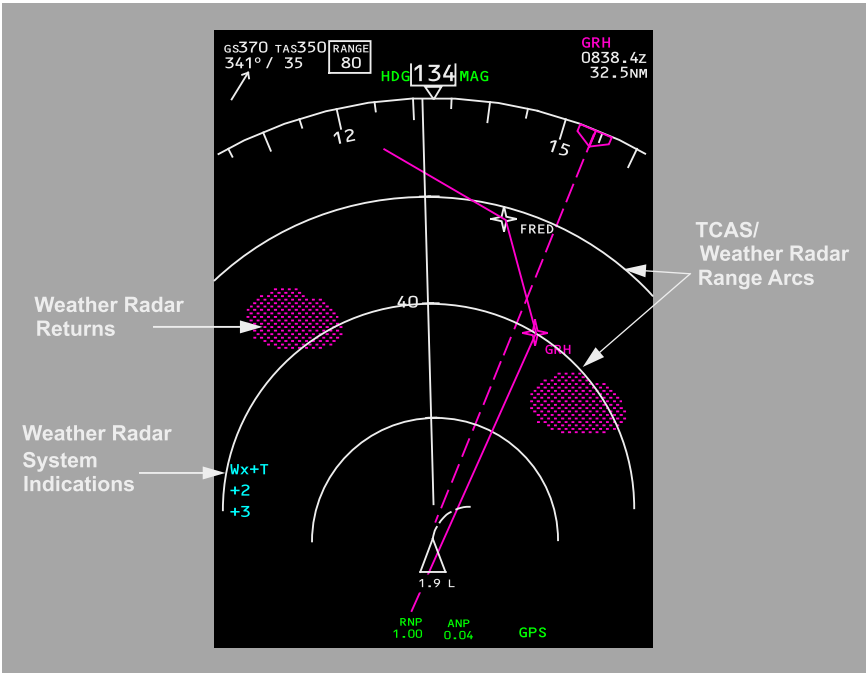
Expanded Map Mode



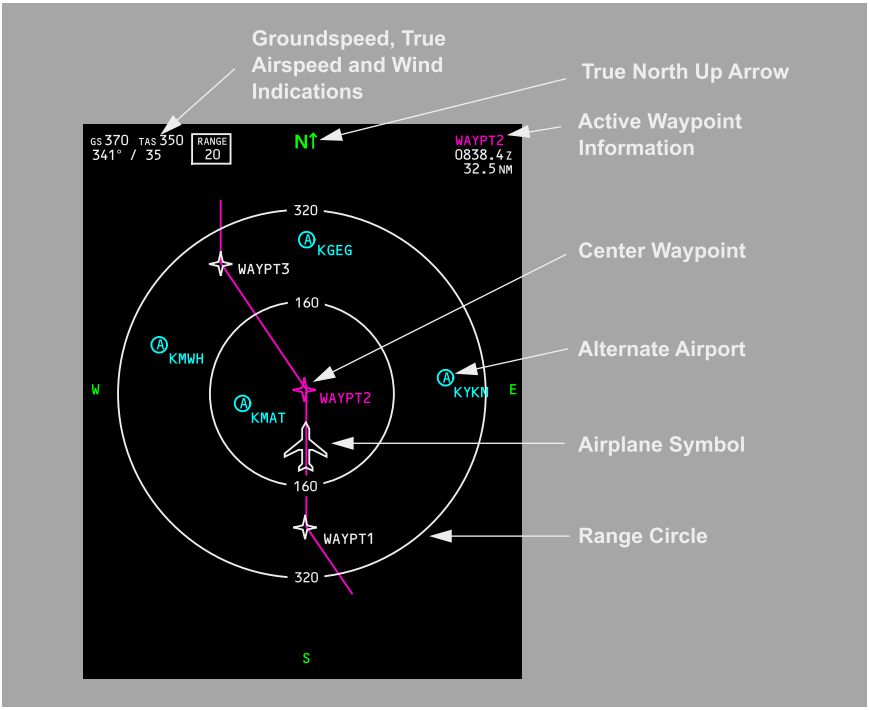
Centered Map Mode



ND Weather Radar System Display Indications



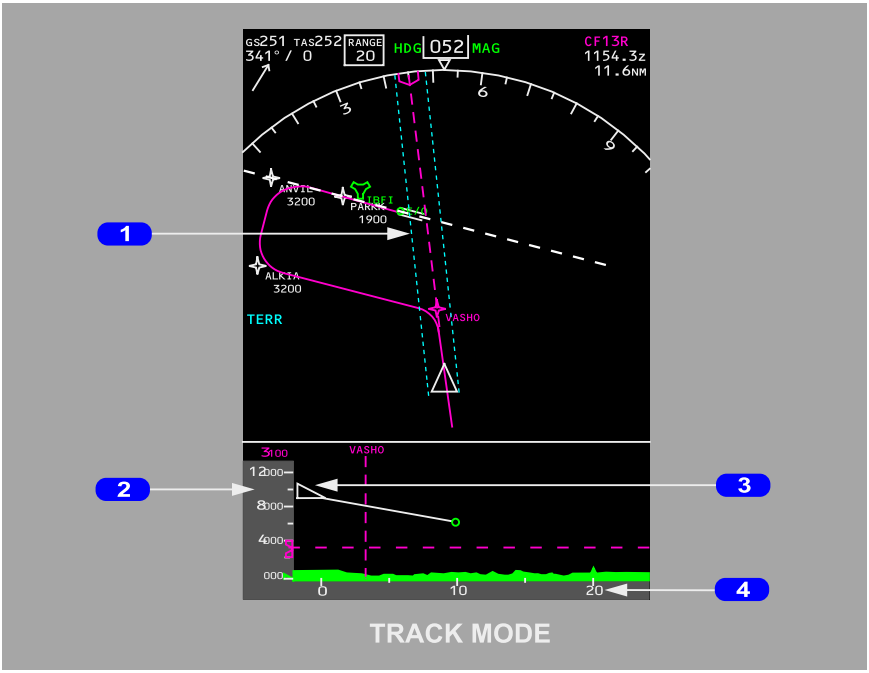
ND Plan Mode

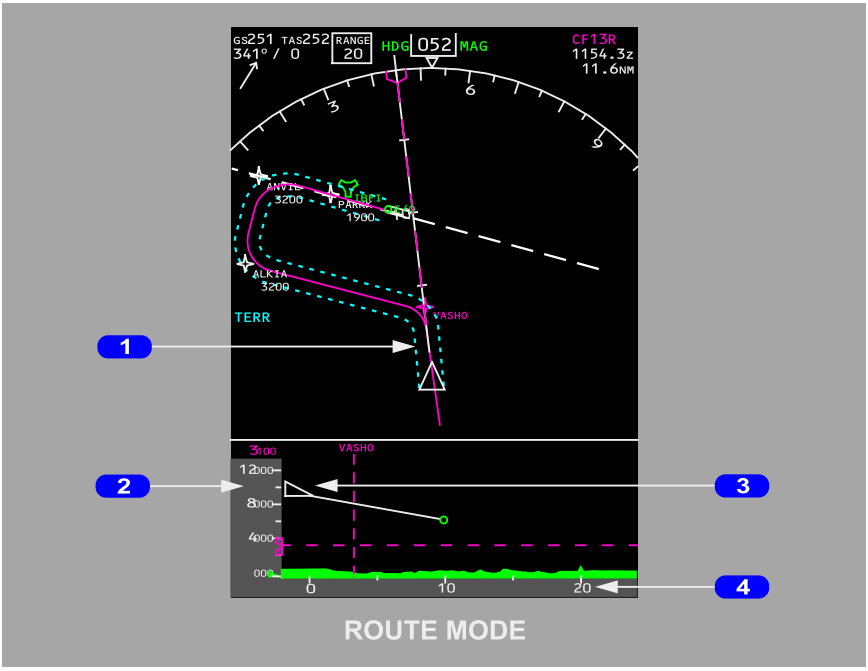


Vertical Situation Display (VSD)

The VSD presents a profile view of the airplane and its environment. It is located on the bottom third of the ND. Terrain, waypoint, and other information shown within the cyan dashed lines (VSD corridor) on the ND is shown in profile on the VSD.

Note: The VSD can be shown only when the ND is in MAP mode.


GS251 TAS252
341° / 0
RANGE
20
HDG 052 MAG
CF13R
1154.3z
11.6NM
3
6
9
ANVIL
3200
IDET
PARKE
1900
ALKIA
3200
TERR
VASHO
VASHO
12000
8000
4000
0
10
20
1
2
3
4
TRACK MODE



1 VSD Corridor

Displayed (cyan)—indicates area mapped by the VSD.

Track mode (default)—dashed lines are offset by 1 RNP from instantaneous track of airplane.

Route mode—dashed lines are offset by 1 RNP from the Flight Management Flight Plan. Automatically selected when:

- airplane is on ground—
  - an active flight plan has been entered, and
  - a departure runway has been selected, and
  - LNAV is armed
- airplane is in air—
  - airplane is in any path-based mode such as LNAV, LOC, or FAC, and
  - lateral path deviation is less than RNP.

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.

During QFE operations, the altitude reference scale is shaded green the same as the PFD altitude scale.

3 Airplane Symbol

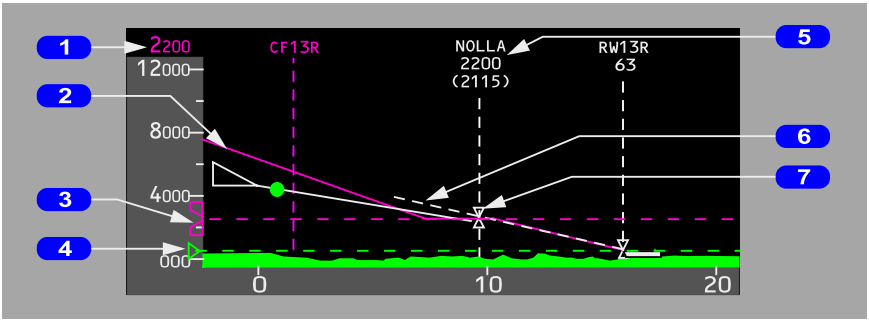
Indicates current airplane altitude (bottom of the triangle) and lateral position (point of the triangle) relative to terrain.

4 Horizontal Reference Scale

Displays range in nautical miles.

The scale is the full range selected on the EFIS control panel when the normal-display ND is used. The scale is twice the full range selected when the full-display ND is used.

Vertical Situation Display (VSD)—General Background



1 MCP Selected Altitude Readout

Displays the altitude set in the MCP altitude window.

2 Active Vertical Path

Displays the path that VNAV commands if active. The VSD must be in route mode for the active vertical path to be displayed.

During climbs, there is no VNAV path, so the line extends from the nose of the airplane to the predicted altitudes at each waypoint in the climb.

3 Selected Altitude Bug and Line

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. The dashed line does not park.

4 BARO Minimums Bug and Line

Indicates the barometric minimums selected on the EFIS control panel:

- pointer and dashed line turn amber when airplane descends below selected minimum altitude
- reset with the RST switch on the EFIS control panel.

5 Waypoint ID and Anchor Line

Displayed with any altitude constraint directly beneath:

- dashed vertical line depicts lateral position
- during QFE operations, altitude constraints are shown in parentheses below the QNH values.

6 FMC Approach Glidepath Angle Line

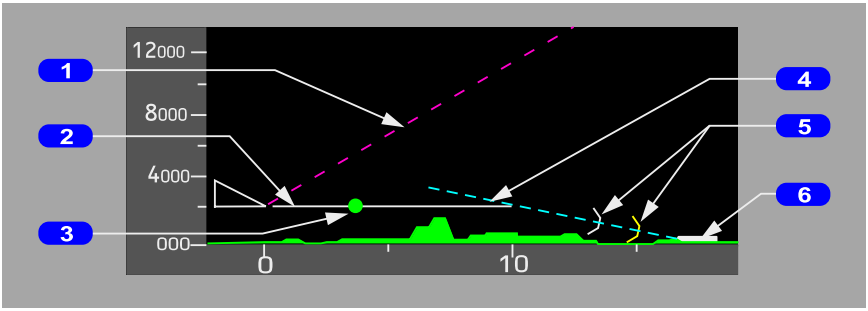
Displayed for approaches that have a designated approach angle:

- dashed line extends 10 NM for situational awareness
- anchored to the missed approach waypoint, not the runway.

7 Altitude Constraint Symbol

Displayed as triangle(s) on waypoint anchor line.

Vertical Situation Display (VSD)—Flight Path Background



1 MCP Selected Vertical Speed (V/S) or Flight Path Angle (FPA) Vector

Displays the selected vertical speed as a dashed target angle line when the MCP V/S mode is selected.

Displays the flight path angle vector as a dashed target angle line when the MCP FPA mode is selected.

2 Vertical Flight Path Vector

Indicates current flight path angle as a function of vertical speed and groundspeed. 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 appears if more than 5 knots above target speed
- dot is unfilled and placed at the end of the vertical flight path vector line if the speed will not be achieved in the distance of the vertical flight path vector line
- dot is unfilled and placed at the edge of the display along the vertical flight path vector line if the speed will not be achieved within the display area.

4 3º Reference Line

Displayed for approaches that do not have a designated approach angle:

- dashed line extends 10 NM for situational awareness
- anchored to the runway threshold
- for reference only, line may intersect terrain.

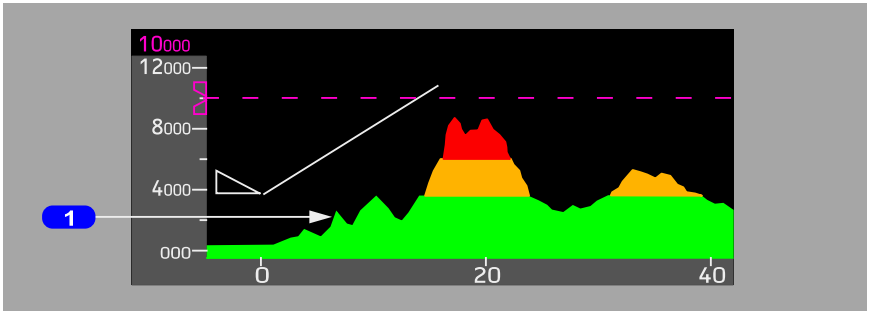
5 Decision Gates

Displayed on the FMC approach glidepath angle line or 3º reference line at 500 feet and 1,000 feet above field elevation.

6 Runway

Represents the selected runway. Runway length is scaled to the selected range.

Vertical Situation Display (VSD)—Terrain Background



1 Terrain Profile Line

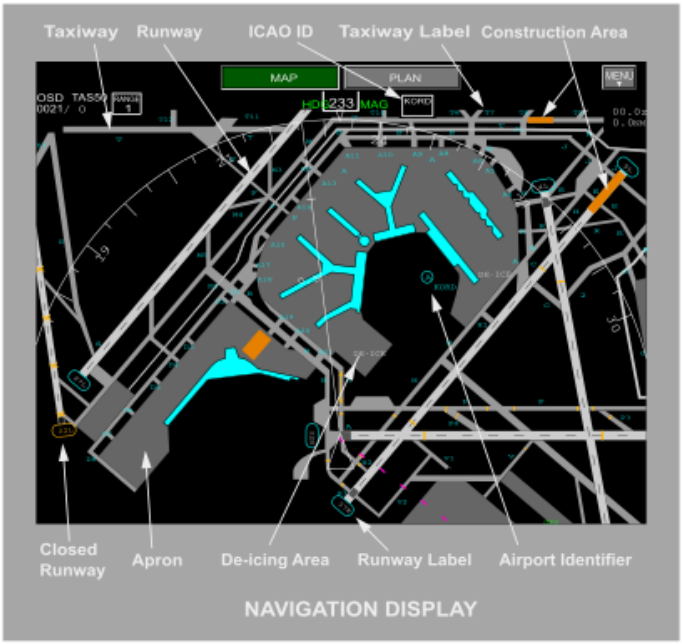
Represents the highest terrain within the enroute corridor:

- highest points of the terrain below and ahead of the airplane
- terrain is depicted so the actual altitude separation between the airplane and terrain is shown
- VSD terrain uses the same color coding that is used to depict GPWS on the lateral map:
  - green: terrain is more than 500 feet (250 feet if gear is down) below the airplane
  - amber: terrain ranges from 500 below (250 feet gear down) to 2,000 feet above the airplane
  - red: terrain more than 2,000 feet above the airplane.

(See GPWS Look–Ahead Obstacle and Terrain Mode on page 15.20.20.)

Airport Map Display

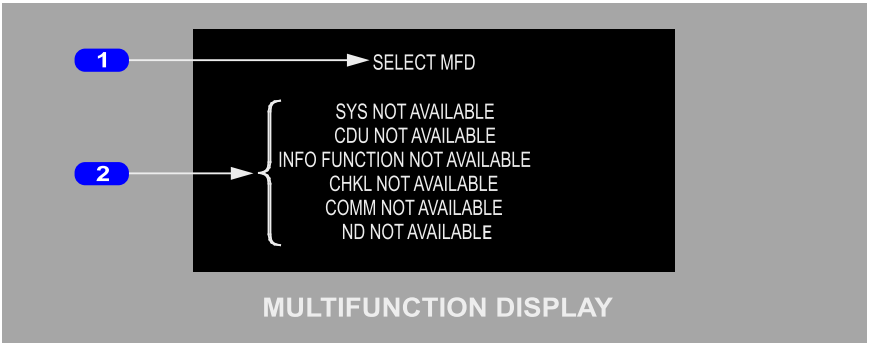
The Airport Map is integrated with the ND. The Airport Map automatically displays at ranges of 5 NM or less if the airport is either the ORIGIN or DESTINATION airport in the active flight plan.



The INFO display shows the effectivity dates for the airport map database. The INFO display can be selected from any of the Display Select Panels or lower display switches on the Multi-Function Keypads.



MFD Messages



1 Select MFD

The number of instances requested for a display format exceeds the maximum available.

Maximum number of instances for each format:

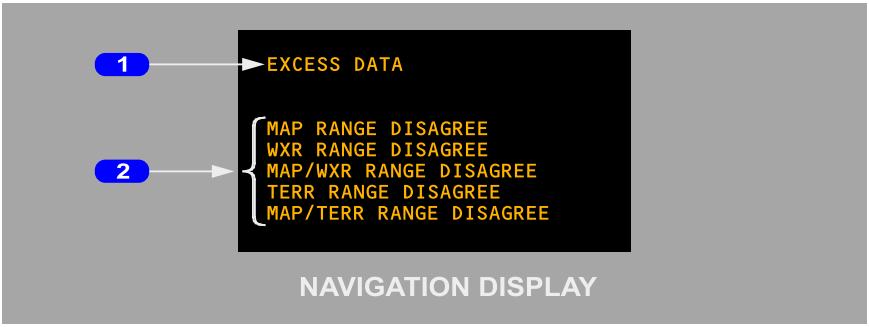
- SYS (2 per side, independent)
- CDU (1 per side, independent)
- INFO (2 per side, independent)
- CHKL (1 per side, synchronized)
- COMM (1 per side, independent)
- ND (1 per side, independent).

2 Display Format Not Available

The DU is operating normally, but the display format is not available.

ND Failure Indications and Flags

ND Failure Messages



1 Excess Data

The amount of map information sent to the primary display system is too great to display.

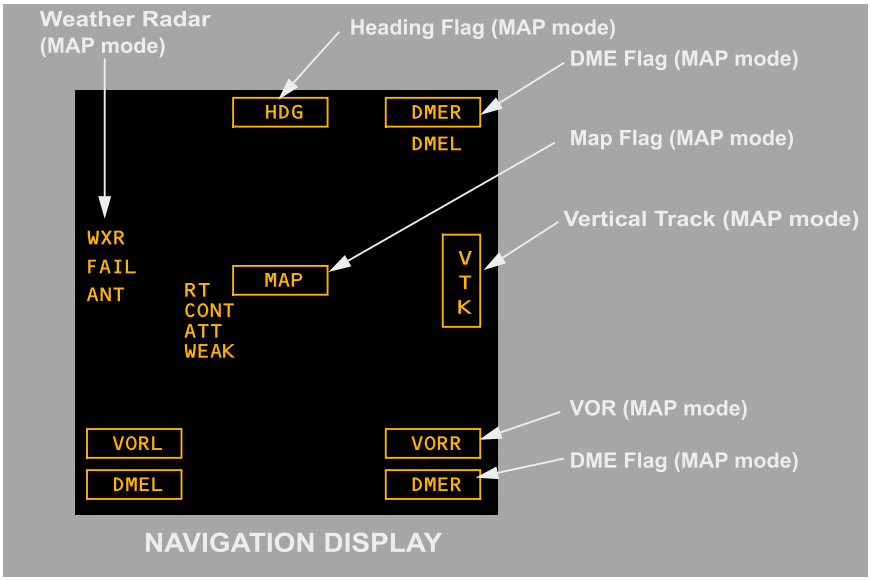
2 MAP/WXR Range Disagree

The selected range and range of display information disagree.

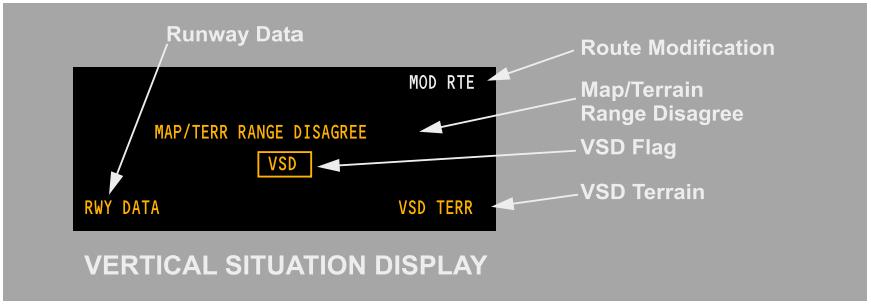
Map information is removed.

ND Failure Flags

Dashes replace numbers if there is no computed information. Failure flags replace symbols or failure messages are displayed, as appropriate. Flag location varies, depending on the ND mode selected.



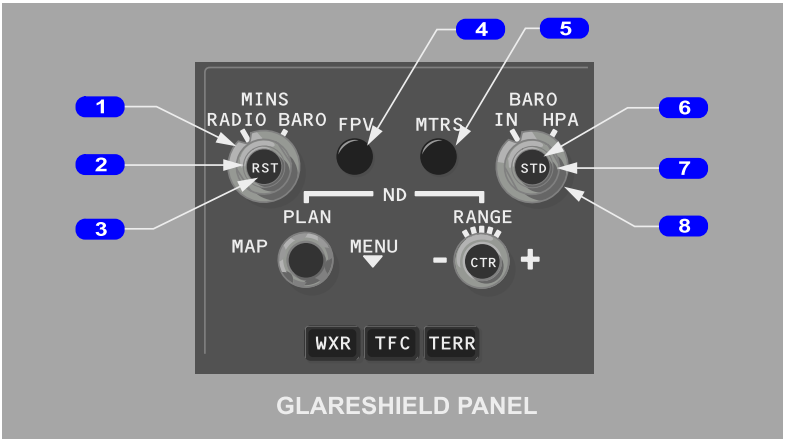
VSD



EFIS Control Panels

The left EFIS control panel controls the left PFD and ND. The right EFIS control panel controls the right PFD and ND.

EFIS Control Panel—PFD Controls



1 Minimums (MINS) Reference Selector (Outer)

RADIO—selects radio altitude as the PFD minimums reference.

BARO—selects barometric altitude as the PFD minimums reference.

2 Minimums (MINS) Selector (Middle)

Rotate (slew)—adjusts the PFD radio or baro minimums altitude.

3 Minimums Reset (MINS RST) Switch (Inner)

Push—

- resets the PFD minimums alert display
- blanks the minimums display when green.

4 Flight Path Vector (FPV) Switch

Push—displays the PFD flight path vector.

5 Meters (MTRS) Switch

Push—displays PFD altitude meters indications.

6 Barometric Standard (BARO STD) Switch (Inner)

Push—

- selects the standard barometric setting (29.92 inches Hg/1013 HPA) for the PFD barometric reference
- if STD is displayed, selects the preselected barometric setting

- if no preselected barometric setting is displayed, displays the last value before STD was selected.

7 Barometric (BARO) Selector (Middle)

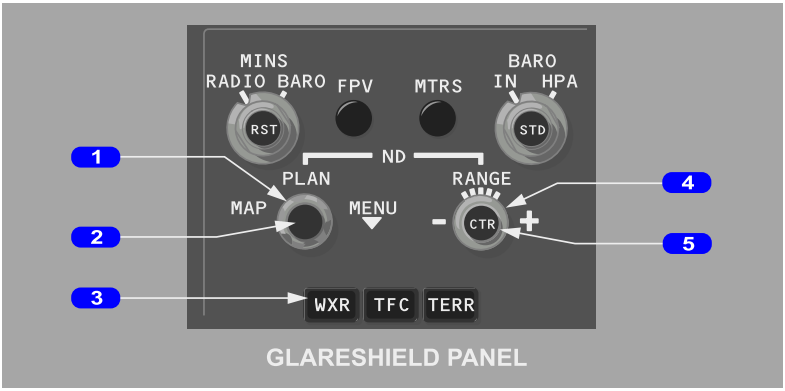
Rotate (slew)—adjusts the PFD barometric reference.

8 Barometric (BARO) Reference Selector (Outer)

IN—selects inches of mercury as the PFD barometric reference.

HPA—selects Hectopascals as the PFD barometric reference.

EFIS Control Panel—ND Controls



1 ND Mode Selector (Outer)

Moves the highlight box to the desired ND map display or map information selection.

MAP—

- displays a moving, heading-up route depiction
- displays FMC-generated route and map information, airplane position, heading, and track.
- displays waypoints, including the active waypoint, within the selected range
- displays VNAV path deviation.

PLAN—

- displays a nonmoving, true north-up, route depiction
- allows route step-through using the CDU legs page
- weather radar and TCAS are not displayed in PLAN mode.

MENU—rotate to move highlight between Map Information Selections.

2 ND Mode Select Switch (Inner)

Push to select the highlighted key on the ND.

3 Map Switches

The map switches:

- displays selected detailed ND and mini-map data
- displays can be selected simultaneously
- second push removes the data.

WXR (Weather Radar)—displays weather radar information. (See Weather Radar on page 11.10.19.)

TFC (Traffic)—displays TCAS information. (See Traffic Alert and Collision Avoidance System (TCAS) on page 15.10.12.)

TERR (Terrain)—displays terrain data. (See GPWS Look-Ahead Terrain Alerting Display and Annunciations on page 15.10.23.)

4 ND Range Selector (Outer)

Selects the desired ND nautical mile range scale:

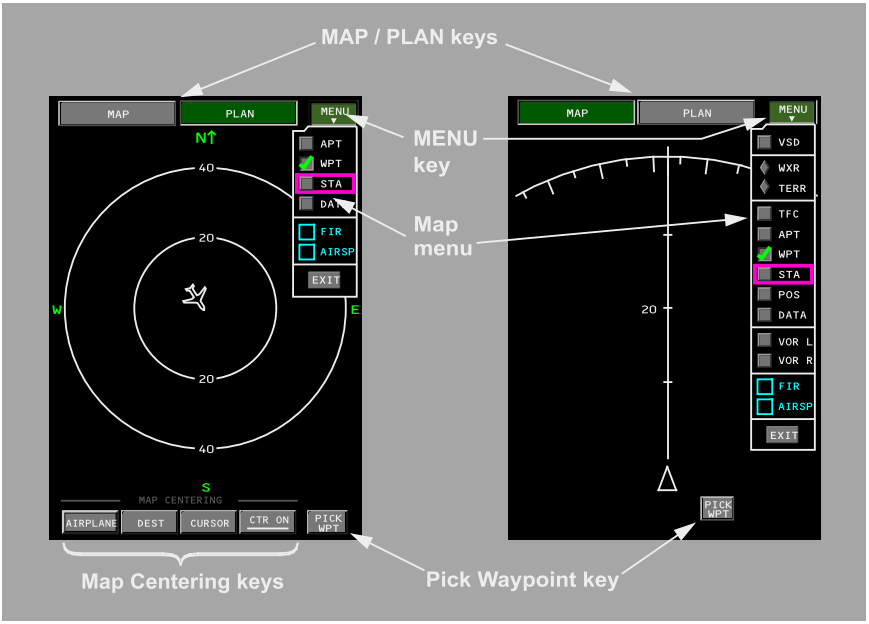
- increment/decrement knob
- rotating clockwise/counter-clockwise increases/decreases ND range respectively
- between 0.5 nm to 1280 nm.

5 ND Center (CTR) Switch (Inner)

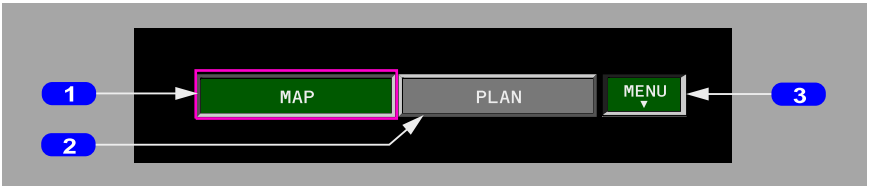
Push—

- displays the full compass rose (centered) for MAP mode
- subsequent pushes alternate between expanded and centered displays.

Map Keys and Information Selections



Map keys are selectable with the ND Mode Selector on the EFIS control panel, the CCD, or the MFD Cursor Control Selector on the MFK. Each key is gray when available for selection and green when currently selected. Each key is cyan when disabled. Each selection on the drop-down menus shows a green check when currently selected. All map keys and information selections are highlighted by a magenta box when the cursor is placed on top of the item.



1 MAP Key

When selected—

- displays a moving, heading-up route depiction
- displays FMC-generated route and map information, airplane position, heading, and track

- displays waypoints, including the active waypoint, within the selected range
- displays VNAV path deviation.

2 PLAN Key

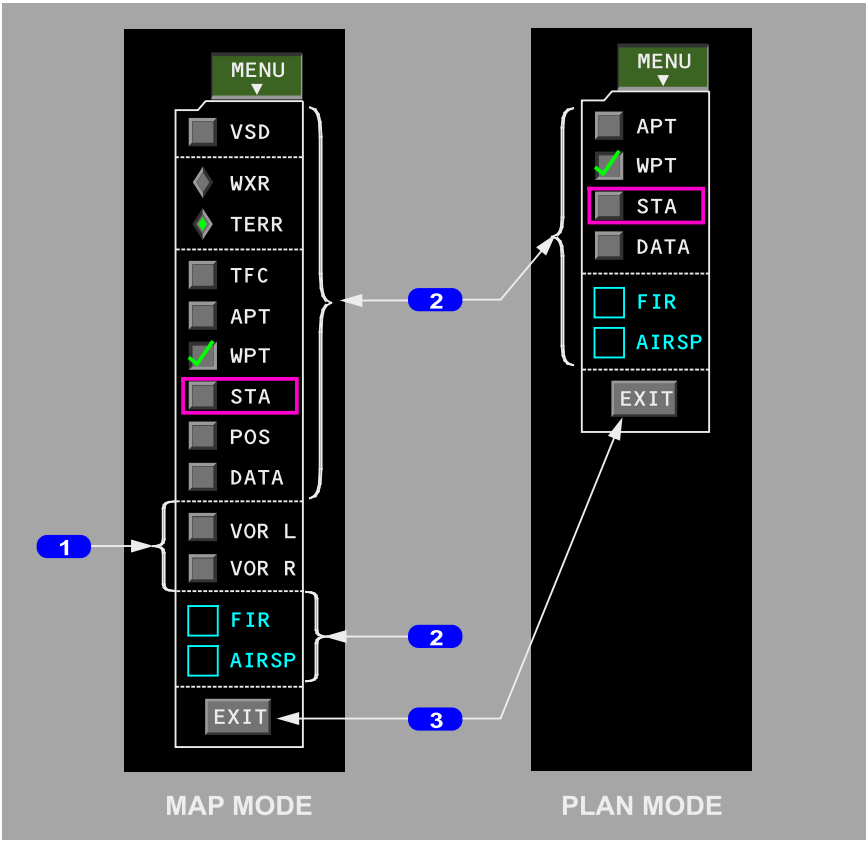
When selected—

- displays a nonmoving, true north-up, route depiction
- allows route step-through using the CDU legs page
- weather radar and TCAS are not displayed in PLAN mode.

3 MENU Key

Selected—displays a drop-down menu containing map information selections.

De-selected—removes menu from ND.



1 VOR Selections

Displays the respective VOR pointer, VOR frequency or identification, and associated DME information.

2 Map Information Selections

Notes: 1. WXR and TERR are not selectable at the same time.

2. Selections that are common to both MAP and PLAN modes retain their states when changing between the two formats. Selections also retain their states when changing to a different MFD display and then back to a ND mode.

VSD—Vertical Situation Display.

WXR (Weather Radar)—displays weather radar information. (See Weather Radar on page 11.10.19.)

TERR (Terrain)—displays terrain data. (See GPWS Look-Ahead Terrain Alerting Display and Annunciations on page 15.10.23.)

TFC (Traffic)—displays TCAS information. (See Traffic Alert and Collision Avoidance System (TCAS) on page 15.10.12.)

APT (Airport)

- displays airports on all ranges
- for ranges greater than 640 NM, APT will display as a star field. This is not dependent on being in an EXCESS DATA condition.

WPT (Waypoint)—displays waypoints when the ND is in the 10, 20 or 40 NM range.

STA (Stations)—

- displays high and low altitude navigation aids, when the ND is in the 10, 20 or 40 NM range
- displays high altitude navigation aids, when the ND is in the 80, 160, 320, or 640 NM range
- for ranges greater than 640 NM, STA will display as a star field. This is not dependent on being in an EXCESS DATA condition.

POS (Position)—

- displays IRS and GPS positions
- displays VOR raw data radials extended from the nose of the airplane to the stations displayed on the CDU NAV RAD page.

DATA (Data)—

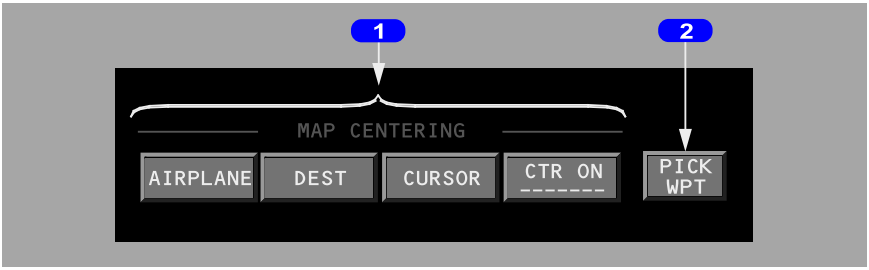
- displays the entered or procedural altitude and ETAs at each waypoint
- times are based on distance to go and groundspeed. They do not consider FMC performance predictions and may differ from other FMC ETAs that do.

FIR (Flight Information Regions)—reserved for future development.

AIRSP (Airspace)—reserved for future development.

3 EXIT Key

Selected (momentary)—removes menu from ND.



1 Map Centering Keys (PLAN Mode only)

AIRPLANE (momentary push)—

- centers the map on the current latitude and longitude of the airplane
- the map does not continually re-center on the airplane.

DEST (momentary push)—

- places the airplane on the center of the destination airport
- displayed cyan if no destination airport is entered in the flight plan.

CURSOR (toggle on/off)—

- when activated, re-centers airplane on the position where the cursor clicks
- cursor changes shape when mode is active
- deactivated when any of the other centering keys are selected, the center on CURSOR key is re-selected, or the cursor leaves the ND.

CTR ON – – – – – – (momentary push) – centers on any database item (STA, WPT, APT) or latitude/longitude coordinate already entered in the scratch pad.

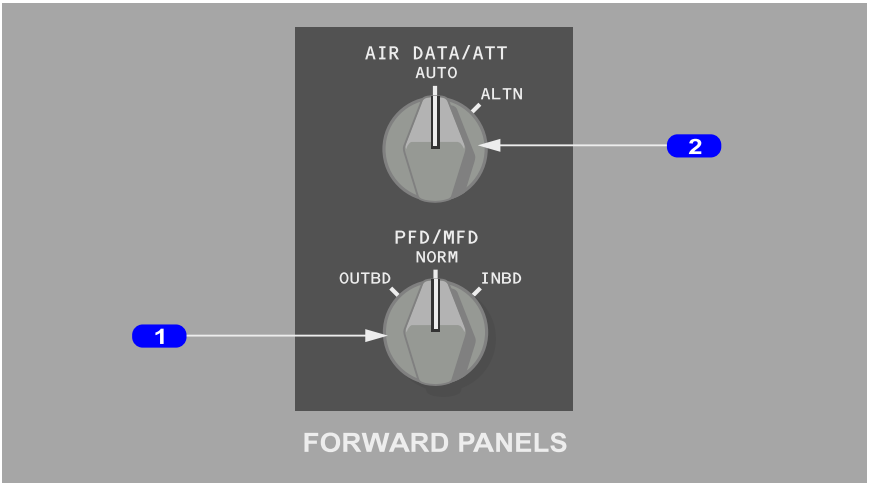
2 Pick Waypoint (PICK WPT) Key (MAP and PLAN modes)

Allows the pilot to graphically create a latitude/longitude point or select a visible waypoint, airport, or navigation aid:

- visible only when the cursor is on the ND map area—
  - enabled when the scratch pad is empty
  - disabled (cyan) when the scratch pad contains data
- when activated, the PICK WPT key label changes to CANCEL.

Instrument Source Select Panels

The instrument source switches are provided for use if a display-related failure is not detected by automatic system monitors. Normally, the display system automatically reconfigures for failures without the pilot having to use these switches.



1 PFD/MFD Selector

NORM—normal position.

INBD DU—non-normal position. When the selector is in this position:

- the outboard DU is blanked
- the inboard DU displays the PFD in reversion mode and EICAS if EICAS was displayed on this side.

OUTBD DU—non-normal position. When the selector is in this position:

- the inboard DU is blanked
- the outboard half of the outboard DU displays the PFD in reversion mode and EICAS if EICAS was displayed on this side.

2 Air Data/Attitude (AIR DATA/ATT) Source Selector

AUTO—normal position:

- the ADRS provides air data to the PFD and HUD
- backup airspeed, based on AOA and inertial data, is automatically provided as required
- backup altitude, based on GPS data, is automatically provided as required
- the IRS provides attitude data to the PFD and HUD

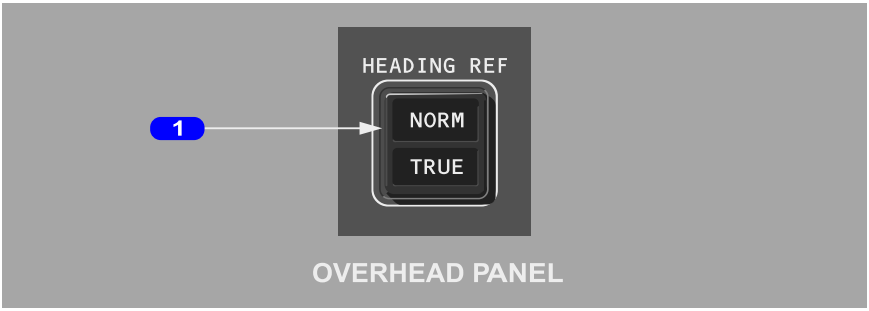
- backup attitude data from the ISFD sources are automatically provided as required.

ALTN—non-normal position. The PFD and HUD alternate air data/attitude source is selected as follows:

- air data—backup airspeed and altitude are displayed on the on-side PFD and HUD
- attitude—ISFD attitude displayed on the on-side PFD and HUD.

Heading Reference

Heading Reference Controls



1 Heading Reference (HEADING REF) Switch

Pushing alternately selects the heading reference for the AFDS, FMCs, NDs and PFDs.

NORM—

- normally references magnetic north
- automatically references true north for FMCs, NDs and PFDs when operating within the polar regions
- automatically references true north for all AFDS cruise roll modes (HDG HOLD, HDG SEL, TRK HOLD, TRK SEL, and LNAV) when operating within the polar regions.

TRUE—references true north regardless of latitude.

When the AFDS roll mode is HDG SEL:

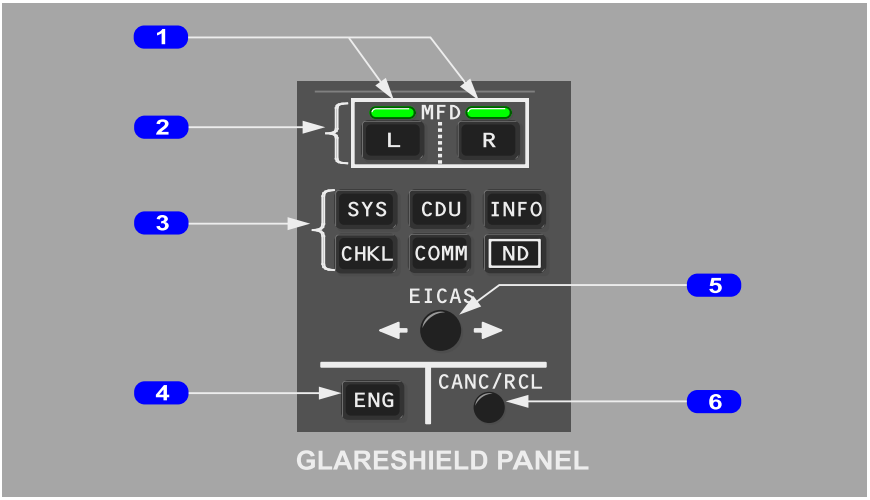
- manually switching the HEADING REF switch from NORM to TRUE or TRUE to NORM activates HDG HOLD as the roll mode
- automatic autopilot switching from magnetic to true or true to magnetic activates HDG HOLD as the roll mode.

When the AFDS roll mode is TRK SEL:

- manually switching the HEADING REF switch from NORM to TRUE or TRUE to NORM activates TRK HOLD as the roll mode
- automatic autopilot switching from magnetic to true or true to magnetic activates TRK HOLD as the roll mode.

(See FMC Polar Operations on page 11.31.8 for additional information.)

Display Select Panel



1 Display Lights

Illuminates to show the MFD window the display select panel controls.

2 Multifunction Display (MFD) Switches

Selects the on-side MFD location (left or right window on each upper display unit) that is affected by pressing display switch(es).

3 Upper Display Switches

Pushing the switch displays the associated format. Pushing the same switch a second time causes the MFD format to be removed and the default format to be displayed.

SYS—system synoptic and maintenance information:

- system menu (see System Displays on page 1.22.5.)
- status messages for dispatch (see Status Display on page 15.10.5.)

- electrical system indications (see Electrical Synoptic Display on page 6.10.6.)
- hydraulic system indications (see Hydraulic Synoptic Display on page 13.10.4.)
- fuel system indications (see Fuel Synoptic Display on page 12.10.6.)
- air system indications (see Air Synoptic Display on page 2.10.10.)
- door system indications (see Door Synoptic Display on page 1.30.12.)
- landing gear/brake indications (see Gear Synoptic Display on page 14.10.6.)
- flight control indications (see Flight Control Synoptic Displays on page 9.10.13.)
- EFIS/DSP backup (see Systems MFD Control Selection on page 10.10.66.)
- circuit breaker functions. (See Circuit Breaker Indication and Control (CBIC) on page 6.10.14.)

CHKL—checklist. (See Normal Checklist on page 10.50.1.)

CDU—display emulation. (See Control Display Unit (CDU) on page 11.10.1.)

COMM—communications. (See Communications Menus on page 5.40.2.)

INFO—displays airport map database effectivity dates. (See Airport Map Display on page 10.10.38.)

ND—navigation display. (See Navigation Display (ND) on page 10.10.28.)

4 ENG Display Switch

Pushing the switch displays the secondary engine information on EICAS. Pushing the switch a second time blanks secondary engine information.

5 EICAS Transfer Switch

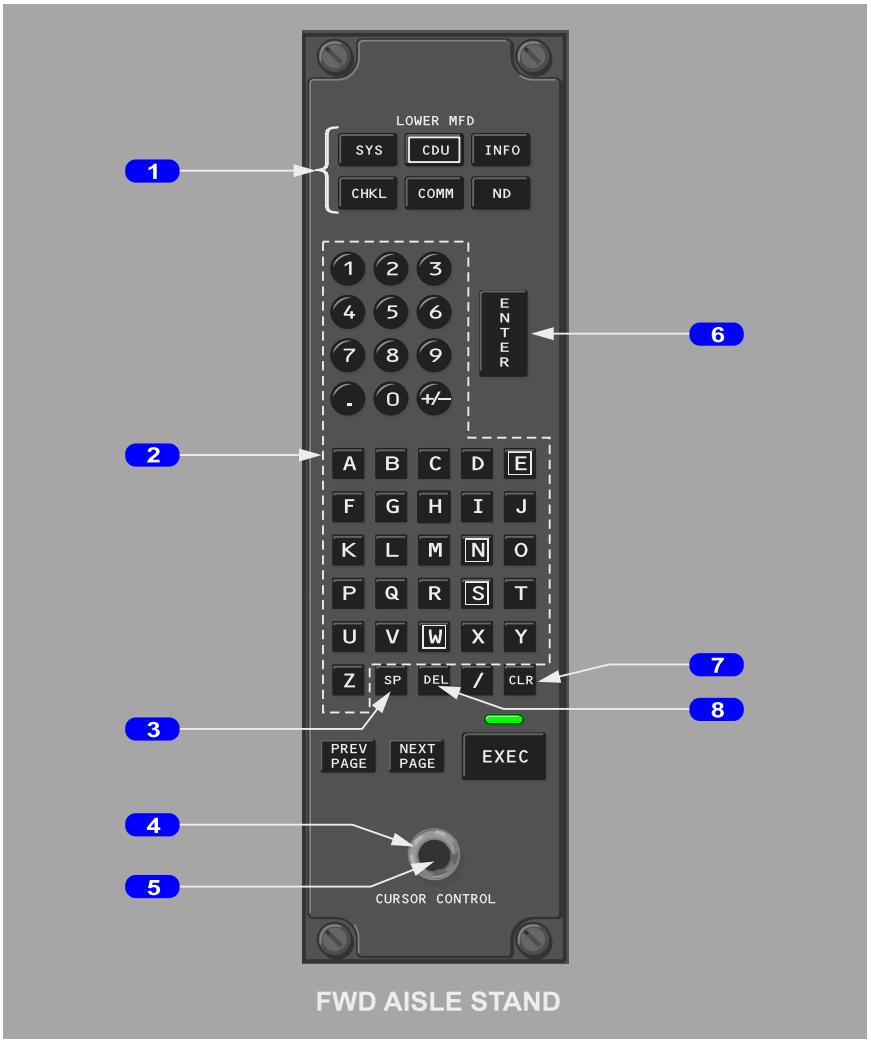
Transfers EICAS format between the Captain and First Officer inboard display units.

6 Cancel/Recall (CANC/RCL) Switch

(See Display Select Panel (DSP) on page 15.10.3 for additional information.)

Multifunction Keypad (MFK)

There are two MFKs on the forward aisle stand, one on each side of the lower DU. Each MFK controls cursor position and operation on the on-side inboard DU and on-side MFD on the lower DU.



1 Lower Display Switches

Pushing the switch displays the associated format. Pushing the same switch a second time causes the MFD format to be removed and the default format to be displayed.

SYS—system synoptic and maintenance information:

- system menu (see System Displays on page 1.22.5.)
- status messages for dispatch (see Status Display on page 15.10.5.)
- electrical system indications (see Electrical Synoptic Display on page 6.10.6.)
- hydraulic system indications (see Hydraulic Synoptic Display on page 13.10.4.)
- fuel system indications (see Fuel Synoptic Display on page 12.10.6.)
- air system indications (see Air Synoptic Display on page 2.10.10.)
- door system indications (see Door Synoptic Display on page 1.30.12.)
- landing gear/brake indications (see Gear Synoptic Display on page 14.10.6.)
- flight control indications (see Flight Control Synoptic Displays on page 9.10.13.)
- EFIS/DSP backup (see Systems MFD Control Selection on page 10.10.66.)
- maintenance functions
- circuit breaker functions. (See Circuit Breaker Indication and Control (CBIC) on page 6.10.14.)

CHKL—checklist. (See Normal Checklist on page 10.50.1.)

CDU—display emulation. (See Control Display Unit (CDU) on page 11.10.1.)

COMM—communications. (See Communications Menus on page 5.40.2.)

INFO—displays airport map database effectivity dates. (See Airport Map Display on page 10.10.38.)

ND—navigation display. (See Navigation Display (ND) on page 10.10.28.)

2 Alpha/Numeric Keys

Push—

- puts selected character in scratchpad
- Slash (/) key – enters “/” in scratchpad
- Plus Minus (+/–) key – first push enters “-” in scratchpad. Subsequent pushes alternate between “+” and “–”.

3 Space (SP) Key

Push—enters space in scratchpad.

4 Cursor Control Selector (Outer)

Rotate—moves the highlight in a predetermined path to another selection on the active MFD.

5 Cursor Select Switch (Inner)

Push—selects the highlighted key on the MFD.

6 ENTER Key

Push—performs an associated action to the highlighted field.

7 Clear (CLR) Key

Push—clears last character of data in the scratchpad.

Push and hold—clears all scratchpad data.

8 Delete (DEL) Key

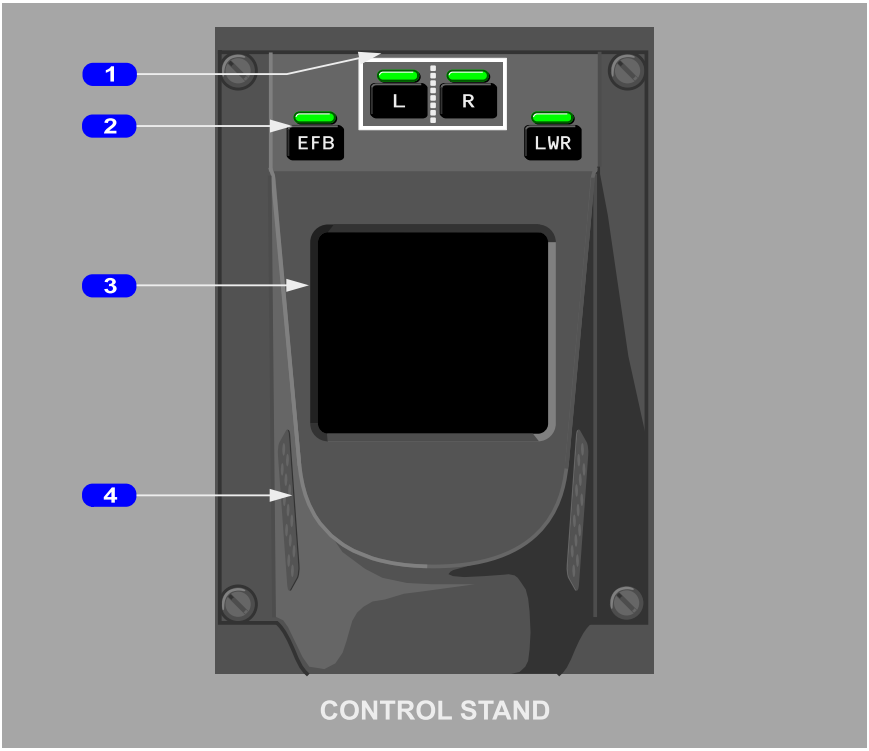
Push—enters “DELETE” in scratchpad.

Cursor Control Device (CCD)

The left CCD controls the left inboard display unit and the lower display unit cursor position and operation.

The right CCD controls the right inboard display unit and the lower display unit cursor position and operation.

The left CCD is shown; the right CCD is similar, except the EFB switch and the LWR switch are located on the opposite side of the CCD.



1 Cursor Location Lights

The associated annunciator light illuminates to indicate where the cursor appears.

2 Cursor Location Switches

Selects the display where the cursor appears (EFB, left MFD, right MFD, or lower MFD) and automatically deselects the previous display.

3 Touch Pad

Finger movement on the touch pad moves the cursor on the selected display. Lifting the finger off the pad and putting it back down in a different location (except the corner areas) does not move the cursor. The cursor only moves when the finger is moved on the touch pad surface.

Corner areas—except for system (SYS) displays, tapping with a finger on one of the four corners places the cursor in the corresponding corner of the display.

Moving the cursor into a corner region without lifting the finger from the pad does not have this effect.

4 Cursor Select Switch

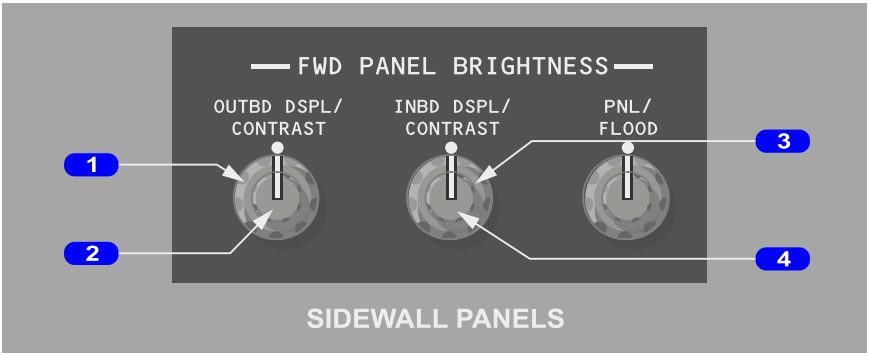
Push—activates the area of the screen that the cursor is currently in, such as a menu item or command button. The area is highlighted by a magenta border to indicate it can be selected.

The switch is used to select menus, checklists, checklist steps, and other functions.

Display Brightness Controls

Forward Panel Brightness Controls

The left panel is shown.



1 Outboard Display (OUTBD DSPL) Brightness Control (Outer)

Rotate—adjusts the brightness of the outboard display unit.

2 Outboard Display (OUTBD DSPL) Brightness Control (Inner)

Rotate—adjusts weather radar/terrain brightness on outboard display.

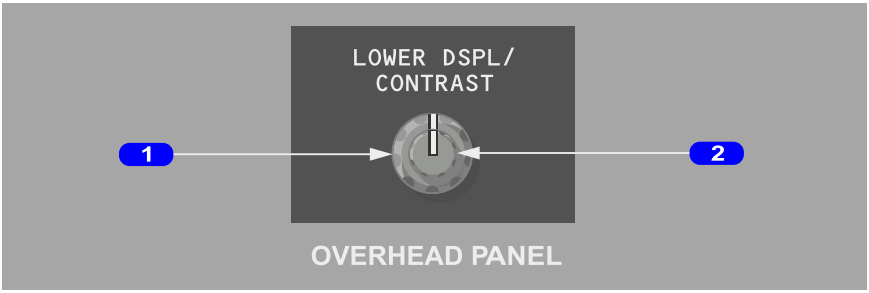
3 Inboard Display (INBD DSPL) Brightness Control (Outer)

Rotate—adjusts the brightness of the inboard display unit.

4 Inboard Display (INBD DSPL) Brightness Control (Inner)

Rotate—adjusts weather radar/terrain brightness on inboard unit.

Lower Display Brightness Controls



1 Lower Display (LWR DSPL/CONTRAST) Brightness Control (Outer)

Rotate—adjusts the brightness of the lower center display unit.

2 Lower Display (LWR DSPL/CONTRAST) Brightness Control (Inner)

Rotate—adjusts weather radar or terrain display brightness on the lower center display unit.

Weather radar and terrain data cannot be displayed at the same time.

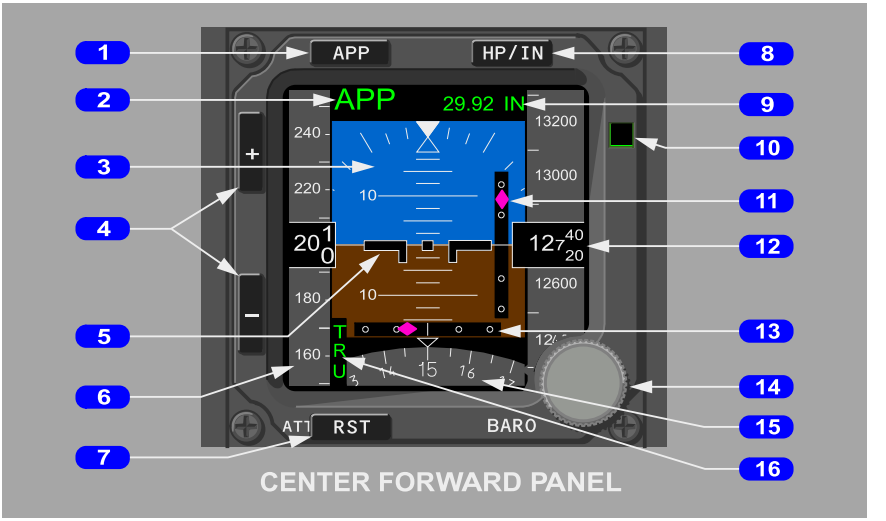
Standby Flight Instruments

The standby flight instruments include the:

- integrated standby flight display
- standby magnetic compass.

Integrated Standby Flight Display (ISFD)

Provides an independent source of attitude, airspeed, and altitude information.



1 Approach (APP) Switch

Push—

- when blank, selects APP
- when APP displayed, selects B/CRS
- when B/CRS displayed, blanks.

2 Approach Mode Annunciation

Indicates approach mode selected.

Blank—no approach deviation data displayed.

APP—ILS/GLS localizer and glideslope deviation data displayed.

BCRS (back course)—reverses sensing for localizer pointer during back course approaches.

3 Attitude Display

Displays airplane attitude.

Indicates bank in reference to the bank scale.

Indicates the horizon relative to the airplane symbol.

Beyond 30º pitch, large red arrowheads (V-shaped) indicate the attitude has become excessive and the direction to the horizon line.

4 Display Brightness Switches

Push—

- + increases display brightness
- - decreases display brightness.

5 Airplane Symbol

Indicates airplane position with reference to the horizon.

6 Airspeed Indications

Indicates airspeed when above 30 knots.

7 Attitude Reset (ATT RST) Switch

Push and hold at least two seconds—

- aligns horizon with the airplane symbol
- reset takes approximately ten seconds
- starts new initialization sequence if previous attempt failed (ground only).

8 Hectopascal/Inch (HP/IN) Switch

Push—changes units of barometric reference.

9 Barometric Setting

Indicates the barometric setting selected with the barometric selector.

STD is displayed when selected with the barometric selector.

10 Ambient Light Sensor

Automatically adjusts display intensity for ambient lighting condition.

11 Glideslope Pointer and Scale

The glideslope pointer indicates glideslope position relative to the airplane—

- the pointer is in view when the glideslope signal is received
- the scale is in view when the APP mode is selected
- the pointer and scale are removed when the B/CRS mode is selected.

12 Current Altitude

13 Localizer Pointer and Deviation Scale

The localizer pointer indicates localizer position relative to the airplane—

- the pointer is in view when the localizer signal is received

- the scale is in view when either the APP or B/CRS 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

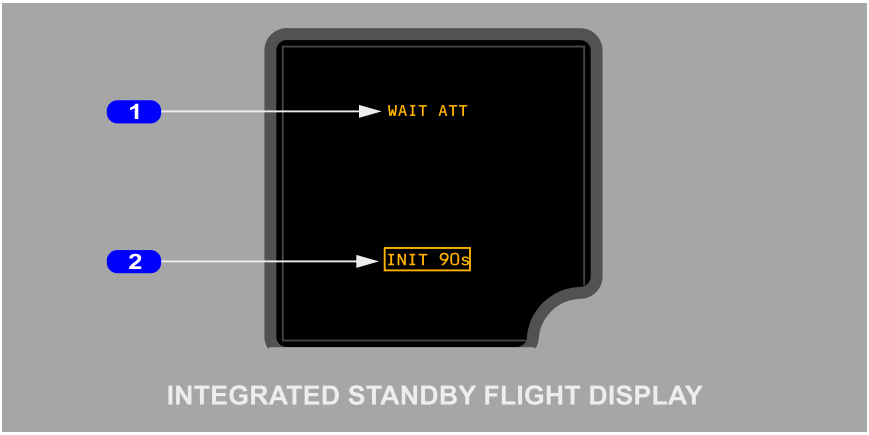
Displays airplane heading.

16 Heading Source

TRU—true heading.

Blank—magnetic heading.

ISFD Messages



1 Attitude Messages

Indicates attitude display status.

ATT:RST (amber)—attitude must be reset using the attitude reset switch.

ATT 10s (amber)—10 second attitude realignment in progress.

WAIT ATT (amber)—indicates temporary self correcting loss of attitude.

2 Initialization message

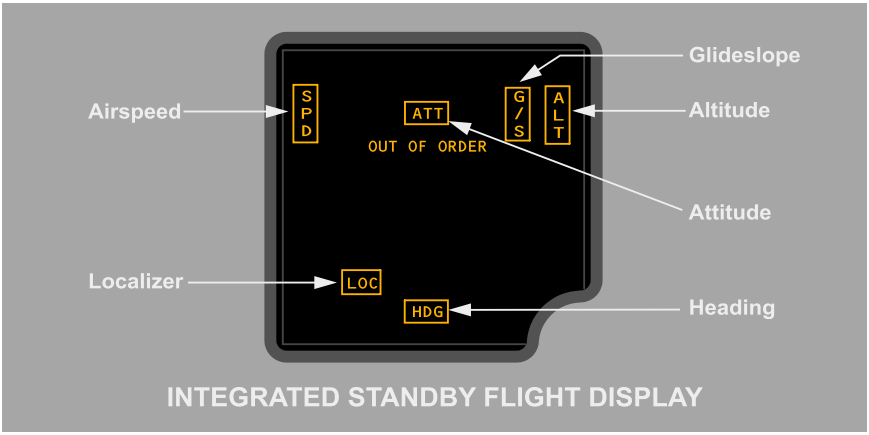
INIT 90s (amber)—countdown of 90 second initialization—

- countdown stops if excessive motion is detected
- countdown resumes when motion stops
- ATT:RST displays if initialization is not complete within six minutes.

ISFD Failure Flags

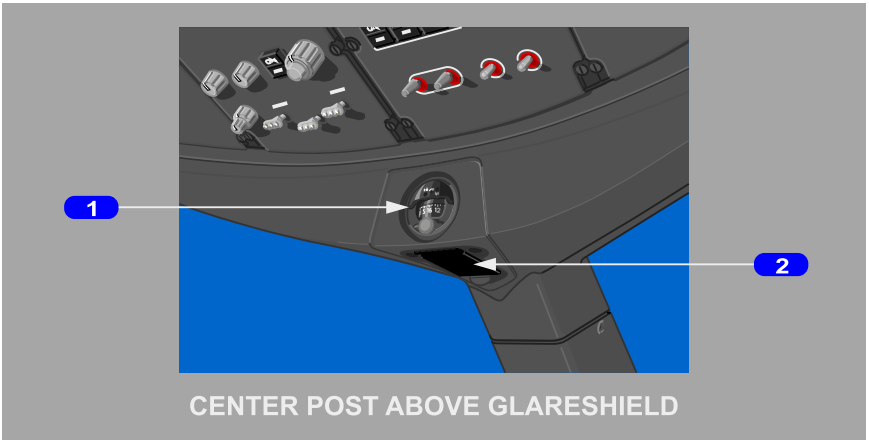
Failure flag replaces appropriate display.

OUT OF ORDER indicates instrument system failure.



INTEGRATED STANDBY FLIGHT DISPLAY

Standby Magnetic Compass



CENTER POST ABOVE GLARESHIELD

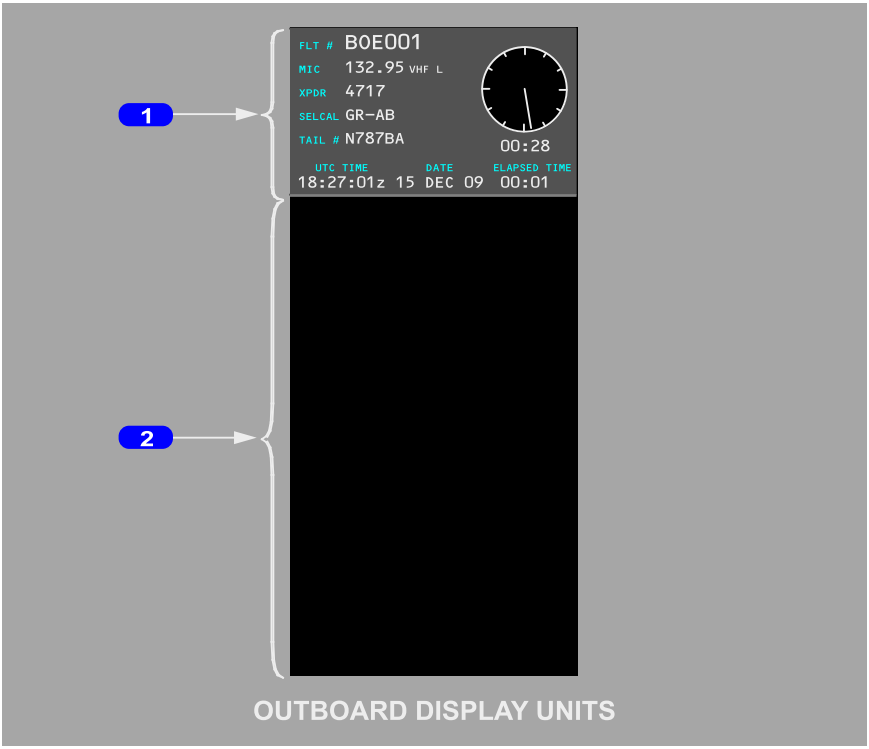
1 Standby Magnetic Compass

Displays magnetic heading.

2 Standby Magnetic Compass Correction Card

Provides appropriate heading corrections.

Auxiliary (AUX) Display



1 Flight Data Block

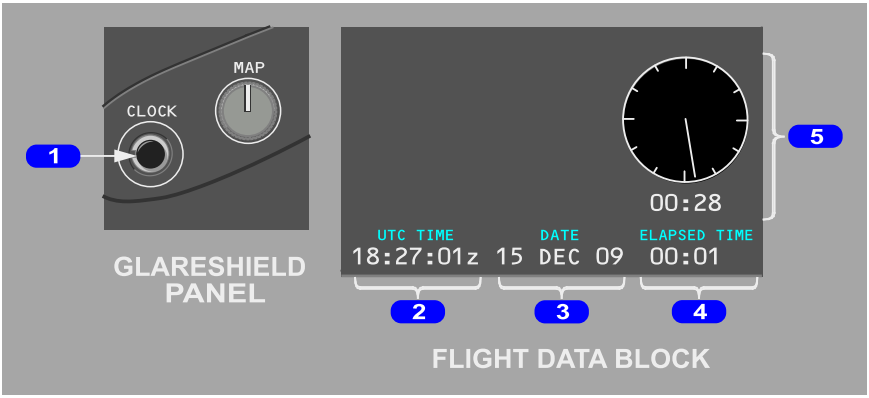
For additional information:

- MIC and SELCAL (see Communication Indications on page 5.10.17.)
- TAIL # (see IDENT Page on page 10.70.9.)
- FLT # and XPDR (see Flight Data Block on page 11.10.11.)
- Date and time functions. (See Clock on page 10.10.64.)

2 ATC Data Block

(See ATC Messages on page 5.40.17 for additional information.)

Clock



1 CLOCK Switch

Push—subsequent pushing starts, stops, removes the chronograph from display.

2 UTC Time

Displays current UTC time (hours, minutes, seconds) using GPS inputs.

3 Date

Indicates current date (day, month, year) using GPS inputs.

4 Elapsed Time

Displays elapsed flight time (hours, minutes, seconds).

Automatic start-stop logic:

- on power up timer is set to 00:00
- timer begins at weight off wheels
- timer stops at weight on wheels plus 30 seconds
- when on ground and V-speeds are entered into CDU (PFD “NO VSPD” flag disappears) timer resets to 00:00.

5 Chronograph Function

Analog dial and sweep second hand—displays elapsed time (minutes, seconds).

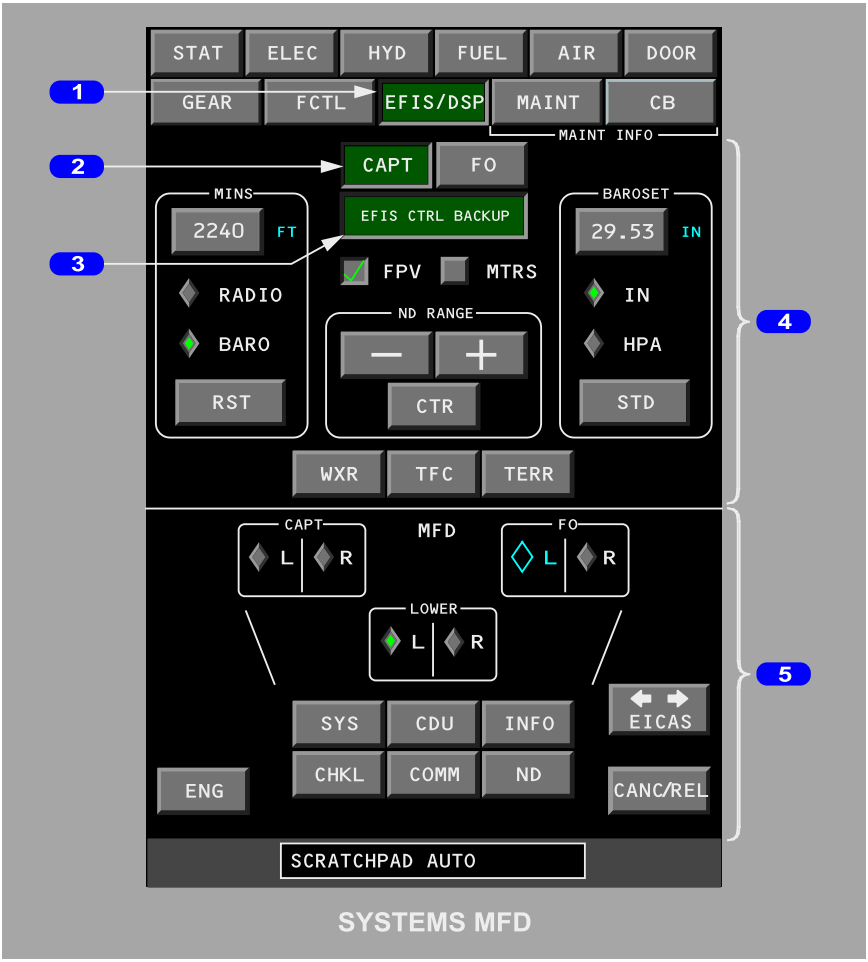
Digital readout—displays elapsed time (minutes, seconds) since starting chronograph.

EFIS Control Panels and Display Select (DSP)—Systems MFD Alternate Control

The EFIS/DSP systems display provides an alternate way to control the functions of the EFIS control panel and/or the display select panel. This display is selected on the SYS page. The DSP controls are available full time while the backup EFIS controls must be enabled prior to activation.

Note: The control call outs 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.

Systems MFD Control Selection



SYSTEMS MFD

1 Backup EFIS/DSP Select Key

Displays backup EFIS/DSP control keys.

2 CAPT/FO Keys

Allows manual reconfiguration to control off-side EFIS/DSP control panels.

3 EFIS CTRL BACKUP Key

Push—enables EFIS backup controls.

4 Backup EFIS Controls

Need to be enabled before functional.

When enabled, initially configured to control on-side EFIS control panel.

When enabled, overrides functional EFIS control panel.

5 DSP Controls

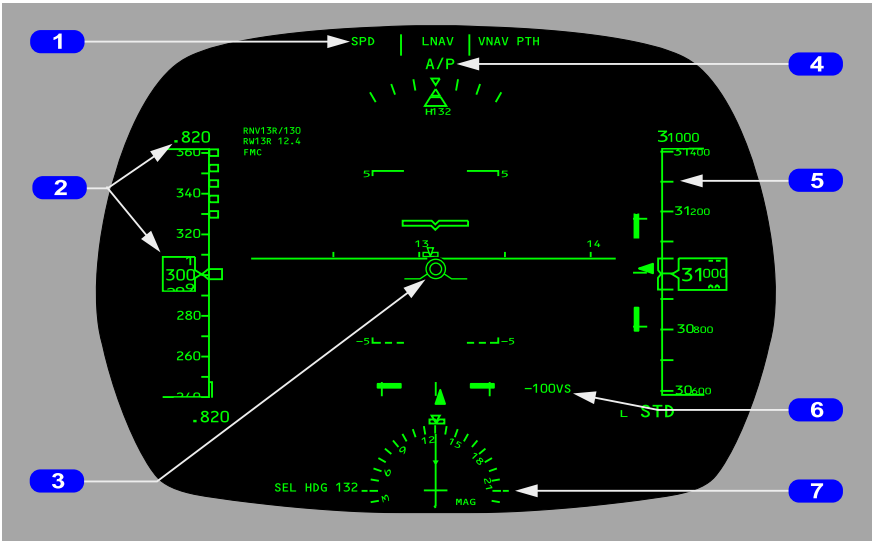
Do not need to be enabled for backup controls to be functional.

Do not override DSP if DSP is still functional.

Head-Up Display (HUD)

Most HUD symbology is the same as the PFD symbology. See HUD-Unique Indications and Symbology on page 10.12.19 for detailed descriptions. When differences do exist in symbology or function, the detailed description is included here in its entirety.

Full Symbology Mode



1 **Flight Mode Annunciations**

2 **Airspeed/Mach Indications**

3 **Attitude, Steering, and Miscellaneous Indications**

4 **Autopilot, Flight Director System Status**

5 **Altitude Indications**

6 **Vertical Speed Indication**

Displays ADRS vertical speed.

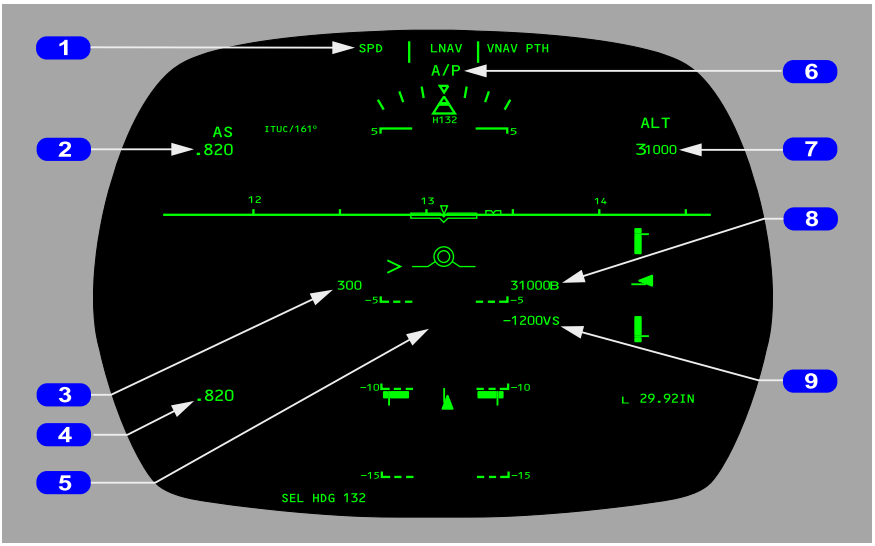
7 Compass Rose

Displays current IRS heading, track, and other related information.

Note: The compass rose is not displayed during ground operations.

Decluttered Symbology Mode

Note: The decluttered symbology mode is not available for takeoff or go-around when TO/GA is the active pitch mode.



1 **Flight Mode Annunciations**

2 **Selected Speed**

3 **Current Airspeed**

4 **Current Groundspeed/Mach**

5 **Attitude, Steering, and Miscellaneous Indications**

6 **Autopilot, Flight Director System Status**

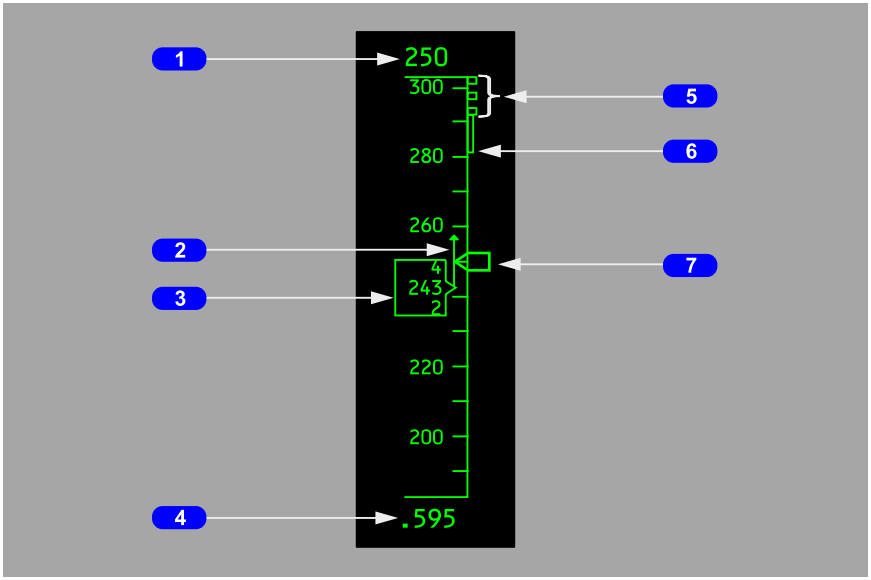
7 **Selected Altitude**

8 **Current Altitude**

9 Vertical Speed Indication

Displays current ADRS vertical speed.

HUD Airspeed Indications



1 Selected Speed

2 Speed Trend Vector

3 Current Airspeed

Indicates current ADRS airspeed.

The box around the current airspeed indication flashes when airspeed is below minimum maneuvering speed.

4 Current Groundspeed/Mach

Displays current groundspeed or Mach (if Mach is 0.40 or greater).

When a transition occurs between the display of groundspeed and Mach number, the new display is highlighted with a box for 10 seconds.

5 Maximum Speed

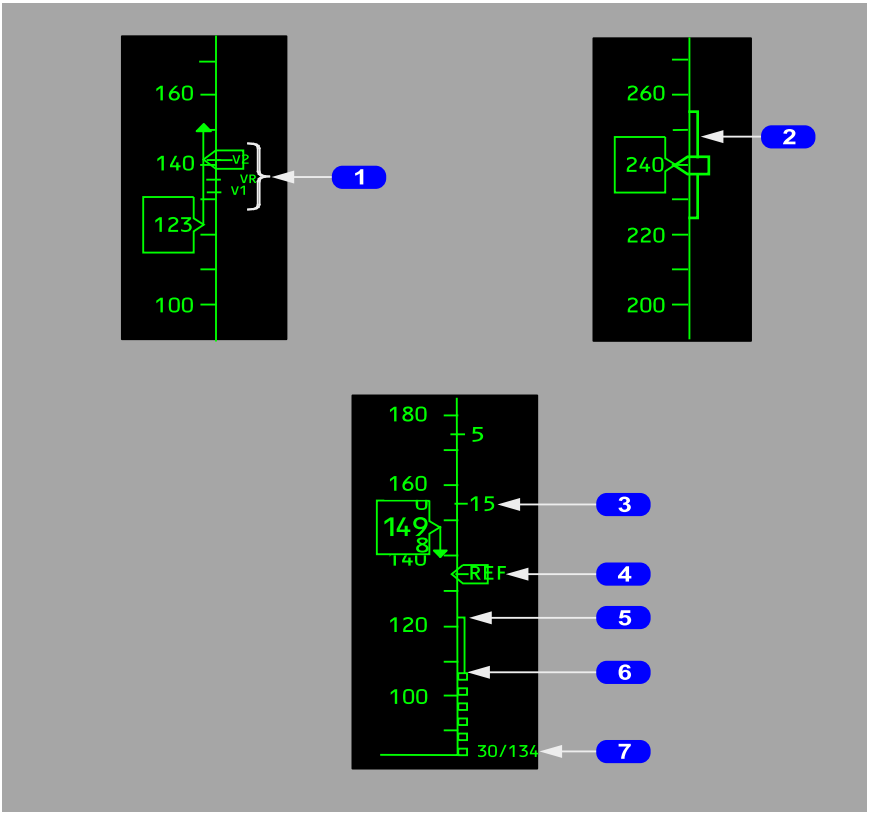
6 Maximum Maneuvering Speed

Bottom of the bar indicates the maximum maneuvering speed. This airspeed provides 1.3 g maneuver capability to high speed buffet (or an alternative approved maneuver capability as preset by maintenance). May be displayed when operating at high altitude at relatively high gross weights.

Note: 1.3 g maneuver capability occurs at 40º of bank in level flight.

7 Selected Speed Bug

HUD Reference Speeds



1 Takeoff Reference Speeds

2 VNAV Speed Band

3 Flap Maneuvering Speeds

4 Landing Reference Speed

5 Minimum Maneuvering Speed

Top of bar indicates minimum maneuvering speed. This airspeed provides:

- 1.3 g maneuver capability to stick shaker below approximately 20,000 ft
- 1.3 g maneuver capability to low speed buffet (or an alternative approved maneuver capability as preset by maintenance) above approximately 20,000 ft.

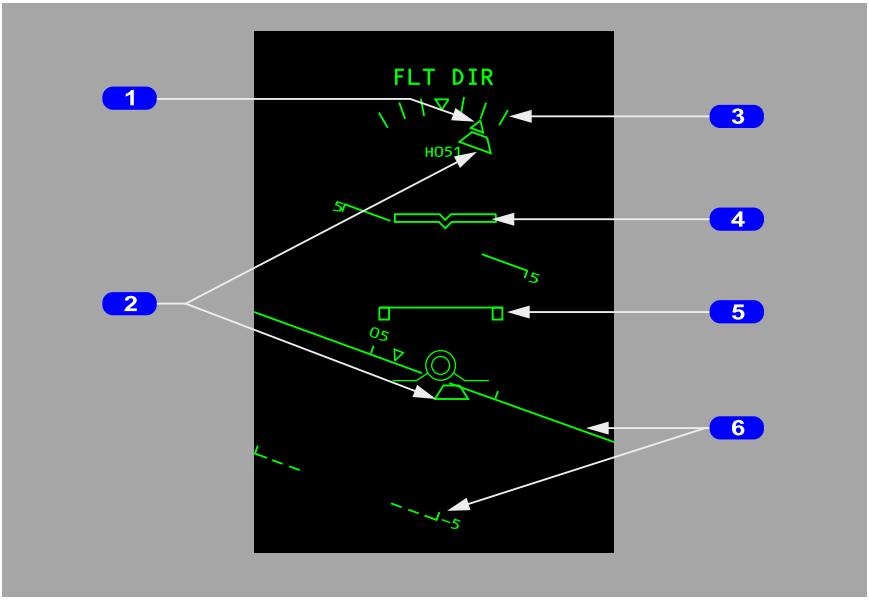
Displayed with first flap retraction after takeoff.

Note: 1.3 g maneuver capability occurs at 40º of bank in level flight.

6 Minimum Speed

7 Landing Flap and VREF Speed

HUD Attitude Indications



1 Bank Pointer

Indicates bank in reference to the bank scale.

Fills if bank angle is 35º or more.

2 Slip/Skid Indications

Displaces to indicate slip or skid.

Fills at full scale deflection.

Note: Indicator below flight path vector symbol only appears during takeoff or low altitude go-around.

3 Bank Scale

Fixed reference for the bank pointer.

Scale marks are at 0º, 10º, 20º, 30º.

Enhanced scale marks at 45º and 60º are added to the scale if the airplane bank is within 10º of those bank angles.

4 Airplane Symbol

5 Angle of Attack Limit

Referenced to the flight path vector symbol. The distance between the AOA limit symbol and the flight path vector symbol represents the margin available to stick shaker.

Displayed during any of the following:

- angle-of-attack is within 5º of stick shaker, or
- whenever stick shaker is active, or
- whenever windshear (solid) guidance cue is displayed.

6 Horizon Line and Pitch Scale

Indicates the IRS horizon and degrees of pitch.

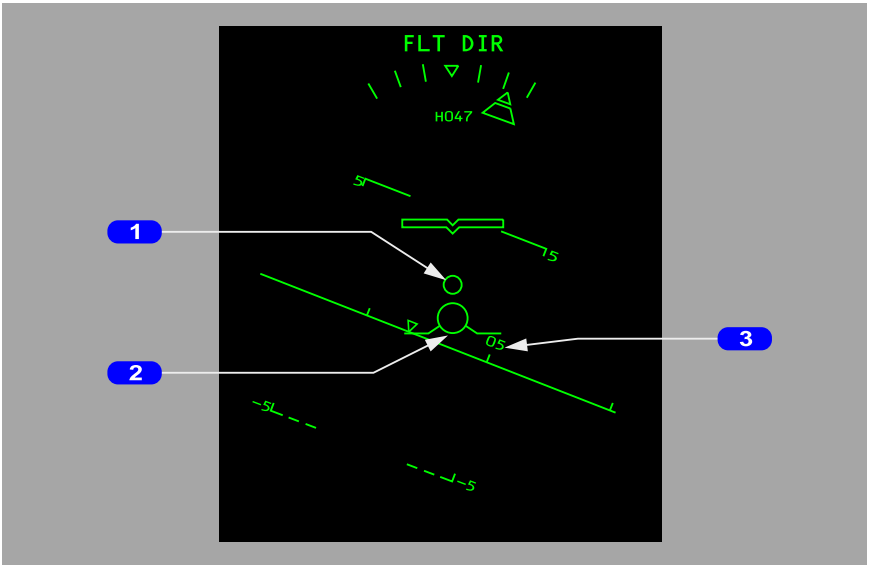
Pitch scale displays 5º increments.

HUD Steering Indications

For additional information:

- See TCAS HUD Vertical Guidance on page 15.10.19

- See Alerts Displayed on the HUD on page 15.10.9.



1 Flight Director Guidance Cue

Indicates flight director pitch and roll steering commands. (See Autopilot Flight Director Roll and Pitch Controls on page 4.10.6 for additional information.)

2 Flight Path Vector Symbol (FPV)

Displays current flight path angle and drift angle during flight:

- flight path angle is depicted by the flight path vector symbol position on the pitch scale
- drift angle is represented by the perpendicular distance from the line drawn through the center of the pitch scale to the center of the flight path vector symbol
- shows as dashed lines instead of solid lines when limited laterally by other symbology or the display field-of-view.

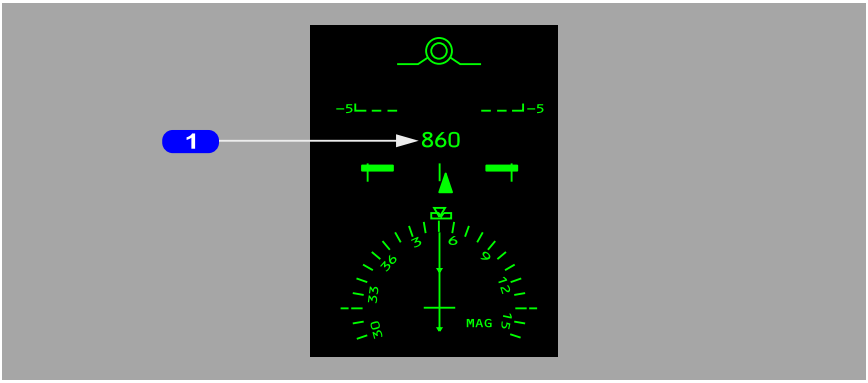
3 Horizon Line Heading Scale

Displays current heading.

Has tic marks every 5º and labels every 10º representing the heading value.

Current heading is located at a point on the horizon line where a line drawn perpendicular to the horizon line goes through the center of the airplane symbol.

HUD Radio Altitude Indications



1 Radio Altitude

Referenced to the flight path vector symbol. The radio altitude indication maintains a set distance directly below the flight path vector symbol:

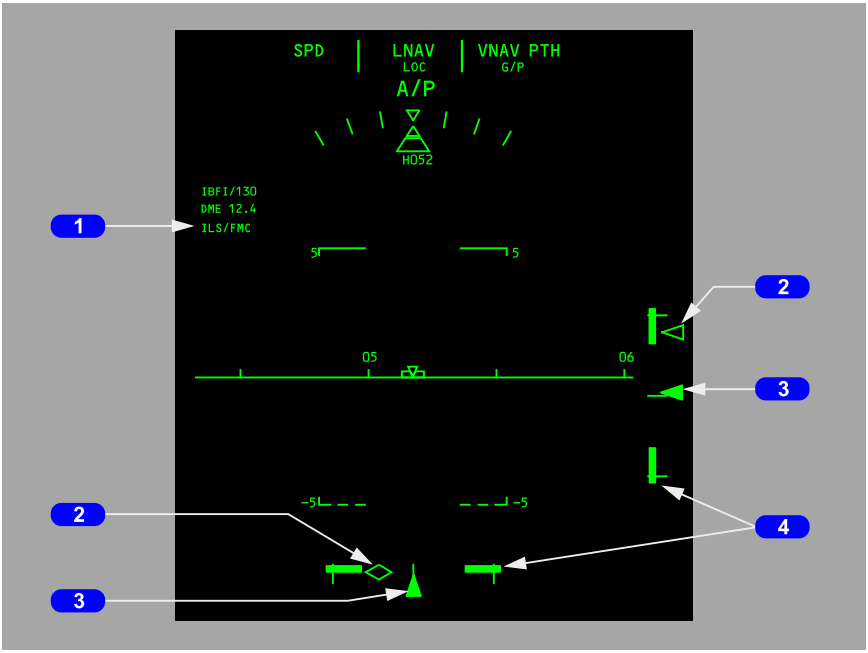
- displays below 2,500 feet AGL
- is boxed for 10 seconds after descending through 2,500 feet AGL
- is boxed when descending below radio altitude minimums. Box blinks for 2 seconds, then is steady.

HUD Navigation Performance Indications

The following information is primarily intended to show differences between the HUD and PFD.

For additional information on NPS and IAN:

- See PFD Navigation Performance Indications on page 10.10.10
- See PFD Integrated Approach Navigation (IAN) Indications on page 10.10.16.



1 **Navigation Source Reference**

2 **Approach Deviation Pointer**

Indicates the selected approach path relative to the airplane position:

- unfilled diamond for LOC or G/S when not captured
- unfilled triangle for FAC or G/P when not captured
- filled diamond when LOC or G/S is captured (active FMA)
- filled triangle when FAC or G/P is captured (active FMA).

3 **NPS Deviation Pointer**

Indicates the selected lateral or vertical path relative to the airplane position:

- unfilled symbol when parked at deflection limit
- filled 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 or ANP bars meet in the middle of the deviation scale.

4 Deviation Scale

Lateral and Vertical scales:

- outer tic marks represent RNP. Center tic mark represents airplane position
- bars represent ANP
- area between bars indicate margin available to remain within RNP criteria
- bars on vertical scale display only during FMC descent phase of flight.

If ANP equals or exceeds RNP:

- solid bars meet in the middle
- after five seconds, bars become hollow (unfilled) and bars and indices blink for three seconds indicating RNP operations can no longer be maintained
- pointer blinks for ten seconds, then steady
- NAV UNABLE RNP EICAS message is displayed (Lateral scale only).

If pointer migrates into bar area for five seconds:

- bars become hollow (unfilled) and blink for 3 seconds, then steady
- indices blink for 3 seconds, then steady
- pointer blinks for 10 seconds, then steady
- bars remain hollow (unfilled) as long as alert is active.

HUD Instrument Landing System Indications

The following information is primarily intended to show any differences between the HUD and PFD. (See PFD Instrument Landing System Indications on page 10.10.12 for additional information.)



1 Approach Reference

Displays the selected ILS/GLS identifier or frequency, approach front course, and ILS/GLS DME distance, and source annunciation.

If the tuned ILS/GLS frequencies disagree, the frequency displayed has a horizontal line through it.

If the approach courses in the ILS/GLS receivers disagree, the course displayed has a horizontal line through it.

2 Localizer Pointer and Scale

The pointer indicates the localizer relative to the airplane position and is:

- unfilled diamond when it appears
- in view when the localizer signal is received
- filled diamond when within 2 1/2 dots from the center.

The scale is in view after the frequency is tuned if NPS are not shown. With either LNAV or VNAV active, or LNAV is armed, the NPS indications remain in view until localizer capture.

At low radio altitudes with the autopilot engaged or flight director on, the pointer flashes to indicate excessive localizer deviation.

At low altitudes, with LNAV active and LOC armed, the pointer flashes if the localizer is not captured.

3 Marker Beacon Indication

4 Glideslope Pointer and Scale

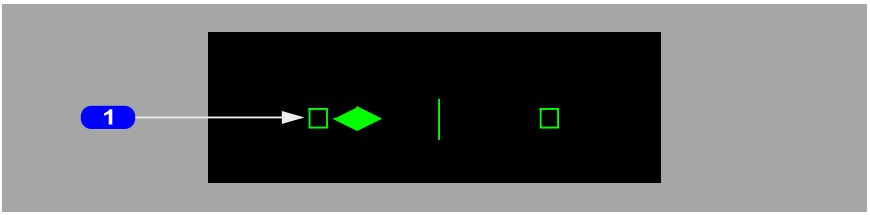
The pointer indicates the glideslope position relative to the airplane, and is:

- unfilled diamond when it appears
- in view when the glideslope signal is received
- filled diamond when within 2 1/2 dots from the scale center.

The scale is in view after the frequency is tuned if NPS are not shown. With either LNAV or VNAV active, or LNAV armed, the NPS indications remain in view until glideslope capture.

At low radio altitudes with the autopilot engaged or flight director on, the pointer flashes to indicate excessive glideslope deviation.

HUD Expanded Localizer Indications



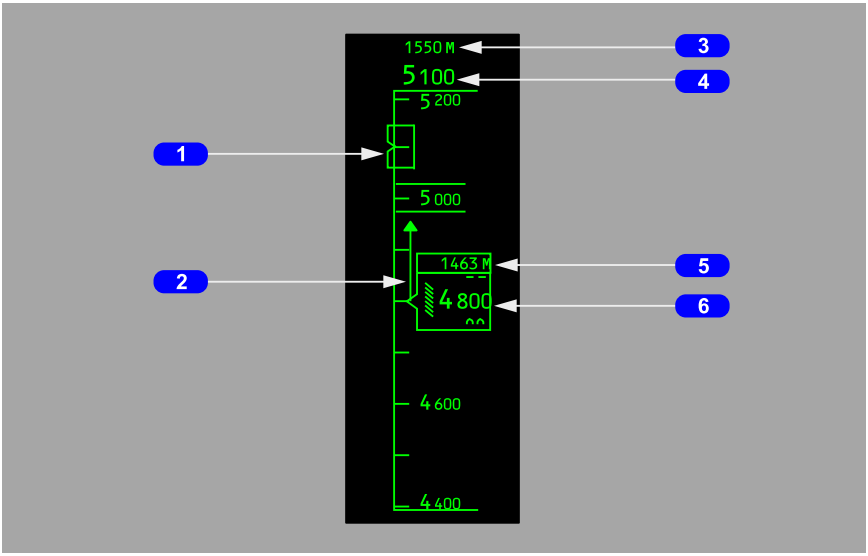
1 Expanded Localizer Scale

Displays when the autopilot is in LOC mode and the airplane is close to the runway center line. Provides a more sensitive display.

Expanded localizer indications also display during HUD takeoff operations.

A rectangle equals 1/2 dot deviation.

HUD Altitude Indications



1 **Selected Altitude Bug**

2 **Altitude Trend Vector**

3 **Selected Altitude—Meters**

4 **Selected Altitude**

Displays the altitude set in the MCP altitude window.

The selected altitude is boxed between 900 feet and 200 feet prior to reaching the selected altitude.

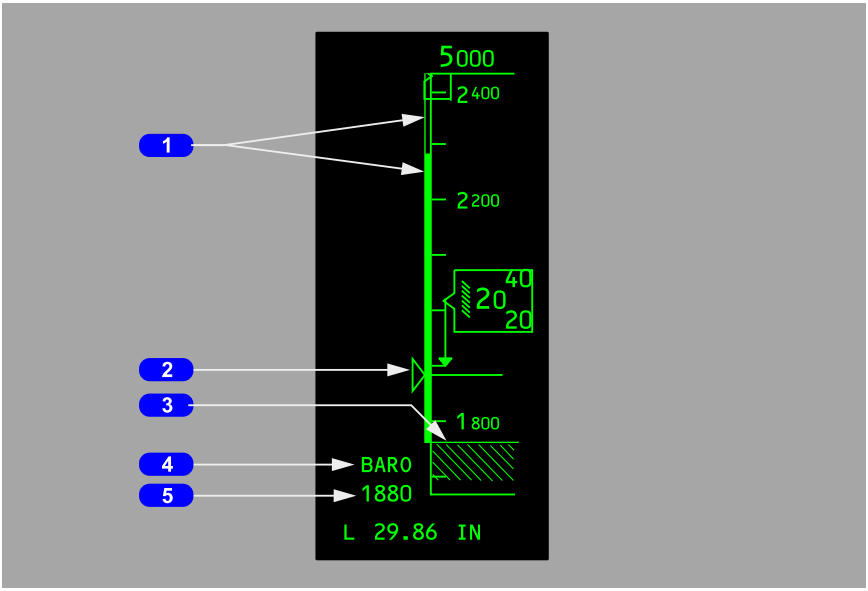
5 **Current Altitude—Meters**

6 **Current Altitude**

Indicates current ADRS altitude.

When deviating beyond 200 feet from selected altitude, boxed outline around current altitude flashes. Alerting terminates if deviation continues beyond 900 feet from selected altitude.

HUD Landing Altitude/Minimums Indications



1 Landing Altitude Reference Bar

Indicates height above touchdown.

(hollow bar)—500 to 1,000 feet above landing altitude.

(filled bar)—0 to 500 feet above landing altitude.

2 BARO Minimums Pointer

When BARO minimums are displayed, the number is also represented as a triangular bug and line on the altitude scale.

Flashes for 3 seconds, then steady when the airplane descends below baro minimums.

When RA minimums are displayed after BARO minimums are selected, the bug remains on the altitude scale.

3 Landing Altitude Indication

4 Minimums Reference

Displays BARO when the EFIS control panel MINS reference selector is set to BARO.

Displays RADIO when the EFIS control panel MINS reference selector is set to RADIO.

Flashes for 3 seconds, then steady when the airplane descends below selected minimum altitude.

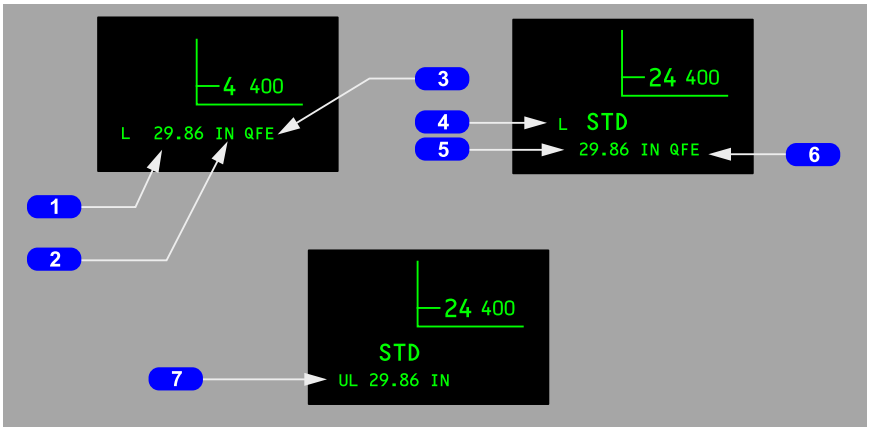
5 Minimums

Displays the approach minimums altitude set using the EFIS control panel MINS selector:

- BARO minimums are feet MSL
- RADIO minimums are radio altitude feet AGL.

Flashes for 3 seconds, then steady when the airplane descends below selected minimum altitude.

HUD Barometric Indications



1 Barometric Setting

Indicates the barometric setting selected on the EFIS control panel barometric selector.

STD is displayed when STD is selected on the EFIS control panel barometric STD switch.

The display is boxed if a barometric setting is set and altitude climbs above the transition altitude, or if STD is set and altitude descends below the transition flight level.

2 Barometric Reference

3 QFE Altitude Reference

Indicates QFE altitude reference selected on the CDU APPROACH REF page.

When selected, QFE is boxed for 10 seconds.

When QNH is selected, QNH is displayed for 10 seconds, then blanks.

4 Autopilot/Flight Director Barometric Source

L or R indicates that the left or right EFIS control panel is the barometric setting reference for the autopilot or flight director (the same indication is displayed on both HUDs).

Displayed when a flight director switch is in the ON position or the autopilot is engaged:

- F/D—one turned on and one not on determines L or R
- F/D—both on—L is displayed
- A/P—first one pushed on determines L or R.

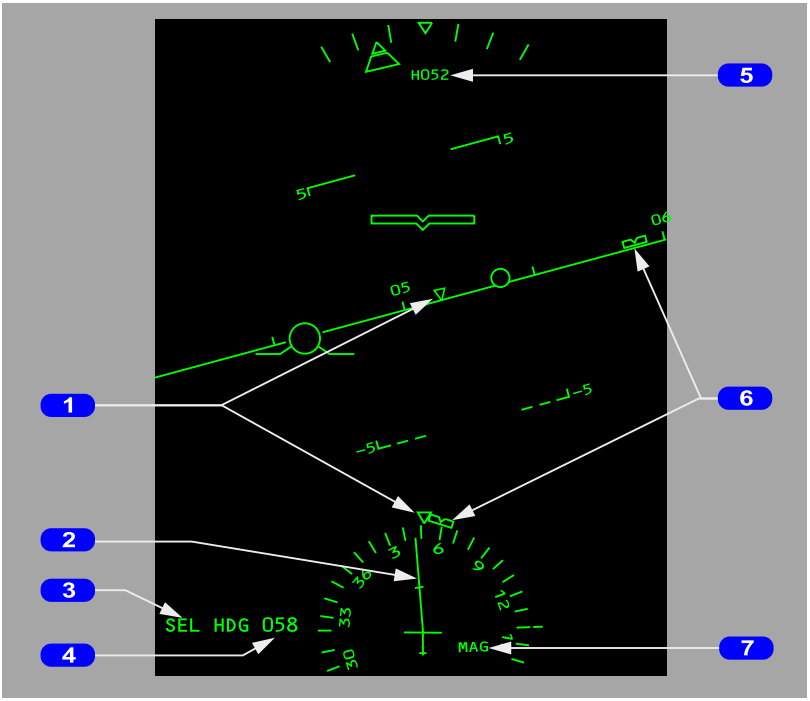
5 Preselected Barometric Setting

6 QFE

7 Uplinked Barometric Setting

HUD Heading/Track Indications

Note: The selected track bug and selected heading bug are not displayed at the same time.



1 Current Heading Pointer

2 Track Line

Indicates the current track and drift angle.

3 Selected Heading/Track Reference (MCP Selection)

When HDG (heading) is selected, SEL HDG is displayed.

When TRK (track) is selected, SEL TRK is displayed.

If selected heading/track exceeds display range, the bug parks on the side of the compass rose and horizon line heading scale, in the direction of the shorter turn to the heading. The symbol's outline is depicted with dashed lines, indicating that it can no longer display the selected heading/track.

4 Selected Heading/Track (MCP Selection)

Digital display of the selected heading or track bug.

5 Digital Heading

Digital heading displays current heading and corresponds to the heading on the horizon reference line.

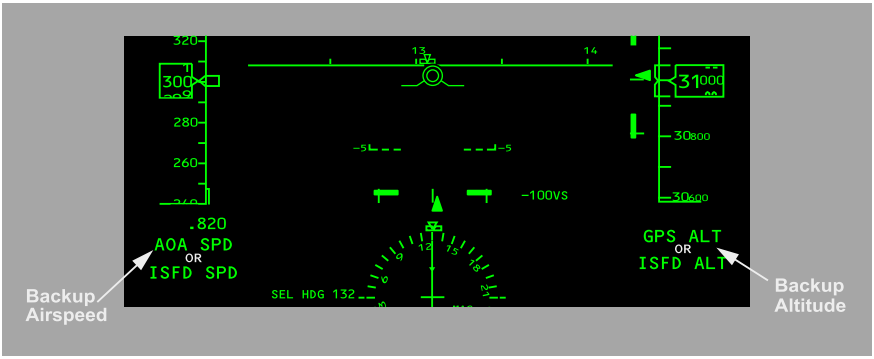
6 Selected Heading/Track Bug (MCP Selection)

7 Heading/Track Reference

Displays the automatic or manually selected heading/track reference:

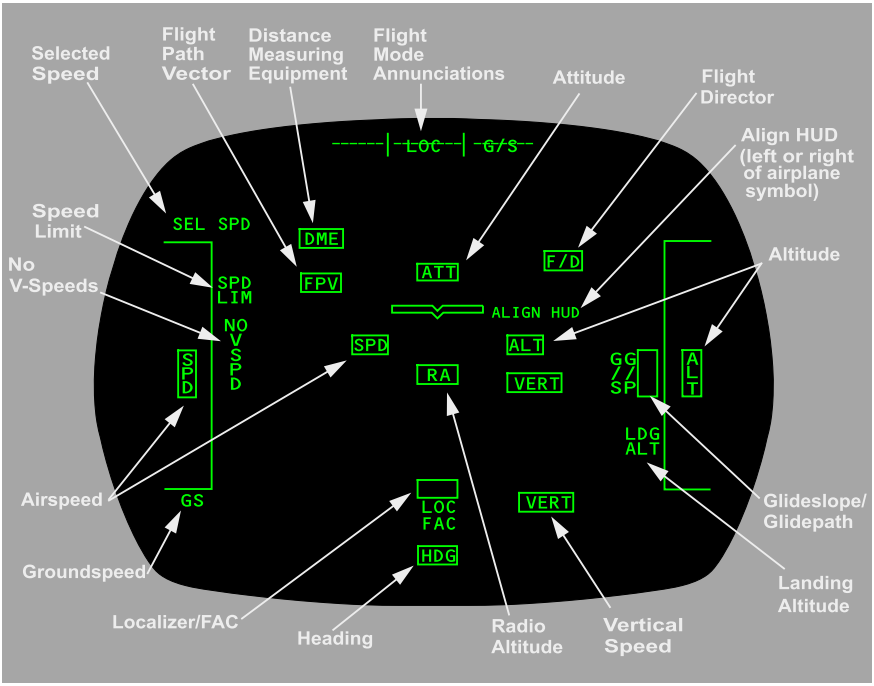
- MAG (magnetic north)
- TRU (true north).

HUD Messages



HUD Failure Flags

Note: HUD failure flags replace the appropriate display to indicate source system failure, or lack of computed information.



HUD-Unique Indications and Symbology

The HUD does have some unique indications not found on the PFD. Those indications are described in detail here.

TO/GA Reference Line



1 TO/GA Reference Line

Displayed on ground when:

- flight director TO/GA mode is active, and
- groundspeed is greater than 65 knots.

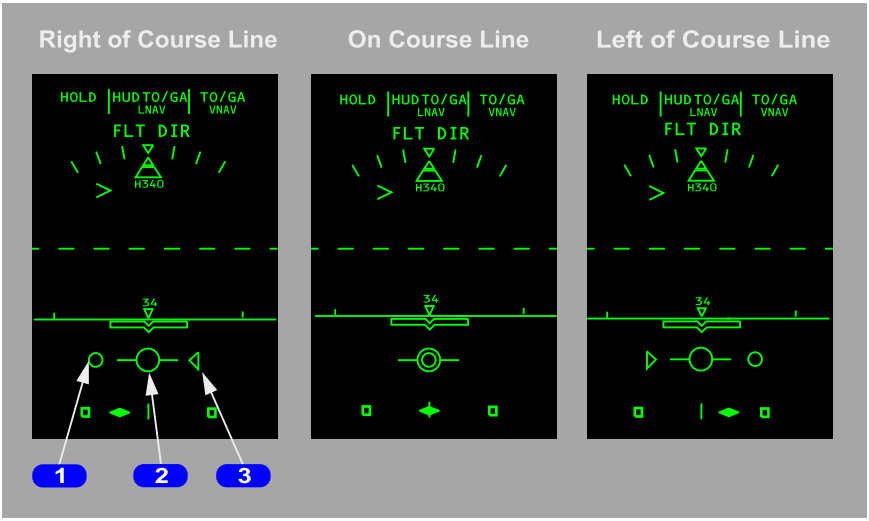
Displayed in air when flight director TO/GA mode is active.

Ground Deviation Indications—HUD Takeoff

For additional information:

- See HUD Takeoff on page 4.20.12

- See Departures Page on page 11.40.26.



1 Flight Director Guidance Cue

Displays localizer position relative to the airplane position.

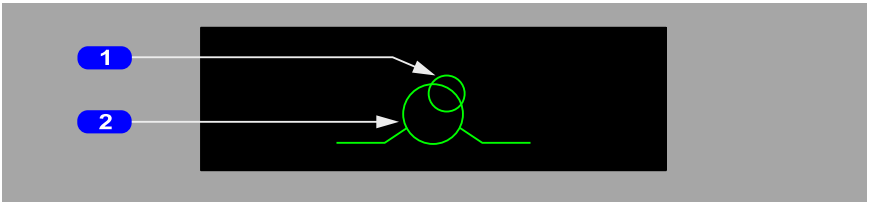
2 Ground Roll Reference Symbol

Displays airplane position relative to the localizer.

3 Ground Excessive Deviation Symbol

Indicates excessive deviation (more than 23 feet) from localizer course line during takeoff roll. Flashing triangle points in direction of runway centerline.

Flight Path Vector Symbol with Guidance Cue



1 Flight Director Guidance Cue

A flight director guidance cue commanding a particular input from pilot.

Displayed only when flight directors are turned on as follows:

- during normal takeoff, appears at approximately 50 feet RA
- during a HUD takeoff, the guidance cue appears with the flight path vector symbol during the ground to air transition
- on approach, removed from HUD at approximately 50 feet RA.

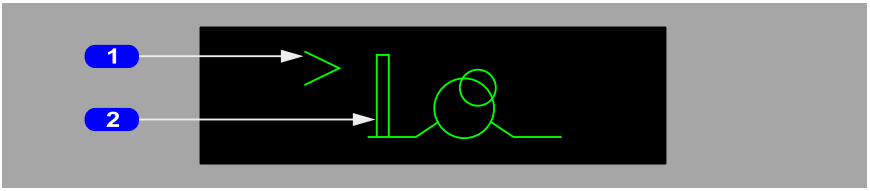
The cue fills (solid) during windshear alerting. (See Alerts Displayed on the HUD on page 15.10.9 for additional information.)

2 Flight Path Vector Symbol

Displays actual flight path vector of the airplane as derived from IRS.

Appears only in flight.

Speed Error Tape and Flight Path Acceleration



1 Flight Path Acceleration symbol

Indicates the inertial acceleration (or deceleration) of the airplane along the flight path.

Removed from the display when a low-level, decreasing performance windshear is detected below 400 feet AGL.

When symbol is above the wing of the flight path vector symbol, the airplane is accelerating. When it is below the flight path vector symbol wing, the airplane is decelerating.

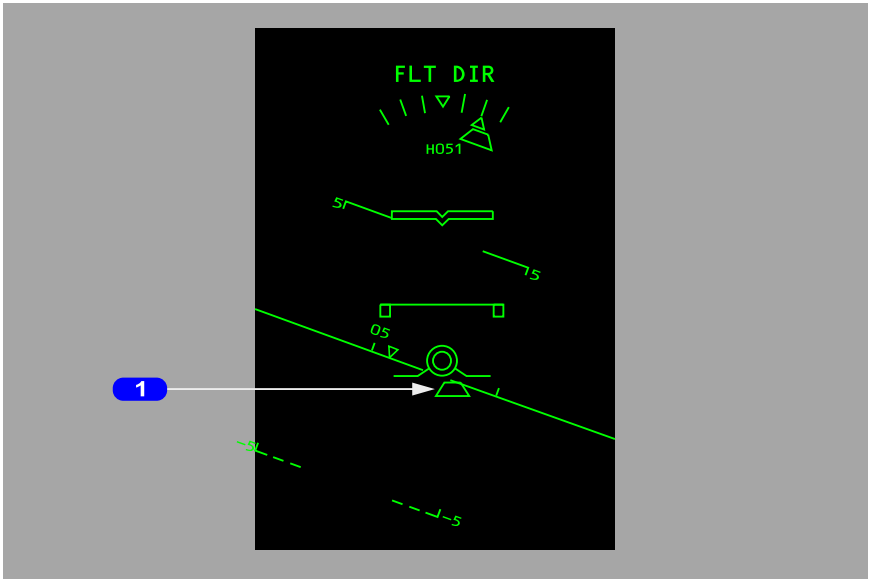
2 Speed Error Tape

Displays difference between the indicated airspeed and the selected airspeed (on the Mode Control Panel) or flight management system commanded airspeed.

Symbol not displayed until first flap retraction.

If the indicated airspeed is faster than the selected speed, the Speed Error Tape rises above the wing. Likewise, if the airspeed is slower than the selected speed, the Speed Error Tape falls below the wing.

Slip/Skid Indication



1 **Slip/Skid Indicator—Flight Path**

Referenced to the flight path vector symbol. Only displayed during takeoff or low altitude go-around to provide yaw reference in the event of engine failure.

Wind Speed, Wind Direction, and Digital Heading



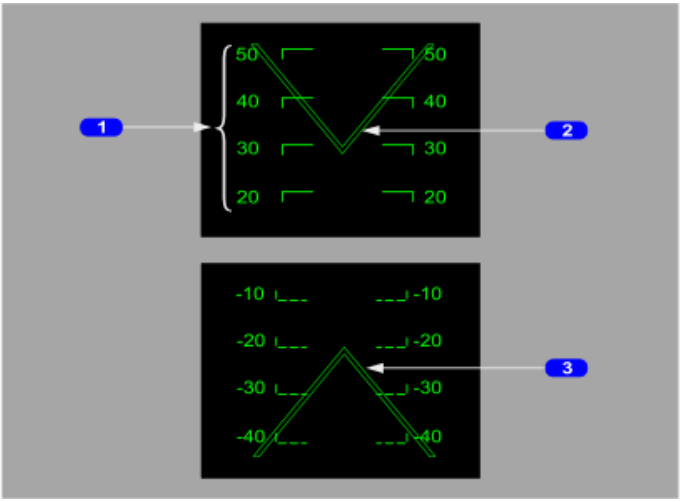
1 Wind Speed and Direction

Indicates wind speed and direction with respect to display orientation. Displays when wind speed exceeds 6 knots, and the airplane is not on the ground.

2 Digital Heading

Digital heading displays current heading and corresponds to the heading on the horizon reference line.

Pitch Scale Chevrons and Pitch Scale Compression



1 Pitch Scale Compression

Pitch scale compresses if the horizon reference line or the flight path vector symbol are parked at the limit of the display because of excessive pitch angle.

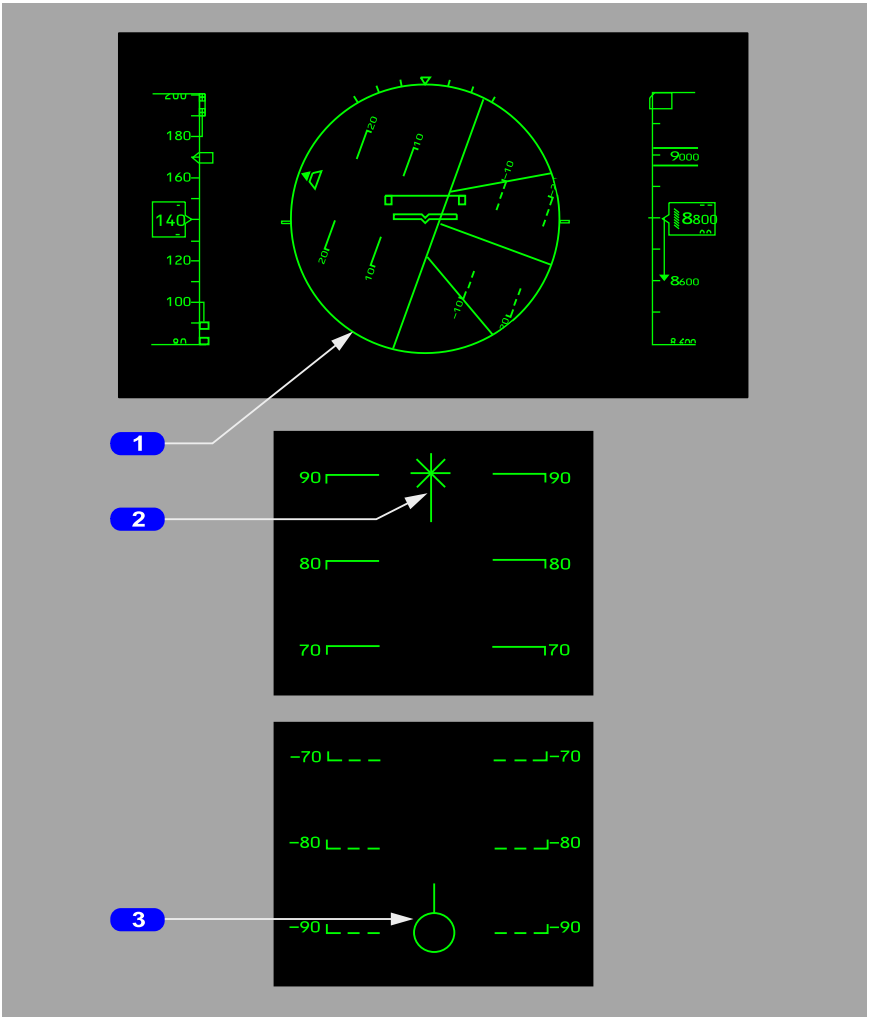
2 Pitch Scale Chevron (Upper)

Overlays compressed pitch scale with tip at +30°, directing pilot to apply pitch down.

3 Pitch Scale Chevron (Lower)

Overlays compressed pitch scale with tip at –20°, directing pilot to apply pitch up.

Unusual Attitude



1 Unusual Attitude symbology

The Unusual Attitude (UA) symbology is displayed when:

- pitch is less than –20°, or
- pitch is greater than +35°, or
- roll exceeds 55° in either direction.

The Unusual Attitude (UA) symbology remains displayed until:

- pitch angle is between –5º and 10º (relative to horizon) for 5 seconds, and
- roll angle is less than 10º for 5 seconds.

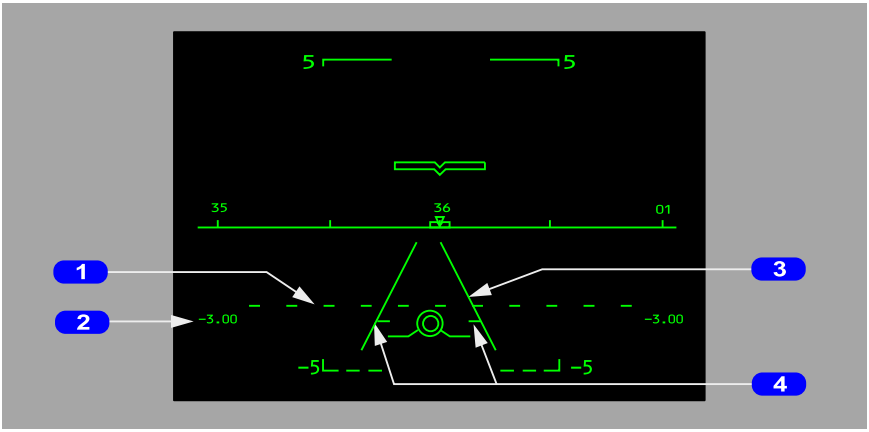
2 Zenith Symbol

Displayed in center of HUD pitch scale at +90º pitch line.

3 Nadir Symbol

Displayed in center of HUD pitch scale at –90º pitch line.

Runway Edge Lines and Glideslope Reference Line



1 Glideslope Reference Line

Display of the glideslope or glidepath value for the active approach shown when the VREF speed is selected. Removed from HUD at 70 feet RA.

2 Digital Glideslope Value

Digital glideslope or glidepath angle for the active approach.

Default value is 3º if the selected approach has no glidepath angle or no approach is selected.

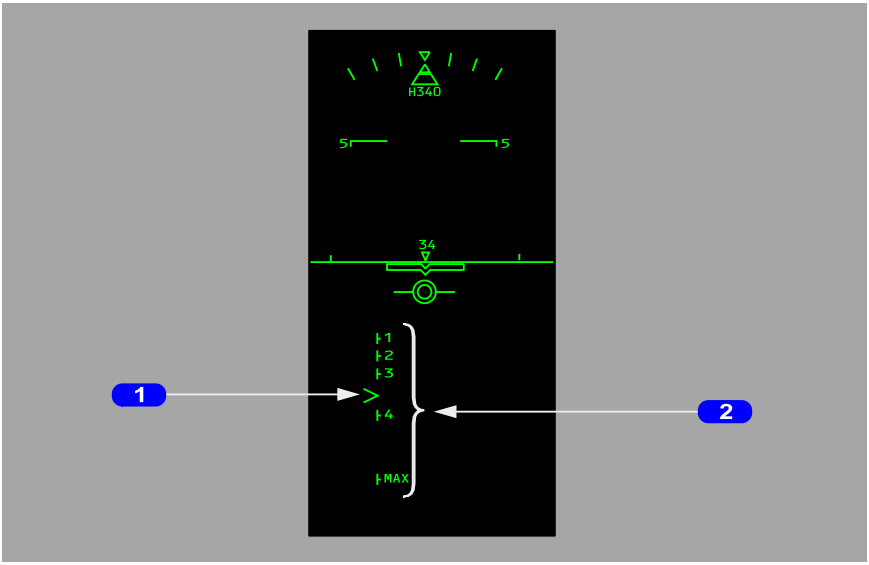
3 Runway Symbol

Calculated position of runway edge lines. Displays only in decluttered mode. Removed from HUD at 60 feet RA.

4 Touchdown Aiming Point

Tick marks on runway edge lines correspond to the touchdown aiming point.

Ground Deceleration Scale



1 Flight Path Acceleration symbol

Vertical position of symbol along ground deceleration scale indicates the actual inertial deceleration rate of the airplane.

2 Ground Deceleration Scale

Vertical indexed scale and pointer indicate the actual deceleration rate being achieved, as provided by the corresponding autobrake setting (1, 2, 3, 4, MAX AUTO).

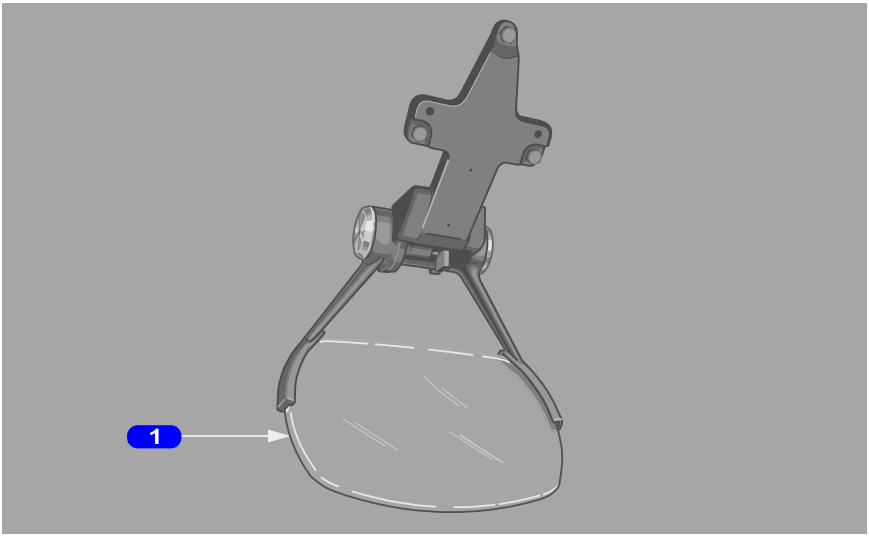
Displayed on landing. Also displayed on takeoff if a deceleration is sensed with the groundspeed above 50 knots, and airplane is still on ground.

Once displayed, it is removed when:

- groundspeed decreases below 25 knots, or
- airplane begins accelerating, or
- airplane lifts off.

HUD Controls

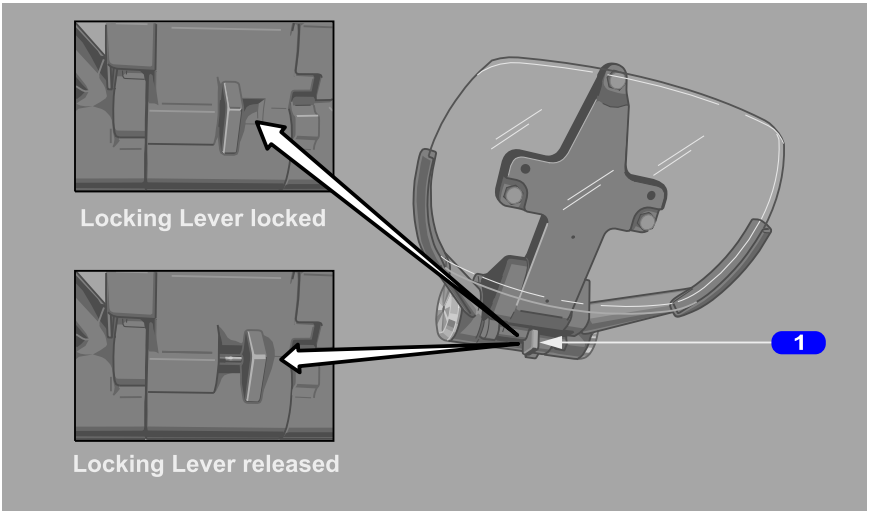
Combiner



1 Combiner

Combines the overhead unit projected flight symbology with the pilot's view through forward window.

Combiner Locking Lever

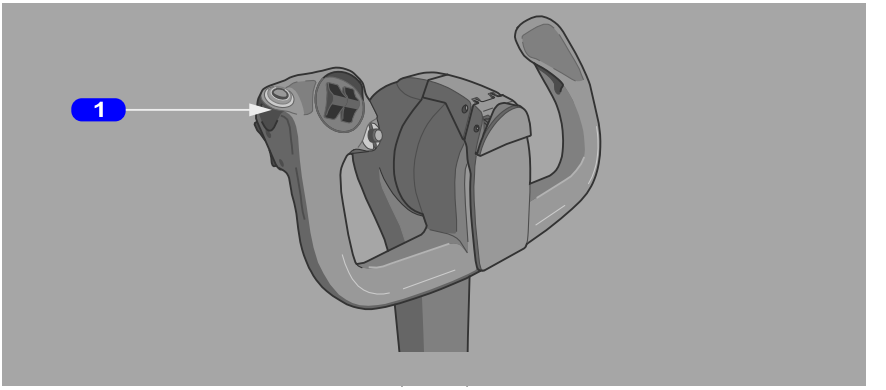


1 **Combiner Locking Lever (stowed position shown)**

Folding combiner upward towards the overhead panel engages locking mechanism. Push lock release to right to release combiner assembly for deployment.

CAUTION: To prevent the possibility of injury, ensure the combiner is fully raised and securely latched in the stowed position.

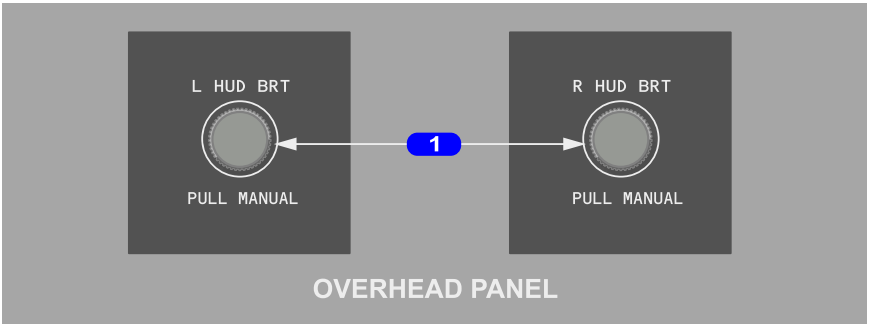
Symbology Control Switch



1 HUD Symbology Control Switch

Push—Alternates between full and decluttered modes.

HUD Brightness Control



1 HUD Brightness (BRT) Control

Pull—

- rotate to set brightness and display contrast level
- the display brightness level must be manually adjusted to maintain a constant display contrast level when background lighting changes.

Push—

- rotate to set brightness and display contrast level
- the display brightness automatically adjusts to maintain a constant display contrast level when background lighting changes.

Rotate—adjusts HUD brightness.

Introduction

The flight instruments and displays supply information to the flight crew on five flat panel liquid crystal display units. The units display five primary groups of information:

- the primary flight display (PFD) with mini-map
- the navigation display (ND)
- the engine indication and crew alerting system (EICAS)
- the auxiliary display (AUX)
- the multifunction display (MFD).

For additional information:

- See Head-Up Display (HUD) on page 10.12.1
- See Head-Up Display System Description on page 10.22.1
- See Primary Flight Displays (PFDs) on page 10.30.1
- See Navigation Displays (NDs) on page 10.40.1
- See Electronic Checklist Displays on page 10.50.1
- See Electronic Checklist Description on page 10.60.1.

Display Selection and Control

After power-up with the PFD/MFD selectors set to NORM, the displays are in the default configuration:

- PFDs are displayed on the two outboard display units (DUs)
- a normal-display ND is shown in the left MFD of the Captain inboard DU
- a full-display ND is shown on the First Officer inboard DU
- EICAS is displayed in the right MFD window of the Captain inboard DU
- the CDU is displayed in each MFD window of the lower DU.

During normal operations, the displays are typically configured as follows:

- PFDs are displayed on the two outboard DUs
- EICAS is displayed in either the right MFD window of the Captain inboard DU or in the left MFD window of the First Officer inboard DU
- a normal-display ND is shown in the MFD window on the same inboard DU as EICAS
- a full-display ND (two MFD windows) is shown on the inboard DU without EICAS
- the CDU is displayed in each MFD window of the lower DU.

Multifunction Display Management (MDM)

There are a total of five MFDs available at any one time on the flight deck. However, five instances of the same MFD cannot be shown at the same time. If

a display is currently shown, additional instances are managed in one of three ways:

- Synchronized—a copy of an instance that is already displayed. Any change on one instance affects all other instances of that display
- Independent—not linked to any other instance on the flight deck. Can be changed without affecting or being affected by other instances of that display
- Blank—when the selected display exceeds the maximum number of instances allowed, an existing instance of that display becomes blank with a message “SELECT MFD.” Additional pilot selection is required to replace the blank display with another display, unless the default display for that location is not already shown.

The maximum number of instances each display format may be shown are:

- SYS (2 per side, independent)
- CDU (1 per side, independent)
- INFO (2 per side, independent)
- CHKL (1 per side, synchronized)
- COMM (1 per side, independent)
- ND (1 per side, independent).

EFIS Control Panels

The EFIS control panels control display options, mode, and range for the respective PFDs and NDs.

For additional information:

- See Primary Flight Displays (PFDs) on page 10.30.1
- See Navigation Displays (NDs) on page 10.40.1.

If an EFIS control panel fails, the displays can be controlled through the backup EFIS/DSP display on the SYS page. The backup EFIS capability is available at all times, but inhibits inputs from the respective EFIS control panel.

The EFIS Control Panel allows control of any on-side ND. However, both pilots have access to the lower DU. If each pilot selects an ND into a window on the lower DU, a single, full-display ND is shown. The pilot that first selected an ND on the lower DU controls the full-display ND.

Display Select Panel

The Display Select Panel (DSP) (one for each pilot) on the glareshield provide control of the MFDs for the on-side inboard DU. Each DU has a left and right window. The currently selected MFD window (left or right) is indicated by the illuminated annunciator light above the corresponding display switch (L or R).

After a MFD window is selected, the appropriate display is selected with the Upper Display Switches (SYS, CDU, INFO, CHKL, COMM, or ND). The ENG switch toggles the display of secondary engine information on the EICAS display.

The EICAS transfer switch toggles the EICAS display between the inboard half of the Captain and First Officer inboard DUs.

Display Select Panel (DSP) control is also available through the backup EFIS/ DSP display on the SYS page. This capability is available at all times. The DSP hardware controls remain active when the EFIS backup is enabled if the DSP is still functional. Any available MFD window may be selected.

Multifunction Keypad (MFK)

Each pilot also has Lower Display Switches (SYS, CDU, INFO, CHKL, COMM, or ND) located on the top of the Multifunction Keypad (MFK). The Lower Display Switches provide the pilots control of the on-side MFD on the lower DU. This allows the selection of the same MFD functions as on the upper inboard DUs.

Display Brightness Control

The MASTER BRIGHTNESS control provides simultaneous brightness adjustment for all displays and panel lighting. Also, each display unit has an individual control with limited range control when master brightness is on, and full range control when master brightness is off.

Two remote light sensors, located left and right on the top of the glareshield, measure brightness in the forward field of view and adjust the overall display brightness as required. Individual sensors on the front of each display unit also affect display brightness. The EFBs, mode control panel displays, standby flight instruments, and aisle stand panel displays are also controlled by the automatic display brightness control system.

PFD/MFD Source Selector

The PFD/MFD selector is used to switch displays if there is undetected display unit failure.

When the selector is in the inboard position (INBD DU), the outboard display unit is blanked and the inboard display unit shows the cropped PFD and EICAS if EICAS was previously displayed on this side. Otherwise, whichever display that was shown in place of EICAS before the failure is shown.

When the selector is in the outboard position (OUTBD DU), the inboard display unit is blanked. The outboard half of the outboard display unit shows the cropped PFD. The inboard half displays EICAS if EICAS was previously shown on that side of the flight deck. Otherwise, whichever display that was shown in place of EICAS before the failure is shown.

Instrument Display Source Selection

The display system automatically reconfigures to compensate for most faults. The Air Data/Attitude (AIR DATA/ATT) Source Selector is provided for the pilots to use if certain faults are not corrected automatically.

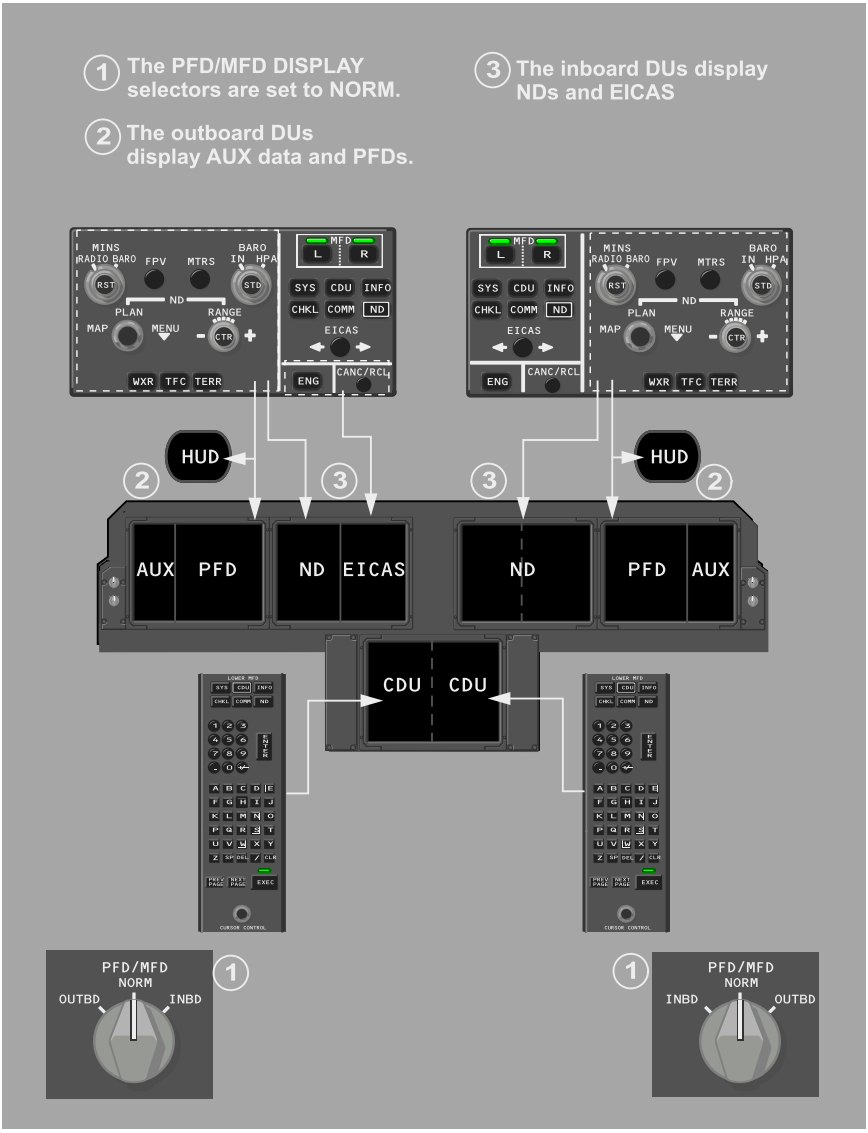
The AIR DATA/ATT source selector controls the source of airspeed, altitude and attitude information for the associated PFD and HUD. They have no effect on the autoflight or navigation system.

If there is an undetected source failure, the non-normal (ALTN) position provides the capability for manual selection of PFD and HUD sources.

Display Selection and Control Examples

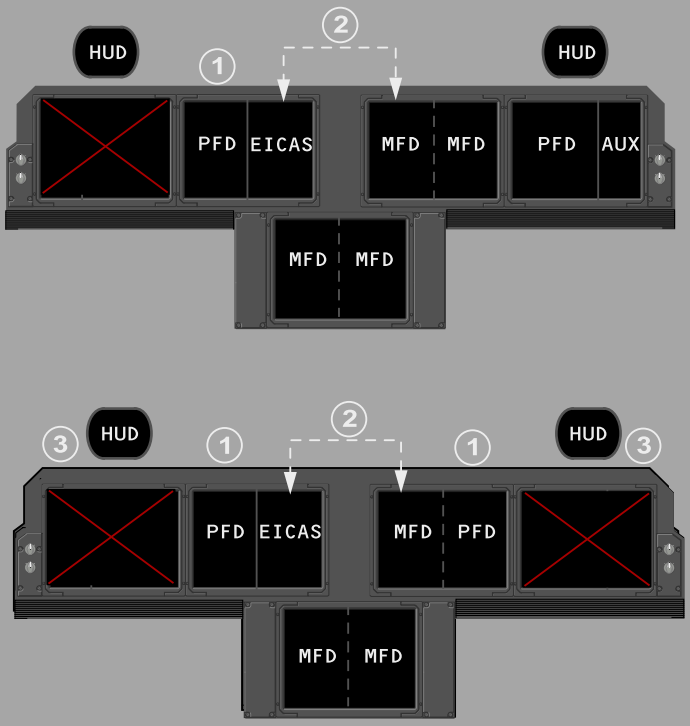
The following examples show display selections.

Default Display Configuration



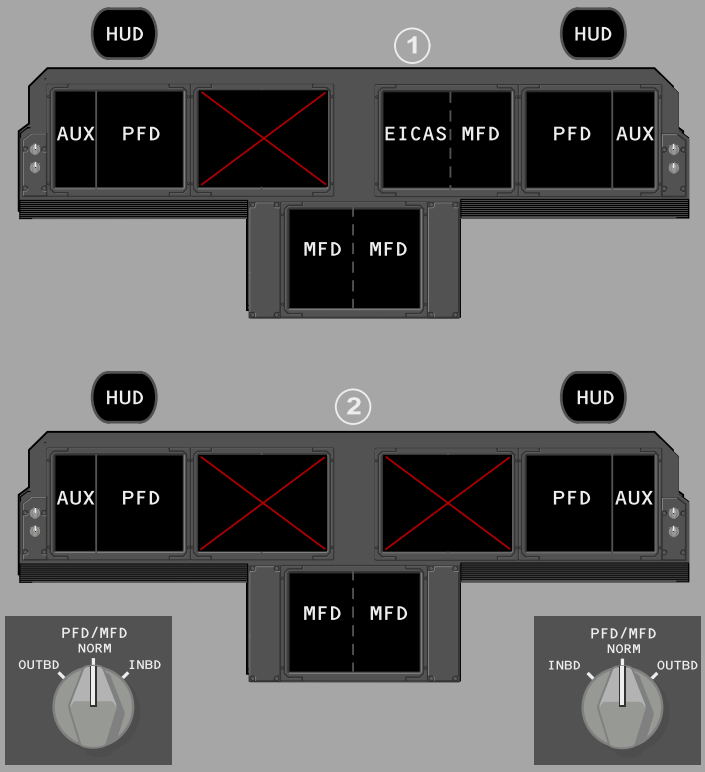
Display Unit Failure Automatic Switching

1. If an outboard DU fails, the PFD automatically moves to the outboard MFD window of the inboard DU. The PFD is cropped on both sides and the AUX display is removed.
2. The EICAS transfer switch on each EFIS control panel can still function normally.
3. When both outboard DUs fail, the AUX display is not shown on any DU.



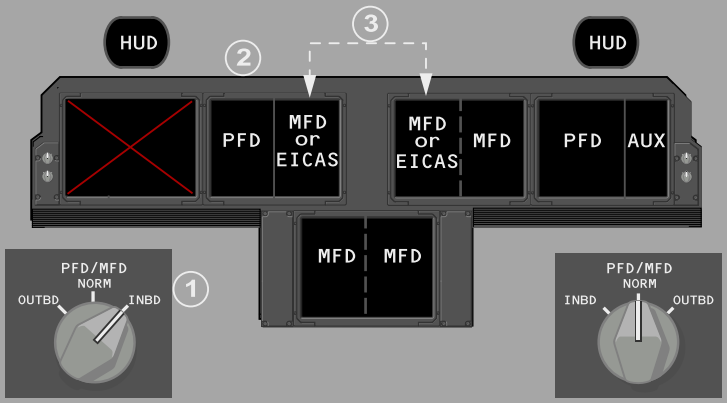
1 If an inboard DU fails, the EICAS display automatically moves to the other inboard DU. Unless the displays are manually reconfigured with the PFD/MFD selector, the EICAS transfer switch can not move the EICAS display.

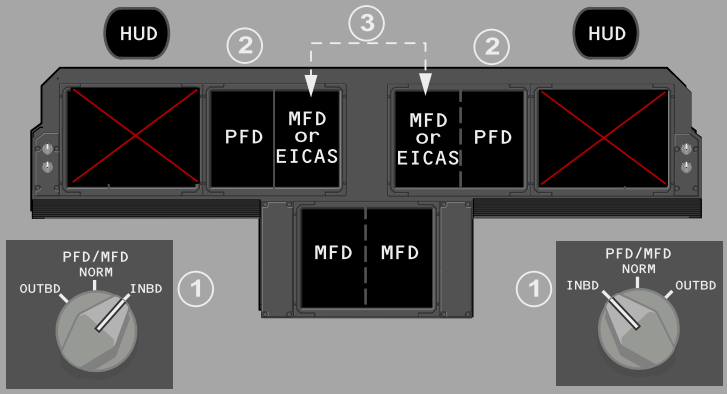
2 If both inboard DUs fail, the EICAS can not be displayed. To enable display of EICAS, the pilots must use the PFD/MFD selector to manually reconfigure the displays.



Display Unit Failure Manual Switching

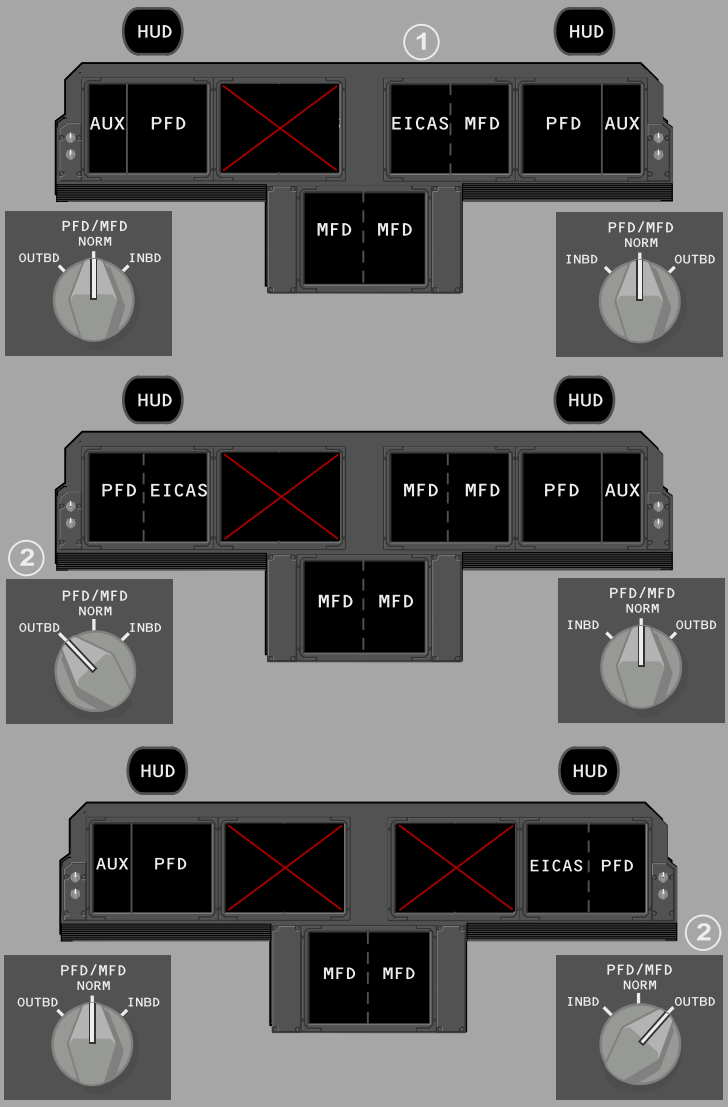
1. If an outboard DU fails and there is no automatic switching, the appropriate PFD/MFD selector is set to INBD DU.
2. The PFD moves to the outboard MFD window of the inboard DU. The PFD is cropped on both sides and the AUX display is removed.
3. The EICAS transfer switch on each EFIS control panel can still function normally.



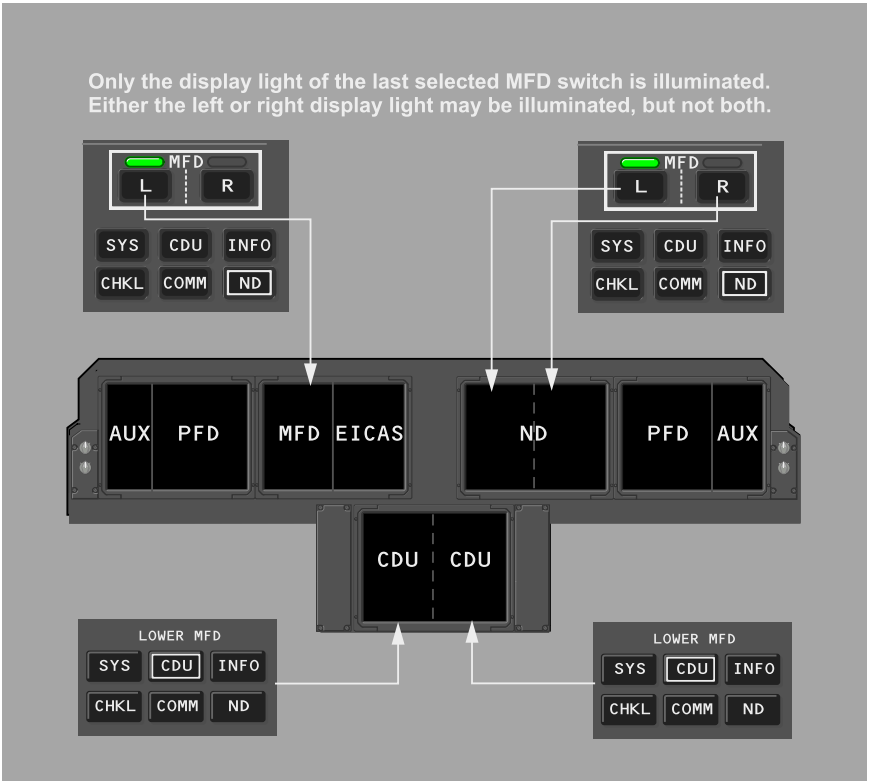


1 If an inboard DU fails, the EICAS display automatically moves to the other inboard DU.

2 To place EICAS on the outboard DU of either side, set the PFD/MFD selector to OUTBD DU.

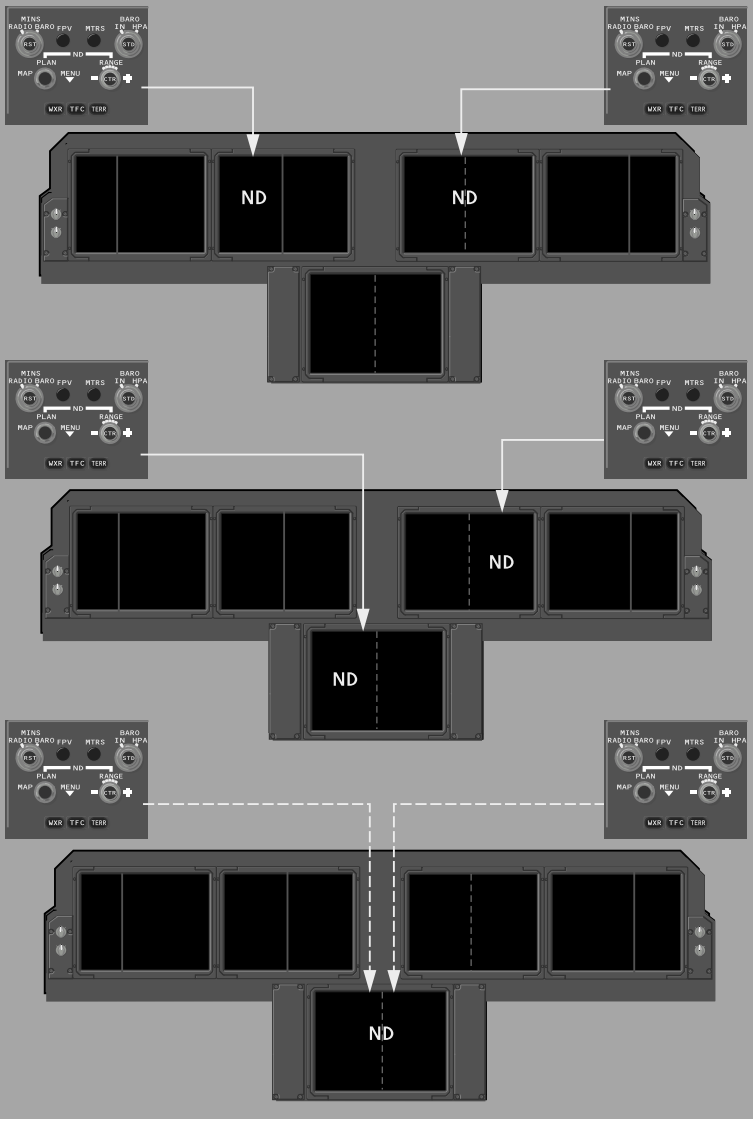


Multi-Function Display Selection

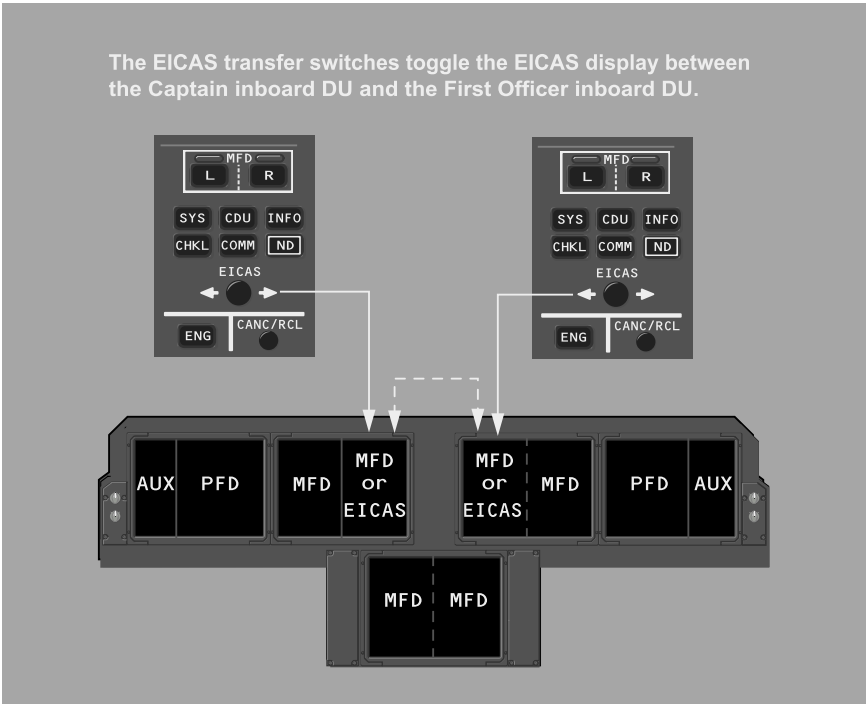


EFIS Control Panel Multiple ND Control

Each EFIS control panel controls the ND on the same side. If an ND is displayed on both MFD windows of the lower display unit, the 2 normal-display NDs combine to form a single full-display ND. The EFIS control panel used to first select the ND on the lower DU is used to control the full-display ND.



EICAS Transfer Switching



Cursor Location Control

The Cursor Control Devices (CCD), Multifunction Keypads (MFK), and EFIS control panels provide control of the display cursor. Each pilot has an identical set of controls for their respective sides of the flight deck. Cursor symbols access only MFDs and EFB displays.

The on-side cursor is automatically pulled to any display only if the pilot requests that particular display. However, if a default display is shown because another display was deselected, the cursor is not pulled to the default display.

For additional information:

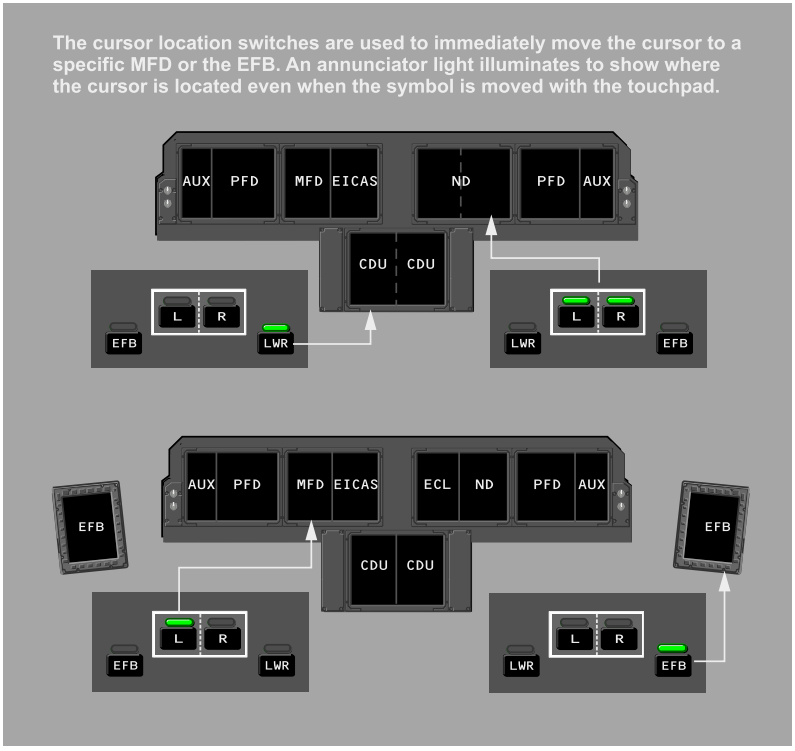
- See MFD Communications Functions on page 5.40.1
- See Electronic Checklist Displays on page 10.50.1
- See Electronic Checklist Description on page 10.60.1
- See Electronic Flight Bag—Controls and Displays on page 10.70.1
- See Electronic Flight Bag—Operation and Applications on page 10.80.1
- See Controls and Indicators on page 11.10.1.

Cursor Control Device (CCD)

The CCD uses a touch pad. The cursor moves relative to finger movement across the touch pad. Except for the four corners of the touch pad, lifting the finger off the touch pad and touching a different location does not move the cursor. Only finger motion in contact with the touch pad moves the cursor.

Except for system (SYS) displays, tapping with a finger on a corner area immediately places the cursor in the corresponding corner of the display. This helps the pilot quickly locate the cursor and speeds access to the selections at the four corners of the display.

Each CCD also has four cursor location switches forward of the touch pad. They can be used to move the cursor immediately to the on-side EFB, either left (L) or right (R) upper MFD, or lower (LWR) MFD. An annunciator light illuminates to show where the cursor appears. When a cursor location switch is used, the cursor is placed on the home location of the corresponding MFD. This is usually on the upper left-hand corner or soft key of the format being displayed on the MFD. However, each application is also able to define the cursor position when the cursor location switches are used.



Multifunction Keypad (MFK)

The MFKs include the rotary Cursor Control Selector and the Cursor Select Switch. Rotate the Cursor Control Selector to move the cursor between active areas in a display. Push the Cursor Select Switch to select the highlighted area in a display.

EFIS Control Panel

The EFIS control panel provides cursor control of any on-side ND. Rotate the ND Mode Selector to move the highlight between MAP and PLAN modes for the ND. Items on the ND drop-down menu are also highlighted with the ND Mode Selector. Push the ND Mode Select switch to select the highlighted key on the ND.

The cursor follows a predetermined path over selectable keys. To exit the drop-down menu, the MENU or EXIT keys must be highlighted and then selected.

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 airspeed and altitude from the center pitot and static air data modules. Attitude information is provided by internal inertial sensors. ILS or GLS information is provided by the left INR receiver. The display receives its heading information from the same source as the captain's primary flight display.

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 is not displayed.

Standby Magnetic Compass

A standard liquid-damped magnetic standby compass is provided. A card located near the compass provides heading correction factors.

Radio Altimeter (RA)

The radio altimeter measures airplane altitude above terrain. Radio altitude is displayed on both the PFD and HUD.

There are two RA systems: left and right. If both RA systems are inoperative or degraded, the EICAS advisory message RADIO ALTIMETER L+R displays and “RA” is also displayed on both PFD and HUD. The RA systems send data to:

- autopilot system
- autothrottle
- GPWS
- TCAS
- weather radar
- primary flight control system.

Auxiliary (AUX) Display

The AUX area outboard of each PFD consists of two distinct areas: clock/flight information and an ATC datalink block. The clock and flight information is located in the upper part of the AUX display and includes:

- flight number
- MIC readout
- transponder code
- SELCAL
- airplane tail number
- UTC time
- date
- elapsed flight time
- chrono dial and readout.

The ATC datalink block is located in the larger, lower part of the AUX display. The datalink block displays uplinked messages, COMM system generated messages, and flight information messages. (See ATC Messages on page 5.40.17 for additional information.)

Clocks

A clock is located on each AUX display. Each clock independently derives UTC time and date from GPS data, and as a result, a slight variation within the clock's seconds display may exist. In addition to time, the clocks also provide elapsed time and chronograph functions. On power up, timer is set to 00:00. Elapsed flight time starts automatically at weight off wheels and ends at weight on wheels plus 30 seconds. When on the ground and v-speeds are entered into CDU (PFD “NO VSPD” flag disappears) timer resets to 00:00. All clock functions except the chrono function are identical between the two pilot stations. The pilots have independent control of the chrono displays.

Display System Information Sources

Inertial Reference System (IRS)

The IRS is the primary source for attitude and inertial navigation position information. The major components of the IRS are:

- two inertial reference units (IRU)
- two attitude heading reference units (AHRU).

Inertial Reference Units (IRU)

The IRU is the primary source for independent inertial navigation position information. The IRU processes information measured by its internal gyros and accelerometers and GPS inputs. (See Inertial Reference Unit (IRU) on page 11.20.3 for additional information.)

Attitude Heading Reference Units (AHRU)

The AHRUs are the primary source for attitude and heading information. (See Attitude and Heading Reference Unit (AHRU) on page 11.20.5 for additional information.)

Air Data Reference System (ADRS)

The ADRS provides primary, secondary, and standby air data. The major components of the ADRS are:

- six air data modules
- six static ports
- three pitot probes
- two angle-of-attack sensors
- one total air temperature probe.

Air Data

Three static ports are located on the left side of the airplane and three static ports are located on the right side of the airplane. Left and right static ports are paired through pneumatic tubing to each of the left, center and right air data modules. The air data modules convert static air pressure to a digital output for use by other systems.

Two pitot probes (right and center) are mounted on the right forward section of the airplane. One pitot probe (left) is mounted on the left forward section of the airplane. An air data module is connected to each pitot probe. The air data modules convert dynamic air pressure to a digital output for use by other systems.

Angle-of-Attack

There are two angle-of-attack sensors, one located on each side of the forward fuselage. The sensors measure airplane angle-of-attack relative to the air mass.

Total Air Temperature

A total air temperature probe is mounted outside the airplane to sense air mass temperature. The temperature sensed by the probe is used by the ADRS to compute total air temperature. The ADRS also receives TAT measurements from each of the EEC TAT sensors for a total of six inputs. These inputs are used to derive a weighted average, trusted TAT.

When on the ground at less than 50 kts CAS, sensors in CAC inlets (two per inlet) provide ADRS TAT. The ADRS selects the lower of the two CAC inlet temperatures.

Static Air Temperature

Static air temperature, displayed on the CDU PROGRESS page, comes from the ADRS, using total air temperature probe information.

Introduction

The airplane is equipped with two head-up displays (HUD); one for each pilot. These displays operate independently from each other.

The system projects flight data symbology onto a transparent glass “combiner” screen in the pilot’s forward field of vision. This allows the pilot to see the data while looking through the forward windscreen.

The HUD and PFD receive flight data from the same sources, thus HUD indications match (repeat) PFD indications, though data format and symbology may differ.

HUD Components

Overhead Unit

The overhead units are located above the head of each pilot. Each overhead unit contains an LCD projector and the optics necessary to display flight data symbology onto the combiner glass.

The HUD projector is monochromatic (green), so all information displayed on the HUD combiner is green.

HUD Controls

Symbology and brightness controls are the only dedicated HUD controls. The HUD system does not have an ON/OFF switch. The projector turns on and displays the symbology by deploying the combiner. Manipulation of the FMS, EFIS, and MCP controls determines data output on both the HUD and PFD.

Symbology Control Switch

Symbology control switches located on the outboard side of each control wheel allow the pilot to alternate between the two display modes. The switches control the respective pilot’s side only.

Brightness Control

The brightness control has two modes of display adjustment.

With the control pulled out, the display brightness and contrast level are both manually adjusted. When background lighting conditions change, the display brightness must be manually adjusted by rotating the control to maintain the same level of display contrast.

With the brightness control pushed in, the display brightness and contrast level are also initially set by rotating the control. The HUD system then automatically adjusts the brightness level to maintain a constant display contrast when

background lighting conditions change. Rotate the brightness control as needed to obtain a different display contrast level.

Combiner

Glass combiner screens are attached above the forward windscreen on a rotating dual arm assembly. Combiner release is accomplished by sliding the locking lever to the right. Push the combiner assembly down and forward allowing the assembly to snap into position from spring tension. A locking mechanism is used to secure the combiner in the stowed position. Stow the combiner by lifting the combiner up and back until the latch engages in the locked position.

An ALIGN HUD message is shown left or right of the airplane symbol on the combiner screen if it is not properly aligned with the projector. Ensuring the combiner is positioned at the stop removes the message.

If there is a sudden and sustained deceleration, the combiner rotates forward and locks in a breakaway position. This prevents the pilot's head from impacting the combiner. Release the combiner by pushing forward to relieve pressure on the latch and slide the locking lever to the right. Then reposition the combiner to the desired position.

Combiner Display Symbology

The data format and symbology displayed on the HUD closely resembles the symbology on the PFD, though some differences do exist.

One of the major differences between the HUD and PFD is that the HUD is capable of displaying two alternate symbology modes: full and decluttered. The full-symbology mode shares many common elements with the PFD. These include speed and altitude tapes, lateral and vertical navigation performance scales, bank angle indicator, and flight mode annunciations (FMA). A partial compass rose is also at the bottom of the full-symbology HUD display. The decluttered mode eliminates airspeed and altitude tapes, displaying only digital values. The partial compass rose is also removed.

Note: The partial compass rose is not displayed in full symbology mode during ground operations.

Due to the monochromatic limitation of the HUD display, many alerting functions that use color (usually amber) symbology on the PFD may use flashing, shape filling/blanking and highlight box symbology on the HUD, or have no distinct HUD alert.

HUD-Unique Indications and Symbology

The HUD has some unique symbology not found on the PFD. This section details those symbols and their function.

Pitch Scale Compression and Chevrons

The HUD pitch scale normally displays 5º lined increments above and below the horizon reference line, and conform with the outside world. For example, as the pilot looks through the HUD, the horizon reference line on the HUD pitch scale should rest at or near the actual horizon outside the airplane. At higher altitudes, the HUD horizon reference line may appear slightly above the actual horizon due to curvature of the earth.

If the HUD horizon reference line or the flight path vector symbol cannot be shown on the display when it conforms with the outside world (excessive pitch up or pitch down), the pitch scale compresses to make room for these symbols. The pitch scale then displays 10º increments.

At excessively high or low pitch angles, chevrons are displayed directing the pilot to pitch the airplane back toward the horizon. For example, if the airplane pitch angle is excessively high, a downward pointing chevron positioned on the +30º pitch scale line comes into view, directing a pitch-down command to the pilot. If the airplane pitch angle is excessively low, an upward pointing chevron positioned on the −20º pitch scale line comes into view, directing a pitch-up command to the pilot.

Unusual Attitude (UA)

The UA symbology displays when airplane pitch angle exceeds −20º or +35º, or if roll exceeds 55º in either direction. Only symbology necessary to help recover from the situation is displayed. The UA symbology replaces the full or decluttered symbology. Any pitch scale compression with chevron is also replaced by the UA symbology.

The UA symbology remains displayed until the airplane pitch angle is between −5º and +10º (relative to horizon) for 5 seconds, and roll angle is less than 10º for 5 seconds. Once the recovery maneuver is within these limits, the UA symbology is replaced by the full-symbology mode, regardless of the mode the HUD was in before encountering the unusual attitude.

The UA symbology includes a zenith symbol centered on the +90º pitch scale line, and a nadir symbol centered on the −90º pitch scale line.

Digital Heading

A numerical digital heading value displays current heading below the roll scale slip/skid indicator. This value corresponds to the heading on the horizon reference line of the pitch scale.

Ground Deviation—HUD Takeoff

During a HUD takeoff, ground deviation indications include the ground roll reference symbol, flight director guidance cue, and ILS/GLS localizer deviation pointer. This guidance is available when HUD takeoff guidance has been selected on the FMC. (See Departures Page on page 11.40.26 for additional

information.) These indications become active when the heading of the airplane is within 45° of the runway heading and the plane is within 2º of the center of the ILS localizer beam or 75 feet of the GLS localizer centerline. If the airplane then deviates more than seven meters (23 feet) right or left from the runway centerline, a flashing triangle appears, pointing in the direction of the runway centerline, to assist in correcting for the deviation.

(See HUD Takeoff on page 4.20.12 for additional information.)

TO/GA Reference Line

In TO/GA mode, flight director vertical guidance is depicted as a horizontal dashed line (pitch target) across the HUD pitch scale. To comply with this guidance, place the airplane reference symbol on the TO/GA reference line.

During takeoff roll, this line becomes visible when groundspeed is greater than 65 knots and is initially fixed at the top of the display. The reference line is available any time TO/GA mode is selected in flight. A flight director pitch up command is displayed when the TO/GA reference line is positioned above the airplane reference symbol. A pitch down command is displayed when the TO/GA reference line is positioned below the airplane reference symbol.

Once in flight, the spacing between the TO/GA reference line and the airplane reference symbol is equal to the spacing between the flight path vector symbol and the guidance cue.

Flight Path Vector Symbol with Guidance Cue

The flight path vector symbol is derived from the inertial sources, and provides an indication of where the airplane is going. The flight path angle is indicated by the position of the center of the flight path circle relative to the pitch scale.

The flight path vector symbol's "gull wing" wing roots are angled downward 30º to the horizontal. In a 30º bank angle, the upward wing's wing root is parallel with the HUD horizon and pitch scale lines.

The flight path vector symbol is only displayed in flight, and has display priority over all other symbols except the guidance cue. If any portion of another symbol (excluding guidance cue) is positioned inside the circle of the flight path vector symbol, that portion of the other symbol is not displayed.

The flight path vector symbol appearance can be limited laterally by other symbology such as speed and altitude tapes, or the display field-of-view. When this occurs, the FPV symbol has a dashed outline instead of a solid outline and can not indicate the airplane's current drift angle.

The guidance cue (small circle) is associated with the flight path vector symbol. This cue represents flight director guidance, and is displayed when the flight directors are turned on. To follow flight director guidance, position the circular body of the flight path vector symbol around the guidance cue. The guidance cue

appears at 50 feet RA on takeoff. If a HUD takeoff is selected, the guidance cue appears at the same time as the flight path vector.

During a windshear alert condition, the guidance cue will change from hollow to solid (filled). (See Alerts Displayed on the HUD on page 15.10.9 for additional information.)

Angle-of-Attack Limit Symbol

The airplane's angle-of-attack (AOA) limit is depicted on the HUD by the angle-of-attack limit symbol. The distance between the AOA limit symbol and the flight path vector symbol represents the margin available before stick shaker occurs. When the AOA limit symbol is positioned on the flight path vector symbol (boxed ends set on the flight path vector symbol wings), the airplane is at the stick shaker angle of attack.

The PFD contains a similar symbol called the pitch limit indicator (PLI). However, on the PFD, the PLI is displayed relative to the airplane reference symbol, not to the flight path vector.

The AOA limit symbol is displayed during any of the following:

- angle of attack is within 5º of stick shaker, or
- stick shaker is active, or
- windshear alerting with (solid) guidance cue displayed.

Slip/Skid Indicators

The Slip/Skid symbology consists of two symbols:

- roll scale slip/skid indicator is referenced to and rotated with the roll scale pointer (or referenced to the UA roll scale pointer, whichever is displayed).
- flight path slip/skid indicator referenced to the flight path vector symbol.

The flight path slip/skid indicator is only displayed during a takeoff, or a low-altitude go-around, providing additional yaw reference in the case of an engine failure. At low altitude, the sensitivity of the slip/skid indicators is enhanced to provide additional awareness.

TCAS Fly-To Symbology

A corrective advisory is displayed on the HUD by a double lined box called the “fly-to box”. The fly-to box is an indication of where the flight path vector symbol should be positioned in order to obtain vertical separation from traffic, directing an evasive maneuver.

For additional information:

- (See TCAS HUD Vertical Guidance on page 15.10.19.)
- (See TCAS HUD and PFD Vertical Guidance on page 15.20.16.)

Speed Error Tape and Flight Path Acceleration

The speed error tape shows the difference between the indicated airspeed and the selected airspeed on the mode control panel. Selected airspeed on takeoff is V2, whereas flight director guidance airspeed is V2 + 15. In order to prevent an incorrect interpretation of the speed error tape, the symbol is not displayed until the first flap retraction.

The speed error tape is positioned on the left wing of the flight path vector symbol, adjacent to the flight path acceleration symbol. If the indicated airspeed is faster than the selected speed, the speed error tape rises above the wing. If the indicated airspeed is slower than the selected speed, the speed error tape falls below the wing. Each 1º of speed error tape length (approximately the diameter of the flight path vector symbol circle) represents approximately 5 knots of airspeed error. The tape length is limited to a 15 knot error indication.

The inertial acceleration (or deceleration) of the airplane along the flight path is indicated by the flight path acceleration symbol “>”. This symbol is an indication of the total sum of all forces affecting the airplane.

In flight, the flight path acceleration symbol is positioned to the left of the flight path vector symbol. When flight path acceleration symbol is above the wing of the flight path vector symbol, the airplane is accelerating. When it is below the flight path vector symbol wing, the airplane is decelerating. To maintain a steady state (neither accelerating nor decelerating), the flight path acceleration symbol is positioned directly to the left of the left flight path vector symbol wing. When the airplane is not in flight, or the flight path vector symbol is not displayed, then the flight path acceleration symbol is referenced to the airplane reference symbol.

To avoid confusion in controlling airplane thrust, the flight path acceleration symbol is removed from the display when a low-level, decreasing performance windshear is detected below 400 feet AGL.

Glideslope Reference Line

During approach, a horizontal dashed line across the HUD pitch scale depicts the projected glideslope angle of the active approach. The glideslope angle numerical value is digitally displayed adjacent to the glideslope reference line.

During visual approaches, a precise descent angle to the runway is maintained by overlaying the glideslope reference line on the runway touchdown zone. Then maintain the flight path vector symbol on the glideslope reference line.

Runway Edge Lines

Runway edge lines is a projection of an 8,000 foot long, 200 foot wide runway, displaying the calculated position of the runway. The runway centerline for the HUD runway edge lines is based on the localizer course, not the geographic orientation of the runway. The runway edge lines symbol is composed of the runway edge lines with two tick marks that correspond to the touchdown aiming point (glideslope intercept point). The symbol displays in the decluttered mode

only, and is enabled at a radio altimeter altitude of 300 feet, and removed at 60 feet.

The calculations depend on the selected course for the ILS and GLS approach procedures as well as inputs from pitch, roll, heading, barometric altitude, localizer deviation, glideslope deviation, and the glideslope angle and elevation from the FMS.

Ground Deceleration (Rate) Scale

A ground deceleration rate scale is shown on landing or when a deceleration is sensed on takeoff. A vertical indexed scale and pointer indicate the actual deceleration rate being achieved, as provided by the corresponding autobrake setting (1, 2, 3, 4, MAX AUTO).

During takeoff, the scale is not displayed, but is added to the display if a deceleration is sensed when the groundspeed is above 50 knots, and the airplane is still on the ground. Once displayed, the scale is removed when groundspeed decreases below 25 knots, the airplane begins accelerating, or the airplane lifts off.

Introduction

The PFDs present a dynamic color display of all the parameters necessary for flight path control. The PFDs provide the following information:

- flight mode annunciation
- airspeed
- altitude
- vertical speed
- attitude
- steering information
- radio altitude
- instrument landing system display
- approach minimums
- heading/track indications
- engine fail, GPWS, and PWS alerts.

The mini-maps present a tactical display map with a fixed range of 20 nautical miles. They provide immediate target and threat information and are placed below the PFDs directly in front of each pilot. The mini-maps display the flight plan with all of its associated information such as the following:

- flight path
- flight plan waypoints with ID and constraints
- altitude profile points
- alternate airports
- runway information
- TCAS targets
- Terrain depiction and alert patterns
- weather radar return patterns
- heading/track indications.

The mini-maps do not display information such as untuned navaids, background waypoints, and background airports. (See ND Symbology on page 10.40.8 for additional information.)

Failure flags are displayed for airplane system failures. Displayed information is removed or replaced by dashes if no valid information is available to the display system (because of out-of-range or malfunctioning navigation aids). Displays are removed when a source fails or when no system source information is available.

(See PFD and HUD Flight Mode Annunciations (FMAs) on page 4.10.16 for additional information.)

Airspeed

Airspeed is displayed on a tape and in a digital window on the left side of the PFD. The current Mach number is digitally displayed below the speed tape when the current Mach number is greater than 0.40. An airspeed trend vector indicates predicted airspeed in 10 seconds. Selected airspeed is displayed above the speed tape.

Takeoff and landing reference speeds and flap maneuvering speeds are shown along the right edge of the speed tape. Maximum and minimum airspeeds are also displayed along the right edge of the speed tape.

CAUTION: Reduced maneuver capability exists when operating within the amber regions below the minimum maneuvering speed or above the maximum maneuvering speed. During non-normal conditions the target speed may be below the minimum maneuvering speed.

Altitude

Altitude is displayed on an altitude tape along the right side of the PFD. It is also shown digitally in a window in the middle of the tape. An altitude trend vector indicates predicted altitude in six seconds.

When meters is selected on the EFIS control panel:

- current altitude in meters is also shown above the altitude window
- selected altitude in meters is displayed above the altitude tape.

Selected altitude is displayed above the altitude tape and is boxed when approaching the selected altitude. Selected altitude is also depicted with a bug on the altitude tape.

The selected barometric approach minimum is indicated on the altitude tape with a triangular pointer and green line.

A landing altitude reference bar is displayed along the inner edge of the altitude indication. The reference bar indicates the height above touchdown. A white bar is displayed from 1000 to 500 feet above landing altitude. An amber bar is displayed from 500 feet to the landing altitude.

The current barometric reference is displayed below the altitude tape. A preselected barometric reference can be displayed when STD is displayed.

Landing reference is selectable between QNH and QFE on the APPROACH REF page of the FMC. QNH is the normal operating mode. Selecting QFE sets the destination landing altitude indication to zero altitude. With the landing reference set to QFE, changing the barometric setting from STD to QFE changes the PFD altitude tape background color to green. With QFE selected and climb mode active, changing the barometric setting from QFE to STD causes the landing reference to toggle from QFE to QNH and the altitude tape background color

changing from green back to normal. (See Approach Reference Page on page 11.43.19 for additional information.)

Vertical Speed

Vertical speed is displayed to the right of the altitude tape with a tape and pointer. Vertical speed is digitally displayed above or below the vertical speed display when vertical speed is greater than 400 feet per minute. It is displayed above with positive vertical speed and below with negative vertical speed. The selected vertical speed bug shows the selected vertical speed when in the AFDS vertical speed (V/S) pitch mode.

Attitude

The attitude indication displays the airplane pitch and roll attitude referenced to the horizon.

Pitch attitude is displayed by an airplane symbol against a pitch scale. The pitch scale is in 2.5º increments.

A pointer indicates bank angle in increments of 10º, 20º, and 30º. Single marks indicate 45º and 60º of bank. A small rectangle under the bank angle pointer indicates slip and skid conditions. Bank angle is also represented by the attitude of the airplane symbol against the horizon line and pitch scale.

A pitch limit indication is displayed at low speeds when the flaps are up and at all times when the flaps are down.

Steering Indications

The flight director steering indications are displayed when the associated flight director switch is on.

TCAS resolution advisories are displayed in the attitude indication area. (See TCAS PFD Vertical Guidance on page 15.10.18 for additional information.)

The flight path vector (FPV) symbol represents airplane flight path angle vertically and drift angle laterally. The flight path vector is displayed on the PFD when the EFIS control panel FPV switch is selected on, or the MCP FPA reference switch is selected on. The FPV shows the Flight Path Angle (FPA) above or below the horizon line and drift angle left or right of the pitch scale's center. The FPA uses inertial and barometric altitude inputs. The vertical FPA is unreliable with unreliable primary altitude displays.

The flight path angle (FPA) symbol shows the selected flight path angle when the MCP FPA reference switch is selected on with either the autopilot engaged or flight director on.

The FPV and FPA symbols are displayed in two sizes and brightness levels. The large, bright FPV/FPA symbols are displayed when the previously stated selections are made and the flight director is off. The small, dim FPV/FPA

symbols are displayed when the previously stated selections are made and the flight director is displayed.

Radio Altitude

The current radio altitude is displayed in the bottom center of the attitude indication area when radio altitude is below 2,500 feet AGL.

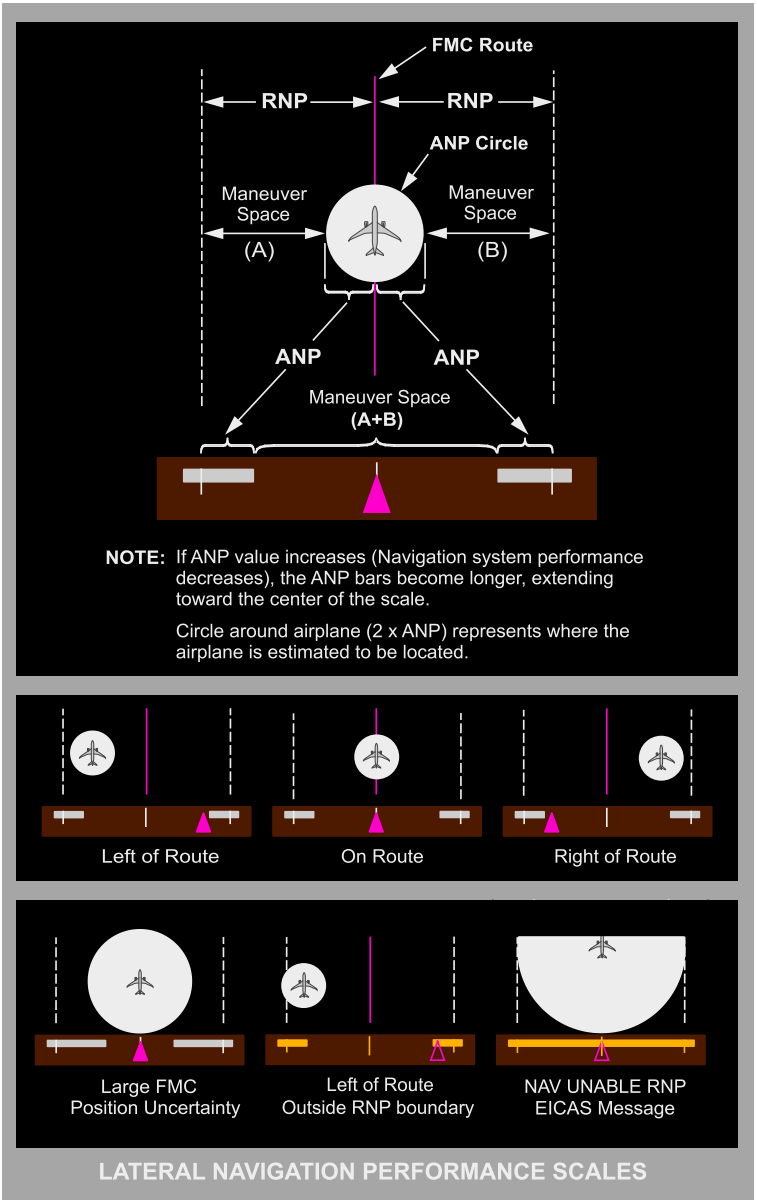
Navigation Performance Indications

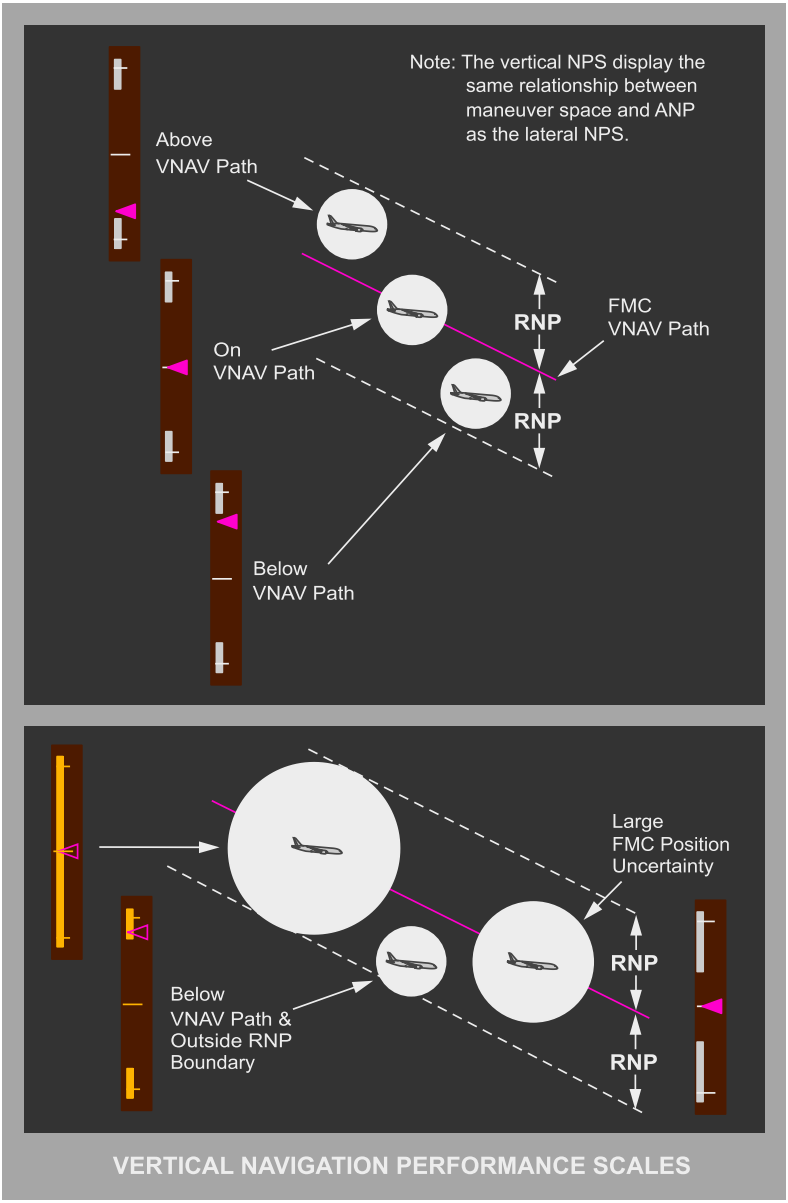
Navigation performance scales and pointers present a real-time display of the location of the LNAV and VNAV path relative to the airplane. The airplane position is represented by the center index (or tic mark) on the scale and the LNAV or VNAV path by a magenta pointer (triangle).

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 grow toward the center of the scale. The gap between the ANP bars represents the area where the magenta pointer can be and the airplane still remain within the RNP for that part of the route. (See Navigation Performance on page 11.31.11 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 then turn amber, the deviation pointer flashes for 10 seconds, and the NAV UNABLE RNP EICAS message is displayed.


FMC Route
RNP
RNP
ANP Circle
Maneuver Space
(A)
Maneuver Space
(B)
ANP
ANP
Maneuver Space
(A+B)
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 located.
Left of Route
On Route
Right of Route
Large FMC Position Uncertainty
Left of Route Outside RNP boundary
NAV UNABLE RNP EICAS Message
LATERAL NAVIGATION PERFORMANCE SCALES



VERTICAL NAVIGATION PERFORMANCE SCALES

Instrument Landing System (ILS) Indications

ILS glideslope and localizer deviation, frequency/identification, DME, course, and marker beacon indications are provided.

The approach reference information appears above and to the left of the attitude display. The ILS station identification or frequency, course, and (if available) DME are displayed.

The marker beacon indication (OM—outer marker, IM—inner marker, or MM—middle marker) is displayed in the upper right corner of the attitude display area.

The glideslope pointer and scale appear on the right side of the attitude indication.

The localizer pointer and scale appear at the bottom of the attitude indication.

Integrated Approach Navigation (IAN) Indications

FMC glidepath and FAC deviation, approach identifier, distance, and course are provided.

The approach reference information appears above and to the left of the attitude display. The IAN deviation source annunciation is below the approach data.

IAN glidepath and FAC deviation indications and alerts are displayed like ILS. Deviation indications appear when a valid IAN approach procedure is selected. IAN approach procedure deviations are not available with QFE selected in the FMC.

Approach Minimums

The selected radio altitude or barometric approach minimums set on the EFIS control panel are shown near the bottom left of the altitude display.

Heading/Track Indications

Selected heading/track information is displayed in the bottom section of the PFD on the mini-map. Current heading is displayed under a pointer at the top of the compass rose. The MCP selected heading bug is displayed on the outside of the compass rose. The MCP selected track bug is displayed on the inside of the compass rose.

Heading or track is displayed based on the position of the MCP HDG/TRK reference switch. The selected heading or selected track is annunciated below and to the left of the airplane symbol. The current heading/track reference (MAG/TRU) is shown below and to the right of the airplane symbol. A line drawn perpendicular to the edge of the compass rose from the invisible center depicts the current airplane track.

Heading information is also displayed on the Horizon Line Heading Scale.

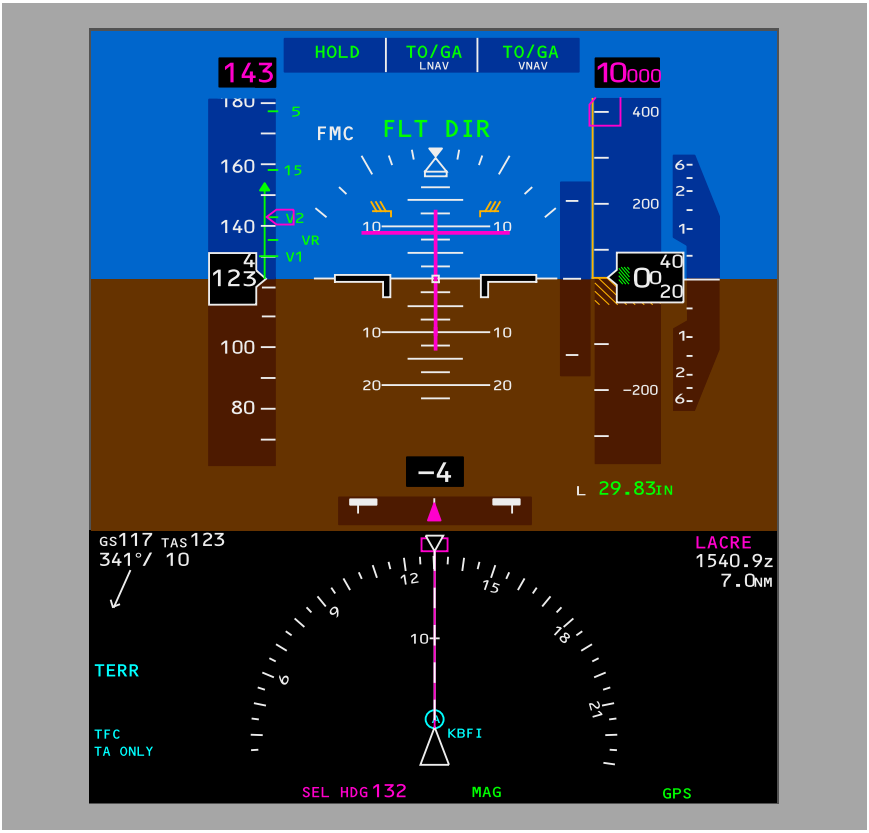
Engine Fail, GPWS and PWS Alerts

Engine fail, GPWS, and PWS alerts are displayed in large capital letters between the attitude display and the heading/track compass rose. (See Alerts Displayed on the PFD on page 15.10.8 for additional information.)

Typical PFD Displays

Typical PFD configurations for six phases of flight follow. The autopilot is engaged with LNAV and VNAV active for climb, cruise, descent, approach, and landing. The AFDS approach mode is used for approach and landing.

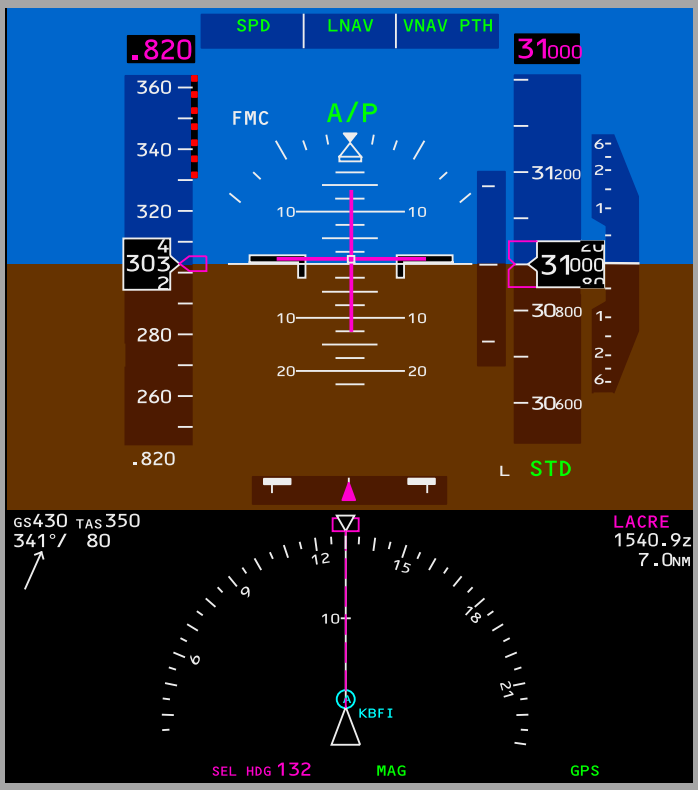
PFD Takeoff Display



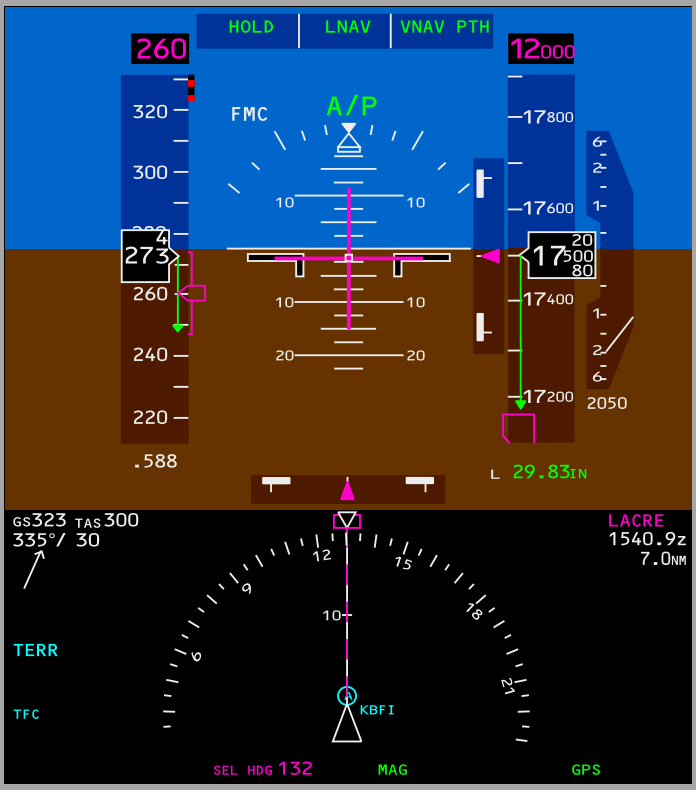
PFD Climb Display



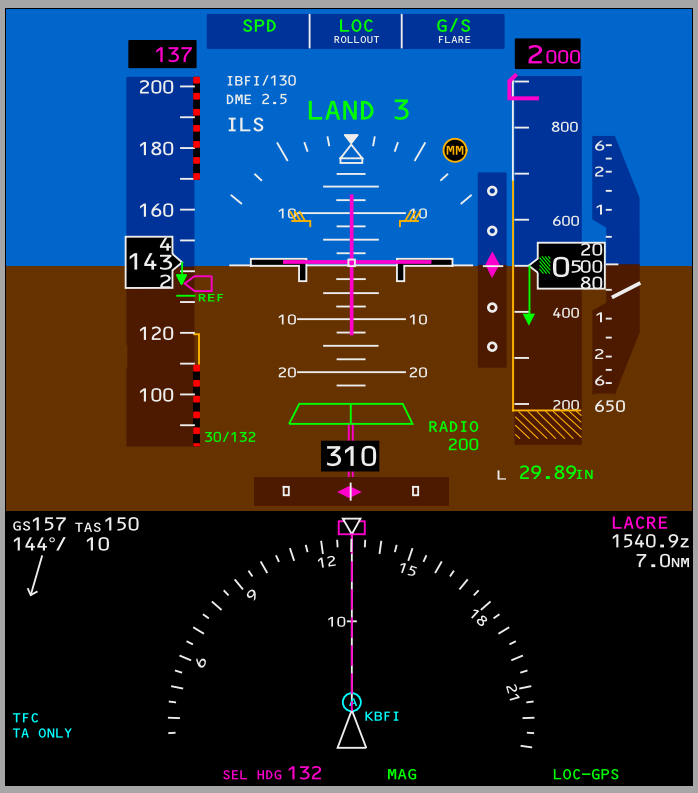
PFD Cruise Display



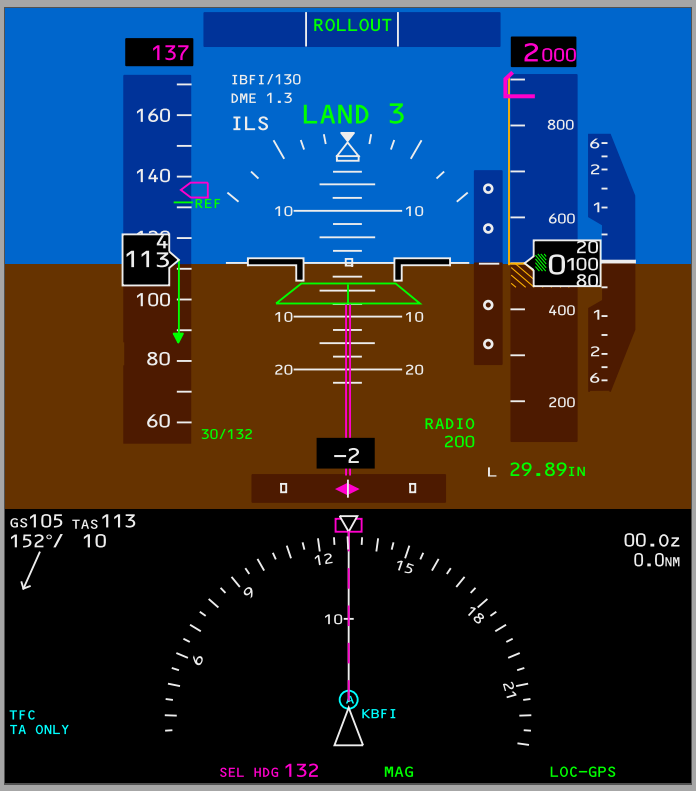
PFD Descent Display



PFD Approach Display



PFD Landing Display



Introduction

The NDs provide a mode–selectable color flight progress display. The modes are:

- MAP
- PLAN.

The MAP mode can be switched between an expanded mode with a partial compass rose and a centered mode with a full compass rose. Both MAP and PLAN modes can be shown in Normal and Full-display format.

(See System Description on page 10.20.1 for additional information.)

Map Mode

The MAP mode is recommended for most phases of flight.

Presented heading-up, this mode shows airplane position relative to the route of flight against a moving map background.

Displayed information can include:

- selected and current track
- selected and current heading
- position trend vector
- range to selected altitude
- map range scale
- groundspeed
- true airspeed
- wind direction and speed
- next waypoint distance
- waypoint estimated time of arrival
- selected navigation data points.

Navigation Data Points

Additional navigation facility (STA), waypoint (WPT), airport (APT), route progress (DATA) and position (POS) data are available for display on the ND in both the expanded and center map modes.

Plan Mode

The PLAN mode is presented true north up. The active route may be viewed using the STEP prompt on the CDU LEGS pages.

ND Information

Heading

Heading is supplied by the FMC or inertial reference system (IRS). The ND compass rose can be referenced to magnetic north or true north. The HEADING REF switch is used to manually select magnetic or true reference. The compass display is automatically referenced to true north when the airplane enters the polar regions with the heading reference switch in NORM.

(See FMC Polar Operations on page 11.31.8 for additional information.)

Track

Track is supplied by the FMC during normal operation and by the IRS when in alternate navigation.

Traffic

Traffic information from the TCAS can be displayed on the ND and the mini-map. (See Traffic Alert and Collision Avoidance System (TCAS) on page 15.10.12 for additional information.)

Weather Radar

Weather radar information can be displayed on the ND and mini-map. (See Weather Radar on page 11.20.16 for additional information.)

Airport Map

The Airport Map is integrated with the ND and consists of runways, taxiways, aprons and buildings with the appropriate labels. The FMC provides the position of the airplane. The Airport Map is automatically displayed when the following conditions are met:

- the airport is either the ORIGIN or DESTINATION airport as specified in the active flight plan
- the airport is in the Airport Map database
- the ND range is 5 NM or less.

The Airport Map can be displayed in either a heading-up mode (MAP) or north-up mode (PLAN). The Airport Map may be displayed at 5 NM, 2 NM, 1 NM and 0.5 NM by selecting the range on the EFIS Control Panel.

Note: When weather radar is selected, only runways and taxiways are shown with associated identifiers and markers. This occurs even if there are no radar returns.

Vertical Situation Display (VSD)

The VSD presents a profile view of the airplane and its environment. Information shown within the cyan dashed lines (enroute corridor) on the ND is shown in

profile on the VSD. The pilot selects the VSD display from the map information selections on the MAP mode drop-down menu.

The VSD depicts terrain and waypoint information that is within the enroute corridor on the ND. The VSD range is a function of the ND range and is depicted on the horizontal reference scale. The normal-display VSD has the same range as the ND except when the ND range is less than 5 NM. The full-display VSD has twice the range of the ND – from 10 NM to 2560 NM.

The altitude reference scale is linked to the VSD range and is not independently adjustable. This ensures that a consistent 3º glidepath is depicted up to an 80 NM range. The selected altitude shown on the VSD is the same as the selected altitude shown on the on-side PFD.

Failure Flags and Messages

Failure flags are displayed for system failures or invalid information. Indications are removed or replaced by dashes when source system information is not available.

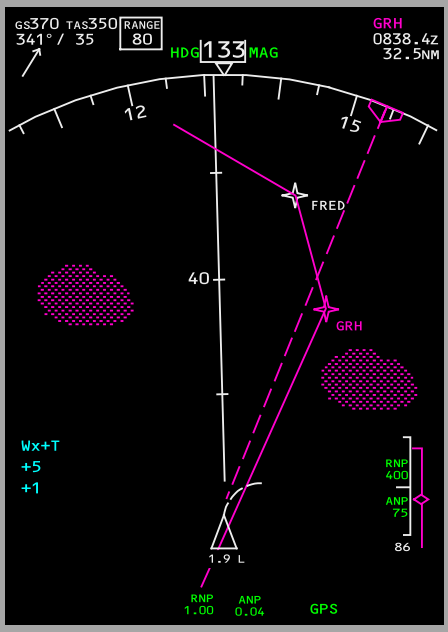
The message EXCESS DATA is displayed if the amount of information sent to the ND exceeds the display capability. When this occurs, the primary display system removes information from the center of the display outward; information near the outer selected range area is still displayed. The message can be removed by:

- reducing the amount of map information, or
- reducing range, or
- deselecting one or more of the map information selections (STA, WPT, APT, DATA, POS).

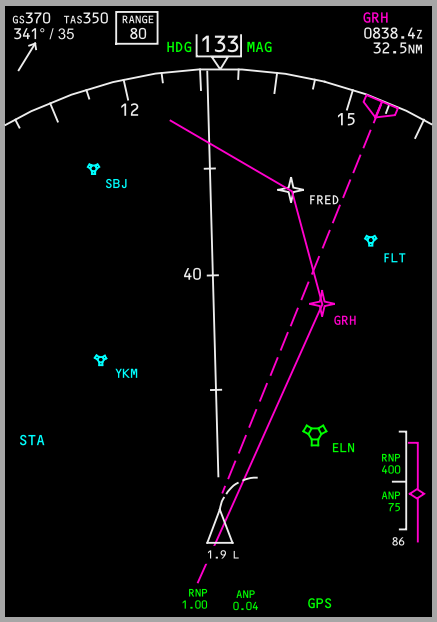
Typical ND Map Displays

ND Expanded Map Displays

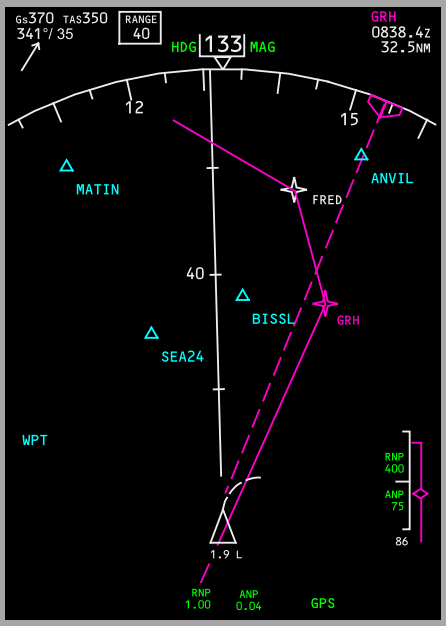
WXR (weather radar) map switch or menu key selected.



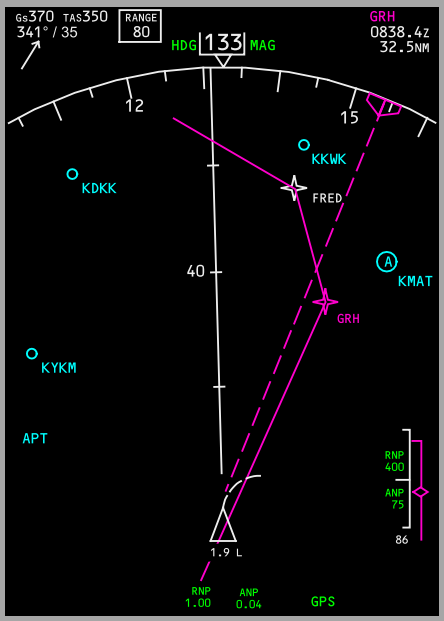
STA (station) map menu key selected.



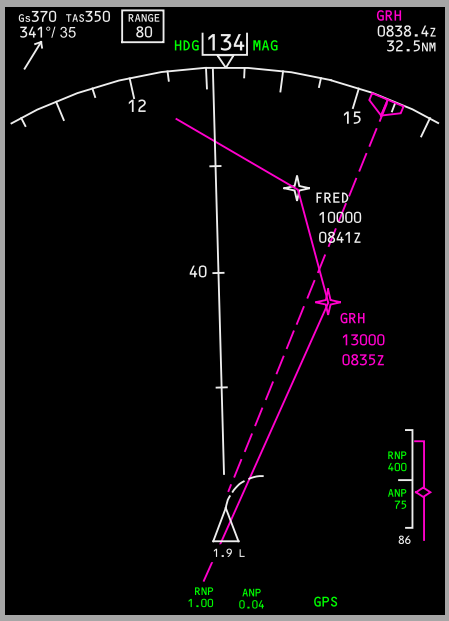
WPT
(waypoint)
map menu key
selected.



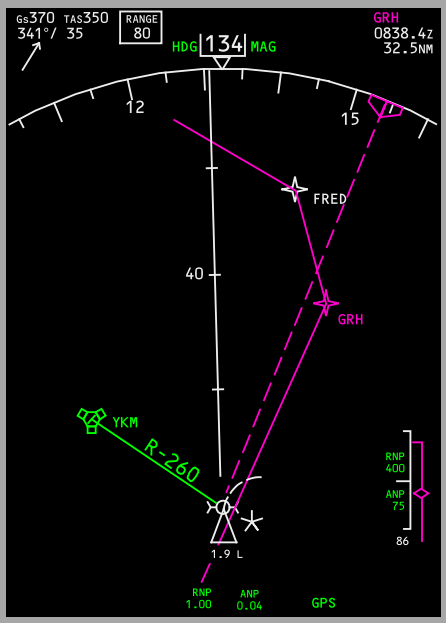
APT
(airport)
map menu key
selected.



DATA map menu key selected.



POS (position) menu key selected.



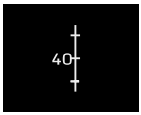
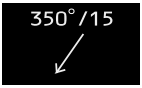
ND Symbology

The following symbols can be displayed on each ND, depending on EFIS control panel switch selections. Colors indicate the following:

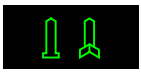
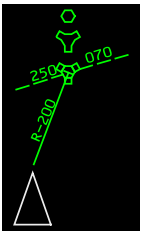
- W (white)—present status, range scales
- G (green)—dynamic conditions
- M (magenta)—command information, pointers, symbols, fly–to condition
- C (cyan)—nonactive or background information
- A (amber)—cautions, faults, flags
- R (red)—warnings.

Heading, Track and Speed

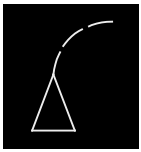
Symbol	Name	ND Mode	Remarks
	Heading orientation (G), current heading (W), heading reference (G), and heading pointer (W)	MAP, MAP CTR	Displays HDG as the display orientation, current heading, MAG or TRU as the heading reference, and points to the heading on the compass rose.
	Selected Heading/ Track (M), and heading/track reference (G)	mini-map	Displays SEL HDG or SEL TRK and MAG or TRU as the reference.
			
	Grid heading (W)	MAP, MAP CTR	Displays above 70º latitude.
	Time to align (W)	All	Indicates time remaining for IRU alignment. Replaces wind direction/ speed and wind arrow, on the ground, during alignment.
	Selected heading bug (M)	MAP, MAP CTR, mini-map	Displays the MCP–selected heading. A dashed line (M) may extend from the marker to the airplane symbol. In the MAP mode with LNAV, LOC, or ROLLOUT

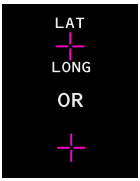
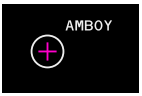
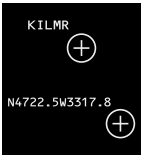
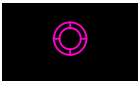
Symbol	Name	ND Mode	Remarks
			active, the dashed line is removed 10 seconds after the selected heading bug is moved.
	Selected track bug (M)	MAP, MAP CTR, mini-map	Displays the MCP–selected track. A dashed line (M) may extend from the marker to the airplane symbol.
	Track line and range scale (W)	MAP, MAP CTR, mini-map	Indicates current track. Number indicates range.
	Heading/track reference (G) box (W) in TRU, box (A) if TRU displayed in descent	MAP, MAP CTR, mini-map	Indicates heading/ track is referenced to magnetic north or true north. Switching from TRU to MAG displays a box around MAG for 10 seconds.
	Expanded compass (W)	MAP	Displays 90º of compass rose.
	Current heading pointer (W)	MAP, MAP CTR, mini-map	Points to current heading on the compass rose.
	Ground speed (W)	All	Current groundspeed.
	True airspeed (W)	All	Current true airspeed displayed above 100 knots.
	Wind direction/speed and wind arrow (W)	All	Indicates wind bearing, speed, and direction, with respect to display orientation and heading/ track reference. Arrow not displayed in the PLAN map mode.

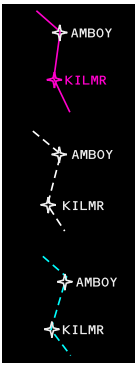
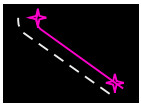
Radio Navigation

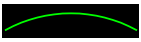
Symbol	Name	ND Mode	Remarks
	Left VOR (G) pointer head and tail	MAP, MAP CTR	Indicates bearing to (head) or from (tail) the tuned station, if selected on the respective MAP or MAP CTR drop-down menu.
	Right VOR (G) pointer head and tail		
	VOR (C, G), DME/ TACAN (C, G), VORTAC (C, G)	MAP, MAP CTR, PLAN	When the STA key is selected, appropriate navaids are displayed (C). Tuned VHF navaids are displayed in green, regardless of menu key selection. When a navaid is manually tuned, the selected course and reciprocal are displayed.
	VOR/DME raw data radial and distance (G)		When the POS key is selected, the station radial extends to the airplane.
	VOR (G) selection	MAP, MAP CTR	Located lower left or right corner. Represents positions selected on the MAP or MAP CTR drop-down menu.
	VOR frequency or identifier (G)	MAP, MAP CTR	Frequency is displayed before identifier is decoded. Decoded identifier replaces the frequency. Small size characters indicate only DME information is being received.
	DME distance (G)	MAP, MAP CTR	Indicates DME distance to the referenced navaid.

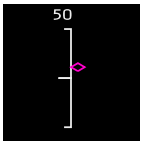
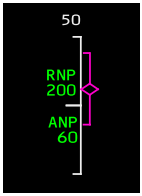
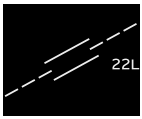
Map

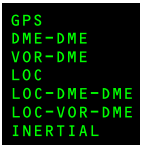
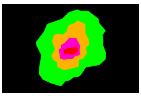
Symbol	Name	ND Mode	Remarks
	Airplane symbol (W), lateral path deviation (W), lateral ANP/RNP values (G, A)	MAP, MAP CTR	Current airplane position is at the apex of the triangle. Displays lateral path deviation distance. When ANP exceeds RNP, the ANP/RNP labels and values are displayed in amber.
	Airplane symbol (W)	mini-map	Current airplane position is at the apex of the triangle.
	Position trend vector (W) (dashed line)	MAP, MAP CTR, mini-map	Predicts position at the end of 30, 60, and 90 second intervals. Each segment represents 30 seconds. Based on bank angle and groundspeed. Selected range determines the number of segments displayed. For range: • greater than 20 NM, 3 segments • = 20 NM, 2 segments • = 10 NM, 1 segment. (mini-map always shows 3 segments even though range is always 20 NM.)
	Airplane symbol (W)	PLAN	Indicates actual position and track along the flight plan route. Symbol changes to a circle north of 82N latitude and south of 82S latitude.
	Waypoint: active (M), inactive (W)	MAP, MAP CTR, PLAN, mini-map	Active—represents the waypoint the airplane is currently navigating to.

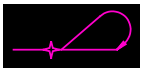
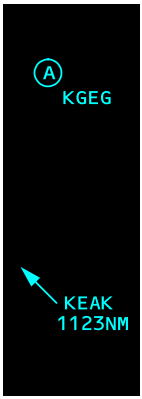
Symbol	Name	ND Mode	Remarks
			Inactive—represents the waypoints on the active route.
	Pick waypoint (PICK WPT) cursor (M)	MAP, MAP CTR, PLAN	Displayed when the PICK WPT key is selected. When the cursor highlights a waypoint, airport, or navaid, the letters “LAT” and “LONG” are removed.
	Highlighted waypoint (W)	MAP, MAP CTR, PLAN	Displayed when a visible route waypoint, background waypoint, airport, or navigation aid is passed over by the cursor.
	Temporary waypoint (W)	MAP, MAP CTR, PLAN	Displayed after a waypoint is selected when PICK WPT cursor is active. Displays selected waypoint name if visible waypoint, airport, or navigation aid is selected. Displays latitude and longitude if visible waypoint, airport, or navigation aid is not selected.
	Cursor shape for Center on Cursor mode (M)	PLAN	Displayed when Center on CURSOR key is selected.
	Off route waypoint (C)	MAP, MAP CTR	When the WPT key is selected, waypoints not on the selected route are displayed, in ND ranges of 10, 20, or 40.

Symbol	Name	ND Mode	Remarks
	Flight plan route: active (M), modified (W), inactive (C)	MAP, MAP CTR, mini-map, PLAN	The active route is displayed with a continuous line (M) between waypoints. Active route modifications are displayed with short dashes (W) between waypoints. Inactive routes are displayed with long dashes (C) between waypoints.
	Offset path and identifier: active route (M), modified route (W)	MAP, MAP CTR, mini-map, PLAN	Presents a dashed line parallel to and offset from the active or modified route.
	Route data: active waypoint (M), inactive waypoint (W)	MAP, MAP CTR, mini-map	When the DATA key is selected, entered or procedural altitude and ETAs for route waypoints are displayed. Times are based on FCM performance predictions.
	Active waypoint data block • active waypoint identifier (M) • distance to active waypoint (W) • active waypoint ETA (W)	MAP, MAP CTR, PLAN	Indicates the active flight plan waypoint (the next waypoint on the route of flight), which is displayed on line 1L of the FMC-CDU ACT RTE LEGS page 1; distance to the waypoint and ETA. Time is based on distance to go and ground speed. It does not consider FMC performance predictions and may differ from other FMC ETAs on the CDU RTE DATA, PROGRESS, and ALTN Airport pages.

Symbol	Name	ND Mode	Remarks
	Altitude range arc (G)	MAP, MAP CTR, mini-map	Based on vertical speed and groundspeed, indicates the approximate map position where the MCP altitude will be reached.
	Range readout (W)	MAP, MAP CTR, PLAN	Shows the current selected range.
	Altitude profile point and identifier (G)	MAP, MAP CTR, mini-map	Indicates the approximate map position of the FMC-calculated T/C (top-of-climb), T/D (top- of-descent), S/C (step climb), and E/D (end of descent) points. Predicted altitude/ETA points entered on the FIX page display the altitude/ ETA along with the profile point. Deceleration points have no identifier.
	Speed profile point and settings (G)	MAP, MAP CTR, mini-map	Indicates the approximate map position for FMC-calculated speed settings. Position and settings are calculated to be on speed, on path and on time at the final approach fix.
	Flap speed profile point and settings (G)	MAP, MAP CTR, mini-map	Indicates the approximate map position for FMC-calculated flap and speed settings. Flap setting is indicated only for flaps 1, 5, and 20. Position and settings are calculated to be on speed, on path and on time at the final approach fix.

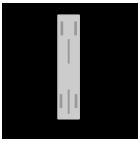
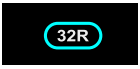
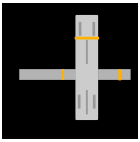
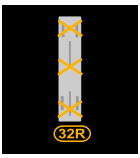
Symbol	Name	ND Mode	Remarks
	ATC conditional clearance point (G)	MAP, MAP CTR, PLAN	Indicates FMC calculated map position where the airplane should comply with an ATC conditional clearance. Symbol is removed when the conditional clearance is met.
	VNAV path pointer (M) and deviation scale (W)	MAP, MAP CTR	Displays vertical deviation from selected VNAV PATH. Displayed only during FMC descent phase of flight. Scale indicates ± 400 feet deviation. Digital display is provided when the pointer indicates more than ± 20 feet.
	Path deviation band (M), vertical path deviation (W), vertical ANP/RNP values (G)	MAP, MAP CTR	Path deviation band is symmetric about the pointer and represents vertical RNP. Whenever ANP exceeds RNP, the ANP/RNP labels and values are displayed in amber. Displayed only during FMC descent phase of flight.
	Airport and runway (W)	MAP, MAP CTR, PLAN	Displayed when selected as the origin or destination and ND range is 80, 160, 320, or 640 NM.
	Airport (C)	MAP, MAP CTR, PLAN	Displayed when the APT key is selected. Origin and destination airports are always displayed, regardless of map switch selection.
	Airport and runway (W)	MAP, MAP CTR, PLAN mini-map	Displayed when selected as the origin or destination and ND range is 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.

Symbol	Name	ND Mode	Remarks
	Energy management circles (C, W)	MAP, MAP CTR	Indicates clean (C) and speedbrake (W) energy management circles as defined on the CDU OFFPATH DES page.
	Selected reference point and bearing distance information (G)	MAP, MAP CTR, PLAN	Displays the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).
	FMC position update status (G)	MAP, MAP CTR, mini-map	Indicates the system providing FMC position update.
	GPS position (W)	MAP, MAP CTR	When the POS key is selected, indicates GPS position relative to FMC position.
	IRU position (W)	MAP, MAP CTR	When the POS key is selected, the star indicates IRU position relative to FMC position.
	Weather radar returns (R, A, G, M)	MAP, MAP CTR, mini-map	The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence is displayed in magenta.
	Selected map options (C)	MAP, MAP CTR, mini-map	Displays MAP menu selected map options.
	North up arrow (G)	PLAN	Indicates map background is oriented and referenced to true north.
	Holding pattern: active route (M), modified route (W), inactive route (C)	MAP, MAP CTR, PLAN	A holding pattern appears when in the flight plan. Depicts entry path until entry completed.

Symbol	Name	ND Mode	Remarks
	Procedure turn: active route (M), modified route (W), inactive route (C)	MAP, MAP CTR, PLAN	A procedure turn appears when in the flight plan. It increases in size upon entering the procedure turn. Also used for procedure hold course reversal.
	Alternate airports	MAP, MAP CTR, PLAN	PLAN: displays up to four alternate airports at all times. MAP, MAP CTR: displays the FMC or pilot selected primary alternate airport. Displays up to four alternate airports when the APT key is selected. Offscale airports (only with 1280 NM scale selected), directional arrow relative to airplane position or PLAN center point and distance.

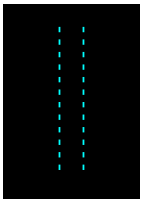
Airport Map

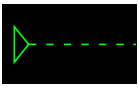
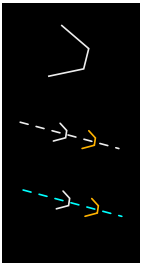
Symbol	Name	ND Mode	Remarks
	Airport beacon (W)	MAP, MAP CTR, PLAN	Displayed at ranges 2, 1, and 0.5 NM.
	ICAO ID (W)	MAP, MAP CTR, PLAN	Airport ICAO Identifier in GRID Heading box. Displayed at all ranges except when in GRID Heading.
	LOAD message (W)	MAP, MAP CTR, PLAN	Displayed at all ranges during delay between execution of flight plan and display of airport map.

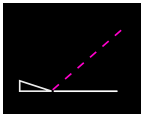
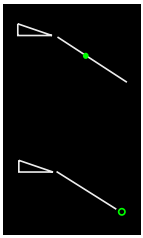
Symbol	Name	ND Mode	Remarks
	DATE message (W)	MAP, MAP CTR, PLAN	Displayed at all ranges when active cycle of Airport Map database is expired or out of range.
	WXR ON message (W)	MAP, MAP CTR, PLAN	Displayed at all ranges when WXR switch is selected.
	Concourse and gates (C)	MAP, MAP CTR, PLAN	Concourse is displayed at ranges 2, 1, and 0.5 NM. Gates are displayed at a range of 0.5 NM.
	Runway	MAP, MAP CTR, PLAN	Displayed at ranges 5, 2, 1, and 0.5 NM.
	Runway identifier (W, C)	MAP, MAP CTR, PLAN	Displayed at ranges 2, 1, and 0.5 NM.
	Taxiway holding position, land and hold short line (A)	MAP, MAP CTR, PLAN	Taxiway holding position displayed at ranges 1 and 0.5 NM. Land and hold short line displayed at ranges 2, 1, and 0.5 NM.
	Closed runway indications (A)	MAP, MAP CTR, PLAN	Displayed at ranges 5, 2, 1, and 0.5 NM.
	Partially closed runway indications (A)	MAP, MAP CTR, PLAN	Displayed at ranges 5, 2, 1, and 0.5 NM.

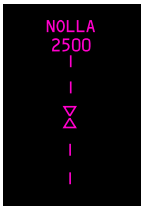
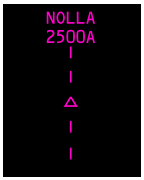
Symbol	Name	ND Mode	Remarks
	Stopway/blast pad, stopway chevrons	MAP, MAP CTR, PLAN	Stopway/blast pad displayed at ranges 5, 2, 1, 0.5 NM. Chevrons displayed at ranges 2, 1, 0.5 NM.
	Taxiway and taxiway identifier	MAP, MAP CTR, PLAN	Taxiway is displayed at ranges 5, 2, 1, 0.5 NM. Taxiway identifier is displayed at ranges 2, 1, and 0.5 NM.
	Construction area (A)	MAP, MAP CTR, PLAN	Construction areas are displayed at ranges 2,1, and 0.5 NM.
	Apron area	MAP, MAP CTR, PLAN	Apron areas are displayed at ranges 5,2,1, and 0.5 NM.
	De-icing area (W)	MAP, MAP CTR, PLAN	Displayed at ranges 1 and 0.5 NM.
	Helicopter landing area (W, C)	MAP, MAP CTR, PLAN	Displayed at ranges 1 and 0.5 NM.

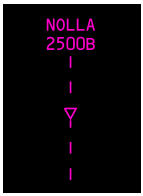
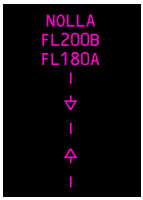
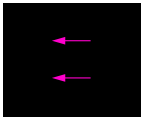
Vertical Situation Display (VSD)

Symbol	Name	ND Mode	Remarks
	Airplane symbol (W)	MAP, MAP CTR	Current airplane altitude is the bottom of the triangle. Current airplane lateral position relative to terrain is the point of the triangle.
	Enroute corridor (C) (dashed line)	MAP, MAP CTR	Indicates area of the map that is shown on the VSD. Displayed full time when VSD is selected. During turns, the corridor edge leading the turn opens in the direction of the turn.

Symbol	Name	ND Mode	Remarks
	Selected altitude bug and line (M)	MAP, MAP CTR	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.
	BARO minimums pointer and line (G)	MAP, MAP CTR	Pointer indicates the barometric minimums selected on the EFIS control panel. Dashed line extends from pointer to background display boundary. Pointer and line turn amber when airplane descends below selected minimum altitude. Reset with the RST switch on the EFIS control panel.
	Decision gates (W, A)	MAP, MAP CTR	Indicates suggested points where airplane should be path and speed stable on approach. Gates are placed on the 3º Reference Line or FMC Approach Glidepath Angle Line: • at 1000 feet above field elevation (W) • at 500 feet above field elevation (A). Decision gates that are below the missed approach waypoint altitude are not displayed.
	Flight path vector (W)	MAP, MAP CTR	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

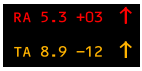
Symbol	Name	ND Mode	Remarks
			speed and groundspeed of the airplane.
	MCP selected vertical speed vector or flight path angle (M)	MAP, MAP CTR	Dashed line indicates the selected vertical speed as a target angle when the MCP V/S mode is selected. Indicates selected flight path angle when MCP FPA mode is selected. Extends to the edge of the background display and rotates about the point of the triangle.
	Range to target speed dot (G)	MAP, MAP CTR	Indicates where the airplane will achieve the FMC or MCP target speed. If the airplane is within 5 knots of target speed, the dot blanks. If the airplane increases 5 knots or more faster than target speed, the dot reappears. Displayed at the end of the Flight Path Vector as an unfilled dot if target speed will not be achieved within the vector length.
	Altitude profile point and identifier (G)	MAP, MAP CTR	Indicates the approximate map position of the FMC calculated T/C (top-of-climb), T/D (top-of-descent), S/C (step climb), and E/D (end of descent) points. Predicted altitude/ETA points entered on the FIX page display the altitude/ETA along with the profile point. Deceleration points have no identifier.

Symbol	Name	ND Mode	Remarks
	Speed profile point and settings (G)	MAP, MAP CTR	Indicates the approximate map position for FMC calculated speed settings. Position and settings are calculated to be on speed, on path and on time at the final approach fix.
	Flap speed profile point and settings (G)	MAP, MAP CTR	Indicates the approximate map position for FMC calculated flap and speed settings. Flap setting is indicated only for flaps 1, 5, and 20. Position and settings are calculated to be on speed, on path and on time at the final approach fix.
	ATC conditional clearance point (G)	MAP, MAP CTR, PLAN	Indicates FMC calculated map position where the airplane should comply with an ATC conditional clearance. Symbol is removed when the conditional clearance is met.
	Waypoint altitude constraint: active (M), inactive (W)	MAP, MAP CTR	At Altitude example.
	Waypoint altitude constraint: active (M), inactive (W)	MAP, MAP CTR	At or Above Altitude example.

Symbol	Name	ND Mode	Remarks
	Waypoint altitude constraint: active (M), inactive (W)	MAP, MAP CTR	At or Below Altitude example.
	Waypoint altitude constraint: active (M), inactive (W)	MAP, MAP CTR	Block Altitude example.
	Hold symbol: active (M), inactive (W)	MAP, MAP CTR	Shown centered between the first and second instance of the hold waypoint.
	Hold return symbol (M)	MAP, MAP CTR	Shown during holding entry and when in holding. Shown to the left of the second hold waypoint.

TCAS

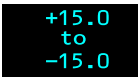
Symbol	Name	ND Mode	Remarks
	TCAS resolution advisory (RA), relative altitude (R)	MAP, MAP CTR, mini-map	(See Traffic Alert and Collision Avoidance System (TCAS) on page 15.10.12) The arrow indicates traffic climbing or descending at a rate greater than or equal to 500 fpm. At rates less than 500 fpm, the arrow is not displayed. The number and associated signs indicate altitude of traffic in
	TCAS traffic advisory (TA), relative altitude (A)		
	TCAS proximate traffic, relative altitude (W)		

Symbol	Name	ND Mode	Remarks
	TCAS other traffic, relative altitude (W)		hundreds of feet relative to the airplane. The number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane. Absence of the number implies altitude unknown.
	TCAS no bearing message (RA–R, TA–A)	MAP, MAP CTR, mini-map	Message provides traffic type, range in NM, altitude and vertical direction.
	TCAS traffic alert message (RA–R, TA–A)	All	Displayed whenever a TCAS RA or TA is active. EFIS control panel TFC switch does not have to be selectedon.
	TCAS off scale message (RA–R, TA–A)	MAP, MAP CTR, mini-map	Displayed whenever RA or TA traffic is outside the traffic area covered by the ND range. (See TCAS Traffic and Alert Message TRAFFIC Display on page 15.10.15)
	TCAS mode (C)	MAP, MAP CTR, mini-map	Indicates the ND TCAS display is active.
	TCAS mode (C)	All	Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off.
	TCAS mode (C)	All	Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.

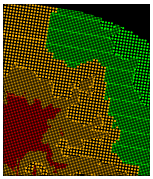
Symbol	Name	ND Mode	Remarks
TCAS OFF	TCAS mode (A)TCAS OFF	MAP, MAP CTR, mini-map	Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA, if traffic is selected. Not displayed if TCAS is failed.
TCAS FAIL	TCAS mode (A)	MAP, MAP CTR, mini-map	Indicates TCAS failure, if traffic is selected.

Radar

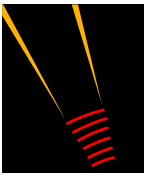
Symbol	Name	ND Mode	Remarks
TEST	Weather radar (WXR) test mode (C) (A)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
WX	WXR precipitation only mode (C)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
WX+T	WXR and turbulence mode (C)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
−3 to +3	WXR receiver gain (C)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
MAP	Mode used with down–tilt when ground mapping (C)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)

Symbol	Name	ND Mode	Remarks
	WXR antenna tilt (C)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
	WXR system failure (A)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
	WXR receiver transmitter failure (A)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
	WXR antenna failure (A)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
	WXR control panel failure (A)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
	WXR loss of attitude data (A)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)
	WXR calibration fault (A)	MAP, MAP CTR, mini-map	Weather radar system is selected on the EFIS control panel or MAP mode drop-down menu. (See Weather Radar on page 11.10.19)

Look-Ahead Terrain

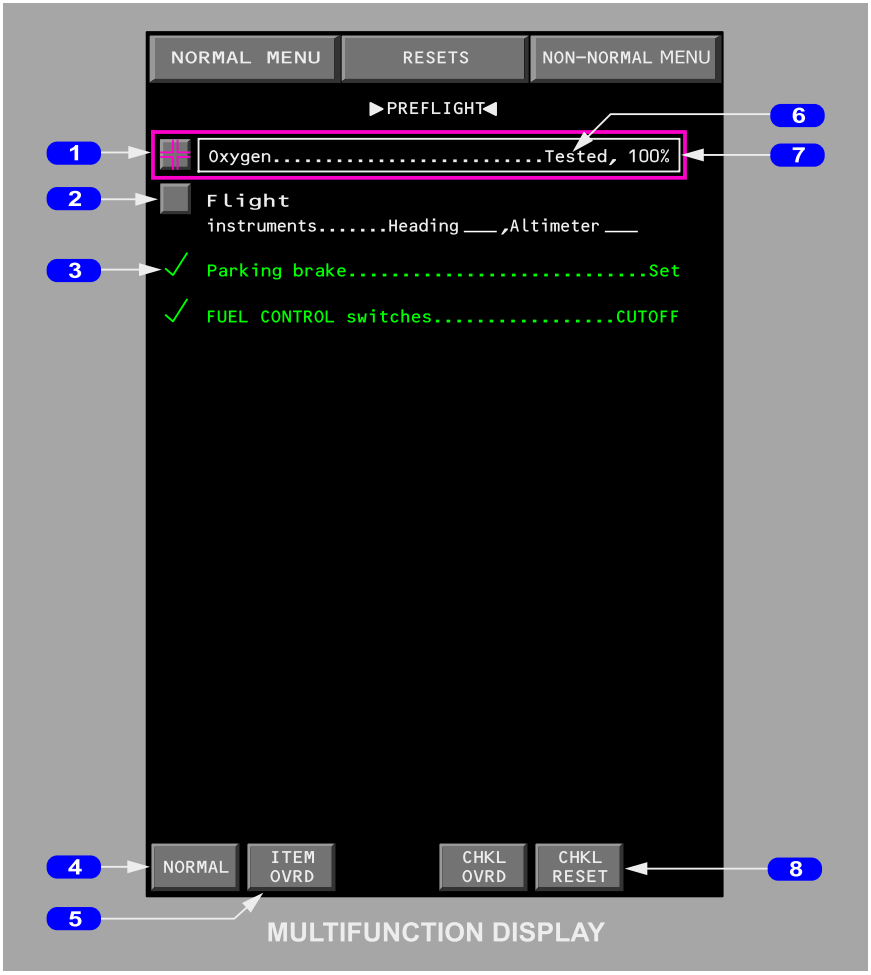
Symbol	Name	ND Mode	Remarks
	Terrain display (R, A, G, M)	MAP, MAP CTR, mini-map	Displays terrain data from the GPWS terrain database. Color and density vary based on terrain height vs. airplane altitude. (See Terrain Display on page 15.10.25.)
	Obstacle annunciation (R, A)	MAP, MAP CTR, mini-map	Obstacle caution alert (A), obstacle warning alert (R).
	Terrain mode annunciation (C); highest and lowest terrain or obstacle altitudes (R, A, G, M)	MAP, MAP CTR, mini-map	Look-ahead Peaks Terrain display enabled (manual or automatic display).
	Terrain test mode annunciation (C)	All	GPWS operating in self-test mode.
	Terrain annunciation (R, A)	All	Look-ahead terrain caution alert active (A), look-ahead terrain warning alert active (R).
	Terrain status annunciations (A)	MAP, MAP CTR, mini-map	Look-ahead terrain alerting and display have failed.
		MAP, MAP CTR, mini-map	Look-ahead terrain alerting and display unavailable due to position uncertainty.
		MAP, MAP CTR, mini-map	GPWS terrain override (TERR OVRD) set to OVRD on TCP.

Predictive Windshear

Symbol	Name	ND Mode	Remarks
	Predictive windshear symbol (R, C, A)	MAP, MAP CTR, mini-map	Displays windshear location and approximate geometric size (width and depth). Amber radials extend from predictive windshear symbol to help identify location of windshear event.
	Windshear annunciation (R, A)	All	Predictive windshear caution active (A). Predictive windshear warning active (R).

Note: The checklists and procedures used in graphics within this section are for reference to ECL functions only, and may not be current or applicable to all aircraft.

Normal Checklist



1 Cursor Selection Box

Highlights the cursor selection area.

2 Open Loop Indicator

Indicates the line item is an open loop action item. Requires flight crew confirmation to become complete.

3 Complete Indicator

Indicates the line item is complete.

4 Normal Checklist (NORMAL) Key

Select—

- shows 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, the cursor selection box, and the cursor move to the first incomplete line item.

Non-Normal Checklist Queue

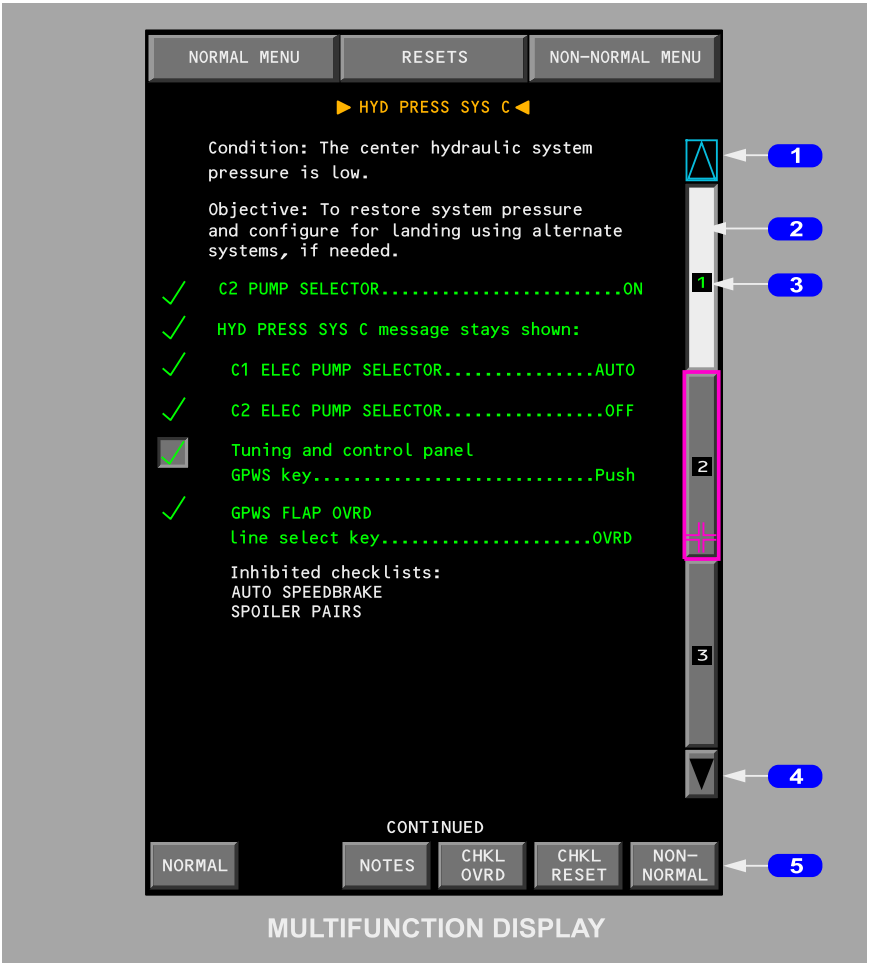


1 Checklist Key

Select—shows the checklist for the title on the key:

- Red—WARNING
- Amber (left justified)—CAUTION
- Amber (indented)—ADVISORY
- White (Initial Cap)—Unannunciated.

Non-Normal Checklist



1 Previous Page Key

Select—shows the previous checklist page.

Shows (gray)—the previous page is available.

Shows (cyan)—the key is inactive. The first page of the checklist is shown.

2 Checklist Page Key

Select—shows the checklist page corresponding to the page number on the key.

Shows (white)—the checklist page corresponding to the page number on the key is currently shown.

Shows (gray)—the checklist page corresponding to the page number on the key is not currently shown.

3 Checklist Page Number

Shows (white)—the checklist page is incomplete.

Shows (green)—the checklist page is complete.

4 Next Page Key

Select—shows the next checklist page.

Shows (gray)—the next page is available.

Shows (cyan)—the key is inactive. The last page of the checklist is shown.

5 Non-Normal Checklist (NON-NORMAL) Key

Shows when there are additional incomplete non-normal checklists in the checklist queue.

Select—

- shows the next incomplete non-normal checklist when one incomplete non-normal checklist is in the checklist queue
- shows the non-normal checklist queue when more than one incomplete non-normal checklist is in the checklist queue.

Shows (white)—an incomplete non-normal checklist has not been shown.

Shows (amber)—an incomplete non-normal checklist has been shown but is not currently shown.

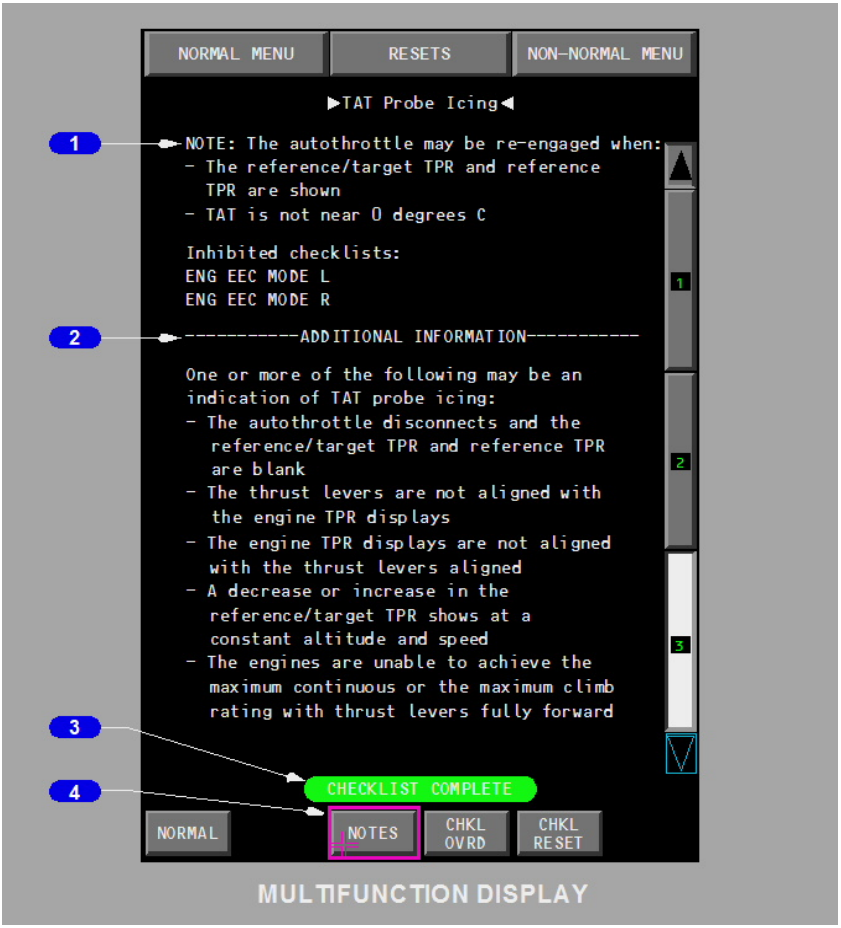
Checklist Timer



1 Timer

Shows the time remaining of a time delay for the current line item. If the line item is complete, the current line item box stays on the line item until the timer expires.

Operational Notes and Additional Information



1 Operational Notes

Shown in a non-normal checklist.

2 ADDITIONAL INFORMATION

Shows information for the crew to consider but is not required for checklist completion.

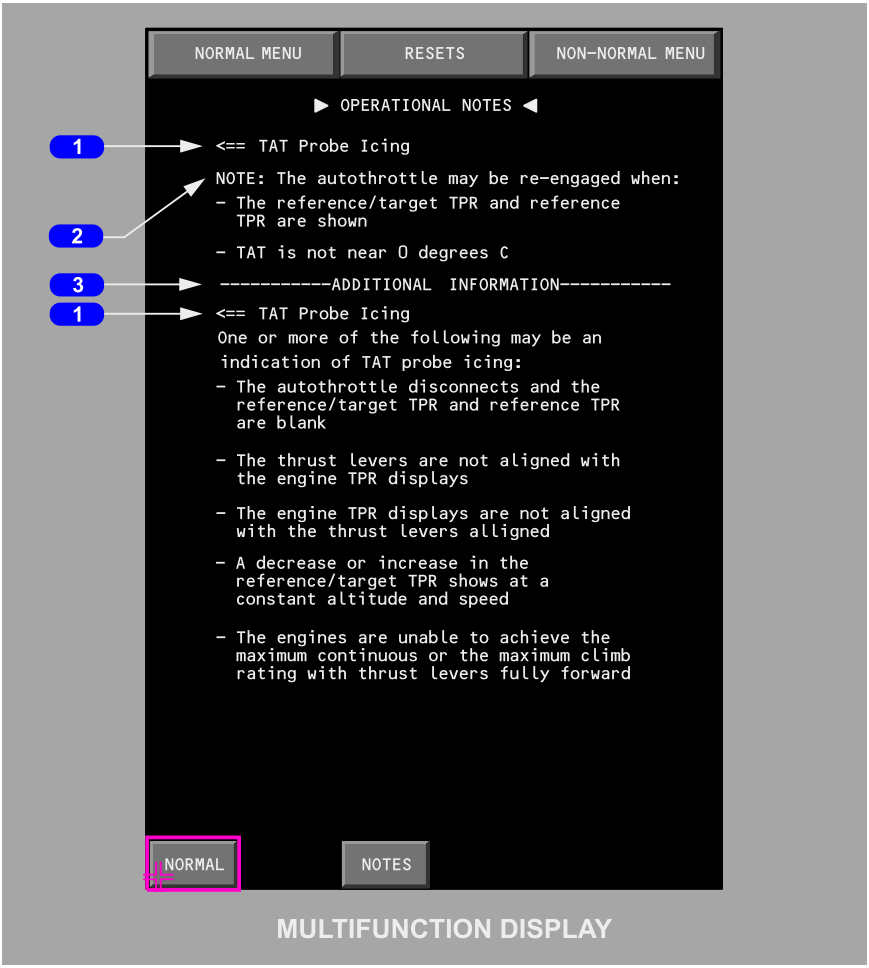
3 CHECKLIST COMPLETE Indicator

Shows when all of the line items are either complete, inactive, or overridden, and all the pages have been shown.

4 Operational Notes (NOTES) Key

Select—shows the operational notes page.

Operational Notes Page



1 Checklist Reference

Indicates the non-normal checklist from which operational notes originated.

2 Operational NOTES

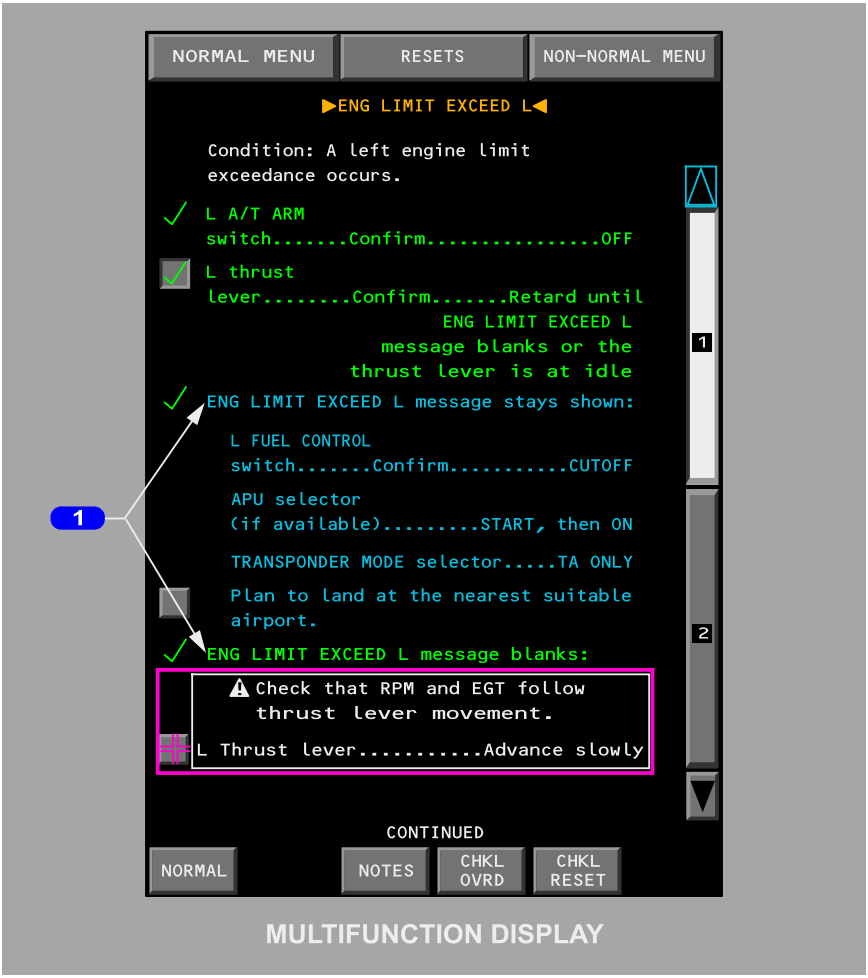
Shown on the operational notes page.

3 ADDITIONAL INFORMATION Indicator

Shows information for the crew to consider but is not required for checklist completion.

Conditional Line Item

Closed Loop



1 Closed Loop Conditional Line Items

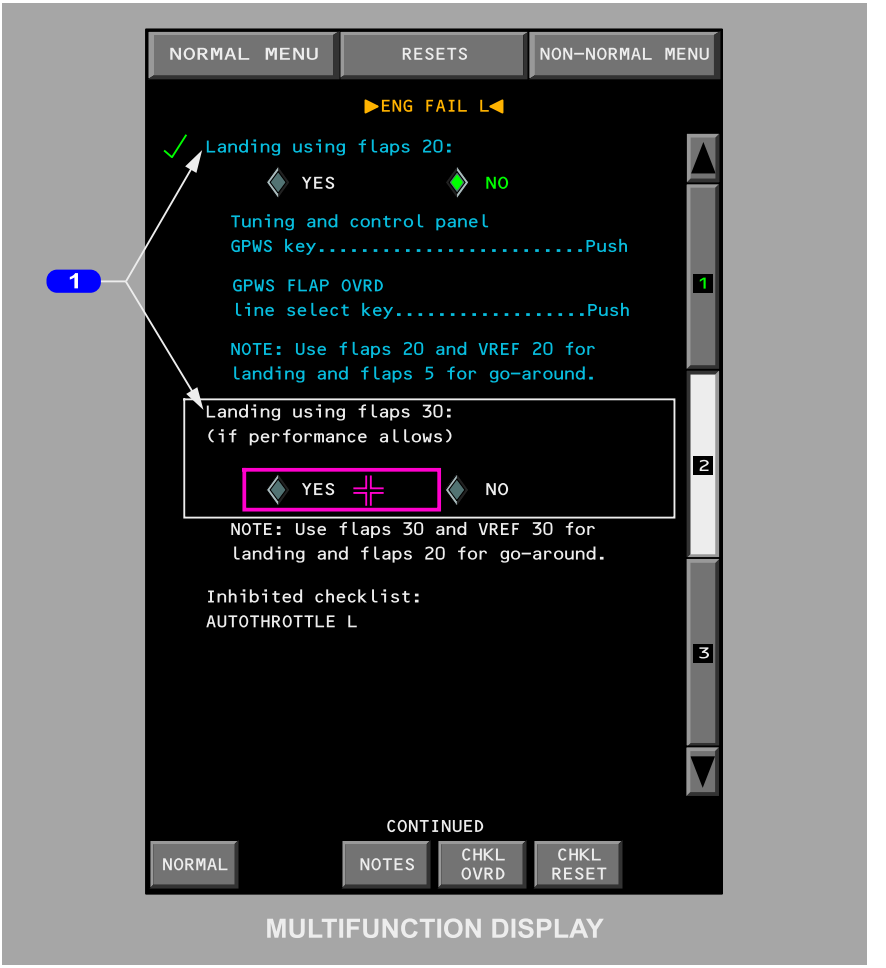
Shows (white)—the conditional line item is incomplete.

Shows (cyan)—the conditional line item is sensed false. All line items indented below the conditional line item become inactive and show cyan. The current line

item box, cursor selection box, and cursor skip the inactive items and move to the next incomplete line item.

Shows (green)—the conditional line item is sensed true. The current line item box, cursor selection box, and cursor move to the next incomplete line item.

Open Loop



1 Open Loop Conditional Line Items

Shows (white)—the conditional line item is incomplete.

Shows (cyan)—the conditional line item is selected NO. All line items indented below the conditional line item become inactive and show cyan. The current line item box, cursor selection box, and cursor skip the inactive items and move to the next incomplete line item.

Shows (green)—the conditional line item is selected YES. The current line item box, cursor selection box, and cursor move to the next incomplete line item.

Deferred Line Items

Non-Normal Checklist



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.

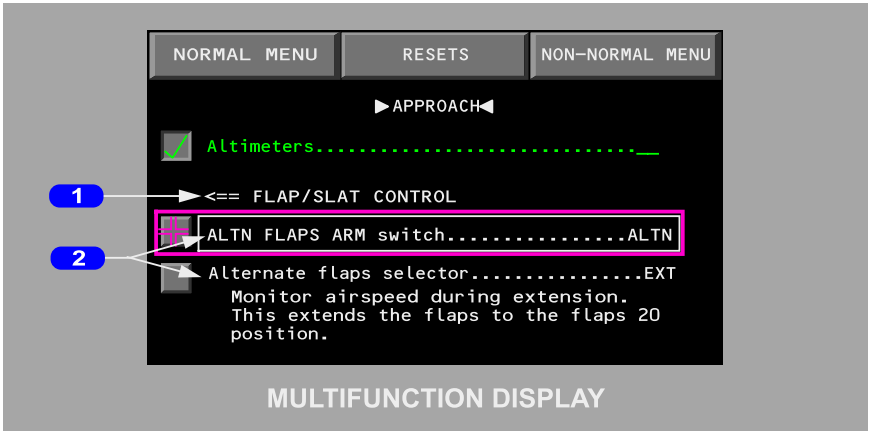
3 Deferred Line Items

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.

Normal Checklist



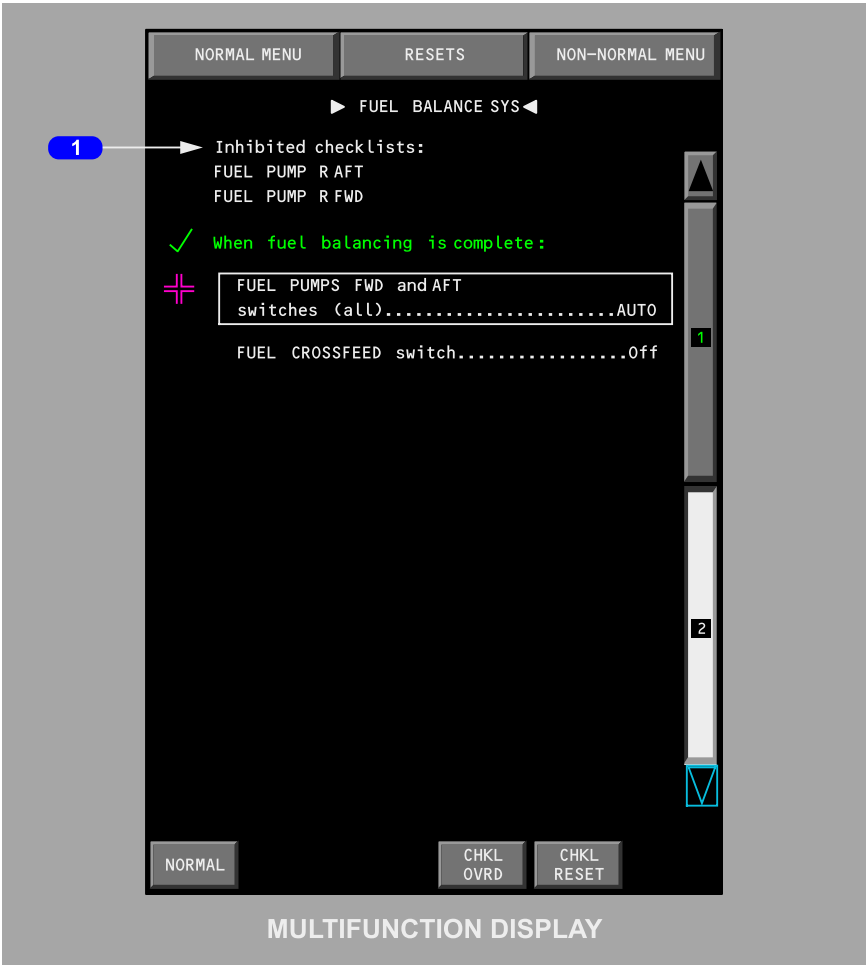
1 Checklist Reference

Shows the non–normal checklist from which deferred line items originated.

2 Deferred Line Items

Shown in a normal checklist.

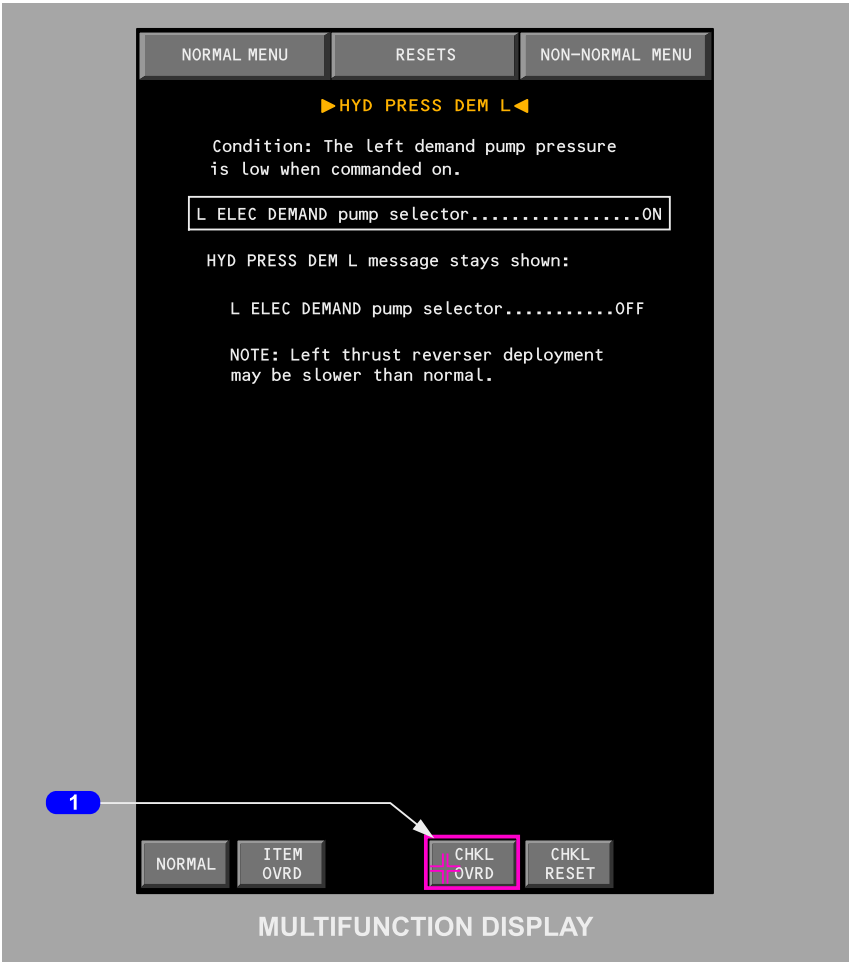
Inhibit Checklist Line Item



1 Inhibit Checklist Line Item

Shows checklists which are inhibited or removed from the checklist queue and whose checklist icons are inhibited or removed from the EICAS display.

Checklist Override



1 Checklist Override (CHKL OVRD) Key

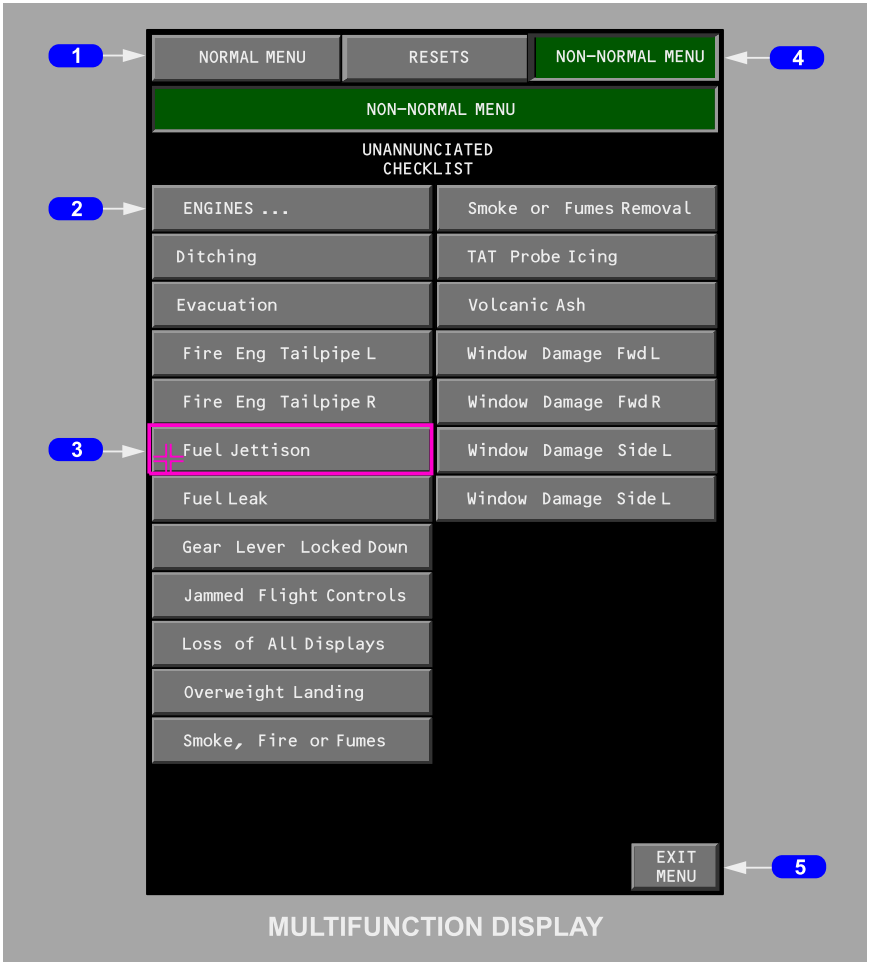
Select—overrides the current checklist.



1 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.

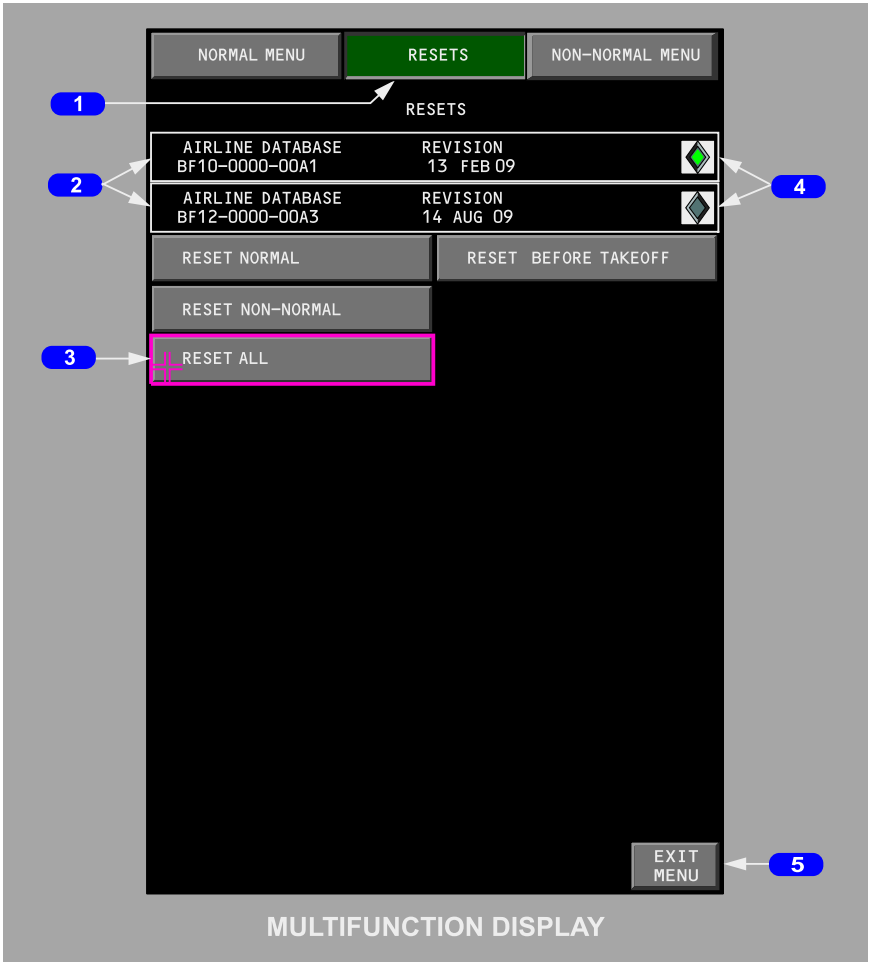
4 Non-Normal Menu (NON–NORMAL MENU) Key

Select (green)—shows the non-normal checklists menu page. The page contains menu keys for the airplane systems.

5 Exit Menu (EXIT MENU) Key

Select—exits page for access to the normal and non–normal checklist keys.

Resets Menu Page



1 Resets Menu (RESETS) Key

Select (green)—shows the checklist resets page.

2 Database Selection Key

Select—

- activates associated checklist database
- selection is only available on the ground and both engines are off.

Shows (white)—the database is available for selection.

Select (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 Active Database Indicators

Shows (green)—the database is active.

Shows (gray)—the database is inactive.

5 Exit Menu (EXIT MENU) Key

Select—exits page for access to the normal and non-normal checklist keys.

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 the cursor control devices (CCDs). Cursor control devices and MFD selection are described in the System Description section of this chapter.

Electronic Checklist Operation

Pushing the checklist display switch on the display select panel shows the correct checklist (see Checklist Access on page 10.60.6 for the checklist display priority order). Only one checklist is displayed at a time.

Three types of checklists can be shown:

- normal
- non-normal for an EICAS message (annunciated)
- non-normal for a condition without an EICAS message (unannunciated).

After each normal checklist is complete, pushing the checklist display switch twice or selecting the normal key shows the next normal checklist in sequence.

Some checklist steps must be checked off by the flight crew to show as complete. Other checklist steps are automatically checked off from sensed flight deck control positions, airplane system status, or EICAS messages.

Checklist Pages

A checklist can have one or more pages. If a checklist is longer than one page, page keys show on the right side of the page.

When a checklist has more than one page and the line items on the current page are complete, the cursor moves to the checklist page key for the next page. CONTINUED shows at the bottom of the page. Pressing the CCD cursor select switch shows the next checklist page.

When a checklist is complete and there are no additional checklists in the non-normal checklist queue, the cursor automatically moves to the normal checklist key in the lower left corner of the page. Pressing the CCD cursor select switch shows the next normal checklist in sequence. If there are checklists in the non-normal queue, the cursor moves to the non-normal key in the lower right corner of the page. Pressing the CCD cursor select switch shows the next non-normal checklist (if only one is in the queue) or the non-normal checklist queue.

Checklist Status

The checklist complete indicator shows at the bottom of all pages of the checklist when all of the line items are either complete, inactive, or overridden, and every page has been shown. If the flight crew chooses not to do a line item, the line item can be overridden with the line item override key at the bottom of the page. When a line item is overridden, the text changes color to cyan and the current line item box moves down to the next incomplete line item. If the flight crew chooses to not complete a checklist, the checklist can be overridden by selecting the checklist override key at the bottom of the page. When a checklist is overridden, the text of the entire checklist changes color to cyan, and the checklist overridden indicator shows at the bottom of all pages.

Checklist Line Items

A checklist has one or more line items. These are the types of line items:

- free text
- action item
- operational note
- conditional
- inhibit checklist.

Free text items show text and have no further function. The other line item types are described below.

Incomplete line items have white text. Complete line items have green text with a complete indicator (a green check mark) to the left. Overridden and inactive line items have cyan text.

When the checklist is opened, the current line item box moves to the first incomplete line item. When the cursor is on that line item, the cursor selection box encloses the current line item box. When the line item becomes complete, the cursor, the cursor selection box, and the current line item box move to the next incomplete line item.

Action Items

Each step in a checklist that requires a flight crew action is an action item. There are two types of action items: closed loop and open loop.

Closed Loop Action Items

Closed loop action items continuously monitor the position of a flight deck switch, lever, or selector. In a few cases, actual system state, such as flap or landing gear position, is monitored. When the control is in the required position, the action item color changes to green and the complete indicator shows to the left of the action item. The current line item box then moves to the next incomplete line item.

Open Loop Action Items

Open loop action items require the flight crew to manually confirm completion with the CCD. Open loop action items do not monitor control position or system state. Open loop action items look different from closed loop action items. Open loop action items have an open loop indicator, a gray box to the left of the line item. When the cursor is within the current line item box or the open loop indicator, and the CCD cursor select switch is pushed, the action item color changes from white to green and a complete indicator shows on the open loop indicator. The current line item box then moves to the next incomplete line item.

Operational Notes

Operational notes are for the ongoing consequences of a non-normal condition, such as inoperative equipment or operational limitations. The flight crew should read all operational notes, but the current line item box does not stop on an operational note because no immediate flight crew action is required. Operational notes have white text, unless inactive or overridden.

The operational notes page stores active operational notes for easy access and review by the flight crew later in flight. After a non-normal checklist that has operational notes is opened, the operational notes are available for the rest of the flight on the operational notes page. Access to the operational notes page is by the operational notes key at the bottom of the checklist page. Operational notes on the operational notes page have a checklist reference with the title of the checklist from which they came.

If there is more than one page of operational notes, page keys show.

The status of the operational note is based on the status of the EICAS message for the checklist with the note. If the EICAS message blanks, unneeded notes can also blank from the notes page.

Conditional Line Items

Conditional line items control the path through a complex checklist. The current line item box steps through line items or it skips line items based on a condition.

There are two types of conditional line items: open loop and closed loop.

Open Loop Conditional Line Items

Open loop conditional line items have choices labeled YES and NO. When the conditional line item becomes the current line item, the cursor moves to the YES–NO line. The flight crew uses the CCD to select the correct answer.

If the flight crew selects YES, the line item indented below the conditional line item becomes active. The current line item box moves to the first incomplete line item.

If the flight crew selects NO, the line items indented below the conditional line item become inactive and change color to cyan. The current line item box skips

the inactive items. Inactive operational notes are removed from the operational notes page. Inactive deferred line items are removed from their normal checklist. Inactive inhibit checklist line items have no effect.

The YES–NO choices remain available after a selection is made. The flight crew can change selections at any time.

A group of two or more open loop conditional line items can be a mutually exclusive set. When the flight crew selects YES on any one of the items in the exclusive set, all of the other items are automatically set to NO. However, the opposite is not true. If all but one of the items are selected NO, the last item is not automatically set to YES. The flight crew must manually select YES on one of the conditional line items in the exclusive set.

Closed Loop Conditional Line Items

A closed loop conditional line item works the same as an open loop item except the choice is made automatically based on a monitored flight deck control, an EICAS message, or an airplane system state. If the condition is true, the conditional line item changes color to green and the line items indented below it become active. If the condition is false, the conditional line item and the line items indented below it become inactive and change color to cyan. The current line item box skips the inactive items.

Inhibit Checklist Line Items

One airplane system failure can cause more than one EICAS alert message (a primary message and one or more consequential messages). The flight crew should do the checklist for the primary message not the consequential messages. Inhibit checklist line items remove unneeded non-normal checklists (consequential checklists) from the checklist queue.

Consequential EICAS alert messages can show for a primary failure condition. For example, the AUTO SPEEDBRAKE message shows due to a HYD PRESS SYS C condition. Consequential EICAS alert messages can also show due to flight crew actions in a non-normal checklist. For example, a FUEL PUMP L AFT message shows when the flight crew selects the FUEL L PUMPS switches off in the FUEL BALANCE SYS 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 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 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 shown at the end of some non-normal checklists. The flight crew is not required to read the additional information to complete the checklist.

Precautionary Text

Precautionary text is critical information shown above a line item. The flight crew should read the precautionary text before doing the line item action.

Checklist Menu Operation

Usually, the flight crew uses the checklist display switch on the display select panel and the normal and non-normal keys to select checklists. Checklists can also be selected and opened with menus. The normal menu, the resets page, and the non-normal menu can be selected with the keys at the top of the checklist page, using the CCD.

An exit menu key is in the lower right corner of all menu pages. This exits the menu page to allow access to the normal and non-normal checklist keys.

Normal Menu

Normal checklists are on the normal menu in the sequence they are completed in a normal flight.

Non-Normal Menu

The non-normal menu has submenus by airplane system. An airplane system submenu has the checklists for that system. If a system has more checklists than can fit on a page, additional submenus group checklists by name. Submenu titles end with "…".

Resets Page

The resets page shows the checklist database part number and revision information and the following manual resets:

- RESET NORMAL
- RESET NON-NORMAL
- RESET ALL.

Other manual resets can also be on this page. These can reset more than one checklist. (See Checklist Resets on page 10.60.10 for additional information.)

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 CCD. A green diamond shows the active database. The flight crew can select either ECL database when the airplane is on the ground and both engines are off. 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 selector position, and EICAS message level determine the priority for checklists when the checklist display switch is pushed.

On the ground with both fuel control switches in CUTOFF and both engine start selectors in NORM, the priority is:

- checklists for EICAS warning messages
- NORMAL checklists (incomplete or not yet opened).

On the ground with one or both fuel control switches in RUN, one or both engine start selectors in NORM, 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 critical line items in a checklist are not complete before the corresponding phase of flight. Also, the normal checklist key changes color to amber to show that one or more normal checklists are incomplete.

These are the critical flight phases:

- before taxi phase—occurs when the airplane is moved under its own power
- before takeoff phase—occurs when the airplane is on the FMC takeoff runway and aligned for takeoff
- approach phase—occurs when the airplane descends through the FMC transition altitude, and the flap handle is not in UP
- landing phase—occurs when the airplane descends below 500 feet above the FMC landing altitude.

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.

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 an EICAS alert message with an icon shows, pushing the checklist display switch shows the checklist for that message. If more than one EICAS alert message with an icon shows, pushing the checklist display switch shows a list with the non-normal checklist queue. If there are more than ten checklists in the queue, the queue has more than one page.

Checklists in the queue are in the same order as the messages show on EICAS. If there are any active unannunciated checklists, they show in the queue after all of the annunciated checklists.

When an EICAS alert message shows, its checklist automatically goes into the queue. When the checklist is complete, the EICAS alert message can still show, but the checklist is removed from the queue. A checklist is also removed from the queue when it is inhibited by another checklist that becomes active.

The flight crew uses the CCD to select a checklist from the queue. When a checklist is open, the non-normal checklist key returns to the queue if there are other non-normal checklists in the queue.

If EICAS alert messages show or blank while the checklist queue is shown, the queue does not change automatically. The flight crew must exit the queue and open it again to see the checklists for the new EICAS messages.

Non-Normal Unannunciated Checklists

Non-normal checklists for conditions that do not have EICAS messages are unannunciated checklists. Unannunciated checklists can be opened only from menus. UNANNUNCIATED CHECKLISTS is the first submenu item 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 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.

Flight Instruments, Displays — Chapter 10
Electronic Flight Bag—Controls and Displays — Section 70

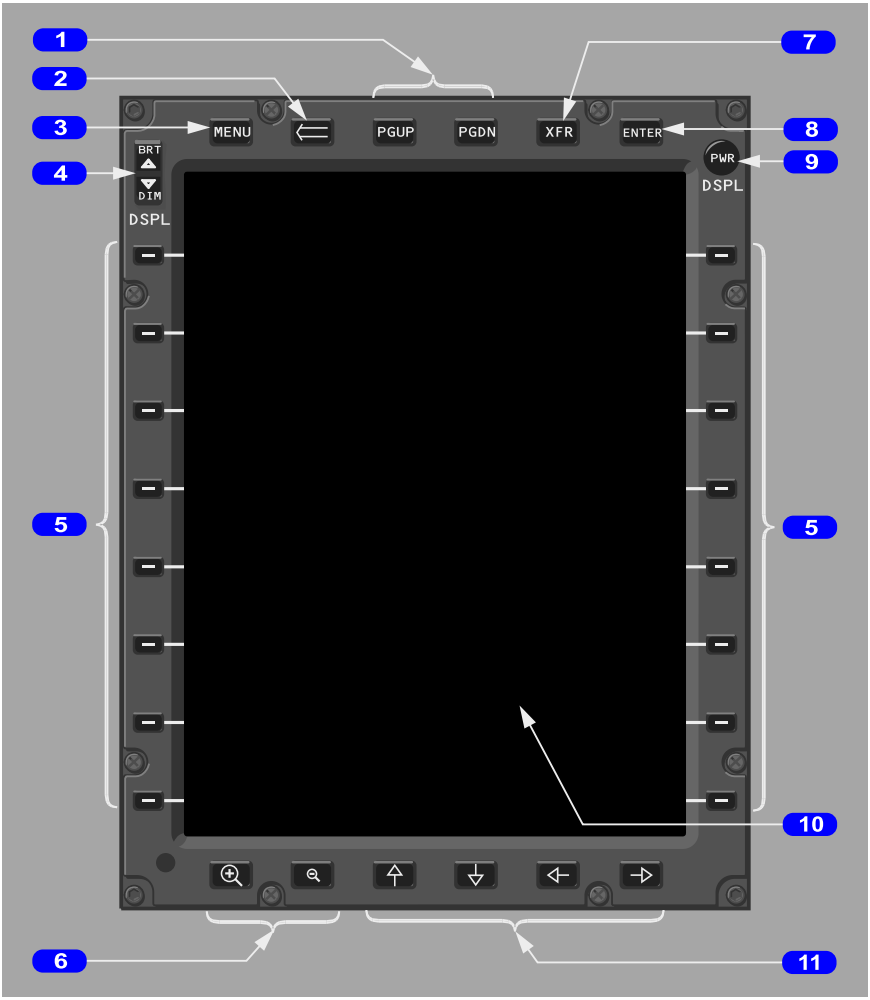
Introduction

The electronic flight bag is an operating system with applications designed to assist the flight crew with routine tasks, enhance security, and reduce the reliance on paper documents. The flight crew uses the EFB display units located in the left and right side panels. The display units operate independently of each other, but can also display information from the off-side unit, exchange data with the FMC, and send information directly to the flight deck printer or an EFB storage location.

Under typical flight conditions, the majority of pilot interaction consists of manipulating bezel keys or using the touch screen on the display unit to move back and forth among applications, or within applications, and to display, send or print data. In addition, the flight crew can interact with the EFB using the cursor control device (CCD) or an optional full size keyboard.

Display Unit

The display unit is the main interface between the flight crew and the EFB and its applications. The display unit incorporates a touch screen and 30 keys located around the screen. There are 16 vertically located line select keys 8 on both sides, and 14 horizontally located bezel keys 8 across the top and 6 across the bottom.



1 Page Up (PGUP) and Page Down (PGDN) Keys

Selection moves the displayed information up or down when the material exceeds one display screen in length.

2 Back Key

Selection returns the display to the previous screen.

3 MENU Key

Selection displays the Main Menu page. Also, selecting MENU while in transfer (XFR) mode cancels the transfer mode.

4 Bright (BRT) DIM Control Switch

Rocker switch changes the display brightness; upper portion brighter, lower portion dimmer.

5 Line Select Keys

When applicable, selection activates the item adjacent to the line select key.

6 Zoom Keys

Selection increases or decreases the zoom level. Left + key to zoom in, right-key to zoom out. Repeated selection brings zoom level to the maximum or minimum.

7 Transfer (XFR) Key

Selection displays a view of the off-side EFB screen onto the on-side display and:

- XFR displays in green text in upper right corner of the screen
- selections being made off-side are seen on the on-side display in real time
- XFR key (second push) exits transfer mode and returns display to the last screen viewed prior to selecting XFR.

Note: Selecting the MENU bezel key also exits the transfer mode and displays the Main Menu page.

8 ENTER Key

When applicable, selection activates the high-lighted item on the page.

9 Power (PWR) Switch

Selection turns the display backlight on or off.

Note: This switch does not power on or off the EFB hardware, only the display unit backlight.

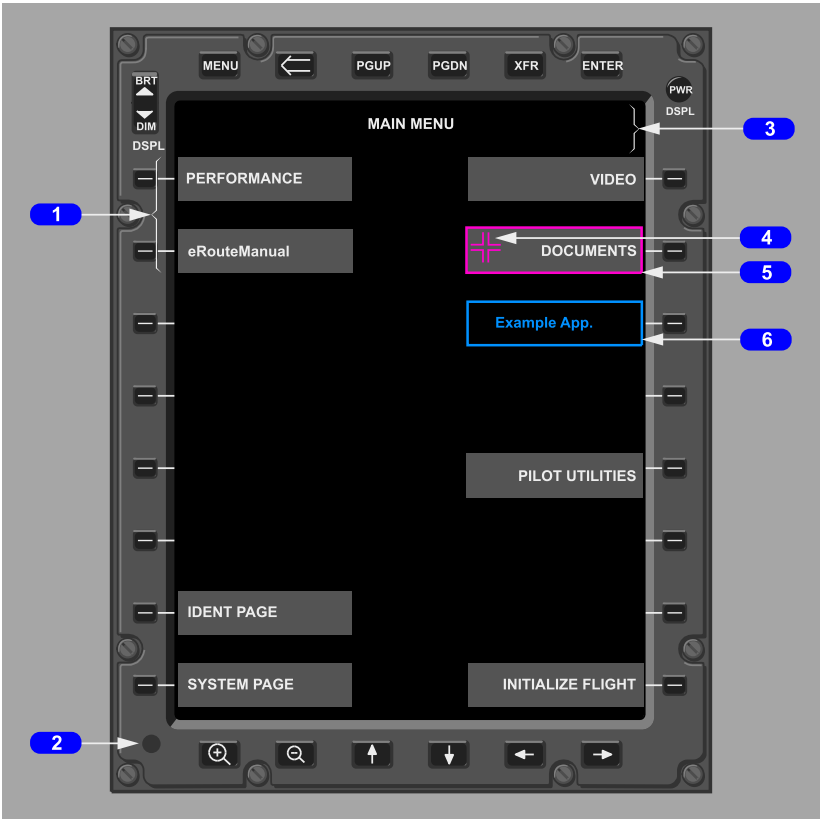
10 Touch Sensitive Screen

Enables direct selection of items on the display screen, and in some applications allows panning and scrolling.

11 Arrow Keys

Moves the viewing window over the display in the direction of the selected arrow.

Display Description



1 Soft Keys

Soft keys for available applications and functions display in white text with a gray background.

Although each application has a unique function on the EFB, they all conform to standard interface display guidelines. These standards include:

- gray soft keys indicating that a function is available for use
- gray soft keys highlighted with a magenta box indicate the function is ready for selection
- cyan outlined soft keys with cyan text indicating that an application or function is currently unavailable
- green soft keys identifying a selected function or currently active application

- amber horizontal stripe beneath soft keys when the associated function has an annunciation.

Note: Black arrows on soft keys indicate there is a sub-menu under that item.

2 Light Sensor

Provides automatic brightness control for the EFB display. The EFB automatic brightness control function controls display using inputs from the BRT/DIM control switch, light sensor, master brightness control and remote light sensor.

3 Cursor

A magenta cursor appears on the display when the EFB key is selected on a CCD.

4 Display Header

The top of the display is reserved for the header which displays the title and fault information. The title may use two lines with the top line providing the name of the software application, and the second line listing the name of the page being viewed.

The main body of the display area is everything below the header. There is no footer or bottom display area.

5 Highlight Box

A magenta highlight box displays around an available soft key when:

- the cursor is moved over the soft key, or
- the soft key is touched on the screen.

An available soft key is selected when:

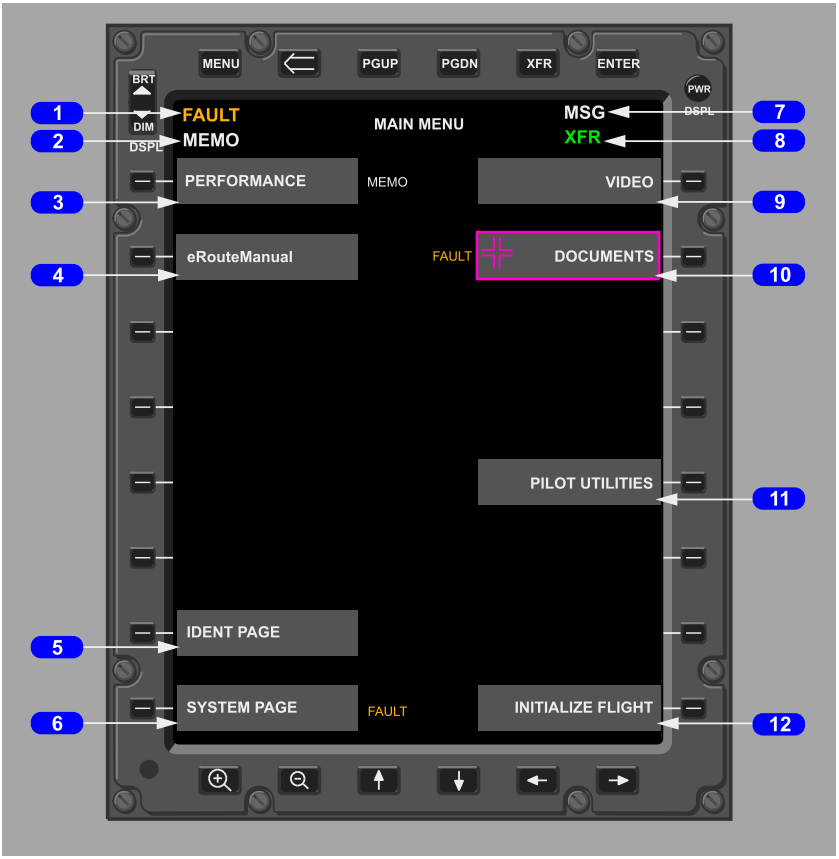
- the soft key is highlighted with the cursor and the cursor select switch is pushed, or
- the soft key is touched on the screen and released.

The soft key momentarily displays a green background when selected, then the application or function displays.

6 Unavailable Applications or Functions

Soft keys for unavailable applications or functions display in cyan text in a cyan box. The application or function may be initializing and become available later.

MAIN MENU Page



1 FAULT Message

Displayed (amber)—

- a fault has occurred within an application
- displays in the header regardless of the application displayed
- also displays next to the affected application soft key on the MAIN MENU page until the fault is acknowledged
- removed from the display upon selection of SYSTEM page regardless if the fault is acknowledged or not.

Only one message at a time can be displayed next to an application soft key. FAULT takes priority over MSG and MEMO. MSG or MEMO displays, as applicable, after the fault has been cleared.

2 MEMO Message

Displayed (white)—

- one or more applications need attention
- displays in the header regardless of the application displayed
- displays next to the affected application soft key on the MAIN MENU page
- removed from display upon selection of appropriate application.

Only one message at a time can be displayed next to an application soft key. FAULT and MSG take priority over MEMO. MEMO displays, as applicable, after the fault has been cleared and the message has been addressed.

3 PERFORMANCE Application Soft Key

Selection starts the performance application.

After flight initialization, displays the TAKEOFF performance page.

Subsequent selections of the application display the page that was in view when the application was last exited.

For additional information, see Typical Onboard Performance Tool on page 10.80.32.

4 eRouteManual Application Soft Key

Selection starts the eRouteManual application.

After flight initialization, displays the eRouteManual application page.

Subsequent selections of the application display the page that was in view when the application was last exited.

For additional information, refer to eRouteManual.

5 IDENT Page Soft Key

Selection displays the IDENT page.

6 SYSTEM Page Soft Key

Selection displays the SYSTEM page.

7 Message (MSG)

Displayed (white)—

- one or more applications has an uplink available
- displays in the header regardless of the application displayed
- displays next to the affected application soft key on the Main Menu page
- removed from display upon selection of appropriate application.

Only one message at a time can be displayed next to an application soft key. FAULT takes priority over MSG. MSG displays, as applicable, after the fault has been cleared.

8 XFR

Displayed (green)—

- the display is in transfer mode and the current view of the other EFB is being displayed
- only MENU and XFR key selections are enabled while in transfer mode.

9 VIDEO Application Soft Key

Selection starts the video surveillance application.

For additional information, see Video Surveillance (Typical) on page 10.80.55.

10 DOCUMENTS Application Soft Key

Selection starts the documents application.

After flight initialization, displays the DOCUMENT LIBRARY page.

Subsequent selections of the application display the page that was in view when the application was last exited.

For additional information, see EFB Document Browser on page 10.80.3.

11 PILOT UTILITIES Application Soft Key

Selection starts the pilot utilities application.

Subsequent selections of the application display the page that was in view when the application was last exited.

For additional information, see PILOT UTILITIES on page 10.80.60.

12 INITIALIZE FLIGHT Soft Key

Selection initializes the installed applications for flight. The following functions are performed:

- clears all previous search results from each of the installed applications
- restores default settings in all installed applications and functions
- refreshes the effectivity expiration data on the IDENT page
- uploads specific data from the airplane's systems to various EFB applications.

After selection, soft key changes to CLOSE FLIGHT for later use.

For additional information:

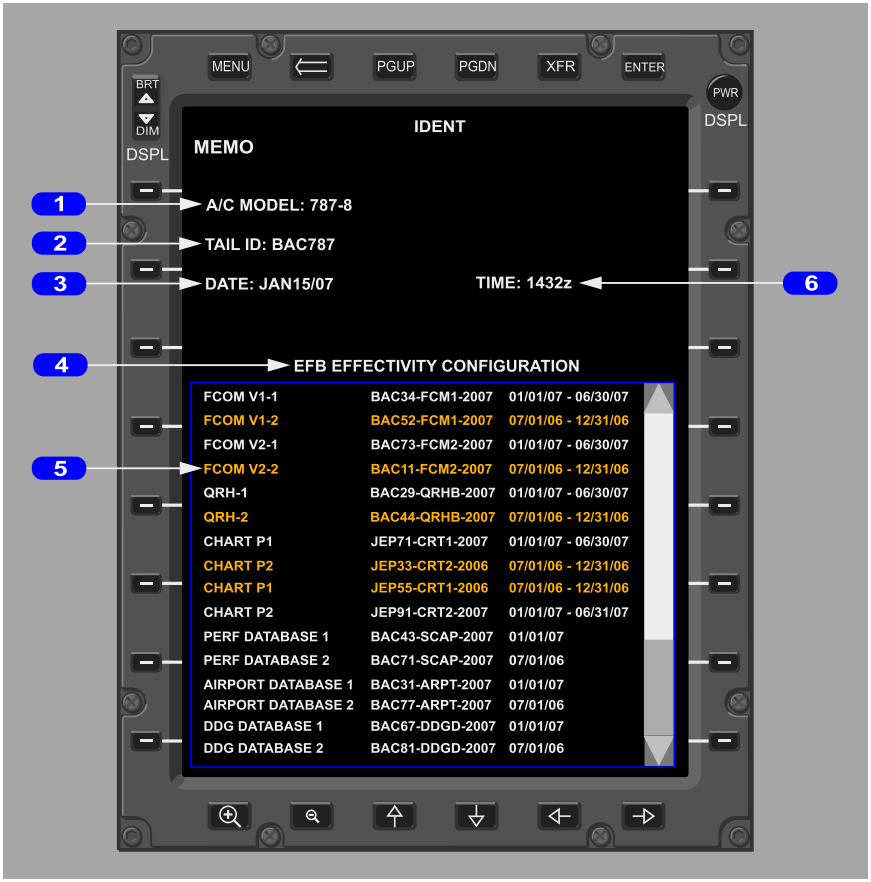
- See Initializing a Flight on page 10.80.2
- See Closing a Flight on page 10.80.2.

IDENT Page

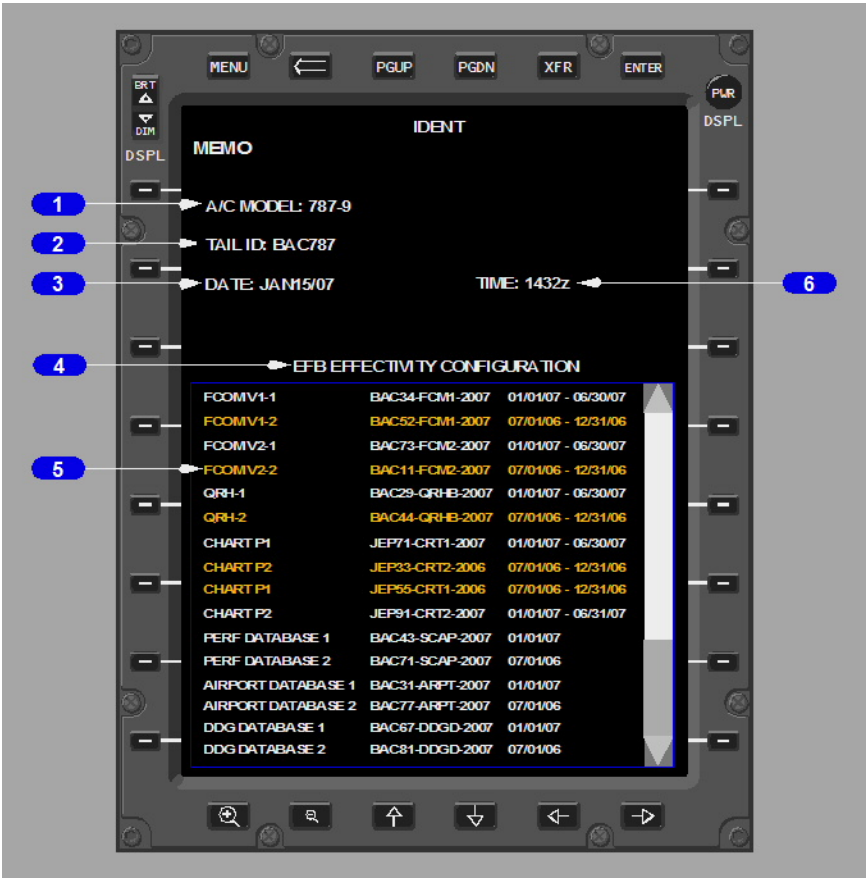
The IDENT page, which is accessible through the main menu page, displays airplane information, date and time, and software and database part numbers with associated effective dates. Part numbers with expired effective dates display in amber font. This page allows quick access to the operational readiness of the system, data, and documents required for flight.

Note: If the IDENT page is unavailable, all part numbers, regardless of effective dates, display on the SYSTEM page.

TQA to TQF



TWA,B



1 A/C MODEL

Displays the airplane model number.

2 TAIL ID

Displays the airplane registration number.

3 DATE

Displays the current date based on Zulu time.

4 EFB EFFECTIVITY CONFIGURATION

Displays the list of loaded databases including; name, part number, and effectivity dates.

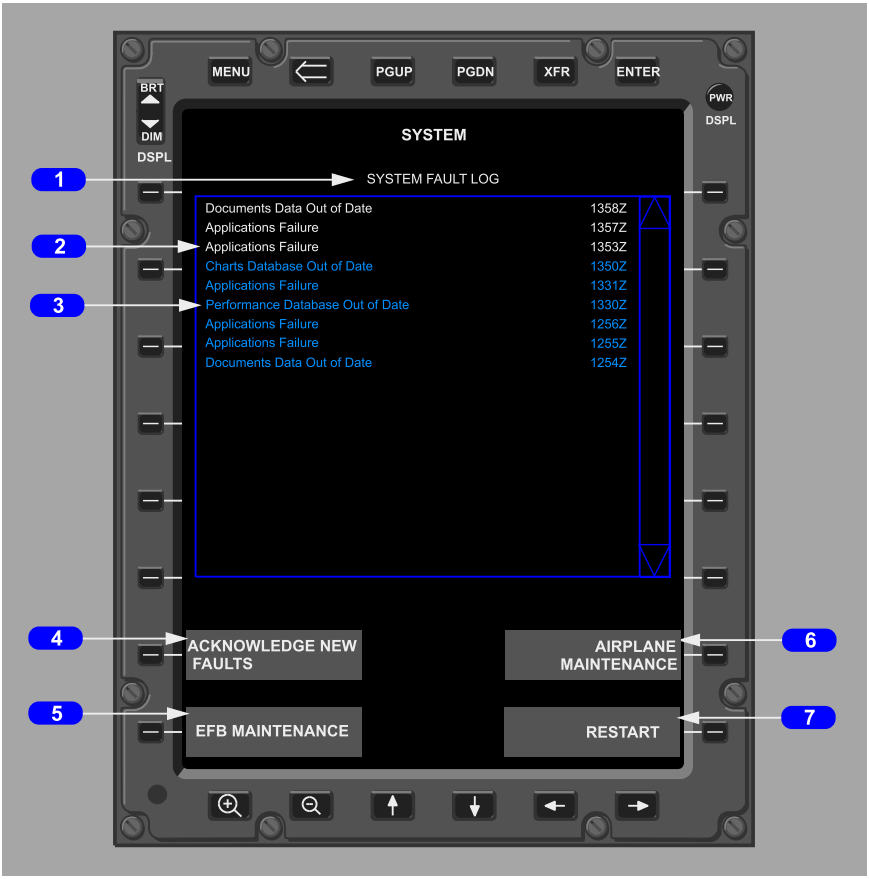
5 Out of Date Database (amber)

An out of date database displays in amber. MEMO displays in the header on all pages and next to any affected applications on the MAIN MENU page.

6 TIME

Displays the current Zulu time.

SYSTEM Page



1 SYSTEM FAULT LOG

Displays a list of hardware, software, and application faults that have occurred within the system, and the time they occurred since the last power-up cycle.

2 Unacknowledged Fault

Unacknowledged fault information is displayed in white.

3 Acknowledged Fault

Acknowledged fault information is displayed in cyan.

4 ACKNOWLEDGE NEW FAULTS Soft Key

Selection acknowledges all new faults.

Unacknowledged faults change to cyan and the FAULT message displayed on the MAIN MENU page adjacent to the SYSTEM page soft key is removed.

Becomes selectable only when there are unacknowledged faults in the list.

5 EFB MAINTENANCE Soft Key

Selection displays the EFB Maintenance menu page. This menu and its applications are for maintenance use only.

6 AIRPLANE MAINTENANCE Soft Key

Selection displays the Airplane Maintenance menu page. This menu and its applications are for maintenance use only.

7 RESTART Soft Key

Selection shuts down all applications and initiates a restart.

After selection, IN PROGESS displays above the RESTART soft key.

After restart, COMPLETE momentarily displays above the RESTART soft key.

This function is for maintenance use only.

EFB Virtual Keyboard Display

The virtual keypad can be used to type information, such as airport identifiers or performance data, into the EFB applications. The keypad is automatically activated for certain functions such as airport searches and performance data entry. The typed selection displays in the active field and can either be in an application, or the field in the keypad itself. The typed data, when complete, is then entered into the appropriate field in the application, or searched for with the returned results listed above the keypad. See each individual application description in this chapter for more information on using the keypad.



1 Data Entry Field

Displays the data entered using the virtual keyboard. The data entry field will display in various locations on the screen depending on the current application being used (this example is for the Airport Search function).

2 Symbol (SYMB)/Number (NUM) Key

Selection toggles between symbols and numbers on the numeric keypad.

Displays cyan when not required for the active data entry field.

3 Space (SP) Key

Inserts a blank space into the active data entry field.

4 Clear Field (CLR FLD) Key

Deletes everything in the active data entry field.

5 Backspace (BKSP) Key

Deletes the previous character in the active data entry field.

6 SHIFT Key

Selection toggles between upper case and lower case on the ALPHA keypad.

Displays cyan when not required for the active data entry field.

EFB MAIN MENU Page

The MAIN MENU page contains access to all the hosted applications via soft keys displayed on the page. The MAIN MENU page also contains the IDENT page and SYSTEM page soft keys, as well as the INITIALIZE FLIGHT soft key. All of these items are described later in this chapter. The MAIN MENU page also displays the FAULT, MEMO, and/or MSG label adjacent to the appropriate application or system soft key.

The MAIN MENU page can be displayed at any time by selecting the MENU bezel button.

SYSTEM Page

If a system FAULT, MEMO, and/or MSG indicator appears on the EFB screen, more information regarding the indication can be found on the SYSTEM page. All existing EFB faults are displayed on the system page. New faults display at the top of the list. Unacknowledged faults display in white font; acknowledged faults display in cyan font. If needed, use the scroll bar to view additional faults. When all faults are acknowledged, the FAULT, MEMO, and/or MSG indicators are removed.

On the SYSTEM page are three applications that should be reserved for use by maintenance personnel. The RESTART soft key is used to restart the Windows operating system. The AIRPLANE MAINTENANCE and EFB MAINTENANCE soft keys provide access to airplane and EFB maintenance pages.

EFB Messages Table

Message	Description
FAULT	Indicates that a fault has occurred. Navigate to the SYSTEM page for more information.
MEMO	Indicates that an application requires attention. When this message displays, navigate to the corresponding application for more information.
MSG	Indicates that one of the applications has a message. When this message displays, navigate to the corresponding application to view the message.
XFR	Indicates that the system is in transfer mode and the contents of the off-side EFB are being displayed. While in this mode, the display cannot be manipulated. Select the XFR soft key or MAIN bezel key to cancel the transfer mode.

Initializing a Flight

The flight is initialized during the CDU/EFB Preflight Procedure.

After initializing the flight the following information is collected from the airplane systems and made available to the EFB applications:

- flight deck date and time
- GPS latitude, longitude, date, and time
- true and magnetic heading
- origin and destination airports
- flight number
- airplane tail number
- several performance data points
- departure runway
- outside air temperature
- altimeter setting
- gross weight (if zero fuel weight entered).

For specific information gathered by each application during flight initialization, see the individual application descriptions found in this chapter.

During flight initialization, all applications are reset to the start-up default settings, thus clearing any information loaded or viewed by the previous flight crew.

To initialize the flight select INITIALIZE FLIGHT from the MAIN MENU page.

Note: During the initialization process certain application soft keys turn cyan to indicate unavailability. This is normal and the applications become available after the initialization is complete.

If the INITIALIZE FLIGHT soft key is not available, a flight has already been initialized. Before initializing a new flight, the current flight must be closed.

Closing a Flight

At the end of the flight, the EFB and its applications should be properly closed. To close the flight select CLOSE FLIGHT from the MAIN MENU page. This "cleans up" the EFB application data, effectively deleting all flight-specific information from memory. A complete power down of the EFB accomplishes a similar function, but only for the non-persistent application data, such as Chart Clips and performance entries.

Note: The CLOSE FLIGHT soft key toggles to INITIALIZE FLIGHT after selection. If INITIALIZE FLIGHT is displayed on the soft key, the flight has already been closed.

EFB Document Browser

Overview

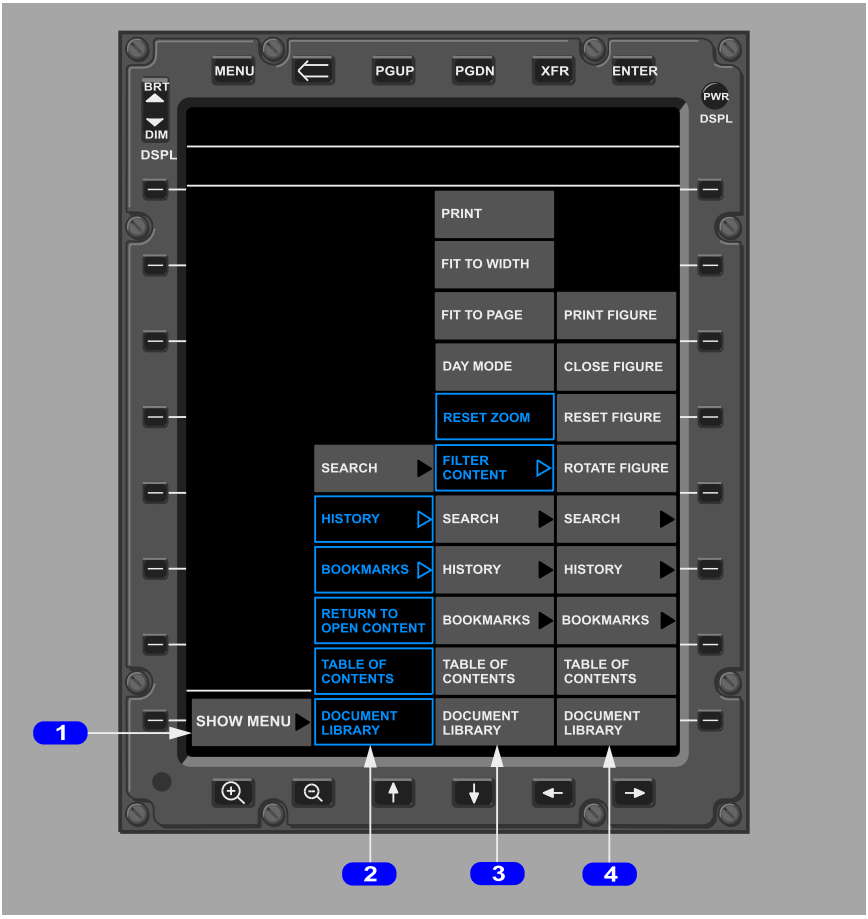
The EFB Document Browser (EDB) application provides the ability to view and search electronic information on the flight deck. The documents included in the library can be customized and loaded by the user. Therefore the descriptions and illustrations provided in this section are examples of a typical EDB installation and may not exactly reflect the currently installed configuration.

Using the EDB, the pilot can quickly and easily navigate throughout the document to find critical information. Key features include eliminating paper documents from the flight deck, ease of navigation within documents, support for XML, HTML, and PDF document formats, support for printing with flight deck printer, key word searches, zooming capabilities, and night use via white text on black background (XML and HTML only).

Although there are limitations to the included PDF functions, the EDB can easily display these types of documents and does provide limited search capabilities.

Note: For consistency, “document” is used throughout this section to describe a book, guide, handbook, or other entire document; “chapter” refers to a section, part, or other division of a document.

Typical EDB Menus



1 SHOW MENU Soft Key

Selection opens a cascading menu of application or screen specific tasks. Items in cyan are unavailable in the present application or screen. Arrowheads indicate the soft key has further cascading menu options.

Note: Menu items vary with content being displayed. Items also vary when viewing XML, PDF, HTML or other display formats.

2 DOCUMENT LIBRARY Menu List

The DOCUMENT LIBRARY page has the following menu items:

- SEARCH—selection opens a further menu
- HISTORY—selection opens a further menu
- BOOKMARKS—selection opens a further menu
- RETURN TO OPEN CONTENT—selection returns view to the currently open document
- TABLE OF CONTENTS—selection returns view to the table of contents
- DOCUMENT LIBRARY—selection returns to the Document Library page.

3 VIEW CONTENT Menu List

The VIEW CONTENT page has the following menu items in addition to some of the DOCUMENT LIBRARY menu items:

- PRINT—selection starts the printing feature
- FIT TO WIDTH (PDF only)—selection expands the document display to the full width of the display area
- FIT TO PAGE (PDF only)—selection presents the entire page of the document in the display area
- DAY/NIGHT MODE (XML and HTML only)—selection toggles between day and night modes
- RESET ZOOM—selection resets the page to the original size
- FILTER CONTENT (XML ONLY)—selection opens a further menu to enter an aircraft tail ID.

4 VIEW FIGURE Menu List

The VIEW FIGURE page has the following menu items in addition to some of the VIEW CONTENT menu items:

- PRINT FIGURE—selection starts the printing feature
- CLOSE FIGURE—selection closes the VIEW FIGURE page and returns to the VIEW CONTENT page where the figure was selected
- RESET FIGURE—selection resets the figure to the original view (removes any rotation or zoom)
- ROTATE FIGURE—selection rotates the figure 90º clockwise. Further selection rotates the figure 90º counter-clockwise.

Viewing Documents or Content

Select and load content to view in any of the following ways:

- select a document from the DOCUMENT LIBRARY page, or
- select a chapter from the TABLE OF CONTENTS page, or
- select a chapter from the History list, or
- select a chapter from the VIEW BOOKMARKS page (if chapter was viewed since initializing the flight), or

- search for words in a document by using the Search function.

After navigating away from viewing the document, select SHOW MENU and then RETURN TO OPEN CONTENT to go back to the currently open content.

Only one document can be viewed at a time. A document selected for viewing remains in the browser until another document is selected, even after exiting the EDB application and returning at a later time.

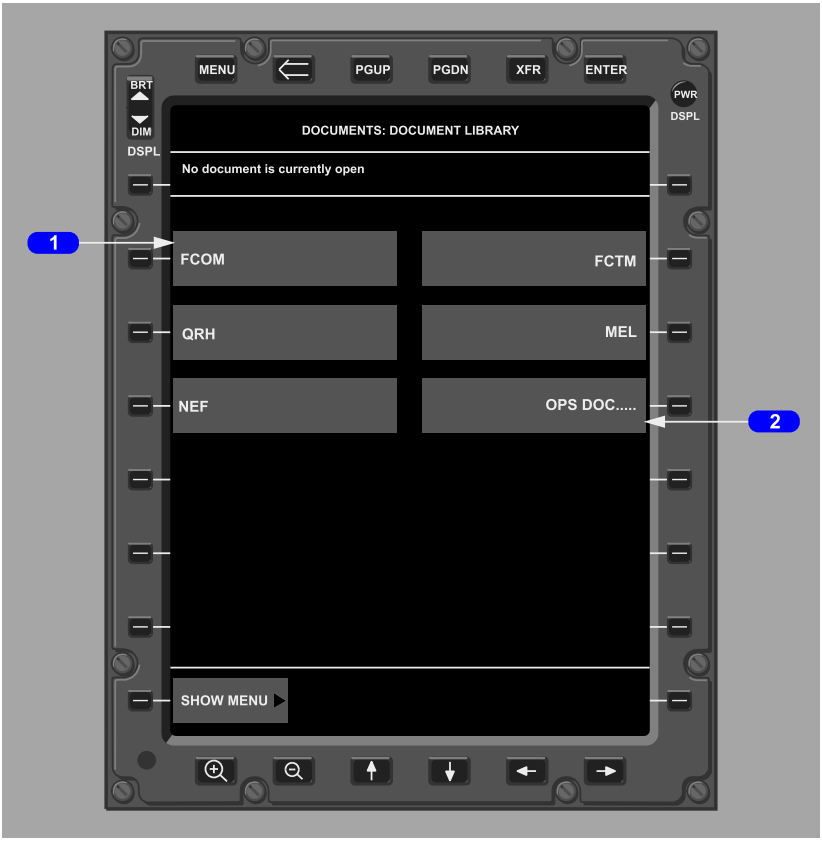
Notes: 1. Initializing a flight clears all previous references (searches, bookmarks, etc.) to any document.

2. For XML documents, the default setting is to display the content associated with a specific tail number. If necessary select SHOW MENU, FILTER CONTENT, and then ALL TAIL NUMBERS to display document content regardless of tail number.

Selecting a Document from the Document Library

The DOCUMENT LIBRARY page displays all of the documents that are available for viewing which may include both single documents and groups of documents. For example, the Document Library might include a Maintenance Documents group; when that group is selected, the titles of the documents defined for that group are displayed in a sub-library page.

DOCUMENTS: DOCUMENT LIBRARY Page



1 Document Soft Key

Selection opens the corresponding document.

After flight initialization, displays the document table of contents.

Subsequent selections of the document display the page that was in view when the document was last exited.

2 Document Group Soft Key

Document groups display the group title followed by an ellipsis (...). Selection displays a second level of the Document Library listing all documents in the group. Selection of a document at this level opens the corresponding document.

After flight initialization, displays the document table of contents.

Subsequent selections of the document display the page that was in view when the document was last exited.

Select the BACK bezel key or the RETURN soft key to access the previous level.

To select a document from the Document Library:

- select DOCUMENTS from the EFB MAIN MENU page. If the EDB application was previously accessed, the system displays the last page being viewed before exiting the application. In this case, select the SHOW MENU soft key and then DOCUMENT LIBRARY
- if necessary, use the PGUP and PGDN bezel keys to page through the document list and locate the document to view. Documents are listed individually or grouped into categories. Grouped documents display in the top-level page only and are identified by use of an ellipsis (...) in the title.

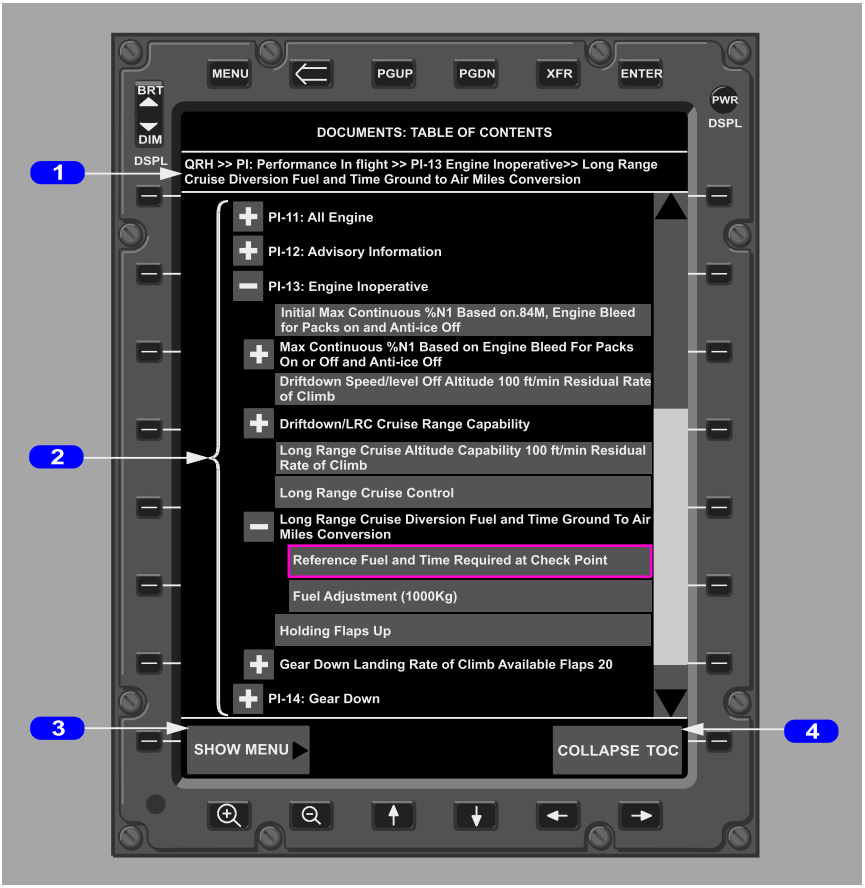
Select the name of the document to view. Depending on whether the document is divided into chapters, one of the following occurs:

- if the selected document does not have a Table of Contents, the document's content displays in the VIEW CONTENT page
- if the selected document is divided into chapters, the TABLE OF CONTENTS page displays with the document title or abbreviation at the top of the page.

DOCUMENTS: TABLE OF CONTENTS Display

From the TABLE OF CONTENTS screen, expand (+) or collapse (–) the Table of Contents as needed to locate the chapter to view. Select COLLAPSE TOC to collapse all the entries in the Table of Contents. Select a chapter to display its contents in the VIEW CONTENT page.

At any time, to return to the TABLE OF CONTENTS screen, select SHOW MENU and then TABLE OF CONTENTS.



1 Hierarchy Chain

Displays the hierarchy of the table of contents.

Begins with the document name and lists the chapter and section, each separated by (>>), as the table of contents is expanded.

The last entry is the current position and is in bold font.

Remains displayed while viewing the document on the VIEW CONTENT page and continues to update as the document is browsed.

2 Table of Contents

Displays the table of contents for the document.

Can be expanded by selecting the + symbol, or collapsed by selecting the – symbol.

Scrolling is controlled using the scroll bar at the far right of the screen.

Content can be displayed on the VIEW CONTENT page by selecting the chapter/section soft keys.

3 SHOW MENU Soft Key

Selection opens a cascading menu of application or screen specific tasks. Menu items not available for the current application or screen are displayed in cyan.

4 COLLAPSE Table of Contents (TOC) Soft Key

Selection returns the entire table of contents to the collapsed view.

Selecting a Document from the History List

Because the EDB application tracks the order in which the documents and chapters were viewed, the History menu option allows the easy return to a previously viewed document or chapter.

To view the content of a document or chapter from the History list:

- select SHOW MENU, HISTORY, and then PREVIOUS HISTORY ITEM to view the content of the previous document or chapter in the history list
- select SHOW MENU, HISTORY, and then NEXT HISTORY ITEM to view the content of the next document or chapter in the history list.

Note: Initializing or closing a flight clears the History list.

Selecting Document Content Using Bookmarks

Using the BOOKMARKS menu function marks content within a chapter for easy retrieval. All bookmarks are stored in a list that displays on the VIEW BOOKMARKS page. The bookmarks function is only available in documents with a table of contents, and only one bookmark in each chapter is permitted. Bookmarks are grouped by document.

To create a bookmark for the content being viewed select SHOW MENU, BOOKMARKS, and then CREATE BOOKMARK. To view a bookmark select SHOW MENU, BOOKMARKS, and then VIEW BOOKMARKS to display the VIEW BOOKMARKS page. Select the document name and then the chapter from the expanded list. The beginning of the chapter's content displays in the VIEW CONTENT page.

Note: Initializing or closing a flight deletes all saved bookmarks.

DOCUMENTS: VIEW BOOKMARKS Page



1 Document Title

Displays the document title where the bookmark is located.

2 Document Chapter/Section

Displays the document chapter/section where the bookmark is located.

Selection displays the VIEW CONTENT page at the beginning of the bookmarked chapter/section.

3 SHOW MENU Soft Key

Selection opens a cascading menu of application or screen specific tasks. Menu items not available for the current application or screen are displayed in cyan.

4 COLLAPSE BOOKMARKS Soft Key

Selection returns the bookmarks to the collapsed view.

Navigating Through a Document

While viewing document content, moving within the document is accomplished in several ways:

- select the PGUP or PGDN bezel key to scroll through chapters that are too long to fit on one screen
- use the scroll bar and arrow bezel keys to move through the displayed content
- select a hyperlink in XML or HTML documents to display the graphics in the VIEW FIGURE page.

In the VIEW FIGURE page:

- use the zoom bezel keys to magnify the image
- use the ROTATE FIGURE menu function to rotate the image to the right or left
- use the RESET FIGURE menu function to return the rotated figure to its original orientation
- use the CLOSE FIGURE menu function to return to the VIEW CONTENT page use the PRINT FIGURE menu function to print the image on the flight deck printer.

Changing the Display of a Document

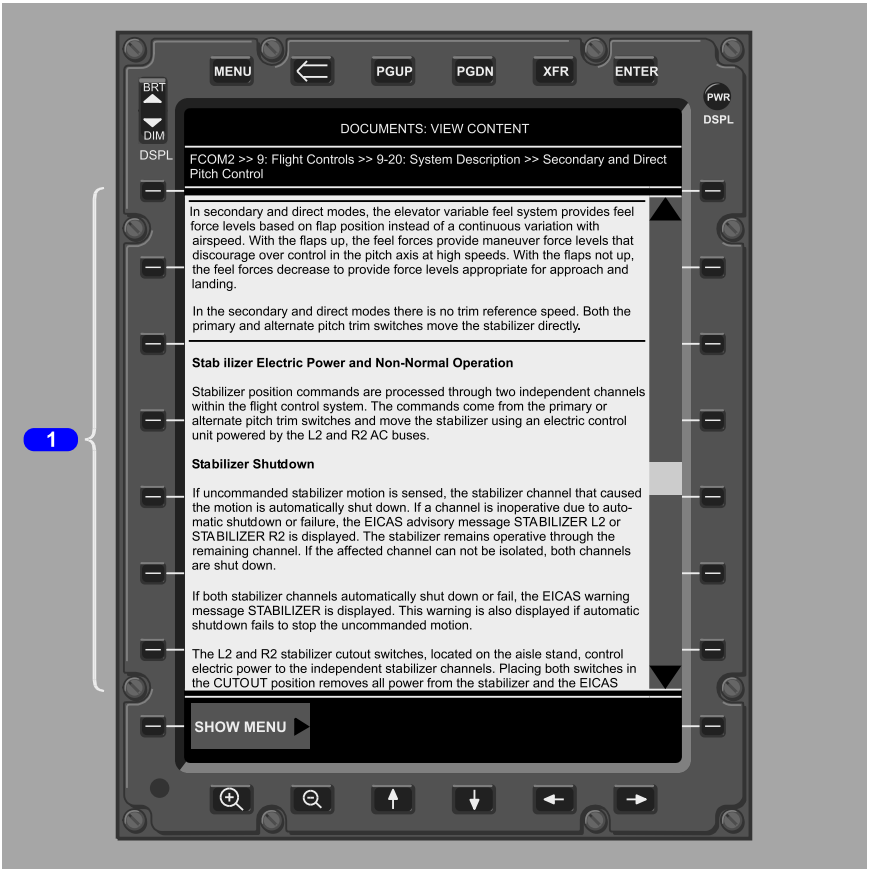
Use any of the options described below to change the display of a document.

For all types of documents; select the zoom bezel keys to change the magnification of the content.

For XML and HTML documents; select SHOW MENU and DAY MODE or NIGHT MODE to toggle between day and night mode viewing if both modes are available.

For PDF documents; select SHOW MENU and FIT TO WIDTH to expand the document display to the full width of the display area. Select SHOW MENU and FIT TO PAGE to view the entire page of the document in the display area. Select SHOW MENU, ROTATE, and then RIGHT or LEFT to rotate the document display 90º to the left or right while maintaining the same view factors.

DOCUMENTS: VIEW CONTENT Page—Day Mode



1 Displayed day mode text

Displays the content in black text on a white background.

Searching for Information within Documents

Text string searches within documents can be performed using the EDB search function. The search results can be limited so that one or all text strings can be included in the search results. Searches can be performed across one, several, or all documents in the Document Library.

To search for one or more text strings select SHOW MENU, SEARCH, and then NEW SEARCH.

Select how a search for multiple text strings is conducted by selecting one of the following options in the Advanced Options area.

In the Enter Search Term field, type the text string(s) to search on. If possible, do not type “and” or “or” in this field. Use a space to separate multiple text strings.

On the SEARCH RESULTS page a Progress monitor displays in the top center of the screen displaying the progress of the current search. After the search is complete, the Progress monitor is removed. The page displays each location that contains the search term specified. The list can be sorted by number of hits, or location in both ascending and descending order.

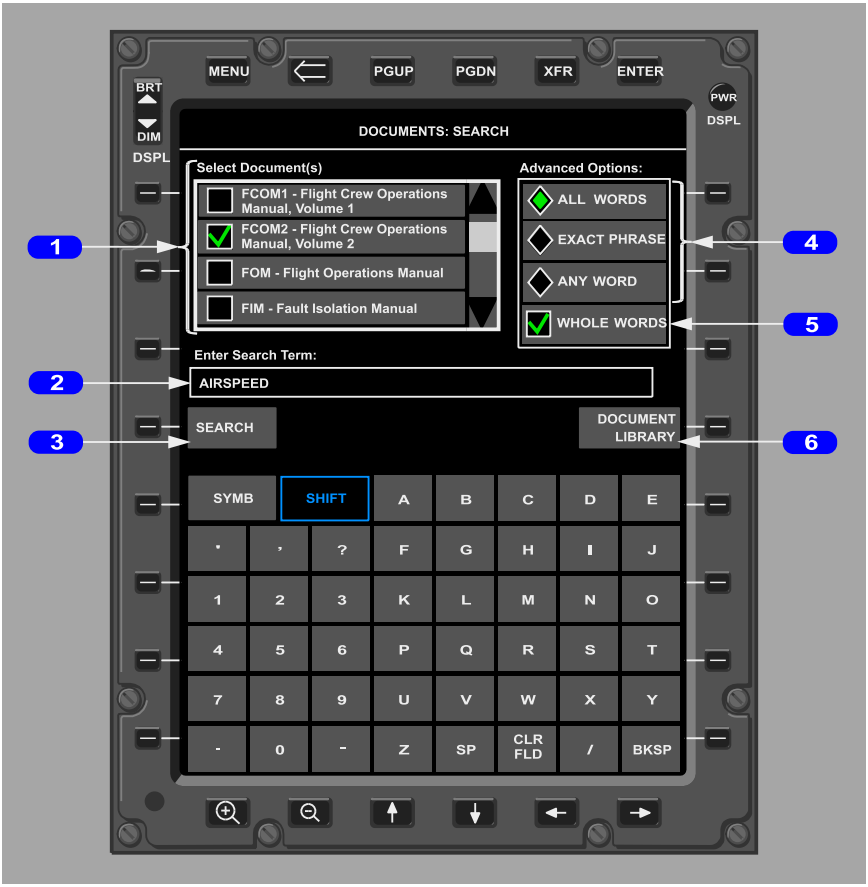
Note: If the search is too large and retrieves many results, selecting CANCEL SEARCH stops the search and returns to the SEARCH page so the original search terms can be refined as necessary.

Select from the results list to view its content in the preview window. Search results display in yellow highlighted text.

Select OPEN DOCUMENT to view the document in the VIEW CONTENT page at the location of the search term. Search results display in yellow highlighted text.

Select SHOW MENU, SEARCH, and SEARCH RESULTS to return to the SEARCH RESULTS page.

DOCUMENTS: SEARCH Page



1 Select Document(s)

Displays a list of available documents in which a term can be searched. Search all documents or individual document titles by placing a green check mark in the box next to the appropriate title. The check mark is removed by selecting the box again.

2 Enter Search Term

Displays the entered search term. Valid entries are alphanumeric strings, separated by a space if more than one term is required.

3 SEARCH Soft Key

Selection begins a search. The Search Results page is displayed while the search is being performed.

4 Advanced Options

Displays a list of advanced search options which can be individually selected. Only one option can be selected from the list.

- ALL WORDS—searches document sections for all text strings typed in the Enter Search Term field. For example, searching for the entry "flaps slats speed" will return hits where the words flaps, slats, and speed occur in a document section regardless of order
- EXACT PHRASE—searches document sections for the phrase exactly as typed in the Enter Search Term field. For example “flap retraction speed”
- ANY WORD—searches document sections for any of the text strings typed in the Enter Search Term field. For example, the entry "flaps slats speed" will return hits for every occurrence of "flaps", every occurrence of “slats” and every occurrence of “speed”.

Selection places a green diamond marker in the area left of the appropriate option.

The diamond marker is moved to another option by further selection.

5 WHOLE WORDS

Displays the option to search on whole words only. For example, when this option is active searching for "speed" finds only the whole word "speed" and does not return results for the words "airspeed" or "groundspeed".

Selection places a green check mark in the box left of the option.

The check mark is removed by selecting the box again.

6 DOCUMENT LIBRARY Soft Key

Selection returns to the Document Library page.

DOCUMENTS: SEARCH RESULTS Page



1 Search Term

Displays the term that was used in the search for the results listed.

2 Search Results Filter

The search results can be displayed by the number of hits or in what document and chapter they occur. The results can be viewed in ascending or descending order.

3 Search Results Soft Key(s)

Displays the search results for the term entered. Each soft key displays the number of hits and the search result hierarchy. The hierarchy could contain the following; document title >> chapter number and name >> section number and name.

Selection of the results soft key highlights it in green and displays the results in the preview window. The displayed results are the lowest level in the hierarchy and the first occurrence of the term.

4 Search Results Preview Window

The highlighted search results from the soft key selected document are displayed in the preview window.

5 CANCEL SEARCH Soft Key

Selection cancels the search in progress and returns to the Document Search page. Soft key is removed from the display when the search is complete.

6 Progress Timer

Displays the current search progress. Timer is removed from the display when the search is complete.

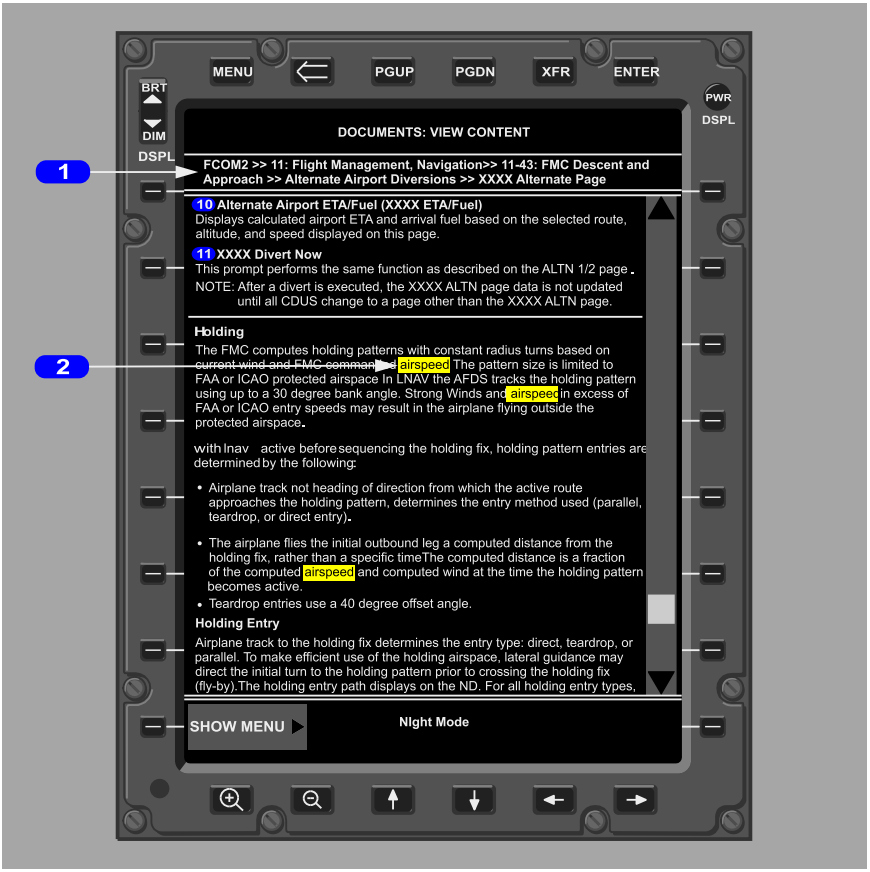
7 Result

Displays the current search result number being displayed in the preview window and the total number of hits the search provided.

8 OPEN DOCUMENT Soft Key

Selection displays the document currently displayed in the preview window on the VIEW CONTENT page. The document is displayed at the location of the highlighted search result.

Search Results Display on the VIEW CONTENT Page



1 Hierarchy Chain

Displays the hierarchy of the displayed page.

2 Highlighted Search Results

The highlighted search results are displayed where they occur in the document.

Viewing Large Tables

Table rows and columns resize based on their content to avoid wrapping of any word. An individual table cell can be selected to highlight its location. Selection of a column header or row header will highlight and select the entire row or column. Clicking on the cell, column or row again removes the highlighting.

Printing a Document on the Flight Deck Printer

Both text and graphics are available from a PDF, XML, or HTML document when using a graphics printer.

Printing XML and HTML Documents

When printing an HTML document (including graphics), the system prints all content contained within the scroll bars on the VIEW CONTENT page.

For XML documents, only the section being viewed will print instead of all the content between the scroll bars on the VIEW CONTENT page.

Another print job can not be started until the PRINT soft key becomes active.

Printing PDF Documents

When printing a PDF document, position the top of the page at the top of the VIEW CONTENT page to ensure that the correct material prints. Selecting PRINT will print the PDF page that is displayed.

Another print job can not be started until the PRINT soft key becomes active.

Understanding Document Conventions

Documents that conform to the Boeing FTID XML Schema and use related style sheets adhere to the following conventions:

- WARNING text is displayed in red font, CAUTION text is displayed in amber font, and NOTE text is displayed in bold font
- linked text is denoted by a dark gray box around the specific text, similar to a soft key on the EFB interface
- graphics are linked so that they can display in a separate page that allows zooming
- a document can display in Day mode, which is suitable for bright light conditions, or Night mode, which is suitable for dark conditions.

Troubleshooting

The EFB Document Browser application might display the following memos upon flight initialization or application startup:

- DOCUMENT EFFECTIVITY OVERLAP—two or more of the same documents have a date overlap. Select the proper document for the flight
- DOCUMENTS ARE OUT OF DATE—one or more documents have exceeded their effectivity dates. Select CONTINUE to use a document, regardless of effectivity (if permitted by customer EFB administrator)
- DOCUMENT FAILED TO PRINT—an error occurred preventing the document from printing. Select CONTINUE to acknowledge the error and return to the VIEW CONTENT page
- CONTENT FAILED TO LOAD—an error occurred preventing content from displaying. Select RETURN to acknowledge the error and return to the VIEW CONTENT screen

- TAIL ID UNAVAILABLE—a tail number included as part of the effectivity is not available. Select CONTINUE to acknowledge the error and go to the DOCUMENT LIBRARY page. Tail-filtering functionality for XML documents will be unavailable for the remainder of the flight.

Typical Enroute Moving Map

Overview

Enroute Moving Map is a situational awareness application. When Enroute is connected to the airplane's systems, the application uses the airplane location data to enable live airplane tracking on the moving map. The application may be used to:

- View information on a moving map
- Create, modify, and load flight routes
- Search for navigational objects
- Retrieve navigational data details.

CAUTION: Although the Enroute application displays navigational data, it is not designed as a navigational tool, and the application does not display an own-ship symbol. Use other tools on the flight deck to navigate the airplane on the route of flight.

Starting the Application

To start the ENROUTE application, select ENROUTE from the EFB MAIN MENU page. The Navigation Mode (NAV) page displays when the application is first started.

Selecting an Application Mode

Four application modes are available:

- Navigation (NAV) Mode—displays a dynamic map in True North Up or Track Up orientation for situational awareness.
- Plan Route (ROUTE) mode—displays the screen for entering, reviewing or modifying a route.
- Regional Notes (NOTES) mode—displays notes equivalent to floating notes or cover/end panel notes on a paper chart.
- Reference Notes (NOTES) mode—displays information equivalent to end/cover panel information or Airway Manual references on a paper chart.

Navigation Mode (NAV) Page



1 Title Bar

Displays the current application mode. Also displays map orientation (North Up or Track Up), Map theme (High Enroute or Low Enroute), and current range scale.

2 Map Display Area

Displays map objects and symbols associated with the theme selected. Each theme displays a particular set of map objects and symbols.

EFB bezel zoom keys controls change the map range scale.

EFB BRT/DIM control switch and the Day and Night modes optimize the map contrast for lighting conditions.

3 Declutter Options Soft Keys

Shows or hides a variety of navigational information.

- APT—Show/hide IFR and VFR airports and airport localizer/ILS glideslope navigational aids
- AWY—Show/hide airways
- WPT—Show/hide waypoints
- SUA—Show/hide special use airspaces
- FIR—Show/hide flight information regions
- LATLNG—Show/hide latitude/longitude grid and grid MORAs
- NAVAID—Show/hide navigational aids (NAVAIDs)
- CTRL—Show/hide controlled airspaces (Air Traffic Radar Tracking and Control Area)
- UNCTRL—Show/hide uncontrolled airspaces (Only available when CTRL is selected)
- COMM—Show/hide communications data and enroute communication sectors
- TERR—Show/hide graduated surface terrain contours (Low Enroute theme only).

Note: Soft key is dimmed if a declutter option is not available in the current theme or zoom level.

4 Mode Soft Key

Displays one of the four application modes.

5 MAP Soft Key

Enables selection and displays Map modes "North Up" or "Track Up".

6 Theme Soft Key

Displays map objects associated with high-altitude or low-altitude airspace. Sub-menu selections are:

- High—map shows objects associated with high-altitude (High Enroute) airspace (operations at 20,000 feet and above), and Low Enroute (operations up to 20,000 feet above sea level
- Low—map shows objects associated with low-altitude (Low Enroute) airspace (operations up to 20,000 feet above sea level)
- Day Mode
- Night Mode.

7 AC Info Soft Key

Provides access to airplane information and other situational details. Sub-menu selections are:

- Position Information—Show/hide airplane location information. Includes current latitude/longitude location, altitude, true track angle, ground speed, and magnetic variance
- Active Waypoint—Show/hide active waypoint. Includes ICAO identifier and name, distance to the waypoint, cross-track error (XTE), estimated time enroute (ETE), and estimated time of arrival (ETA)
- Destination Airport—Show/hide destination airport. Includes ICAO identifier and name, bearing, track, distance from present position, estimated time enroute (ETE), and estimated time of arrival (ETA).

8 PPos Soft Key

Places the map within the context of the airplane's current position and restores moving map functionality if map motion had been suspended (e.g. while panning the map).

9 Search Soft key

Opens the Enroute Data Search dialog box to enable searching for navigational objects in the database.

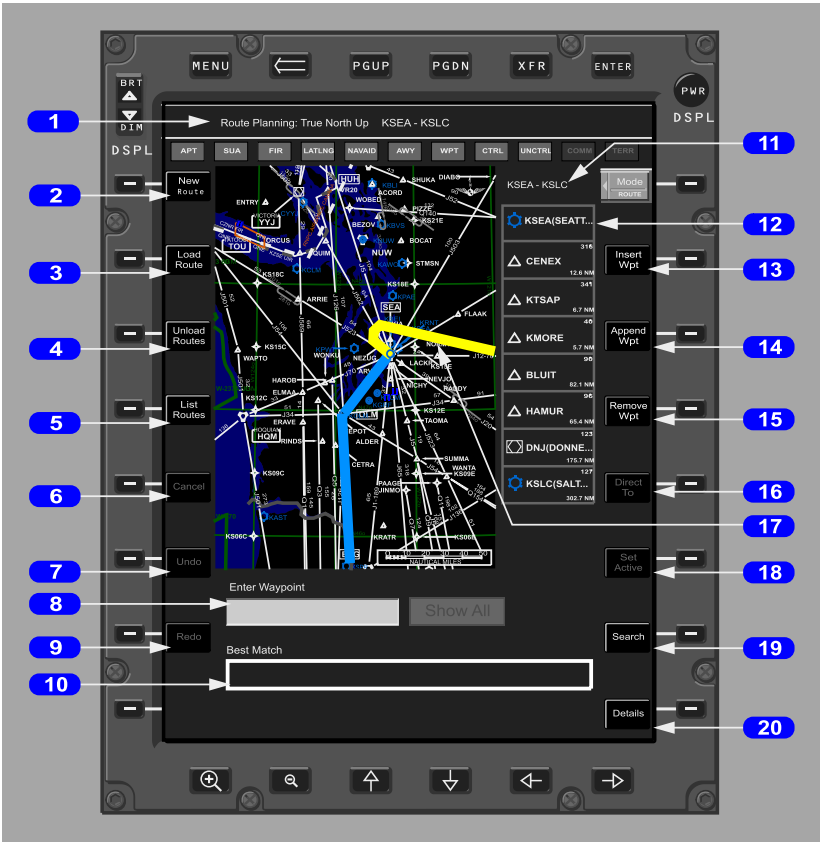
10 Details Soft Key

Opens the Details view to provide the details of an object on the map. To view object details, select the Details soft key and then select the object on the map display. Select the Close soft key to exit the details view.

11 Range Scale

Displays range scale units set by the airline EFB administrator such as: nautical miles per screen inch (NM/inch), or optional km/inch, km/cm, SM/inch, SM/cm, NM/inch, or NM/cm units.

Plan Route Mode (ROUTE) Page



1 Title Bar

Displays the current application mode. Also displays map orientation (North Up or Track Up) and active route.

2 New Route Soft Key

Enables creation of a new route. If the EFB is connected to aircraft systems detects an origin and destination airport, those airports are included in each new route. The name of the route matches origin and destination airport entries.

3 Load Route Soft Key

Displays one or more of the routes created on the route-planning map.

4 Unload Route Soft Key

Clears all routes from the map.

5 List Routes Soft Key

Displays a list of all routes that are currently loaded and enables retrieval of existing routes.

6 Cancel Soft Key

Cancels the previous action.

7 Undo Soft Key

Reverts to the previous state.

8 Enter Waypoint Field

Enter information to locate an object or designate a route. A keyboard is automatically displayed when selecting the entry field.

9 Redo Soft Key

Restores the previous action – Redo reverses an Undo action.

10 Best Match Field

Displays the best match for the text entered in the Enter Waypoint field. Select the Show All to display all matches.

11 Route Information

Displays a list of available routes or the currently active route being created or modified. For each route, the application shows the origin and destination, and the total distance of the route.

12 Route Details Display Area

Displays route/waypoint details.

13 Insert Wpt Soft Key

Enables insertion of a waypoint(s) from the Enter Waypoint text box. The application displays arrows next to the route detail at all of the possible insertion points. Adds the waypoint in the Enter Waypoint text box to the end of the route.

14 Append Wpt Soft Key

Adds the waypoint(s) in the Enter Waypoint text box to the end of the route.

15 Remove Wpt Soft Key

Removes waypoint is currently highlighted in route.

16 Direct To

Modifies route using the current airplane position as a waypoint and removes all intermediate waypoints and airways to move directly to another waypoint.

17 Route and Map Display Area

The active route appears on the map in yellow and any other selected routes appear on the map are blue.

18 Set Active

Enables override of the automated sequencing of waypoints and setting of any waypoint in the route as the active waypoint.

19 Search

Opens the Enroute Data Search dialog box to enable searching for any navigational object in the database.

20 Details

Displays details about an object on the map.

Creating or Modifying Routes

Routes must be created before they will display on the map. Enter an origin and destination airport if not already entered. Routing points may be added by one of following three entry methods:

- Airway routing—Enter point-to-point waypoints to complete the route. Airways are separated by a single period (dot). Two dots to connect waypoints direct without an airway. For instance, KSEA..KSLC indicates that the two airports are connected directly without using an airway. Airways within a route always connect through established navaids (i.e. route sequence BTG.V23.OED.V122.LMT).
- Plain text entry—enter an ICAO identifier, IATA identifier, airport name, city name, or a text string. (i.e. waypoint "BTG")
- Latitude/Longitude routing—enter the latitude/longitude information as part of multiple waypoints

Enter information in the Enter Waypoint field and select the Insert Wpt soft key and insert into the route. The application displays the available insertion points and draws the route on the map after insertion. Continue adding waypoints until route is complete.

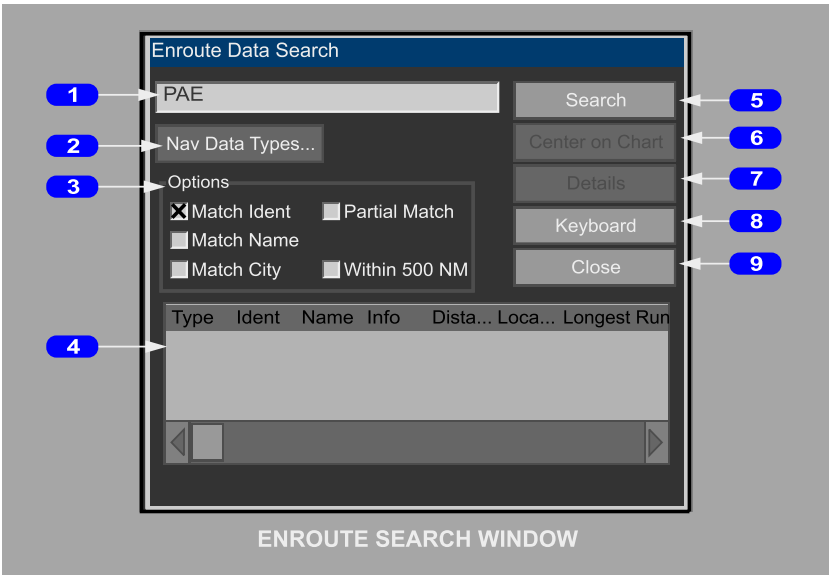
Existing routes may be modified using the same entry methods described above.

Note: Closing a flight and reinitializing the EFB erases routes from system memory.

Enroute Data Search

Use the Enroute Data Search function to search for navigational objects in the database. Objects may be searched by identifier, name, or location.

Search options may be applied to show only specific object types such as navigational data types, airports, fixes, airways, airspaces and distance from current position.

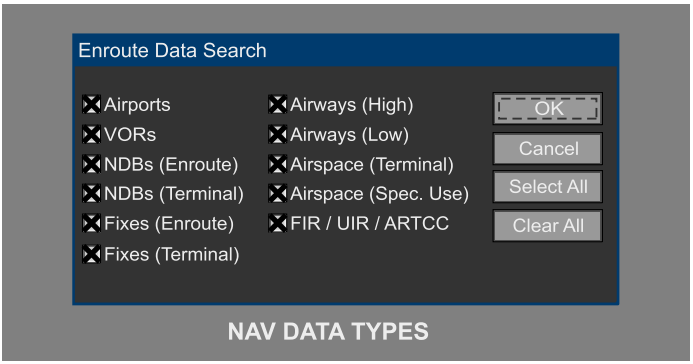


1 Search Entry Field

Enter a term to locate an object by name. A keyboard is automatically displayed when selecting the entry field.

2 NAV DATA TYPES Soft Key

Displays a window to specify the types of navigational data to include (or exclude) in the search. All types are selected by default.



3 Search Options

List of search options which can be individually selected to refine search results. More than one option can be selected from the list.

4 Search Results Area

Places the map within the context of the airplane's current position and restores moving map functionality if map motion had been suspended (e.g. while panning the map).

5 Search Soft Key

Displays results based on information entered.

6 Center on Chart Soft Key

Displays results based on information selected in the Search Results area.

7 Details Soft Key

Displays results based on information selected.

8 Keyboard Soft Key

Displays a touch sensitive keypad used for data entry.

9 Close Soft Key

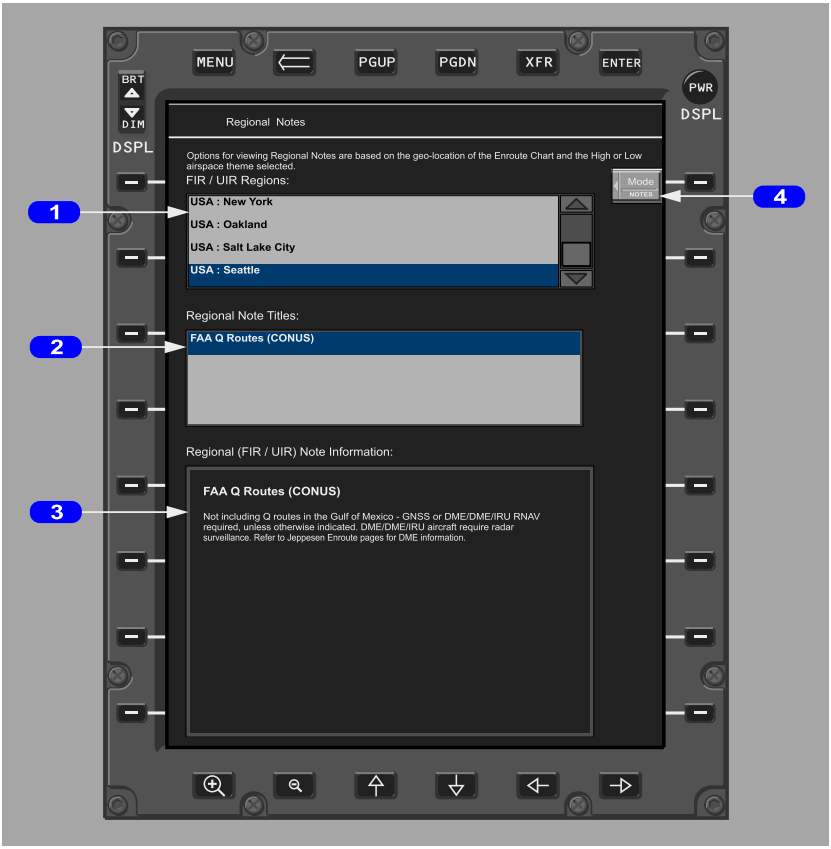
Selection closes the Enroute Data Search window.

Regional Notes

The Enroute application displays Regional Notes which have the following information:

- FIR / UIR Regions
- Regional Note Titles
- Regional (FIR / UIR) Notes Information.

The application filters the content based on the center of the current map location.



1 FIR / UIR Region Display List

Displays the list of available regions. Slide scroll box up/down or use up/down arrows to view available database regions.

2 Regional Note Titles Display List

Displays the list of Regional Notes titles associated with the selected region.

3 Regional (FIR / UIR) Note Information Display

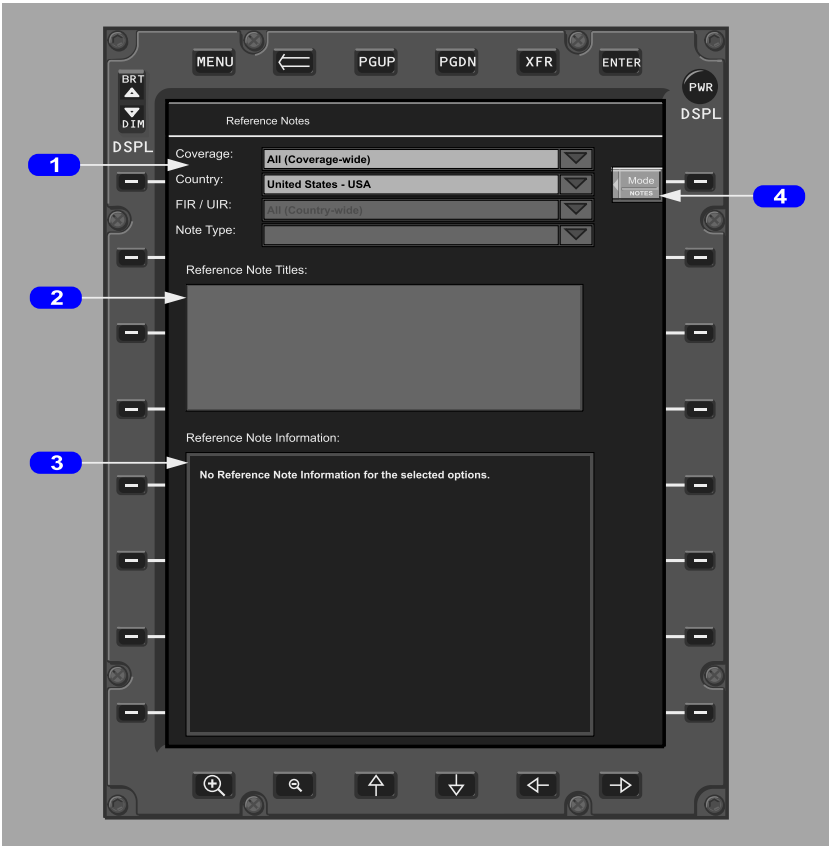
Displays the contents of the selected Regional Note.

4 Mode Soft Key

Select another application mode to exit the Regional Notes screen.

Reference Notes

The first time reference notes are accessed, the application automatically selects the coverage based on current location. Following that, reference notes always return to the information displayed during last access.



1 FIR / UIR Region Display List

Displays the list of available regions. Slide scroll box up/down or use up/down arrows to view available database regions.

2 Regional Note Titles Display List

Displays the list of Regional Notes titles associated with the selected region.

3 Reference Note Information Display

Displays the contents of the selected Regional Note.

4 Mode Soft Key

Select another application mode to exit the Regional Notes screen.

Typical Onboard Performance Tool

Overview

The Onboard Performance Tool (OPT) application calculates takeoff and landing performance using a combination of pre-loaded and manually-entered data for a specific aircraft configuration under current conditions.

The EFB administrator can activate or deactivate certain performance functions and set preferences such as; pounds or kilograms, flap configuration and brake settings, according to company policy and fleet management specifications.

CAUTION: The OPT application interface is configurable (keys, labels, colors, etc.). The information presented in this section represents a typical application and individual airline implementation may be different.

Pre-loaded Data and Pilot Inputs

Pre-loaded data are configured, maintained and updated by the customer's EFB administrator. This data can include information about the following items:

- the airport; such as airport elevation, runway information, takeoff intersections, obstacle information, etc.
- the aircraft; such as tail number, engine type and rating, flap configurations, MEL, CDL, loading capacity, CG envelope, etc.
- NOTAM data that might affect performance; such as temporary runway construction, runway modifications, or obstacles
- company policies; such as V1 basis, the use of lineup allowances, contaminated runway selections.

After selecting INITIALIZE FLIGHT on the EFB MAIN MENU page, the following information is retrieved from the FMC by the OPT application:

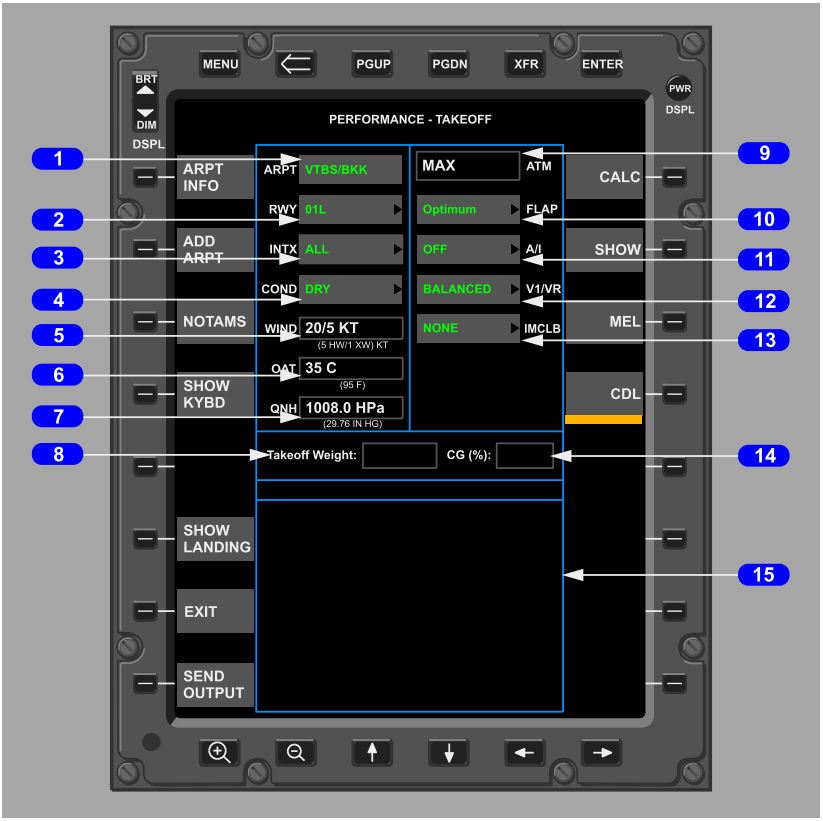
- origin airport
- departure runway

- destination airport
- outside air temperature
- altimeter setting
- aircraft gross weight.

Note: The altimeter value transferred to OPT is the value displayed on the on-side PFD. In other words, if the INITIALIZE FLIGHT is selected from the captain's EFB, the altimeter value displayed on the captain's PFD is transferred to the OPT.

Any required data or selections not pre-loaded by the transfer function requires manual entry or selection prior to any performance calculation.

PERFORMANCE—TAKEOFF Inputs Page



1 Airport (ARPT)

Displays the airport identifier from the airport search function or transferred from the FMC route (RTE) page in the ORIGIN field. Manual entry of an airport on this page is not allowed.

2 Runway (RWY)

Displays the runway selected by the flight crew or transferred from the FMC route (RTE) page in the RUNWAY field.

Selection opens the drop-down list. Selecting a runway or EXIT closes the list.

Runways closed by NOTAM display amber. If selected an error message is displayed but the program still performs the requested calculation.

3 Runway Intersection (INTX)

Displays—

- NO INTX boxed in cyan when no runway intersection data exists
- INTX LIST in standard grey box when runway intersection data exists
- after selection, displays the runway intersection option selected.

Selection opens the drop-down list. Selecting from the list or EXIT closes the list.

If there are more than three intersections, the full-length runway and the first three intersections are grouped under the FIRST FOUR menu item. Selecting FIRST FOUR provides performance results for the full length runway and the first three intersections listed.

If there are fewer than three intersections, these are grouped with the full length runway under the ALL menu item. Selecting ALL provides performance results for the full length runway and every intersection listed.

4 Runway Condition (COND)

Displays the runway condition selected by the flight crew.

Selection opens the drop-down list. Selecting from the list or EXIT closes the list.

5 WIND

Displays the wind direction and speed (ddd/ss K) entered by the flight crew.

The wind direction can be replaced with a headwind or tailwind component by entering a numeric value. Headwind components are positive values (i.e. 10) and tailwind components are negative values (i.e. -10).

A tailwind component can also be entered using a leading or trailing T entered with the wind velocity (i.e. T10 or 10T).

6 Outside Air Temperature (OAT)

Displays the temperature entered by the flight crew or transferred from the FMC TAKEOFF REF page 2 in the REF OAT field.

Temperature is displayed in the unit (Celsius or Fahrenheit) set by company policy. The default can be over-ridden by typing a C or F after the value entered.

7 Barometric Pressure (QNH)

Displays the barometric pressure entered by the flight crew or transferred from the data displayed on the primary flight display (PFD). If the entry is made from the Captain's EFB, then the QNH value transferred is from the Captain's PFD. Likewise, the First Officer's EFB uses the QNH value transferred from his PFD.

Entry can be either hectopascals or inches of mercury. The value is automatically recognized as hectopascals or inches of mercury and is labeled accordingly.

8 Takeoff Weight

Displays the takeoff weight entered by the flight crew or transferred from the FMC performance initialization (PERF INIT) page in the gross weight (GR WT) field. The last occurrence of these entries is the takeoff weight displayed.

Calculation with the actual takeoff weight entered is used to determine the assumed temperature data for takeoff.

Calculation with the takeoff weight field blank is used to determine the maximum takeoff weight data.

9 Assumed Temperature Method (ATM)

Displays the assumed temperature value/modifier. The field becomes active after an entry in the Takeoff Weight field.

Valid entries are:

- 0 or MAX—either uses the maximum assumed temperature available
- positive values—use the number entered (i.e. entering 40 uses 40C) for the assumed temperature
- negative values—use a decrement equal to the value entered (i.e. entry of -10 is used as a 10 degree decrement) from the maximum assumed temperature available.

If the entry in this field is outside the operating parameters for the conditions, an error message displays after selecting calculate (CALC).

10 FLAPS

Displays the selected takeoff flap setting.

Selection opens the drop-down list. Selecting from the list or EXIT closes the list.

11 Anti-Ice (A/I)

Displays the selected anti-ice setting.

Selection opens the drop-down list. Selecting from the list or EXIT closes the list.

12 V1

Displays the selected V1 setting.

Selection opens the drop-down list. Selecting from the list or exit closes the list.

13 IMCLB

Displays the selected improved climb setting.

Selection open the drop-down list. Selecting from the list or exit closes the list.

14 Percent Center of Gravity [CG (%)]

Displays the percent center of gravity (CG%) entered by the flight crew. This is a mandatory entry but is not used in any performance calculation. It is used when transferring performance data to the FMC for the stabilizer trim calculation.

The CG field becomes active only after an entry in the Takeoff Weight field.

15 Performance Data Display Area

Displays the airplane performance information for the corresponding conditions selected.

Information displayed includes:

- flap setting
- engine out acceleration height
- runway and intersection if applicable
- takeoff gross weight
- engine power setting
- selected temperature
- V-speeds (V1, VR, V2)
- landing reference speed (VREF)
- runway information such as engine failure procedure.

Calculating Takeoff Performance

Unless otherwise specified, all of the information in this section is referenced to the Takeoff page in the OPT application.

To complete a takeoff calculation, entries in the following fields are required:

- ARPT—origin airport
- RWY—planned departure runway
- COND—departure runway condition

- WIND—airport surface wind
- OAT—outside air temperature
- QNH—altimeter setting
- FLAP—takeoff flap position
- A/I—anti-ice setting
- Takeoff Weight—actual takeoff weight
- CG—center of gravity value
- V1—V1 options
- IMCLB—improved climb options.

These required entries can be made by a combination of transferring data from the FMC and manual entry, or by manual entry alone.

The CALC soft key does not become available until all the required entries are complete. If an invalid value was entered in a field (for example, 299.2 in the QNH field or 430/15 in the WIND field), a system error displays either after the entry is made, or after CALC is selected.

The following fields are also available for use when required:

- INTX—takeoff runway intersection
- ATM—assumed temperature method value/modifier
- ARPT INFO—displays airport, runway and obstacle information
- ADD ARPT—temporary creation of an airport runway that is not contained in the database
- NOTAMS—temporary creation of a runway NOTAM that effects runway length or obstacles and may affect performance calculations
- SHOW/HIDE KYBD—display or hide the keyboard
- SHOW LANDING—toggles between the Performance Takeoff and Landing pages
- COPY FMC DATA—copy data from the FMC for use in performance calculations
- SEND OUTPUT—send performance data to various locations
- SHOW FULL/ATM—toggles between the full rated takeoff performance and the assumed temperature performance figures
- CALC—initiates the performance calculation
- MEL—items that may affect performance calculations
- CDL—items that may affect performance calculations.

After completing the takeoff data entries and selecting CALC, the following values are displayed in the performance results area:

- FLAP—flap setting
- ACCEL HT—engine out acceleration height
- V1, VR, V2 and VREF speeds
- RWY/INTX—runway and intersection

- TOGW—takeoff gross weight
- TPR or %N1—takeoff thrust setting
- SEL TEMP—selected/assumed temperature if available
- Engine Failure Procedure (if applicable).

For each takeoff calculation, OPT generates two types of performance if available; an assumed temperature method (ATM) and a full rated thrust. Both can be alternately displayed using the SHOW FULL/ATM soft key.

To calculate the takeoff weight complete all the required fields and enter the actual gross weight in the Takeoff Weight field. Enter any required modifier in the ATM field and select CALC. The calculated performance figures for the assumed temperature are displayed in the results area.

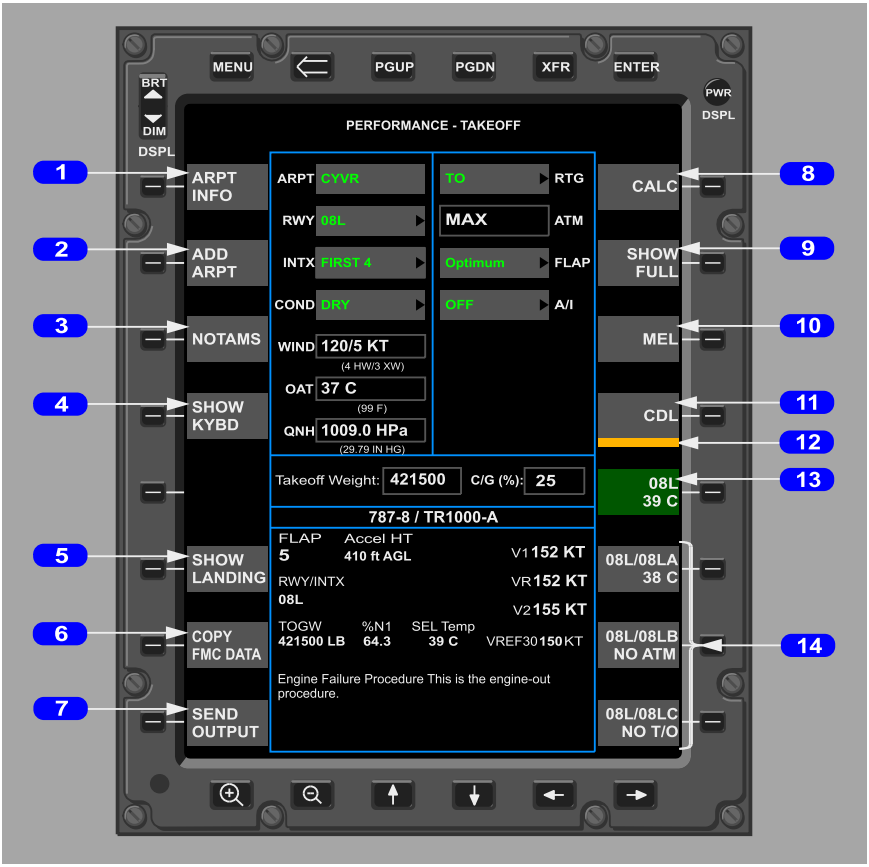
Note: If the OPT takeoff weight does not closely match the FMC takeoff weight, a message regarding verifying the input weight against the FMC weight is displayed. Performance results are generated, but the message cautions that the two figures are in disagreement and should be verified.

If needed, select SHOW FULL to display the full thrust data for the TOGW entered. Select SHOW ATM to redisplay the assumed temperature results.

To calculate the maximum takeoff weight (MTOW) allowed for the entered conditions, complete all the required fields; but leave the TAKEOFF WEIGHT field blank. Select CALC to display the MTOW performance data in the results area (no speeds are calculated). This is sometimes helpful when planning takeoff performance for the flight.

If speeds are then required, enter the actual takeoff weight in the Takeoff Weight field and select CALC again. An information message regarding the availability of assumed temperature may be displayed. Select OK to clear the message and then select the SHOW FULL soft key to display the full thrust takeoff data including speeds.

PERFORMANCE—TAKEOFF Page



1 Airport (ARPT) Information (INFO) Soft Key

Selection displays the Airport Data page.

Active only after an airport and runway are selected in the ARPT and RWY fields.

2 ADD Airport (ARPT) Soft Key

Selection displays the Add Airport page.

3 Notice to Airmen (NOTAMS) Soft Key

Selection displays the NOTAMs page.

4 SHOW KYBD (Keyboard) Soft Key

Displays a touch sensitive keypad at the bottom of the page that is used for data entry.

5 SHOW LANDING Soft Key

Selection displays the Landing page.

6 COPY FMC DATA Soft Key

Selection copies data from the FMC to the takeoff and landing pages.

7 SEND OUTPUT Soft Key

Selection displays the send output menu. Active only after CALC has been performed. Send output choices may include:

- Send to FMC—transfers OPT information to the FMC
- Send to Printer—prints on the aircraft printer
- Send to Storage—saves data to storage for later retrieval.

Notes:
1. SEND OUTPUT may be accomplished from either EFB. When Send to FMC is selected, transfer may take several moments (seconds) before the uplink is displayed on the FMC.
2. Attempts to SEND OUTPUT simultaneously from both EFBs will be unsuccessful and disable the transfer function.

8 CALC (Calculate) Soft Key

Selection initiates the calculation of takeoff data.

Becomes active only after all the required data has been entered.

9 SHOW FULL/SHOW ATM Soft Key

Selection toggles between the display of full thrust data and assumed temperature data for the airport/runway entered.

10 Minimum Equipment List (MEL) Soft Key

Selection displays the MEL page.

11 Configuration Deviations List (CDL) Soft Key

Selection displays the CDL page.

12 Amber bar

Indicates an active NOTAM, MEL, or CDL item exists. This item is considered in the performance calculations.

13 Full Length Runway Soft Key

Displays the runway and temperature data upon which the calculations are based.

Selection turns the soft key green and displays the full length runway data in the performance display area.

If the Takeoff Weight field is left blank, the soft key displays the runway and the calculated maximum gross weight.

If an assumed temperature calculation is not possible, NO ATM displays in the soft key data field.

If no takeoff performance is available, NO T/O displays in the soft key data field.

14 Intersection Runway Soft Key(s)

Displays the runway/intersection and temperature data upon which the calculations are based.

Selection turns the soft key green and displays the runway intersection data in the performance display area.

If the Takeoff Weight field is left blank, the soft key displays the runway/intersection and the calculated maximum gross weight.

If an assumed temperature calculation is not possible, NO ATM displays in the soft key data field.

If no takeoff performance is available, NO T/O displays in the soft key data field.

Calculating Landing Performance

Unless otherwise specified, all of the information in this section is referenced to the Landing page in the OPT application.

To complete a landing calculation, entries in the following fields are required:

- ARPT—destination airport
- RWY—planned landing runway
- COND—landing runway condition
- WIND—airport surface wind
- OAT—outside air temperature
- QNH—altimeter setting
- FLAP—landing flap position
- A/I—anti-ice setting.

These required entries can be made by a combination of transferring the destination airport from the FMC and manual entry, or by manual entry alone.

The CALC soft key does not become available until all the required entries are complete. If an invalid value was entered in a field (for example, 299.2 in the

QNH field or 430/15 in the WIND field), a system error is displayed either after entry, or after CALC is selected.

The following fields are also available for use when required:

- BRKS—braking method
- NNC—non-normal landing configurations that effect performance
- ARPT INFO—displays airport, runway and obstacle information
- ADD ARPT—temporary creation of an airport runway that is not in the OPT application database
- NOTAMS—temporary creation of a runway NOTAM that effects runway length or obstacles and may affect performance calculations
- SHOW/HIDE KYBD—display or hide the keyboard
- SHOW TAKEOFF—toggles between the Performance Takeoff and Landing pages
- COPY FMC DATA—copy data from the FMC for use in performance calculations
- SEND OUTPUT—send performance data to various locations
- CALC—initiates the performance calculation
- MEL—items that may affect performance calculations
- CDL—items that may affect performance calculations.

There are two types of landing calculations OPT can perform, dispatch and enroute advisory.

To calculate a dispatch landing weight complete all the required fields; but leave the LANDING WT field blank. Select CALC and the following values are displayed in the performance results area:

- Limit Wt—landing limit weight for Normal, With Ice, and Low Visibility conditions if applicable
- VREFXX—landing flaps reference speed for Normal, With Ice, and Low Visibility conditions if applicable
- Quick Turnaround Weight
- Quick Turnaround Time.

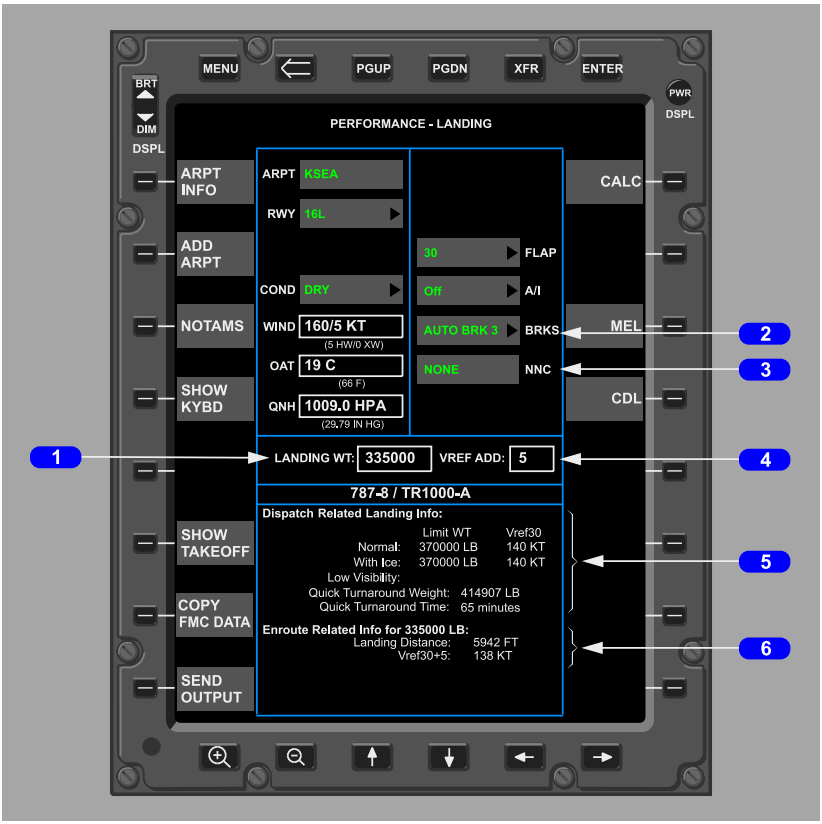
To calculate the enroute advisory landing data complete all the required fields and enter the predicted landing weight in the LANDING WT field. Enter the non-normal condition in the NNC field and then select CALC. The following are displayed in the performance results area:

- Landing Distance—the enroute non-normal advisory landing distance
- NNC SPD + Y—the enroute non-normal advisory landing flaps reference speed with additive if applicable.

To calculate both the dispatch and the enroute landing data complete all the required fields and enter the predicted landing weight in the LANDING WT field. Enter the required braking method in the BRKS field. The non-normal condition in the NNC field must be NONE. Select CALC to display both the dispatch and

enroute related landing distance, turn around, and landing flap VREF speeds in the performance results area.

PERFORMANCE—LANDING Page



1 Landing Weight (WT) Entry Field

Displays the manually entered landing weight.

Leaving the landing weight field blank calculates only dispatch limit weights.

2 Brake Setting (BRKS)

Becomes active when a value is entered in the LANDING WT field.

Selection opens the drop-down list. Selecting from the list or EXIT closes the list.

Displays the brake setting information. Selecting a brake setting is only required for enroute landing performance calculations.

3 Non-Normal Configuration (NNC)

Becomes active when a value is entered in the LANDING WT field.

Selection displays an alphabetical list of non-normal aircraft landing configurations. This is a required field for all enroute calculations. If a non-normal configuration does not exist, select NONE from the list. After making a selection select COMPLETE to return to the Landing page.

4 Reference Speed (VREF) Additive (ADD) Field

Displays the default or manually entered approach speed increment used for headwind or gust conditions.

5 Dispatch Related Information

Displays dispatch related landing information.

6 Enroute Related Information

Displays enroute related landing information.

Displayed only when a value is entered in the LANDING WT field.

Send and Copy Performance Data

Certain performance information can be sent and copied to and from the OPT and the FMC. Other data can be sent from the OPT to an onboard printer or to EFB memory storage.

The following data is copied to the OPT application from the FMC using the COPY FMC DATA soft key:

- origin airport
- departure runway
- aircraft gross weight
- OAT
- QNH
- destination airport (on the Landing page).

The COPY FMC DATA function is useful when input conditions change after the airplane performance has been calculated. New data can be generated by first entering the new values into the appropriate fields on the FMC, and then on the OPT performance page select the COPY FMC DATA soft key. This transfers all of the previously listed FMC conditions into the respective OPT fields. All data fields are transferred from the FMC to the OPT, regardless if the field has changed or not, and will have a green colored box around the entry field. The green box draws attention to the fields that have been copied from the FMC. Verify the new data is correct, enter the CG, and select CALC to recalculate the aircraft's performance using the updated conditions. Finally, select the SEND OUTPUT soft key and then the SEND TO FMC option to transfer the new performance to

the FMC. The message SENDING TO FMC appears above the SEND OUTPUT soft key and the soft key turns cyan while the data is being sent. The transfer may take several moments (seconds) before the uplink is displayed on the FMC. A takeoff uplink from the OPT will be pending on the FMC. Review and verify the data then select ACCEPT or REJECT as required.

Performance calculations can also be updated without using the COPY FMC DATA function. Change the necessary data directly in the OPT application by entering the new values in the appropriate fields. Select CALC to recalculate the aircraft's performance using the updated conditions. Now select the SEND OUTPUT soft key and then the SEND TO FMC option to transfer the new performance to the FMC. The message SENDING TO FMC appears above the SEND OUTPUT soft key and the soft key turns cyan while the data is being sent. A takeoff uplink from the OPT will be pending on the FMC. Review and verify the data then select ACCEPT or REJECT as required.

When SEND TO FMC is selected, the FMC receives the following information from the EFB:

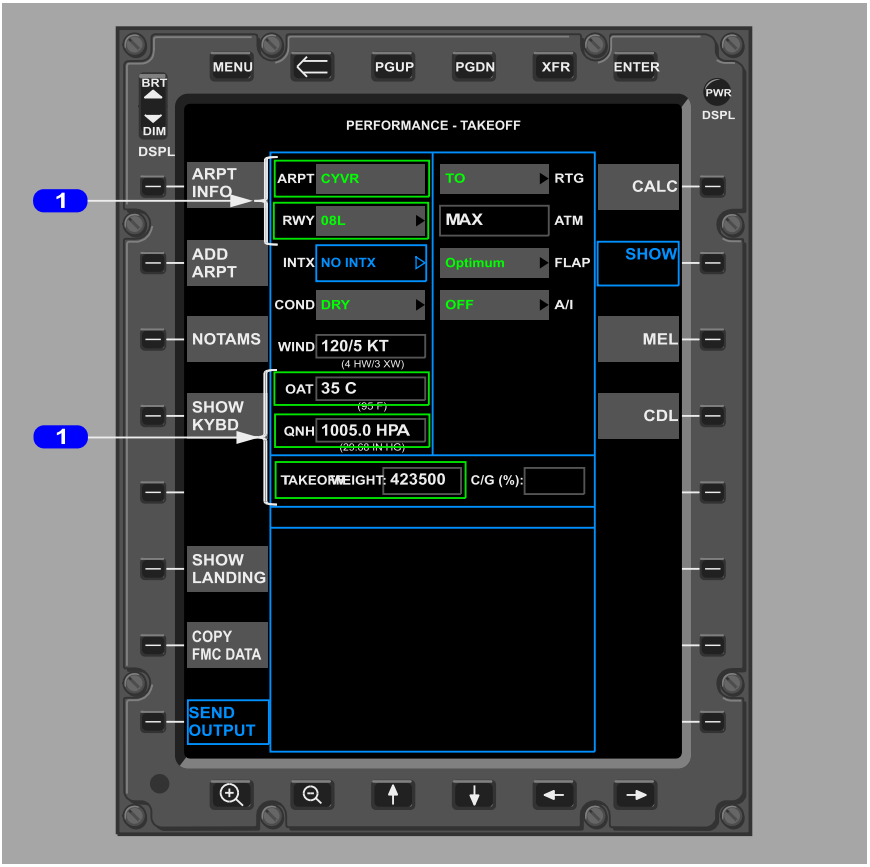
- thrust limit/assumed temperature
- V-speeds
- flap setting
- CG
- wind
- engine out acceleration height.

The message SENDING TO FMC appears above the SEND OUTPUT soft key and the soft key turns cyan while the data is being sent. A takeoff uplink from the OPT will be pending on the FMC. Review and verify the data then select ACCEPT or REJECT as required.

There are many other data points besides the standard FMC takeoff data that can be transmitted using the SEND OUTPUT function. To send customer defined performance data from the FMC; select SEND OUTPUT, select the required destination (Printer or Storage), and then select COMPLETE to send. Select CANCEL to return to the performance page without sending.

If the SEND OUTPUT soft key is not available for selection, then either performance results do not exist or the EFB is not configured for printing, saving or sending.

PERFORMANCE—COPY FMC DATA Function



1 Data transferred from the FMC

After selection of the COPY FMC DATA soft key, the transferred data from the FMC is displayed in the relevant fields and outlined with a green box. All the fields receiving data from the FMC are boxed, regardless if the previous value was changed or not. The fields that receive data from the FMC are:

- ARPT (origin, or destination when on the Landing page)
- RWY
- OAT
- QNH
- Takeoff Weight.

A green box is removed from around a field when that field is modified.

All green boxes are removed when a new calculation is performed, or upon return to the Takeoff or Landing page after selection of any other page.

Reviewing Airport Data

The airport and runway data that are used to calculate takeoff and landing performance come from a database that is stored, maintained, annotated, and verified by the administrator. This information, such as airport elevation, runway and obstacle data, can be viewed at any time within the OPT application.

While on the Takeoff or Landing page select ARPT INFO (this soft key is only active when the ARPT and RWY fields are complete). The Airport Data page displays the information upon which takeoff and landing performance calculations are based. This data displays in the units determined by company policy. The Airport Data page displays the following information, if available, from the airport database:

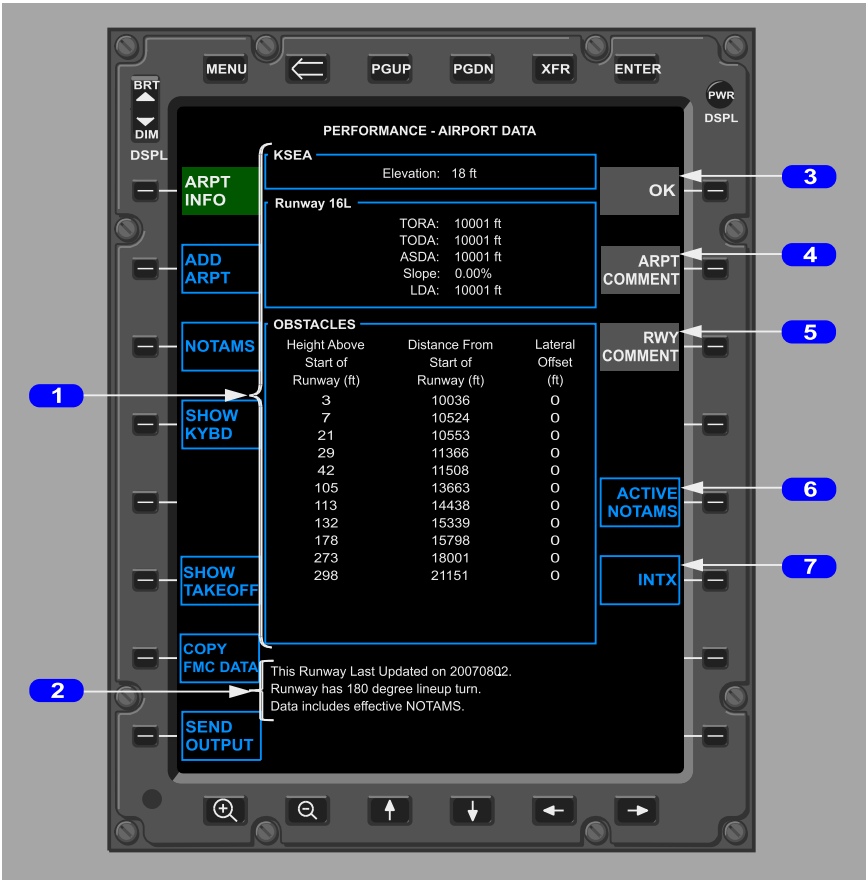
- Airport data—
  - elevation (height above sea level)
- Runway data—
  - runway Length
  - clearway
  - stopway
  - slope
  - LDA—Landing Distance Available
- Obstacle data—
  - Height Above either Start of Runway or End of Runway
  - Distance From either Start of Runway or End of Runway
  - Lateral Offset (distance from the runway centerline)
- Airport or Runway notes at the bottom of the page may include—
  - date of last update
  - lineup allowance per the administrator’s setting
  - NOTAM details effecting airport or runway.

Note: The data included on the ARPT INFO page is provided as advisory information only. This data should not be used to modify any takeoff or landing procedure and technique, nor should it be used to make decisions regarding runway usage.

Also on the Takeoff or Landing page, more information regarding the airport and runway can be found using the soft keys; ARPT COMMENT, RWY COMMENT and INTX.

Select OK to return to the previous Takeoff or Landing page.

PERFORMANCE—AIRPORT DATA Page



1 Airport Information

Displays the active airport information.

2 File Information

Displays information regarding the displayed airport file.

3 OK Soft Key

Selection returns to the previous Takeoff or Landing page.

4 Airport (ARPT) COMMENT Soft Key

Selection displays the Airport Comments page.

This soft key is active when airport comments are available in the database. When finished viewing the information, select OK to return.

5 Runway (RWY) COMMENT Soft Key

Selection displays the Runway Comments page.

This soft key is active when runway comments are available in the database. When finished viewing the information, select OK to return.

6 ACTIVE NOTAMS Soft Key

Selection displays the Active NOTAMs page for the selected runway.

This soft key is active when NOTAMs are available in the database. When finished viewing the information, select OK to return.

7 Intersections (INTX) Soft Key

Selection displays the Intersection page for the selected runway.

This soft key is active when intersection information is available in the database. When finished viewing the information, select OK to return.

Adding/Deleting a Temporary Airport

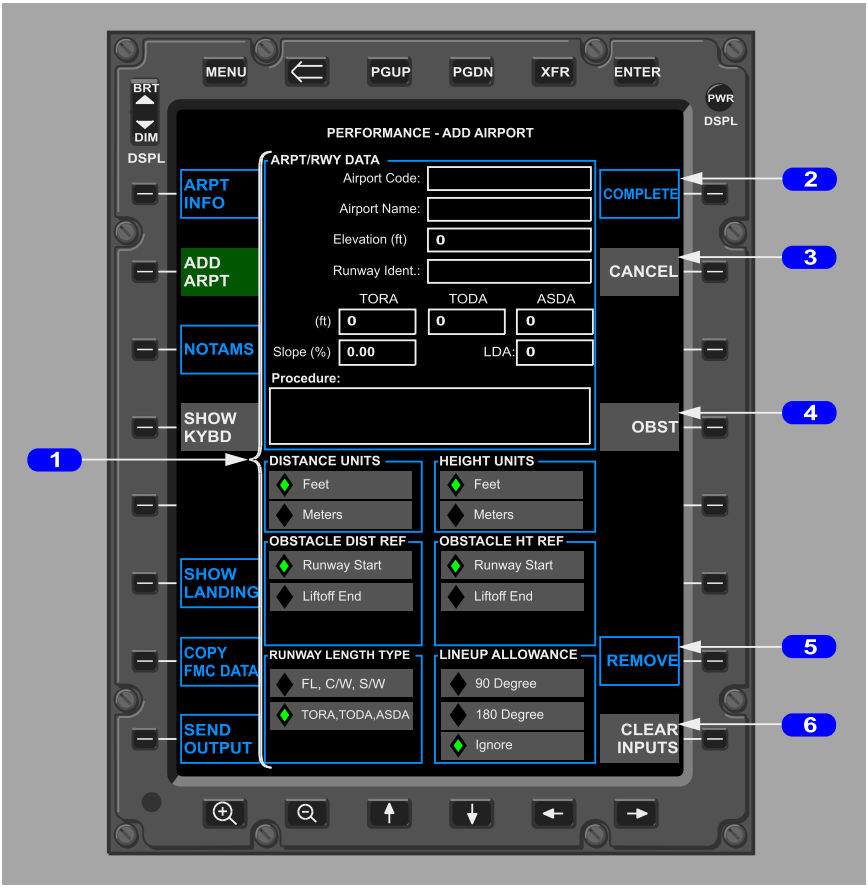
The OPT application can accommodate data for an airport and a runway that is not included in the database. The Add Airport page allows the user to enter temporary airport data and to calculate takeoff or landing performance based on that entry. Only one airport and one runway can be added at a time.

Note: The OPT removes all of the data for the added airport when either the FLIGHT INITIALIZE or FLIGHT CLOSE soft key is selected. The OPT also deletes the temporary airport data should the EFB be completely powered down. Permanent airport data must be added by the administrator.

Add a temporary airport from the Takeoff or Landing page by selecting the ADD ARPT soft key and then set the preferred measurement units for entering the airport data (green diamond indicates current selection). Enter the airport and runway data in the required fields. If an obstacle exists select the OBST soft key to add distance and height information (the OBST soft key toggles to ARPT/RWY to allow return to the Add Airport page). After all of the airport and runway data has been entered select COMPLETE to add the temporary information. The COMPLETE soft key becomes available only after all of the required fields have data. After selecting COMPLETE the Takeoff or Landing page is displayed with the added airport selected for use.

Delete the temporary airport from the Takeoff or Landing page by selecting the ADD ARPT soft key. On the Add Airport page select REMOVE (this soft key is active only after an airport was added) to delete the temporary airport information being displayed and return to the Takeoff or Landing page.

PERFORMANCE—ADD AIRPORT Page



1 Airport Information Input Fields

Entry fields required to add an airport.

2 COMPLETE Soft Key

Selection adds the airport to the database and returns to the previous Takeoff/ Landing page. Becomes active only after all required fields are complete.

3 CANCEL Soft Key

Selection cancels the airport addition and returns to the previous Takeoff/Landing page.

4 Obstacle (OBST) Soft Key

Selection displays the obstacle entry page.

5 REMOVE Soft Key

Selection removes the airport from the database and returns to the previous Takeoff/Landing page.

6 CLEAR INPUTS Soft Key

Selection removes all inputs made in all entry fields.

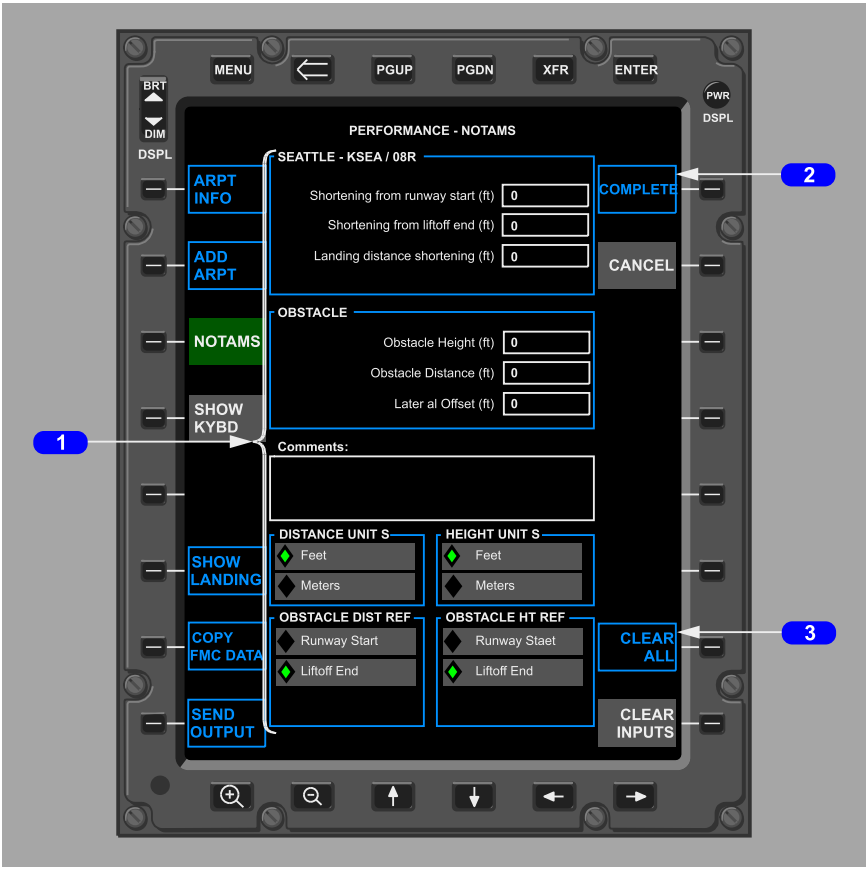
Entering NOTAM Information

The OPT application allows the entry of NOTAM corrections that alter available runway or obstacle data (for example runway construction or temporary obstacles).

Note: The administrator can set the OPT to remove the added NOTAM when either the FLIGHT INITIALIZE or FLIGHT CLOSE soft key is selected. The OPT deletes the temporary NOTAM should the EFB be completely powered down. The administrator can enter NOTAM data that uses effective dates to activate certain NOTAM changes.

Add temporary NOTAM information from the Takeoff or Landing page by selecting the NOTAMS soft key and then set the preferred measurement units for entering the NOTAM data (green diamond indicates current selection). Enter any shortened runway figures and/or any obstacle information in the appropriate fields. Comments can be added in the comment field as required. After the required data has been entered select COMPLETE to add the temporary information. The Takeoff or Landing page displays with a horizontal amber line under the NOTAMS soft key to indicate that the NOTAM data is considered in the performance calculations.

PERFORMANCE—NOTAMS/Add NOTAMS Page



1 NOTAM Input Fields

Entry fields required to add a NOTAM.

2 COMPLETE Soft Key

Selection adds the NOTAM to the database and returns to the previous Takeoff/Landing page. Becomes active only after all required fields are complete.

3 CLEAR ALL Soft Key

Selection clears all NOTAMs added and returns to the previous Takeoff/Landing page.

Accommodating MEL or CDL Issues

The OPT application can account for minimum equipment list (MEL) or configuration deviation list (CDL) performance penalties in takeoff and landing performance calculations.

Note: The administrator can set the OPT to remove the added MEL/CDL items when either the FLIGHT INITIALIZE or FLIGHT CLOSE soft key is selected. The OPT can be configured to delete the MEL/CDL items when the EFB is completely powered down.

CAUTION: Added MEL/CDL items are not automatically applied to enroute landing performance selections. For example, if the autobrake is selected as inoperative on the MEL page, the autobrake can still be selected for use in the BRKS field on the Landing page.

Add MEL/CDL performance penalties on the Takeoff or Landing page by selecting the MEL or CDL soft key. The MEL/CDL page displays a Chapter List which contains chapter titles conforming to the IATA standard for airplane components. Select CANCEL to exit the list without selecting any item. From the Chapter List select the appropriate chapter to display a list of individual items. Selecting the appropriate item is indicated by a green check mark. Additionally, the item's number displays in the Active Items list at the bottom of the page. When finished, select COMPLETE to accept the selections. The Takeoff or Landing page displays with a horizontal amber line under the MEL/CDL soft key to indicate that MEL/CDL data is considered in the performance calculations.

Individual items can be removed from the MEL/CDL page by de-selecting the item and then selecting COMPLETE. All selected items can be removed at once by selecting CLEAR ALL and then selecting COMPLETE.

Note: The Takeoff or Landing page displays without the amber MEL/CDL annunciation only when all MEL/CDL items have been cleared.

PERFORMANCE—MEL/CDL Input Page



1 MEL/CDL Revision Information

Displays the revision, document name/number, and date of current revision.

2 ATA Chapter Listing

Displays current ATA chapter title.

Selection opens a drop-down list of all the ATA chapters.

3 MEL/CDL Items

Line selectable MEL/CDL items. Chapter number is omitted in the item reference but listed in the drop-down box title.

Selection places a green check mark in the appropriate box. Selecting the item again removes the check mark.

4 Active Items

Lists all selected MEL/CDL items. This list would include any items selected in other chapters as well. The list is limited to either MEL or CDL specific items.

eRouteManual

Overview

The eRouteManual application provides the ability to consult en route and terminal charts on the EFB.

The operator can choose the NAV CHARTS provider between JEPPESEN and LIDO.

EN ROUTE CHARTS

The en route charts are the high and low altitudes navigation charts. En route charts can be either static or dynamic:

- Static charts : Digital copy of the paper charts,
- Dynamic charts : Offer an adjustable level of details, and lookup features for more information about all objects in the chart.

The dynamic en route charts can automatically adjust with the aircraft position during the flight.

TERMINAL CHARTS

Terminal charts provide airport charts, and have:

- Airport general information,
- Airport, taxi and parking facilities,
- Departure, arrival and approach procedures.

The user can make a selection of airports from the application database, to enable a quick access to the charts of these airports.

Video Surveillance (Typical)

The video surveillance application on the EFB provides immediate real-time video surveillance of the area outside the flight deck entrance. If installed, expanded video surveillance is available for other parts of the aircraft. To start the application, select VIDEO from the EFB MAIN MENU page. The VIDEO

SURVEILLANCE page displays the default view set by the administrator when the application is started.

Note: Selecting the flight deck IFE/PASS SEATS power switch OFF will disable the video surveillance cameras.

Selecting an Image

The Video Surveillance page displays four video images; the largest is the primary image and the three smaller are the thumbnail images. Each thumbnail view is from a different area of the aircraft. The primary image is an enlarged duplicate view of the currently selected thumbnail image. Both the current thumbnail and the primary image are bordered in green when selected and operating.

To select a different thumbnail to display in the primary image area, touch the thumbnail view on the screen. The cursor device may also be used to highlight and select the thumbnail view.

Manipulating the Display

To freeze the current primary image select the FREEZE soft key. Selecting FREEZE does the following:

- stops the video and displays a still image
- image border changes from green to cyan to help indicate a frozen image
- toggles the soft key to UNFREEZE.

Select UNFREEZE to return to live video.

To manipulate the display further, select the SHOW MENU soft key on the VIDEO SURVEILLANCE page. Several more soft key options become available for changing the display. These additional options are:

- BRIGHT + : increases the brightness of the image
- BRIGHT – : decreases the brightness of the image
- HIDE MENU : returns to the thumbnail Video Surveillance page
- DEFAULT : returns all settings to their defaults
- CONTRAST + : increases the contrast of the image
- CONTRAST – : decreases the contrast of the image
- MAINTENANCE : displays the Maintenance page for maintenance use.

VIDEO SURVEILLANCE Main Page



1 Primary Display Area

Displays the selected thumbnail image inside a green border.

Border changes to cyan when FREEZE is selected.

Border turns amber and NO VIDEO SIGNAL displays when the selected image is not available.

2 Primary Display Title Bar

Displays the name of the thumbnail image being displayed in the primary area.

3 FREEZE/UNFREEZE Soft Key

Selection toggles between FREEZE and UNFREEZE.

Selection either freezes or unfreezes the image in the primary display.

4 Thumbnails

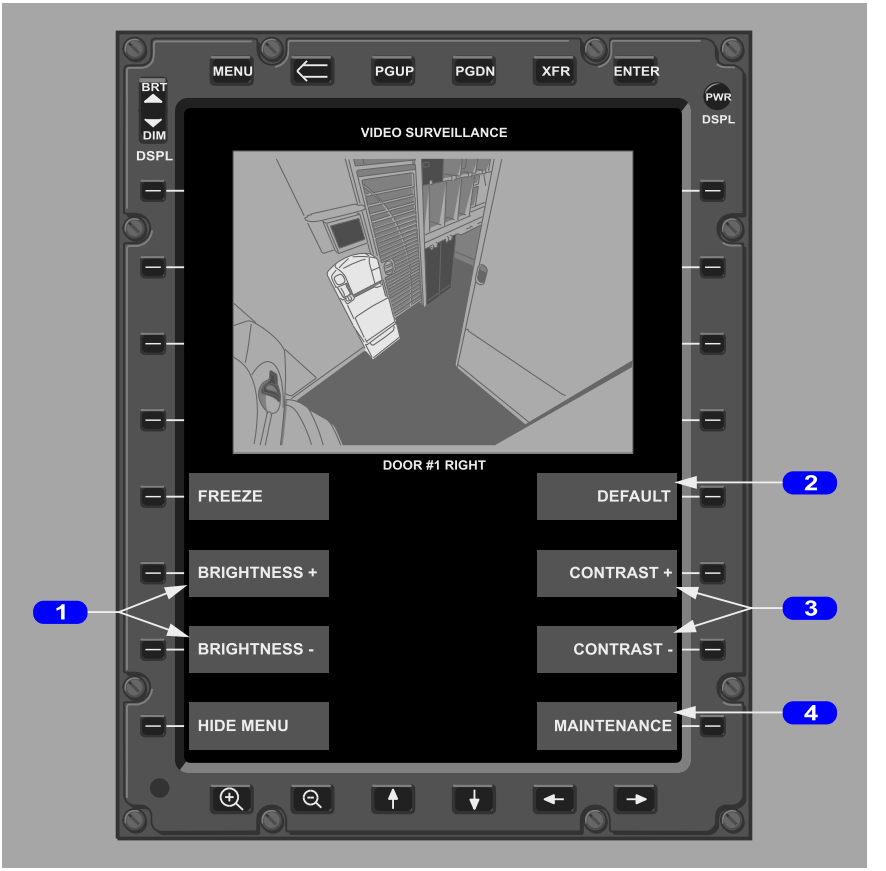
Any of the three thumbnail images:

- borders are gray when they can be selected for display in the primary area
- borders become white when the cursor is moved over the image
- borders become green when being displayed in the primary area
- borders turn amber and NO VIDEO SIGNAL displays when the image is not available.

5 SHOW/HIDE MENU Soft Key

Selection toggles between displaying and hiding the additional BRIGHT, CONTRAST, DEFAULT, and MAINTENANCE soft keys.

VIDEO SURVEILLANCE Show Menu Page



1 BRIGHTNESS +/– Soft Keys

Changes the brightness of the image in the primary display as indicated by the + and – selections.

2 DEFAULT Soft Key

Returns the brightness and contrast to the default settings.

3 CONTRAST +/– Soft Keys

Changes the contrast of the image in the primary display as indicated by the + and – selections.

4 MAINTENANCE Soft Key

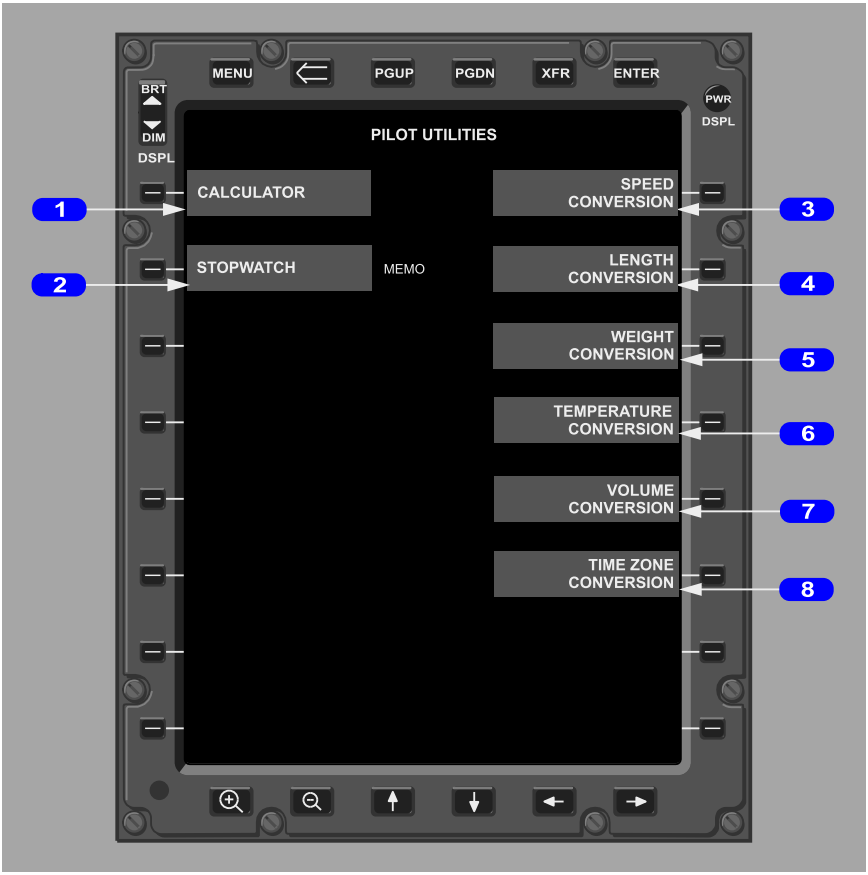
Displays the Maintenance page for maintenance personnel use.

Troubleshooting

The message NO VIDEO SIGNAL may be displayed while using the Video Surveillance application. This message is displayed inside a video display box and is accompanied by an amber box where the video image was displayed. The message indicates a system failure and the video image is not available for display.

PILOT UTILITIES

PILOT UTILITIES provides flight crews with a general set utilities to help aid typical tasks within the cockpit.



1 CALCULATOR Soft Key

Displays calculator capable of:

- addition
- subtraction
- multiplication
- division
- square root function
- storing numbers for later use.

Equation to be calculated is displayed as it is entered. After selecting the equal sign, either the result or an error message displays.

2 STOPWATCH Soft Key

Counts time up or down.

Timer counts down from an entered time. If ALERT ON COMPLETION is selected, a memo message screen displays when the timer reaches zero.

Count up selection also displays the start time and current time.

3 SPEED CONVERSION Soft Key

Converts pilot entered speed between selected units. Unit choices include:

- feet per minute (FT/M)
- kilometers per hour (KM/H)
- knots (KT)
- meters per second (MPS)
- miles per hour (MPH).

4 LENGTH CONVERSION Soft Key

Converts pilot entered length between selected units. Unit choices include:

- feet
- kilometers
- meters
- nautical miles
- statute miles.

5 WEIGHT CONVERSION Soft Key

Converts pilot entered weight between kilograms and pounds. Conversion result is calculated as each entry is made in the INPUT UNIT text box.

6 TEMPERATURE CONVERSION Soft Key

Converts pilot entered temperature between Celsius and Fahrenheit.

7 VOLUME CONVERSION Soft Key

Converts pilot entered volume between imperial gallons, US gallons, and liters.

8 TIMEZONE CONVERSION Soft Key

Converts pilot entered UTC time to a selected time zone. If ADJUST TIME FOR DAYLIGHT SAVING is selected, one hour will be added to the converted time.

Flight Instrument and Display EICAS Messages

Note: The OVERSPEED warning and the ALTITUDE ALERT caution messages are covered in Chapter 15, Warning Systems.

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
AIRSPEED UNRELIABLE	Advisory		The airspeed or Mach indications disagree with AOA calculated airspeed.
ALTN ATTITUDE CAPT, FO	Advisory		The AIR DATA/ATT source selector is in ALTN.
BARO SET DISAGREE	Advisory		The captain's and first officer's barometric settings disagree.
CHKL INCOMPLETE NORM	Caution	Beeper	A normal checklist needs to be completed.
CHKL NON-NORMAL	Advisory		There is a hidden non-normal checklist. All of these occur: • a non-normal checklist is not complete • the ECL is not displayed • the related EICAS message is not shown.
EFIS/DSP PANEL L, R	Advisory		One of these occurs: • the EFIS/DSP panel is failed • MFD control of the EFIS/DSP is used.
HUD SNGL OPERATION	Advisory		Only a single head-up display is operating.
HUD SYS CAPT, F/O	Advisory		The head-up display is failed.
HUD TAKEOFF	Caution	Beeper	Head-up display takeoff guidance is not available.
PFD UNRELIABL CAPT, F/O	Advisory		A display fault is detected in the airspeed or altitude indication on the affected PFD.
RADIO ALTIMETER L +R	Advisory		The left and right radio altimeters are failed.

Message	Level	Aural	Condition
SGL SOURCE ATTITUDE	Advisory		One of these occurs: • both AIR DATA/ATT source selectors are in the ALTN position • all attitude information is lost from the IRUs and AHRUs.
SGL SOURCE RAD ALT	Advisory		Both PFDs and HUDs use the same radio altimeter source.

Flight Management, Navigation — Chapter 11
Table of Contents

Controls and Indicators 11.10

Flight Management System 11.10.1
Control Display Unit (CDU) 11.10.1
Function and Execute Keys 11.10.3
Multifunction Keypad 11.10.4
CDU Page Components 11.10.6
CDU Page Color 11.10.7
CDU Cursor and Highlight Box 11.10.9
Flight Data Block 11.10.11
Inertial System 11.10.12
Inertial Reference System (IRS) 11.10.12
Tuning and Control Panel (TCP) 11.10.12
Transponder 11.10.14
Alerting and Transponder Control Panel (ATP) 11.10.14
Tuning and Control Panel (TCP) 11.10.14
Tuning and Control Panel—ATP Inoperative 11.10.18
Weather Radar 11.10.19
Tuning and Control Panel (TCP) 11.10.19

Navigation Systems Description 11.20

Introduction 11.20.1
Global Positioning System (GPS) 11.20.1
GPS Displays 11.20.1
GPS Data 11.20.1
GPS System Schematic 11.20.2
Air Data Reference System (ADRS) 11.20.3
Air Data and Attitude Sources 11.20.3
Inertial System 11.20.3
Inertial Reference System (IRS) 11.20.3
Inertial Reference Unit (IRU) 11.20.3

Attitude and Heading Reference Unit (AHRU) 11.20.5
IRS Failure 11.20.5
IRS Schematic—Normal Mode 11.20.7
IRS Schematic—with NAV AIR DATA SYS Message 11.20.8
IRS Schematic—with NAV AIRSPEED DATA Message 11.20.9
IRS Schematic—with NAV IRU Message 11.20.10
IRS Schematic—with NAV INERTIAL SYS Message 11.20.11
Radio Navigation Systems 11.20.11
Distance Measuring Equipment (DME) 11.20.11
Instrument Landing System (ILS) 11.20.12
Navaid Identifier Decoding 11.20.13
VOR 11.20.13
Transponder 11.20.14
Alerting and Transponder Control Panel (ATP) 11.20.14
Tuning and Control Panel—Normal Operation 11.20.15
Tuning and Control Panel—ATP Inoperative 11.20.15
Weather Radar 11.20.16

Flight Management System Description 11.30

Introduction 11.30.1
Flight Management Computer (FMC) 11.30.1
Control Display Units (CDUs) 11.30.2

Flight Management System Operation 11.31

Introduction 11.31.1
Preflight 11.31.1
Takeoff 11.31.2
Climb 11.31.2
Cruise 11.31.2
Descent 11.31.2
Approach 11.31.3
Flight Complete 11.31.3
Operational Notes 11.31.3

Terminology 11.31.4
Maintenance Index 11.31.6
Navigation Position 11.31.7
FMC Position Update 11.31.7
FMC Polar Operations 11.31.8
Navigation Performance 11.31.11
Lateral Navigation (LNAV) 11.31.13
Waypoints 11.31.13
ND Map Displays 11.31.21
Vertical Navigation (VNAV) 11.31.21
Speed/Altitude Constraints 11.31.21
Speed Only Constraints 11.31.22
Takeoff and Climb 11.31.23
MCP Altitude Intervention 11.31.25
Cruise 11.31.25
Cruise Climb 11.31.25
Step Climb 11.31.26
Cruise Descent 11.31.27
Required Time of Arrival (RTA) 11.31.27
MCP Speed Intervention 11.31.28
Descent 11.31.28
Early Descent 11.31.30
Cruise and Descent Profile (Instrument Approach Using VNAV) 11.31.32
Approach 11.31.33
Integrated Approach Navigation (IAN) 11.31.34
Missed Approach 11.31.36
Engine Out Operations 11.31.37
Data Entry Rules 11.31.41
Altitude Entry 11.31.41
Airspeed Entry 11.31.42
Data Pairs 11.31.42

Flight Management Computer 11.32

FMC Databases 11.32.1

Thrust Management 11.32.1

Reduced Thrust Takeoff 11.32.2

Derated Thrust Climb 11.32.3

Fuel Monitoring 11.32.3

Loss of FMC Electrical Power 11.32.5

FMC Failure 11.32.5

Single FMC Failure 11.32.5

Dual FMC Failure 11.32.5

Triple FMC Failure 11.32.6

Air Traffic Control Datalink 11.33

Introduction 11.33.1

Company Datalink 11.34

Introduction 11.34.1

Datalink 11.34.2

Manual Downlinks 11.34.2

Reports 11.34.2

Report Status 11.34.3

Automatic Downlinks 11.34.3

Uplinks 11.34.3

Requests 11.34.4

Request Status 11.34.5

FMC Datalink Uplinks (Accept/Reject) 11.34.5

FMC Datalink Uplinks (Load/Purge) 11.34.6

FMC Datalink Uplinks (Load/Exec-Erase) 11.34.7

FMC Datalink Uplinks (Automatic) 11.34.8

Datalink Management 11.34.9

CDU Datalink Status Displays 11.34.10

FMC Communications Page 11.34.11

FMC Preflight 11.40

Introduction 11.40.1

Preflight Page Sequence 11.40.1

Minimum Preflight Sequence 11.40.2

Supplementary Pages 11.40.3

Preflight Pages—Part 1 . . . . . 11.40.3

Initialization/Reference Index page 11.40.4

Identification Page 11.40.5

Position Initialization Page 1/4 . . . . . 11.40.8

Position Reference Page 2/4 . . . . . 11.40.10

Position Reference Page 3/4 . . . . . 11.40.13

Position Reference Page 4/4 . . . . . 11.40.15

Route Page 1/X 11.40.17

Route Page 2/X 11.40.22

Departure/Arrival Index Page 11.40.24

Departures Page 11.40.26

Navigation Radio Page 11.40.29

Preflight Pages—Part 2 . . . . . 11.40.34

Performance Initialization Page 11.40.34

Thrust Limit Page 11.40.37

Takeoff Reference Page 1/2 . . . . . 11.40.40

Takeoff Reference Page 2/2 . . . . . 11.40.45

FMC Takeoff and Climb 11.41

Introduction 11.41.1

Takeoff 11.41.1

Climb 11.41.1

Altitude Intervention 11.41.2

Climb Page 11.41.2

Engine Out Climb 11.41.14

EO CLB Page 11.41.15

Engine Out Departure 11.41.16

Air Turnback 11.41.17
Arrivals Page 11.41.17

FMC Cruise 11.42

Introduction 11.42.1
LNAV Modifications 11.42.1
RTE LEGS Page Modifications 11.42.1
Add Waypoints 11.42.2
Delete Waypoints 11.42.3
Change Waypoint Sequence 11.42.5
Remove Discontinuities 11.42.6
Direct To And Intercept Course To 11.42.7
Intercept Course From 11.42.10
Select Desired Waypoint Page 11.42.12
Airway Intercept 11.42.13
Route Offset and Strategic Lateral Offset Procedure (SLOP) 11.42.17
Cruise Page 11.42.21
All Engine Cruise 11.42.21
Engine Out Cruise 11.42.24
VNAV Modifications 11.42.28
Cruise Climb 11.42.28
Planned Step Climb 11.42.28
Calculated Step Climb 11.42.29
Constant Speed Cruise 11.42.32
Cruise Descent 11.42.34
Early Descent 11.42.34
Navigation Data 11.42.36
Reference Navigation Data Page 11.42.36
Fix Information Page 11.42.37
Route and Waypoint Data 11.42.40
Route Data Page 11.42.40
Wind Data 11.42.41

Wind Page 11.42.42
Position Report Page 11.42.44
In–Flight Position Update 11.42.47
Progress Pages 11.42.48
Progress Page 1 . . . . . 11.42.48
Progress Page 2 . . . . . 11.42.51
RTA Progress Page 3 . . . . . 11.42.54
RNP Progress Page 4 . . . . . 11.42.59

FMC Descent and Approach 11.43

Introduction 11.43.1
Descent 11.43.1
Altitude Intervention 11.43.1
Descent Page 11.43.1
Descent Forecast Page 11.43.6
Offpath Descent Page 11.43.8
Engine Out Descent 11.43.10
Approach 11.43.10
Arrivals Page 11.43.11
Arrivals Page—IFR Approaches 11.43.12
Arrivals Legs Page 11.43.14
Procedure Hold (in lieu of procedure turn) Legs Page 11.43.15
Arrivals Page—VFR Approaches 11.43.16
Approach Reference Page 11.43.19
Alternate Airport Diversions 11.43.21
Alternate Page 1/2 . . . . . 11.43.21
Alternate List Page 2/2 . . . . . 11.43.25
XXXX Alternate Page 11.43.26
Holding 11.43.30
Holding Entry 11.43.30
Hold Page (First Hold) 11.43.30
HOLD Page (Existing Hold) 11.43.33

Alternate Navigation System Description 11.50

Introduction 11.50.1

Alternate Navigation Waypoint 11.50.1

Alternate Navigation TCP Pages 11.50.1

Alternate Navigation Page 11.50.1

Alternate Navigation Radio Page 11.50.4

EICAS Messages 11.60

EICAS Messages 11.60.1

FMC Messages 11.60.3

FMC Alerting Messages 11.60.4

FMC Communications Messages 11.60.11

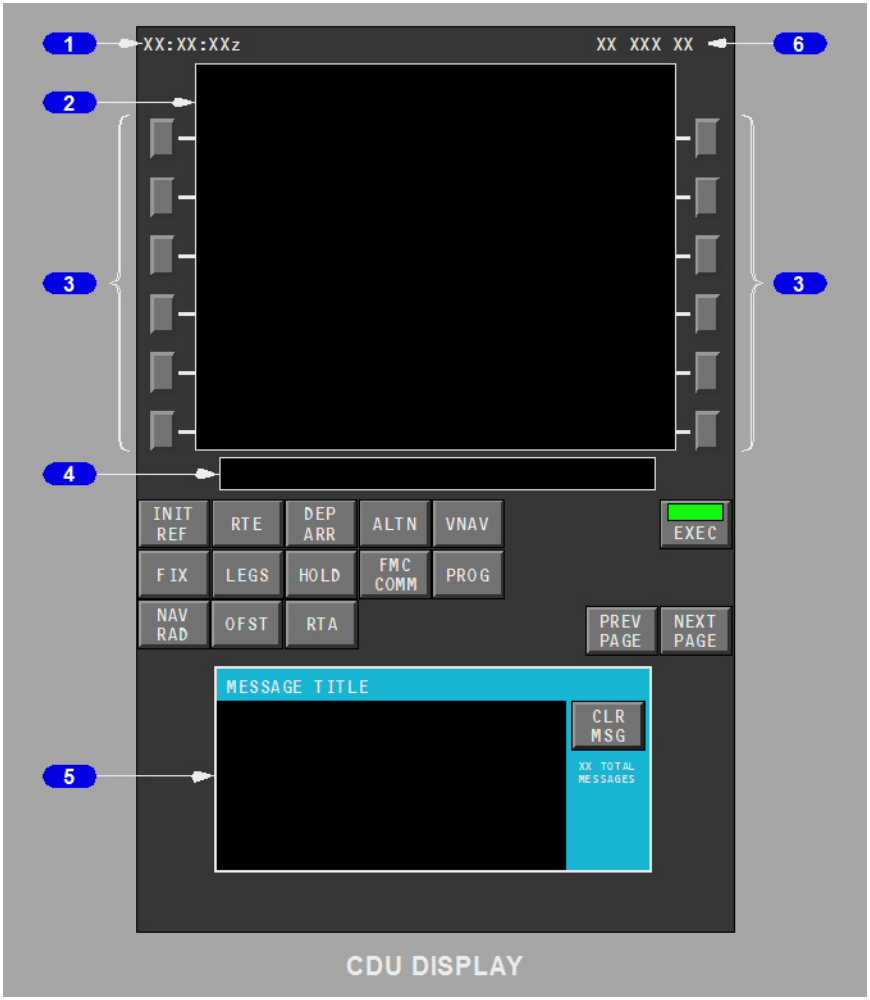
FMC Advisory Messages 11.60.14

FMC Entry Error Messages 11.60.16

Flight Management System

Control Display Unit (CDU)

An interactive graphical CDU can be displayed on any of the MFDs. The display is accessed by pushing the CDU switch on the associated display select panel.



1 Time Display

Displays current UTC time from the GPS.

2 Control Display Unit (CDU) Display

Displays FMS data pages.

3 Line Select Keys

Select—

- moves data from scratchpad to selected line
- moves data from selected line to scratchpad
- selects page, procedure, or performance mode as applicable
- deletes data from selected line when DELETE displays in scratchpad.

Conventions—

- scratchpad must be blank for line select transfer
- data can not be transferred to a blank line
- a blank scratchpad can not be transferred to a line
- not all data can be modified
- message displays if inappropriate entries are attempted.

4 Scratchpad

Displays crew entered data or crew line-selected data:

- up to 24 characters may be entered in the scratchpad at one time
- data may be transferred to and from the scratchpad by pushing the cursor select switch on the cursor control device or cursor control selector or by pushing the ENTER key on the multifunction keypad
- data may also be transferred to the scratchpad while using the PICK WPT function on the ND.

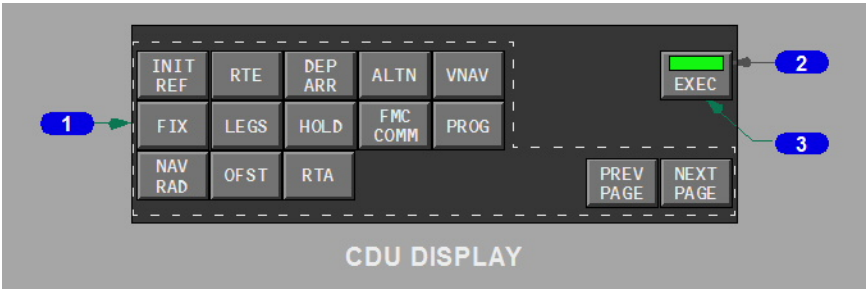
5 CDU Help Window

Displays error/help messages to the crew. (See Help Window on page 5.40.9 for additional information.)

6 Date Display

Displays current UTC date from the GPS.

Function and Execute Keys



1 CDU Function Keys

Select—

INIT REF	displays page for data initialization or for reference data
RTE	displays page to input or change origin, destination, route and flight number
DEP ARR	displays page to input or change departure and arrival procedures
ALTN	displays page to modify destination and route for alternate diversion
VNAV	displays page to view or change vertical navigation path data
FIX	displays page to create reference points on ND map
LEGS	displays page to evaluate or modify lateral and vertical route data
	displays page to correlate route waypoints on the ND
HOLD	displays page to create holding patterns and display holding pattern data, or to exit holding pattern
FMC COMM	displays FMC datalink status page
PROG	displays page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates

NAV RAD	displays page to view or control navigation radio tuning
OFFSET	displays lateral offset page
REQUIRED TIME OF ARRIVAL	displays RTA LIMITS page
PREV PAGE	displays previous page of multiple page displays (for example, LEGS pages)
NEXT PAGE	displays next page of multiple page displays.

2 Execute Light

Illuminated (green)—active data is modified but not executed.

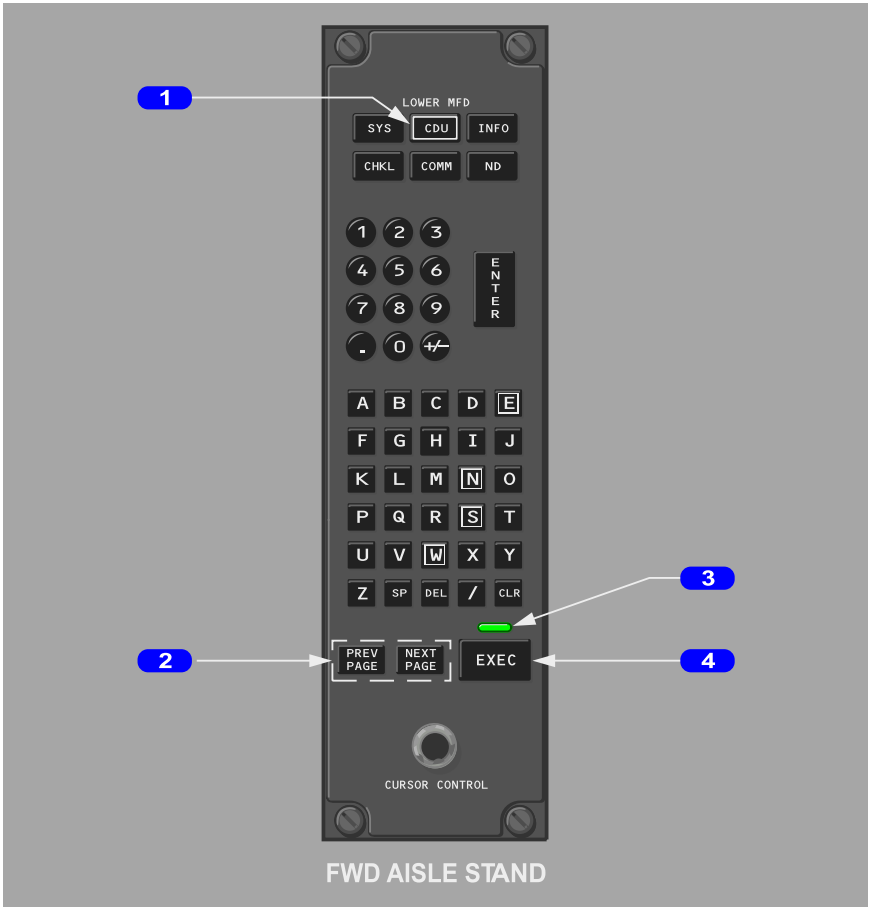
3 Execute (EXEC) Key

Push (while EXEC light is illuminated green)—

- activates data modification(s)
- extinguishes execute light.

Multifunction Keypad

Input to the emulated CDUs is done through the multifunction keypads. Two keypads are provided, one each for the captain and first officer. The keypads are located on the forward aisle stand adjacent to the lower MFD. (See Multifunction Keypad (MFK) on page 10.10.53 for additional information.)



1 Control Display Unit (CDU) Switch

Push—displays the emulated CDU on the lower MFD.

2 Previous (PREV)/NEXT PAGE Key

Push—

- PREV PAGE—displays previous page of multiple page displays
- NEXT PAGE—displays next page of multiple page displays.

3 Execute Light

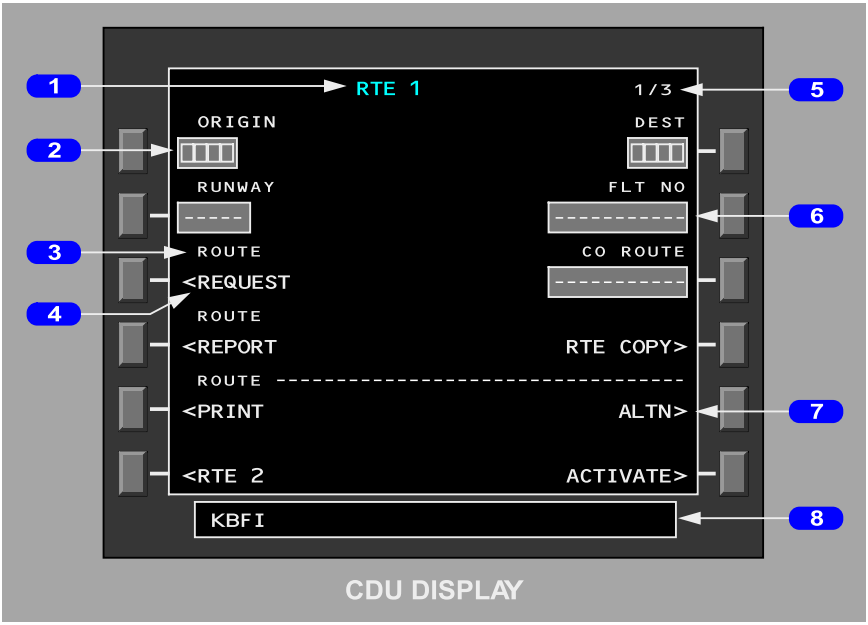
Illuminated (green)—active data is modified but not executed.

4 Execute (EXEC) Key

Push (while EXEC light is illuminated green)—

- activates data modification(s)
- extinguishes execute light.

CDU Page Components



1 Page Title

Subject or name of data displayed on page.

ACT (active) or MOD (modified) indicates whether page contains active or modified data.

2 Boxes

Data input is mandatory.

3 Line Title

Title of data on line below.

4 Data Line

Displays—

- data associated with line title
- prompts
- selectors.

Large font indicates crew entered or verified data. Small font indicates FMC computed data.

5 Page Number

Left number is page number. Right number is total number of related pages. Page number is blank when only one page exists.

6 Dashes

Data input is optional.

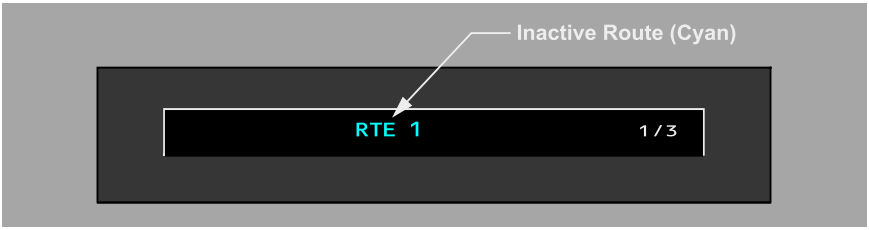
7 Prompts

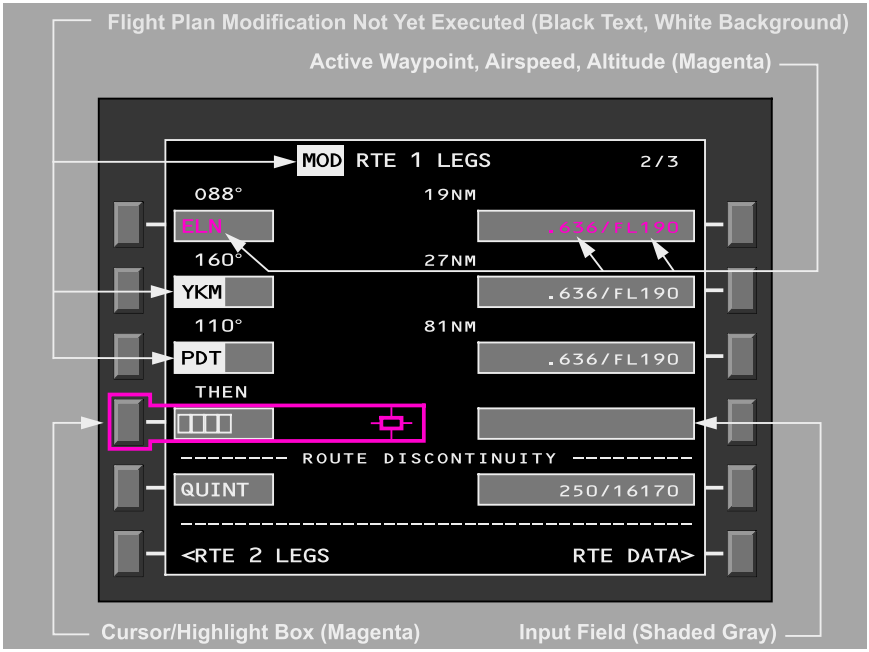
Display pages, select modes, and control displays. Caret “<” or “>” is before or after prompt.

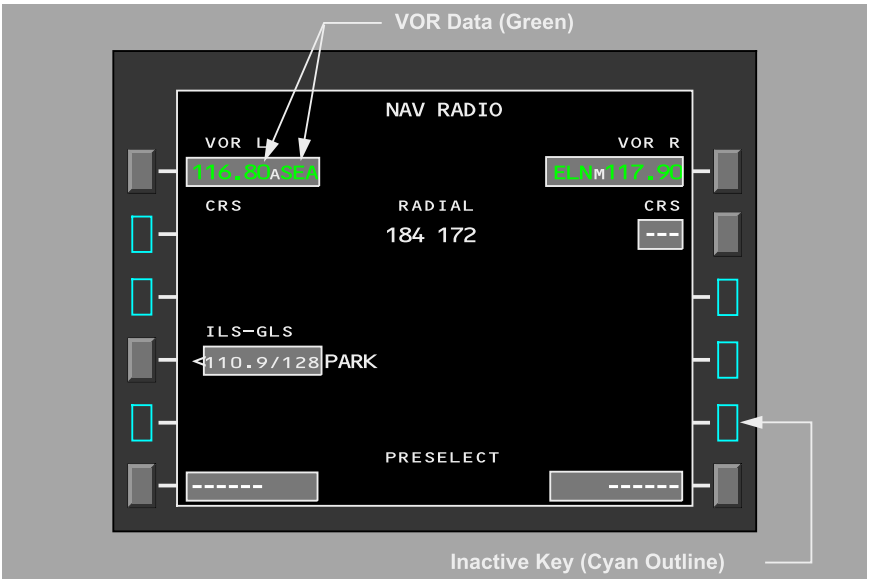
8 Scratchpad

Displays alphanumeric entries, or line selected data.

CDU Page Color




Flight Plan Modification Not Yet Executed (Black Text, White Background)
Active Waypoint, Airspeed, Altitude (Magenta)
MOD RTE 1 LEGS 2/3
088°
19NM
ELN
.636/FL190
160°
27NM
YKM
.636/FL190
110°
81NM
PDT
.636/FL190
THEN
ROUTE DISCONTINUITY
QUINT
250/16170
<RTE 2 LEGS
RTE DATA>
Cursor/Highlight Box (Magenta)
Input Field (Shaded Gray)


VOR Data (Green)
NAV RADIO
VOR L
116.80ASEA
VOR R
ELM 117.90
CRS
RADIAL
184 172
CRS

ILS-GLS
<110.9/128 PARK
PRESELECT

Inactive Key (Cyan Outline)



Color is used as follows:

- black—
  - background color of page
  - modifications
  - MOD precedes page titles of modified pages
- cyan—
  - inactive RTE page title
  - inactive key outline
- 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
  - cursor
  - highlight box
- shaded gray—input field
- white—
  - background for modified text
  - most data.

CDU Cursor and Highlight Box

Interaction with the CDU is accomplished by using the Cursor Control Device (CCD) or the Cursor Control Selector (CCS). When using the CCD, hovering the cursor over an active area of the CDU displays the highlight box. When using the CCS the highlight box moves down when the CCS is rotated in a clockwise direction and up when the CCS is moved in a counterclockwise direction. The highlight box does not return to the top or bottom of the display when it reaches the bottom or top respectively.

Each CDU page is composed of active and inactive areas. The highlight box only displays over an active area. When the highlight box is displayed, an action may be performed such as data entry or line key selection.

Additional manual manipulation of the highlight box is provided by the four corners on the CCD touch pad that, when touched, result in the highlighting of the corresponding 1L, 1R, 6L, or 6R line select key position.

An enter or line key selection may be performed utilizing any of the following:

- pushing the ENTER key on the on-side multifunction keypad
- pushing the Cursor Select Switch on the on-side multifunction keypad
- pushing the Cursor Select Switch on the on-side CCD.

Automatic Highlight Box Positioning

To facilitate data entry during preflight an autotabbing feature (airline configurable enabled or disabled) has been implemented to guide the pilot through the data entry process. When data is entered into a field in which autotabbing has been enabled, the cursor automatically moves to the next appropriate entry field. Autotabbing only operates when entering a page from a line select key and does not operate when a function key is used to enter a page. Autotabbing is enabled on the following FMC pages:

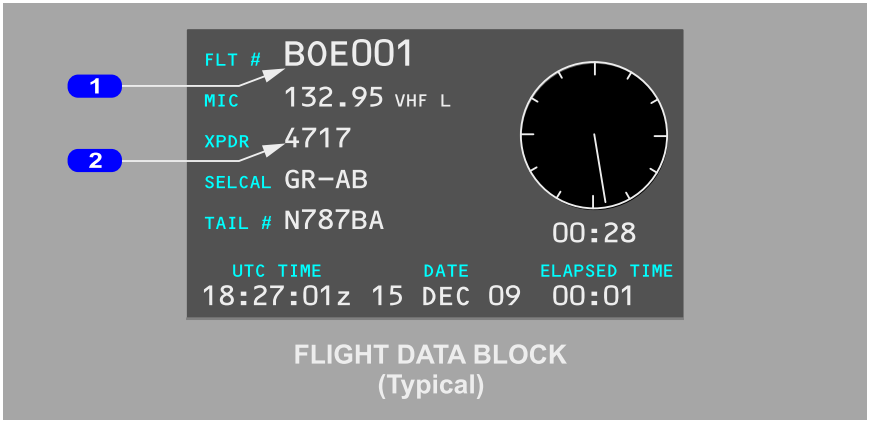
- ROUTE 1/X
- PERF INIT
- TAKEOFF REF 1/2.

The pilot can still move the highlight box with either the CCD or the CCS to any active area within a page even if that area is not on the immediate autotabbing sequence. This action does not disable autotabbing regardless of the position of the highlight box. As long as a valid entry is made on a field that is in the autotabbing sequence, autotabbing immediately takes over the highlight box repositioning again.

If a valid entry is made in a field that is not in the autotabbing sequence, the highlight does not move and the pilot must move it manually to the next desired field. Whenever a delete is performed, the pilot must also manually move the highlight box to the next desired field.

Autotabbing only operates in the display area adjacent to the line selection keys and does not include the CDU function keys. Autotabbing is discontinued after the FMS preflight is complete.

Flight Data Block



FLIGHT DATA BLOCK
(Typical)

1 Flight Number (FLT #)

Displays the current flight number as set on the RTE 1/X page.

2 Transponder (XPDR) Code

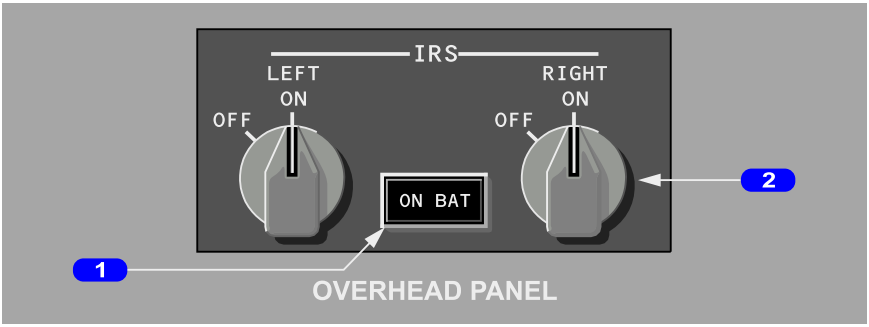
Displays the current ATC transponder squawk code as set on the TCP XPDR page.

For additional information:

- FLT #—(see Route Page 1/X on page 11.40.17.)
- XPDR code—(see Tuning and Control Panel (TCP) on page 11.10.14.)
- Flight data block—(see Auxiliary (AUX) Display on page 10.10.63.)

Inertial System

Inertial Reference System (IRS)



1 On Battery (ON BAT) Light

Illuminated (white)—airplane battery powers IRS.

Note: ON BAT light illuminates only when IRS has been aligned on airplane or ground power, and primary power is subsequently removed or failed (battery power only remains). On the ground, a warning horn is sounded in the nose wheel well to alert the ground crew that the IRS is depleting the battery.

2 IRS Selectors

ON—applies power to the associated IRS.

OFF—removes power from the associated IRS.

Note: IRS selectors must be pulled out before moving to the OFF position.

Tuning and Control Panel (TCP)

The transponder, weather radar and alternate navigation functions may be accessed from any of the three Tuning and Control Panels (TCPs) located on the aft aisle stand. The transponder additionally uses the Alerting and Transponder Control Panel (ATP). (See Tuning and Control Panel (TCP) on page 5.10.4 for additional information.)



1 Mode Select Keys

Push—selects desired mode page for display:

- WXR—displays weather radar page
- XPDR—displays transponder page.

2 Navigation (NAV) Key

Push—selects the ALTN NAV (alternate navigation) page. (See Alternate Navigation System Description on page 11.50.1 for additional information.)

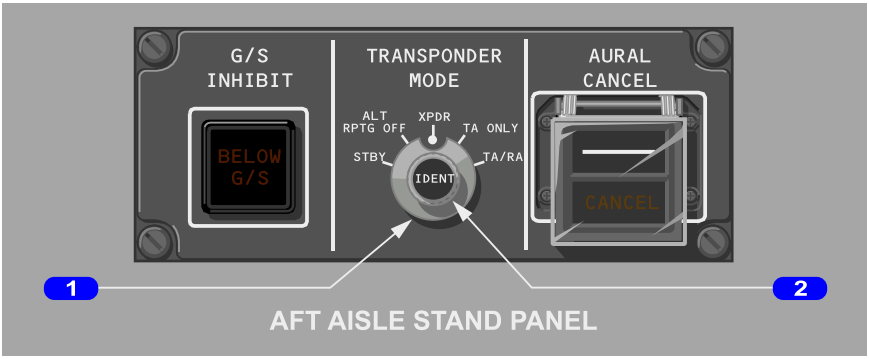
3 Menu Key

Push—selects the MENU page.

Transponder

Alerting and Transponder Control Panel (ATP)

The Alerting and Transponder Control Panel serves as the primary means for setting transponder modes and for sending an IDENT to ATC. The ATP is used in conjunction with the transponder display on the Tuning and Control Panel.



1 Transponder/TCAS Mode Selector

STBY (standby)—transponder not active.

ALT RPTG (altitude reporting) OFF—

- transponder enabled in modes A and S
- altitude reporting disabled
- ADS-B out enabled.

XPDR (transponder)—

- transponder enabled in modes A, C, and S
- in flight, altitude reporting enabled
- ADS-B out enabled.

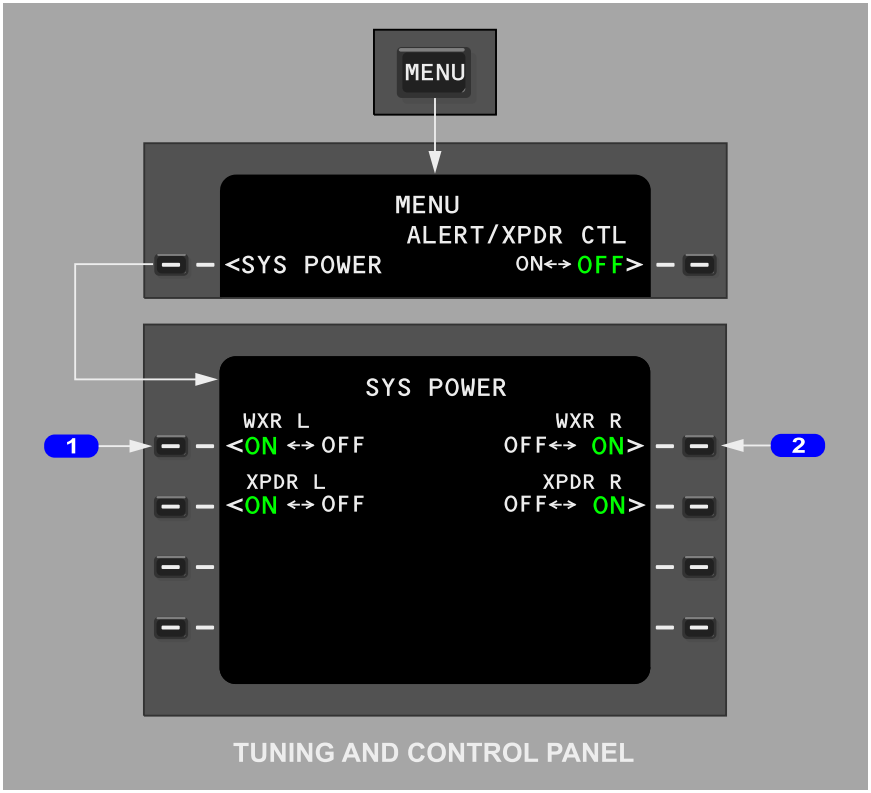
TA (traffic advisory) ONLY and TA/RA (resolution advisory) (see Traffic Alert and Collision Avoidance System (TCAS) on page 15.10.12 for additional information.)

2 Identification (IDENT) Switch

Push—transmits an identification signal.

Tuning and Control Panel (TCP)

Power to the left and right transponders is controlled from the TCP SYS POWER screen. This screen allows the flight crew to remove power from the transponders in response to a loss of cooling in the forward E/E bay (EICAS advisory message EQUIP COOLING FWD displayed).



1 Left Transponder Power (XPDR L)

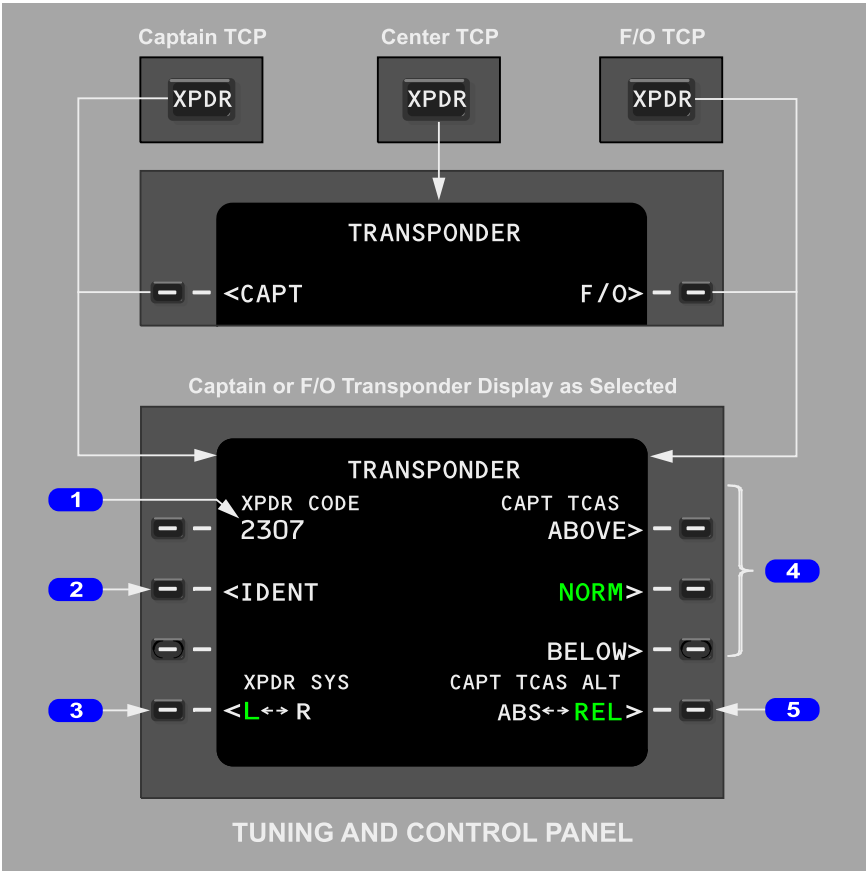
Push—toggles system power for the left transponder ON (enabled) or OFF (disabled).

2 Right Transponder Power (XPDR R)

Push—toggles system power for the right transponder ON (enabled) or OFF (disabled).

The transponder control pages on the TCP are accessed by selecting the XPDR mode select key.

The center TCP can control both left and right side transponders. When XPDR is selected from the center TCP the flight crew is prompted to select either the CAPT (Captain) or F/O (First Officer) display.



1 Transponder (XPDR) Code

Displays the current ATC transponder squawk code.

The squawk code is also displayed in the flight data block on the outboard side of each PFD. (See Flight Data Block on page 11.10.11 for additional information.)

Transponder code is typed into the scratchpad and then entered using line select key 1L.

2 Identification (IDENT)

Push—

- transmits an identification signal
- the IDENT prompt changes to large green font for 10 seconds.

3 Transponder System (XPDR SYS)

Push—

- toggles the selection of the left or right ATC transponder/TCAS system
- the selected system is highlighted in large green font.

The left system is the default selection.

Note: If a transponder becomes inoperative, the TCP senses the fault and automatically switch operation to the other side. The change in the XPDR SYS field (i.e. from L to R) may be the only indication the flight crew receives that an autoswitch has occurred. The flight crew is still be able to manually select an inoperative side.

4 XXXX TCAS Display

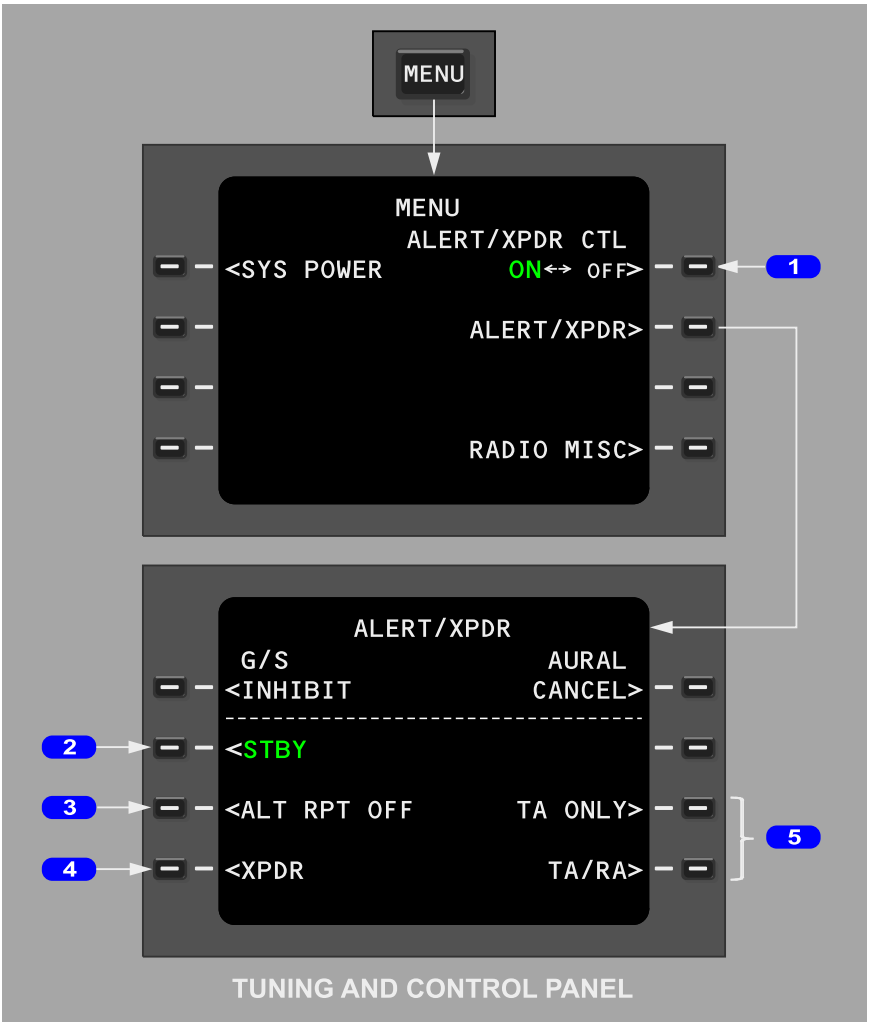
(See Traffic Alert and Collision Avoidance System (TCAS) on page 15.10.12 for additional information.)

5 XXXX TCAS Altitude (ALT)

(See Traffic Alert and Collision Avoidance System (TCAS) on page 15.10.12 for additional information.)

Tuning and Control Panel—ATP Inoperative

If the Alerting and Transponder Control Panel fails, the EICAS advisory message TRANSPONDER PANEL is displayed and the transponder and TCAS modes must be set using the Tuning and Control Panel.



1 ALERT/Transponder Control (XPDR CTL)

Push—

- toggles transponder control between ATP and the TCP

- selection appears in large green font
- when set to ON, ALERT/XPDR prompt is displayed.

Note: With ALERT/XPDR CTL set to ON, even a functional ATP no longer controls the transponder/TCAS mode, ILS glideslope inhibit, and aural cancel functions.

2 Standby (STBY)

Push—
- places transponder in standby mode
- STBY displayed in large green font.

3 Altitude Reporting (ALT RPT) OFF

Push—
- transponder enabled
- altitude reporting disabled
- ALT RPT OFF displayed in large green font.

4 Transponder (XPDR)

Push—
- transponder enabled
- in flight, altitude reporting enabled
- XPDR displayed in large green font.

5 Traffic Advisory (TA) ONLY and TA/Resolution Advisory (RA)

(See Traffic Alert and Collision Avoidance System (TCAS) on page 15.10.12 for additional information.)

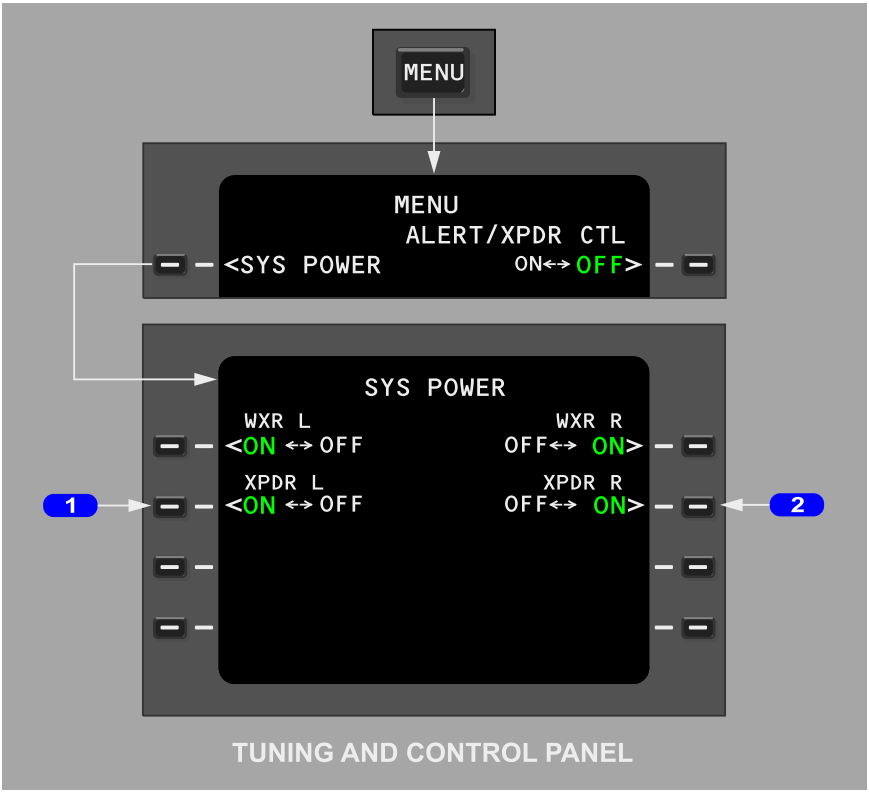
Weather Radar

Tuning and Control Panel (TCP)

Power to the left and right weather radar systems is controlled from the TCP SYS POWER screen. This screen allows the flight crew to remove power from the weather radar systems in response to a loss of cooling in the forward E/E bay (EICAS advisory message EQUIP COOLING FWD displayed).

When both WXR L and WXR R are selected to OFF, neither the WXR switch located on the EFIS control panel or the WXR check box on the ND drop-down menu will function.

With at least one weather radar system (WXR L or WXR R) selected to ON, pushing the WXR switch on the EFIS control panel or checking the WXR check box on the ND drop-down menu will power the transmitter/receiver and display weather radar returns on the ND and/or mini-map. (See Weather Radar on page 11.20.16.)

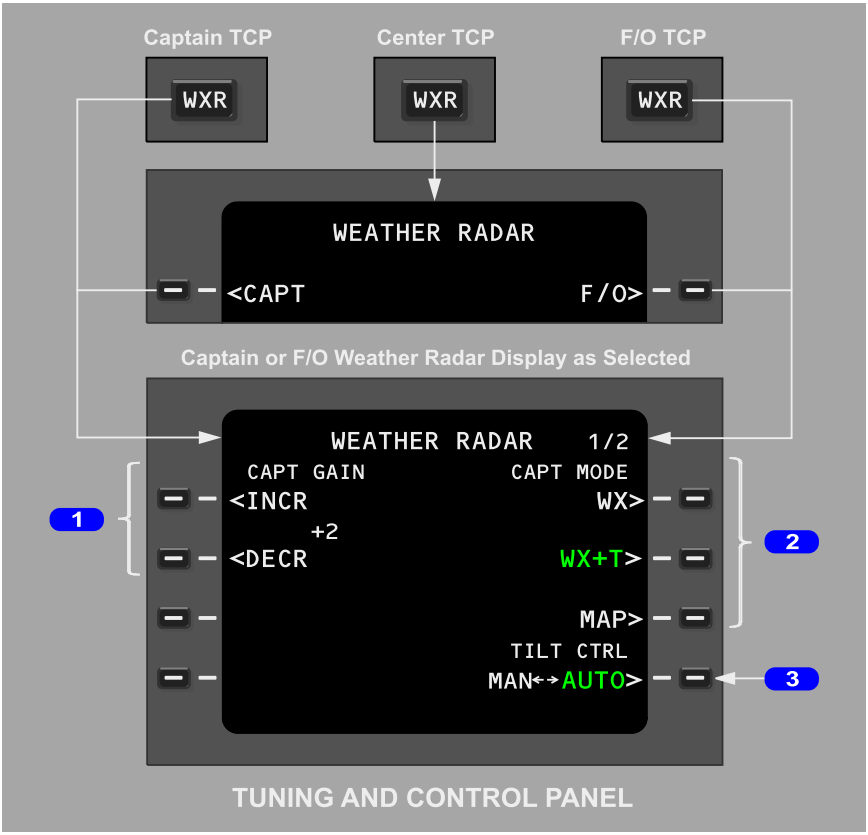


1 Left Weather Radar System Power (WXR L)

Push—toggles system power for the left weather radar ON (enabled) or OFF (disabled).

2 Right Weather Radar System Power (WXR R)

Push—toggles system power for the right weather radar ON (enabled) or OFF (disabled).



1 Gain Control

Push and hold—

- INCR—increases gain
- DECR—decreases gain
- current gain setting is displayed between line select keys 1L and 2L
- defaults to a calibrated gain level.

Note: In WX and WX+T modes, weather radar returns may be reduced or not displayed if gain is adjusted below the default calibrated gain level.

2 Mode Switches

Push—selects desired mode.

WX—displays weather radar returns.

WX+T (turbulence)—displays weather returns and turbulence within precipitation at calibrated gain level. Turbulence within 40 NM is displayed at all display ranges.

Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

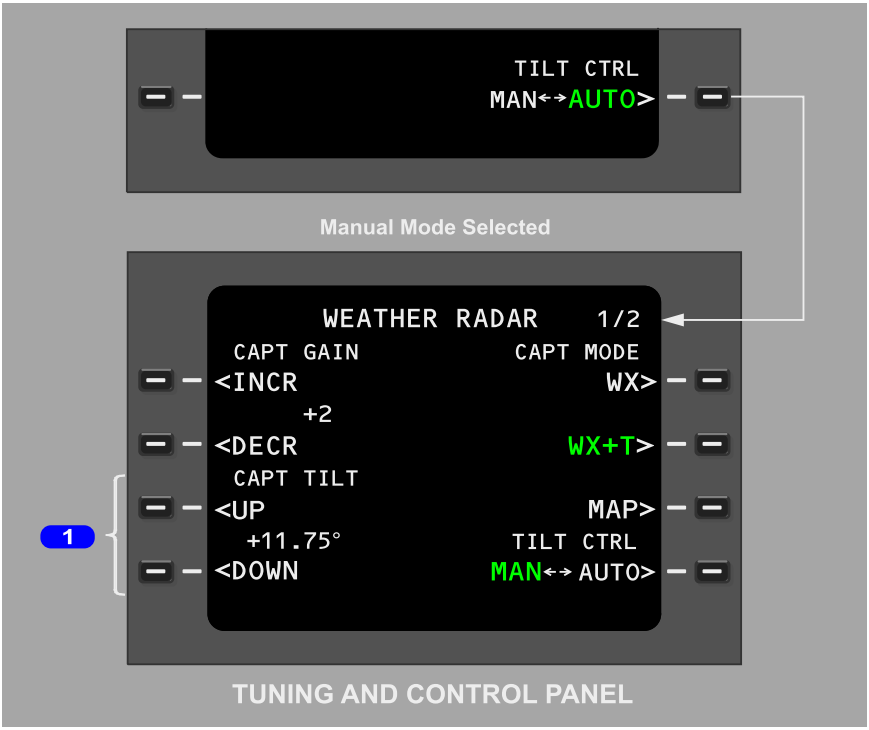
MAP—displays ground returns at selected gain level.

Selection is displayed in large green font.

3 Tilt Control

Push—selects manual (MAN) or automatic (AUTO) antenna tilt.

Selection is displayed in large green font.



1 Manual Antenna Tilt

Displayed when tilt control (TILT CTRL) is set to manual (MAN).

Push and hold—

- UP—slews antenna tilt up to a maximum of +15º

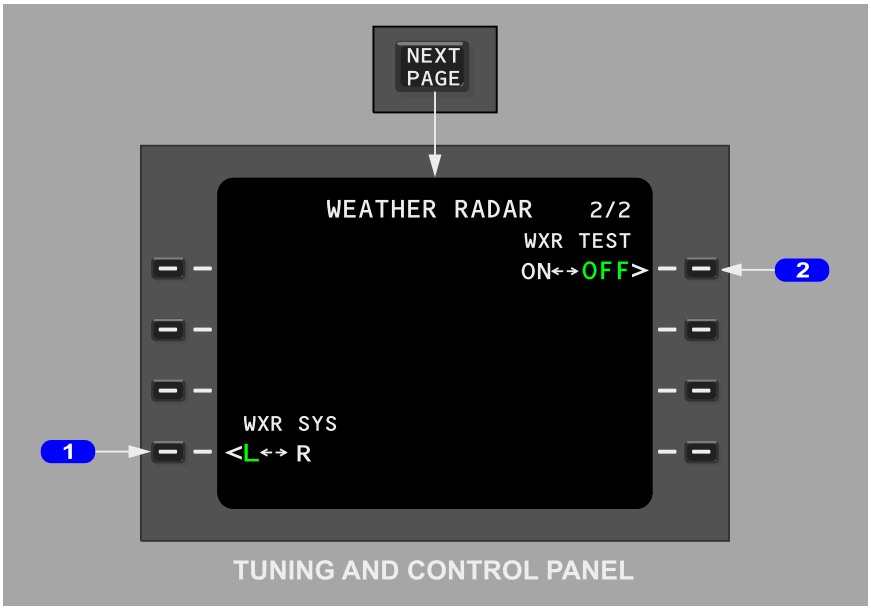
- DOWN—slews antenna tilt down to a maximum of –15º.

Push (with value entered into scratchpad)—

- UP—sets antenna up tilt to value entered in scratchpad
- DOWN—sets antenna down tilt to value entered in scratchpad.

Valid scratchpad entries are 1 to 15.

Current +/– antenna tilt is displayed in degrees between line select keys 3L and 4L.



1 Weather Radar System (WXR SYS)

Push—

- toggles the weather radar system between the left and right system
- the selected system is highlighted in large font green text
- the default selection is the left system.

2 Weather Radar Test (WXR TEST)

Push—

- tests weather radar system operation without transmitting
- with WXR selected on any ND or PFD minimap, a test pattern and PWS symbol display along with any fault messages that result from the test

- when on the ground, selecting WXR on the EFIS control panel and TEST on the TCP WXR page 2/2 activates a 12 second test. Initially, the amber WINDSHEAR annunciation displays and the aural MONITOR RADAR DISPLAY sounds. Next, the Master Warning Light illuminates and the EICAS alert message WINDSHEAR SYS displays. Finally, the red WINDSHEAR annunciation displays and the aural GO AROUND WINDSHEAR AHEAD, and then WINDSHEAR AHEAD, WINDSHEAR AHEAD sounds
- the test pattern and PWS symbol remain displayed until:
  - WXR is deselected using the WXR button on the Display Control Panel or the WXR box on the ND drop-down menu
  - a PWS alert occurs when the airplane is in flight or on takeoff roll
  - WXR TEST is selected to OFF on the WEATHER RADAR 2/2 page.

  Note: When WXR TEST is selected ON, all other WXR modes (WX, WX +T, and MAP, from WEATHER RADAR 1/2) are automatically set to OFF. When the WXR TEST is selected back to OFF, the previously active WXR mode will automatically be set to ON.

Introduction

Navigation systems include global positioning system (GPS), air data reference system (ADRS), inertial reference system (IRS), VOR, DME, ILS, ATC transponder, weather radar, and the flight management system (FMS). The FMS is described in the Flight Management System Description section of this chapter.

For additional information on navigation systems displays:

- See Primary Flight Display (PFD) on page 10.10.1
- See Navigation Display (ND) on page 10.10.28.

Global Positioning System (GPS)

Left and right GPS receivers are independent and supply very accurate position data to the IRS. The IRS in turn supplies a very accurate hybrid GPS inertial position to the FMC. In the event that the IRS becomes inoperative, the GPS supplies position and track data directly to the FMC. All GPS tuning is automatic.

GPS Displays

POS REF page 4/4 displays the left and right GPS-IRU position. The ND annunciates GPS when the FMC uses GPS position updates.

When POS (position) is selected on the ND drop-down menu, the ND map displays raw GPS position as left and right GPS symbols. The GPS symbols are identical and display as a single symbol when the GPS receivers calculate the same position.

GPS Data

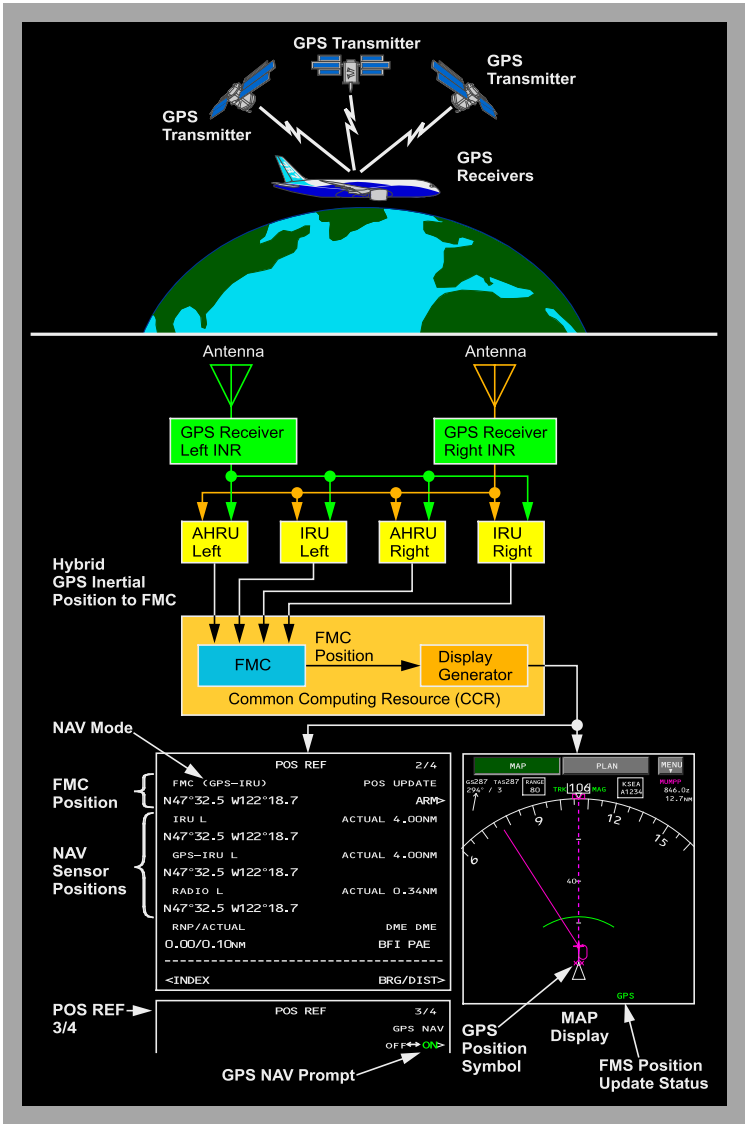
If the IRS becomes inoperative during flight, the FMC automatically uses GPS data to navigate. No EICAS message is displayed.

Use the GPS NAV prompt on the POS REF page 3/4 to inhibit GPS navigation data. The EICAS advisory message GPS alerts the crew when both GPS systems have failed.

GPS position updates should be used during all approaches in which the FMC database and approach procedures are referenced to the WGS-84 reference datum. GPS updates should be inhibited for all other approach operations, 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 accommodate a non-WGS reference datum or other reason).

GPS System Schematic



Air Data Reference System (ADRS)

The ADRS provides airplane altitude and airspeed for the displays, flight management system, flight controls, engine controls, and other systems.

Air Data and Attitude Sources

The ADRS receives air data from the left, center, and right pitot and static systems, and sends trusted voted air data to the PFDs. The ADRS is completely independent of the IRS.

When voted ADRS air data is invalid and the AIR DATA/ATT switch is in the AUTO position, backup airspeed (AOA SPD) and/or backup altitude (GPS ALT) are automatically provided by the IRS and GPS systems. (See Instrument Source Select Panels on page 10.10.49 for additional information.)

The air data modules are remote sensors that convert the sensed analog pressures to digital values for the air data functions within the ADRS. In addition, the ADRS receives data from two angle of attack sensors, an airframe mounted dual element total air temperature probe, and engine TAT sensors.

The integrated standby flight display (ISFD) receives data from the center pitot static system. Altitude, attitude, and airspeed are independent of IRU and AHRU values.

In the event both voted and backup air data is unavailable, ISFD altitude (ISFD ALT) and ISFD airspeed (ISFD SPD) are displayed on the PFDs.

Inertial System

Inertial Reference System (IRS)

The IRS calculates airplane airspeed, attitude, heading, and position data for the displays, flight management system, flight controls, engine controls, and other systems. The major components of IRS are the inertial reference units (IRUs), and attitude and heading reference units (AHRUs).

Inertial Reference Unit (IRU)

The IRU combines inertial reference functions with GPS position information to provide hybrid GPS inertial position outputs.

IRU Power

Initial power–up requires battery bus power and the IRS switches to be ON. If the IRSs are switched off, they must complete a full realignment cycle before the airplane can be moved.

If electrical power is subsequently removed from the airplane and the Battery switch is switched OFF, the hot battery bus continues to supply electrical power to the IRS. The ON BAT light illuminates, and the horn in the landing gear wheel well sounds to alert maintenance personnel that the IRS is on battery power.

IRU Alignment

On initial power–up, the IRUs enter the align mode. The EICAS memo message IRU ALIGN MODE L+R displays. Attitude or heading/track data is removed from the PFDs. When the GPS system is operating normally there is no requirement for the flight crew to enter present position on the CDU POS INIT page. The POS INIT page displays dashes in the SET INERTIAL POS line to allow the option of manually entering present position. If the GPS position is not available during the alignment, the dashes are replaced with boxes and present position must be entered to complete the alignment. Alignment time is approximately 7 to 10 minutes at mid latitudes and up to 17 minutes at high latitudes. The airplane should not move until alignment is complete.

If the latitude/longitude position is not close to the position of the origin airport, the EICAS advisory message FMC MESSAGE is displayed along with the CDU help window message INERTIAL/ORIGIN DISAGREE. If the crew–entered latitude/longitude position does not pass internal IRU comparison tests, the EICAS advisory message FMC MESSAGE is displayed along with the CDU help window message ENTER INERTIAL POSITION.

If a new airplane present position entry fails the internal check twice, the EICAS advisory message FMC MESSAGE is displayed along with the CDU help window message ALIGNMENT REINITIATED. The system automatically starts a new alignment cycle.

When the alignment is complete, the IRS changes to the navigate mode and the airplane can be moved. If the airplane stops for an extended period, the IRS changes to the automatic realign mode and refines the alignment until the airplane moves again.

In the automatic realign mode, IRS velocity and acceleration errors are reset to zero. The inertial position can be manually updated when the IRS is in the automatic realign mode by entering a new latitude/longitude position on the POS INIT 1/3 page.

The IRU has the additional capability to complete an alignment while in flight. This capability allows the IRU to completely recover from an in flight loss of alignment due to a power interruption or inadvertent shutdown. When power is restored to the IRU while in flight, attitude information becomes available within a few seconds and full navigation capability is restored within about 10 minutes. This capability relies on GPS data and is therefore not available if the GPS receivers are not functioning.

Note: A position update is recommended if the total time in the navigation mode is expected to exceed 18 hours.

IRU Failure

Should both IRUs fail, the EICAS advisory message NAV IRU is displayed. The FMC will continue to receive a hybrid GPS inertial position solution using the AHRUs inertial sensors combined with GPS position.

Attitude and Heading Reference Unit (AHRU)

Like the IRUs, the AHRUs supply a stable source of attitude, heading and rate information used in voted solutions for flight controls, displays, and other using systems. Although the AHRUs do not have the ability to provide an independent inertial position, they do contribute to a hybrid GPS inertial position that combines the accuracy of the GPS position with the stability of the AHRUs inertial sensors.

IRS Failure

If the IRS fails, meaning both AHRUs and both IRUs fail, the EICAS caution message NAV INERTIAL SYS is displayed. GPS output from the integrated navigation radios (INRs) provides the necessary position and track data for the FMC to continue to operate without the IRS. In this mode, the FMC continues to provide flight planning, navigation, and performance information to the crew. ND map center and map expanded modes are still available. LNAV and VNAV guidance coupled to the autopilot however are not available when the IRS is inoperative.

The CDU POS INIT page displays the SET HDG prompt immediately after any IRU or AHRU failure. However, voted heading information is still being sent to the IRS from the working IRUs and AHRUs and no aircrew action is required. Should the IRS fail however, the aircrew must use the SET HDG prompt to periodically sync the display heading to the standby compass magnetic heading.

The following functions are inoperative after failure of the IRS:

AFDS Modes:

- FPA
- G/S
- HDG HOLD/SEL*
- LNAV
- LOC
- TO/GA
- TRK HOLD/SEL
- VNAV.

Navigation Functions:

- FMC Performance Predictions
- FMC VNAV pages
- ND Wind Direction and Speed (wind arrow).

PFD Functions:

- PFD Heading*.

Notes: 1. *These functions are operative when standby magnetic compass heading is entered on the POS INIT page.

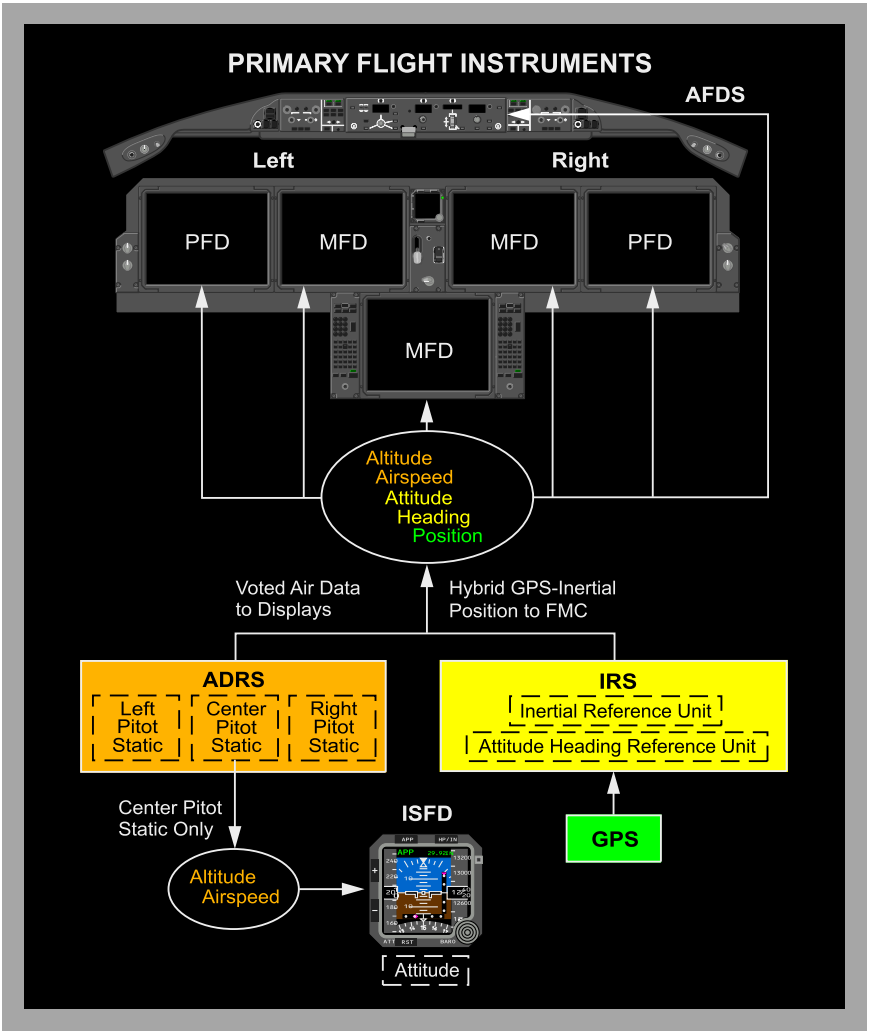
2. ND map mode display following IRS failure references TRK.

3. The autobrake is also inoperative.

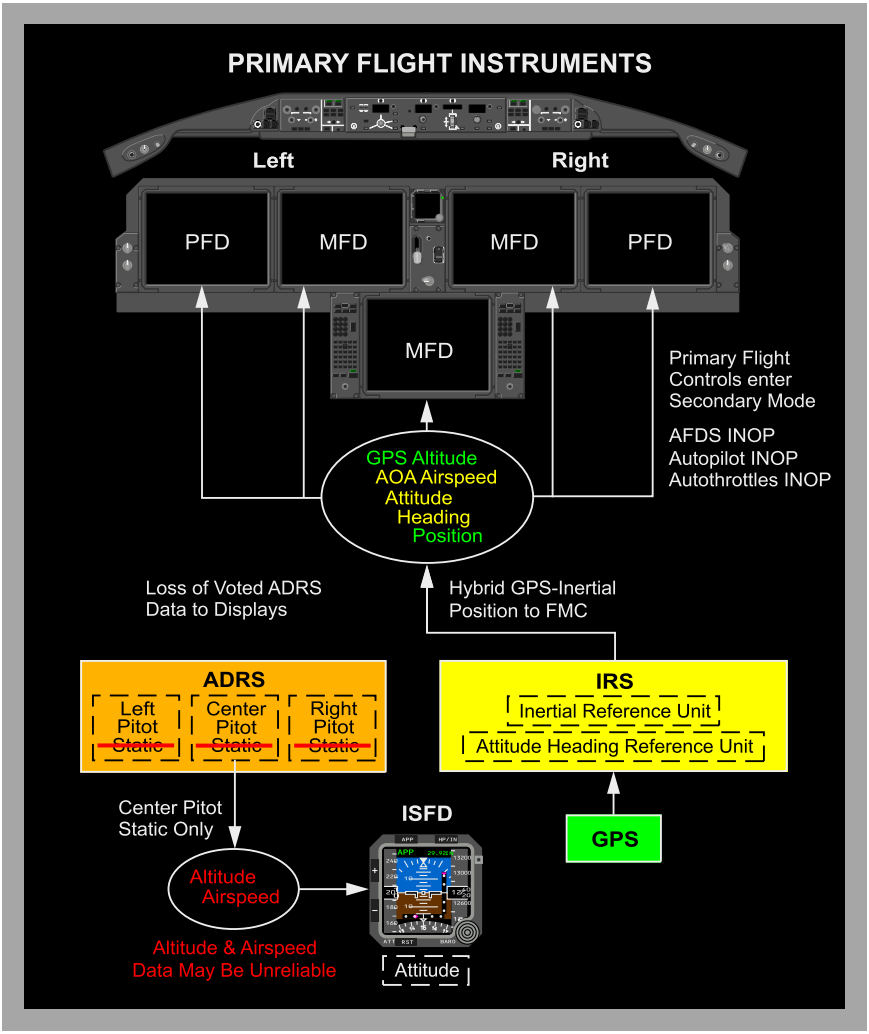
The following additional functions are inoperative after failure of both the IRS and GPS:

- CDU active leg course and distance
- CDU direct-to a waypoint
- FMC Alternate Airport DIVERT NOW
- FMC navigation radio autotuning
- ND Map (center and expanded).

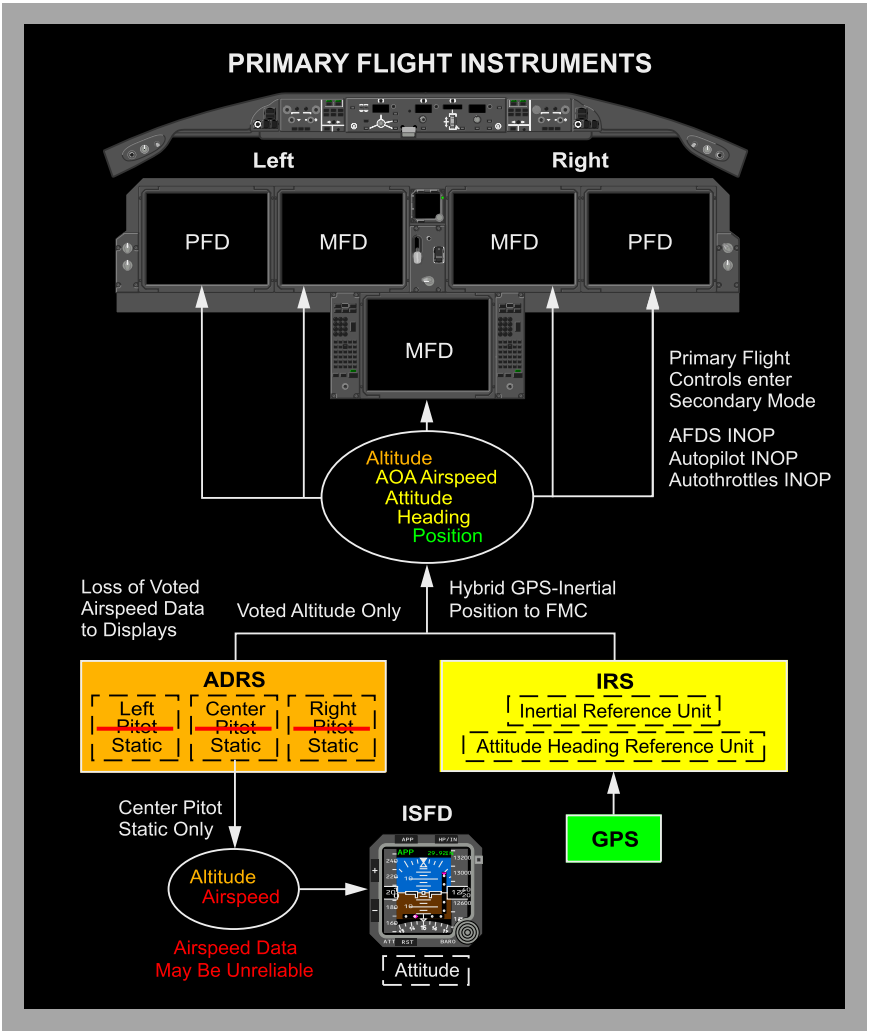
IRS Schematic—Normal Mode



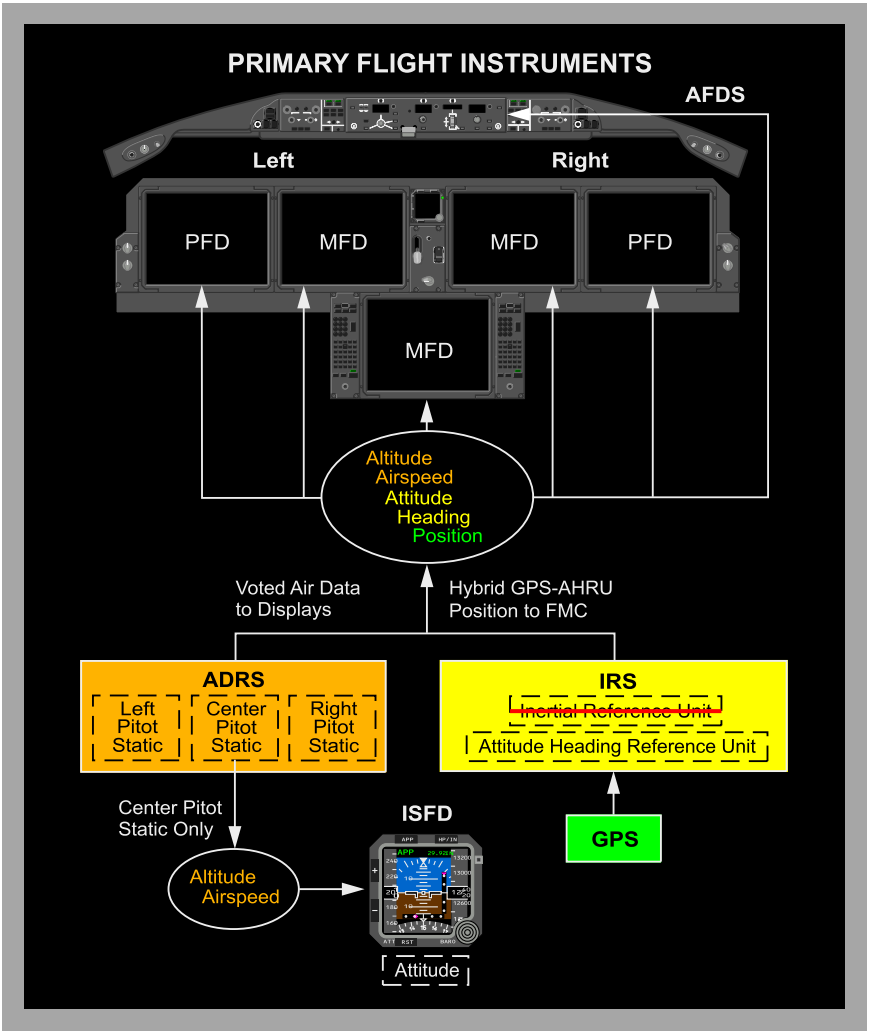
IRS Schematic—with NAV AIR DATA SYS Message



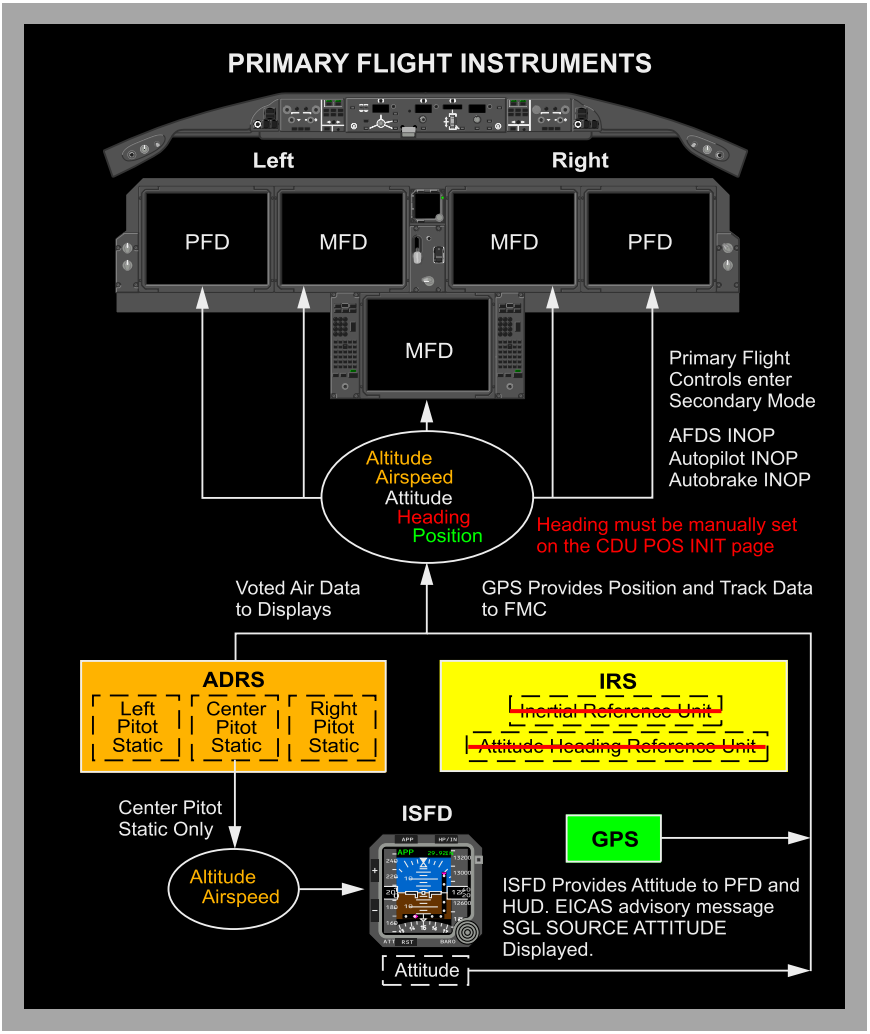
IRS Schematic—with NAV AIRSPEED DATA Message



IRS Schematic—with NAV IRU Message



IRS Schematic—with NAV INERTIAL SYS Message



Radio Navigation Systems

Distance Measuring Equipment (DME)

Two DME systems are installed. The DMEs are usually tuned by the FMC, but may be tuned manually.

DME Tuning

DME is tuned manually when the VOR portion of a VOR/DME pair is entered on the NAV RADIO page. The FMC tunes DME as necessary for radio position updates. Manual DME tuning does not inhibit FMC DME tuning.

The FMC uses two DMEs for position updates. The FMC uses DME/DME radio position updates when more accurate sources are not available. DME/DME position updates are usually more accurate than VOR/DME updates. The FMC cannot tune specific DMEs if the navaids are inhibited on the REF NAV DATA page.

DME Displays

DME distances are displayed on the ND map when VOR L or VOR R are selected on the ND drop-down menu. DME distance also displays on the PFD when the ILS receivers are tuned to a collocated DME and localizer facility.

POS REF page 2/4 displays the identifiers of the DME stations used for FMC position updates.

Instrument Landing System (ILS)

Two ILS receivers are installed. They are usually tuned by the FMC, but can be tuned manually on the NAV RADIO page.

ILS Tuning

Two conditions must be met for FMC ILS autotuning to occur:

- an ILS, LOC, back course, LDA (localizer-type directional aid), or SDF (simplified directional facility) approach have been selected to the active route, and
- the airplane is within 50 NM from the top of descent, 150 NM of the landing runway threshold, or the FMC is in descent mode.

On initial takeoff, ILS autotuning is inhibited for 10 minutes to prevent clutter on the PFD. Selection and execution of a new approach in the active flight plan causes the ILS to autotune to the new approach frequency, even if this is accomplished during the 10 minute takeoff inhibit period. ILS autotune inhibit does not apply to subsequent takeoffs on the same flight (for example, touch-and-go or stop-and-go landings).

Both ILS receivers can be manually tuned from the NAV RADIO page at anytime unless ILS approach tuning inhibit is active.

ILS approach tuning inhibit (also applies to GLS and IAN) is active when:

- autopilot is engaged or flight director is on and either the localizer or glideslope is captured, or
- HUD takeoff mode is active for at least 5 seconds and on the ground.

ILS tuning (also applies to GLS and IAN) is again enabled when:

- either TO/GA switch is pushed, or
- the autopilot is disengaged and both flight director switches are switched off, or
- the MCP approach mode is deselected above 1,500 feet radio altitude, or
- the airplane becomes airborne after a HUD TO/GA takeoff.

The ILS frequency (also applies to GLS and IAN) is automatically returned when ILS tuning is enabled and a new approach is selected on the CDU.

In the unlikely event that all three FMCs fail, or if all of the large displays fail, the left ILS can be tuned from ALTN NAV RADIO page 2/2 on the TCP.

ILS Displays

The tuned ILS frequency displays on the PFD and on the ND in the approach mode.

When both ILS receivers are operating, deviations from the left ILS are displayed on the captain's PFD, and deviations from the right ILS are displayed on the first officer's PFD. If an ILS receiver fails, data from the remaining ILS is displayed on both the captain's and first officer's displays and the EICAS caution message SINGLE SOURCE APPROACH is displayed. Front or back course deviation is determined from airplane heading.

Navaid Identifier Decoding

The Morse code identifier of a tuned VOR, ILS, or DME can be converted to alpha characters. The decoded identifier then displays on the PFD and ND. The crew should monitor this identifier for correct navigation radio reception. The identifier name is not compared with the FMC database.

Due to the large variation in ground station identifier quality, the decode feature may incorrectly convert the intended identifier name. Examples: the Hong Kong localizer "KL" may display as "KAI", or the Boeing Field ILS may display as "QBFI" or "TTTT" instead of "IBFI."

Pilots should verify the identity of the tuned navigation station from the audio Morse code when the tuned frequency remains displayed or an incorrect identifier displays.

VOR

Two VOR receivers are usually tuned by the FMC but, can be tuned manually by the crew. The tuned VORs display on the ND and may be used for position updates.

VOR Tuning

The crew manually tunes VORs on the NAV RADIO page.

The FMC can tune a VOR and a collocated DME for position updates. The FMC uses VOR/DME radio position updates when more accurate sources are not available. Specific VOR/DME pairs can be inhibited on the REF NAV DATA page. If the crew enters two VOR identifiers on the NAV RADIO page, then the FMC cannot tune any other station for VOR/DME updates.

VOR Displays

The NAV RADIO page displays FMC tuned or manually tuned VOR data. POS REF page 2/4 displays the identifier of the VOR and DME pair used for position updates.

The ND displays the identifier or frequency of the VORs tuned on the NAV RADIO page. The FMC usually tunes the same VOR in the left and the right. The ND VOR L and VOR R data are usually the same.

Left and right VOR bearing pointers display on the ND map compass rose when the related VOR check box on the ND drop-down menu is selected. The tuned frequency or identifier, and associated DME distances are also displayed in the lower corners of the ND when the VORs are selected on the ND drop-down menu.

Transponder

Two ATC transponders and the traffic alert and collision avoidance system (TCAS) are controlled from the ATP and the TCP.

Alerting and Transponder Control Panel (ATP)

The ATP controls the following Transponder/TCAS modes:

- ALT RPTG OFF
- STBY
- TA ONLY
- TA/RA
- XPDR.

Traffic displays if the transponder mode selector is in TA ONLY or TA/RA. The transponder responds to Mode S interrogations in all modes except STBY. In flight, the selected transponder activates beacon and altitude reporting when the transponder mode selector is in XPDR, TA ONLY, or TA/RA.

If the ATP becomes inoperative the Transponder/TCAS modes can be set through the backup function of the TCP.

Transponders provide selective interrogation and downlink information, such as flight number, airspeed or groundspeed, magnetic heading, altitude, GPS position, etc. Some airports use transponder information to monitor airplane position on the ground when the transponder is active (mode selector not in STANDBY). 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.

Tuning and Control Panel—Normal Operation

The transponder control pages on the TCP are accessed by selecting the XPDR mode select key.

The TCP controls:

- Altitude Mode (Absolute or Relative)
- ATC Ident function
- Mode A numeric code
- TCAS envelope (Above, Normal, or Below)
- Transponder select (Left or Right).

The Captain and First Officer TCPs share control of the:

- IDENT function
- left or right side selection
- XPDR code.

Any changes made are also reflected on the center and cross-side TCPs. TCAS envelope and altitude settings control only the on-side TCAS display, and changes on one TCP are not reflected on the cross-side TCP.

The center TCP can control both left and right side transponders. When XPDR is selected from the center TCP the flight crew is prompted to select either Captain (left) or First Officer (right).

Should the on-side transponder fail, the TCP automatically switches to the cross-side transponder. A status message is logged and a status prompt displayed. Should both transponders fail, the EICAS advisory message TRANSPONDER is displayed. If altitude reporting fails, the transponder can be switched to the alternate altitude source. (See Traffic Alert and Collision Avoidance System (TCAS) on page 15.10.12 for additional information.)

Tuning and Control Panel—ATP Inoperative

If the ATP fails, the EICAS advisory message TRANSPONDER PANEL is displayed and the transponder and TCAS modes must be set using the TCP.

The ALERT/XPDR CTL page of the TCP is accessed from the MENU page by turning ALERT/XPDR CTL to ON (LSK 1R), and then selecting the ALERT/XPDR CTL page (LSK 2R).

When selected ON the transponder and TCAS modes can be set via the ALERT/XPDR CTL page.

Weather Radar

The weather radar system consists of a transmitter/receiver unit and antenna. Control is managed through the TCP. Radar returns display on the ND (MAP mode only) and mini-map.

At least one weather radar system must be selected ON from the TCP SYS POWER screen before the WXR switch on the EFIS control panel or the WXR check box on the ND drop-down menu will function.

The WXR switch on the EFIS control panel and the WXR check box on the ND drop-down menu perform the same function. Both control power to the transmitter/receiver and allow weather radar returns to display on the ND and/or mini-map. (See Weather Radar on page 11.10.19.)

The radar display range automatically adjusts to the ND range selected on the EFIS control panel. At ND ranges greater than 320 NM, WXR can still be displayed but only shows weather returns out to 320 NM.

The weather radar system performs various levels of self test on power up, during each sweep, and when descending through 2,300 feet AGL.

Turbulence can be sensed by the weather radar only when there is sufficient precipitation. Clear air turbulence can not be sensed by radar.

The weather radar also provides predictive windshear alerting. (See Predictive Windshear (PWS) Display and Annunciations on page 15.10.30 for additional information.)

Introduction

The flight management system (FMS) aids the flight crew with navigation, in–flight performance optimization, automatic fuel monitoring, and flight deck displays. Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for airplane orientation and command markers on the airspeed, altitude, and thrust indicators to help in flying efficient profiles.

The flight crew enters the applicable route and flight data into the CDUs. The FMS then uses the navigation database, airplane position, and supporting systems data to calculate commands for manual and automatic flight path control.

The FMS tunes the navigation radios and sets courses. The FMS navigation database supplies the necessary data to fly routes, SIDs, STARs, holding patterns, and procedure turns. Cruise altitudes and crossing altitude restrictions are used to calculate VNAV commands. Lateral offsets from the programmed route can be calculated and commanded.

Flight Management Computer (FMC)

The basis of the flight management system is the flight management computer function. Since the term FMC is universally understood, it is used here for standardization and simplification.

There are three independent FMCs. At power up, one FMC is designated to accomplish the flight management tasks while the other FMCs monitor. The second FMC is ready to replace the first FMC if system faults occur. When the second FMC becomes active, the third FMC becomes its backup. (See FMC Failure on page 11.32.5 for additional information.)

The FMC uses flight crew entered flight plan data, airplane systems data, and data from the FMC navigation database to calculate airplane present position and pitch, roll, and thrust commands necessary to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route data are sent to the NDs. The ND drop-down menu is used to select the items displayed on the ND. The MCP selects the autothrottle, autopilot, and flight director operating modes.

For additional information:

- See Autopilot Flight Director System Controls on page 4.10.1
- See Map Keys and Information Selections on page 10.10.45.

The FMC is certified for area navigation when used with navigation radio and/or GPS updating. The FMC and CDU are used for enroute and terminal area

navigation, RNAV approaches, and to supplement primary navigation during all types of instrument approaches.

Control Display Units (CDUs)

The flight crew controls the FMC using emulated CDU displays. The CDUs may be displayed on any of the MFDs as selected by the aircrew. (See Multifunction Display Management (MDM) on page 10.20.1 for additional information.)

Introduction

When first powered, the FMS is in the preflight phase. When completing a phase, the FMS changes to the next phase in this order:

1. preflight
2. takeoff
3. climb
4. cruise
5. descent
6. approach
7. flight complete.

Preflight

During preflight, the flight crew enters the flight plan and load sheet data into the CDU. Some data can be entered by datalink. The flight plan defines the route of flight from the origin to the destination and initializes LNAV. Flight plan and load sheet data provide performance data to initialize VNAV.

Required preflight data consists of:

- initial position (when not provided by GPS)
- performance data
- route of flight
- takeoff data.

Optional preflight data includes:

- alternate airport
- navigation database selection
- route 2
- standard instrument departure (SID)
- standard terminal arrival route (STAR)
- thrust limits
- wind.

Preflight starts with the IDENT page. If the IDENT page is not displayed, it can be selected with the IDENT prompt on the INIT/REF INDEX page. Visual prompts help the flight crew select CDU preflight pages. Preflight pages can be manually selected in any order.

After data on each preflight page is entered and checked, selecting the lower right line select key selects the next preflight page. After selecting ACTIVATE on the ROUTE page, the execute (EXEC) light illuminates. Selecting the EXEC key activates the route.

The departure/arrival (DEP/ARR) page can be used to select a SID. Selection of the SID may cause a route discontinuity. Resolution of the discontinuity and execution of the modification should be accomplished on the ROUTE or LEGS page.

Once the crew has entered the route and PERF INIT page information, they should verify the OAT on the THRUST LIM page and then select the TAKEOFF REF 1/2 page. From TAKEOFF REF 1/2 the crew selects FLIGHT INITIALIZATION on the EFB. The EFB receives the minimum required information from the FMC (GWT, ORIGIN, OAT, QNH and takeoff runway). The crew then fills in other required or optional information in the EFB performance tool application and selects CALC. Once the EFB application has generated the appropriate takeoff data (reference speeds, runway condition, takeoff thrust and flap setting) the crew selects SEND TO FMC. A "•FMC" COMM alert is displayed with an associated aural. A TAKEOFF UPLINK CDU help window message is then displayed on the CDU. The crew selects LOAD or REJECT after reviewing the data on the THRUST LIMIT, TAKEOFF REF 1/2 and TAKEOFF REF 2/2 pages.

When all required preflight entries are complete, the PRE–FLT line title on the TAKEOFF REF page is replaced by FMC PREFLIGHT COMPLETE. The THRUST LIM prompt displays at the next page select line location.

For additional information:

- See Initializing a Flight on page 10.80.2
- See Send and Copy Performance Data on page 10.80.44.

Takeoff

The takeoff phase starts with selection of TO/GA and terminates with thrust reduction for climb. LNAV and VNAV can be armed before takeoff to activate at the applicable altitude. (See Automatic Flight Takeoff Profile on page 4.20.13 for additional information.)

Climb

The climb phase starts at thrust reduction for climb and terminates at the top of climb (T/C) point. The T/C is where the airplane reaches the cruise altitude entered on the PERF INIT page.

Cruise

The cruise phase starts at the T/C point and terminates at the top of descent (T/D) point. Cruise can include step climbs and en route descents.

Descent

The descent phase starts at the T/D point or when the VNAV descent page becomes active, and terminates at the start of the approach phase.

Approach

The approach phase starts when the first waypoint of the procedure sequences or when the runway is the active waypoint and the distance to go is less than 25 NM, or when the flaps are moved out of the UP position.

Flight Complete

Thirty seconds after engine shutdown, the flight complete phase clears the active flight plan and load data. Some preflight data fields initialize to default values in preparation for the next flight.

Operational Notes

When operating in the LNAV and VNAV modes, observe system operation for unwanted pitch, roll, or thrust commands. If unwanted operation is observed, select heading select and flight level change modes.

The system must be carefully monitored for errors following:

- activation of a new database
- power interruption
- IRS failure.

The FMC does not sequence the active waypoint when more than 21 NM off the active route and not on an offset route. Return to the active route can be accomplished using the DIRECT TO or INTERCEPT COURSE TO/FROM procedures.

When a waypoint is in the route more than once, certain route modifications (such as DIRECT TO and HOLD) use the first waypoint in the route.

Some SIDs or STARS contain a heading vectors leg. VECTORS waypoints display on the ND as a magenta line without an end point leading away from the airplane symbol. If LNAV is active, the DIRECT TO or INTERCEPT COURSE TO/FROM procedures can be used to start waypoint sequencing beyond the vectors leg.

When entering airways in a route page, the start and end waypoints must be in the database. A route segment must be entered as a DIRECT leg.

If the engines remain operating between flights, entering a new cruise altitude before the next flight recalculates the proper vertical profile.

If a climb to cruise altitude is necessary after completing a descent, a new cruise altitude entry must be made. Cruise altitude can be entered on the CLB page.

DIRECT TO courses are segments of a great circle route. When entering a DIRECT TO waypoint on the LEGS page, the course above the waypoint before execution is the arrival course at the waypoint. However, after execution, the course is the current course to fly to the waypoint. These courses may not be the same.

Terminology

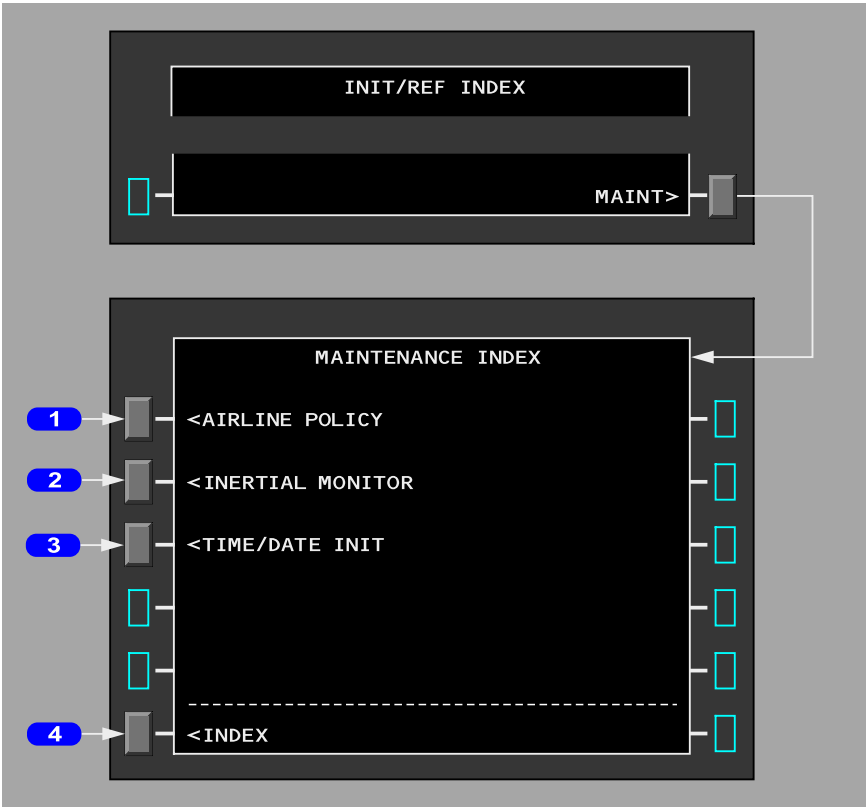
The following definitions describe the FMC and CDU terminology:

Active	flight plan data used to calculate LNAV or VNAV guidance commands.
Activate	changing a route from inactive to active for navigation by: • selecting the ACTIVATE prompt • selecting the execute (EXEC) key.
Altitude constraint	a crossing restriction at a waypoint.
Delete	using the DELETE key removes FMC data and reverts to default values, dash or box prompts, or a blank entry.
Econ	a speed schedule calculated to minimize operating cost. The economy speed is based on the cost index. A low cost index causes a lower cruise speed. Maximum range cruise or the minimum fuel speed schedule may be obtained by entering a cost index of zero. This speed schedule ignores the cost of time. A minimum time speed schedule may be obtained by entering a cost index of 9999. This speed schedule calls for maximum flight envelope speeds. A low cost index may be used when fuel costs are high compared to operating costs.
Enter	putting data in the CDU scratchpad and line selecting the data to the applicable location. New characters can be typed or existing data can be line selected to the scratchpad for entry.
Erase	removing entered data, which has resulted in a modification, by selecting the ERASE prompt.
EICAS Message	refers to a non-normal message displayed on the EICAS.
Execute	selecting the illuminated EXEC key to make modified data active.
Inactive	data not being used to calculate LNAV or VNAV commands.
Help Window	a small window on the CDU display that shows FMC messages and information.
Initialize	entering data required to make the system operational.
Message	FMC information displayed in the CDU help window.
Modify	changing active data. When a modification is made to the active route or performance mode, MOD displays in the page title, ERASE displays next to line select key 6 left, and the execute key illuminates.

Prompt	CDU symbols that aid the flight crew in accomplishing a task. Prompts can be boxes, dashes, or a caret (< or >) line to remind the flight crew to enter or validate data.
Purge	select the PURGE prompt to remove all airports uplinked to the ALTN LIST.
Select	selecting a key to obtain the necessary data or action, or to copy selected data to the scratchpad.
Speed restriction	an airspeed limit associated with a specified altitude entered by the flight crew.
Speed transition	an airspeed limit associated with a specified altitude entered by the FMC.
Waypoint	a point on the route or in the navigation database. It can be a fixed point such as a latitude and longitude, VOR station, or an airway intersection. A conditional waypoint is not associated with a land reference; it is based on a time or altitude requirement. An example of a conditional waypoint is “when reaching 4,000 feet”.

Maintenance Index

The MAINTENANCE INDEX page prompts are used only on the ground.



1 AIRLINE POLICY

The airline policy pages display operating parameters kept in the airline maintained file. The FMC references this file for data before it calculates default values. These pages are not normally used by the flight crew.

2 INERTIAL MONITOR

This is a maintenance function.

3 TIME/DATE INIT

Select—displays the TIME/DATE INIT page.

Allows manual entry of time and date when GPS is not available.

4 **INDEX**

Select—displays the INIT/REF INDEX page.

Navigation Position

The FMC can use hybrid GPS inertial, DME/DME, VOR/DME, and IRS data to compute the FMC position and velocity. When hybrid GPS inertial data is the most accurate data, the FMC uses hybrid GPS inertial data for the FMC position.

If hybrid GPS inertial data is not available, or inhibited, the FMC reverts to using inertial data for FMC position. In this scenario, the FMC position transitions from inertial data to radio-inertial data when the radio-inertial data provides the most accurate FMC position (smallest ANP). This assures the FMC provides the best position accuracy when GPS data is not available. Therefore, inhibiting of DME/DME navigation is not required for RNP AR approaches.

For additional information:

- See Global Positioning System (GPS) on page 11.20.1
- See Inertial System on page 11.20.3
- See Radio Navigation Systems on page 11.20.11.

FMC Position Update

FMC position may be manually updated to any of the calculated navigation system positions displayed on POS REF page 2/4.

On the ground with GPS NAV OFF, pushing a TO/GA switch updates the FMC position to the takeoff runway threshold or to the position shift position, when entered. When making an intersection takeoff, the intersection displacement distance from the runway threshold must be entered on the TAKEOFF REF page. With GPS NAV ON, the TO/GA update is inhibited.

The FMC position is always calculated using hybrid GPS-inertial data. Radio updating is not used unless GPS updating is not available or has been inhibited. Updating priority is based on the availability of valid data from the supporting systems.

The FMC automatically tunes VOR, DME, and ILS radios 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. When radio updating is in effect, 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.

The current FMC position source and associated ANP are displayed on POS REF page 2/4 and the Navigation Display (ND) per the following table:

Primary FMC Position Update Source	Failed, Invalid or Inactive	POS REF page 2/4	ND Annunciation
GPS-IRU		GPS-IRU	GPS
GPS-AHRU	IRU	GPS-AHRU	GPS
GPS	LOC, IRS (IRU, AHRU)	GPS	GPS
DME/DME, IRS	LOC, GPS	RADIO	DME-DME
VOR/DME, IRS	LOC, GPS, DME/DME	RADIO	VOR-DME
IRU	LOC, VOR, DME, GPS	INERTIAL	INERTIAL
LOC-DME/DME, IRU*	GPS	LOC-RADIO	LOC-DME-DME
LOC- VOR/DME, IRU*	GPS	LOC-RADIO	LOC-VOR-DME
LOC-IRU*	GPS, VOR, DME	LOC	LOC
Both GPS and IRS invalid or failed	GPS, IRS (IRU, AHRU)	blank	map not available

*** The FMC changes to LOC updating when:**

- **the tuned localizer is associated with the destination runway**
- **the airplane is less than 6000 feet above localizer navaid elevation**
- **the airplane is less than 20 NM from the localizer navaid for a front course approach or less than 12 NM for a back course approach**
- **the airplane is within 1.25° of the localizer centerline**
- **the difference between airplane track and the localizer course is less than a 45° intercept angle.**

For additional information on FMC position:

- See Navigation Performance on page 11.31.11
- See Position Reference Page 2/4 on page 11.40.10
- See In–Flight Position Update on page 11.42.47.

FMC Polar Operations

When entering the polar regions, the autopilot will automatically switch to a true north reference for all cruise roll modes (HDG HOLD, HDG SEL, TRK HOLD, TRK SEL, and LNAV) regardless of the position of the HEADING REF switch. Automatic switching to a true north reference is annunciated by a white box around the word TRU on both the ND and PFD. The CDU RTE LEGS page will also display a “T” next to the leg course data on the line title when operating

in true north reference. A true heading reference can be manually selected by placing the HEADING REF switch to TRUE inside or outside the polar region.

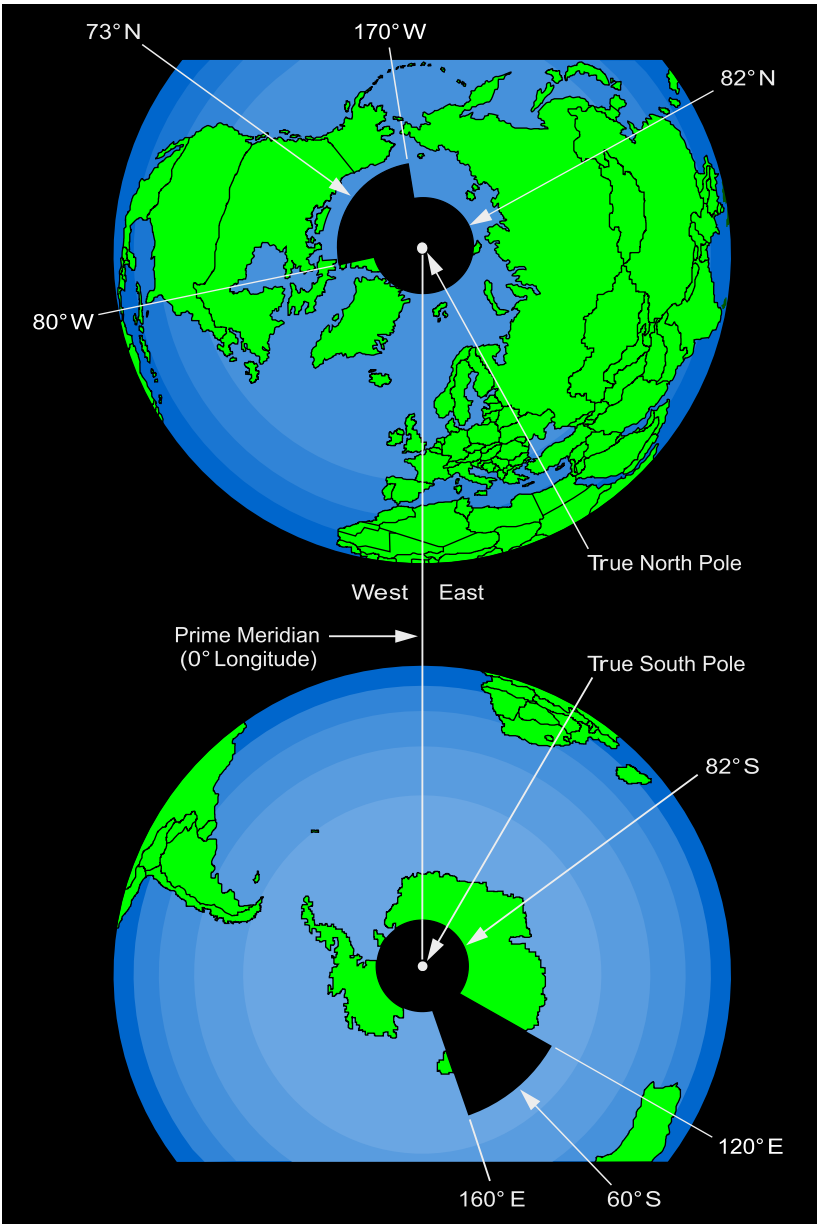
When leaving the polar regions, the autopilot will automatically switch back to a magnetic reference if the HEADING REF switch is in the NORM position. The ND and PFD display a green box around the word MAG to annunciate the change back to magnetic reference. If the heading reference is TRU in the descent phase, the ND and PFD display an amber box around the word TRU.

The current GRID heading displays near the top of both NDs when the airplane is north of 70°N or south of 70°S. The GRID heading is not used by any airplane system.

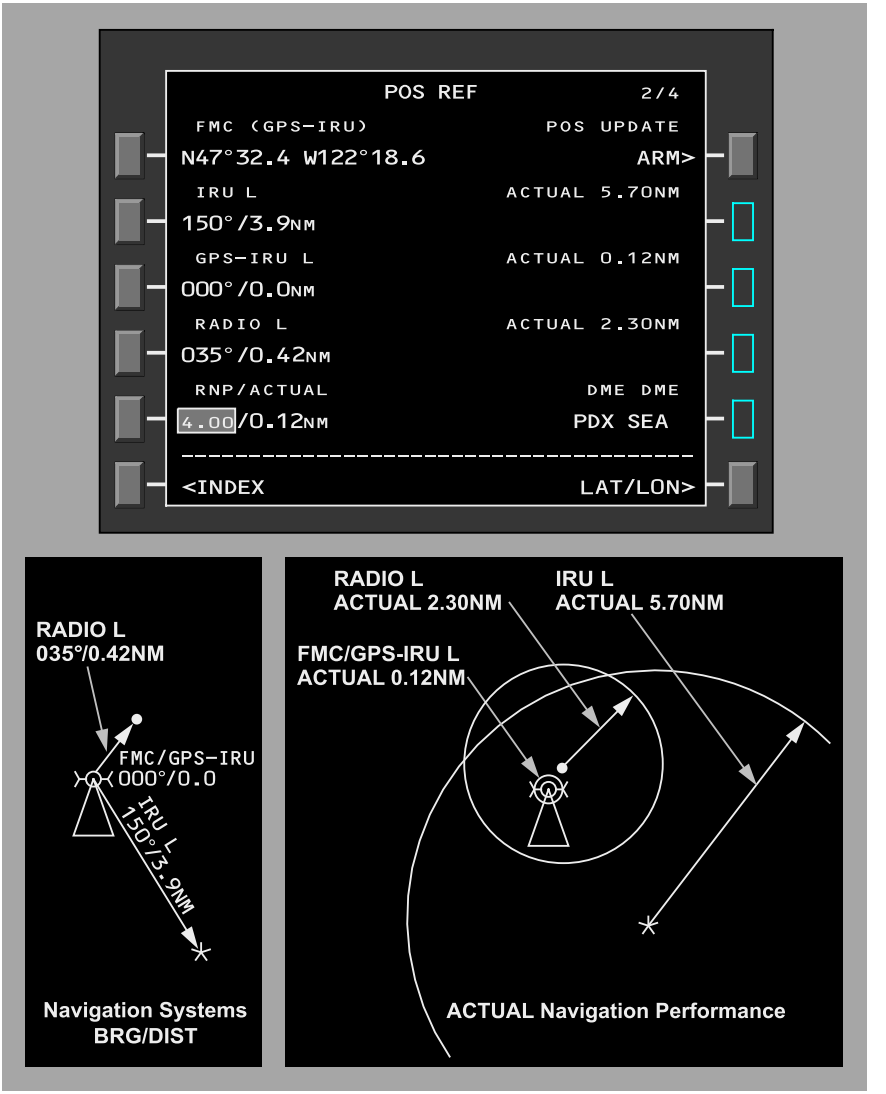
Notes:

1. When operating the autopilot in the polar region in other than LNAV, the TRUE position on the HEADING REF switch should be selected.
2. When operating north of 82°N or south of 82°S using the ND PLAN mode, the airplane position symbol changes to a circle with a "X" in the middle.
3. If the IRS fails in a polar region, the EICAS advisory message NAV INERTIAL SYS displays and all autopilot and AFDS roll modes fail. When heading information is restored by entry of a reference heading on the POS INIT page, HDG SEL and HDG HOLD roll modes are restored. GPS continues to provide navigation data to the FMC and active route information displays on the ND. When operating in this degraded mode, heading on the POS INIT page may be referenced to magnetic, true, or grid heading. The heading display drifts significantly under these conditions. Periodic updating of the heading reference on the POS INIT page should be accomplished at least every 10 minutes.

FMC Polar Regions



Navigation Performance



The FMC uses data from the navigation systems to accurately calculate the position of the airplane. The current FMC position displays on line 1 of the POS REF page 2. The primary source of update displays in parentheses above the FMC position.

Navigation system positions display on the left side of lines 2 through 4. The bearing/distance is from the FMC position to the individual navigation system position.

The FMC position displays on the ND at the tip of the triangle. All other positions display relative to the FMC. The RADIO position is shown above as a •, but is not shown on the ND. The ACTUAL navigation performance circles shown above do not display on the ND.

Actual Navigation Performance

Actual navigation performance (ANP) is the FMC position accuracy. It displays on POS REF page 2, lines 1-3, for the navigation source displayed on the left side. ACTUAL navigation performance is a circular prediction centered at the FMC position. Airplane position is estimated to be within this ACTUAL navigation performance circle 95 percent of the time.

After a manual position update using the ARM function on POS REF page 2, the ACTUAL navigation performance of the FMC changes to the ACTUAL navigation performance of the selected navigation source. In the example above, selection of the NOW prompt on the IRU L line would change the FMC ACTUAL navigation performance to 5.7 NM. The FMC then updates from the best available navigation system and eventually, the manual update has no effect on position calculation. Some updates can be inhibited; GPS, VOR/DME and DME/DME updates on POS REF page 3 and VOR/DME updates on the REF NAV DATA 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 onboard navigation systems to alert the flight crew if ANP exceeds RNP. The FMC supplies a default RNP value for takeoff, en route, oceanic/remote, terminal, and approach phases of flight. The flight crew may enter an RNP value, if required. RNP displays on POS REF page 2.

Vertical Actual Navigation Performance

Vertical ANP is the FMC estimate of the quality of its altitude determination. It displays on RNP PROGRESS page 4/4. Vertical ANP is the estimated maximum altitude error. The FMC computes the vertical path and the certainty that the actual altitude is within a vertical range equal to plus or minus the displayed vertical ANP value.

Note: Vertical ANP is calculated from the baro corrected altitude provided by the Air Data Reference 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.

Vertical Required Navigation Performance

Vertical RNP is the vertical navigation accuracy required for operation within a defined airspace. It is expressed in feet. The FMC supplies a default vertical RNP value for enroute, oceanic/remote, terminal, and approach phases of flight. The FMC alerts the flight crew if vertical ANP exceeds vertical RNP. When required, vertical RNP values may be manually entered or displayed on RNP PROGRESS page 4/4. Manual entry of a vertical RNP value greater than that required for a phase of flight results in the CDU help window message VERIFY VERT RNP—PROG 4/X to display.

Lateral Navigation (LNAV)

LNAV provides steering commands to the next waypoint or the selected route intercept point. When armed on takeoff, LNAV engages at or above 50 feet, when laterally within 2.5 nautical miles of the active route leg. FMC LNAV guidance normally provides great circle courses between waypoints. However, when an arrival or approach from the FMC database is entered into the active route, the FMC commands a heading, track, fixed radius turn or a DME arc to comply with the procedure. If an airway contains a waypoint with a fixed radius turn specified in the Navigation Database, LNAV honors the fixed radius turn when reasonable.

When operating at high gross weights above the FMC optimum altitude, the airplane may be maneuver margin limited, or thrust limited, at normal LNAV bank angles. The 787's FMC limits the bank angle as required to enable turns with no loss of altitude or airspeed.

The FMC evaluates enroute LNAV turns, starting 5 minutes prior to the turn, and calculates a bank limit if required. For large course changes, the reduced bank angle may cause the airplane to overshoot the LNAV route during the turn. The EICAS advisory message LNAV BANK ANGLE LIM is displayed. Selecting a higher thrust limit, if available, on the THRUST LIM CDU page can reduce the effect.

When a holding fix is the active waypoint and the airplane is within 3 minutes of the hold, the FMC evaluates need for a bank limit. If the computed holding turn radius is larger than the protected airspace radius, the EICAS advisory message FMC HOLD AIRSPACE is shown.

Overshoot is not a factor with a turn from a heading to intercept an LNAV course or waypoint. The FMC moves the start of the intercept turn back in space to avoid an overshoot.

Waypoints

Waypoint (navigation fix) identifiers display on the CDU and navigation display.

The CDU message NOT IN DATABASE displays if a manually entered waypoint identifier is not kept in the database. The waypoint can still be entered as a

latitude/longitude, place–bearing/distance or place–bearing/place–bearing waypoint.

FMC–generated waypoints contain a maximum of five characters assigned according to the following rules:

Navaid Waypoints

VHF—waypoints located at VHF navaids (VOR/DME/LOC) are identified by one, two, three or four character facility identifier. Examples:

- Los Angeles VORTAC—LAX
- Riga Engure, USSR—AN
- Tyndall TACAN—PAM.

NDB—waypoints located at NDBs are identified by use of the station identifier. Example: FORT NELSON, CAN—YE.

Fix Waypoints

Waypoints located at fixes with names containing five or fewer characters are identified by the name. Examples:

- ACRA
- ALPHA
- DOT.

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 multi-word names use the first letter of the first word and abbreviate the last word, using the above rules sequentially until a total of five characters remain. Examples:

- CLEAR LAKE becomes CLAKE
- ROUGH ROAD becomes RROAD.

Unnamed Waypoints

If an unnamed turn point, intersection, or fix is collocated with a named waypoint or navaid on a different route structure (such as low altitude routes or an approach), the name or identifier of the collocated waypoint is used. Example:

- Unnamed turn point on J2 between the Lake Charles (LCH) and New Orleans (MSY) VORTACs is coincidental with the Lafayette (LFT) low altitude VORTAC. LFT is used as the identifier for the turn point.

Identifier codes for unnamed turn points not coincidental with named waypoints are constructed from the identifier of a navaid serving the point and the distance from the navaid to the point. If the distance is 99 nautical miles or less, the navaid identifier is placed first, followed by the distance. If the distance is 100 nautical miles or more, the last two digits are used and placed ahead of the navaid identifier. Examples (NAVAID—DISTANCE—IDENT):

- CSN—106—06CSN
- INW—18—INW18.

Waypoint located at unnamed flight information region (FIR), upper flight information region (UIR), and controlled airspace reporting points are identified by the three–letter airspace type identification followed by a two–digit sequence number. Example:

- FRA01.

Unnamed oceanic control area reporting points in the northern hemisphere use the letters N and E, while points in the southern hemisphere use the letters S and W. Latitude always precedes longitude. For longitude, only the last two digits of the three digit value are used.

Placement of the designator in the five character set indicates whether the first longitude digit is 0 or 1. The letter is the last character if the longitude is less than 100° and is the third character if the longitude is 100° or greater.

N is used for north latitude, west longitude. E is used for north latitude, east longitude. S is used for south latitude, east longitude. W is used for south latitude, west longitude. Examples:

- N50° W040° becomes 5040N
- 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 Waypoint Names

Unnamed terminal area fixes along a DME arc procedure are identified with the first character D. Characters 2 through 4 indicate the radial on which the fix lies. The last character indicates the arc radius. The radius is expressed by a letter of the alphabet where A = 1 mile, B = 2 miles, C = 3 miles and so forth. Example:

- EPH252°/24 = D252X.

An unnamed waypoint along a DME arc with a radius greater than 26 miles is identified by the station identifier and the DME radius. Example:

- CPR338°/29 = CPR29.

When there are multiple unnamed waypoints along a DME arc with a radius greater than 26 miles, the station identifier is reduced to two characters, followed by the radius, and then a sequence character. Examples:

- CPR134°/29 = CP29A
- CPR190° /29 = CP29B.

Procedure Fix Waypoints

Marker beacons are identified by the marker type identifier followed by the runway number. Examples:

- Outer Marker 13R = OM13R
- Middle Marker 21 = MM21.

Runway–related fixes—waypoints located at unnamed runway–related fixes are identified by adding a two–letter prefix to the runway number. The following list is used to determine the applicable prefix:

RX runway extension fix

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 as follows:

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

( )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

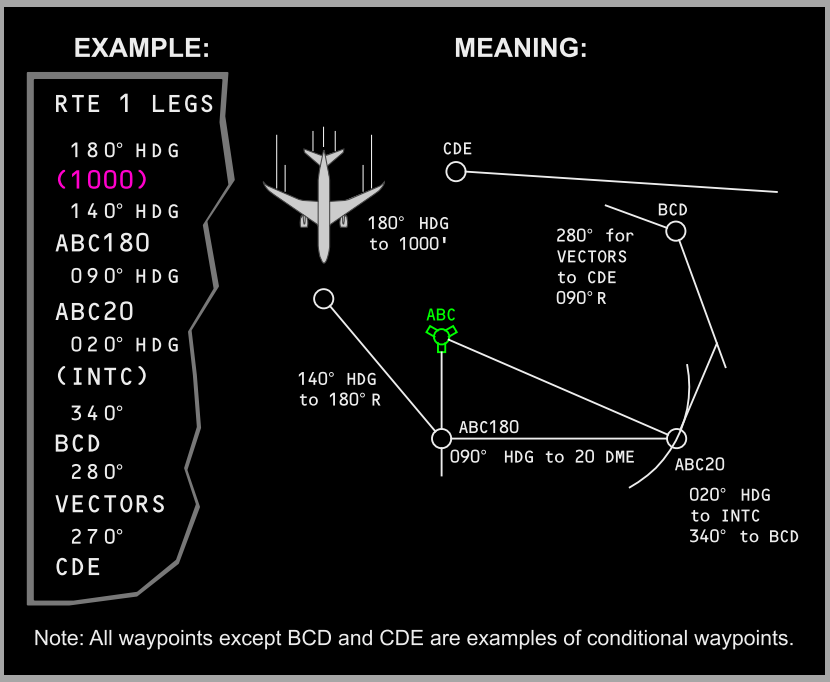
Application of the abbreviation rules may create identical identifiers for different waypoints. When a duplicate waypoint identifier is entered, the page changes to the SELECT DESIRED WPT page. The page lists the latitude and longitude of waypoints with the same identifier and the type of facility or waypoint. Select the latitude/longitude of the correct waypoint to enter the correct waypoint on the original page.

Conditional Waypoints

Conditional waypoints may display in the route when selecting a DEPARTURES or ARRIVALS page procedure. Usually, conditional waypoints cannot be manually entered on a route or legs page. These waypoints indicate when an event occurs and are not at a geographically–fixed position. The types of conditions are:

- climb/descent through an altitude
- 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.



Manually Entered Latitude/Longitude Waypoints

Pilot defined waypoints entered as a latitude and longitude display in a seven–character format. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude are full degrees. Examples:

- N47° W008° is entered as N47W008 and displays as N47W008
- N47° 15.4’ W008° 3.4’ is entered as N4715.4W00803.4 and displays as N47W008.

Note: Selecting the waypoint will show all the digits and decimal points in the scratchpad. The POS REPORT page will show the last (POS), current (EST) and next (NEXT) waypoint identifiers in degrees and minutes of latitude/longitude (4715N00803W).

Manually Entered Place Bearing/Distance or Place Bearing/ Place Bearing Waypoints

Waypoints entered as a place bearing/distance or place bearing/place bearing are identified by the first three characters of the entry followed by a two–digit sequence number. Examples:

- SEA330/10 becomes SEA01
- SEA330/OLM020 becomes SEA02.

The two digit sequence numbers reserved for RTE1 are 01 through 49. The two digit sequence numbers reserved for RTE2 are 51 through 99.

Manually Entered Airway Crossing Waypoints

Airway crossing fixes are entered as a five character waypoint name or by entering consecutive airways on the ROUTE page. In the latter case, the display is an X followed by the second airway name. Example: entering J70 on the VIA line of the ROUTE page causes box prompts to display opposite on the same line. Leaving the box prompts empty and entering J52 on the next VIA line, directly below J70, causes the FMC to calculate the intersection of the two airways and replace the boxes with the waypoint identifier, XJ52.

Manually Entered Latitude or Longitude Reporting Point Waypoints

Latitude or longitude reporting waypoints are entered as the full latitude or longitude followed by a dash, then the increment chosen for the following multiple waypoints. Example:

- W060–10 adds waypoints starting at W060 in ten degree increments from that point to the destination
- the entry must be made on a LEGS page on any line before the first reporting point
- usually, this entry is made on the active waypoint line and proper sequencing is performed by the FMC.

Manually Entered Along–Track Waypoints

Along–track waypoints are created on the active route and do not cause route discontinuities when they are created.

Along–track waypoints are entered using the waypoint name (the place), followed by a slash and minus sign, for points before the waypoint, or no sign for points after the waypoint, followed by the mileage offset for the newly defined waypoint. The created waypoint is then inserted over the original waypoint. The distance offset must be less than the distance between the originating waypoint and next (positive value) or preceding (negative value) waypoint. Latitude and longitude waypoints cannot be used to create along–track waypoints. Examples:

- VAMPS/25 is 25 miles after VAMPS on the present route and displays as VAM01

- ELN/-30 is 30 miles before ELN on the present route and displays as ELN01.

ND Map Displays

The route displays on the ND in the map, map center, mini-map 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
- an activated, but not yet executed route, displays as an alternating cyan/white dashed line
- the active route displays in magenta
- modifications to an active route display as dashed white lines
- modified waypoints display in white
- executed route offsets display as a dashed magenta line
- missed approach route displays as solid cyan line.

The ND displays the FMC position at the apex of the airplane symbol. All ND map data displays relative to this apex.

When adequate GPS or radio updating is not available, the ND map may display a shift error. This error results in the displayed position of the airplane, route, waypoints, and navigation aids being shifted from their actual position. An undetected, across track map shift may result in the airplane flying a ground track that is offset from the desired track. An undetected, along-track map shift may result in the flight crew initiating altitude changes earlier or later than desired. In either case, an undetected map shift may compromise terrain or traffic separation.

Map shift errors can be detected by comparing the position of the airplane on the ND map with data from the ILS, VOR and DME systems.

Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight. Multiple VNAV CDU pages correspond to these flight phases. Selecting the VNAV function key displays the active phase page. Other VNAV pages may be displayed using the NEXT PAGE or PREV PAGE keys.

Note: The altimeter must be used to verify each crossing altitude in a VNAV procedure.

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 selecting the applicable key on the right side of the CDU. Barometric altitude constraints must be below the cruise altitude to be valid. Values entered as part

of a procedure and manually entered constraints are shown in large font. FMC predicted values do not act as constraints, and display in small font.

A waypoint constraint is magenta when it is active. The constraint does not have to be in line 1 to be active. Waypoints can have altitude or airspeed/altitude constraints.

Modified waypoint constraints are shaded white until they are executed. Speed constraint entries require an altitude constraint at the same waypoint. All speed constraints are considered by the FMC as at or below constraints.

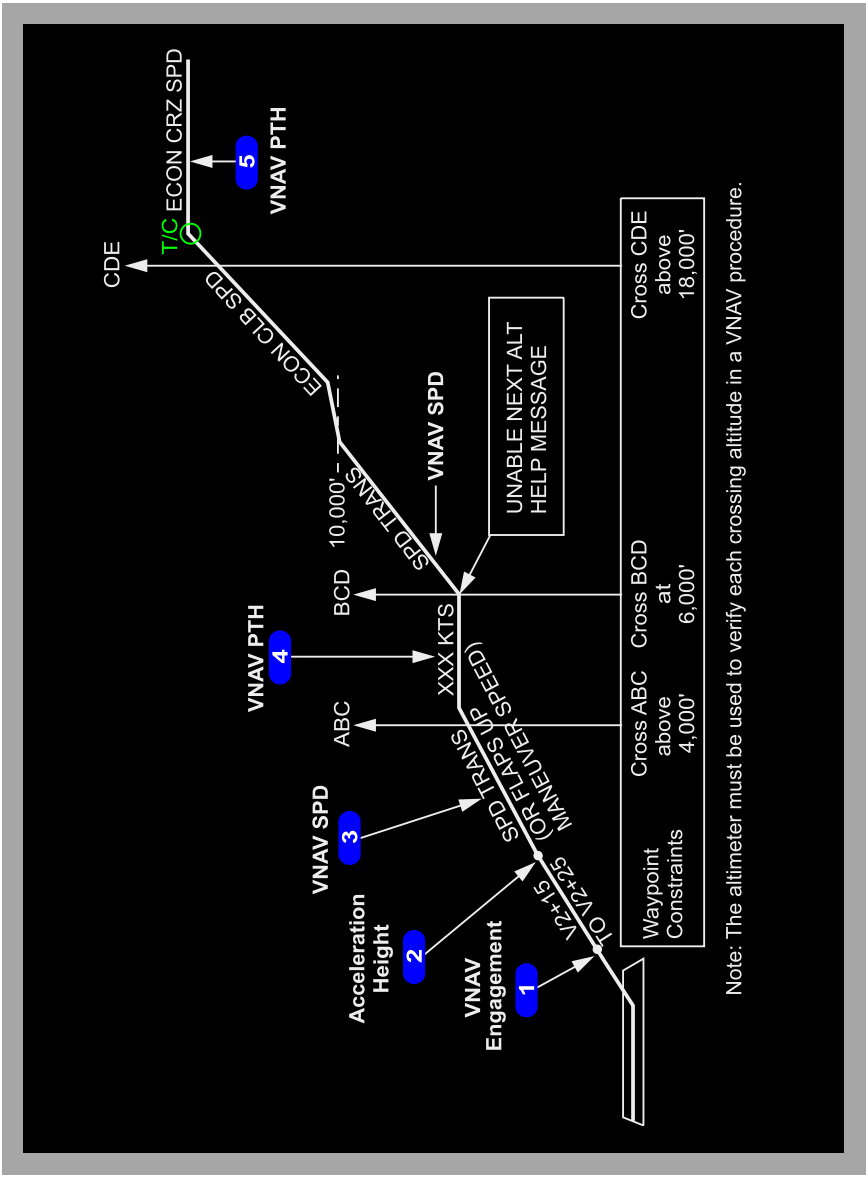
At or above altitude constraints are entered with a suffix letter A (example: 220A). At or below altitude constraints are entered with a suffix letter B (example: 240B). Mandatory altitude constraints are entered without any suffix letter (example: 270).

Altitude constraints with two altitudes may be entered in either order. The lower altitude constraint, followed by a suffix letter A, and the upper altitude constraint, followed by a suffix letter B (example: 220A240B or 240B220A).

Speed Only Constraints

Speed only constraints enable the flight crew to comply with an ATC speed only clearance using VNAV, without using speed intervention. Speed only constraints can be entered in all phases of flight by datalink or manual entry. Speed constraints in the climb phase cause VNAV to command a speed at or below the constraint speed for all waypoints prior to, and including the constraint waypoint. Speed constraints in the descent phase cause VNAV to command a speed at or below the constraint speed at the constraint waypoint, and for all following waypoints in the descent phase.

Takeoff and Climb



1 Takeoff

If armed for takeoff, VNAV activates at 400 feet RA 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 + 15 and V2 + 25 knots.

2 Acceleration Height

At acceleration height or altitude capture below acceleration height, VNAV commands an airspeed increase to a speed 5 knots below the flap placard speed for the existing flap setting. When flaps are retracted or at an AFDS capture altitude, VNAV commands the greater of flaps up maneuver speed or the speed transition associated with the origin airport, limited by configuration.

The FMC changes the thrust reference mode to the selected climb thrust at the thrust reduction point.

3 VNAV Climb

The VNAV climb profile uses VNAV SPD or VNAV PTH at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude constraints that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

If the climb speed profile cannot achieve an altitude constraint, the UNABLE NEXT ALT CDU help window 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.

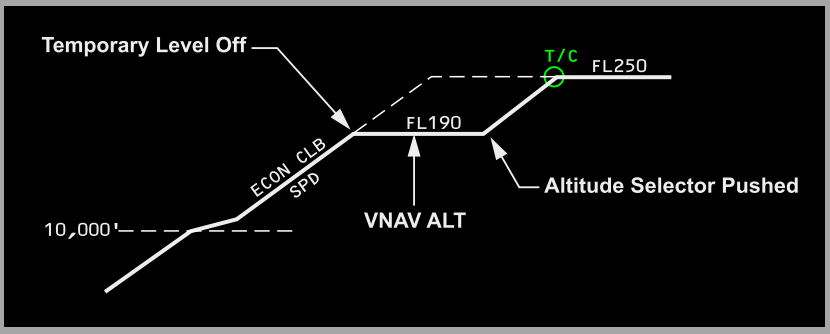
If the FMC predicts the airplane will not reach an altitude constraint, the FMS–CDU help window message UNABLE NEXT ALTITUDE displays. Speed intervention can be used by pushing the IAS/MACH selector and manually setting a lower airspeed to provide a steeper climb; or, climb derates can be deleted on the THRUST LIMIT page.

5 Top Of Climb (T/C)

The point where the climb phase meets the cruise altitude is called the top of climb. Approaching this point, the FMC changes from the climb phase to the cruise phase. The T/C displays any time the FMC calculates a change from a climb phase to a cruise phase, such as a step climb.

The T/C point displays on the map as a green open circle with the label T/C.

MCP Altitude Intervention



ALTITUDE INTERVENTION EXAMPLE

Whenever the airplane levels off at an MCP altitude not in the FMC, VNAV ALT annunciates. For example, FMC cruise altitude is FL250 and the clearance altitude, FL190, is set in the MCP. Pitch maintains altitude and thrust maintains FMC target speed. In the example, the speed after the temporary level off would be ECON CLB SPEED.

Setting the clearance altitude in the MCP window and pushing the altitude selector continues the climb. VNAV SPD activates. Pitch maintains FMC speed and thrust increases to the armed reference thrust limit. In the example, the airplane climbs to FMC CRZ ALT and then levels at FL250 in cruise.

Cruise

During cruise, the FMC commands economy cruise speed or the pilot entered speed until reaching the top–of–descent (T/D) point. Other cruise speed options are:

- engine out (ENG OUT)
- flight crew entered speed
- flight crew entered constant Mach between two or more waypoints
- long range (LRC)
- 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 passing the top of descent.

Cruise Climb

Setting an altitude above the current cruise altitude in the MCP altitude window and pushing the altitude selector causes the cruise altitude to be set to the

MCP altitude and the airplane to climb to the new cruise altitude. The CRZ page displays ACT ECON CRZ CLB.

Step Climb

Fuel and ETA calculations assume the airplane climbs at each calculated step climb point as airplane weight decreases. FMC calculated step climb increments are based on the step size shown on the CRZ page. Entering a step size of zero causes the FMC to assume a constant altitude cruise

Flight crew entry of a STEP TO altitude on the CRZ page or "S" on a waypoint on the LEGS page overrides FMC step climb calculations. Entry of a step altitude on the LEGS page overrides a STEP TO entry made on the CRZ page.

Calculated step altitudes display on the LEGS page. The distance and ETA to the next step point (calculated or flight crew entered) display on the CRZ and PROGRESS pages. They also display on the ND map with a green circle and "S/C".

The FMC calculates step climb locations and altitudes as a function of the lateral flight plan, current cruise speed mode and altitude, entered forecast winds and temperatures, step size, cruise cg, and gross weight.

The primary factor affecting step climb calculation is the entry of accurate forecast cruise winds and temperatures on the WINDS page. Unless enroute winds are entered, all step climb locations and altitudes are calculated assuming zero wind. IRS winds are not used in the calculation of step climb data.

For ECON cruise, step climbs are optimized to provide minimum trip cost according to the entered Cost Index. For other selected speeds, calculated step climbs minimize trip fuel.

Calculated step locations display on the ND (S/C); the next step displays on the ECON CRZ page. Flight plan calculations of time and fuel at destination are based on executing step climbs as calculated. LEGS page waypoint altitudes reflect the optimum step climb profile.

Inflight entry of a STEP TO altitude in 1R causes the FMC to use the entered enroute winds and temperatures to calculate the optimum location for a climb to the step altitude; the ETA and DTG for the step display in 2R. Following entry of an altitude in 1R, the FMC uses only that altitude to calculate data for 2R. When the FMC calculates an immediate step climb to the entered altitude is optimal, 2R displays NOW. If the FMC determines remaining at the current altitude for the duration of the flight is more optimal than flying at the entered altitude, 2R displays NONE.

Planned step climb points (S/C) may be entered on the LEGS page at selected waypoints. In this case, both altitude and step location are constrained. With planned step climb points entered, flight plan calculations assume a constant cruise altitude until reaching the planned step waypoint. Optimized step climb calculations resume after passing the last planned step climb waypoint.

When the last planned step is a step descent, step climbs are no longer calculated.

Optimum (OPT) altitude calculation does not use forecast or IRS winds and temperatures. Recommended (RECMD) altitude calculation is based on step size, current CRZ ALT, and entered forecast enroute winds and temperatures.

All altitude calculations are limited by maximum (MAX) altitude.

If a climb is not initiated within 5 minutes after passing a planned or calculated step climb point, the EICAS advisory 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.

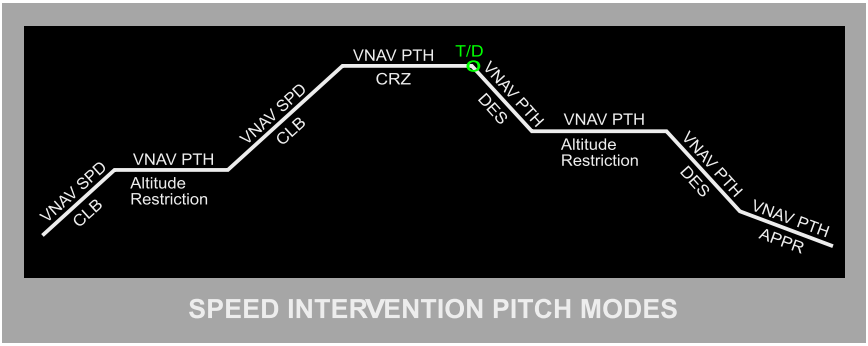
Required Time of Arrival (RTA)

Any flight plan waypoint up to and including the missed approach waypoint can be specified as an RTA waypoint. VNAV controls speed to arrive at the RTA waypoint within ± 6 seconds of a specified time. RTA speed targets are limited by airplane speed limitations, speed and altitude constraints, speed transitions, and by manually entered maximum and minimum speeds. RTA becomes the VNAV speed mode after selection of the RTA prompt on a VNAV page and when the PROGRESS 1/4 page 4L field displays "RTA SPD" as the line title followed by the speed target displayed in magenta. The RTA function continues to operate when a cruise speed segment is active. The RTA function uses entered forecast winds for calculating step climbs. If the RTA is not achievable, the EICAS advisory message FMC UNABLE RTA is displayed.

An RTA can also be entered on the RTA PROGRESS page. The minimum data required is: RTA waypoint, time, and type. Types are AT, AT OR BEFORE, and AT OR AFTER. Additional entry data affecting RTAs is: RTA threshold, minimum and maximum RTA speeds, and take off time. (See RTA Progress Page 3 .)

During a climb RTA, elevators control speed at the reference thrust limit. During descent, the descent path profile is maintained, but command speed changes to meet the RTA. Sequencing an RTA waypoint greater than 200 NM from the End of Descent (E/D) sets command speed to ECON or the planned speed. Sequencing an RTA waypoint less than 200 NM from the E/D sets command speed to a SEL SPD.

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 the MCP speed window can be opened without changing the pitch mode. The pitch mode remains in VNAV PTH throughout the descent as long as the speed remains within the VNAV speed band on the PFD. When using speed intervention during descent, closing the IAS/MACH window resets the FMC target speed to the IAS/MACH window speed if that speed is lower than the FMC target speed.

If the airplane speed deviates beyond the VNAV speed band, the pitch mode changes to VNAV SPD. Speed is maintained by pitch and the airplane departs the vertical path.

During a VNAV, non-ILS approach while using speed intervention, the pitch mode is VNAV PTH. The vertical path is maintained regardless of IAS/MACH selector changes.

If a “direct to” is executed to a waypoint in the approach, VNAV transitions to the approach phase when the airplane passes the “direct to” waypoint. If a waypoint located after the first waypoint of an FMC database approach is added and executed, VNAV does not transition to approach phase when passing the first waypoint of the approach.

Descent

The FMC calculates a descent path based on airspeed and altitude constraints and the end of descent (E/D) point. Dashes display on the LEGS page for speed and altitude descent waypoints. When an arrival or approach procedure is selected on the ARRIVALS page and incorporated into the flight plan, the

FMC creates an E/D. The E/D is located 50 feet above the runway threshold (RW waypoint) for all approaches except VOR approaches. The E/D for VOR approaches is the missed approach point; which may be the VOR, runway waypoint (RWXXX), or a named waypoint. During cruise, an E/D is also created when an altitude constraint is entered on the LEGS page on a downstream waypoint.

The top of descent (T/D) is the point where the cruise phase changes to the descent phase. It displays on the ND as a green circle with the label T/D. The descent path starts at the T/D and includes waypoint altitude constraints. The path to the first constraint is based on:

- idle thrust
- speedbrakes retracted
- FMC cruise wind
- applicable target speed
- wind entries on the DESCENT FORECAST page
- predicted use of anti-ice.

The descent may be planned at economy Mach/CAS (based on Cost Index) or a manually entered Mach/CAS. VNAV does 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.

The speed tape displays a VNAV PTH speed band during descent.

If flight plan modifications or 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 CDU help window message THRUST REQUIRED displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 5 knots above the greater of best holding speed or minimum maneuvering speed, and the CDU help window message THRUST REQUIRED displays again. With autothrottles active, this condition should

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 CDU help window message DRAG REQUIRED displays. The airplane may accelerate up to VMO/MMO minus 11 knots to maintain the path. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to VMO/MMO minus 16 knots, and the CDU help window message DRAG REQUIRED displays again.

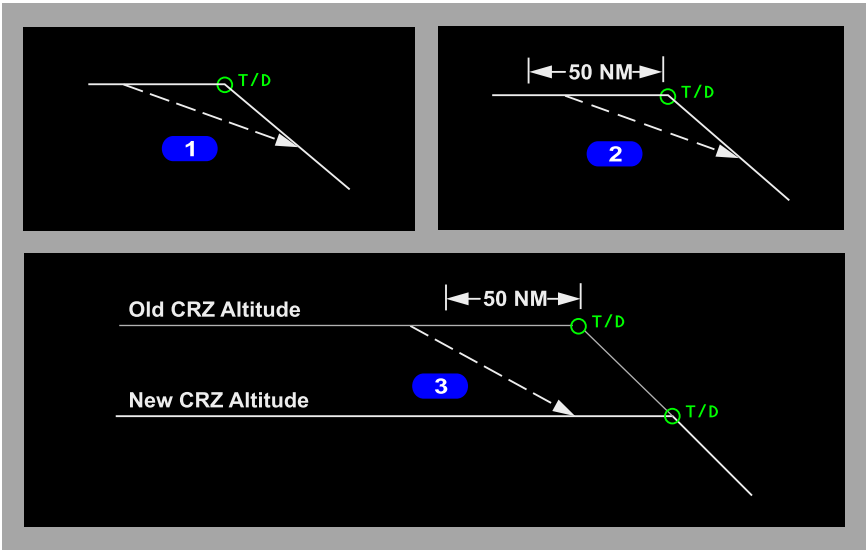
If flight plan modifications or unknown winds occur when below the first speed constraint, VNAV continues to maintain the path and allows the speed to vary up to the following limits:

- with greater than 15 knots below the target speed, and autothrottles not active, the CDU help window message THRUST REQUIRED displays. The airspeed may decrease to minimum maneuvering speed. Subsequently, VNAV commands the airplane to fly below the path to stop the deceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further deceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV resets the target speed to 10 knots less than the transition speed for the destination airport (not less than minimum maneuvering speed), and the CDU help window message THRUST REQUIRED displays again.With autothrottles active, this condition should not occur as thrust levers are in SPD and target speed is maintained during the descent
- with greater than 10 knots above target speed, the CDU help window message DRAG REQUIRED displays. The airplane may accelerate up to 15 knots above target speed to maintain the path. The maximum speed excursion allowed is 5 knots above the transition speed after the airplane is below transition altitude for the destination airport or 5 knots below the flaps placard speed if flaps are extended. If further correction is required, VNAV may allow the airplane to rise up to 150 feet above the path to stop the acceleration. If VNAV can no longer maintain the airplane within 150 feet of the path without further acceleration, speed reversion occurs, the pitch mode annunciation changes from VNAV PTH to VNAV SPD, VNAV commands a speed 10 knots less than the transition speed for the destination airport, and the CDU help message DRAG REQUIRED displays again.

Early Descent

When a descent is started before the T/D, VNAV commands a descent at a reduced descent rate until the descent path is intercepted.

Start an early descent by selecting the DES NOW prompt on the DES page or by pushing the MCP altitude selector. In an early descent, the autothrottle mode annunciation is initially THR, followed by HOLD, allowing the pilot to adjust the rate of descent. The pitch mode is VNAV SPD.



1 DES NOW

Use the DES NOW prompt on the VNAV DES page. VNAV starts an early descent and captures the descent path.

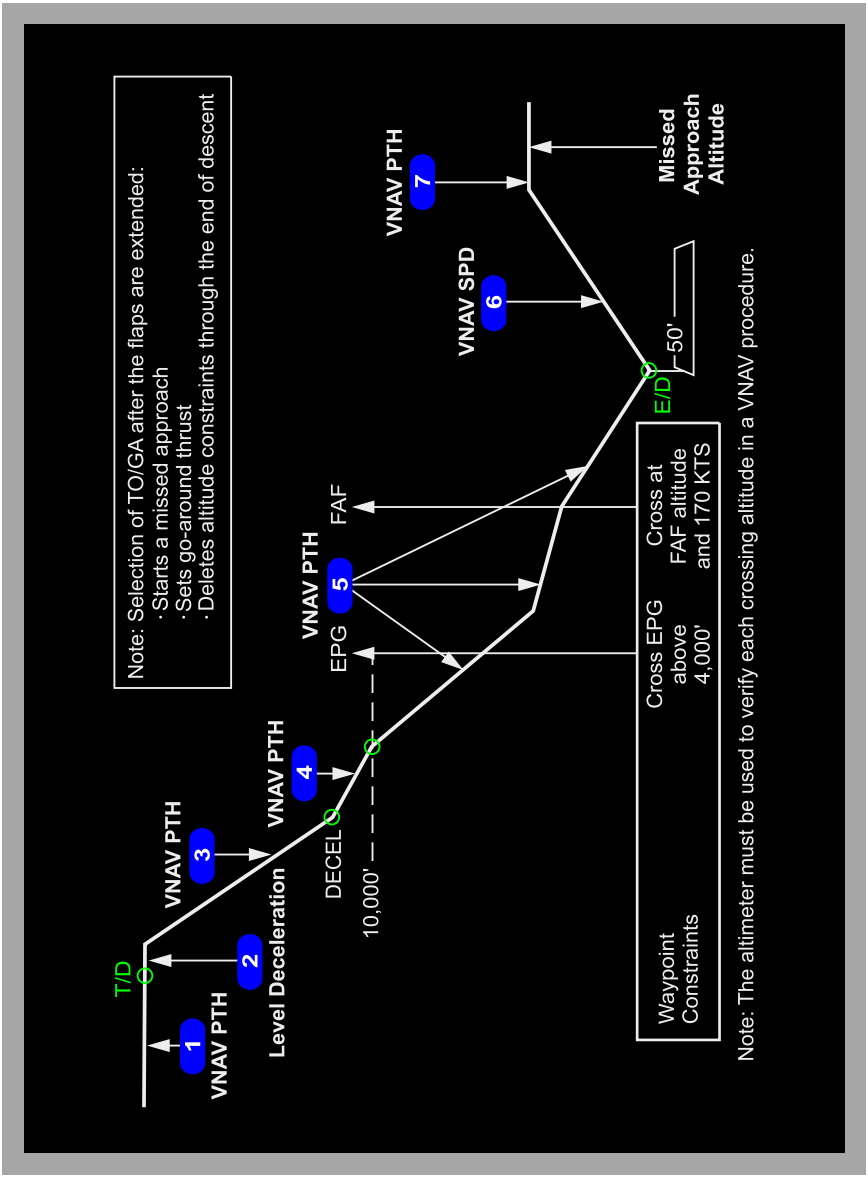
2 Within 50 NM of Top of Descent Point

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 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 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 the top of descent, FMC is in cruise mode and commands VNAV PTH and ECON cruise speed.

2 Level Deceleration Phase

At top of descent, FMC transitions to descent and commands the airspeed to ECON descent speed and maintains altitude in VNAV PTH.

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 PTH at ECON descent speed.

4 Descent Deceleration Phase

Before the speed restriction altitude, the FMC commands the target descent airspeed. The pitch mode remains VNAV PTH and the descent rate approximates 500 feet per minute.

5 Descent and Approach

When at target speed, VNAV commands a descent and starts approach in VNAV PTH at commanded speed. Extending flaps from UP to 1 arms go-around; EICAS displays GA as the reference thrust limit. Activation of VNAV changes the reference thrust limit to CRZ; selection of landing flaps (25 or 30) changes the reference thrust limit to GA. Prior to extending flaps to a landing position and with VNAV PTH and CRZ reference thrust limit, pressing TO/GA changes the reference thrust limit to GA.

6 Missed Approach

When selected during missed approach, VNAV activates in VNAV SPD.

7 Missed Approach Level Off

At missed approach altitude, VNAV SPD changes to VNAV PTH.

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 approach, or
- the airplane is on a direct-to intercept course-to the active waypoint and the distance to go is less than 12 NM, or

- the missed approach point is the active waypoint and the distance to go is less than 25 NM.

The approach condition may be delayed if the flight crew manually inserts, bypasses, or deletes an approach waypoint on the LEGS page.

The FMC transitions out of “on approach” under the following conditions:

- the pilot selects TO/GA, or
- the airplane lands, or
- the airplane flies beyond the last waypoint in the approach (missed approach waypoint or runway). The VNAV page title changes from "ACT xxxxx DES" to "ACT END OF DES".

When the FMC is “on approach”, the following features are available:

- the 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 RTE 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 glidepath angle may be defined for a leg in a STAR and displays on the LEGS page for the procedure.

Selection of another approach can be accomplished on the ARRIVALS page. An along-course intercept to the next logical approach waypoint in the new approach can be selected on the “INTC CRS TO” line on the LEGS page or by selecting the "XXXXX INTC>" prompt on the ARRIVALS page.

Note: During approach maneuvering with IAS/MACH window closed, VNAV sets command speed to flap maneuvering speed as the airplane passes the flap profile point indicated on the ND. The command speed change occurs even if flap selection is not made. If flaps are not extended before passing the flap profile point, the IAS/MACH window should be opened and the desired speed set to avoid an underspeed condition. When flaps are extended prior to the flap profile point, VNAV commands flap maneuvering speed for the flap position selected.

Integrated Approach Navigation (IAN)

Integrated Approach Navigation allows the use of consistent procedures for all types of instrument approaches. Any approach that has a glidepath angle

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:

- a source for deviation scales
- distance to the missed approach waypoint
- final approach course (FAC) deviations from the defined LNAV path
- glidepath (G/P) deviations from the defined VNAV path.

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.

For additional information on IAN:

- See Approach Procedure on page NP.21.27
- See Arrivals Page—VFR Approaches on page 11.43.16
- See Integrated Approach Navigation (IAN) on page 4.20.15
- See Integrated Approach Navigation (IAN) Indications on page 10.30.7
- See PFD Integrated Approach Navigation (IAN) Indications on page 10.10.16
- See Position Reference Page 2/4 on page 11.40.10
- See RNP Progress Page 4 on page 11.42.59.

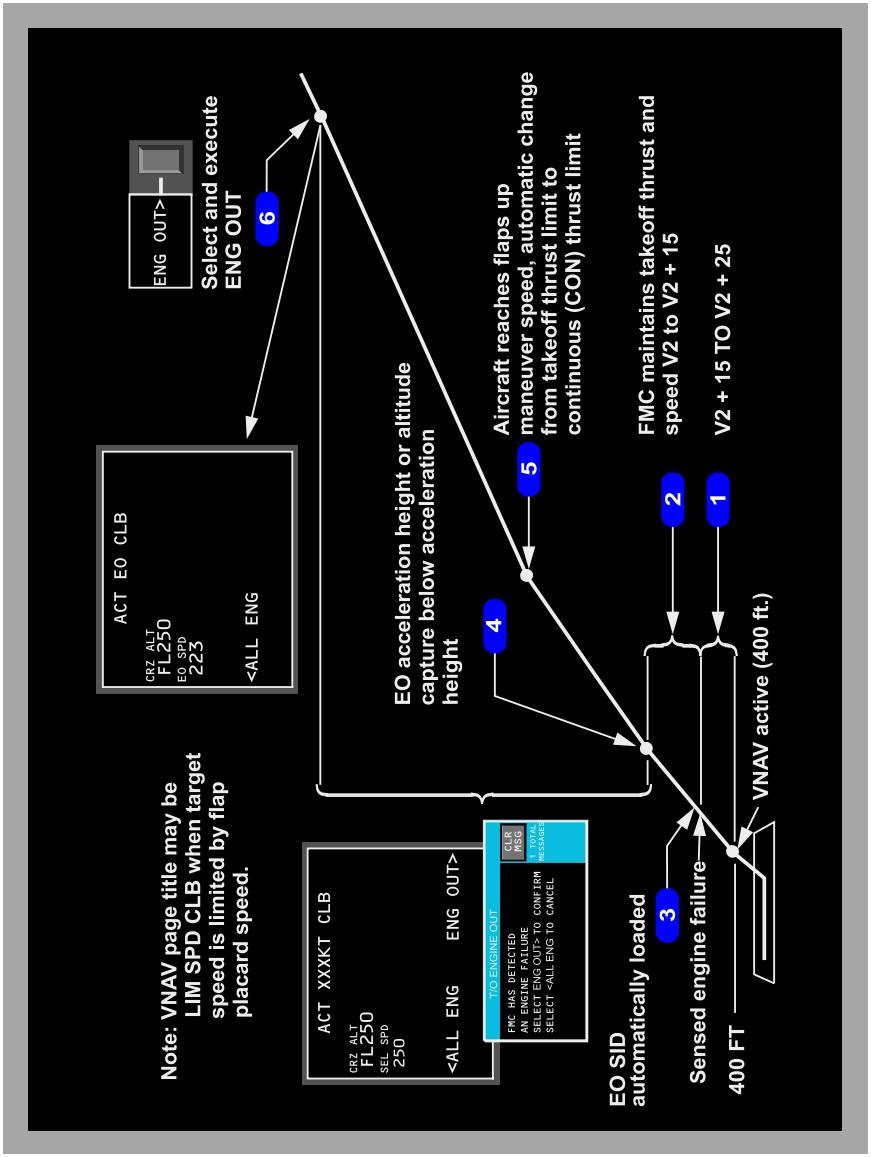
Missed Approach

A missed approach is accomplished by selection of either TO/GA 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 activates:
  - above 50 feet radio altitude when autopilot is not engaged, or
  - above 200 feet radio altitude when autopilot is engaged
- if no LNAV path is available, LNAV shows on the FMA, the roll bar blanks, and the flight director guidance cue on the HUD blanks. If another roll mode is desired, select it on the MCP.
- 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 greater 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, or 20 towards 5). For example, when a missed approach is accomplished without pushing the TO/GA switch
- AFDS guidance to fly the published missed approach procedure to the new cruise altitude is active when VNAV (and LNAV) are selected
- when cruise phase is active, the speed target is the most restrictive of speed transition, best hold speed, or ECON cruise (above speed transition altitude).

Engine Out Operations

Takeoff and Climb



1 Takeoff

Condition: Before a sensed engine failure and above VNAV activation altitude.

Result: VNAV SPD commands a climb at V2 + 15 to V2 + 25 knots. Autothrottle annunciation is THR REF and the thrust limit is takeoff.

2 Sensed Engine Failure

Condition: After VNAV activation, engine failure is sensed, airplane below engine out acceleration height and below the thrust reduction point entered on the TAKEOFF REF page.

Result: VNAV remains in VNAV SPD and commands a speed of V2 to V2 + 15. Autothrottle remains in THR REF and the thrust limit remains takeoff (TO).

3 EO SID

Condition: Flaps out of up and an engine out standard instrument departure (EO SID) is in the FMC database.

Result: The FMC loads the EO SID as a flight plan modification. The modification may be either executed or erased.

4 Acceleration Height

Condition: At acceleration height or altitude capture below acceleration height.

Result: VNAV commands an acceleration to flaps up maneuver speed, limited by the airplane configuration (flap placard). Selecting the VNAV function key displays the ACT XXXKT CLB page where XXX is the flaps up maneuver speed. The T/O ENGINE OUT CDU help window message is displayed advising the aircrew that an engine failure has been detected by the FMC.

5 Thrust Reduction

Condition: Airplane has accelerated to the commanded flaps up maneuver speed.

Result: Thrust is automatically reduced from TO to continuous (CON) thrust. If the engine failure occurs above the thrust reduction point, the current climb thrust is maintained.

6 VNAV Climb (Engine Out)

Condition: Selecting the ENG OUT> prompt on the VNAV CLB page to display applicable engine out performance data. Execution activates engine out performance data and terminates the VNAV engine out takeoff phase.

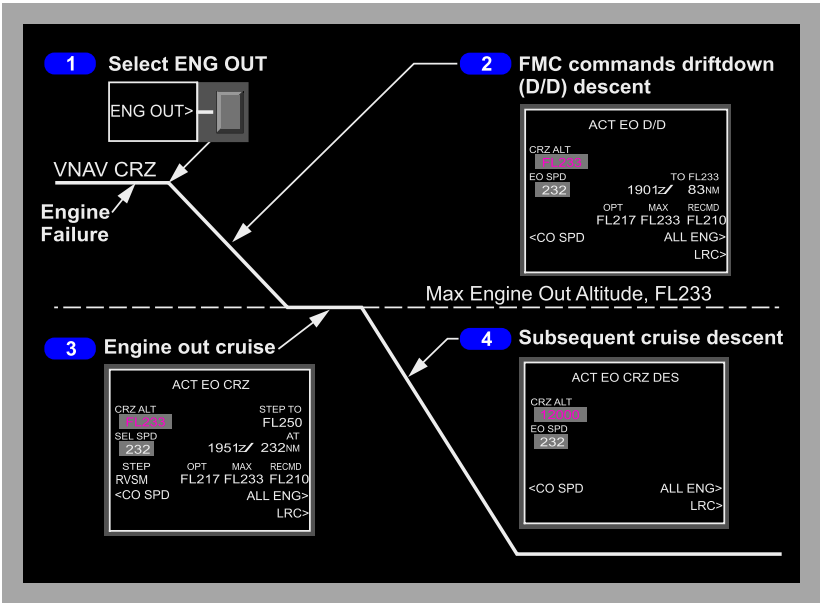
Result: The FMC engine out climb function is active, the pitch mode is VNAV SPD, the command speed is EO SPD, and the reference thrust limit is CON.

Climb (Above EO Max Alt)

When the airplane is above the engine out maximum altitude, selection of the ENG OUT> on the VNAV CLB page or the XXXX ALTN page creates a modification and displays the applicable engine out driftdown (D/D) performance data enabling the a descent to the engine out maximum altitude. Execution of the modification activates the engine out driftdown function.

Cruise (Above EO Max Alt)

When the airplane is above the engine out maximum altitude, selection of ENG OUT> on the VNAV CRZ page or the XXXX ALTN page creates a modification and displays applicable engine out driftdown (D/D) performance data. When executing the ENG OUT modification, the reference thrust limit becomes CON, thrust levers advance to CON, the default command speed is EO SPD, and the EO MAX altitude shows as the cruise altitude in 1L. The EO MAX altitude shown in 1L does not change with time or changes in command speed.



1 Engine Out Modification

Selecting ENG OUT> creates a modification and displays the applicable engine out driftdown (D/D) performance data.

2 Drift Down Execution

A driftdown descent can be initiated by setting the MCP altitude at or below EO MAX altitude and executing the modification.

Result:

- VNAV commands EO SPD
- when EO SPD is achieved, VNAV controls the driftdown descent rate to a minimum of 300 feet per minute (fpm)
- time and distance for the D/D to EO MAX altitude show at 2R
- VNAV captures the MCP altitude and commands EO CRZ.

Executing the ENG OUT modification without descending changes the pitch mode to VNAV ALT. A driftdown descent does not start until setting the altitude at or below EO MAX altitude and pushing the altitude selector. The result above describes the driftdown.

A normal enroute cruise descent can be initiated by setting the MCP altitude to a lower altitude and pushing the altitude selector.

Result:

- the airplane descends in a normal VNAV cruise descent at two-engine ECON speed
- the reference thrust limit is CLB/CRZ
- the airplane descends at ECON CRZ and approximately 1,250 fpm.

During the enroute cruise descent, when the airplane is above EO MAX altitude, executing the ENG OUT modification commands a driftdown descent to the EO MAX altitude. The command speed is E/O SPD. The rate of descent decreases to a minimum of 300 fpm.

3 Engine Out Cruise

When VNAV captures the EO MAX altitude, the VNAV cruise page title becomes EO CRZ and the pitch annunciation is VNAV PTH, regardless of the MCP altitude window setting. Calculations for EO Step Climb display at 2R. Thrust limit remains in CON.

4 Subsequent Cruise Descent

The FMC is in engine out mode. When the airplane is more than 50 nm from T/D, setting a lower MCP altitude and pushing the altitude selector executes an engine-out cruise descent.

Result: VNAV cruise descent at approximately 1,250 fpm at EO SPD. When the EO cruise descent intersects the planned descent profile, descent mode becomes active.

Data Entry Rules

Altitude Entry

Altitudes can be entered into the FMC as three digit (XXX), four digit (XXXX), five digit (XXXXX), or flight level (FLXXX) numbers. The FMC displays altitude or flight level entries in the proper form based on the transition altitude. Some data lines further restrict the valid entry forms.

Three digit entries represent altitude or flight levels in increments of 100 feet. Leading zeros are required.

Examples of three digit (XXX, FLXXX) entries with transition altitude = 10,000 feet:

- 800 feet is entered as 008 or FL008; displays as 800
- 1,500 feet is entered as 015 or FL015; displays as 1500
- 11,500 feet is entered as 115 or FL115; displays as FL115
- 25,000 feet is entered as 250 or FL250; displays as FL250.

Four digit entries represent feet, rounded to the nearest ten feet. Leading zeros are required. This form is used when the altitude does not exceed 9,994 feet.

Examples of four digit (XXXX) entries with transition altitude = 18,000 feet:

- 50 feet is entered as 0050; displays as 50
- 835 feet is entered as 0835; displays as 840
- 1,500 feet is entered as 1500; displays as 1500
- 8,500 feet is entered as 8500; displays as 8500
- 9,994 feet is entered as 9994; displays as 9990.

Five digit entries represent feet, rounded to the nearest ten feet. This form is used when the altitude exceeds 9,994 feet.

Examples of five (XXXXX) digit entries with transition altitude = 4,000 feet:

- 50 feet is entered as 00050; displays as 50
- 835 feet is entered as 00835; displays as 840
- 1,500 feet is entered as 01500; displays as 1500
- 8,500 feet is entered as 08500; displays as FL085
- 9,995 feet is entered as 09995; displays as FL100
- 11,500 feet is entered as 11500; displays as FL115
- 25,000 feet is entered as 25000; displays as FL250.

Negative altitude entries are allowed to −1000 feet.

Airspeed Entry

Airspeeds can be entered into the FMC as calibrated airspeed, CAS, or Mach number, M. Calibrated airspeeds are entered as three digits (XXX) in knots. Mach numbers are entered as one, two, or three digits following a decimal point.

Data Pairs

Many CDU pages display data in pairs separated by a slash “/.” Examples of these pairs include wind direction/speed and waypoint airspeed/altitude constraints. When entering both values in a pair, the slash is inserted between the values. When it is possible to enter only one value of the pair, the slash may not be required. When entering only the outboard value of a pair, the trailing or leading slash may be entered, but is not required before transferring to the data line. When entering the inboard value of a pair, the trailing or leading slash must be entered before transferring to the data line. Omission of the required slash normally results in an INVALID ENTRY message.

FMC Databases

The FMC utilizes several databases containing the following items:

- navigation
- option settings
- performance.

The performance database supplies performance data to the flight crew. It supplies the FMC with data to calculate pitch and thrust commands. All pertinent data can be displayed on the CDU. The database includes:

- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds.

The navigation database includes most data found on navigation charts. This data can be displayed on the CDU or ND. The database contains:

- airports
- location of VHF navigation aids
- other airline selected data, such as SIDs, STARs, approaches, and company routes
- runways
- transition altitudes.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the usual navigation chart revision cycle. The FMC uses the active data for navigation calculations. The contents of the navigation database are periodically updated and transferred to the FMC before the expiration date of the active data.

The AMI file contains airline specified data. If the FMC senses a conflict in an AMI value after a new AMI data load, the CDU help window message CHECK AIRLINE POLICY is displayed.

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 active. Thrust management:

- calculates reference thrust limits and thrust settings, or follows FMC thrust settings
- commands thrust levers
- senses and transmits autothrottle failures
- commands thrust equalization through the engine electronic controls.

Thrust limits are expressed as TPR limits. Thrust equalization references TPR.

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
CON	continuous
CRZ	cruise
G/A	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 above EICAS TPR indications.

The flight crew can specify the thrust reduction height where the change from takeoff to climb thrust takes place by making an entry on the CDU TAKEOFF REF page. This can be an altitude from 400 feet to 9,999 feet, an entry of 1 for flaps 1, or an entry of 5 for flaps 5.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extends engine life.

Derate/Variable Takeoff Rating

Two fixed derates can be selected on the THRUST LIM page. TO 1 and TO 2 reduce takeoff thrust by percentages specified by the operator on the airline policy page. The derate percentages can be set between maximum takeoff thrust and the maximum certified derate in one percent increments. The Airplane Flight Manual (AFM) provides performance data for these derates.

With both TO 1 and TO 2, the thrust setting parameter is considered a limitation for takeoff; therefore, thrust levers should not be advanced further except in an emergency. A further thrust increase following an engine failure could result in a loss of directional control. Use the takeoff speeds calculated by the EFB for the selected derate or variable takeoff rating condition.

Derate/variable takeoff rating can be further reduced by assumed temperature.

Assumed Temperature Thrust Reduction Takeoff

Entering an assumed temperature higher than the actual temperature reduces takeoff thrust.

The maximum thrust reduction authorized is 25 percent below any certified rating. Do not use assumed temperature reduced thrust if conditions exist that affect braking, such as slush, snow, or ice on the runway, or if potential windshear conditions exist.

The assumed temperature thrust setting is not considered a limitation. The assumed temperature reduction can be removed. If conditions are encountered where more thrust is necessary, the crew can manually apply full thrust.

Derated Thrust Climb

Two fixed climb thrust derates (CLB 1 and CLB 2) can be selected on the THRUST LIM page. The percentage of derate is 5% for CLB 1 and 15% for CLB 2.

The derated climb thrust is maintained until reaching 10,000 feet where the thrust then increases linearly with altitude to achieve CLB thrust at 30,000 feet.

In cruise, the thrust reference defaults to CLB.

Use of an assumed temperature reduced thrust takeoff or takeoff derate affects automatic selection of the climb derate. If the takeoff derate percentage (fixed derate plus assumed temperature method) is:

- less than 5% then CLB is selected, or
- greater than or equal to 5% and less than 15% then CLB 1 is selected, or
- greater than or equal to 15% then CLB 2 is selected.

On the ground, the pilots may override the automatic climb derate selection after the takeoff selection is complete.

Use of derated climb thrust reduces engine maintenance costs, but increases total trip fuel.

Fuel Monitoring

The FMC receives fuel data from the fuel quantity system or from manual entries. Fuel quantity values display on the PERF INIT page as calculated (CALC), MANUAL, or SENSED. They display on PROGRESS page 2/4 as TOTALIZER and CALCULATED. TOTALIZER and SENSED values are the same data with different names.

The FMC usually uses the calculated value for performance computations. Before engine start, the calculated value is set to agree with the fuel quantity indicating system value. When the FMC receives a positive fuel flow signal at engine start, the calculated value is independent of the fuel quantity system and decreases at the fuel flow rate.

If a manual fuel quantity is entered on the PERF INIT page prior to engine start, the manual entry will be deleted and replaced with the TOTALIZER value when the engines are started.

When the APU is running, the APU fuel burn schedule is used to decrease the calculated fuel value.

During fuel jettison, the calculated value is set equal to the fuel quantity system value. When fuel jettison is completed, the calculated value is independent of the fuel quantity indicating system and decreases at the fuel flow rate. This fuel quantity value displays as CALC (calculated) on the PERF INIT page and CALCULATED on PROGRESS page 2/4.

If the flight crew inputs a fuel quantity, the line title changes to MANUAL and replaces the calculated value. Like the calculated value, the manual value is updated by fuel flow rate.

The calculated value is invalid if fuel flow data is invalid. The FMC uses the fuel quantity indicating system quantity for performance computations. The line title on the PERF INIT page changes to SENSED and displays as TOTALIZER on PROGRESS page 2/4.

The fuel used by each engine is calculated with its related fuel flow signal. FUEL USED displays on PROGRESS page 2/4. 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 while on the ground or invalid for greater than two minutes after airborne, the display blanks.

Note: If a record of FUEL USED is required after a flight it should be recorded prior to engine shutdown.

When the airplane is in stable, level flight the FMC compares the actual fuel flow from the EECs with the predicted fuel flow from its performance tables. If the actual fuel flow exceeds the predicted fuel flow by a significant amount, the EICAS advisory message FUEL FLOW ENG L/R is displayed. This provides an alert for a potential engine fuel leak downstream of the fuel flow sensors. This type of leak will not trigger the FUEL DISAGREE message because the leaking fuel decreases the CALCULATED fuel quantity at the same rate as the TOTALIZER quantity.

The EICAS advisory message FUEL DISAGREE is displayed if the FMC calculates a large difference between the fuel quantity indicating system quantity and calculated value. The flight crew should select PROGRESS page 2/4, and select the fuel value for the FMC to use through landing.

The FMC continually estimates fuel remaining at the destination airport when the active route is flown. The EICAS advisory message INSUFFICIENT FUEL displays if the estimate is less than the fuel reserve value; or if no reserve value entered, then 4000 lbs (1,814 kgs). For the inactive route or active route in a modified state the CDU help window message INSUFFICIENT FUEL displays.

Notes: 1. FMC calculated fuel predictions assume a clean configuration and does not include APU burn. Flight with gear and flaps extended,

or the APU running, cause fuel prediction errors. Fuel predictions are accurate after the gear and flaps are retracted or the APU is shutdown.

2. With the ENG OUT prompt selected, FMC fuel predictions are based on single engine performance and include APU predicted burn.

If the actual fuel temperature is within 3 deg.C of the value displayed on the PERF INIT page, the EICAS advisory message FUEL TEMP LOW displays.

Loss of FMC Electrical Power

The FMC must have continuous electrical power to operate. When the electrical power is interrupted and returns, the FMC restarts.

After restart, the performance data displayed on the PERF INIT page must be re–entered. The route previously in use is available but must be reactivated.

The flight crew must modify the active waypoint to activate LNAV. Selecting the applicable active waypoint and proceeding direct or intercepting a course to the waypoint allows LNAV activation.

FMC Failure

Single FMC Failure

At powerup, the three FMCs are designated as master, spare and backup. All Flight Management computing tasks are accomplished by the master (active) FMC. The spare (standby) FMC automatically becomes active and assumes all FMC functionality in the event the master FMC fails. The backup FMC then assumes the role of the spare FMC. This transition occurs automatically and is not apparent to the crew. No crew action is necessary. LNAV and VNAV, if active, remain active and all flight plan and performance data is retained.

Dual FMC Failure

If two FMCs fail in flight, the third FMC automatically takes over in a single FMC configuration. The EICAS advisory message SINGLE FMC is displayed. All data is retained, NDs continue to operate, but LNAV and VNAV deselect. The flight crew needs to reactivate and execute the flight plan, and reselect LNAV and VNAV.

A software reset may occur while in single FMC operation. This is a self-protection mode which prevents permanent loss of the FMC in the unlikely event the FMC is presented with an insoluble computation. Resets are accompanied by the appropriate CDU help window message. Symptoms of a reset may include the active route becoming inactive, performance data being erased, and LNAV and VNAV disengaging. To regain FMC operation, select another roll and/or pitch mode on the MCP, enter necessary performance data on the PERF INIT page, activate and execute the flight plan, and re-engage LNAV and VNAV.

Triple FMC Failure

In the unlikely event all FMCs become inoperative, the EICAS advisory message FMC is displayed. The loss of all FMCs is accompanied by the loss of PFD mini-map displays, loss of ND map displays, loss of the CDU pages on the MFD and loss of both LNAV and VNAV. The TCPs provide the capability to enter a single Latitude/Longitude waypoint. The TCPs then provide track, distance to go, and groundspeed for the entered waypoint. The ability to tune the left integrated navigation receiver is provided through the TCPs. Left side ILS or GLS deviations are then displayed on the ISFD.

Autothrottles should still be available and may be used in conjunction with any valid autopilot roll and/or pitch mode.

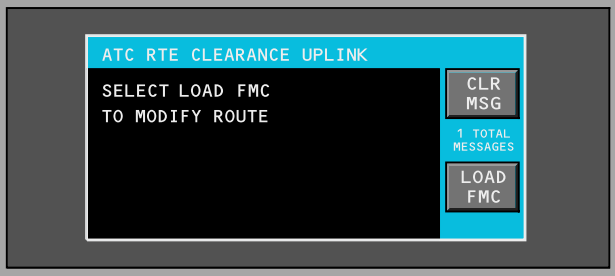
(See Alternate Navigation System Description on page 11.50.1 for additional information.)

Introduction

Most Air Traffic Control datalink functions are accomplished on the MFD. The multifunction keypad is used as an input device for downlink message forms.

Arriving ATC uplink messages are annunciated to the crew by the appearance of the communications alert message “dot ATC” on the EICAS display, the ATC uplink information on the ATC data block, and a Hi-Lo alerting chime. Following alerting, the crew may view the message on the ATC data block and then select the COMM display on the MFD. The ATC message displayed on the ATC data block is repeated on the COMM display. A variety of clearance information may be uplinked from ATC, including clearances such as headings, altitudes and speeds, as well as route clearance data.

In the ATC data block message, the words ACCEPT and REJECT are displayed to indicate that the crew must either accept or reject the clearance. The ACCEPT or REJECT switches on the glare shield or the soft keys on the COMM display can be used to complete this action. When a clearance is of a type that can be loaded into the FMC, LOAD FMC buttons appear on both the COMM display and the CDU help window. The crew may accomplish the FMC loading or accept/reject actions in either order. However, loading the FMC first provides the opportunity to view the clearance on the ND map display as a flight plan modification prior to acceptance. Selection of either LOAD FMC prompt causes the clearance to be loaded into the FMC and displayed on the CDU as a flight plan modification. The message ROUTE X UPLINK LOADING is displayed in the CDU help window and on the COMM display during loading.



CDU HELP WINDOW

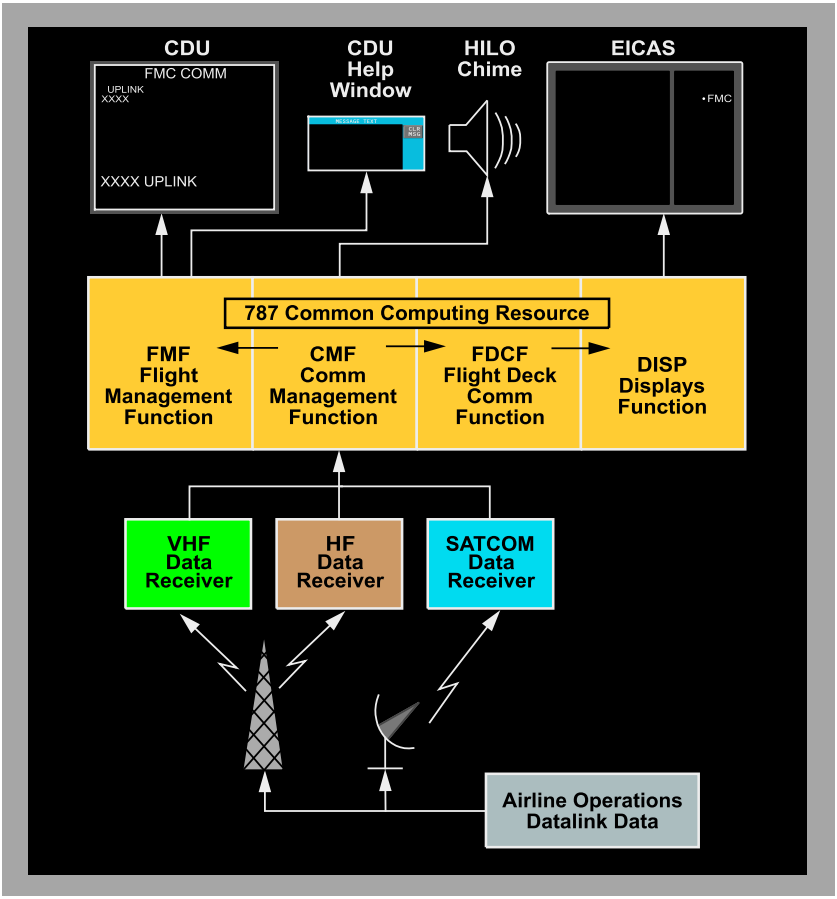
The modification may be subsequently executed or erased as with any flight plan modification. If an FMC modification was previously pending, the new ATC modification cannot be loaded into the FMC and the LOAD FMC prompts display in Cyan to indicate that they cannot be selected at the moment. Once the FMC

is clear of all modifications, the LOAD FMC prompt is displayed in shaded white and completion of the FMC loading may be accomplished.

(See ATC Datalink on page 5.40.19 for additional information.)

Introduction

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.



Datalink

Downlinks are datalink messages transmitted to a ground station. Requests for data and reports of FMC data are two types of downlinks. Requests are made manually by the flight crew. Reports can be made manually or may occur automatically.

Uplinks are messages transmitted to the airplane. Most uplinks require manual selections by the flight crew. Some uplinks are input automatically.

Manual Downlinks

Select a REQUEST prompt to start the downlink request for data. REQUEST prompts (as configured by the airline) may be displayed on the PERF INIT, TAKEOFF REF 1/2, DESCENT FORECAST, RTE, ALTN, ALTN LIST or RTE DATA pages. Downlink reports of the active route may be accomplished by selection of the REPORT prompt on the RTE page and a position report may be downlinked by selection of the REPORT prompt on the POS REPORT page.

When the communications function is unable to prepare FMC downlinks, the words FAIL, NO COMM, or VOICE display on the CDU pages in place of the REQUEST and REPORT prompts. The datalink status also displays on the FMC COMM page. Radios supporting datalink operations can be reconfigured by the crew through the MFD COMM function.

(See Command Key Functions on page 5.40.4 for additional information.)

The status messages are:

- FAIL—
  - the data communications management function is inoperative, or
  - the data radios have failed
- NO COMM—
  - the data radios are operational but, not available
- VOICE—all available radios are operating in the VOICE mode.

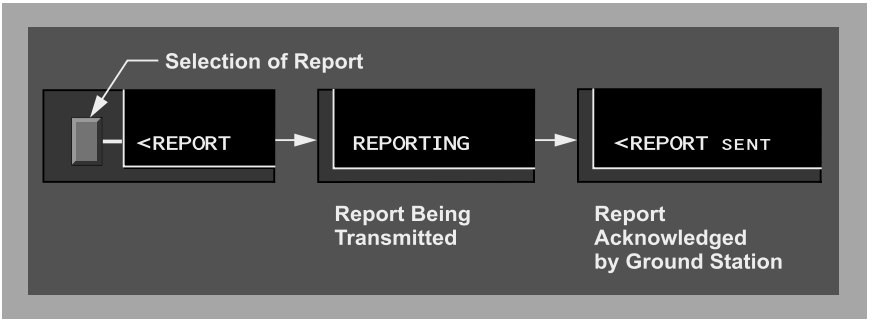
Reports

Selecting the REPORT prompt downlinks a report applicable to that page. The pages below contain REPORT prompts.



Report Status

Below is a typical sequence of status in response to sending a report.



Automatic Downlinks

The FMC can be configured by the airline to automatically transmit downlinks of FMC data at predetermined points during the flight or in response to specific data requests from the airline dispatcher. The FMC response in these cases is completely automatic and no flight crew action is necessary.

Uplinks

Uplinked data may be loaded automatically or may require flight crew action. Two uplinks automatically load data into the FMC and do not require execution. Uplinked data that waits in system memory for flight crew action are considered to be pending.

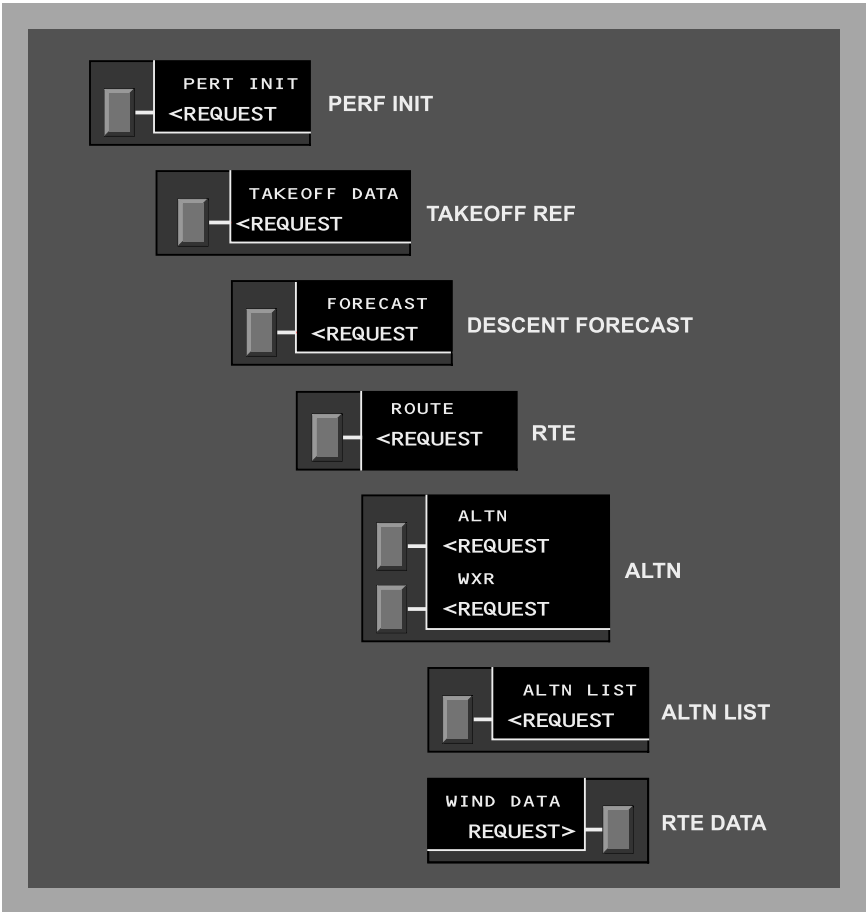
A pending uplink is included or discarded when the flight crew selects the applicable prompt. Flight crew response to an uplink depends on the type of uplink. Flight crew action is made with ACCEPT/REJECT or LOAD/PURGE prompts, FMC modification ERASE prompt or EXEC key, or when the page with the uplink is selected. Glareshield–mounted accept and reject switches operate the same as MFD ACCEPT/REJECT prompts.

Data can be uplinked from the airline dispatcher directly to the PERF INIT, TAKEOFF REF 1/2 and 2/2, DESCENT FORECAST, RTE, ALTN, ALTN LIST, and WIND pages. The uplinks are annunciated to the crew by the •FMC EICAS communications alert and a hi–lo chime. The uplink is identified by a CDU help window message and by the presence of an UPLINK label over the applicable COMM page prompt.

If there is no active route, wind uplinks are not annunciated, and the <WIND prompt on the COMM page is not shown.

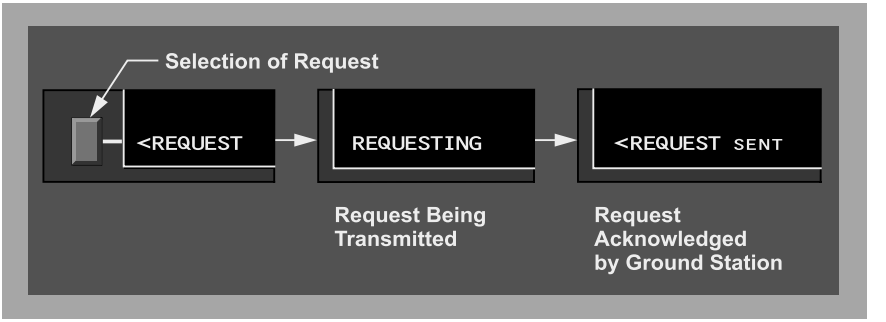
Requests

A REQUEST prompt on each page downlinks a unique request applicable to that page. The pages below (as configured by the airline) may contain request prompts.



Request Status

Below is a typical sequence of status in response to sending a request.



FMC Datalink Uplinks (Accept/Reject)

ACCEPT and REJECT display on the PERF INIT, TAKEOFF 1/2 and ALTN 1/2 pages after receipt of uplink data.

Uplink data displays initially in small font for preview.

Select ACCEPT prompt:

- displays uplinked data in large font
- replaces previous data with uplinked data
- changes page to pre–uplink format
- clears CDU help window message
- transmits a downlink accept message (if enabled).

Select REJECT prompt:

- replaces uplinked data with previous data
- changes page to pre–uplink format
- clears CDU help window message
- transmits a downlink reject message (if enabled).



FMC Datalink Uplinks (Load/Purge)

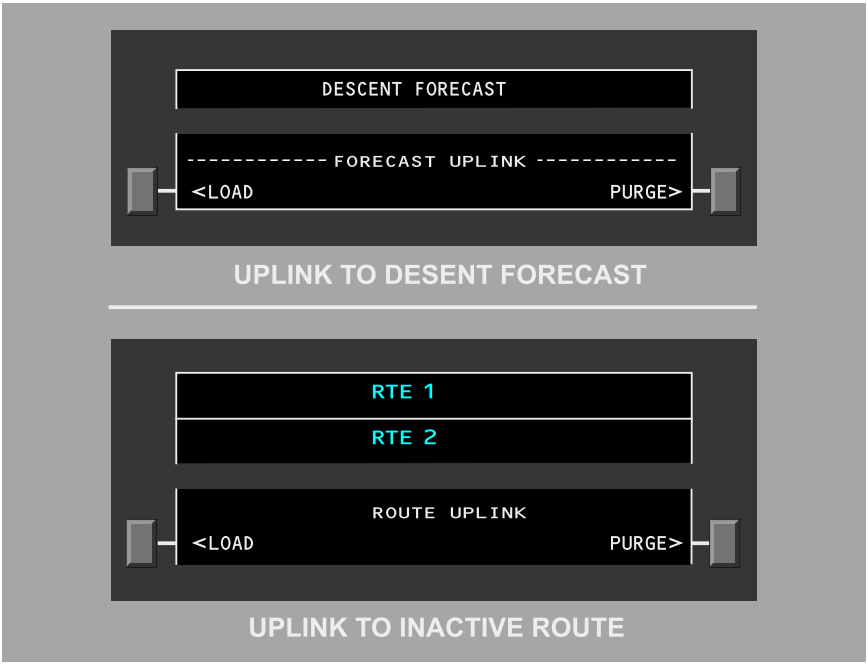
LOAD and PURGE display on the DESCENT FORECAST page after receipt of uplink data. LOAD and PURGE display on the active RTE 1 or RTE 2 page when there is an uplink to the inactive route.

Select LOAD prompt:

- loads uplinked data into FMC for viewing
- clears CDU help window message
- replaces previous data with uplinked data
- changes page to pre–uplink format
- transmits a downlink accept message (if enabled).

Select PURGE prompt:

- replaces uplinked data with previous data
- changes page to pre–uplink format
- clears CDU help window message
- transmits a downlink reject message (if enabled).



FMC Datalink Uplinks (Load/Exec-Erase)

LOAD displays on the RTE and WIND pages after receipt of uplink data.

After the uplinked data is loaded, the EXEC light illuminates and the ERASE prompt displays.

Select LOAD prompt:

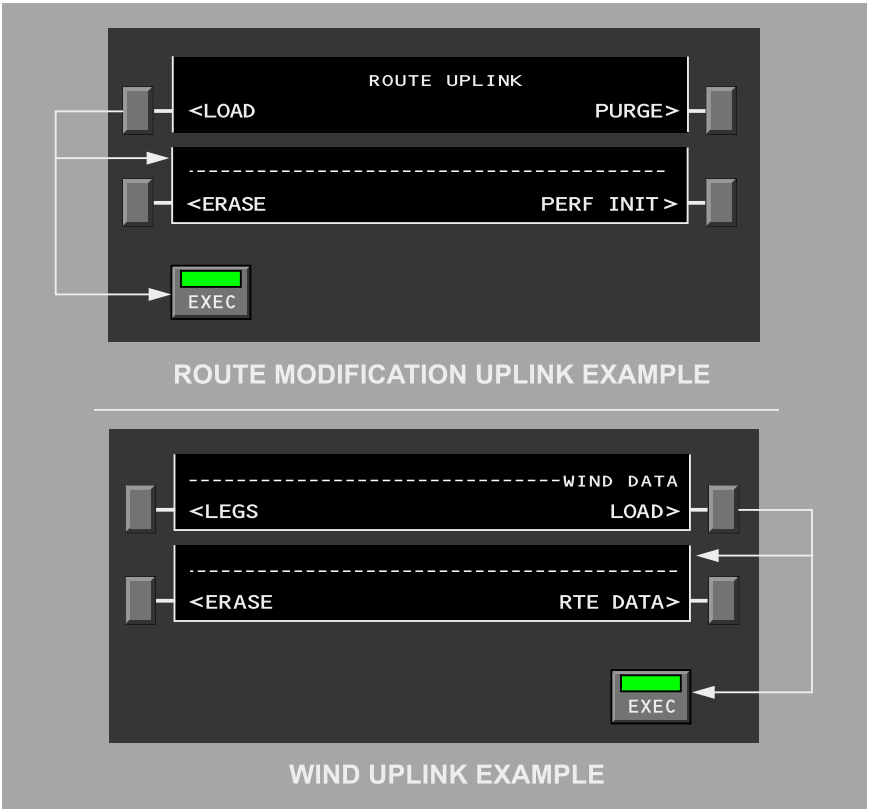
- loads uplinked data into FMC
- loaded data can be viewed
- clears CDU help window message
- replaces existing data with modified uplinked data
- changes page title to MOD
- shows ERASE prompt
- illuminates EXEC light.

Select the EXEC key to:

- put modified data in active flight plan
- change page format to pre–uplink format
- transmit a downlink accept message (if enabled).

Select ERASE prompt to:

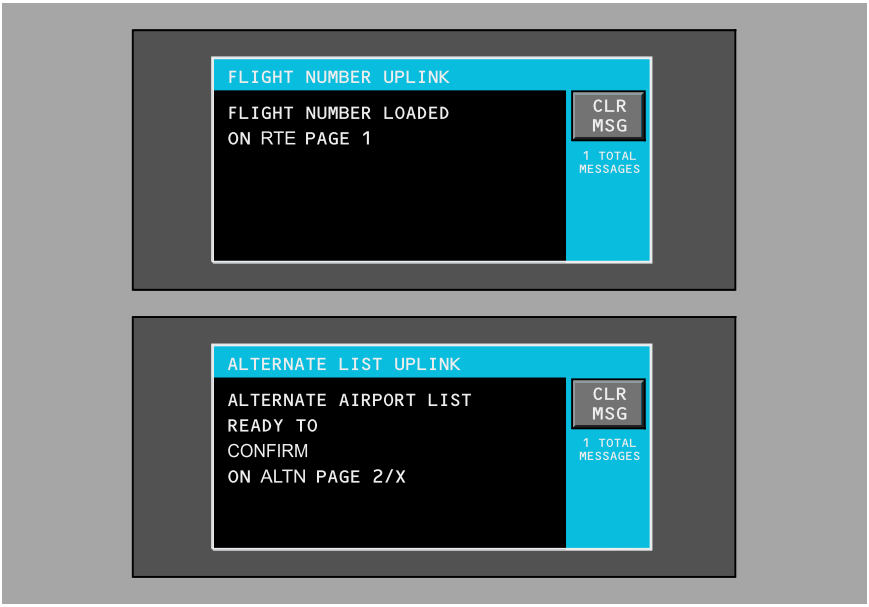
- remove modified data
- return page display to pre–uplink format
- transmit a downlink reject message (if enabled).



FMC Datalink Uplinks (Automatic)

FLT NO and ALTN LIST data can be automatically uplinked and loaded. FLT NO automatically loads into the RTE 1/x page without flight crew action. The list of 20 alternates automatically loads into the ALTN LIST page without flight crew action.

The CDU help window messages FLIGHT NUMBER UPLINK or ALTERNATE LIST UPLINK stay in the CDU help window until the applicable CDU page is selected.



Datalink Management

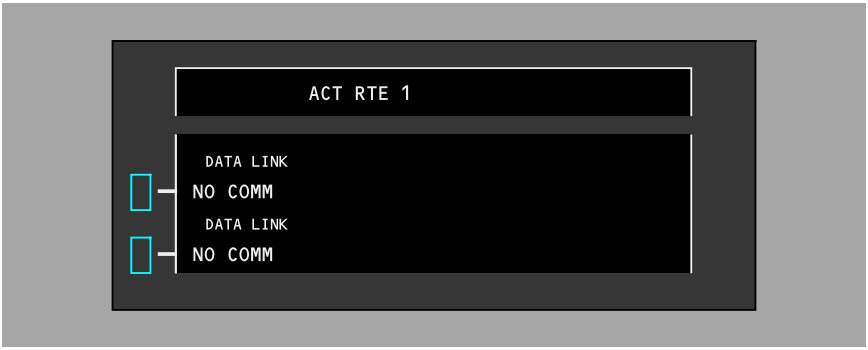
The flight crew should monitor system status of FMC datalink. This is accomplished on various CDU pages or on the FMC COMM page. Changes to datalink system operating modes are accomplished with the COMM function on the display select panel or multifunction keypad.

CDU Datalink Status Displays

Datalink operation is verified when the correct line title is above the related prompt. In the example below, the line title ROUTE is above the REQUEST and REPORT prompts on the RTE page.

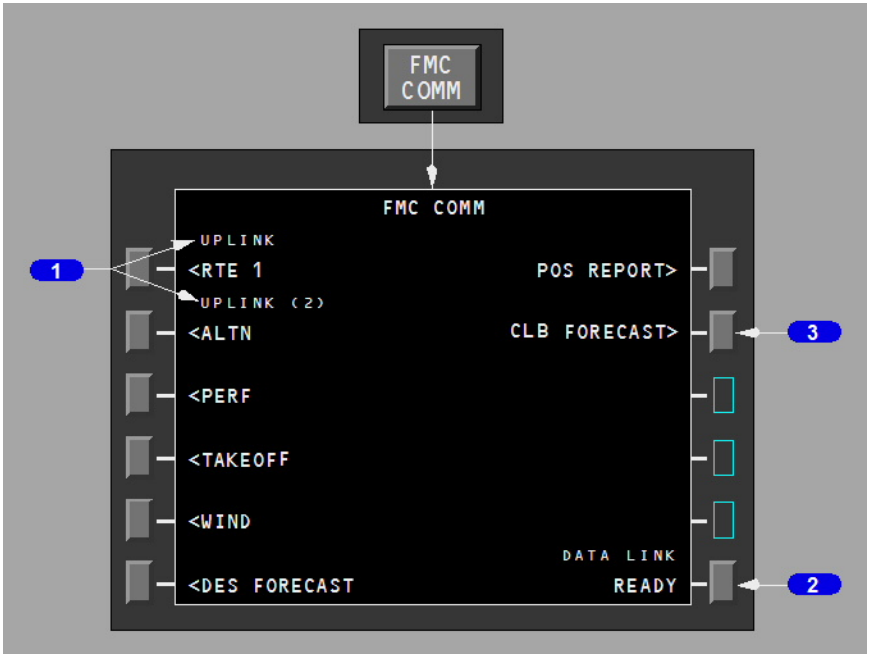


When the datalink system is not operating, CDU page prompts change to NO COMM, VOICE or FAIL and the line titles change to DATA LINK.



FMC Communications Page

General datalink status displays on the FMC COMM page. Page select prompts display for each FMC page with access to datalink data.



1 Uplink Status

The page line title displays UPLINK when an uplink message is pending and all preprocessing is complete. Preprocessing of uplinks ensures necessary data is available for display when the uplink message is selected. Examples of preprocessing include:

- RTE ALTN, ALTN LIST, PERF, TAKEOFF and WIND uplinks are held until route activation or modifications are complete
- subsequent uplinks of the same type are held until previous uplinks are included or discarded by the flight crew.

When both ALTN and ALTN LIST uplinks are pending, (2) displays to the right of UPLINK in the line title.

The EICAS communication message •FMC displays whenever any UPLINK message is pending.

2 DATA LINK

Displays the datalink system status.

System status can be:

- FAIL
- NO COMM
- READY
- VOICE.

3 Climb (CLB) Forecast

Select—displays CLIMB FORECAST page.

Page Select Prompts

Selection of any of these prompts displays the related page:

- ALTN
- CLB FORECAST
- DES FORECAST
- PERF
- POS REPORT
- RTE X
- TAKEOFF
- WIND

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.

The FMC provides the pilot entered Zero Fuel Weight, Origin airport and takeoff runway to the Electronic Flight Bag (EFB). The EFB will use this data along with other airplane data (OAT and QNH) to compute the optimal V-speeds for the airplane/conditions. The flight crew then selects a “Send to FMC” prompt on the EFB to uplink the reference speeds to the FMC. The takeoff V-speeds, V1, VR, and V2 are displayed on the TAKEOFF REF 1/2 page in small font along with associated takeoff planning data. REJECT and ACCEPT prompts are displayed at LSK 5L and 5R on the TAKEOFF REF 1/2 page. Once the flight crew selects the ACCEPT prompt on the TAKEOFF REF 1/2 page, the V-speeds are displayed in large font on the CDU pages and also displayed on the PFD speed tape.

Although the EFB is the expected tool to provide V-speeds on the 787, the crew still has the option to manually enter the desired V-speeds and associated takeoff data. A third option is to have the V-speeds and takeoff data uplinked by datalink from the Airline Company (AOC). Using datalink reduces the number of required flight crew actions. Manual flight crew entries replace existing data.

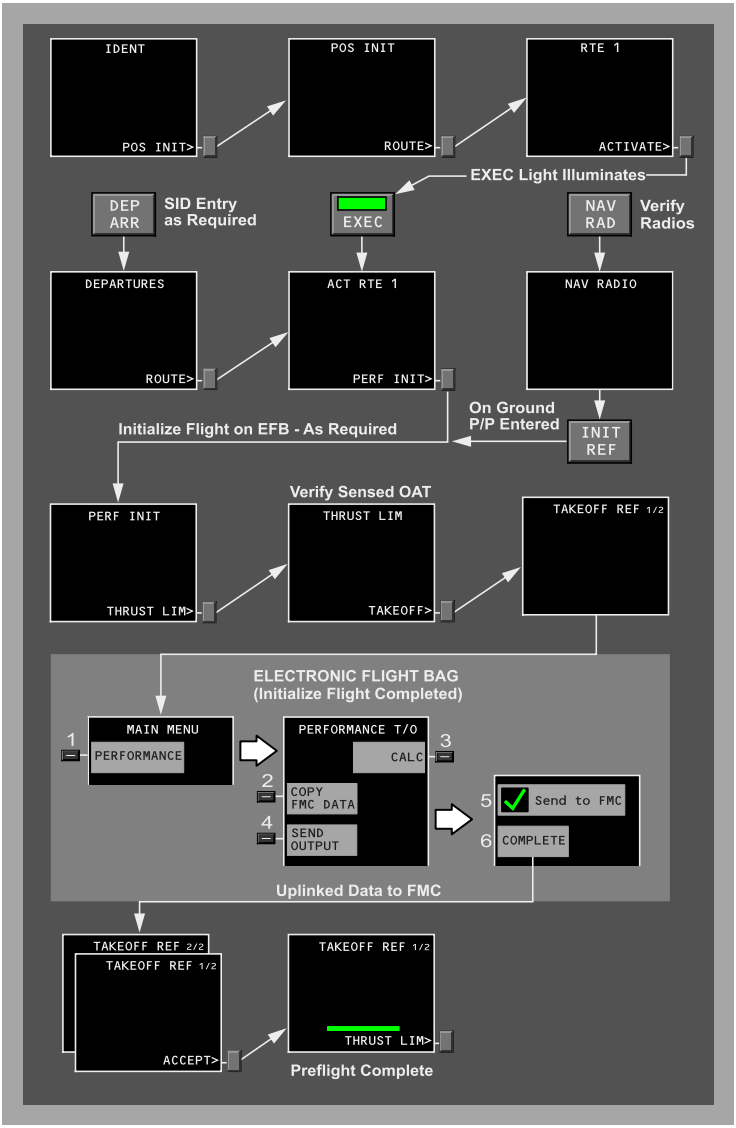
Preflight Page Sequence

The identification page usually displays when power is applied to the FMC. Preflight flow continues in this sequence:

- identification (IDENT) page
- position initialization (POS INIT) page
- route (RTE) page
- DEPARTURES page (no prompt)
- navigation radios (NAV RAD) page (no prompt)
- EFB—INITIALIZE FLIGHT (no prompt)
- performance initialization (PERF INIT) page
- thrust limit (THRUST LIM) page
- takeoff reference (TAKEOFF REF 1/2) page
- EFB—Onboard Performance Tool (no prompt)
- takeoff reference (TAKEOFF REF 2/2) page (no prompt)
- takeoff reference (TAKEOFF REF 1/2) page.

Some of these pages are also used in flight.

Minimum Preflight Sequence



During preflight, a prompt in the lower right directs the flight crew through the minimum requirements for preflight completion. Selecting the prompt key displays

the next page in the flow. If a required entry is missed, a prompt on the TAKEOFF page leads the flight crew to the preflight page missing data.

Airplane GPS position is necessary for FMC preflight and flight instrument operation. Entry of inertial position is optional as the IRS has continuous access to GPS position.

A route must be entered and activated. The minimum route data is origin and destination airports, and a route leg.

Performance data requires entry of airplane weights, fuel reserves, cost index, and cruise altitude.

Takeoff data requires a flap setting and center of gravity.

Supplementary Pages

Supplementary pages are sometimes required. These pages have no prompts and interrupt the usual sequence. Discussions of each page includes methods to display the page.

When the route includes SIDs and STARs, they can be entered using the DEPARTURES or ARRIVALS pages.

Route discontinuities are removed and the route is modified on the ROUTE and RTE LEGS pages. Speed/altitude restrictions are entered and removed on the RTE LEGS page. The RTE LEGS page is described in the FMC Cruise section of this chapter.

Alternate airports are added on the ALTN page. The ALTN page is described in the FMC Descent/Approach section of this chapter.

Waypoints, navigation, airport, and runway data is referenced on the REF NAV DATA page. The REF NAV DATA page is described in the FMC Cruise section of this chapter.

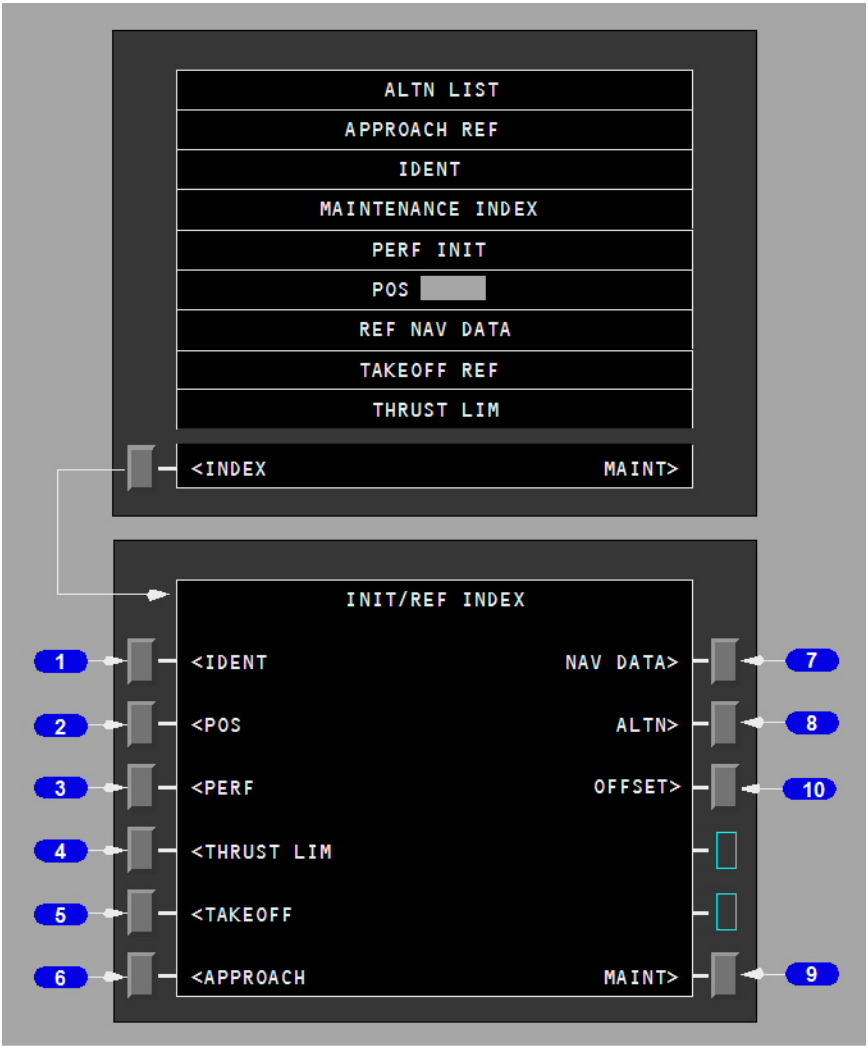
VNAV performance is improved if forecast winds and temperatures are entered during the preflight. Wind and temperature data for specific waypoints is entered on the WIND page. The WIND page is described in the FMC Cruise section of this chapter.

Preflight Pages—Part 1

The preflight pages are presented in the sequence used during a typical preflight.

Initialization/Reference Index page

The initialization/reference index page allows manual selection of FMC pages. It gives access to pages used during preflight and not usually used in flight.



1 Identification (IDENT)

The IDENT page is used to verify basic airplane data and currency of the navigation database.

2 Position (POS)

The POS INIT page is used for IRS initialization.

The POS INIT page is also used for syncing display heading to the magnetic compass when the IRS is in reversionary attitude mode.

3 Performance (PERF)

The PERF INIT page is used for initialization of data required for VNAV operations and performance predictions.

4 Thrust Limit (THRUST LIM)

The THRUST LIM page is used to select thrust limits and derates.

5 TAKEOFF

The TAKEOFF REF page is used to enter takeoff reference data and V speeds.

6 APPROACH

The APPROACH REF page is used for entry of the approach VREF speed.

7 NAV DATA

The REF NAV DATA page is used for data on waypoints, navaids, airports, and runways. NAV DATA pages are accessible only from this page.

8 Alternate (ALTN)

The ALTN page is used for alternate airport planning and diversions.

9 Maintenance (MAINT)

For maintenance use only; displays maintenance pages.

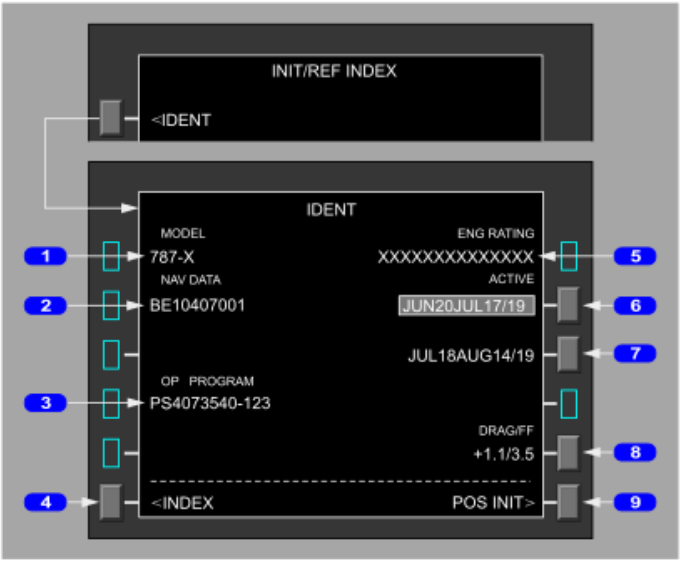
10 Lateral Offset (OFFSET)

The OFFSET page is used for setup or revising a tactical, planned, or automatic strategic offset.

Identification Page

Most of the data on this page is for flight crew verification. Active date and drag/fuel flow accept manual entries.

The flight crew verifies FMC data, selects a navigation database, and checks or modifies drag and fuel flow factors on the identification page.



1 MODEL

Displays airplane model.

2 NAV DATA

Displays the navigation database identifier.

3 OP PROGRAM

Displays the Flight Management Operational Program part number.

4 INDEX

Select—displays the INIT/REF INDEX page.

5 ENG RATING

Displays engine model. Header displays INTERMIX RATING for engine intermix installations.

6 ACTIVE

Displays the effectivity date range for the active navigation database.

If the active navigation database is out of date, it can be changed to the inactive navigation database. Selecting the date range prompt of the inactive navigation database copies that date into the scratchpad. Selecting the date range prompt

of the active navigation database transfers the scratchpad date up to the ACTIVE database line. The previous active date moves to the inactive date line.

The line title ACTIVE is above the active navigation database date. No line title is above the inactive navigation database date. The navigation database date can only be changed on the ground. Changing the navigation database removes all previously entered route data.

When an active database expires in flight, the expired database is used until the active date is changed after landing.

7 Inactive Date Range

Displays the effectivity date range for the inactive navigation database.

8 DRAG/FF

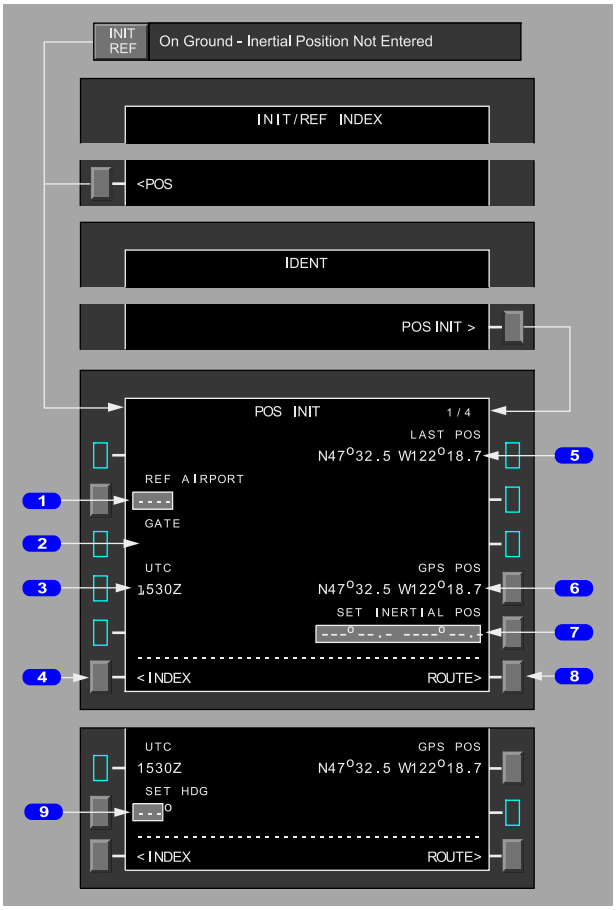
Displays the airplane drag and fuel flow correction factors.

9 Position Initialization (POS INIT)

Select—displays the POS INIT page.

Position Initialization Page 1/4

The position initialization page allows entry of airplane present position for IRS alignment in the event that automatic GPS updating is not available. The page is also used to enter the heading when the IRS is in reversionary attitude mode.



1 Reference Airport (REF AIRPORT)

Entry of the reference airport displays the airport latitude/longitude.

Optional entry.

Valid entries are ICAO four letter airport identifiers.

Removes previous GATE entry.

Entry blanks at lift–off.

2 GATE

The gate entry allows further refinement of the latitude/longitude position.

Optional entry after reference airport entered.

Valid entry is a gate number at the reference airport.

Displays the latitude and longitude of the reference airport gate.

Changes to dashes when a new reference airport entered.

Entry blanks at lift–off.

3 Coordinated Universal Time (UTC)

Displays UTC time as updated from the GPS.

The displayed value cannot be selected, modified or overwritten.

Display is blank if no valid GPS time is available.

4 INDEX

Select—displays the INIT/REF INDEX page.

5 Last Position (LAST POS)

Displays the last FMC calculated position.

6 GPS Position (GPS POS)

Displays the GPS present position. During preflight, the GPS POS may not display due to satellite availability, performance, or unfavorable geometry.

7 Set Inertial Position (SET INERTIAL POS)

The set inertial position entry is optional because the IRS has continuous access to the GPS position. Entry may be accomplished by selecting the most accurate latitude/longitude from LAST POS, REF AIRPORT, GATE, GPS POS, or make a manual entry.

If an entered position fails the IRU internal check, the CDU help window message ENTER INERTIAL POSITION displays. If the entered position fails the IRU check after the position is entered a second time, the CDU help window message ALIGNMENT REINITIATED displays.

The entered position is compared with the FMC origin airport position. If the entered position is not within 6 NM of the FMC origin airport position, the CDU help window message INERTIAL/ORIGIN DISAGREE displays.

Dashes display when any IRU or AHRU is in the alignment mode and can receive a new position update. Enter the most accurate inertial position to remove any accumulated IRU position errors.

Enter airplane position latitude and longitude.

When box prompts are displayed, present position entry is required. Box prompts are displayed if GPS position is not available, and any IRU or AHRU is requesting position.

Blanks when the airplane is moving.

New inertial position entries can be made anytime dashes are displayed. New entries display for 2 seconds. After 2 seconds, dashes display to allow entry of another position.

8 ROUTE

Select—displays the ROUTE page.

9 SET HDG

Dashes display in flight when any IRU or AHRU is in reversionary attitude mode.

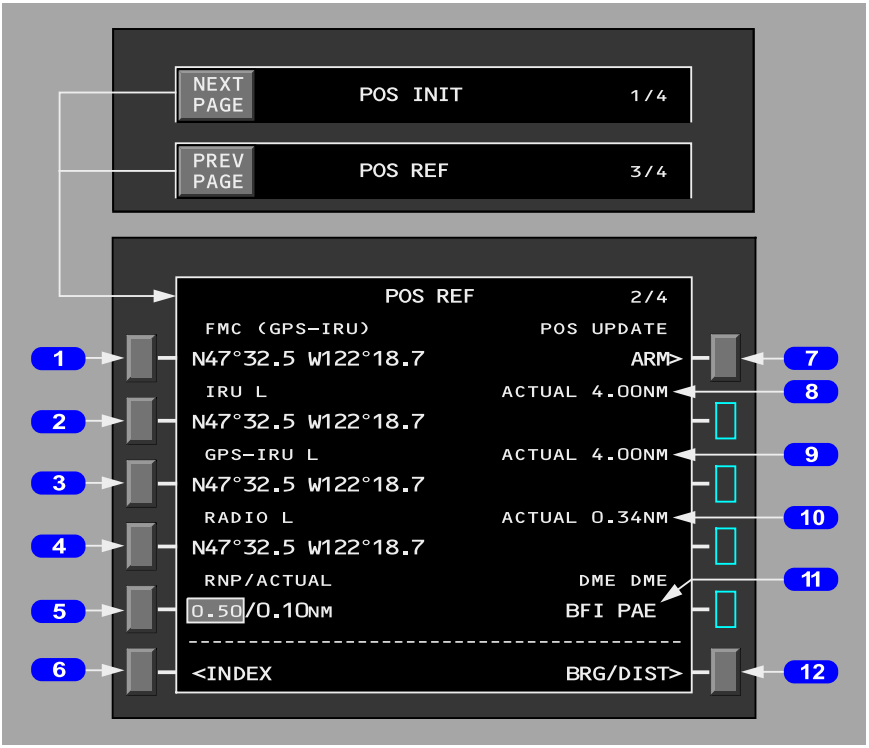
Entry of magnetic heading is displayed in the primary flight displays only after all IRUs and AHRUs have failed.

Valid entry is 0 to 360 (0 or 360 displays as 000°). Entered heading displays in large font for 2 seconds then is followed by dashes to allow entry of another heading.

Position Reference Page 2/4

Position reference page 2 displays positions calculated by the FMC, IRU, GPS, and radio navigation receivers. The FMC position can be updated to IRU, GPS, or radio position on this page.

This page displays latitude/longitude or bearing/distance. All position displays are in actual latitude and longitude, as calculated by the related system. The IRU, GPS, and radio position data can be changed to bearing/distance.



1 FMC

The source used by the Master FMC for position data displays next to the FMC line title. In the example, the FMC uses GPS-IRU for position data.

Displays the FMC calculated latitude/longitude.

Identifies the source for calculating the FMC position:

- GPS—position calculated from GPS position data
- GPS-AHRU—position calculated from GPS and AHRU position data
- GPS-IRU—position calculated from GPS and IRU position data
- INERTIAL—position calculated from IRU position data
- LOC—position calculated from localizer and IRU position data
- LOC-RADIO—position calculated from localizer and navigation radio position data
- RADIO—position calculated from navigation radio position data.

2 INERTIAL

Displays latitude/longitude (or bearing/distance) position of the IRU sensor currently being used by the Master FMC.

Blank if no valid IRU position exists.

3 GPS

Displays latitude/longitude (or bearing/distance) position of the GPS sensor currently being used by the Master FMC.

Blank if no valid GPS position exists.

4 RADIO

After airborne, displays latitude/longitude (or bearing/distance) position of the navigation radios being used by the Master FMC.

Blank if no valid RADIO position exists.

5 Required Navigation Performance and Actual Navigation Performance (RNP /ACTUAL)

Displays RNP values stored in the navigation database for departure and arrival procedures; or, if there are none, displays the default values stored within the FMC by flight phase. Also displays FMC actual navigation performance (ACTUAL).

Default RNP is in small font.

Valid RNP entries are in the range 0.01 to 99.9. ACTUAL entry not allowed.

When ACTUAL exceeds RNP, the EICAS caution message NAV UNABLE RNP displays.

Note: The FMC first reverts to inertial updating in the event GPS updating is unavailable or inhibited. As inertial-only performance degrades, the FMC reverts to radio-inertial update to provide most accurate FMC position (smallest ANP).

6 INDEX

Select—displays the INIT/REF INDEX page.

7 UPDATE ARM

Select—

- arms FMC position update function
- changes prompt to ARMED
- adds NOW prompts to right side of INERTIAL, GPS, and RADIO lines.

Select a NOW prompt key to update FMC position to the selected source.

8 ACTUAL—INERTIAL

Displays actual navigation performance of the IRU.

9 ACTUAL—GPS

Displays actual navigation performance of the GPS.

10 ACTUAL—RADIO

Displays actual navigation performance of radio updating.

11 Radio Update Station(s)/Mode

Displays radio station identifiers.

Position update mode is indicated in the line title:

- DME DME
- LOC
- VOR DME.

12 Bearing/Distance (BRG/DIST) or Latitude/Longitude (LAT/LON)

Select—alternates position data format between bearing/distance or latitude/longitude.

The page illustration is shown in the latitude/longitude display format.

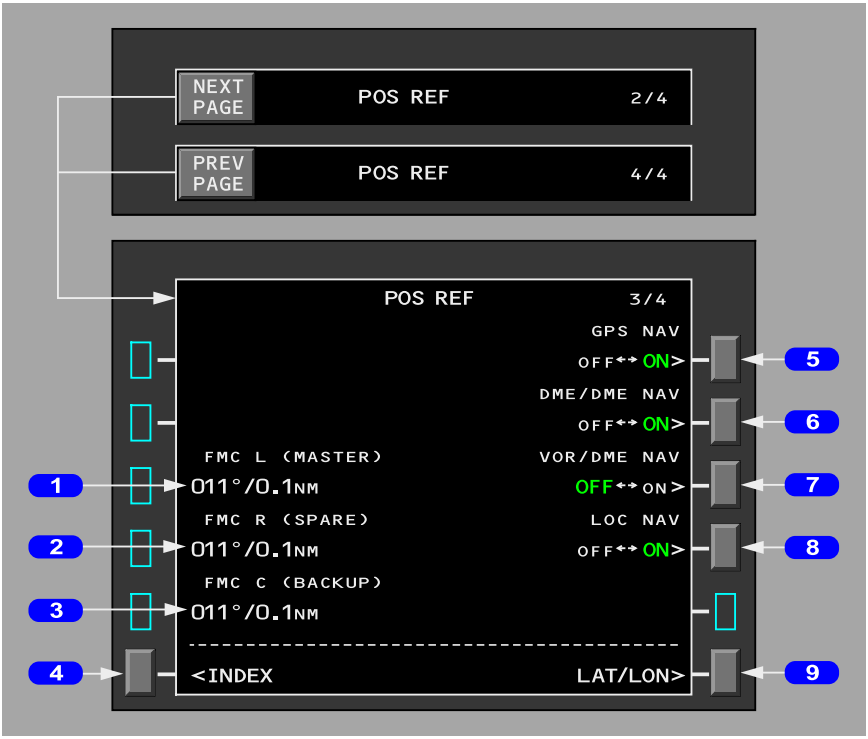
Latitude/longitude format displays are actual position.

Bearing/distance format displays the bearing and distance of other position sources relative to the Master FMC position.

Position Reference Page 3/4

On position reference page 3, the flight crew can observe the calculated positions of the left, right and center FMCs. The line title indicates which FMC is being used as MASTER, SPARE or BACKUP. This page also allows the flight crew to enable or inhibit position updating modes used by the FMC.

This page can display the bearing/distance or latitude/longitude format. The bearing/distance format displays bearing and distance of the position sources relative to the Master FMC position.



1 FMC L

Displays the left FMC calculated position and its current usage (MASTER).

2 FMC R

Displays the right FMC calculated position and its current usage (SPARE).

3 FMC C

Displays the center FMC calculated position and its current usage (BACKUP).

4 INDEX

Select—displays the INIT/REF INDEX page.

5 GPS NAV

Select—alternately selects GPS NAV ON (enabled) and OFF (disabled).

OFF—GPS position data is not available to the FMC. OFF displays in large green letters; ON displays in small white letters.

ON—GPS position data is available to the FMC. ON displays in large green letters; OFF displays in small white letters.

Notes: 1. When power is initially applied to the airplane or when engines are shut down, GPS NAV is set to ON.

2. Inhibiting GPS updating may be required in certain operational environments such as making an approach at a non WGS-84 surveyed airport.

6 DME/DME NAV

Select—alternately selects DME/DME NAV ON (enabled) and OFF (disabled).

OFF—DME/DME position data is not available to the FMC. OFF displays in large green letters; ON displays in small white letters.

ON—DME/DME position data is available to the FMC. ON displays in large green letters; OFF displays in small white letters.

7 VOR/DME NAV

Select—alternately selects VOR/DME NAV ON (enabled) and OFF (disabled).

OFF—VOR/DME position data is not available to the FMC. OFF displays in large green letters; ON displays in small white letters.

ON—VOR/DME position data is available to the FMC. ON displays in large green letters; OFF displays in small white letters.

8 LOC NAV

Select—alternately selects LOC NAV ON (enabled) and OFF (disabled).

OFF—LOC position data is not available to the FMC. OFF displays in large green letters; ON displays in small white letters.

ON—LOC position data is available to the FMC. ON displays in large green letters; OFF displays in small white letters.

9 Latitude/Longitude (LAT/LON) or Bearing/Distance (BRG/DIST)

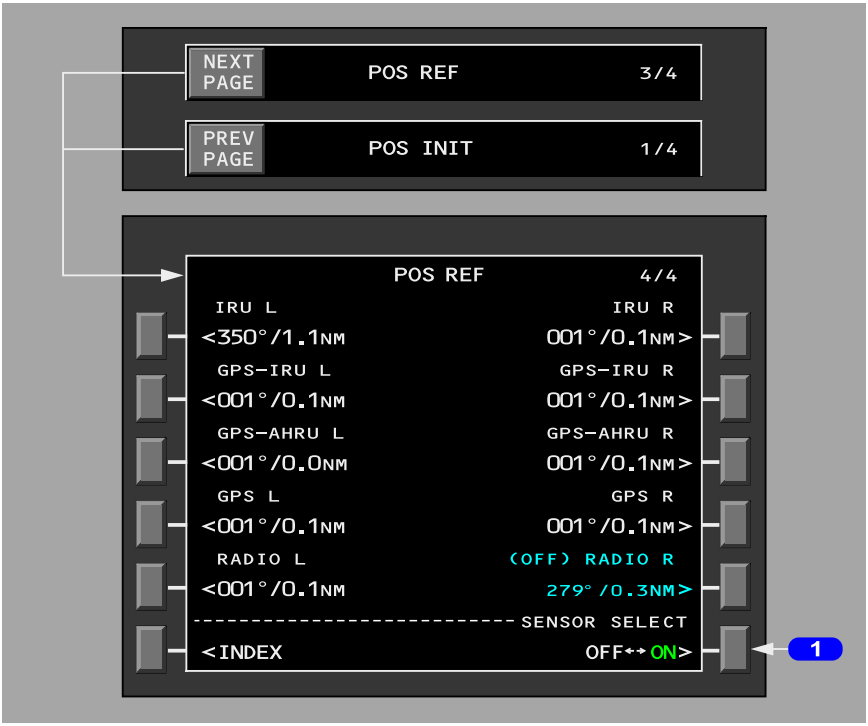
Select—alternately changes the display of position data on POS REF 2/4 and 3/4 to latitude/longitude format or bearing/distance format.

The page illustration is shown in the bearing/distance display mode.

Position Reference Page 4/4

Position reference page 4 displays the present position of individual navigation sensors in bearing/distance format from the Master FMC position. This page

provides the capability to remove specific sensors from the FMC navigation solution.



1 SENSOR SELECT

Select—alternately selects SENSOR SELECT ON (enabled) and OFF (disabled).

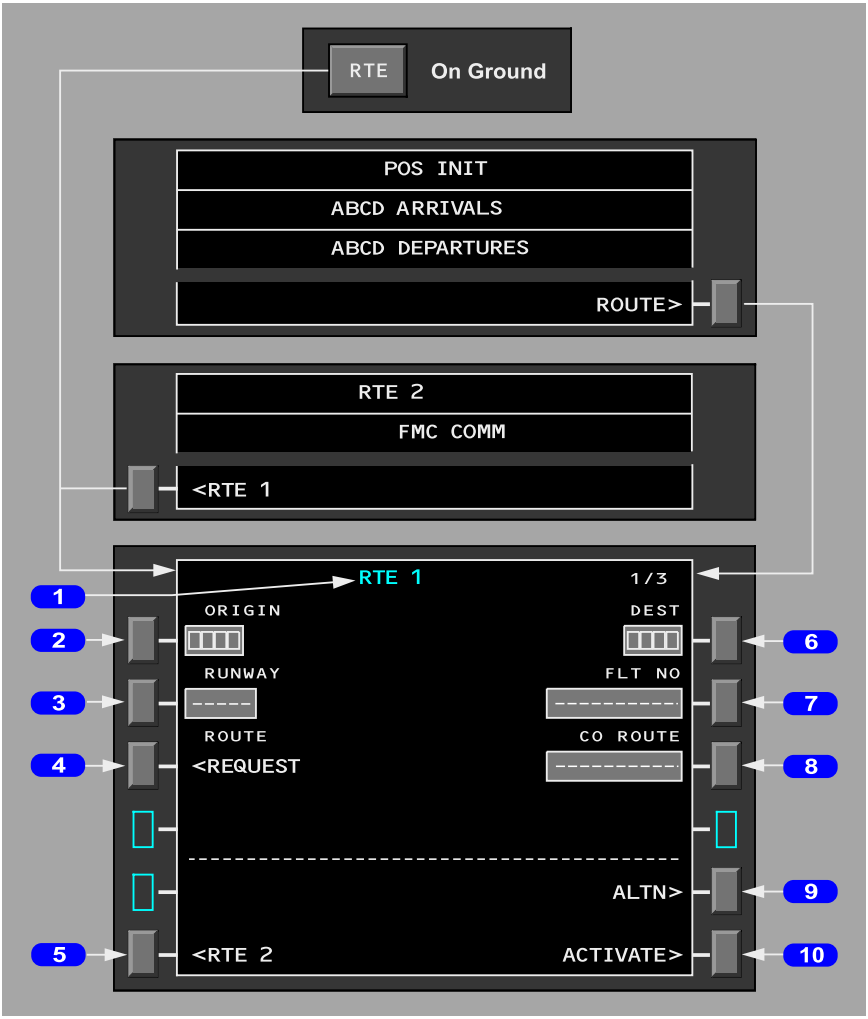
ON (large green font)—caret prompts are displayed on each sensor line that can be controlled:

- line selecting a sensor toggles it on or off
- the system prevents both of the IRU sensors or both of the GPS sensors from being selected OFF simultaneously
- when a sensor is selected OFF, the data line and header are displayed in small font cyan with (OFF) in the header
- selecting a sensor OFF does not disable or remove power from the sensor, it simply prevents the FMC from using its output for the navigation solution.

OFF (large green font)—caret prompts are removed and sensor selection is disabled.

Route Page 1/X

Two routes (RTE 1 and RTE 2) can be displayed in air traffic control format. Routes can be entered by the flight crew or uplinked through datalink. All routes have two or more pages. The first route page displays origin and destination data. Subsequent route pages display route segments between waypoints or fixes. ROUTE 1 and ROUTE 2 allow management of alternate or future routes while leaving the active route unmodified. ROUTE 2 has an identical page structure as ROUTE 1. When RTE 2 is active, page display logic is the same as RTE 1.



1 Page Title

White when the route is active.

Cyan when the route is inactive or pending activation.

The white shaded word MOD precedes the page title when the route is modified and the change is not executed.

Multiple route pages are indicated by the page sequence number to the right of the title. The minimum number of route pages is 2.

2 ORIGIN

Entry:

- must be a valid ICAO identifier in the navigation database
- is made automatically when a company route is entered
- enables direct selection of departure and arrival procedures
- displays MOD in page title of an active route
- entry on the ground deletes route; in flight, entries are valid on the inactive route
- clears wind levels on the WIND page, all existing company route identifiers, runways, destination airport, legs, and enroute procedures from an existing route.

3 RUNWAY

Enter the applicable runway for the origin airport. Runway must be in the navigation database. Entry is optional.

New entries on an active route cause MOD to display in the route title.

Automatically entered when part of a company route.

Can be selected on the DEPARTURES page.

FMC deletes runway after the first waypoint is crossed.

4 ROUTE REQUEST

Line title displays DATA LINK when the datalink status is NO COMM, VOICE, or FAIL.

Select—transmits a datalink request for a flight plan route uplink.

Flight crew can operationally fill in origin, destination, runway, flight number, company route name, or route definition to qualify request.

5 RTE 2, ERASE

RTE 2:

Select—displays the RTE 2 page 1/x.

Allows access to an inactive route for creation and modification or activation.

Inactive route modifications do not alter the active route.

Prompt changes to RTE 1 when RTE 2 is displayed.

ERASE:

Select—deletes all lateral and vertical mods to the displayed modified route. Selection of <ERASE while a pending activation route is displayed returns the inactive route.

6 Destination (DEST)

Entry:

- must be a valid ICAO identifier in the navigation database
- is made automatically when a company route is entered
- enables selection of departure and arrival procedures.

7 Flight Number (FLT NO)

Enter the company flight number.

Entry is optional for activation of the route.

Limited to 10 characters.

Flight crew entered or uplinked.

Flight number is included in the PROGRESS page title.

Flight number can be entered on multifunction COMM display ATC LOGON page.

Transponder transmits flight number to ATC when Eurocontrol-compliant transponder is installed.

8 Company Route (CO ROUTE)

A company route can be called from the navigation database by entering the route identifier. The data supplied with a company route can include origin and destination airports, departure runway, SID and STAR, and the route of flight. All company route data is automatically entered when the route identifier is entered.

An entry is optional for activation of the route.

Enter a company route identifier.

Valid entry is any flight crew entered or uplinked company route name. If the name is not contained in the NAV database, the entry is allowed and the CDU help window message NOT IN DATA BASE displays.

Entry of a new company route replaces the previous route.

In–flight entry is inhibited for the active route.

9 Alternate (ALTN)

Select—displays the ALTN page.

10 ACTIVATE

Selecting the ACTIVATE key to arm the route for execution as the active route. When the EXECUTE key is selected, the route becomes the active route and the ACTIVATE prompt is replaced with the next required preflight page prompt.

Select—prepares the selected route for execution as the active route.

Activation of a route is required for completion of the preflight.

Displayed on inactive route pages.

After route activation, the ACTIVATE prompt is replaced by:

- PERF INIT, when the required performance data is incomplete, or
- TAKEOFF when the required performance data is complete.

More Route Page Prompts for an Active Route



1 ROUTE REPORT

REPORT:

Select—transmits a flight plan downlink report.

LOAD:

Select—when the displayed route is inactive, it is replaced or modified by the flight plan uplink. When the displayed route is active, it is replaced or modified by the flight plan uplink and a modified route is created.

2 ROUTE PRINT

Select—sends the active route to the flight deck printer.

3 Route Copy (RTE COPY)

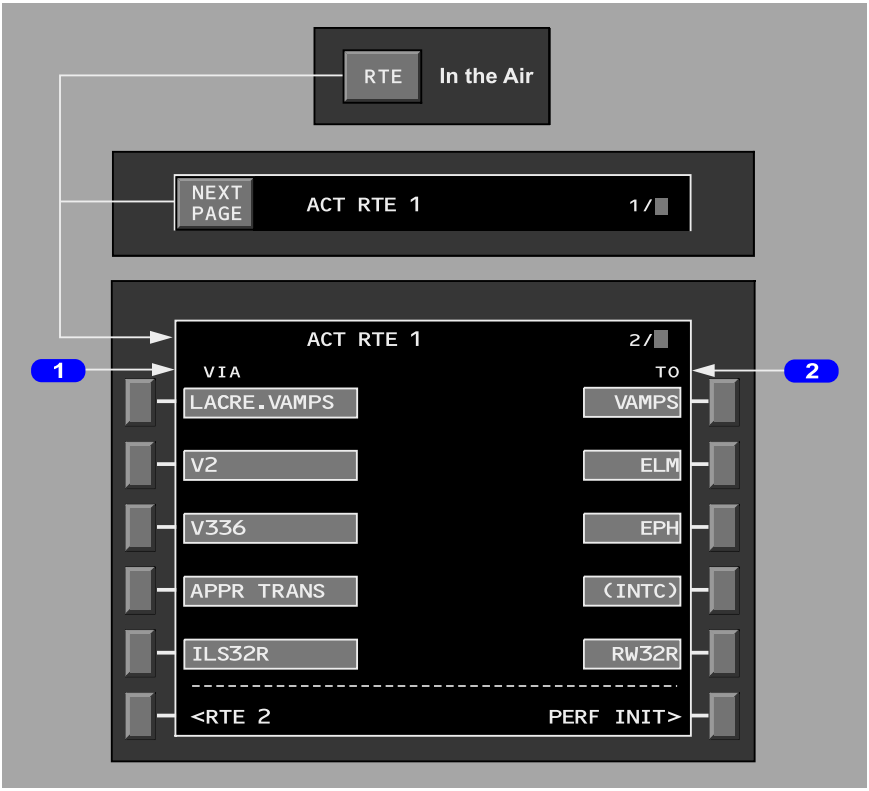
Select—copies the entire active route (RTE x) into the inactive route (RTE y).

Displayed only on the active route page.

Displays COMPLETE after the route is copied.

Route Page 2/X

The subsequent route pages 2/X through X/X, display route segments in air traffic control format. Route segments are defined as direct routing, airways, or procedures with start and end points such as waypoints, fixes, navaids, airports, or runways. More waypoints for each route segment are shown on the RTE LEGS page.



1 VIA

The VIA column displays the route segment to the waypoint or termination in the TO column. Enter the path which describes the route segment between the previous waypoint and the segment termination.

Enter an airway in the VIA column and boxes display in the TO column.

Valid entries can also include procedures or DIRECT. Procedures are usually entered through selections on DEPARTURES and ARRIVALS pages. DIRECT is usually entered as a result of entering a TO waypoint first.

Valid airways must:

- contain the fix entered in the TO waypoint, and
- contain the previous TO waypoint, or
- intersect the previous VIA route segment.

Dashes change to DIRECT if the TO waypoint is entered first.

Dashes display for the first VIA beyond the end of the route.

Invalid VIA entries display the CDU help window message NOT IN DATA BASE.

Invalid VIA entries are:

- airways and company routes which do not contain the TO waypoint of the previous line
- airways that do not intersect the previous airway
- airways or company routes that are not in the navigation database.

The start and end waypoints determine whether the entered airway is valid. The route segment must contain the waypoint entered in the TO position. The TO waypoint of the previous route segment must be the same as the start point of the next route segment or a route discontinuity is created between the segments.

Entry of a SID or transition enters the VIA and TO data for the route segments of the SID. A SID links to the next route segment when the final SID waypoint is part of the route segment.

When no SID is used, entering an airway on the first line of page 2 initiates an airway intercept from the runway heading and:

- replaces the airway with dashes in the first line VIA
- shows boxes in the first line TO waypoint
- moves the airway to line 2 after the TO waypoint is entered
- enters the first fix on the airway nearest to being abeam of the departure heading in the airway line TO waypoint.

A route can contain segments formed by the intersection of two airways. Entering two intersecting airways in successive VIA lines without a TO waypoint causes the FMC to create an airway intersection waypoint to change from one segment to the next. The FMC created waypoint intersection (INTC) displays in the first airway segment TO waypoint.

LACRE3.VAMPS is an example of a SID selection made on the DEPARTURES page.

V2 and V336 are examples of airway entries.

APP TRANS is an example of a STAR selection made on the APPROACH page.

ILS32R is an example of an approach selection made on the APPROACH page.

2 **TO**

Enter the end point of the route segment specified by the VIA entry.

Entry of a waypoint in the TO column without first entering a VIA airway shows DIRECT in the VIA column.

Data input is mandatory when boxes are displayed.

Valid waypoint entries for a DIRECT route segment are any valid waypoint, fix, navaid, airport, or runway.

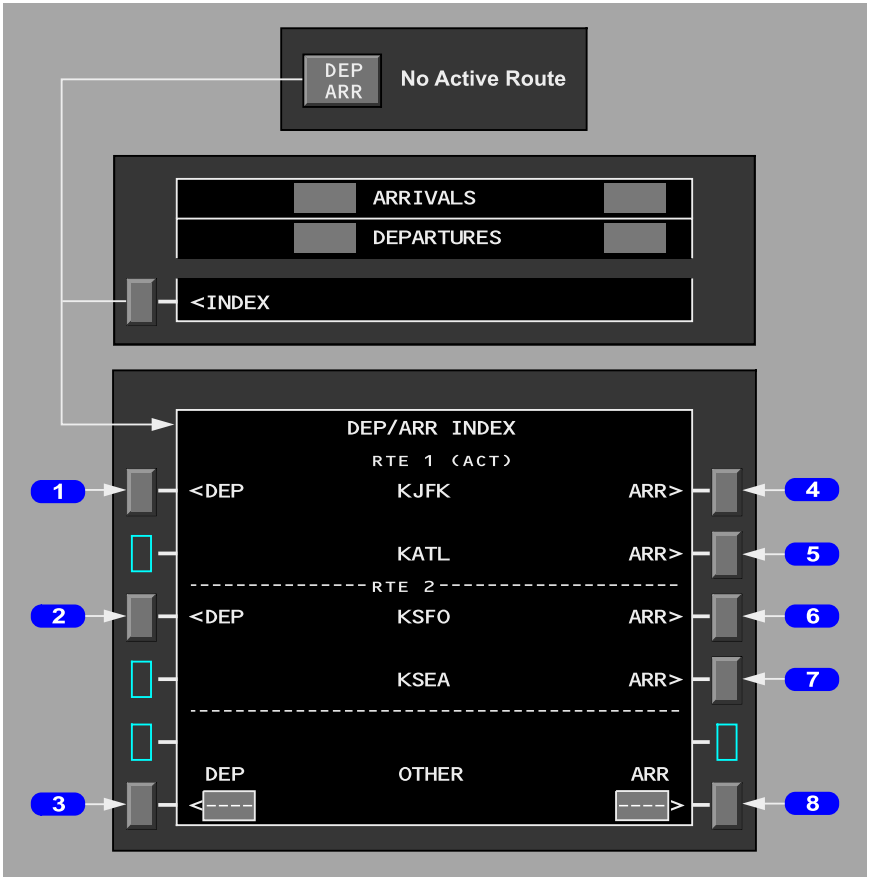
Valid waypoint entries for airways are waypoints or fixes on the airway.

Dashes display on the first TO waypoint after the end of the route.

Departure/Arrival Index Page

The departure and arrival index page is used to select the departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival data for any other airport in the navigation database.

Departure and arrival prompts are available for the origin airport. Destination airports have only arrival prompts.



1 Departure (DEP)—Route 1

Select—displays the departure page for route 1 origin airport.

2 Departure (DEP)—Route 2

Select—displays the departure page for route 2 origin airport.

3 Departure (DEP) — Other

Displays the departure page for the airport entered into this line through the scratchpad.

DEP prompt for OTHER allows display of departure data about airports that are not an origin or destination. The data can be viewed but cannot be selected because the airport is not on the route.

4 Arrival (ARR)—Route 1 Origin

Select—displays the arrival page for route 1 origin airport. Origin airport arrivals selection is used during a turn–back situation.

5 Arrival (ARR)—Route 1 Destination

Select—displays the arrival page for route 1 destination airport.

6 Arrival (ARR)—Route 2 Origin

Select—displays the arrival page for route 2 origin airport. Origin airport arrivals selection is used during a turn–back situation.

7 Arrival (ARR)—Route 2 Destination

Select—displays the arrival page for route 2 destination airport.

8 Arrival (ARR)—Other

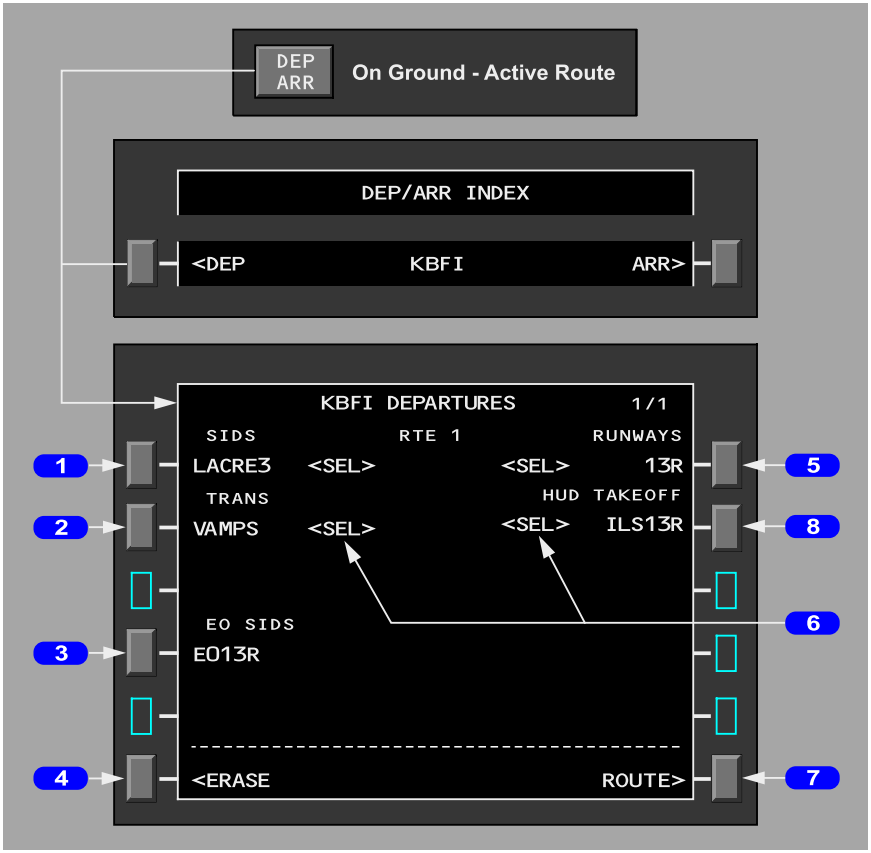
Displays the arrival page for the airport entered in this line through the scratchpad.

ARR prompt for OTHER allows display of arrival data about airports that are not an origin or destination. The data can be viewed but cannot be selected because the airport is not on the route.

Departures Page

The departures page is used to select the departure runway, SID, and transition for the route origin airport.

The departures page for the inactive route displays when the DEP ARR function key is selected with an inactive RTE or RTE LEGS page displayed.



1 Standard Instrument Departures (SIDS)

Displays a list of SIDS for the airport.

Select—

- selects SID for use in the route
- other SIDs no longer display and transitions for the selected SID display
- runways for selected SID remain and others no longer display.

2 Transitions (TRANS)

Displays transitions compatible with the selected SID.

Select—

- selects transition for entry in 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.

Select—displays EO SID as the selected SID.

4 ERASE or INDEX

Erase displays when a route modification is pending. INDEX displays when no route modification is pending.

ERASE selected—removes route modifications not executed and displays the original route.

INDEX selected—displays the DEP/ARR INDEX page.

5 RUNWAYS

Displays a list of runways for the selected airport.

The runway selected on the RTE 1/X page displays as <SEL> or <ACT>.

Select—

- selects runway for use in the route. All other runways no longer display
- SIDs associated with selected runway remain, all others no longer display
- subsequent change of a runway deletes departure procedures previously selected.

6 Selecting Options

Selecting an option displays <SEL> inboard of the option and creates a route modification. After executing the modification, <SEL> becomes <ACT>. Executing a modification or leaving the page and returning displays all options and the <SEL> or <ACT> prompts.

7 ROUTE

Select—displays the related RTE page.

8 HUD TAKEOFF

When available, HUD TAKEOFF options are shown on the DEPARTURES page. Selecting a HUD TAKEOFF runway provides highly accurate HUD guidance during takeoffs.

Select—

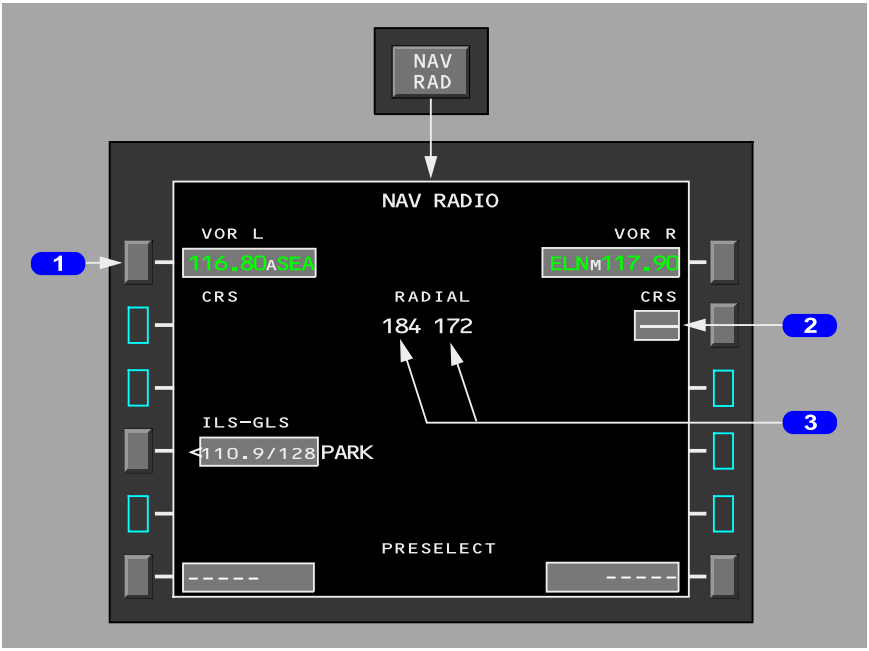
- selects runway to be used for HUD takeoff, all other runways are removed from the display

- the FMC tunes the selected navaid to provide takeoff guidance through the HUD
- SIDs associated with selected runway remain, all other SIDs and TRANs are removed from the display
- subsequent change of a runway deletes departure procedures previously selected.

Navigation Radio Page

VOR, ILS and GLS navigation radios are normally autotuned by the FMC. The NAV RADIO page displays the VOR and ILS-GLS status and allows manual control of these radios. Entering data on this page tunes the selected navigation radio. VOR courses can also be entered.

VOR



1 VOR Frequency and Tune Status

The tuning status displays adjacent to left and right VOR frequencies. Entry of a frequency or identifier manual–tunes a VOR. The FMC will autotune VORs for

procedure flying and route operations. The FMC also tunes related DMEs. The 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 250NM of airplane position
- A (autotuning)—FMC selects a navaid for best position orientation
- M (manual)—VOR is manual–tuned. Manual–tuning takes priority over FMC autotuning. Deletion of a manual–tuned frequency returns system to autotuning.

Valid entries:

- VOR or non–ILS DME identifiers (XXX) or VOR or non-ILS DME frequencies (YYY.Y or YYY.YY)
- VOR identifier/course (XXX/ZZZ) or frequency/course (YYY.Y/ZZZ or YYY.YY/ZZZ); the course displays on the CRS line.

The identifier and frequencies are green and tuning status is white.

Note: When magnetic variation at the airplane and VOR locations are significantly different, the ND VOR radial and ND POS green radial do not point directly to the VOR. This difference decreases as the airplane approaches the VOR.

2 CRS

Blank when in autotune.

Valid entry is a three–digit course. Data can be entered when dashes or a course are displayed.

With a VOR approach selected, sequencing an IAF/FAF causes the FMC to procedure autotune the VOR frequency. When the approach has a runway waypoint, the FMC selects the inbound course.

VOR course is green. Radial is white.

3 RADIAL

Displays radial from left and right VOR stations to the airplane.

ILS–GLS



1 ILS-GLS Tuning

The tuning status displays adjacent to the ILS frequency/course or GLS channel. The ILS and GLS receivers operate in FMC autotune or manual tuning modes. The FMC autotunes the ILS frequency/course or the GLS channel depending upon the approach selected in the flight plan. When the ILS or GLS is not necessary, the FMC sets the ILS-GLS status to PARK. This removes the displays from the PFD.

Airplane position on the route determines the ILS-GLS operating mode. The operating mode displays are:

- PARK—the ILS or GLS is not being used and is not tuned
- XXX.XX/YYY PARK—the ILS is tuned for the selected approach but is not being used
- “A” indicates autotuning under FMC control for approach guidance
- “M” indicates the ILS or GLS is manually tuned.

ILS autotuning is inhibited for ten minutes after takeoff and during manual–tuning. Autotuning and manual–tuning are inhibited when:

- the autopilot is engaged and either the localizer or glideslope is captured
- only the flight director is ON and either the localizer or glideslope is captured and the airplane is below 500 feet radio altitude
- on the ground with the localizer alive, the airplane heading within 45º of the localizer front course and the groundspeed is greater than 40 knots.

Subsequent manual–tuning is enabled when:

- either TO/GA switch is pushed
- the autopilot is disengaged and both flight directors are switched off
- the MCP approach switch is deselected when the airplane is above 1500 feet radio altitude.

Valid entries:

- ILS frequency and front course (XXX.XX/YYY)
- front course, with a frequency already entered (/YYY)
- GLS channel (XXXXX) in the range of 20000 to 99999.

Note: Since ILS frequency and GLS channel are entered on the same line it is not possible to have both ILS and GLS tuned simultaneously.

2 PRESELECT

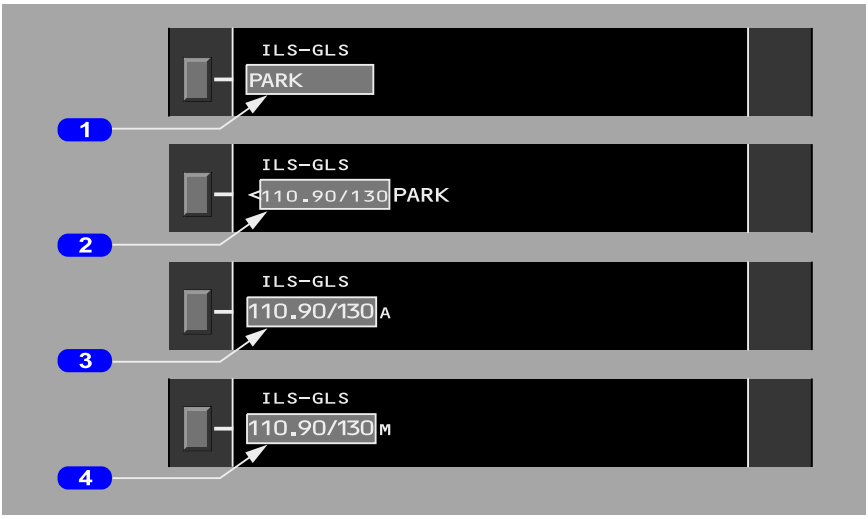
Any valid page data may be entered.

Put data into this line for later use. Data can be moved to the appropriate line when necessary.

ILS–GLS Tuning Status

The display initializes to PARK. When PARK displayed, the ILS or GLS is not tuned. The tuning status displays are:

- XXX.XX/YYY PARK—the ILS is autotuned for the selected approach but is not being used
- XXXXX PARK—the GLS is autotuned for the selected approach but is not being used
- A (autotune)—ILS or GLS is autotuned for approach guidance
- M (manual)—ILS or GLS is manual tuned.



1 Park

PARK displays when:

- electrical power is first applied
- more than 200 NM from the T/D, or
- less than halfway to the destination.

2 Tuning Status—Frequency, Course, and Park

ILS frequency, front course, and PARK display when an ILS, LOC, back course, LDA (localizer-type directional aid), or SDF (simplified directional facility) 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–GLS.

3 Tuning Status—Autotune

ILS frequency, front course, and A display when an ILS, LOC, back course, LDA (localizer-type directional aid), or SDF (simplified directional facility) is selected, and:

- less than 50 NM from the T/D, or
- less than 150 NM from the runway threshold, or
- FMC is in descent mode.

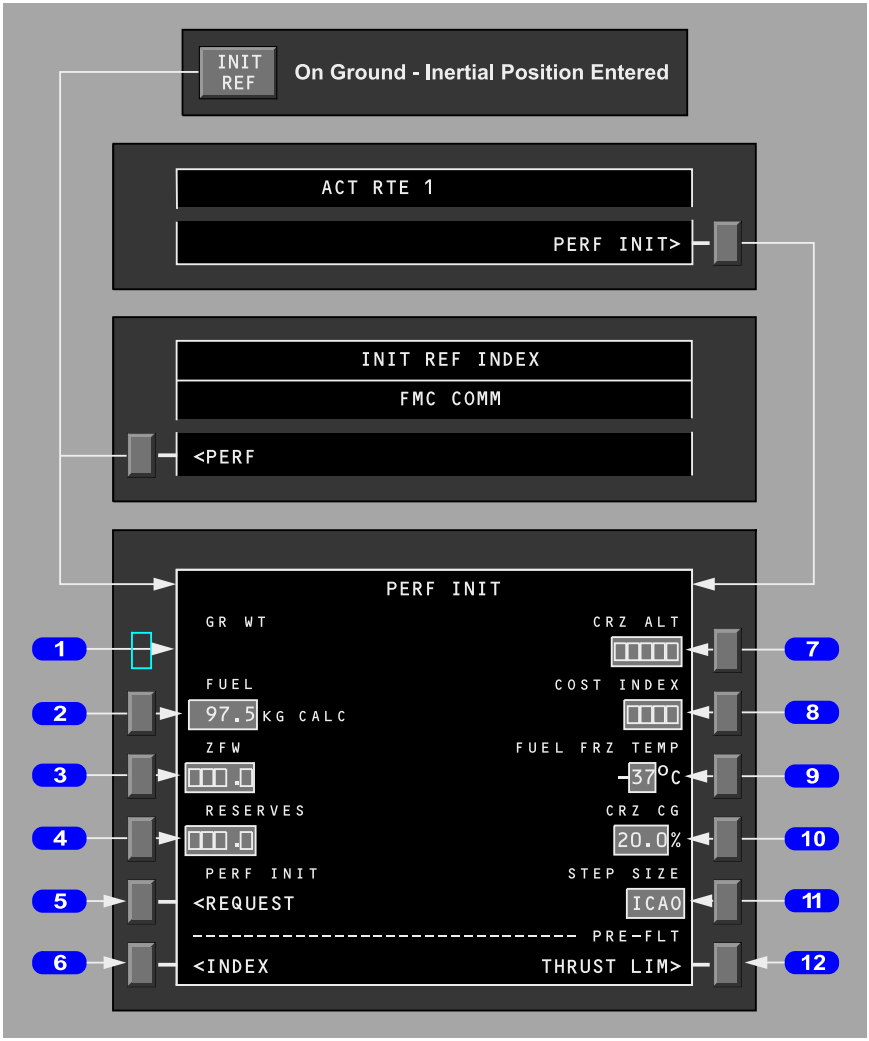
4 Tuning Status—Manual

Receiver tuned manually and valid frequency/course display.

Preflight Pages—Part 2

Performance Initialization Page

The performance initialization page allows the entry of airplane and route data to initialize performance calculations. This data is required for VNAV calculations. (See Fuel Temperature on page L.10.5 for additional information.)



1 Gross Weight (GR WT)

Calculated gross weight is displayed after Zero Fuel Weight is entered.

Manual entry is not allowed.

2 FUEL

Fuel on board displays when the fuel totalizer calculations are valid. The source for the display is included in the line:

- CALC (calculated)—fuel quantity is from FMC calculations. Manual entry is possible
- MANUAL—fuel quantity has been manually entered. Manual entries blank totalizer on PROGRESS page 2/4
- SENSED—fuel quantity is from the totalizer. Manual entry is not possible.

Box prompts indicate invalid totalizer signals received from the fuel quantity system. Manual entry required.

Valid entry is XXX or XXX.X.

Only manual entries can be deleted.

3 Zero Fuel Weight (ZFW)

Normally, ZFW is entered from the airplane dispatch papers and the FMC calculates the airplane gross weight.

Valid entry is XXX or XXX.X.

Entry of a value after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window message TAKEOFF SPEEDS DELETED.

ZFW can be manually entered or uplinked. When a performance uplink is pending, uplinked values (small font) display beside the entered values (large font).

4 RESERVES

Valid entry is XXX or XXX.X.

Can be manually entered or uplinked. When a performance uplink is pending, uplinked values (small font) display beside the entered values (large font).

5 Performance Initialization Request (PERF INIT REQUEST)

Select—transmits a datalink request for performance data uplink.

Flight crew can fill in ZFW, CG, cruise altitude, reserves, cost index, or fuel temperature to qualify request.

6 INDEX

Select—displays the INIT/REF INDEX page.

7 Cruise Altitude (CRZ ALT)

Cruise altitude can be entered by the flight crew or from a company route or uplink.

Valid entry is XXX, XXXX, XXXXX or FLXXX.

Entry displays this cruise altitude on the CLB and CRZ pages.

8 COST INDEX

Cost index is used to calculate ECON climb, cruise, and descent speeds. Larger values increase ECON speeds. Entering zero results in maximum range airspeed and minimum trip fuel. Cost index can be entered by the flight crew or from a company route or uplink.

Valid entries are 0 to 9999.

9 Fuel Freeze Temperature (FUEL FREEZE TEMP)

Displays the fuel freeze temperature for a given fuel.

Default value from the airline policy page displays in small font and may not be deleted.

Temperature may be crew entered or uplinked.

Flight crew entered value displays in large font.

Valid entries are −99 deg. C to −1 deg. C.

When actual fuel temperature is with 3 deg. C of the displayed value, the EICAS advisory message FUEL TEMP LOW displays.

10 Cruise Center of Gravity (CRZ CG)

The FMC uses the CRZ CG to calculate maximum altitude, and minimum and maximum amber band speeds. The flight crew may improve the accuracy of calculated maximum altitude and maneuver margin to buffet by entering the actual CRZ CG, when known. A flight crew entered value shows in large font. A more aft CRZ CG results in a less restrictive initial buffet envelope (higher maximum altitude, lower low-speed buffet speed, and increased high buffet speed).

Displays default value of 28.0% in small font.

A PERF INIT uplink containing a cruise CG value pending ACCEPT/REJECT displays in small font. Accepting causes the value to display in large font.

Flight crew entered value displays in large font.

Valid entry is 6.0 through 39.5.

11 STEP SIZE

Displays the climb altitude increment used for planning the optimum climb profile.

Default value is ICAO.

Valid manual entries are 0 to 9000 in 1000 foot increments.

In–flight entries are inhibited. In–flight step size changes are made on the CRZ page.

For a non–zero entry, performance predictions are based on step climbs at optimum points. For a zero entry, performance predictions are based on a constant CRZ ALT.

12 Thrust Limit (THRUST LIM)

Select—shows the THRUST LIM page.

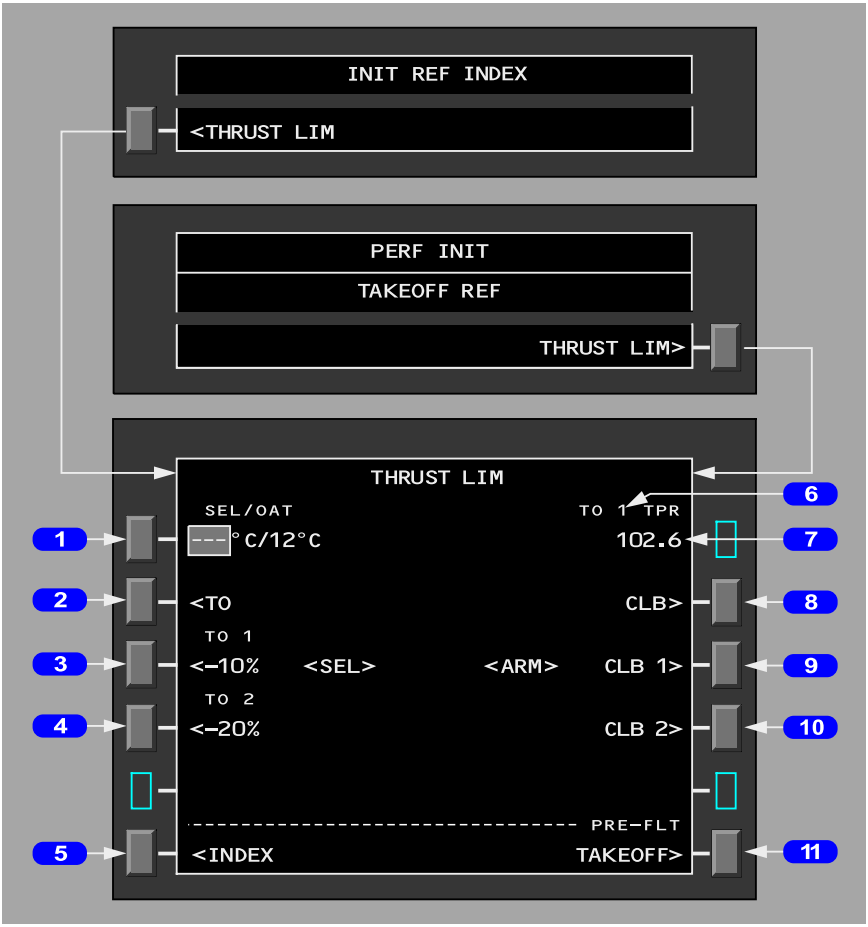
Thrust Limit Page

The thrust limit page allows selection and display of reference thrust for takeoff. Takeoff thrust derate by use of assumed temperature is also accomplished on this page.

Additional page data displays are:

- <ARM>—identifies the armed climb thrust reference mode
- <SEL>—identifies the selected takeoff thrust reference mode.

The <ARM> prompt changes to <SEL> when the armed climb mode becomes active.



1 Assumed Temperature (SEL), Outside Air Temperature (OAT)

Entry of assumed temperature is allowed when the airplane is on the ground and dash prompts or large font temperature data is displayed.

Entry of an assumed temperature warmer than the OAT reduces takeoff thrust and displays D as part of the thrust reference mode.

Valid entries are 0 deg. C to 99 deg. C or 32 deg. F to 210 deg. F.

Entry of one, two, or three character temperature followed by “F” displays assumed temperature in degrees Fahrenheit; otherwise, assumed temperature displays in degrees Centigrade.

Uplinked temperatures display on both the THRUST LIM and TAKEOFF REF pages. Flight crew entered or uplinked values replace previously displayed values.

Entry of a value after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window message TAKEOFF SPEEDS DELETED.

OAT defaults to degrees Centigrade unless a manual OAT degrees Fahrenheit entry has been made. When SEL temperature is in degrees Fahrenheit, the OAT also displays in degrees Fahrenheit.

When OAT is not available, the slash is followed by box prompts allowing manual OAT entry using one of the following formats:

- /SNN where S represents the sign and NN is a temperature value in the range of –99 to +60 inclusive
- /SN where S represents the sign and N is a single digit temperature value in the range of 0 to 9 inclusive
- /NN where NN is a two digit positive temperature value in the range of 00 to 60 inclusive, and
- /N where N is a single digit positive temperature value in the range of 0 to 9 inclusive
- a Fahrenheit entry must include an “F” as the last character.

The assumed temperature thrust derate is not the same as TO 1 and TO 2 fixed thrust derates described below. If TO 1 or TO 2 is selected and an assumed temperature is then entered, thrust is further derated.

If entry results in greater than a 25% reduction in thrust, the entered value is dialed back to a value that results in a 25% reduction.

2 Takeoff (TO)

Select—selects full rated (TO) takeoff thrust limit.

Selection of a new rating after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window message TAKEOFF SPEEDS DELETED.

3 Takeoff 1 (TO 1)

Select—selects fixed percentage derate (TO 1) for takeoff thrust limit.

Takeoff thrust derate can also be entered by accepted uplink.

Selecting TO 1 arms the appropriate climb thrust (CLB, CLB 1 or CLB 2). (See Derated Thrust Climb on page 11.32.3 for additional information.)

Selection of a new TO 1 rating after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window message TAKEOFF SPEEDS DELETED.

4 Takeoff 2 (TO 2)

Select—selects fixed percentage derate (TO 2) for takeoff thrust limit.

Takeoff thrust derate can also be entered by accepted uplink.

Selecting TO 2 arms the appropriate climb thrust (CLB, CLB 1 or CLB 2). (See Derated Thrust Climb on page 11.32.3 for additional information.)

Selection of a new TO 2 rating after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window message TAKEOFF SPEEDS DELETED.

5 INDEX

Select—displays the INIT/REF INDEX page.

6 Thrust Reference Mode

Displays selected takeoff thrust mode.

“D-” displays when an assumed temperature derate is active.

7 Takeoff TPR Limit

Displays the takeoff TPR calculated by the thrust management function. Displays N1 when the engines are operated in the alternate mode.

8 Climb (CLB)

Select—selects the full rated (CLB) climb thrust limit.

Selecting a climb line select key overrides an automatic selection.

9 Climb 1 (CLB 1)

Select—selects a percentage derate (CLB 1) climb thrust limit.

Climb thrust derate can also be entered by accepted uplink.

10 Climb 2 (CLB 2)

Select—selects a percentage derate (CLB 2) climb thrust limit.

Climb thrust derate can also be entered by accepted uplink.

11 TAKEOFF

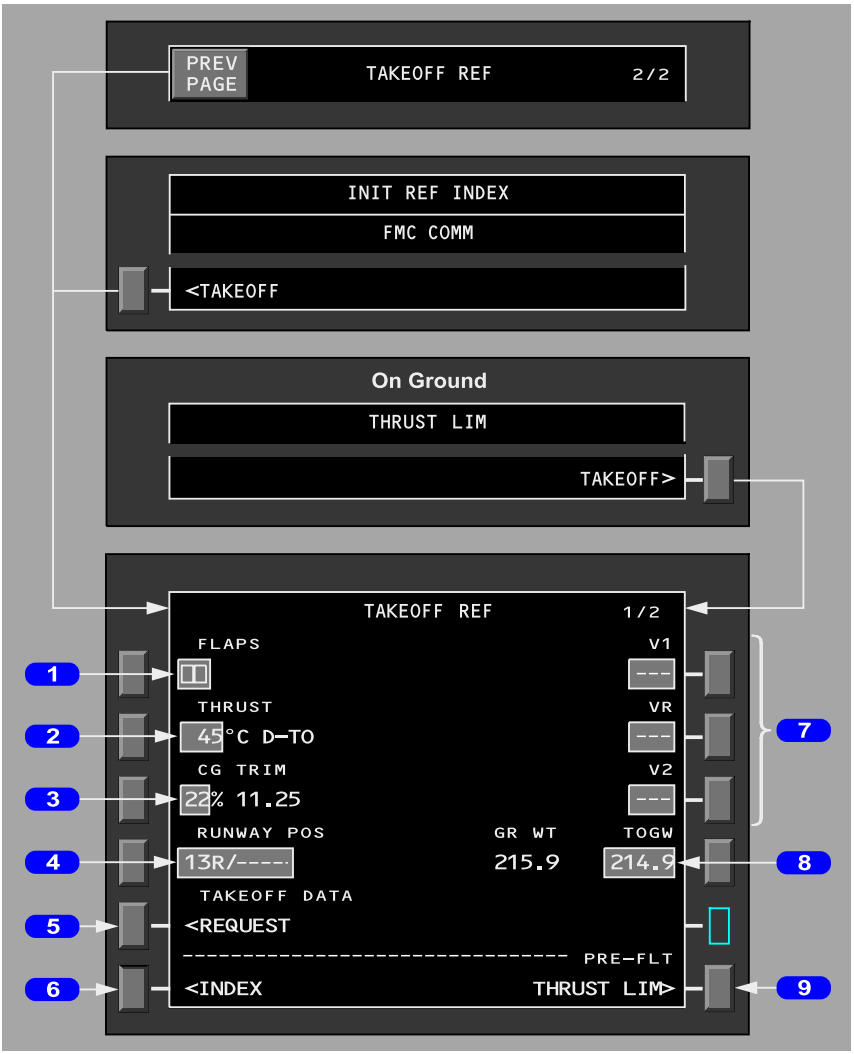
Select—displays the TAKEOFF REF page.

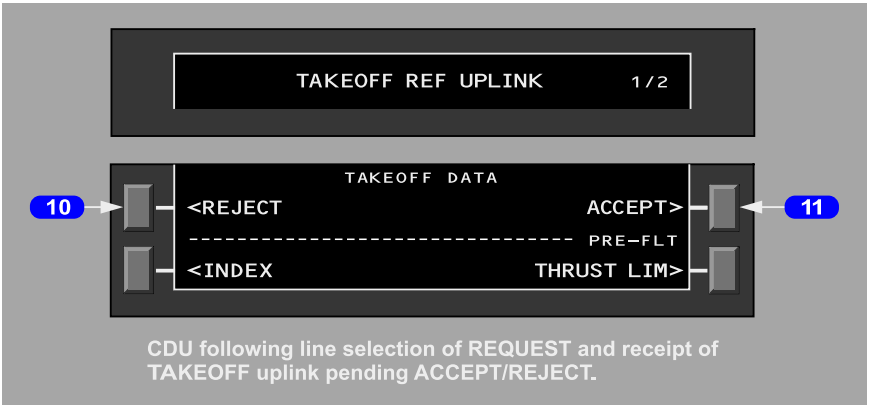
Takeoff Reference Page 1/2

The takeoff reference page allows the flight crew to manage takeoff performance. Takeoff flap setting and V speeds are entered and verified. Thrust limits,

takeoff position, and takeoff gross weight can be verified or changed. Preflight completion status is annunciated until complete.

Takeoff reference page entries finish the normal preflight. The takeoff flap setting must be entered and V speeds should be set before completion.





CDU following line selection of REQUEST and receipt of TAKEOFF uplink pending ACCEPT/REJECT.

1 FLAPS

TQA to TQF Displays takeoff flap setting. Valid entries are 5, 15, or 20.

TWA,B Displays takeoff flap setting. Valid entries are 5, 10, 15, 17, 18, or 20.

Flight crew entry or uplink.

Entry of 5 when FLAPS 5 is the climb thrust reduction point displays the CDU help window message INVALID ENTRY.

Entry of a value after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window 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.

Entry is only allowed when the airplane is on the ground and dash prompts or large font temperature data is displayed.

Valid entries are 0 deg. C to 99 deg. C or 32 deg. F to 210 deg. F. Fahrenheit entries must be appended with an “F”.

Entry of a value after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window message TAKEOFF SPEEDS DELETED.

3 Center of Gravity (CG), TRIM

Valid entry is CG within the valid range.

After CG entered, the FMC:

- calculates and displays the stabilizer takeoff setting to the right of the CG entry (trim display is in 0.25 unit increments)

- updates the takeoff green band displayed on stabilizer position indicator.

4 Runway/Position (RWY/POS)

Displays the selected takeoff runway, and TO/GA push distance from the runway threshold or runway intersection identification.

Displays the takeoff runway from the active RTE page if previously selected. Runway entry does not change runway entered on RTE or DEPARTURES page.

Flight crew may enter or uplink runway and intersection data.

Valid entry of a runway intersection is an alphanumeric up to three characters, preceded by a slash (/).

Valid position entry is a one or two numeric in the range 0-30. It must be followed by two zeros and preceded by a slash (preceding the entry with a “-”means a longer takeoff distance is available; for example, -0300 is 300 meters before the runway threshold).

Entry of a value after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window message TAKEOFF SPEEDS DELETED.

RWY/POS update inhibited when GPS is primary FMC navigation source.

5 TAKEOFF DATA REQUEST

Select—transmits a company datalink request for takeoff data.

Flight crew can enter RWY, intersection or position shift, CG, TOGW, or OAT toqualify the request.

6 INDEX

Select—displays the INIT/REF INDEX page.

7 V Speeds (V1, VR, V2)

Dashes display when:

- required information not entered
- IRS not aligned.

EFB calculated speeds display in small font. The takeoff data comes from the EFB performance page and is sent as an uplink to the FMC after the pilot initiates “Send to FMC” from the EFB.

Flight crew entered speeds display in large font and replace EFB uplinked or AOC uplinked speeds. The following applies to manually entered or accepted uplinked speeds:

- V1 speeds less than V1MIN are indicated by display of “MIN V1” in the line title and the value of V1MIN in the data line
- VR speeds less than V1MIN or VRMIN are indicated by display of “MIN VR” in the line title and the greater value of V1MIN or VRMIN in the data line

- V2 speeds less than V2MIN are indicated by display of “MIN V2” in the line title and the value of V2MIN in the data line.

Select—

- crew entered V speeds replace EFB uplinked or AOC uplinked speeds.

If performance data changes:

- existing speeds are replaced with dashes
- V speeds are removed from the PFD
- amber PFD speed tape message NO V SPD displays
- CDU help window message TAKEOFF SPEEDS DELETED displays.

8 Gross Weight (GR WT), Takeoff Gross Weight (TOGW)

GR WT displays airplane gross weight from the PERF INIT page.

TOGW—entry of a TOGW followed by selection of the <REQUEST prompt transmits a request for an uplink of new takeoff data based on the entered TOGW.

Valid entry is any weight within the allowable airplane takeoff gross weight range.

Entry of a TOGW after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window message TAKEOFF SPEEDS DELETED.

A takeoff uplink displays the uplinked TOGW and associated V speeds.

9 Thrust Limit (THRUST LIM)

Select—displays the THRUST LIM page.

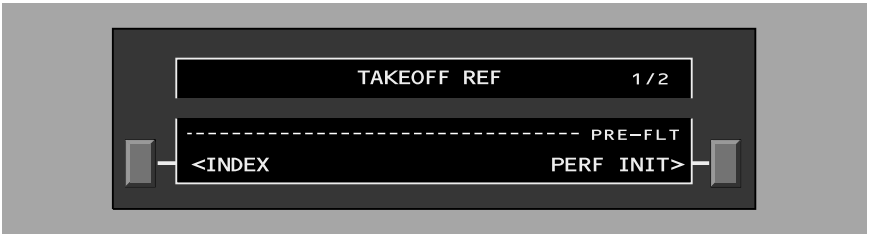
10 REJECT

Select—rejects the takeoff data uplink and returns the REQUEST prompt.

11 ACCEPT

Select—accepts the uplink takeoff data; all pending uplink values are treated as if entered by the flight crew.

Preflight Status



If the required preflight entries are not complete, the words PRE–FLT display on the right side of the dashed line. Preflight pages requiring entries display below the dashed line as prompts.

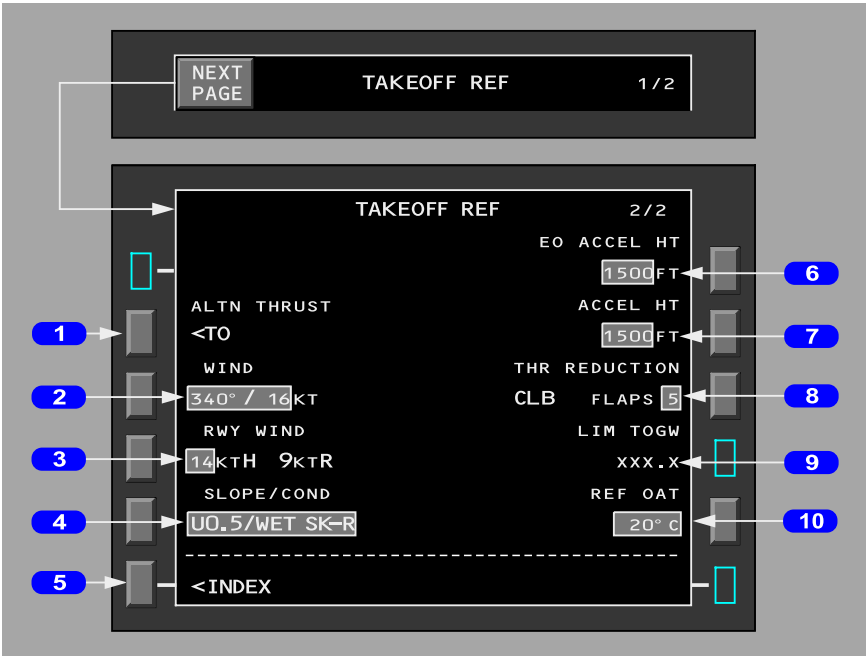


When preflight entries are complete, the line 6 header displays FMC PREFLIGHT COMPLETE in white letters on a green background. The THRUST LIM prompt displays at LSK 6R. The line 6 header FMC PREFLIGHT COMPLETE is also displayed on the PERF INIT and THRUST LIM pages.

Takeoff Reference Page 2/2

TAKEOFF REF 2/2 provides additional takeoff data and the ability to modify the climb profile. Preflight entries are required on page 2 before page 1 can be completed. Data may be entered by the aircrew or uplinked from either the company or EFB.

Note: Acceleration/thrust reduction heights (corrected for barometric pressure) are added to airport elevation causing acceleration/thrust reduction at the desired MSL altitude. For example, for an airport elevation of 980 feet, an entry of 2020 ACCEL HT causes acceleration at 3,000 feet MSL altitude.



1 Alternate Thrust (ALTN THRUST)

Display is active if a TAKEOFF REF uplink has been accepted which includes alternate thrust data.

Line title may display:

- ALTN THRUST
- ALTN THR/FLAPS.

Data may display temperature and:

- TO, TO/FLAPS
- TO 1, TO 1/FLAPS
- TO 2, TO 2/FLAPS
- yy° TO x (assumed temperature), yy° TO x/FLAPS.

Select (with data on the line)—selects alternate thrust or alternate thrust/flaps for takeoff resulting in:

- the line title displays STD THRUST or STD THR/FLAPS
- the ACCEPT/REJECT prompt displays on the TAKEOFF REF page 1/2
- new takeoff data displays
- the EICAS •FMC message displays

- the CDU help window message TAKEOFF DATA LOADED displays.

2 WIND

Displays uplinked surface wind direction and speed.

Wind direction and speed can be entered by the flight crew or uplink.

Valid directions are from 0º to 360º. (0º and 360º are shown as 000º).

Valid speeds are from 0 to 250 knots.

Subsequent entries may be wind direction or speed only.

Entry of wind direction/speed results in calculation and display of RWY WIND.

Entry or uplink of a value after takeoff speeds have been accepted deletes takeoff speeds and displays the CDU help window message TAKEOFF SPEEDS DELETED.

3 Runway Wind (RWY WIND)

Displays the calculated headwind/tailwind and crosswind components for the takeoff runway and surface wind.

Calculated values display in small font.

Speed displays in knots and:

- H for headwind
- T for tailwind
- R for right crosswind
- L for left crosswind.

Flight crew entry is limited to headwind/tailwind entry.

Valid flight crew entries are a two digit number followed by H or T.

Flight crew speed entry without a letter defaults to a headwind component.

A flight crew entry clears the WIND line.

Entry results in display of the CDU help window message TAKEOFF SPEEDS DELETED.

4 Slope/Condition (SLOPE/COND)

Displays flight crew entered or uplinked data entry.

Valid runway slope entries are 1 or 2 digit numbers between 0.0 through 2.0 in percent gradient. Slope entries may be proceeded by U (for uphill) or D (for downhill). Entries without a U or a D are assumed to be uphill.

Valid runway condition is “D” or “DRY” for dry, “W” or “WET” for wet or “S” or “WET SK-R” for a wet skid resistant runway.

Entry of a value displays the CDU help window message TAKEOFF SPEEDS DELETED.

5 INDEX

Select—displays the INIT/REF INDEX page.

6 Engine Out Acceleration Height (EO ACCEL HT)

Displays the altitude above airport (height above airport, corrected for temperature and barometric setting) where acceleration will start for flap retraction with an engine out.

Default value is from the airline policy file.

Value can be entered manually or accepted as part of a takeoff uplink.

Valid entry is a height from 400 to 9999 feet.

The FMC adds airport elevation to entered EO ACCEL HT causing acceleration at an MSL altitude. For example, with an airport elevation of 980 feet, an entry of 2020 EO ACCEL HT causes acceleration at 3,000 feet MSL altitude.

7 Acceleration Height (ACCEL HT)

Displays the altitude above airport (height above airport, corrected for temperature and barometric setting) where acceleration will start for flap retraction.

Default value is from the airline policy file.

Value can be entered manually or accepted as part of a takeoff uplink.

Entry is optional. Valid entry is a height from 400 to 9999 feet.

The FMC adds airport elevation to entered ACCEL HT causing acceleration at an MSL altitude. For example, with an airport elevation of 980 feet, an entry of 2020 ACCEL HT causes acceleration at 3,000 feet MSL altitude.

8 Climb Thrust and Thrust Reduction (THR REDUCTION) Point

Displays armed climb thrust rating and the altitude above airport (height above airport, corrected for temperature and barometric setting) or flap setting where reduction from takeoff thrust to climb thrust will begin.

Default value is from the airline policy file.

Value can be entered manually or accepted as part of a takeoff uplink.

Entry is optional. Valid entries are 1 for flaps 1, 5 for flaps 5, or a height from 400 to 9999 feet.

The FMC adds airport elevation to entered THR REDUCTION causing thrust reduction at an MSL altitude; for example:

- with an airport elevation of 980 feet, a THR REDUCTION entry of 1020 causes thrust reduction at 2,000 feet MSL altitude, or
- 1 for flaps 1 or 5 for flaps 5 (entry of 5 when FLAPS 5 is specified as the takeoff flap setting displays the CDU help window message INVALID ENTRY).

If a manual entry creates a situation in which thrust reduction and takeoff flaps are the same, the takeoff flap entry is automatically deleted and the CDU help window message TAKEOFF FLAPS DELETED is displayed.

9 Limit Takeoff Gross Weight (LIM TOGW)

Displays takeoff gross weight limit for the uplinked data. Manual entry not allowed.

Prefix ALTN or STD is added to line title when alternate or standard takeoff data is pending.

Display is blank if no uplink data is pending or accepted.

10 Reference Outside Air Temperature (REF OAT)

A temperature value entered in this field is downlinked with other takeoff data if the takeoff data <REQUEST prompt on TAKEOFF REF 1/2 is selected.

Crew entry results in display of the CDU help window message TAKEOFF SPEEDS DELETED.

Displays flight crew entered or uplinked data entry.

Valid entries are –54 deg. C to 99 deg. C or –65 deg. F to 199 deg. F.

Entry is optional for preflight completion.

Introduction

The FMC takeoff phase starts with the selection of takeoff/go-around (TO/GA). Preparation for this phase starts in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase changes to the climb phase when the FMC commands climb thrust. The climb phase continues to the top of climb point, where the cruise phase starts.

During takeoff and climb, the specific page listed below is used to:

- TAKEOFF REF page—make last minute changes to the departure runway
- DEPARTURES page—make last minute changes to the SID
- CLIMB page—modify climb parameters and monitor airplane climb performance
- RTE X LEGS page—modify the route and monitor route progress
- PROGRESS page—monitor the overall progress of the flight
- THRUST LIM page—select alternate climb thrust limits
- DEP/ARR INDEX page—select an approach during a turn-back.

Takeoff

When changes are made to the departure runway and SID, the TAKEOFF REF and DEPARTURES pages must be modified to agree. The modified data are entered the same as during preflight.

With correct takeoff parameters, the FMC commands the selected takeoff thrust when the TO/GA switch is pushed. During the takeoff roll, the autothrottle commands the thrust and the FMC sets target speed to between V2 + 15 and V2 + 25 knots.

Usually, LNAV and VNAV are armed before takeoff. When armed before takeoff, LNAV activates at 50 feet radio altitude and commands roll to fly the active route leg. VNAV activates at 400 feet above runway elevation and commands pitch to fly the climb profile.

Climb

At acceleration height or altitude capture below acceleration height, VNAV commands acceleration to a speed 5 knots below the flap placard speed for the existing flap setting. When flaps are retracted, VNAV commands the speed displayed on the SPD TRANS line.

At the climb thrust reduction point, the FMC commands a reduction to the armed climb thrust. Passing the transition altitude displayed on the SPD TRANS line, VNAV commands an acceleration to the economy climb speed, which is

maintained until entering the cruise phase. Waypoint speed constraints take priority, provided they are greater than transition speed or flaps up maneuver speed.

During the climb, VNAV complies with the LEGS page waypoint altitude and speed constraints. A temporary level–off for a crossing altitude restriction is accomplished at the commanded speed. The commanded speed is magenta.

When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, the FMC displays the CDU help window message UNABLE NEXT ALTITUDE. A different speed profile that gives a steeper climb angle must be manually selected.

Altitude Intervention

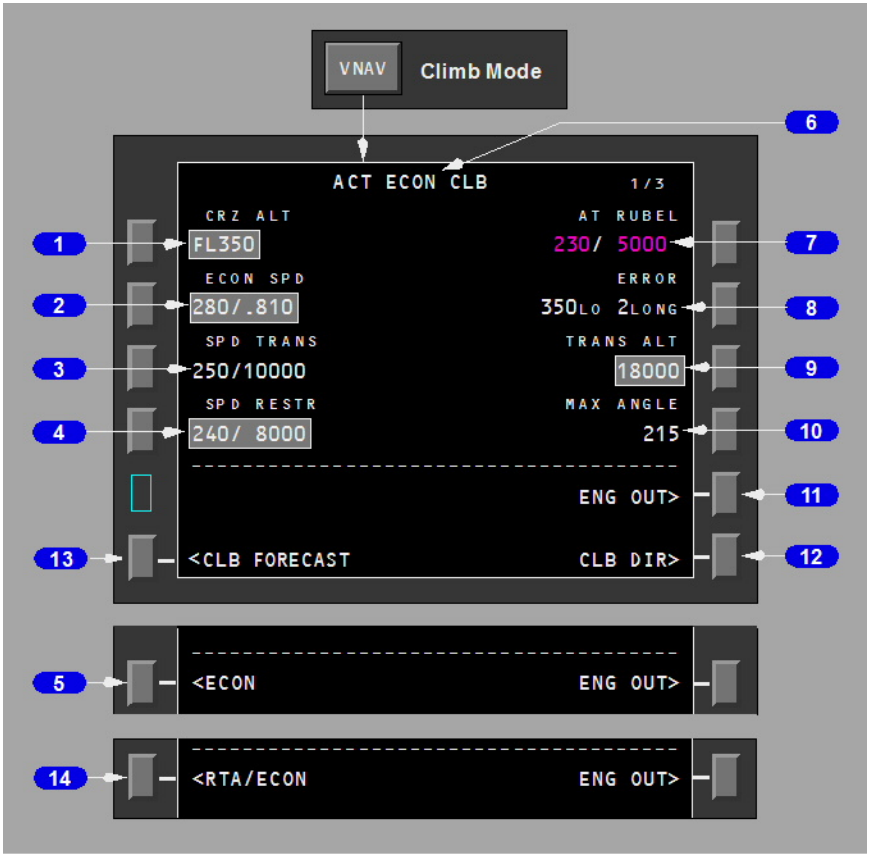
If an unplanned level-off is required, setting the altitude window to the required altitude causes the airplane to level at the set altitude. VNAV SPD changes to VNAV ALT. The climb can be continued by setting the altitude window to a higher altitude and pushing the altitude selector. If the altitude window is set to an altitude above other altitude constraints, each altitude constraint can be deleted by each push of the altitude selector. If cruise altitude is set in the altitude window, all waypoint altitude climb constraints to the T/C can be deleted by selection of the CLB DIR> prompt on the CLB page.

Climb Page

The climb page is used to evaluate, monitor, and modify the climb path. The data on the climb page comes from preflight entries made on the route and performance pages, and from the airline policy file.

The climb page is the first of the three pages selected with the VNAV function key. When the FMC changes to the cruise mode, the climb page data is blanked.

FMC command climb speed can be economy, select, engine out, or RTA.



1 Cruise Altitude (CRZ ALT)

Displays cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, or FLXXX. Altitude displays in feet or flight level depending on transition altitude.

The altitude can be changed by two methods:

- a new cruise altitude can be manually entered from the CDU at any time. The modified cruise altitude displays in shaded white until executed
- a new cruise altitude can be entered from the MCP, if intermediate altitude constraints do not exist between the airplane altitude and the MCP altitude. Set cruise altitude in the altitude window and push the altitude selector. The cruise altitude changes without modification or execution.

2 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

ECON SPD:

- speed based on cost index in CAS or Mach
- used by FMC at altitudes above all waypoint speed constraints, speed restrictions, and speed transition altitudes.

Valid entries are CAS or Mach.

SEL SPD:

- displays when intermediate level off required below an existing speed constraint
- displays when flight crew enters speed.

Valid entries are CAS or Mach.

RTA SPD - displays when an RTA is active.

The FMC commanded speed is magenta. Below CAS/Mach transition altitude, CAS is magenta and Mach is white. Above CAS/Mach transition altitude, Mach is magenta and CAS is white.

3 Speed Transition (SPD TRANS)

The speed transition line displays the transition speed/altitude from one of these sources:

- the navigation database value for the origin airport
- the value specified from the airline policy page
- the greater of the transition speed associated with the origin airport or flaps up maneuver speed (example 250/10000).

Magenta when it is FMC command speed.

Not displayed above transition.

Can be deleted.

4 Speed Restriction (SPD RESTR)

Speed restrictions for an altitude less than the cruise altitude are manually entered on this line.

Dashes before entry by flight crew.

Valid entry is a CAS and altitude (example 240/8000).

An entry creates a modification. Entry is shaded white until executed; magenta when it is FMC command speed.

5 Economy (ECON)

Select—changes climb speed to ECON. Must be executed.

Prompt displays when the climb speed is not ECON.

6 Page Title

The page title displays the type of climb:

- ECON—speed based on a cost index
- LIM SPD—speed based on airplane configuration limiting speed
- MCP SPD—MCP speed intervention selected
- EO—engine out mode selected
- XXXKT—fixed CAS climb speed profile or when engine failure detected
  XXX is flaps up maneuver speed
- M.XXX—fixed Mach climb speed profile
- ACT—displays prefix when climb phase active
- MOD—displays prefix in shaded white text when a modification is pending.

Fixed climb speeds are for:

- takeoff/climb acceleration segment constraints
- waypoint speed constraints
- a speed constraint associated with an altitude
- a speed transition
- a flight crew selected speed (SEL SPD).

7 Waypoint Constraint (AT XXXXX)

Displays altitude or airspeed/altitude constraint at waypoint XXXXX.

Can also display HOLD AT XXXXX followed by a speed/altitude constraint.

FMC commands the slower of constraint speed or performance speed.

Constraints are entered on RTE LEGS page.

Delete here or on RTE LEGS page.

Blank if no constraint exists.

Magenta when it is FMC command speed or altitude.

8 ERROR at Waypoint

Displays altitude discrepancy and distance past waypoint where altitude will be reached.

Blank if no error exists.

9 Transition Altitude (TRANS ALT)

Transition altitude for origin airport contained in navigation database. FMC uses 18,000 feet if transition altitude is not available.

Manually change transition altitude here or on DESCENT FORECAST page.

Valid entries are XXX, XXXX, XXXXX, or FLXXX.

CDU altitude data change from altitudes to flight levels above the transition altitude.

10 Maximum Angle (MAX ANGLE)

Displays maximum angle of climb speed.

Select—displays speed in the scratchpad for pilot selection to the speed line.

11 Engine Out (ENG OUT)

Select (below speed transition or restriction altitude)—

- displays MOD EO CLB page
- deletes climb speed transition or restriction data.

Select (below engine-out maximum altitude)—displays MOD EO CLB page.

Select (above engine-out maximum altitude)—

- displays MOD EO D/D or MOD EO LRC D/D page
- cruise altitude (1L) lowered to engine-out maximum altitude if that altitude is less than the active cruise altitude.

Shaded white until the modification executed. Upon execution, thrust reference limit becomes CON in all cases above.

12 Climb Direct (CLB DIR)

Displays when climb altitude constraint exists between current altitude and FMC cruise altitude.

Select—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.

13 Climb (CLB) Forecast

Select—displays CLIMB FORECAST page.

14 Required Time Of Arrival (RTA) /Economy (ECON)

RTA

- Select—activates RTA speed. Displays ECON prompt.
- Displays when an RTA waypoint has been entered and ECON is the active climb speed.

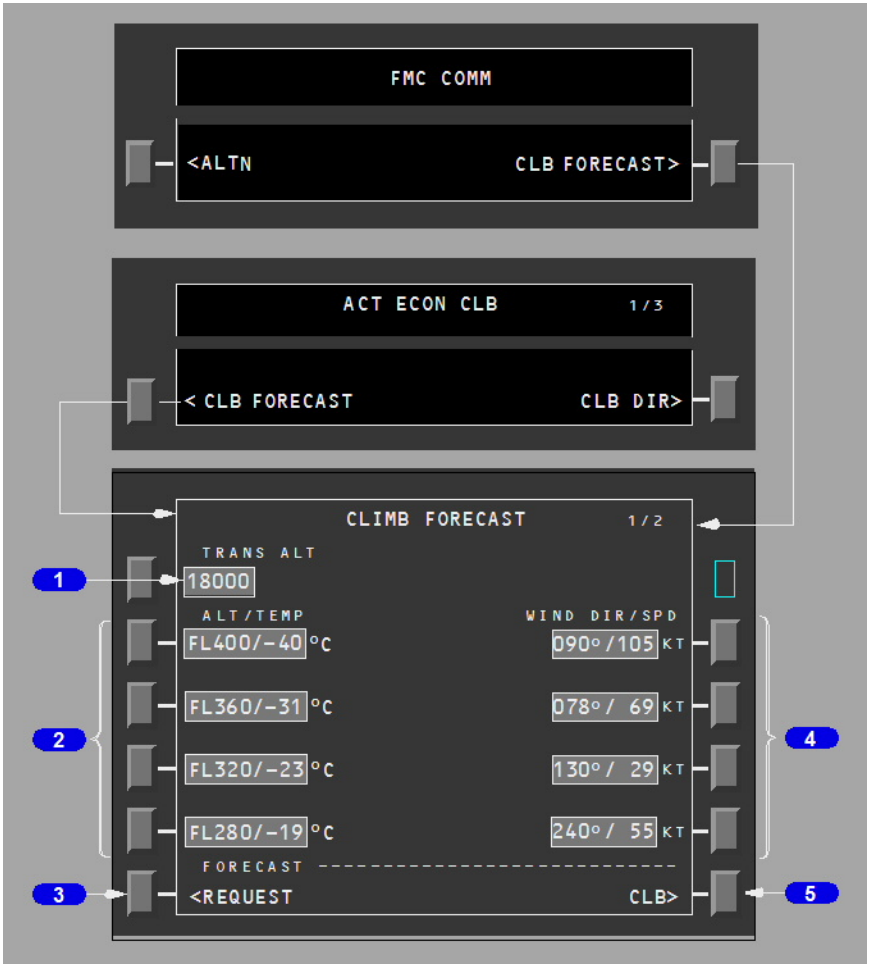
RTA/ECON

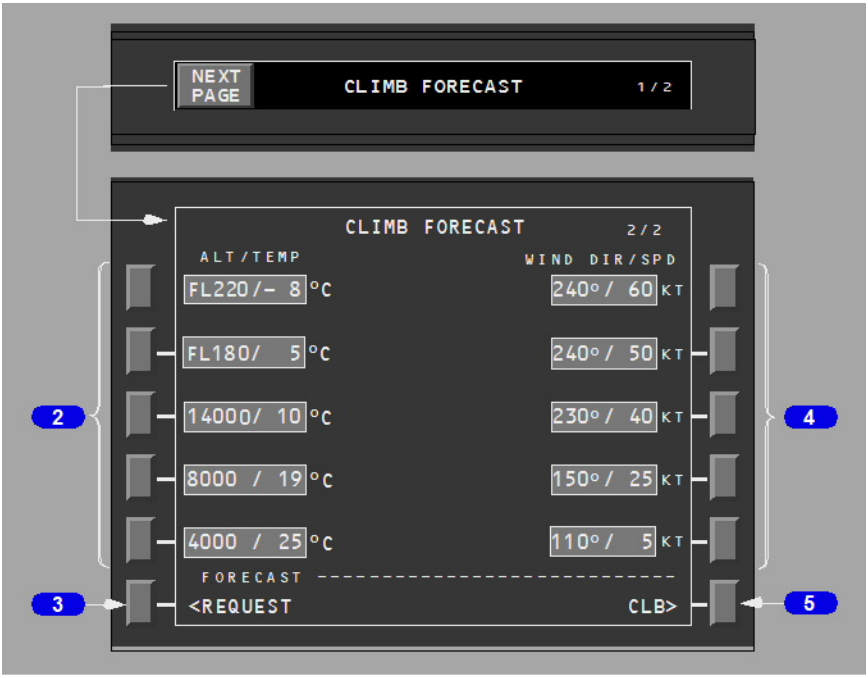
- Select—activates RTA speed.
- Displays when an RTA waypoint has been entered and SEL SPD is the active climb speed.

Climb Forecast Page

The climb forecast pages are used to enter wind data for climb.

Entries are wind direction/speed, and temperature for up to nine altitudes.





1 Transition Altitude (TRANS ALT)

Displays the entered transition altitude, or it may be shown when a TRANS ALT is associated with a Standard Instrument Departure procedure.

The default transition altitude is FL180.

Above transition altitude, altitudes are in flight levels. Below transition altitude, altitudes are in thousands of feet.

Valid entry is an altitude or flight level.

2 Altitude/Temperature (ALT/TEMP)

Displays entered or uplinked altitudes and temperatures in large font.

Temperatures are interpolated between altitudes when shown in small font.

3 FORECAST REQUEST/LOAD

Select—REQUEST or LOAD.

REQUEST—sends a downlink request for climb forecast.

LOAD—loads climb forecast and initiates a downlink response.

4 Wind Direction/Speed (WIND DIR/SPD)

Displays entered or uplinked wind direction and speed in large font.

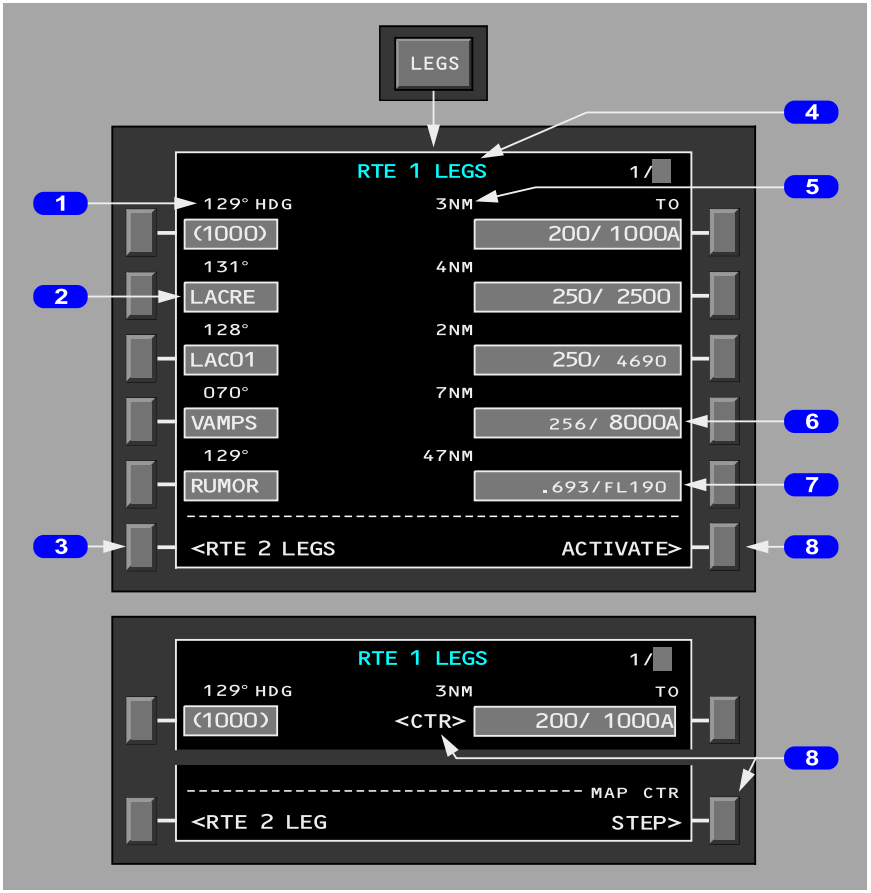
5 Climb (CLB)/PURGE

Select—CLB or PURGE.

CLB—shows VNAV CLB page.

PURGE—clears the pending climb forecast status and initiates a downlink response.

RTE X LEGS Page



1 Leg Direction

Leg segment data in line title:

- courses—magnetic (xxx°) or true (xxx° T)
- arcs—arc radius in miles, ARC, turn direction (example: 24 ARC L)
- heading leg segments—xxx° HDG or xxx° THDG (when referenced to true north)
- track leg segments—xxx° TRK or xxx° TTRK (when referenced to true north)
- special procedural instructions from database—HOLD AT, PROC TURN, or PROC HOLD (FMC exits hold when crossing the fix after entry).

Calculated great circle route leg directions may be different than chart values.

Dashes display for an undefined course.

2 Waypoint Identifier

Active leg is always the first line of the first active RTE X LEGS page.

Active waypoint is on active leg and is magenta. Modified waypoints are shaded white until executed.

All route waypoints display in flight sequence. Waypoints on an airway are included on the route legs page.

Waypoints can be modified. Examples:

- add waypoints
- delete waypoints
- change waypoint sequence
- connect route discontinuities.

Displays the waypoint by name or condition.

Boxes display for route discontinuities.

Dashes display after the end of the route.

3 Route 2 Legs (RTE 2 LEGS)

Select—

- displays the RTE 2 LEGS
- when RTE 2 LEGS page displayed, prompt changes to RTE 1 LEGS.

4 Page Title

Title format displays route status:

- RTE X LEGS (cyan)—inactive route
- ACT RTE X LEGS (white)—active route
- MOD (shaded white) RTE X LEGS (white)—modified active route.

5 Distance to Waypoint

Distance (decreasing) from airplane to active waypoint or from waypoint to waypoint. Blank for some leg types (e.g. HDG or VECTORS).

6 Waypoint Speed/Altitude Constraints

Waypoint speed or altitude constraints display in large font.

FMC predictions display in small font.

Manual entry allowed in climb, cruise or descent phase. Entered by FMC when constraints are part of a procedure.

Magenta when it is an FMC commanded speed/altitude. Airspeed constraint may be magenta in one line with magenta altitude in another line.

Speed constraint is assumed to be at or below the displayed speed.

Valid entries are:

- speed entry can be airspeed or Mach (XXX/, .84/)
- altitude entry can be thousands of feet or flight level (19000, FL190)
- XXX/XXXXX—airspeed/altitude entered simultaneously
- XXX, XXXX, XXXXX or /XXX, /XXXX, /XXXXX—altitude only
- enter FL190 or 19,000 feet as 190 or 19000. Enter FL090 or 9,000 feet as 090 or 9000. Enter 900 feet as 009 or 0900. Enter 90 feet as 0090.

Altitude constraint suffixes:

- blank—cross at altitude
- A—cross at or above altitude
- B—cross at or below altitude
- both—altitude block. If constraint is to cross between two altitudes enter lower altitude followed by “A” and higher altitude followed by “B”. Example: 220A240B or 240B220A. Altitudes can be entered in any order
- S—planned step climb. (See Planned Step Climb on page 11.42.28.)

7 Waypoint Speed/Altitude Predictions

Waypoint speed and altitude predictions display in small font.

Dashes display in predicted descent region prior to descent path calculation. Descent path calculation requires an altitude constraint below cruise altitude.

Manual entry allowed in climb or descent phase.

8 ACTIVATE, Route (RTE) DATA

Select—

- ACTIVATE—activates inactive flight plan; displays RTE DATA prompt
- RTE DATA—displays route data page

- MAP CTR STEP (map center step)– changes centered waypoint on ND. <CTR> is adjacent centered waypoint on the RTE LEGS page.

ACTIVATE prompt displays when RTE and RTE LEGS flight plan is inactive.

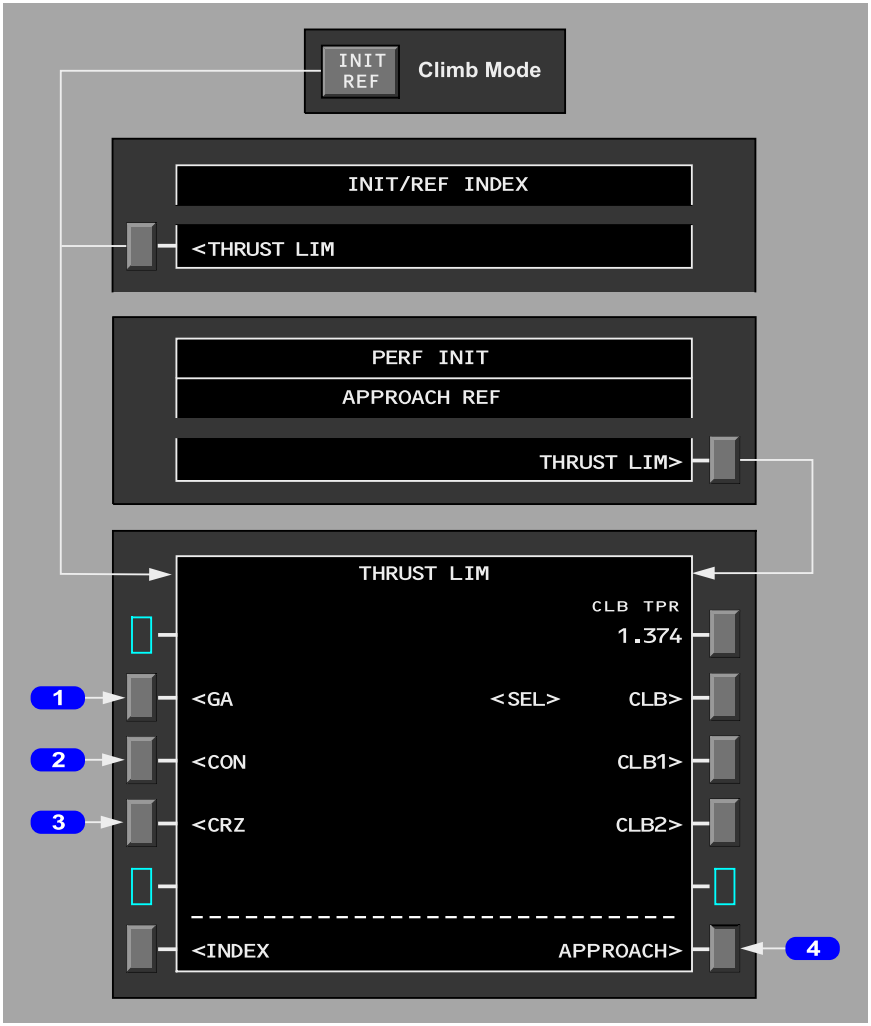
RTE DATA displays after ACTIVATE prompt selected.

MAP CTR STEP prompt displays when the PLAN is selected on the map display.

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)

Select—selects go–around thrust limit.

2 Continuous (CON)

Select—selects maximum continuous thrust limit.

3 Cruise (CRZ)

Select—selects cruise thrust limit.

4 APPROACH

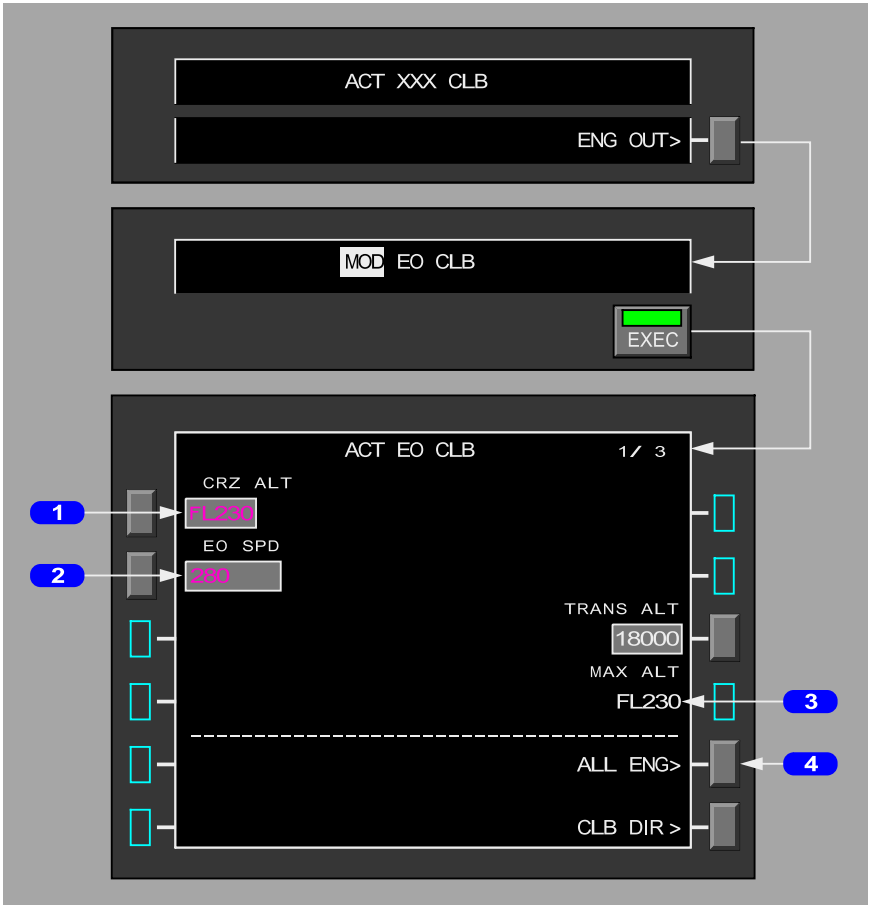
Select—displays APPROACH REF page.

Engine Out Climb

Engine out (EO) VNAV climb guidance is available on the EO CLB page. The EO CLB page must be selected and executed by the flight crew. Engine out data is available with both engines operating. The engine out climb phase changes to the engine out cruise phase at the top of climb.

EO CLB Page

The modified page displays engine out performance limitations. Manual entries are allowed. After execution, VNAV gives EO guidance in the climb and reference thrust limit changes to CON.



1 Cruise Altitude (CRZ ALT)

Displays cruise altitude if less than MAX ALT.

Displays MAX ALT if less than cruise altitude.

Manual entry is allowed.

2 Engine Out Speed (EO SPD)

Displays engine out climb speed.

Valid entry is XXX for CAS.

Valid entry is 0.XXX for Mach. Trailing zeros can be omitted.

A manual entry may cause MAX ALT to change.

3 Maximum Altitude (MAX ALT)

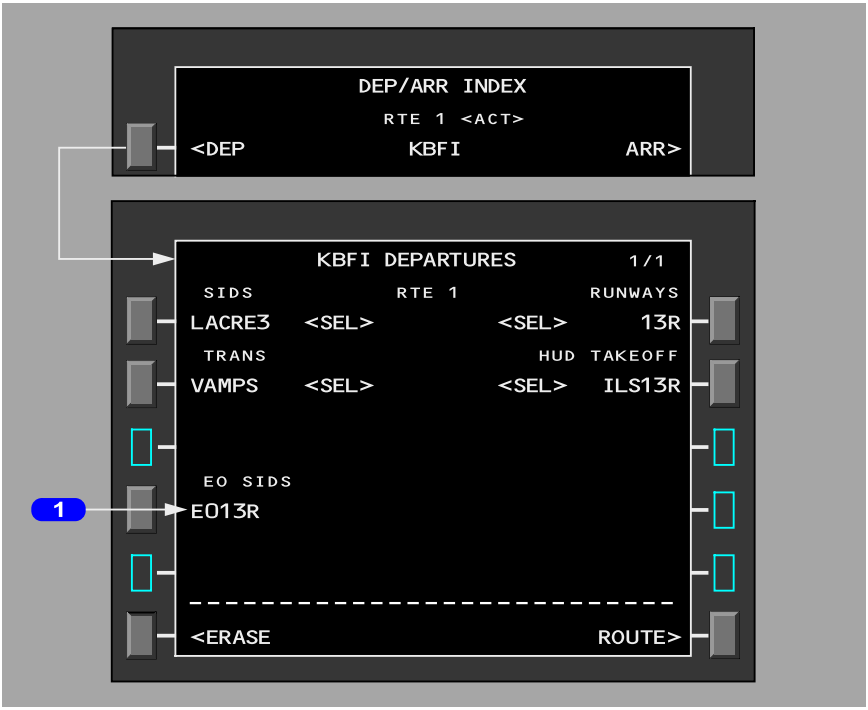
Displays lower of maximum altitude at engine out climb speed or cruise speed.

Entry not allowed.

4 ALL ENG

Select—modifies page to display all engine (ALL ENG) performance data.

Engine Out Departure



1 Engine Out Standard Instrument Departure (EO SID)

Engine out SIDs can be created by the airline for specific runways.

The FMC puts the EO SID into the route as a modification if:

- an engine failure is sensed
- flaps extended
- and the navigation database has an EO SID for the departure runway.

The modification can be executed or erased.

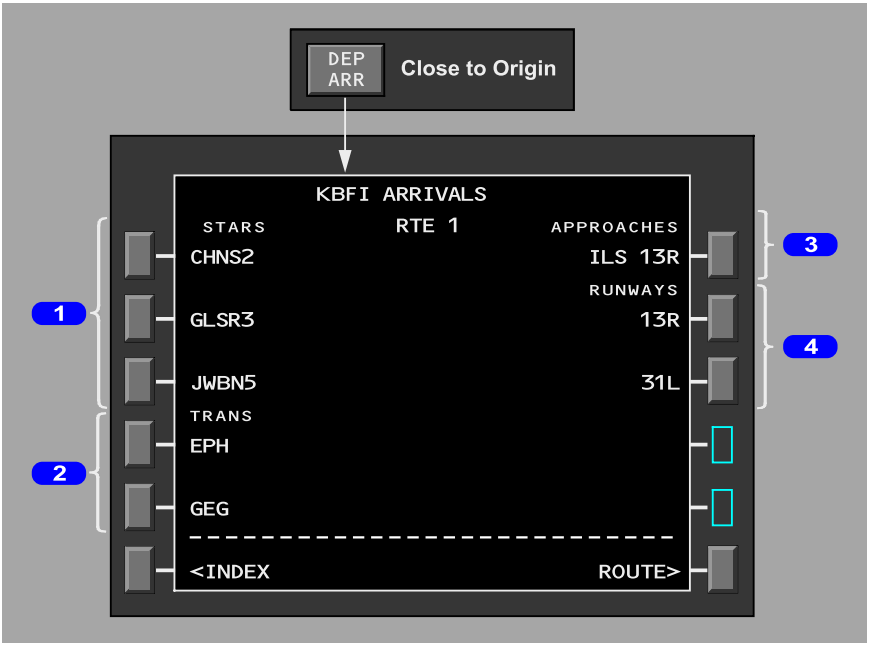
-NONE- is displayed if no EO SID exists.

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, select the DEP ARR function key to show the ARRIVALS page for the origin airport.



1 STARS

Displays STARS for origin airport.

2 Transitions (TRANS)

Displays transitions for origin airport.

3 APPROACHES

Displays approaches for origin airport.

4 RUNWAYS

Displays runways for origin airport.

Introduction

The cruise phase starts at the top of climb.

During cruise, the primary FMC pages are:

- RTE X LEGS
- CRZ
- PROGRESS.

The RTE LEGS pages are used to modify the route. The CRZ pages display VNAV related data. The PROGRESS pages display flight progress data. During cruise, the specific page listed below is used to:

- POS REF page—verify the FMC position
- RTE DATA page—display progress data for each waypoint on the RTE LEGS page
- WINDS page—enter forecast wind and temperature
- REF NAV DATA page—display data about waypoints, navaids, airports, or runways, and can be used to inhibit navaids
- RTE X page—use to select a route offset
- FIX INFO page—display data about waypoints. Page data can be transferred to other pages to create new waypoints and fixes
- SELECT DESIRED WAYPOINT page—shows a list of duplicate waypoints from the navigation database. The flight crew selects the correct waypoint from the list
- POS REPORT page—display data for a position report.

The CLB page changes to CRZ at the top of climb. The CRZ CLB and CRZ DES pages change to CRZ at the new cruise altitude. The CRZ page changes to DES at top of descent.

LNAV Modifications

This section describes typical techniques to modify the route. The modifications include:

- add and delete waypoints
- change waypoint's sequence
- remove discontinuities
- intercept a course.

RTE LEGS Page Modifications

When modifications are made to a RTE LEGS page, several prompt or identifying features help the flight crew make the modifications, such as:

- ERASE

- INTC CRS TO
- INTC CRS FROM.

Modified entries display in shaded white.

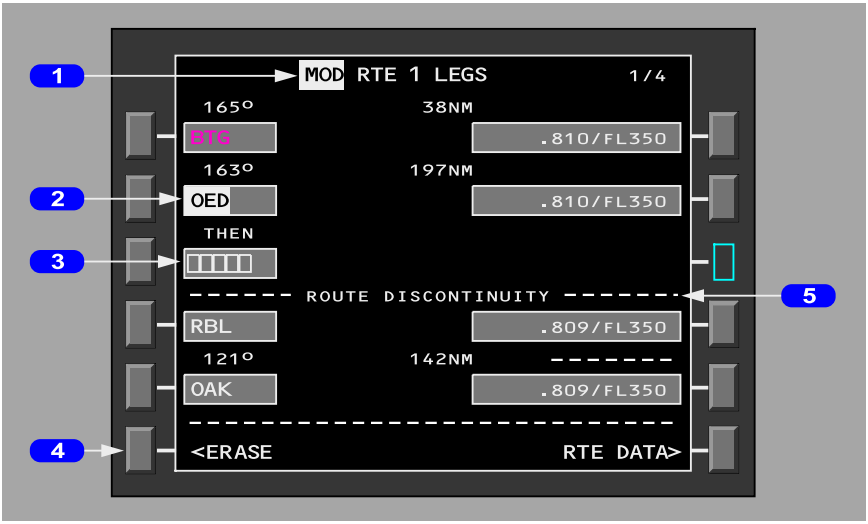
Add Waypoints

Waypoints can be added to the route at any point. Added waypoints are followed by route discontinuities.

First, enter the waypoint name in the scratchpad.

Second, locate the desired line in the flight plan and select the adjacent line select key. The scratchpad waypoint name is put into the selected line. The entered waypoint is connected to the waypoint above it via a direct route. A route discontinuity follows the waypoint.

For example, OED is typed into the scratchpad. Select line select key 2L to put OED into line 2. The FMC assumes BTG direct OED. RBL and the rest of the flight plan follow the route discontinuity.



1 Page Title

MOD (shaded white)—replaces ACT when modification in progress.

ACT (white)—replaces MOD when ERASE selected or execute key selected.

2 Modified Waypoint

Waypoint name is shaded white until executed.

OED waypoint entered into the route after BTG. Modification creates a route discontinuity because OED was not in active route. The FMC now requires routing beyond OED.

3 Discontinuity Waypoint

Discontinuity is removed when applicable waypoint is entered in boxes.

4 ERASE

Select—removes all modifications and shows active data.

Displays when the FMC contains modified data.

Removed when selected or modifications executed.

5 ROUTE DISCONTINUITY

Line title separates route segments when there is a discontinuity.

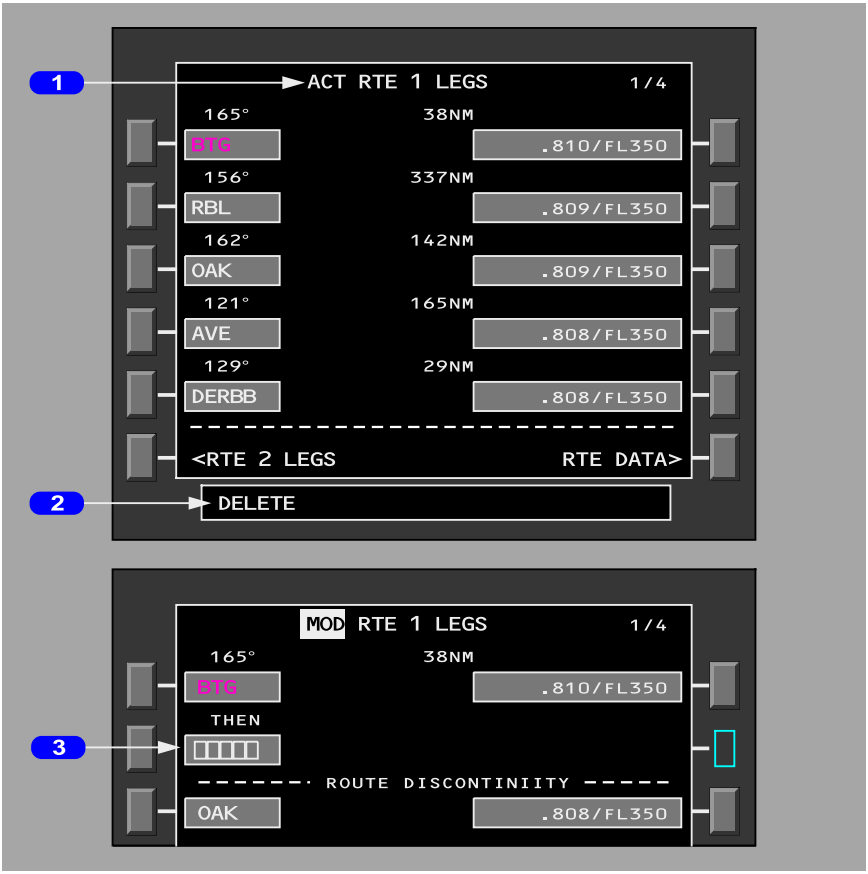
Note: Performance predictions to destination on the PROGRESS page are calculated assuming the route of flight is direct between waypoints on either side of a route discontinuity.

Delete Waypoints

Use the RTE LEGS page to remove waypoints from the route. The active waypoint can not be deleted. Two methods to remove a waypoint are:

- change the waypoint's sequence
- delete the waypoint with the DELETE function key.

The data in the route before and after the deleted waypoint does not change. A discontinuity is put in the route when the DELETE function key is used to remove a waypoint.



1 Active Route

The active route shows RBL followed by OAK and AVE.

2 DELETE Entry

Selecting the DEL function key arms the delete function and selects DELETE to the scratchpad.

3 Route Discontinuity

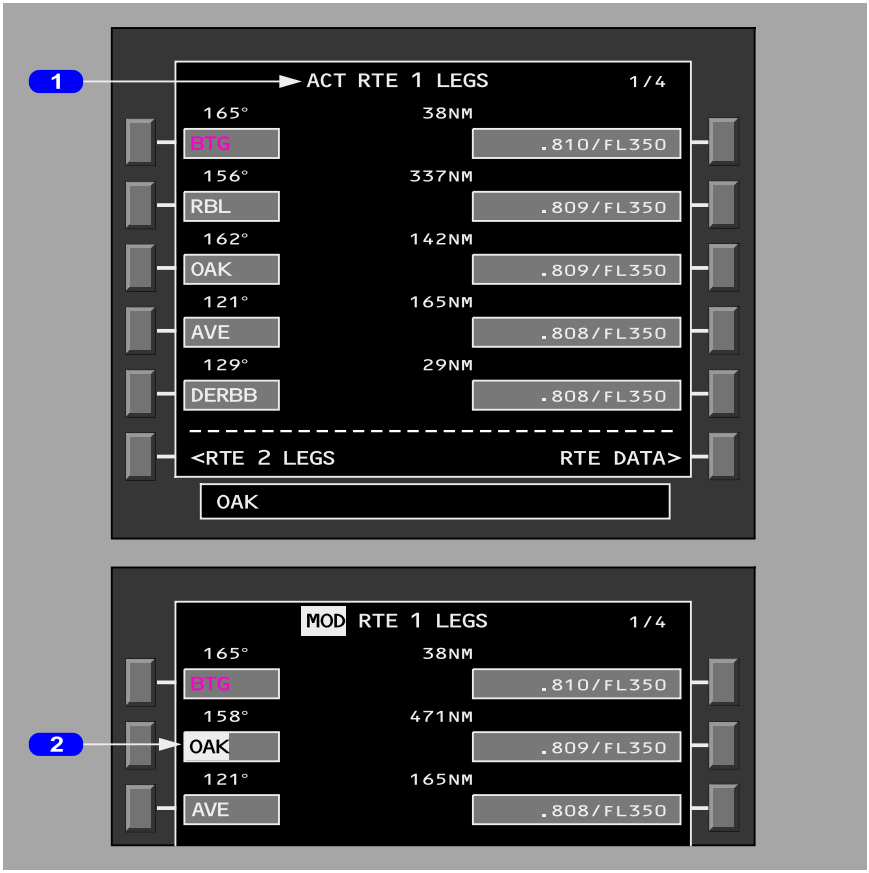
With DELETE in the scratchpad, selecting the line select key for RBL deletes the waypoint. Boxes replace RBL and a route discontinuity displays.

Change Waypoint Sequence

Waypoints moved from one position in the flight plan to another do not cause route discontinuities.

The waypoint may be typed in the scratchpad or copied from the flight plan. To copy a waypoint from the flight plan, find the applicable waypoint on one of the RTE LEGS pages. Select the line select key adjacent to the waypoint.

The example below shows the flight plan being modified to fly from BTG direct OAK. Select the line select key adjacent to OAK to put OAK in the scratchpad. Select the line select key adjacent to RBL. RBL is removed from the flight plan and the routing is direct from BTG to OAK to AVE. The modification does not cause a route discontinuity. Several waypoints can be removed from the flight plan at a time with this method.



1 Active Route

The active route shows RBL followed by OAK and AVE. The clearance is to fly from BTG direct OAK. The OAK waypoint is selected to the scratchpad.

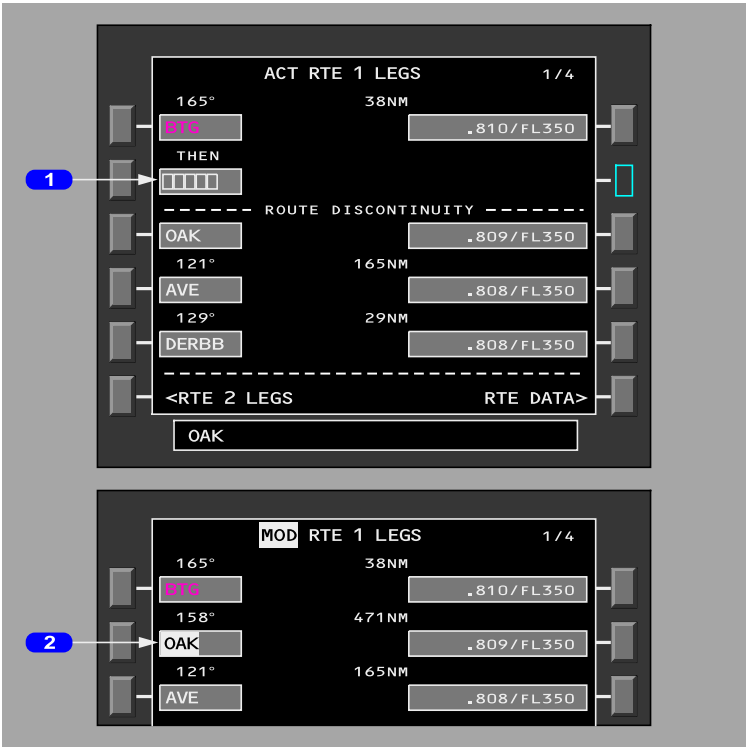
2 Change OAK's Sequence

OAK is selected to the waypoint after BTG. RBL is removed with no discontinuity.

Remove Discontinuities

A discontinuity exists when two waypoints are not connected by a route segment. Connect a route segment after the discontinuity to the route segment before the discontinuity to remove the discontinuity.

Copy the subsequent waypoint from the route into the scratchpad and enter it into the discontinuity, just as when adding a waypoint.



1 Route Discontinuity

The active route has a discontinuity after BTG. The example shows how to fly direct from BTG to OAK. Copy OAK to the scratchpad. Any subsequent waypoint in the route can be selected to the scratchpad to remove the discontinuity.

2 Continuous Route

Select OAK to the boxes to remove the discontinuity.

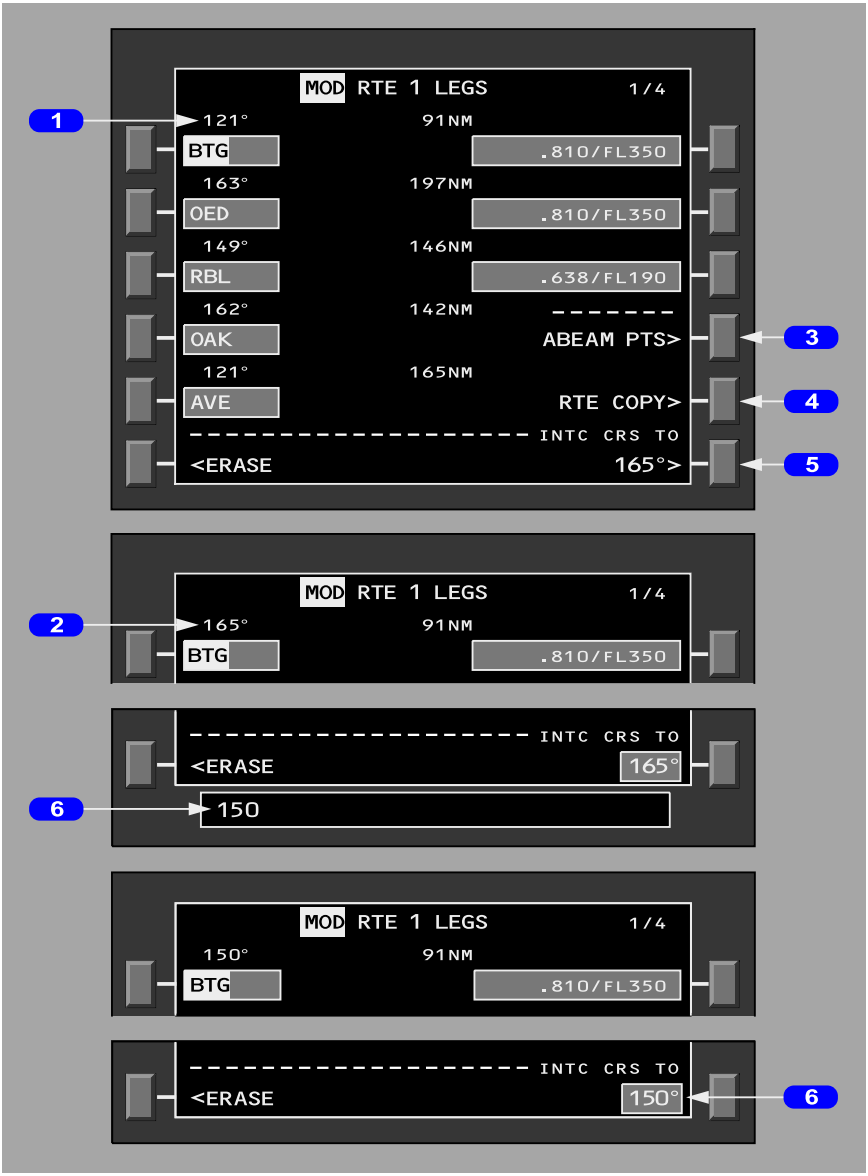
Entering a waypoint in the boxes which does not already exist on the route moves the discontinuity one waypoint further down the route.

Direct To And Intercept Course To

If the airplane passes the last active route waypoint (or offset) or the last waypoint prior to a route discontinuity, LNAV maintains the current heading. The EICAS advisory message FMC INTERCEPT HDG is displayed. If LNAV is not active, activation can be accomplished in the following three ways:

- when the airplane is within 2.5 miles of the active leg and on an intercept heading to the active leg, pushing the LNAV switch activates LNAV. The airplane turns to intercept the active leg. If the intercept angle is large, the airplane may overshoot the active leg
- when more than 2.5 miles from the active leg, pushing the LNAV switch when the airplane is on an intercept heading to the active leg arms LNAV and displays the intercept path on the ND map. Activation occurs as necessary to intercept the active leg with no overshoot. The intercept heading must intersect the active leg inbound before the active waypoint
- fly direct to a waypoint or intercept a course to a waypoint. Enter a waypoint in the RTE LEGS page active waypoint line to fly direct. Use the INTC CRS TO prompt in line 6R to create an intercept course to the waypoint. Pushing the LNAV switch arms or activates LNAV, depending on the distance to the active leg.

The example below depicts the airplane being off course to the right, followed by a modification to fly direct to BTG.



1 Leg Direction

Direct course from airplane present position to entered waypoint.

Execute to proceed direct to active waypoint.

2 Intercept Course

After selecting INTC CRS TO and prior to execution, displays direct–to inbound course at the waypoint; changed by entry in intercept course to (INTC CRS TO) line or by selecting intercept course to. After execution, displays current required track to fly inbound course to the waypoint.

3 Abeam Points (ABEAM PTS)

Select—

- creates place bearing distance waypoint on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a database airport, navaid, NDB, or waypoint
- creates latitude/longitude waypoint on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a latitude/longitude waypoint
- creates a new place bearing distance waypoint based on the original “place” on the Direct To leg abeam the bypassed waypoint if the bypassed waypoint was a place bearing distance waypoint
- creates a new latitude/longitude reporting point on the Direct To leg based on the entered latitude or longitude reporting point
- line title displays ABEAM PTS and line data displays SELECTED
- altitude/speed constraints for bypassed waypoints are removed.

ABEAM PTS prompt displays whenever the active waypoint name is modified, usually for direct–to routing.

Abeam waypoints created from designated position reporting waypoints become position reporting waypoints.

4 Route Copy (RTE COPY)

Select—

- copies the active route into the inactive route
- erases previous inactive route
- line title displays RTE COPY and line data displays COMPLETE
- subsequent route modifications remove RTE COPY prompt.

5 Intercept Course TO (INTC CRS TO)—Select

Displays whenever the active waypoint name is modified.

Displays boxes if entered waypoint not in the active route.

Displays current route course and prompt caret if entered waypoint in the active route.

When boxes displayed, valid entry is intercept course from 000° through 360°. May be changed until executed. Entered or selected value displays in large font.

Select—

- when current route course (165°) displayed, selects it as intercept course to active waypoint
- displays entry or current route course as course to active waypoint
- removes ABEAM PTS and RTE COPY prompts.

6 Intercept Course TO (INTC CRS TO)

To change intercept course:

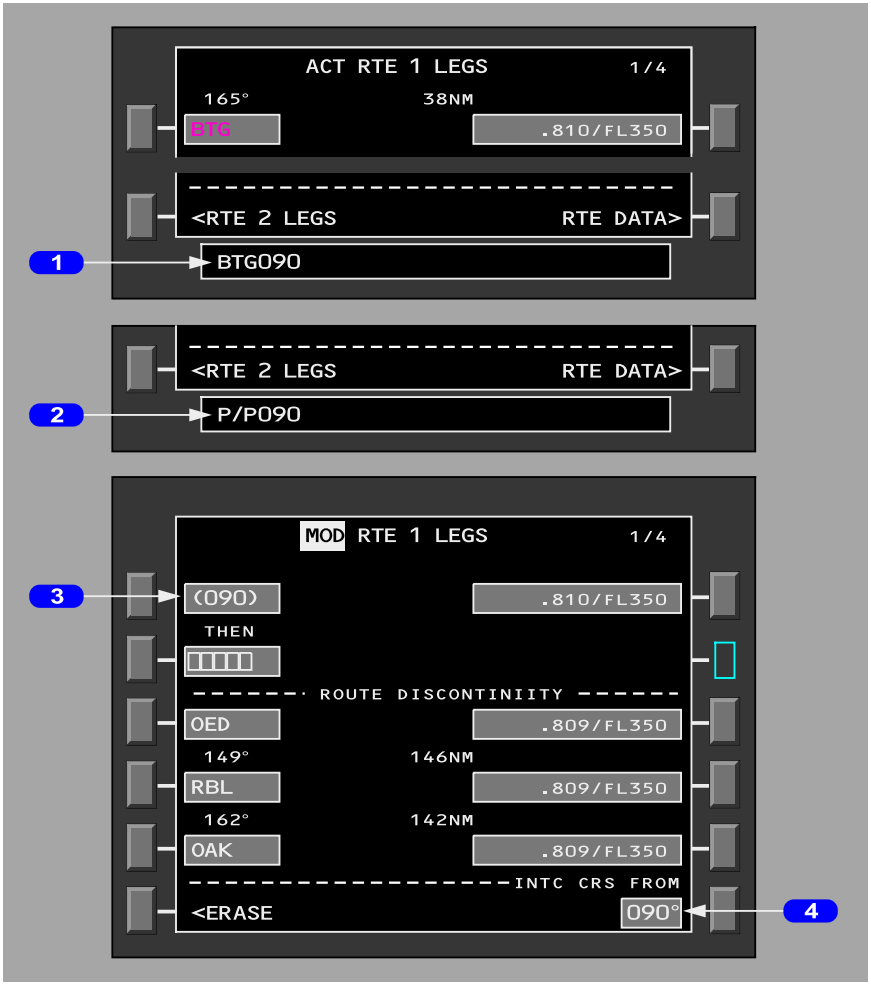
- enter the inbound intercept course (150°) in the scratchpad
- select the INTC CRS TO line to change the leg direction; intercept course to BTG of 150° is entered in the INTC CRS TO line and above the active waypoint.

Intercept Course From

The steps to create an intercept course from a waypoint are like the steps for an intercept course to. The waypoint name in the scratchpad is suffixed with the outbound course.

An intercept course can be created outbound from a waypoint in the navigation database or from present position. The waypoint does not have to be in the route. Entering a waypoint and course pair in the active waypoint line displays the INTC CRS FROM prompt. The FMC calculates a route leg with the waypoint as the origin of the entered course.

The example shows a 090° course from BTG, entered as BTG090. When this course intercept is line selected to the active waypoint line, the course (090°) displays in the leg direction and the waypoint displays as a conditional waypoint consisting of a course intercept (090°).



1 Waypoint and Outbound Course

Enter the waypoint name and outbound course in the scratchpad.

2 Present Position and Outbound Course

Enter P/P and outbound course in the scratchpad.

3 Active Outbound Course Entry

After the active waypoint line is selected, the outbound course displays. The waypoint name is not used.

For example, BTG090 is entered into the active waypoint line. The FMC calculates a new route leg with BTG as the origin on an outbound course of 090°.

4 Intercept Course From (INTC CRS FROM)

Displays outbound course from entered waypoint.

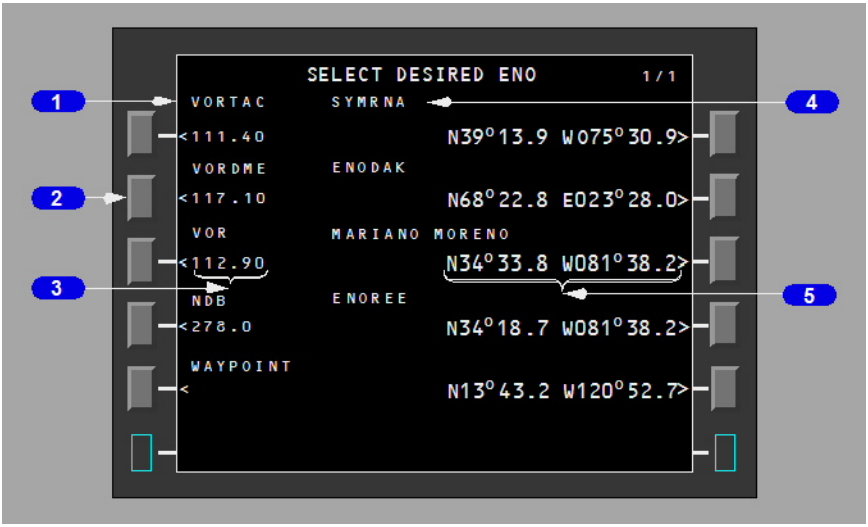
Shows the active waypoint name is modified with P/P or waypoint outbound entry.

Valid input is any course from 000° through 360°. May be changed until executed.

Select Desired Waypoint Page

The SELECT DESIRED WPT page displays after a waypoint entry when the FMC encounters more than one location for the same waypoint name. Selection of a waypoint returns the display to the previous page.

The example below shows the SELECT DESIRED WAYPOINT page with the waypoint ENO entered.



1 Type

Displays the type of navaid for each duplicate name.

2 Waypoint

Displays 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 PROGRESS 1/4, FIX INFO, DIR/INTC, REF NAV DATA, VNAV DES Vertical Bearing, OFFPATH DES, or CENTER MAP entry, the sort is based on proximity to current airplane position.

Select—select the correct waypoint by selecting the applicable left or right line select key; returns display to page previously in use.

Selecting any CDU function key exits page without selecting a waypoint.

Displays only a caret prompt when the fix type is not a NAVAID or NDB.

3 Frequency

Displays frequency of the navaid.

4 Fix Full Name

Displays full name of the duplicate fix.

5 Latitude/Longitude

Displays the latitude/longitude for each duplicate name.

Airway Intercept

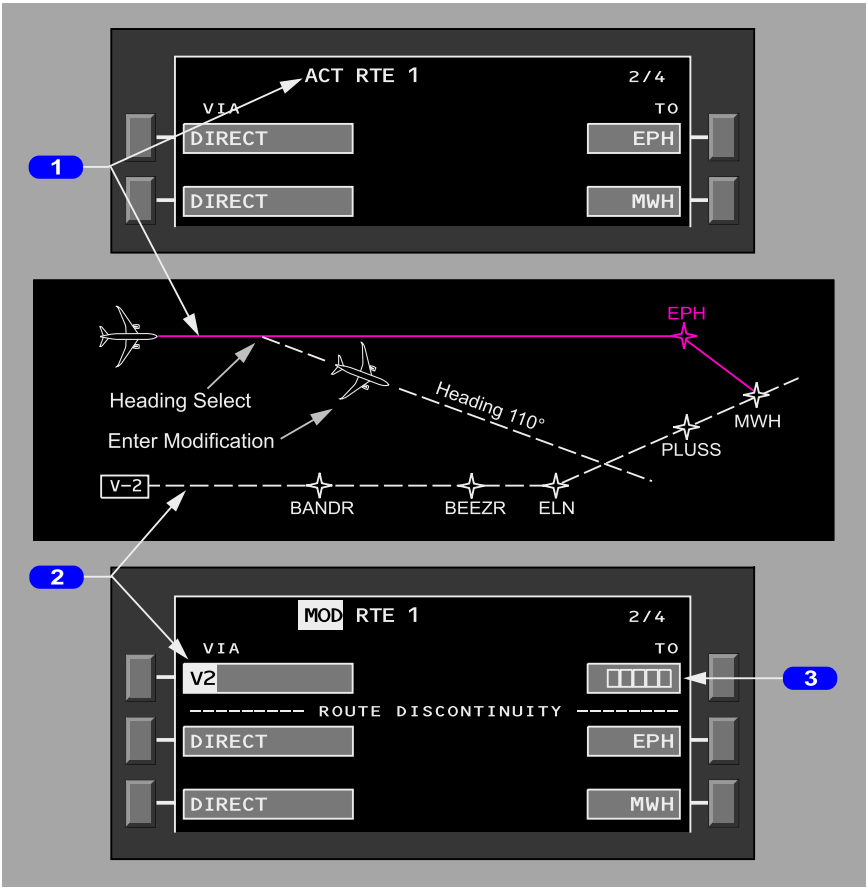
LNAV can be used to intercept an airway. An airway intercept changes the active waypoint on the RTE and LEGS pages.

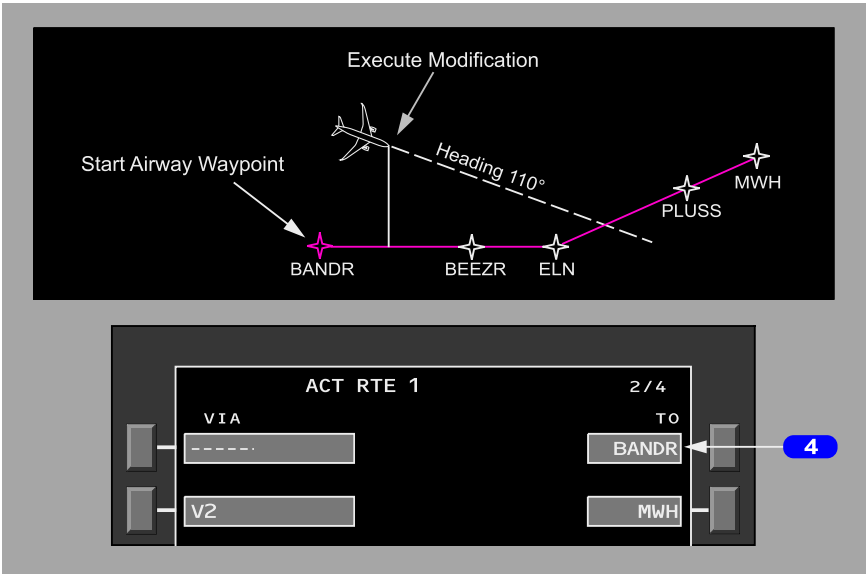
Example

The active route is direct to EPH, then direct to MWH. ATC clears the airplane to:

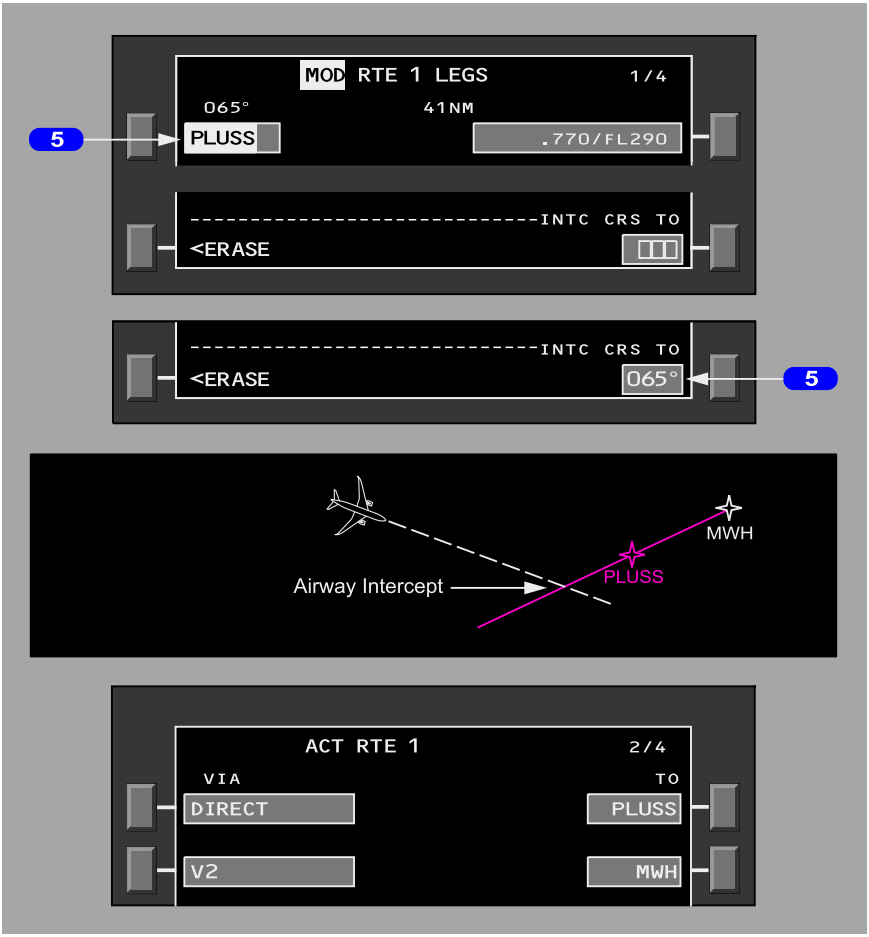
- turn right heading 110°

- intercept V2 to MWH.




Execute Modification
Start Airway Waypoint
Heading 110°
MWH
PLUSS
BANDR
BEEZR
ELN
ACT RTE 1
2/4
VIA
TO

BANDR
4
V2
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 displays 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 the 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 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 EICAS advisory message FMC INTERCEPT HDG is displayed.

5 New Active Waypoint

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.

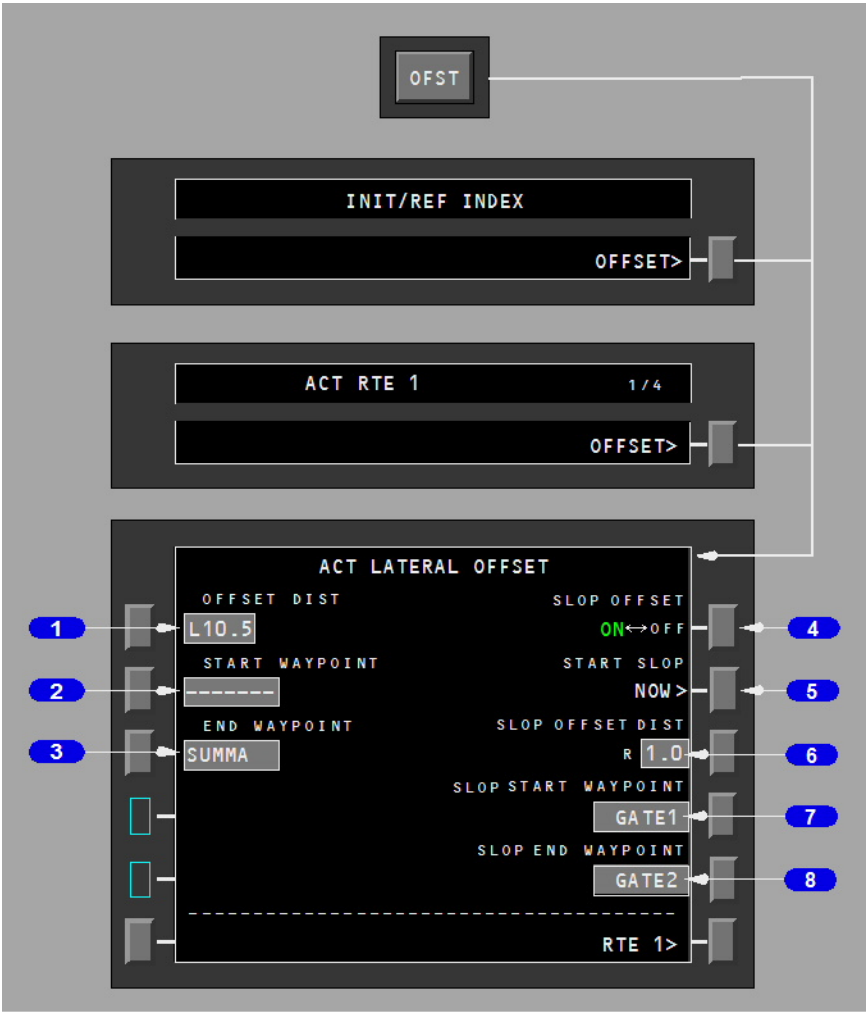
Following the course intercept to PLUSS modification and execution, the LEGS page displays PLUSS as the active waypoint. LNAV can be armed and the airway intercept can be completed.

Route Offset and Strategic Lateral Offset Procedure (SLOP)

The LATERAL OFFSET page can be accessed by: selecting the OFST function key, selecting the OFFSET prompt on the INIT REF INDEX page or on the RTE page 1, or by selecting the LOAD SLOP command button on the SLOP TRANSITION Help Window. The OFFSET prompt displays for the active route when the airplane is in flight. The offset displays as a white, dashed line on the ND until the offset modification is executed or erased. After execution, the offset route displays as a dashed magenta line. The original route continues to display as a solid magenta line. When executing the offset modification without an entered START waypoint, with LNAV active and the autopilot engaged, the airplane turns to capture the offset course.

When on the route offset, active route waypoints sequence normally.

With SLOP OFFSET ON and a SLOP START waypoint displayed, the SLOP offset displays on the ND. With LNAV active and the autopilot engaged, at the SLOP START waypoint the airplane turns right to the offset distance; then, follows the parallel track.



1 OFFSET Distance (DIST)

Valid entries are L (left) or R (right) followed by magnitude XX.X, or XX.X followed by L or R (XX.X is any number from 0.1 to 99.9 NM, in 0.1 NM

increments). Entry of a valid offset distance displays START WAYPOINT in 2L and END WAYPOINT in 3L line titles.

When executed and no start waypoint has been entered, the offset displays on the ND as a dashed magenta line from the current position. The ND displays a 30° entry path to and exit path from the offset. An FMC-determined default end waypoint displays in 3L.

An offset propagates from present position along the route to an approach or approach transition, end of route, track change greater than 135°, holding pattern, or non-offsetable leg. If the current leg is non-offsetable, box prompts display. An offset can be removed by deleting the offset, entering an offset value of zero, executing a direct to or an intercept leg to a waypoint, or entering a PPOS hold. Blank when no active route or no offset-able legs in the active route.

2 START WAYPOINT

Displays box or dash prompts depending on mandatory or optional entry.

Valid entries are waypoints in the active, modified, or pending active route. Entry of a non-offsetable leg displays the help window message NO OFFSET AT LEG XXXXXXX.

Blank when no active route, no offsetable legs in the active route, or the start waypoint is sequenced.

3 END WAYPOINT

Displays dashes when able to enter a valid end waypoint.

Valid entries are waypoints in the active, modified, or pending active route. Entry of a non-offsetable leg displays the help window message NO OFFSET AT LEG XXXXXXX. If a non-offsetable leg exits prior to the entered end waypoint, the end waypoint entry is accepted and the help window message OFFSET ENDS AT YYYYYYY displays. YYYYYY is the flight plan default Offset End waypoint.

Displays FMC calculated end point in the active route when a valid direction/ distance entered in 1L, and no entered or uplinked end waypoint exists.

When a flight plan change results in a non-offsetable leg in the lateral offset, upon execution of the change the help window message OFFSET ENDS AT YYYYYYY displays. YYYYYYY is the Offset End waypoint. The entered end waypoint continues to display in large font even though the offset will terminate before reaching that waypoint.

Deletion of the entered end waypoint extends the offset to the next downtrack valid Offset End waypoint which displays in small font. The help window message OFFSET ENDS AT YYYYYYY displays.

Blank when no active route or no offsetable legs in the active route.

4 Strategic Lateral Offset Procedure (SLOP) OFFSET

Displays a toggle selection ON-OFF. Default is ON in large font green; OFF displays in small font white. Selection reverses color and font size.

5 SLOP START/END

Line title displays START SLOP when SLOP not active; displays END SLOP when SLOP is active.

Displays NOW> when SLOP OFFSET is ON, an offset is not active, the active leg is offsetable, and a MOD SLOP offset does not exist.

Select - modifies page, displays the SLOP offset as a white, dashed line on the ND. Execution displays the offset magenta line at the offset distance shown in 3R. With LNAV active and the autopilot engaged, the airplane turns to capture the SLOP offset.

Line title and data line display in cyan when NOW displays without a “>”.

6 SLOP OFFSET Distance (DIST)

Displays default distance in small font white when no value entered. Manual entry displays in large font.

Valid entries are in the format X.X (X.X is any number from 0.1 to 2.0 NM). Leading and trailing zeroes, and decimal point are optional (for example: .1, 2, 1.0)

Displays in magenta when the active flight plan segment is part of the SLOP offset and SLOP OFFSET is ON.

7 SLOP START WAYPOINT

Displays dashes when START SLOP NOW> is in 2R and no default or entered SLOP START waypoint exists.

Displays in small font white when START SLOP NOW> is in 2R, a valid SLOP START gateway waypoint exists, and no SLOP START waypoint has been entered. Manual entry displays in large font.

8 SLOP END WAYPOINT

Displays dashes when no gateway waypoint exists in the flight plan, START SLOP NOW> is in 2R, and no entered SLOP START or END waypoint exists.

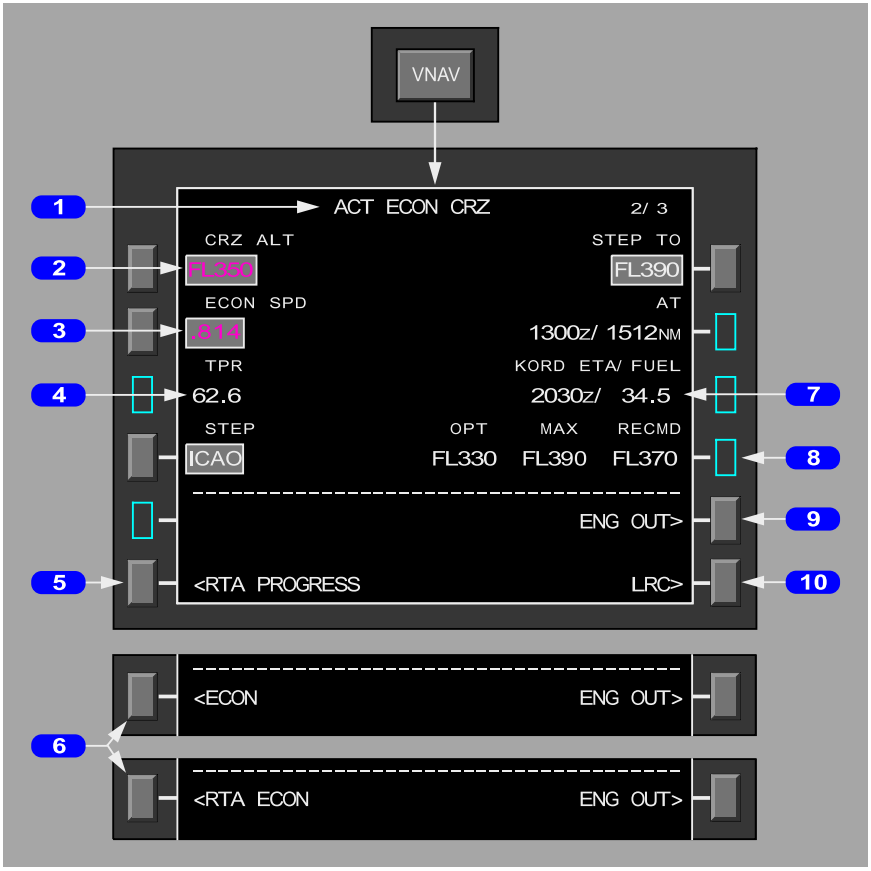
When no waypoint has been manually entered, displays the default gateway end waypoint in small font white.

Cruise Page

All Engine Cruise

The cruise page is used to monitor and change cruise altitude and speed. Speed changes can be manually selected or automatically selected with the selection of other VNAV modes. Cruise climbs, cruise descents, and step climbs can be accomplished from the cruise page.

When using VNAV in economy mode, page data is based on operating at ECON SPD. Economy cruise speed is based on cost index. When the flight crew enters a selected speed, page data changes. When the FMC is in the engine out mode, the data reflects airplane capabilities with one engine inoperative. The long range cruise (LRC) mode calculates speeds to maximize airplane range.



1 Page Title

The page title displays active (ACT) or modified (MOD) cruise. Usually, the title contains ECON for economy cruise. Selected speeds, engine out, and long range cruise modify the title.

Page titles include:

CO CRZ	engine out mode with CO speed selected
ECON CRZ	speed based on cost index
ECON CRZ CLB or CRZ DES	cruise climb or descent with ECON selected
EO CRZ	engine out mode with EO SPD selected
EO D/D	engine out mode with the airplane altitude above the maximum altitude for engine out performance
EO LRC CRZ	displays after descending to engine out maximum altitude
LRC CRZ	long range cruise selected
LRC CRZ CLB or DES	cruise climb or descent with LRC selected
LRC D/D	engine out mode with LRC selected
MCP SPD CRZ	selected MCP cruise speed
RTA CRZ CLB or DES	cruise climb or descent with RTA selected
RTA CRZ	RTA cruise selected.

2 Cruise Altitude (CRZ ALT)

Displays cruise altitude entered on PERF INIT page.

Valid entries are: XXX, XXXX, XXXXX, OR FLXXX. Altitude displays in feet or flight level depending on the transition altitude.

Modified values display in shaded white.

A new entry changes the page title to CRZ CLB or CRZ DES.

Changing the MCP altitude and pushing the altitude selector enters the MCP altitude as the active cruise altitude, without creating a modification.

3 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

Displays target speed or Mach in magenta.

MOD displays in the page title in shaded white until the modification is erased or executed.

SEL SPD displays when flight crew enters speed.

LRC SPD, ECON, RTA SPD, EO SPD or company speed (CO SPD) display when selected, depending on the VNAV mode.

4 TPR

Displays required TPR setting to maintain level flight at the target airspeed.

5 Required Time Of Arrival (RTA) PROGRESS

Select—displays RTA PROGRESS 3/4.

6 Economy Speed or Required Time Of Arrival/Economy

ECON

- Select—selects VNAV ECON mode
- Displays when an RTA waypoint is not in the flight plan and VNAV is not in the economy mode.

RTA/ECON

- Select—selects RTA speed mode. Displays ECON prompt
- Displays when an RTA waypoint is in the flight plan and VNAV is not in the RTA mode.

7 Destination ETA/FUEL

Displays estimated time of arrival and calculated fuel remaining at the destination.

Displays the same data for the alternate airport when a DIVERT NOW modification is selected from the ALTN page.

Line title displays ETA/FUEL W/MOD when a route modification is pending.

Calculations are based on optimum step climbs and cruise altitudes.

8 Optimum, Maximum, and Recommended Altitude (OPT, MAX, RECMD)

Blank when RTA is active.

OPT – calculation of OPT altitude is based on gross weight, cost index, cruise speed schedule, and cruise cg. Forecast winds and temperature deviations from standard day are not used in the calculation. The optimum altitude is not calculated during an RTA cruise segment.

MAX – displays maximum altitude based on:

- current gross weight minus calculated fuel burn to climb to MAX altitude
- temperature
- number of engines operating
- cruise reference thrust limit default set by airline (CRZ or CLB)
- speed (ECON, LRC, SEL, EO, or CO)

- residual rate of climb default set by airline (range: 100 to 999 feet per minute)
- disregarding altitude or speed constraints
- cruise cg
- does not reflect the effect of speed if speed intervention (MCP IAS/MACH window) is selected.

RECMD – displays the most economical altitude to fly for the next 250 - 500 NM based on gross weight, cruise speed schedule, and entered forecast winds and temperatures at cruise altitudes. The FMC evaluates altitudes from 9,000 feet below the current CRZ ALT up to the MAX altitude. Recommended altitudes are consistent with the specified step size and step climb schedule. If the step size is zero, the recommended cruise level is calculated assuming a 2,000 foot step size. The recommended altitude is set to the CRZ ALT when within 200 NM of the T/D or within 500 NM of the destination airport. The recommended altitude is not calculated during an RTA cruise segment.

For additional information, refer to:

- See Route Data Page on page 11.42.40
- See Wind Data on page 11.42.41

For RTA CRZ mode active: OPT, MAX, and RECMD are not computed. OPT, MAX, and RECMD headers are blank.

9 Engine Out (ENG OUT)

Select—

- displays MOD XXX CRZ page title; XXX is the active all engine CRZ speed mode before ENG OUT is selected
- changes command speed line title to EO SPD
- below engine-out maximum altitude: upon execution, thrust reference limit changes to CON and page title becomes ACT EO CRZ
- above engine-out maximum altitude: sets CRZ ALT to engine-out maximum altitude; and upon execution, thrust reference limit becomes CON and page title becomes ACT EO D/D
- Changes fuel burn calculations based on single engine performance and includes APU predicted burn.

10 Long Range Cruise (LRC)

Select—displays long range cruise page.

Engine Out Cruise

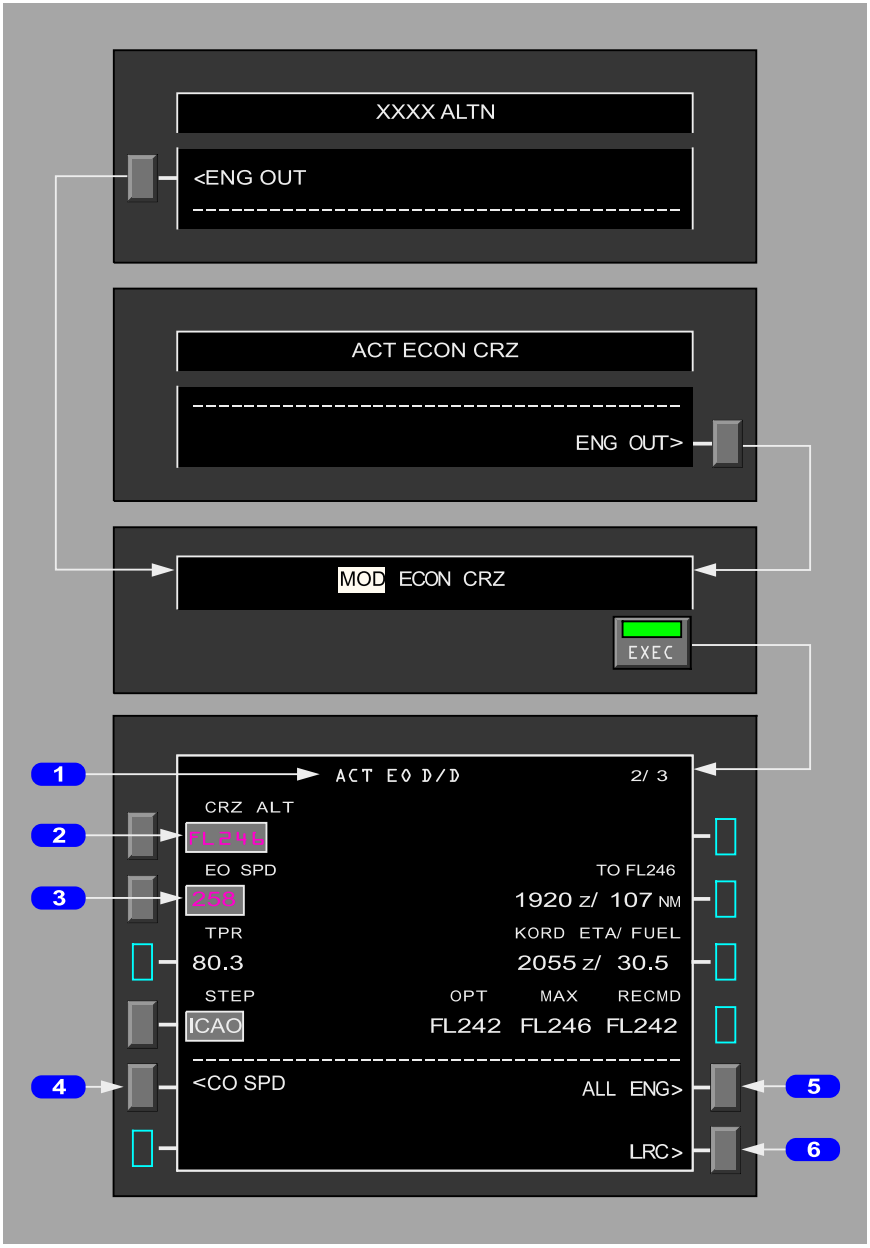
Engine out VNAV guidance displays on the EO CRZ or EO D/D page. Engine-out data is also available with both engines operating by selecting the ENG OUT prompt.

The modified page displays engine-out performance information. When above the maximum engine-out cruise altitude, VNAV calculates engine-out guidance for drift down (D/D). The EO D/D page changes to the EO CRZ page when reaching the engine-out cruise altitude. Subsequent engine-out cruise climb or descent is accomplished the same as two engine cruise climb or descent.

(See Cruise (Above EO Max Alt) on page 11.31.39, for additional information.)

As the airplane gross weight decreases, maximum altitude increases. A step climb may be possible under these conditions.

The example is based on a cruise altitude above the maximum engine-out altitude. When ENG OUT is first selected, the default target speed is EO SPD.


XXXX ALTN
<ENG OUT
ACT ECON CRZ
ENG OUT>
MOD ECON CRZ
EXEC
1
ACT EO D/D
2/ 3
CRZ ALT
2
FL246
EO SPD
3
250
TO FL246
1920 z/ 107 NM
TPR
80.3
KORD ETA/ FUEL
2055 z/ 30.5
STEP
ICAO
OPT
MAX
RECMD
FL242 FL246 FL242
4
<CO SPD
ALL ENG>
5
LRC>
6

1 Page Title

Displays LRC D/D when LRC selected.

Displays MCP SPD D/D when MCP speed selected.

Displays EO LRC CRZ when reaching engine out cruise altitude.

Displays EO CRZ CLB or EO CRZ DES when EO SPD selected and the airplane is below the engine-out maximum altitude.

2 Cruise Altitude (CRZ ALT)

Displays altitude from MAX ALT line when current CRZ ALT above MAX ALT.

Manual entry of an altitude above maximum engine-out altitude results in the CDU help window message, “MAX ALT FLXXX”.

Valid entries are the same as all engine cruise page.

3 Engine Out Speed (EO SPD)

Displays the target speed or Mach in magenta.

Manual entry is allowed.

Valid entries are the same as all engine cruise page.

A manually entered speed changes the line title to SEL SPD.

Selecting any speed shows engine out speed (EO SPD) as a select prompt at 6L.

Manual entries may change MAX altitude.

4 Company Speed (CO SPD)

Select—Modifies the page with company speed, engine out data from the airline policy page.

5 ALL Engine (ENG)

Select—displays a MOD XXX CRZ page with performance based on both engines operating.

Selection and execution allows subsequent selection of two engine economy VNAV modes.

6 Long Range Cruise (LRC)

Select—enables execution of engine out long range cruise.

Displayed when EO, CO SPD or SEL SPD is the active mode.

VNAV Modifications

During the cruise phase, VNAV can calculate two types of climbs: cruise and step climbs. Cruise and planned climbs can be entered by the flight crew. Optimum step climbs are calculated by the FMC. In all cases, the new climb altitude must be selected in the MCP altitude window before VNAV commands the climb.

Cruise Climb

Setting an altitude above the current cruise altitude in the MCP altitude window and pushing the altitude selector causes the cruise altitude to be set to the MCP altitude and the airplane to climb to the new cruise altitude. The reference thrust limit is CLB and the pitch flight mode annunciation is VNAV SPD.

Another method to accomplish a cruise climb: set a higher MCP altitude, enter the altitude in the CRZ ALT line, and execute.



1 During Cruise Climb

VNAV page title displays CRZ CLB in a climb to cruise altitude.

2 End of Cruise Climb

VNAV page title displays ECON CRZ after level off at cruise altitude.

Planned Step Climb

When a step climb is planned to start at a waypoint, the data can be entered on the RTE LEGS page. The FMC performance predictions assume the airplane will start the climb at the identified waypoint.

The FMC displays the distance and ETA to the step point on the PROGRESS page. The corresponding altitude profile point and identifier is shown on the ND.

If a climb is not initiated within 5 minutes after passing a planned step climb point, the EICAS advisory message VNAV STEP CLIMB is displayed.



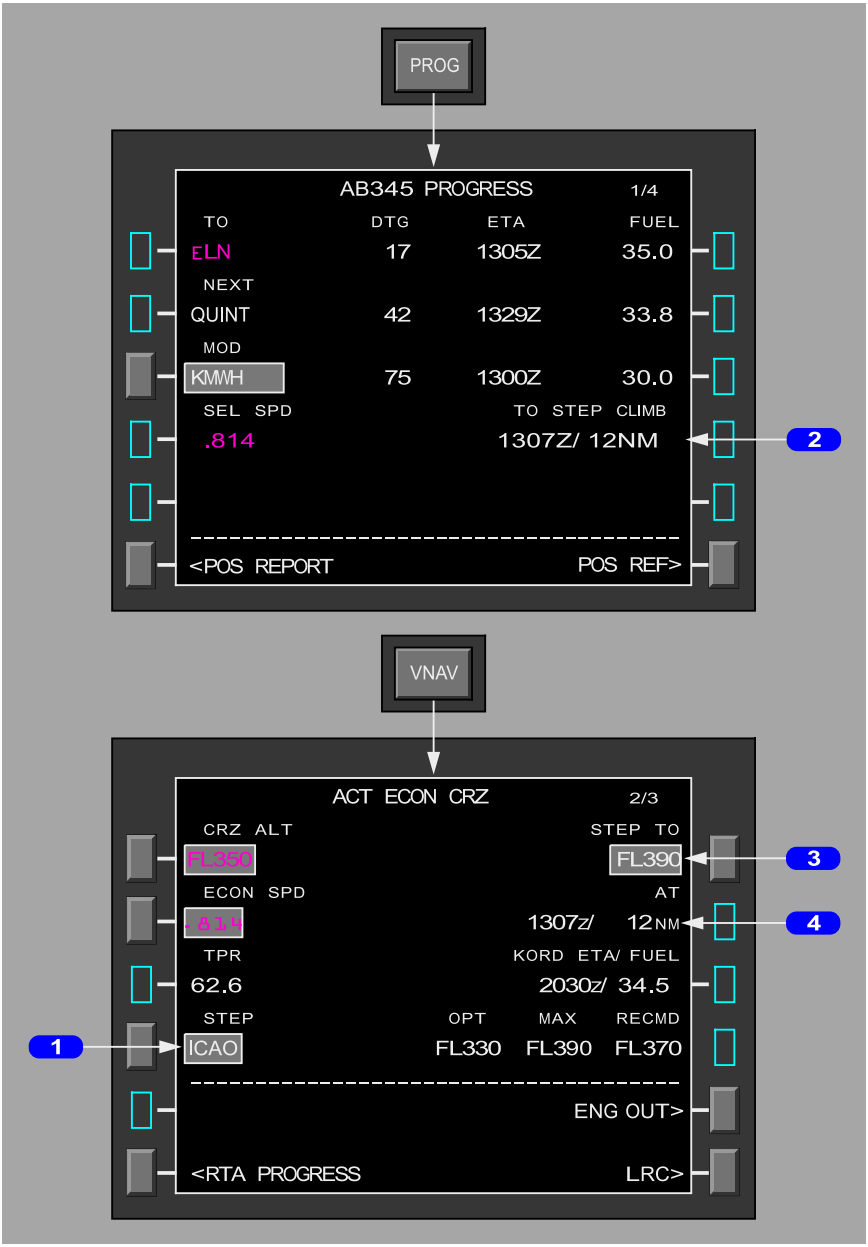
1 Step Climb Altitude

Enter the cruise altitude as an altitude constraint and the letter S. The FMC assumes the step climb starts at the waypoint. Accomplish the step climb at the waypoint with the steps described in cruise climb.

Calculated Step Climb

With a non–zero value entered on the STEP SIZE line on the PERF INIT or CRZ page, the FMC calculates step climb points that minimize trip cost. For all speed modes, the step climb points are a function of the lateral flight plan, the entered COST INDEX (for ECON and RTA speed modes only), entered forecast winds and temperatures, CRZ ALT, gross weight, and STEP SIZE. Multiple step climbs are possible based on performance and route length. The calculated STEP TO altitude is less than or equal to the maximum altitude at the step point.

If a climb is not initiated within 5 minutes after passing a calculated step climb point, the EICAS advisory message VNAV STEP CLIMB is displayed.


PROG
AB345 PROGRESS
1/4
TO
DTG
ETA
FUEL
ELN
17
1305Z
35.0
NEXT
QUINT
42
1329Z
33.8
MOD
KMWH
75
1300Z
30.0
SEL SPD
.814
TO STEP CLIMB
1307Z/ 12NM
<POS REPORT
POS REF>
VNAV
ACT ECON CRZ
2/3
CRZ ALT
FL350
STEP TO
FL390
ECON SPD
.814
AT
1307z/ 12NM
TPR
62.6
KORD ETA/ FUEL
2030z/ 34.5
STEP
ICAO
OPT
MAX
RECMD
FL330
FL390
FL370
ENG OUT>
<RTA PROGRESS
LRC>
1
2
3
4

1 STEP SIZE

Used for calculation of optimum step point and step climb predictions.

Displays the default step climb size of ICAO.

Valid entries are altitudes from 0 to 9000 in 1000 foot increments.

Entry of a “0” value causes the FMC to compute ETA and fuel predictions for a constant cruise altitude.

Deletion of a manual entry defaults back to ICAO.

2 TO STEP CLIMB

When the cruise climb start point is the next VNAV event, the line title changes to TO STEP CLIMB.

Displays the ETA and DTG to the point where the step climb starts.

If the airplane passes the step climb point and has not started to climb, the ETA and DTG are replaced with the word NOW.

When the FMC calculates a step climb is not advised, the ETA and DTG are replaced with the word NONE.

3 STEP TO

Line title displays STEP TO 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 driftdown 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.

When a calculated step climb altitude is displayed (small font), the altitude can be overwritten to evaluate another step climb. The FMC calculates the step climb location using entered forecast winds and temperatures and displays data on this page and the PROGRESS page 1, 4R.

Valid entries are FLXXX (or XXX flight level) or XXXXX (feet).

Entry of zero for step size causes the FMC to calculate performance data at the entered CRZ ALT with no step climbs.

Preflight entry of a non-zero increment or ICAO 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 step size.

Displays STEP TO altitude based on entering "S" (following altitude) on a waypoint on the LEGS page.

When using a non-zero step size, the STEP TO altitude is the next higher altitude, calculated by adding the step size increment to the current CRZ ALT. If step climbs have not been accomplished as calculated, multiple step increments may be used.

Entering an altitude above maximum altitude displays the scratchpad message MAX ALT FLXXX.

Blank when:

- there is no active flight plan, or
- within 200 NM of the T/D, or
- within 500 NM of the destination airport with no planned steps in the flight plan, or
- engine out drift down is active.

4 AT, AT XXXXXXX, AVAIL AT, TO FLXXX, TO T/D

AT—Displays when the altitude in 1R is not an entered step climb on the LEGS page. Displays the ETA and DTG to the step climb point where a climb to the STEP TO altitude minimizes trip cost (ECON CRZ) or fuel (other CRZ speed).

AT XXXXXXX—Displays the LEGS page step climb waypoint when the FMC calculates the step climb can occur within 5 NM of the step climb waypoint. The data line displays ETA and DTG to the climb point. Displays NOW when passing the step climb point.

AVAIL AT—Displays when a STEP TO the next step altitude entered on a LEGS page waypoint can not occur within 5 NM of the planned step waypoint due to thrust or buffet. The data line displays ETA and DTG to the climb point. Displays NOW when passing the step climb point. Displays NONE when the planned step climb cannot be accomplished.

TO FLXXX—Displays when the airplane is more than 200 NM from the T/D or more than 500 NM from the destination airport and engine out drift down is active. The data line displays ETA and DTG to the cruise altitude.

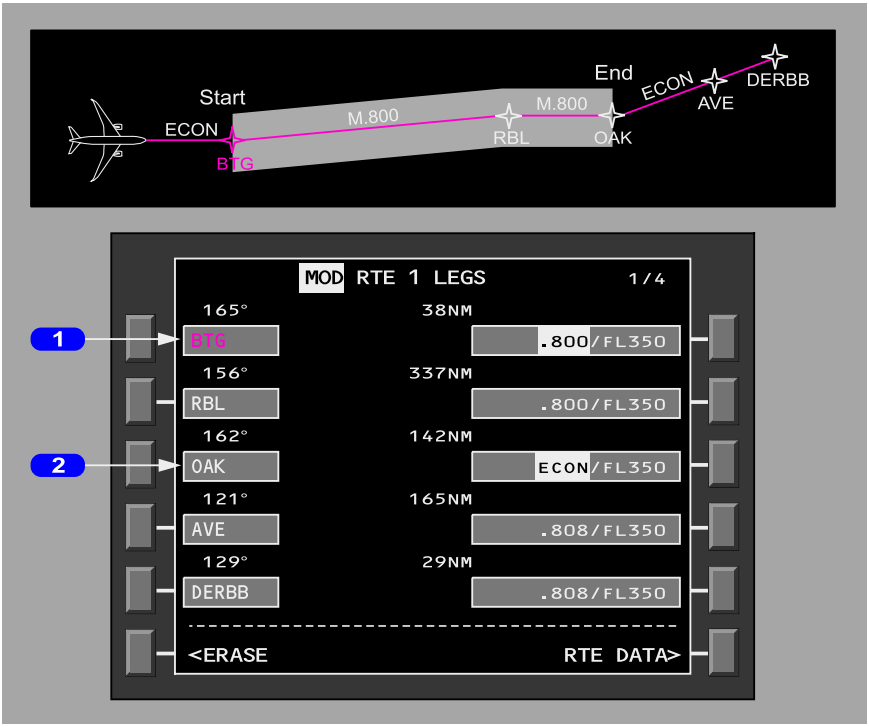
TO T/D—Displays when the airplane is within 200 NM of the T/D or within 500 NM of the destination airport with no planned step climbs in the flight plan. The data line displays ETA and DTG to the T/D point.

Constant Speed Cruise

A speed for a cruise segment can be specified. A cruise segment has a start waypoint and an end waypoint. The airplane maintains a constant speed

between the two waypoints. The waypoints must be in the cruise phase. The FMC controls the speed after the end waypoint or top of descent.

Modification must be executed.



1 Start Waypoint for Constant Speed Cruise

The constant speed cruise starts at BTG at .800 Mach. Entry is in Mach.

2 End Waypoint for Constant Speed Cruise

The constant speed cruise ends at OAK then ECON speed is used. If an RTA waypoint exists at RBL or OAK, the RTA is deleted.

Entry can be a Mach number, ECON/ or E/, LRC/ or L/. If an RTA waypoint is in the flight plan, RTA/ or R/ may be entered.

If no end waypoint is specified, the constant speed terminates at top of descent.

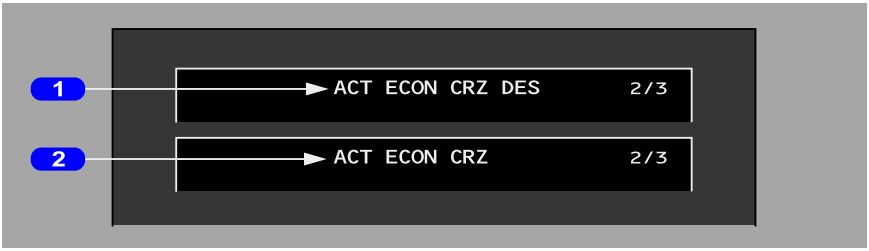
The FMC may select the end waypoint if an RTA waypoint is entered. The FMC selects the end waypoint to allow enough distance to arrive at the RTA waypoint

on time. In the example, if the FMC selected OAK as the end waypoint, RTA would replace ECON.

(See RTA Progress Page 3 on page 11.42.54 for additional information.)

Cruise Descent

Setting an altitude below the current altitude in the MCP altitude window and pushing the altitude selector (more than 50 NM from a T/D) causes the cruise altitude to be set to the MCP altitude and the airplane to descend to the new altitude. The CRZ page displays ACT ECON CRZ DES. If the altitude set in the altitude window is below the speed transition (SPD TRANS) or restriction (SPD RESTR) altitude displayed on the DES page, those altitudes and speeds are deleted. Transition or speed restrictions must be maintained by flight crew action. The autothrottle sets a calculated thrust value for an approximate 1250 foot per minute descent. Pitch changes maintain the commanded cruise speed. Thrust levers can be manually positioned to adjust the descent rate.



1 During Cruise Descent

VNAV page title displays cruise phase in a descent to a new cruise altitude.

2 End of Cruise Descent

VNAV page title displays cruise phase after level off at new cruise altitude.

Early Descent

An early descent is a descent started prior to the T/D. The VNAV descent page becomes active.

During cruise, setting an altitude below the current altitude in the MCP altitude window and pushing the altitude selector activates the DES NOW function when the airplane is within 50 NM of the T/D or if the MCP altitude is set below the highest descent altitude constraint in the VNAV descent profile.

The autothrottle sets thrust to maintain the target descent rate; then annunciates HOLD. Pitch maintains the commanded speed. Thrust levers can be manually positioned to adjust the descent rate.

Another method to accomplish an early descent: set a lower MCP altitude, page forward to the VNAV DES page and line select DES NOW, and execute.



1 Descend Now (DES NOW)

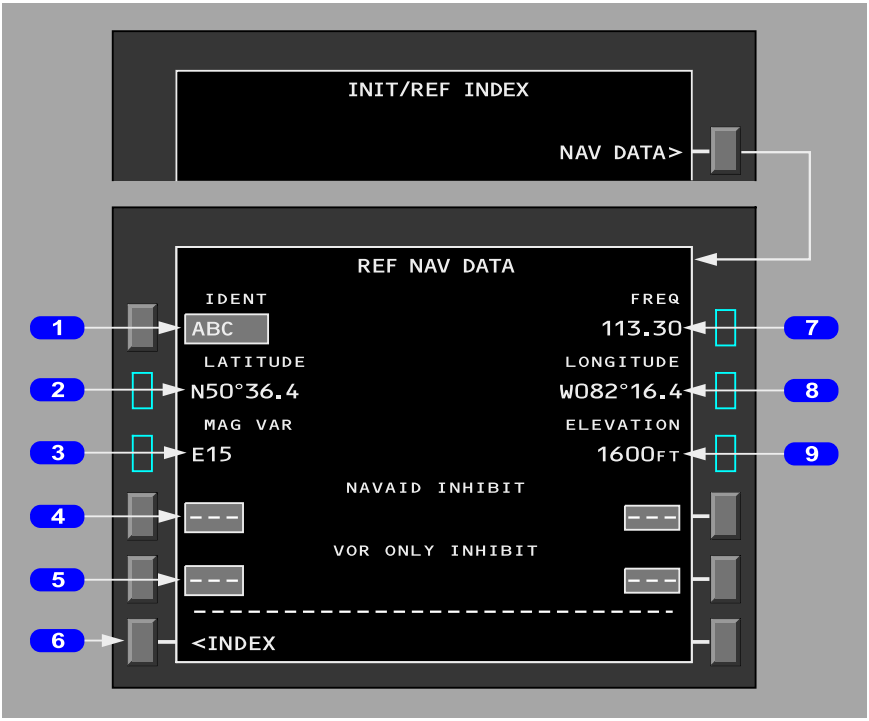
The DES NOW prompt is shown on the descent page when the descent phase is not active. Select the DES NOW prompt and execute to start a VNAV ECON descent of approximately 1250 feet per minute at ECON speed.

Upon reaching the planned descent path, VNAV commands pitch to capture the path and to maintain ECON speed with idle thrust. If the airplane approaches a constraint altitude before reaching the constraint waypoint, VNAV commands level off and changes to VNAV PTH until the planned descent path is intercepted.

Navigation Data

Reference Navigation Data Page

The reference navigation data page displays data about waypoints, navaids, airports, and runways. Use this page to inhibit FMC position updates from radio navaids. The navaids are always available for manual tune, autotune and the ND.



1 Identification (IDENT)

Valid entries are any waypoint, navaid, airport, or runway from the navigation database.

Entry changes to dashes when page is exited and then reselected.

2 LATITUDE

Displays latitude of entered identifier.

3 Magnetic Variation (MAG VAR), LENGTH

MAG VAR—displays magnetic variation when entered identifier is a navaid.

LENGTH—displays runway length when entered identifier is a runway.

4 NAVAID INHIBIT

Valid entries are: VOR, VOR/DME, VORTAC, or DME identifiers from the navigation database.

Inhibits use of entered navaids for updating by the FMCs.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

5 VOR ONLY INHIBIT

Valid entries are VOR identifiers from the navigation database.

Inhibits use of only VOR portion of entered navaid for updating by the FMCs. DME–DME position updating is not inhibited.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

ALL is displayed when VOR/DME NAV is selected OFF using the prompt on the POS REF page 3/4.

6 INDEX

Select—displays the INIT/REF INDEX page.

7 Frequency (FREQ)

Displays frequency of entered identifier when it is a navaid.

8 LONGITUDE

Displays longitude of entered identifier.

9 ELEVATION

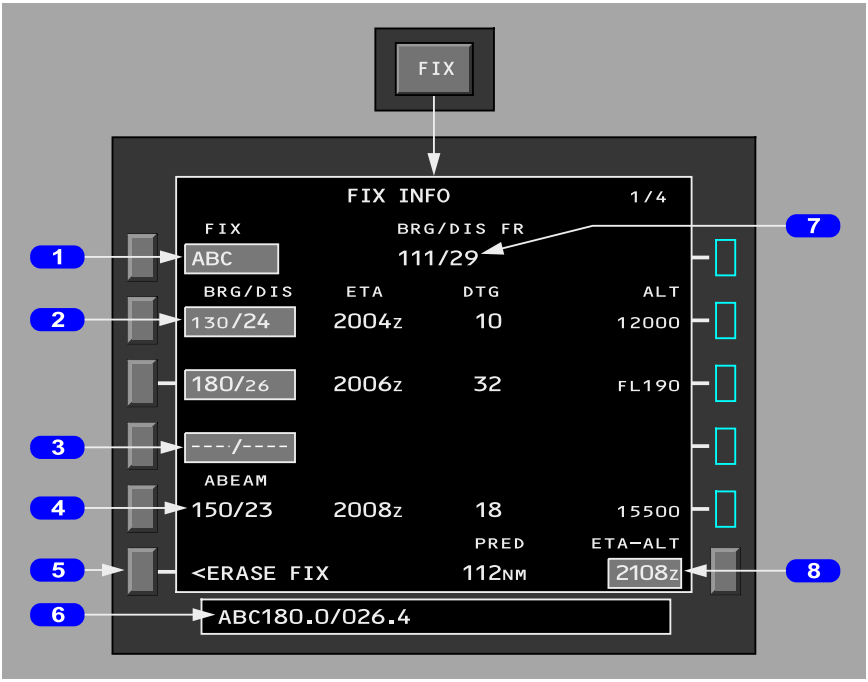
Displays elevation of entered identifier when it is a navaid, airport, or runway.

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. The page can be cleared by selecting the ERASE FIX prompt or by using the DEL key.

Magnetic/True Bearing

Magnetic or true fix bearings depend on airplane location. (See FMC Polar Operations on page 11.31.8 for additional information.)



1 FIX

Valid entries are airports, navaids, place bearing distance, place bearing/place bearing, along-track, latitude/longitude, and waypoints from the navigation database. The selected fix displays on the ND and is highlighted by a green circle.

2 Bearing/Distance (BRG/DIS), ETA, DTG, ALT

Valid entries are XXX/YYYY:

- leading zeros can be omitted for distance entries
- distance only entries (up to 5400 NM) must start with a slash (/).

Distances from the fix display on the ND as a circle around the fix.

When the circle intersects the active route, the ETA, DTG, and predicted altitude at the intersection display for the closest of the two intersections.

Bearings from the fix display on the ND as radial lines from the fix.

When the bearing intersects the active route, the ETA, DTG, and predicted altitude at the intersection display.

ETA—displays the estimated time if arrival to the intersection point.

DTG—displays the distance to go to the intersection point.

ALT—displays the predicted altitude at the intersection point.

Select—copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or page as a waypoint.

3 Bearing/Distance (BRG/DIS)—Dashes

Enter a bearing, distance, or both bearing and distance from the fix. A bearing and distance from the fix displays on the ND as a waypoint fix point. ETA, DTG, and predicted do not display.

4 ABEAM

Displays ABEAM prompt if entered fix exist in the navigation database and an active route exists.

Select—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.

Select again—copies the fix place/bearing/distance into the scratchpad. This fix can be placed in the route on a LEGS or RTE page as a waypoint.

5 ERASE FIX

Select—removes all fix data from the page and the ND.

6 Route Intersection Point Copied

Selecting the line select key for one of the BRG/DIS entries copies the fix place/bearing/distance definition into the scratchpad. This fix can be placed into the route on a LEGS page as a waypoint.

7 Bearing/Distance From (BRG/DIS FR)

Displays the bearing and distance of the airplane from the fix.

8 Predicted Distance to ETA or Altitude (PRED ETA-ALT)

Valid entry is altitude, flight level, or time. Time entry must be followed by “Z”.

Entering an altitude or flight level displays the predicted along-track distance and altitude or flight level on this line. The predicted airplane position displays on the ND route line as a green circle with the entered altitude/flight level.

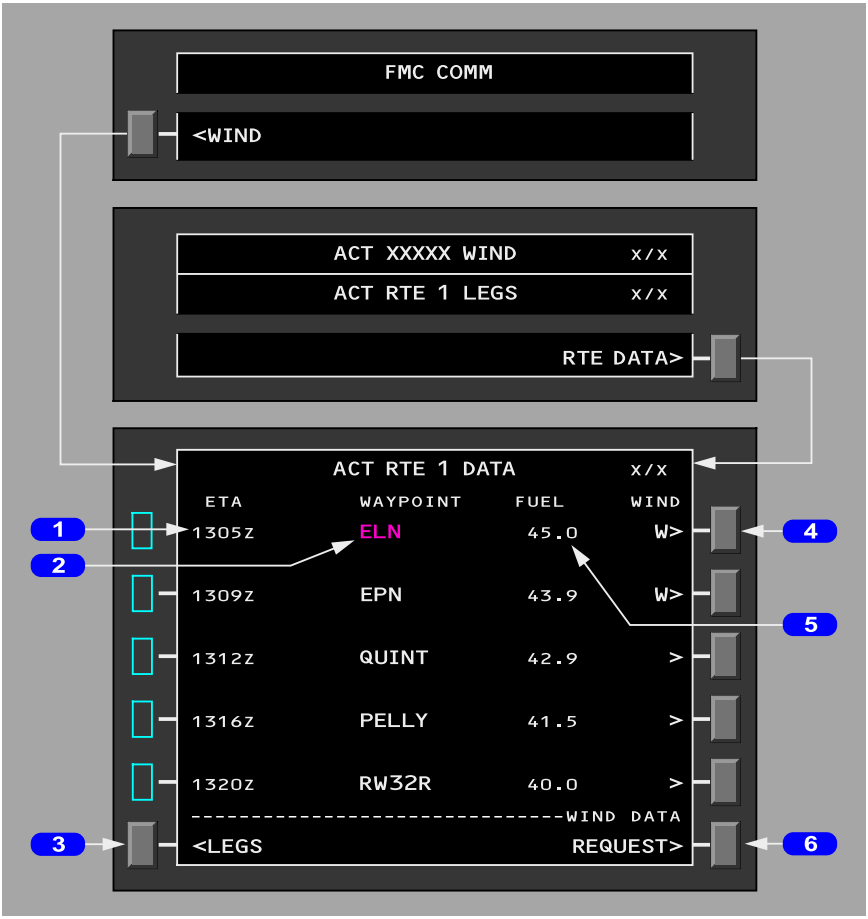
Entering a time displays the predicted along-track distance and time. The predicted airplane position displays on the ND route line as a green circle with the entered ETA.

Route and Waypoint Data

Route Data Page

The route data page displays data for each waypoint on the ACT RTE X LEGS page. This page also allows access to the WIND page. This page is available only for the active route.

The ETA and calculated fuel remaining at the waypoint display for each waypoint. Manual entry is not possible.



1 ETA

Displays ETA for waypoint.

2 Waypoint (WPT)

Displays identifier for waypoint.

3 LEGS

Select—displays RTE LEGS page.

4 WIND (W> or >)

W>—indicates waypoint winds have been entered.

>—winds not entered.

Select—selects WIND page for the selected waypoint.

5 FUEL

Displays the FMC calculated fuel remaining at the waypoint.

Note: ETA and estimated fuel calculations assume a direct flight across route discontinuities.

6 WIND DATA REQUEST

Select—transmits a datalink request for wind and descent forecast data.

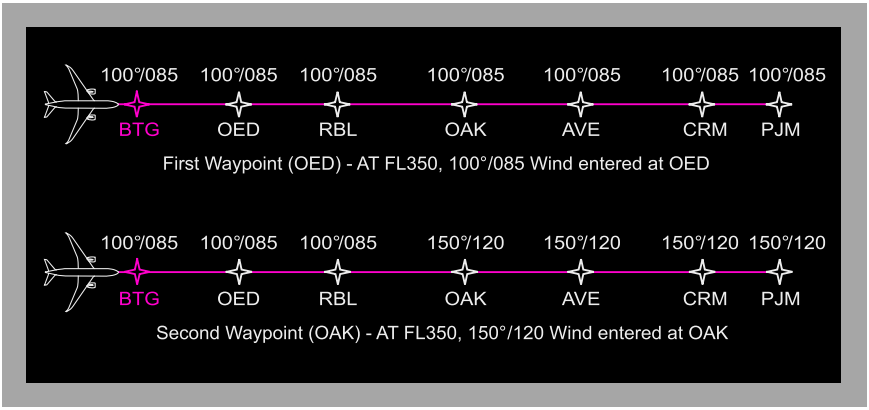
Flight crew may enter up to four altitudes on any wind page to qualify the request.

Wind Data

The FMC uses wind data to improve performance prediction accuracy. Wind data includes altitude and direction/speed.

The FMC applies the first entered wind data to all waypoints in the flight plan. Wind data entered at another waypoint (at the same altitude) changes wind data downtrack from the second entered waypoint either to the end of the track, or to the next entered wind. The wind data before the second entered waypoint does not change. Therefore, enter wind data for waypoints closest to the airplane, then enter wind data for waypoints downtrack from the airplane.

For example: at FL 350, 100°/085 is entered at waypoint OED. All waypoints in the route have the OED wind data. Then, additional wind data entered at OAK changes the wind data at OAK and through the end of the route.



Entered wind data are mixed with sensed wind data for performance predictions. The FMC uses entered winds for predictions far ahead of the airplane and sensed winds close to the airplane. The FMC mixes these winds for predictions in between. Sensed winds display on the progress page 2/4.

Inaccurate forecast wind and temperature information degrades the accuracy of the recommended altitude displayed on the cruise page.

The FMC adjusts ECON climb speed and top of climb using entered and/or sensed wind speed. FMC calculated ECON climb speed may fluctuate if top of climb is near a waypoint with approximately a 45° or larger track change and if a significant wind velocity has been entered or is predicted for that waypoint. This fluctuation does not occur when using a manually entered climb speed or speed intervention.

Wind Page

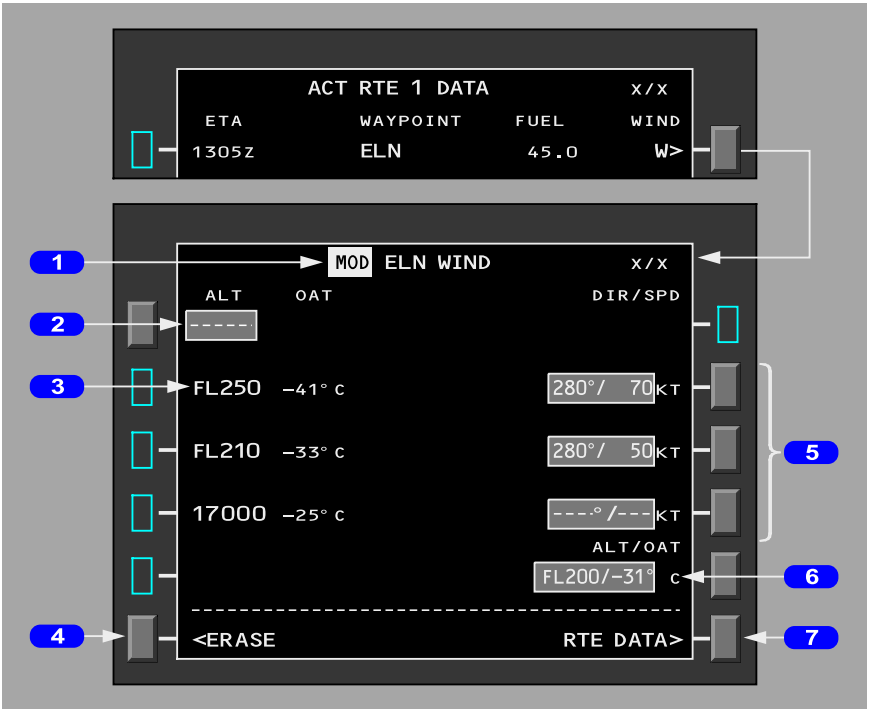
The wind page is used to enter forecast winds and temperatures at waypoints for up to four altitudes to enhance VNAV performance.

This data can be uplinked or manually entered.

Wind speed and direction are entered for the specific altitudes.

OAT can be entered for any one altitude. The FMC calculates the temperature for the entered altitudes using the standard lapse rate.

The altitudes are entered first. The altitudes can be entered in any order and are sorted and displayed in ascending order.



1 Page Title

Displays ACT XXXXX, where XXXXX is the waypoint at which winds have been entered.

When a route is being modified, MOD in shaded white as shown in the page title.

2 Altitude (ALT)

Enter altitude or flight level for wind entries. Altitude data entry possible only on line 1L.

After data entry, data is sorted by altitude and placed in lines 1 through 4. Dashes display on right side of line for wind direction and speed entry.

When all four lines have data, one must be deleted before new data can be entered.

3 Altitude/Flight Level Data

Displays the altitude or flight level for wind or OAT entries.

Data entered on 1L displays on lines 1 through 4. Data entry is not possible in lines 2L through 4L.

OAT entries made using the ALT/OAT line display in large font. Calculated OAT based on standard lapse rate display in small font.

4 ERASE

Select—removes modified data.

5 Direction and Speed (DIR/SPD)

Displays dashes after altitude/flight level entry in the ALT line. Enter wind direction and speed for the altitude.

Displays entered wind direction and speed for related altitude.

Values propagate in both directions for the first wind entered and downtrack for other entered winds. Propagated values display in small white font.

Manual entries display in shaded white until executed, then in large white font.

6 Altitude/Outside Air Temperature (ALT/OAT)

Blank unless at least one altitude entry has been made.

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.

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.

Manual entries display in shaded white until executed.

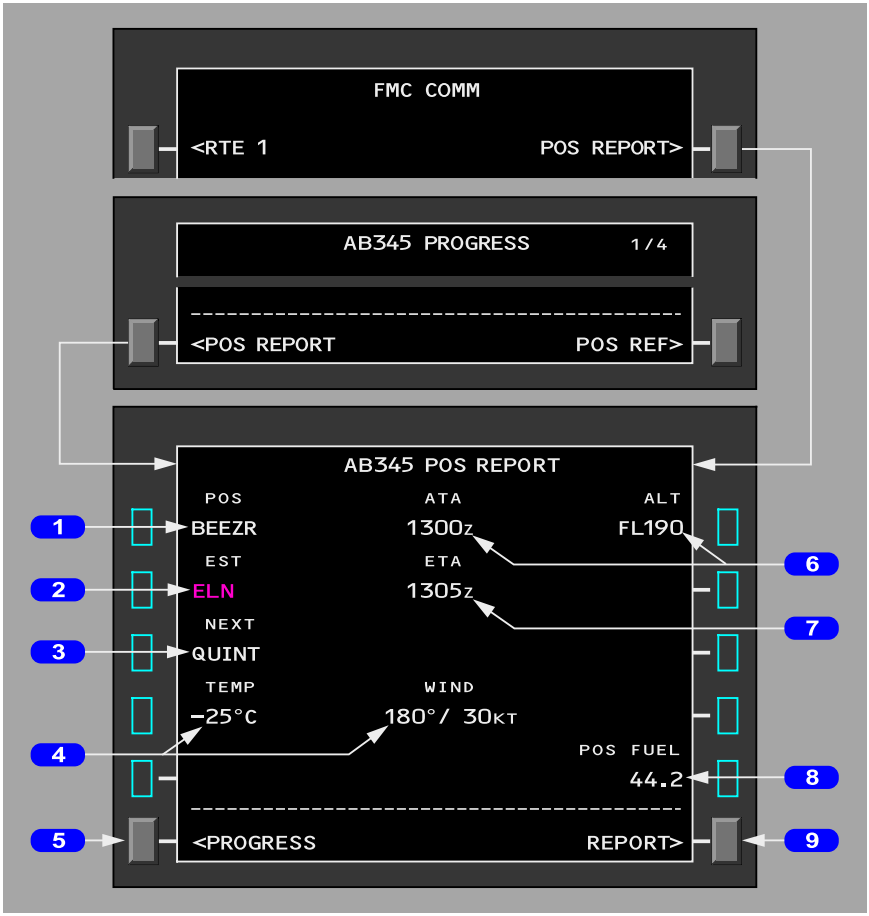
7 Route Data (RTE DATA)

Select—displays the RTE DATA page.

Position Report Page

The position report page displays data for a position report. A position report can be datalinked from the page.

The page contains reference data only. Manual entries are inhibited.



1 Position (POS)

Displays the last waypoint name or latitude/longitude used to report position. This is the previous active waypoint.

2 Estimate (EST)

The active waypoint displays in magenta.

3 NEXT

Waypoint after active waypoint.

4 Temperature and Wind (TEMP WIND)

TEMP displays the OAT in deg. C.

WIND displays the wind direction and speed.

5 PROGRESS

Select—displays the PROGRESS page.

6 Actual Time of Arrival and Altitude (ATA ALT)

ATA displays the actual time of arrival for the POS waypoint.

ALT displays the current airplane altitude.

7 ETA

Displays the estimated time of arrival for the active waypoint.

8 Position Fuel (POS FUEL)

Displays the FMC calculated fuel remaining at the POS waypoint.

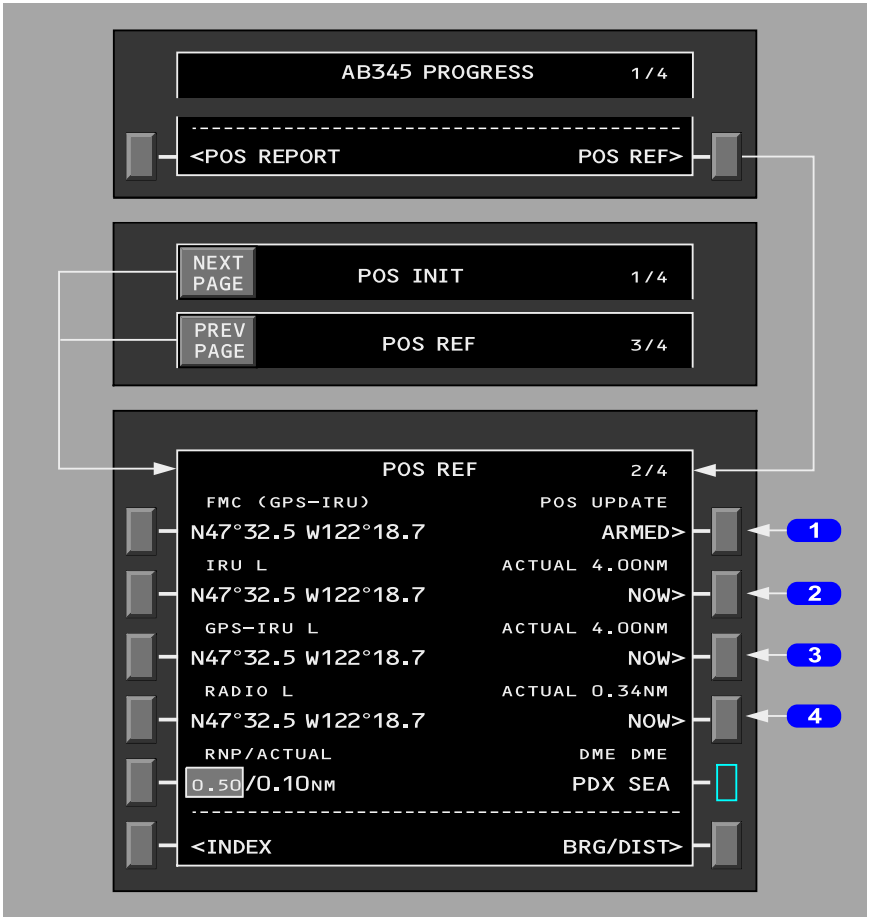
9 REPORT

Select—transmits a datalink downlink of the data on this page.

The datalink reports both current and last sequenced waypoint positions and altitudes.

In–Flight Position Update

FMC position update can be accomplished on the POS REF 2/4 page in flight.



1 UPDATE ARMED

Selecting the ARM prompt arms the position update function. ARM changes to ARMED. Each of the position update sources have a NOW prompt.

2 IRU NOW

Select—updates the FMC position to the indicated IRU sensor position.

Header displays position uncertainty (ANP) in nautical miles.

3 GPS NOW

Select—updates the FMC position to the indicated GPS sensor position.

Header displays position uncertainty (ANP) in nautical miles.

4 RADIO NOW

Select—updates the FMC position to the indicated RADIO sensor position.

Header displays position uncertainty (ANP) in nautical miles.

Progress Pages

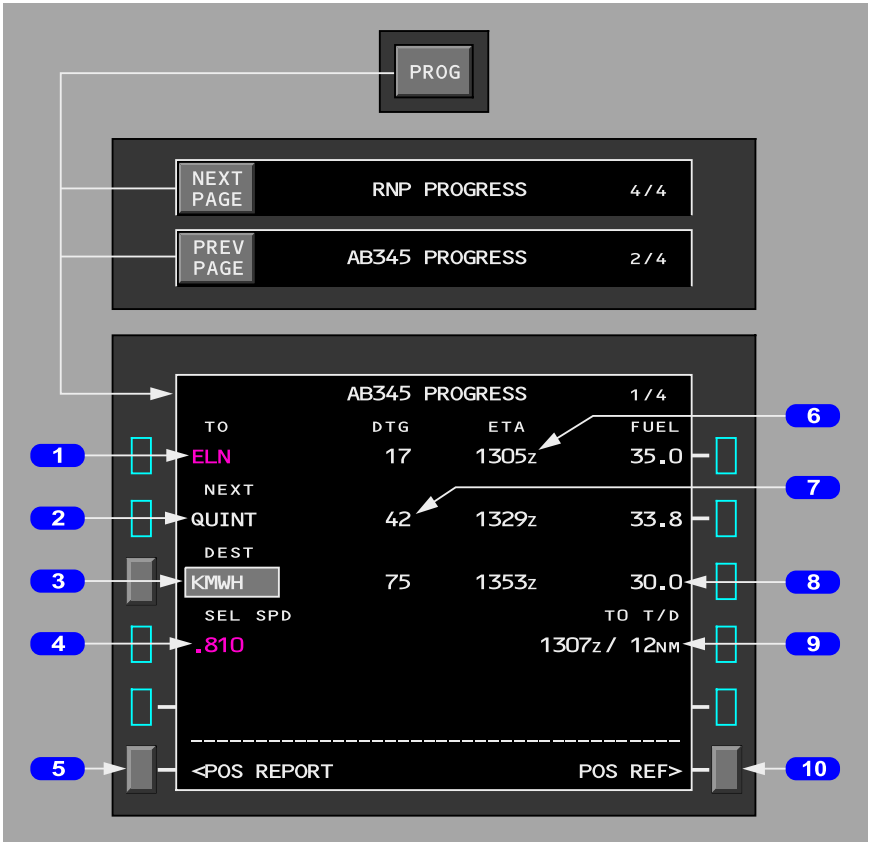
Progress Page 1

The progress page displays general flight progress data. The FMC Communication section of Chapter 5, Communications describes position reports.

The page title displays the company flight number entered on the RTE page.

Page one of the progress pages displays general data about:

- destination data
- FMC speed
- T/C, T/D, etc.
- waypoints (active and next).



1 TO

Active waypoint displays in magenta.

Can not be modified.

2 NEXT

Waypoint after TO waypoint displays in white.

Can not be modified.

3 Destination (DEST)

Any waypoint or airport in navigation database can be entered. The line titles are:

- DEST—performance predictions to destination (default display)

- DIR TO FIX—when entered waypoint is not in flight plan (data is based on flying present position direct to the waypoint)
- EN ROUTE WPT—when entered waypoint is in flight plan (line data are based on flying the flight plan route to the waypoint)
- MOD—a modification has been made on another page (performance predictions include modification).

Remove entries with DELETE key or change all CDU displays to a different page.

4 Selected Speed (SEL SPD)

The FMC active command speed displays in magenta.

The active speed mode is the same as on the performance page, unless changed by the MCP or a limit. The speed modes are:

CO SPD	engine out operations at airline specified engine out company speed
ECON SPD	economy speed
EO SPD	engine out speed
LIM SPD	speed is limited by VMO, MMO, flap limit, or buffet limit
LRC SPD	long range cruise speed
MCP SPD	MCP speed entered on the MCP IAS/MACH indicator
RTA SPD	RTA speed is active
SEL SPD	selected speed manually entered on the CDU or engine out operations during takeoff.

5 Position Report (POS REPORT)

Select—displays the POS REPORT page.

6 ETA

Estimated time of arrival at waypoint or destination.

7 Distance To Go (DTG)

Distance to go to waypoint or destination.

8 FUEL

Estimated fuel remaining at waypoint or destination.

9 TO T/D

Data line displays ETA and DTG to line title point.

Data line displays NOW when the airplane is past the climb/descent point when STEP CLB or T/D displays in the line title.

Data line displays NONE when the line title is STEP CLB and the step has not been entered on the CRZ page or the FMC calculates a step climb is not advised.

Line titles are:

E/D	end of descent data
LEVEL AT	time and distance to level off in Drift Down mode
STEP CLB	step climb data
T/C	top of climb
T/D	top of descent data.

10 Position Reference (POS REF)

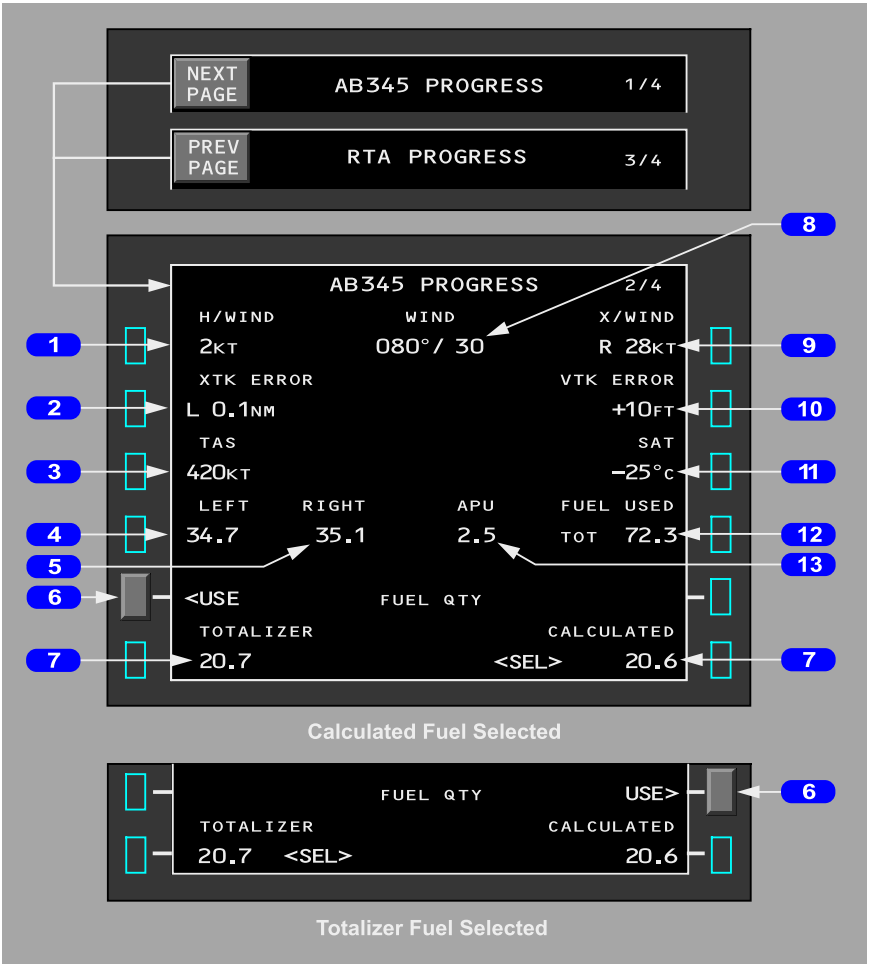
Select—displays position reference page.

Progress Page 2

Progress page two contains:

- fuel data
- static air temperature
- true airspeed
- track error data

- wind data.



1 Headwind (H/WIND), Tailwind (T/WIND)

Displays headwind (H/WIND) or tailwind (T/WIND) component.

Wind component data is relative to the airplane.

2 Crosstrack Error (XTK ERROR)

Displays crosstrack (XTK) error in nautical miles left or right of the active route.

3 TAS

Displays airplane true airspeed.

4 Left Fuel Used (LEFT)

Displays fuel consumed by left engine as sensed by fuel flow meters.

5 Right Fuel Used (RIGHT)

Displays fuel consumed by right engine as sensed by fuel flow meters.

6 USE

Select—selects method used to calculate fuel quantity, either TOTALIZER or CALCULATED. <SEL> is displayed next to the fuel quantity being used. Aircrew may switch between TOTALIZER and CALCULATED at any time by selecting the USE prompt.

7 Fuel Quantity TOTALIZER, CALCULATED

The fuel remaining line displays two independent fuel quantities, TOTALIZER and CALCULATED. TOTALIZER is the totalizer system fuel quantity. It is blank if the fuel quantity is manually entered on the PERF INIT page; the manually entered quantity displays under CALCULATED and the fuel quantity indicating system is not used until flight completion.

When no manual fuel quantity entry is made on the PERF INIT page, CALCULATED displays the FMC calculated fuel quantity remaining. Before engine start, the CALCULATED value is set equal to the TOTALIZER. The displayed totalizer quantity can be between 99% and 101% of the actual fuel. After engine start, the CALCULATED fuel quantity is decreased by the fuel flow sensing system (FUEL USED).

After fuel jettison or after all engines are shut down, CALCULATED resets to the totalizer system fuel quantity.

8 WIND

Displays current wind direction and speed referenced to true north.

9 Crosswind (X/WIND)

Displays left (L) or right (R) crosswind component relative to airplane heading.

10 Vertical Track (VTK) Error

Displays error above (+) or below (–) the vertical path.

11 Static Air Temperature (SAT)

Displays outside static air temperature.

12 Total Fuel Used (FUEL USED TOT)

Displays sum of the LEFT, RIGHT and APU fuel used values.

13 APU Fuel Used (APU)

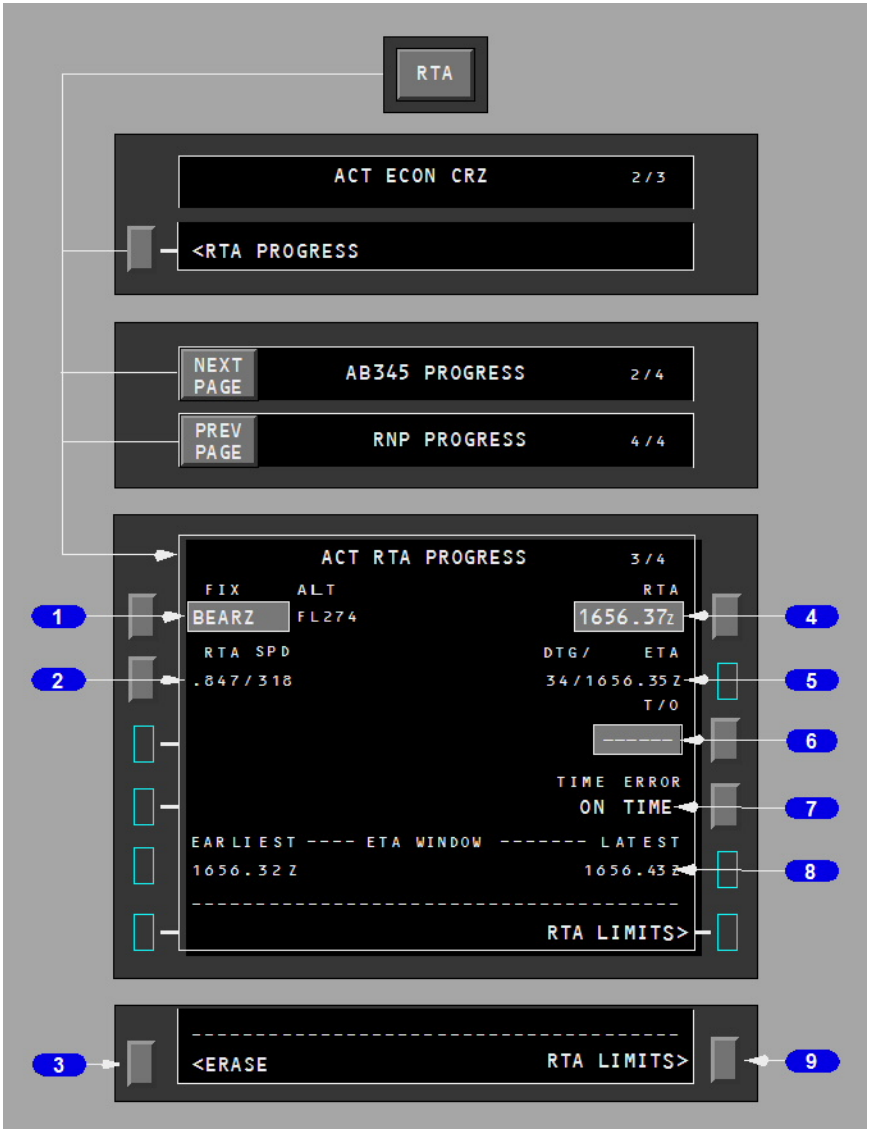
Displays fuel consumed by the APU as sensed by fuel flow meters.

Blank until valid APU fuel flow exist.

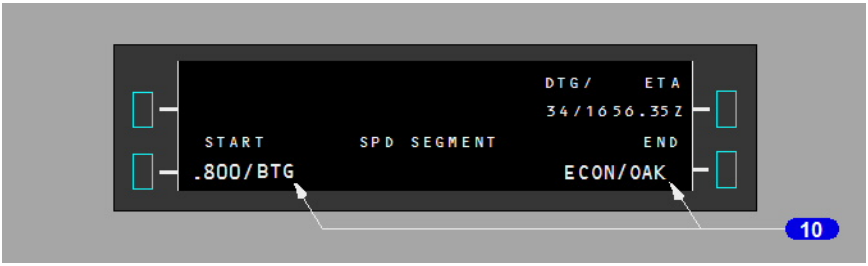
When the APU is turned off, total fuel used by the APU remains displayed and the value is used in the total fuel used calculation.

RTA Progress Page 3

Progress page three is used to enter data for required time of arrival (RTA). RTA can be entered or changed during preflight or in flight. Creating an RTA changes CRZ page title to RTA CRZ. The RTA function operates in the climb, cruise, and descent phases.


RTA
ACT ECON CRZ 2/3
<RTA PROGRESS
NEXT PAGE
AB345 PROGRESS 2/4
PREV PAGE
RNP PROGRESS 4/4
ACT RTA PROGRESS 3/4
FIX
ALT
RTA
BEARZ
FL274
1656.37Z
RTA SPD
DTG/ ETA
.847/318
34/1656.35Z
T/O

TIME ERROR
ON TIME
EARLIEST ---- ETA WINDOW ------- LATEST
1656.32Z
1656.43Z
RTA LIMITS>
<ERASE
RTA LIMITS>
1
2
3
4
5
6
7
8
9



1 FIX ALT

Valid entry is a waypoint in the active or pending active route. Waypoints defined by coordinates must be down selected to the scratchpad, then selected to the FIX line.

Entry by flight crew or datalink.

Entry displays boxes in 1R and RTA in the line title and DTG/ETA in 2R line title.

Displays calculated altitude at the RTA FIX.

When RTA is active, deletion of FIX terminates RTA and resumes ECON. Display returns to boxes.

When RTA is not active, deletion of FIX erases a pending RTA MOD. Display returns to boxes.

Displays boxes when an active or modified route exists.

Displays blank if engine out has been selected.

2 Required Time Of Arrival (RTA) Speed (SPD)

Displays RTA speed to arrive at the RTA fix as close as possible to the RTA time, subject to applicable speed limits.

Blank when RTA fix is not entered.

3 Displays ERASE when modification pending

Select—displays previous unmodified page, or if no previous active values, deletes RTA in 1R.

4 Required Time Of Arrival (RTA)

Boxes display after entry of RTA FIX in 1L.

Valid entry is time from 0000.00 to 2359.59. Entry of seconds is optional.

Suffix to RTA indicates:

- no suffix—arrive at entered time
- A—arrive at or after entered time

- B—arrive at or before entered time.

Entry before takeoff causes recommended T/O time to display in small font.

Deletion terminates RTA and returns ECON as the command speed.

5 Distance To Go (DTG)/Estimated Time Of Arrival (ETA)

Displays calculated altitude and ETA at RTA fix after entry of FIX in 1L.

Blank until performance data is entered.

6 Recommended Takeoff (RECMD T/O)

Displays T/O in line title and dashes until FIX entered.

Displays RECMD T/O in line title on the ground when a performance calculated takeoff time to meet an entered FIX displays on the data line.

Displays NOW in the data line when no takeoff time has been entered and the current time is later than the calculated time to meet an RTA at ECON speed.

Valid entry is time from 0000.00 to 2359.9. Entry of seconds is optional.

Manual entry recalculates all flight plan time predictions.

Blanks in flight.

7 Time Error

Displays "ON TIME" when the airplane will arrive at the RTA fix time

Displays "EARLY MM:SS" when the ETA at the RTA fix is earlier than the RTA fix time. MM:SS is the time before the RTA time.

Displays "LATE MM:SS" when the ETA at the RTA fix is later than the RTA fix time. MM:SS is the time after the RTA time.

Blank when RTA fix is not entered.

8 ETA Window

Displays the earliest/latest time the airplane can arrive at the RTA fix.

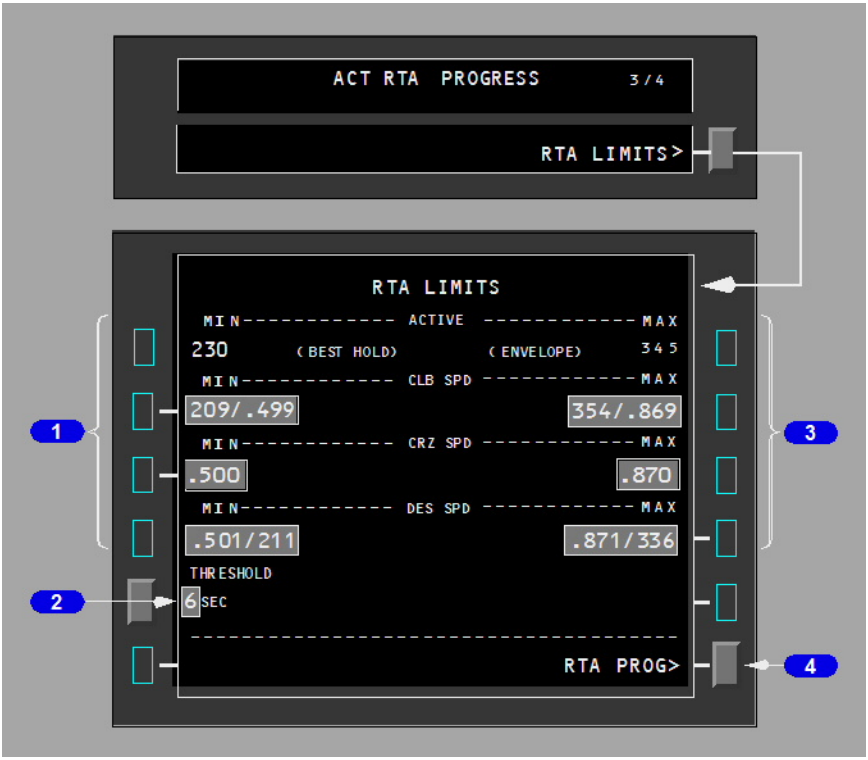
9 RTA LIMITS

Select - displays RTA Limits page.

10 Cruise Speed Segment

Displays cruise speed segment start and end waypoints.

Selection of the RTA LIMITS prompt displays the RTA LIMITS page.



1 Minimum (MIN)

Blank when RTA fix and time not entered. Displays the active minimum speed limit for the RTA and the basis for the limit. BEST HOLD displays when limited by the best hold speed, ENVELOPE displays when limited by the airplane operational envelope, and RTA MIN displays when limited by minimum speed for the RTA function.

Minimums display the default or crew entered minimum speeds by flight phase.

2 Threshold

Displays default, crew entered, or uplinked RTA threshold. If the ETA to the RTA fix is not within the threshold, the EICAS message UNABLE RTA displays.

The threshold does not apply to an early arrival to an At-or-Before RTA or to a late arrival to an At-or-After RTA.

3 Maximum (MAX)

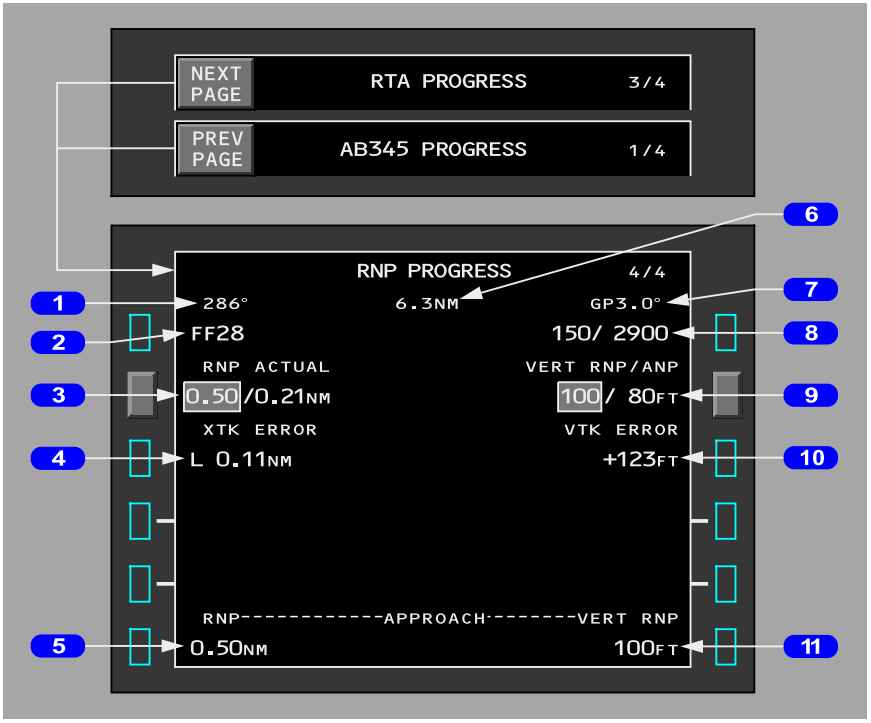
Blank when RTA fix and time not entered. Displays the active maximum speed limit for the RTA and the basis for the limit. THRUST displays when limited by available thrust, ENVELOPE displays when limited by the airplane operational envelope, and RTA MAX displays when limited by the maximum speed for the RTA function.

4 RTA Progress (PROG)

Select - displays RTA PROGRESS page.

RNP Progress Page 4

Progress page four displays concise RNP information. Some of the information on page 2 has been repeated to display all related RNP information together.



1 Leg Direction

Leg segment data in line title:

- arcs—distance in miles, ARC, turn direction (example: 24 ARC L)

- courses—magnetic (xxx°) or true (xxx° T)
- heading leg segments—xxx° HDG
- special procedural instructions from database—HOLD AT, PROC TURN, or PROC HOLD (FMC exits hold when crossing the fix after entry)
- track leg segments—xxx° TRK.

Calculated great circle route leg directions may be different than chart values.

Dashes display for an undefined course.

2 Waypoint Identifier

Displays the next waypoint.

3 Required Navigation Performance and Actual Navigation Performance (RNP /ACTUAL)

Display same as 5L POS REF 2/4. Manual entry displays in large font; propagated to 5L POS REF 2/4 page.

4 Crosstrack Error (XTK ERROR)

Displays present crosstrack error from the desired LNAV course. L or R indicates left or right of course. Errors in excess of 99.99 NM display as 99.99 NM.

5 Lateral RNP (Approach)

Displays the lowest applicable RNP (initial, intermediate, or final segment) for the selected approach.

Entry not allowed at 6L. Manual entry at 2L displays in large font.

Displays RNP from navigation database, if available. If not available, displays the default RNP for the approach flight phase from the FMC. Both display in small font.

6 Distance To Go

Displays the distance remaining to the next waypoint.

7 Glidepath

Displays the FMC computed glidepath for the approach.

8 Waypoint Speed/Altitude

Displays waypoint speed or altitude constraints in large font. Displays FMC predicted value in small font when no restrictions have been specified.

9 Vertical Navigation Performance

Displays both vertical RNP and ANP for the current leg.

Valid display range for vertical ANP is 0 to 999 feet.

Manual entries are allowed and display in large font.

Valid entries are 10 to 999 feet and may be suffixed with an optional "/".

Entries clear at flight completion.

Values from the navigation database display in small font.

10 Vertical Track Error (VTK ERROR)

Displays present vertical error from the FMC computed glidepath.

11 Vertical RNP (Approach)

Displays the lowest applicable vertical RNP for the approach.

Manual entries (entered in 2R) display in large font.

Values from the navigation database display in small font.

Introduction

The descent phase starts at the top of descent point and continues to the end of descent point. Planning for the descent phase starts during cruise.

The approach phase starts when the airplane is in the descent phase and flaps are out of up. In general, the approach starts no later than sequencing the final approach fix. (See Approach on page 11.31.3 for additional information.)

Alternates are available from preflight through approach phase of flight and can be selected or updated at any time. Diversion to an alternate can be accomplished during all phases of flight.

The only automatic page change in the descent/approach phases is the VNAV selected page change from cruise to descent at the top of descent. (See Early Descent on page 11.31.30 for additional information.)

Descent

During descent, LNAV is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

During descent, the specific page listed below is used to:

- DESCENT FORECAST page—enter forecast wind data to aid descent planning
- OFFPATH DES page—analyze descent performance with and without the use of speedbrakes
- ALTN page—manage the selection of alternate airports and diversions.

Altitude Intervention

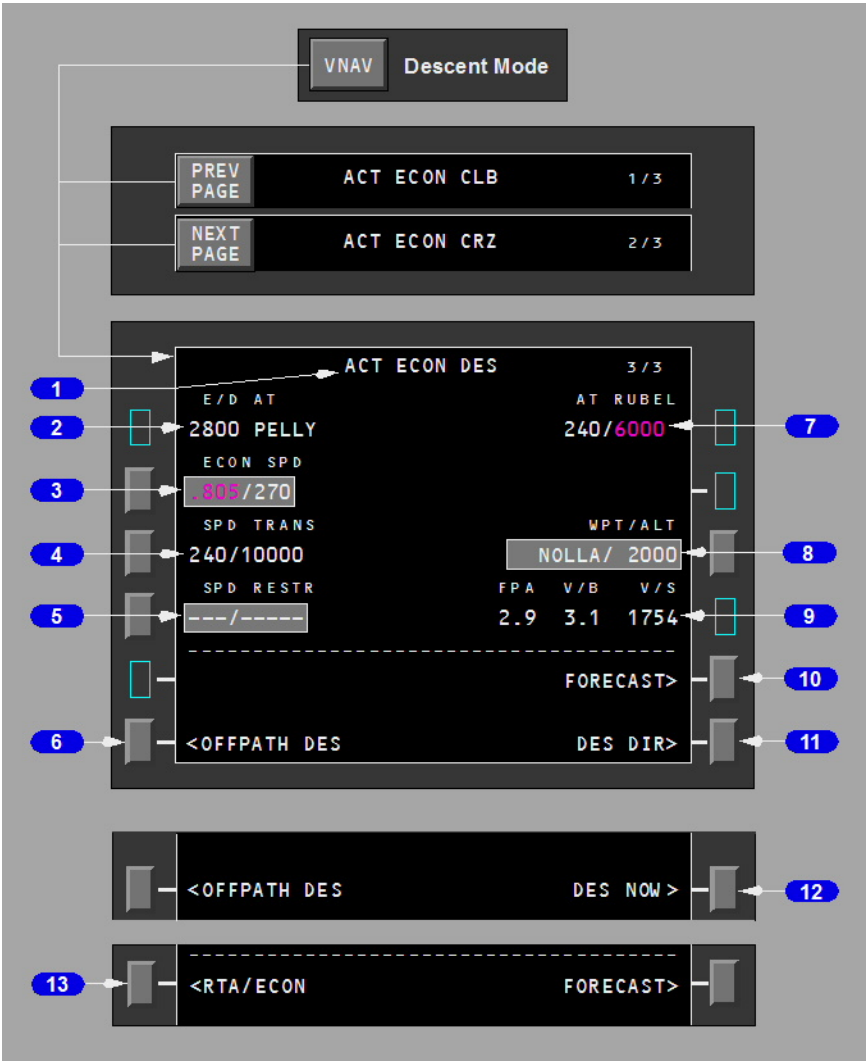
If an unplanned level-off is required, setting the altitude window to the required altitude causes the airplane to level at the set altitude. VNAV PTH changes to VNAV ALT. The descent can be continued by setting the altitude window to a lower altitude and pushing the altitude selector. If the altitude window is set to an altitude below other altitude constraints, each altitude constraint can be deleted by each push of the altitude selector. Or, all waypoint altitude constraints between the current airplane altitude and the altitude window setting can be deleted by selection of the DES DIR> prompt on the DES page.

Descent Page

The descent page is used to monitor and revise the descent path. Descent speeds are economy (ECON) and fixed speed (SEL). The default VNAV descent mode is ECON. A fixed speed descent is flown when speed intervention is used

or a speed is entered on the DES page. The descent page is blank with DES as the title until an altitude constraint below the cruise altitude is entered.

This page title includes the VNAV speed mode. The ECON mode controls descent speed at the economy speed until reaching a lower speed restriction. The fixed speed mode controls descent speed at the fixed speed until a lower speed restriction is reached.



1 Page Title

The page title displays active (ACT) or modified (MOD) descent. Usually, the title displays ECON for economy descent. Fixed speed descents modify the title.

The page title displays the type of descent:

- ECON—speed based on a cost index
- LIM SPD—speed based on airplane configuration limiting speed
- MCP SPD—MCP speed intervention is selected
- XXXKT—fixed CAS descent speed profile
- M.XXX—fixed Mach descent speed profile
- END OF DES—E/D AT waypoint reached if not followed by a climb segment.

Fixed descent speeds are for:

- a flight crew entered selected speed (SEL SPD)
- a speed transition
- a speed restriction associated with an altitude constraint
- waypoint speed constraints.

2 End Of Descent At (E/D AT)

Displays the end of descent altitude and waypoint.

The end of descent point is a waypoint in the descent phase with the lowest altitude constraint.

The altitude displays in magenta when altitude becomes the FMC altitude target.

Page is blank if no E/D point exists.

3 Economy Speed (ECON SPD), Selected Speed (SEL SPD)

Both CAS and Mach values display.

ECON SPD—

- economy speed based on cost index
- displays CAS and Mach values.

SEL SPD—

- displays when flight crew enters speed
- displays constraint speed on transition into a selected speed segment (waypoint speed constraint, SPD RESTR, or SPD TRANS)
- valid entries are CAS or Mach.

RTA SPD - displays when an RTA is active.

The FMC commanded speed is magenta. Initially, Mach is magenta and CAS is white. Below CAS/Mach transition altitude, CAS is magenta and Mach is white.

4 Speed Transition (SPD TRANS)

The transition speed is usually 10 knots less than the destination airport limiting speed from the navigation database. When no airport limit speed exists, the default speed of 240 knots displays. The transition altitude is the point the transition speed is active for the destination airport. When no altitude exists in the navigation database, the default of 10,000 feet displays.

Speed displays in magenta when it is the FMC speed target.

Blanks below SPD TRANS altitude.

Deleting causes the airplane to fly economy or selected speed if not limited by a waypoint constraint or speed restriction.

5 Speed Restriction (SPD RESTR)

Speed restrictions at altitudes higher than E/D altitude and not associated with specific waypoints are manually entered on this line.

Valid entry is a CAS and altitude (example 240/8000). Entry may be deleted.

Magenta when it is FMC command speed.

6 Off Path Descent (OFFPATH DES)

Select—displays the OFFPATH DES page.

7 AT XXXXX

Displays the next waypoint constraint from the RTE LEGS page.

XXXXX is:

- the waypoint identifier
- HOLD AT XXXXX
- AT VECTORS
- AT (INTC).

The constraint is speed/altitude. Blank when no constraint exists.

Can be deleted on this page.

VNAV commands the lesser of constraint speed or present performance speed.

Speed and/or altitude display in magenta when they are the FMC target values.

8 Waypoint/Altitude (WPT/ALT)

Displays the reference vertical bearing waypoint identifier and altitude.

Displays pilot entered waypoint/altitude data if entered.

Defaults to the next descent waypoint constraint (displayed in 1R) if no pilot entry.

For window altitude constraints, displays the upper altitude if the airplane is above it, otherwise the lower altitude is displayed.

Displays dashes if no constraint exists in the descent portion of the flight plan.

Valid entry is any waypoint/altitude combination where the waypoint exists in the Nav Database, or in the flight plan (including lat/long waypoints and reporting points) and the altitude is below the current airplane altitude.

9 Flight Path Angle (FPA), Vertical Bearing (V/B), Vertical Speed (V/S)

Display is blank if no waypoint/altitude combination is displayed at line select key 3R or if the airplane is below the altitude displayed at line select key 3R.

FPA—

- Displays the current flight path angle of the airplane
- Display is blank for FPA greater than positive 0.05º.

V/B displays the calculated vertical bearing required to achieve the waypoint altitude displayed at line select key 3R.

V/S displays the vertical speed required to achieve the waypoint altitude displayed at line select key 3R.

10 FORECAST

Select—displays the DESCENT FORECAST page.

11 Descend Direct (DES DIR)

Select—deletes all waypoint altitude constraints between the airplane altitude and the MCP altitude. FMC cruise altitude is not affected.

Displays in descent phase with altitude constraint between airplane and E/D.

12 Descend Now (DES NOW)

Select—

- activates the FMC descent phase
- starts a 1,250 feet per minute descent schedule until intercepting the planned descent path.

Displays when the descent phase is not active.

13 Required Time Of Arrival (RTA)/Economy (ECON)

RTA

- Select—activates RTA speed. Displays ECON prompt.
- Displays when an RTA waypoint has been entered and ECON is the active descent speed.

RTA/ECON

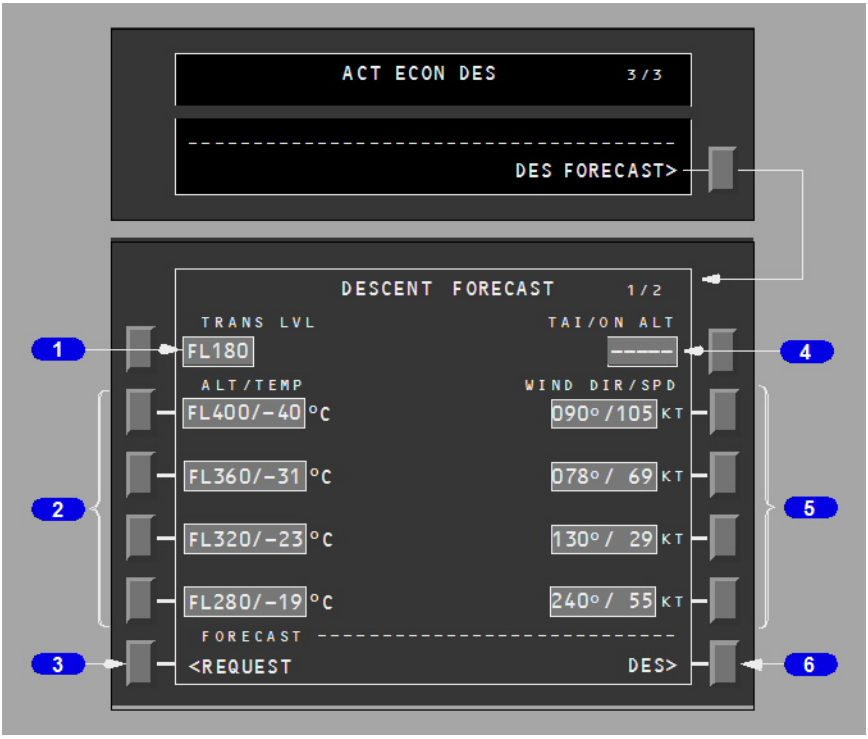
- Select—activates RTA speed.

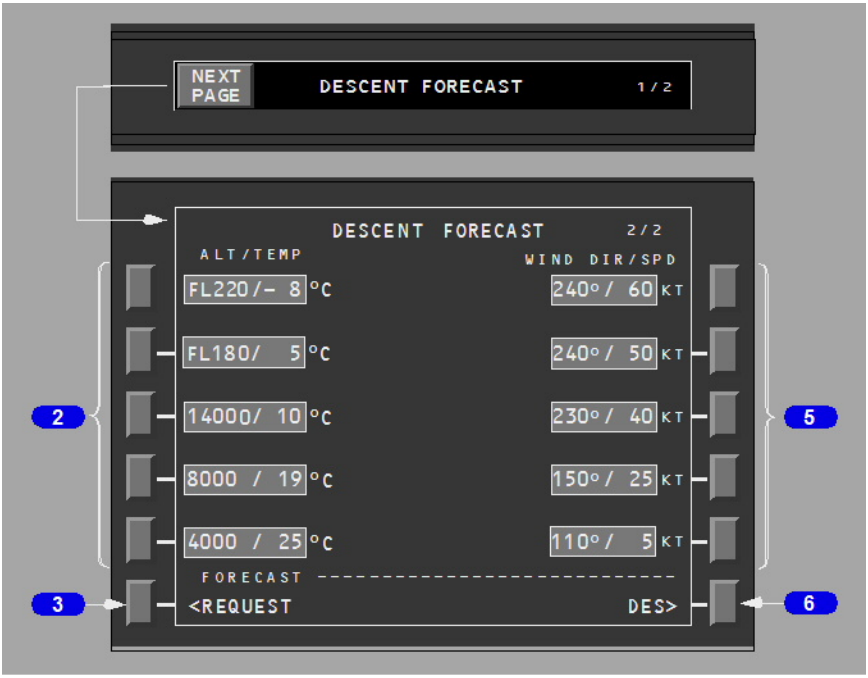
- Displays when an RTA waypoint has been entered and SEL SPD is the active speed.

Descent Forecast Page

The descent forecast page is used to enter wind data for descent, and the altitude at which anti–ice use is anticipated for more accurate descent path calculation.

Entries are wind direction/speed, temperature for up to nine altitudes, and the altitude anti–ice is turned on.





1 Transition Level (TRANS LVL)

Displays the transition level.

The transition level can be specified by the arrival procedure. The default transition level is FL180.

Above transition level, altitudes are in flight levels. Below transition level, altitudes are in thousands of feet.

Valid entry is an altitude or flight level.

2 Altitude/Temperature (ALT/TEMP)

Displays entered or uplinked altitudes and temperatures in large font.

Temperatures are interpolated between altitudes when shown in small font.

3 FORECAST REQUEST/LOAD

Select—REQUEST or LOAD.

REQUEST—sends a downlink request for descent forecast.

LOAD—loads descent forecast and initiates a downlink response.

4 Thermal Anti–Ice On Altitude (TAI/ON ALT)

Enter the altitude where anti-ice is first turned on during the descent.

5 Wind Direction/Speed (WIND DIR/SPD)

Displays entered or uplinked wind direction and speed in large font.

6 Descent (DES)/PURGE

Select—DES or PURGE

DES—shows VNAV DES page.

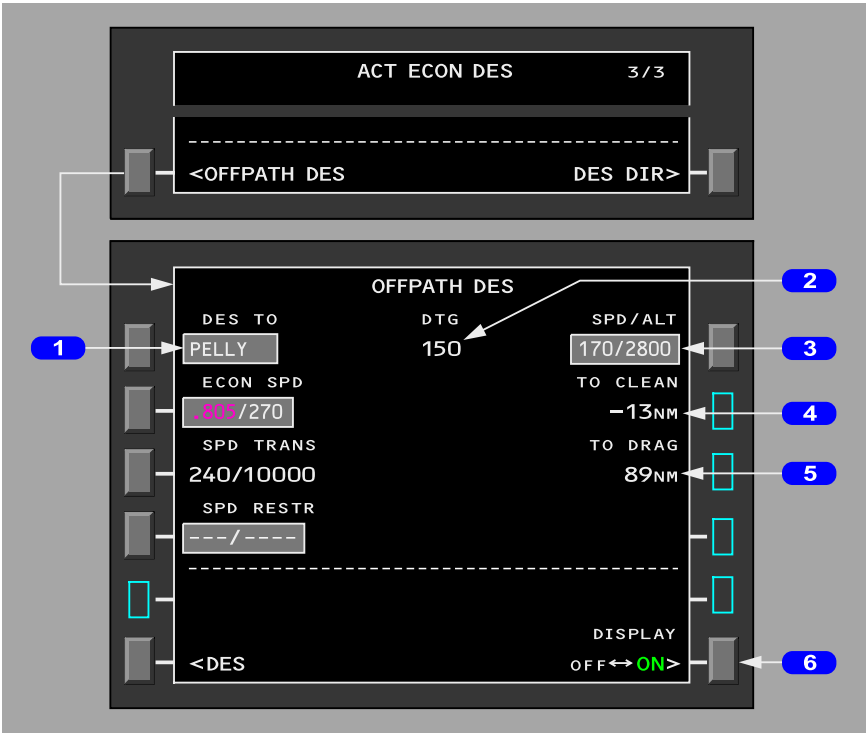
PURGE—clears the pending descent forecast status and initiates a downlink response.

Offpath Descent Page

The offpath descent page allows the analysis of descent performance off the present route of flight, direct to a selected waypoint. Data entered on the page shows clean and drag descent ranges on the page and on the ND. The ranges are based on an entered waypoint and altitude constraint. The range can be used to determine if the altitude constraint can be met in a direct descent to the waypoint.

The FMC puts the last descent waypoint with an altitude constraint into DES TO.

The ECON SPD, SPD TRANS, SPD RESTR, and DES data are the same as the DES page.



1 Descend To (DES TO)

The waypoint for a direct-to descent. Usually, this is the E/D waypoint from the active route. Manual entry of waypoints on or off of the route are allowed. The DTG calculations are for a descent direct to the selected waypoint.

When within 150 feet of the DES TO altitude for a waypoint other than the E/D waypoint, the display automatically changes the DES TO waypoint to the E/D waypoint from the DES page.

A waypoint is entered for direct–to analysis.

2 Distance To Go (DTG)

Displays the straight line distance to the entered waypoint.

3 Speed/Altitude (SPD/ALT)

Displays the speed/altitude constraint for the entered waypoint.

A manual waypoint entry displays boxes for manual speed and altitude entry.

4 TO CLEAN

Distance to the clean descent circle. The distance is negative when a clean descent is no longer possible.

A clean circle assumes no drag devices are used for descent.

A direct descent to the DES TO waypoint at a SPD/ALT constraint is possible when the airplane is outside the clean circle. The clean circle displays on the ND when the DISPLAY prompt is ON.

5 TO DRAG

Distance to the drag descent circle. The distance is negative when a drag descent is no longer possible.

A drag circle assumes speedbrakes are UP for descent.

A direct descent to the DES TO waypoint at a SPD/ALT constraint is possible when the airplane is outside the drag circle. The drag circle displays on the ND when the DISPLAY prompt is ON and the airplane is inside the clean circle.

6 DISPLAY

Select—alternates between ON and OFF.

ON—displays the clean and drag circles on the ND. The drag circle does not display until the airplane position is inside the clean circle.

OFF—removes the clean and drag circles from the ND.

Selected state is large green font, otherwise small white font.

Automatically changes to OFF within 150 feet of the waypoint constraint altitude.

Engine Out Descent

There are no specific engine out pages for descent. Use the two engine descent planning features and pages.

Approach

During approach, roll and pitch modes usually change to the approach guidance supplied by navigation radios. The FMC continues to calculate and show present position and can supply LNAV and VNAV approach guidance for certain types of approaches when radio navigation is not used.

The RTE LEGS and PROGRESS pages are used to manage the airplane until other approach guidance becomes active. Other pages which support approaches are:

- ARRIVALS page—to select arrival and approach procedures
- APPROACH REF page—to specify approach flap settings and set the approach VREF

- HOLD page—to manage holding patterns.

Holding is described in this section but it can be used during any phase of flight.

Accessing the arrivals page more than 400 NM from the departure airport or more than halfway along the active route displays arrivals for the destination airport. Prior to these points, accessing the arrivals page displays arrivals for the departure airport.

Arrivals Page

The arrivals page allows selection of a runway, approach, approach transition, standard terminal arrival route (STAR) or profile descent, and an arrival transition to the destination airport.The INDEX key accesses the DEP/ARR INDEX and provides arrival/departure data for any other airport in the navigation database. Route 1 and route 2 have separate arrival pages.

Airports are using multiple RNAV/ILS approaches to the same runway. ICAO has developed a naming convention which adds an additional character to the approach name; Z, Y, X,. in the approach title following the guidance source. The primary approach is identified as the “Z” approach; all subsequent procedures (normally with different missed approach paths) use the alpha characters in reverse order beginning with Y. This change requires approach names with up to eight characters to be encoded in the navigation database.

Selecting Options

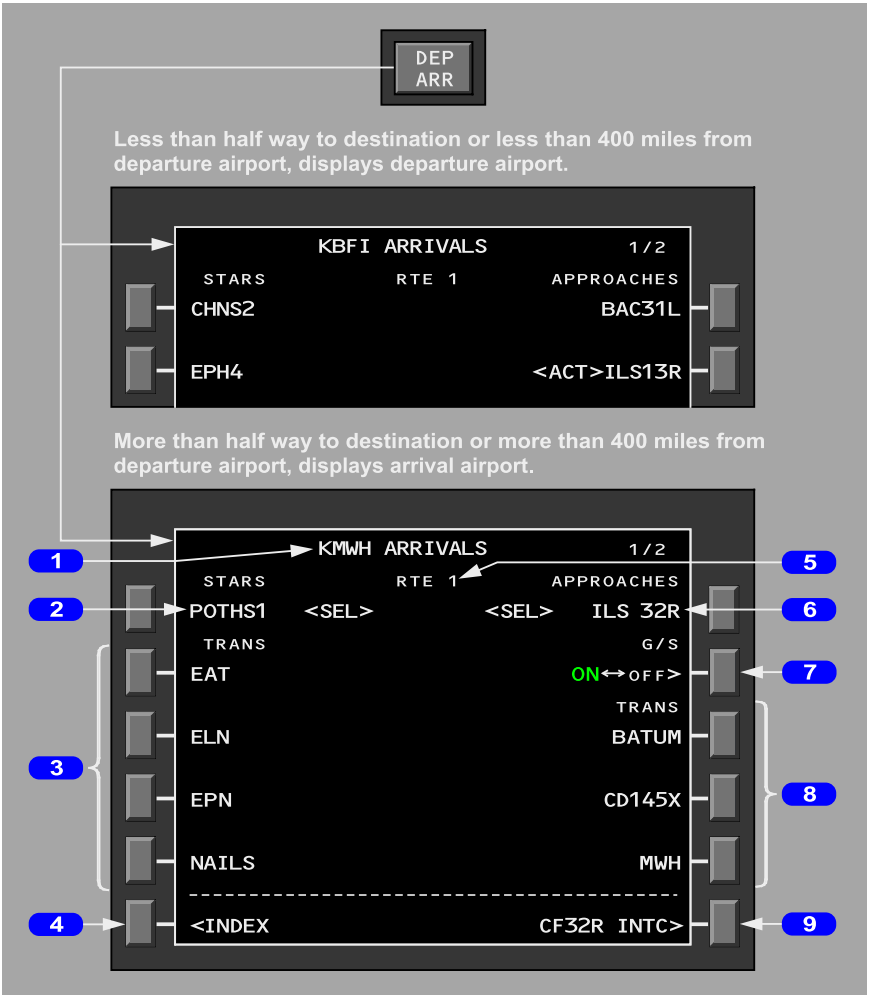
Selecting a runway, approach, approach transition, STAR/profile descent, or arrival transition displays <SEL> inboard of the selection and displays MOD in the page title. The other options within the same category are removed from the list. When the modification is executed, <SEL> changes to <ACT>. Selecting another page and returning to ARRIVALS displays all options; the applicable <SEL> or <ACT> prompts display.

When a STAR is selected followed by selection of an approach or runway and a transition exists in the navigation database, the transition waypoints with associated speed/altitude constraints are inserted into the flight plan linking the STAR to the approach or runway. If more than one transition exists, selection of the applicable transition is made under TRANS on the left side of the page. Some STARs serve more than one runway. If a STAR and runway are selected and subsequently a different runway is selected, and if the STAR is compatible with the new runway, the transition waypoints are inserted into the flight plan linking the STAR to the runway.

If a different STAR, runway, or STAR-runway combination is desired, selecting another page and returning to the ARRIVALS displays all options.

The VSD RWY DATA failure flag displays until an arrival runway is executed. (See VSD on page 10.10.41 for additional information.)

Arrivals Page—IFR Approaches



1 Page Title

The destination airport identifier displays in the title.

Airports with more than 5 runways or STARs produce multiple arrivals pages.

2 Standard Terminal Arrivals (STARS), Profile Descents (PROF DES)

STARS display in a list under the STARS line title. Profile descents display below STARS under the PROF DES line title.

NONE displays when there are no STARS in the database.

Select—

- selects STAR or PROF DES for entry into the route, <SEL> displays
- all other arrival procedures no longer display and transitions for the selected procedure display
- deletes a previously selected procedure
- displays ERASE prompt.

3 STAR Transitions (TRANS)

Displays list of transitions for the selected arrival procedure.

Select—

- selects transition for entry into the route
- all other transitions no longer display.

4 INDEX

Select—displays the DEP/ARR INDEX page.

5 Route 1 (RTE 1)

Displays the active route number (RTE 1 or RTE 2).

6 APPROACHES

Displays the destination airport approaches.

ICAO eight character approach names are supported. Example: RNVZ 08R.

Selection and execution of an ILS approach autotunes the ILS receivers and displays the course. Selection and execution of a back course (B/CRS) approach autotunes the ILS and displays the front course.

Select—

- selects approach for entry into the route; <SEL> displays; TRANS replaces RUNWAYS
- displays profile descents for the selected approach; deletes all other approaches and runways
- displays INTC prompt for the selected approach
- displays ERASE prompt.

7 Glideslope (G/S)

Select—toggles glideslope ON and OFF.

Line is blank if active route does not contain a localizer based approach.

Defaults to ON (green) when an ILS or IGS approach is in the active route.

Defaults to OFF (green) when a LOC, SDF, LDA or B/CRS approach is in the active route.

8 Approach Transitions (TRANS)

Displays a list of transitions to the selected approach.

Approach transitions include IAFs, feeder fixes, and fixes providing routing to the FAF.

When a transition is not selected, the FMC displays a straight-in approach starting at a waypoint 4 to 8 miles outside of the FAF. The waypoint may be conventionally named (i.e. LACRE) or a charted fix (i.e. CFXXX, where XXX is the runway number).

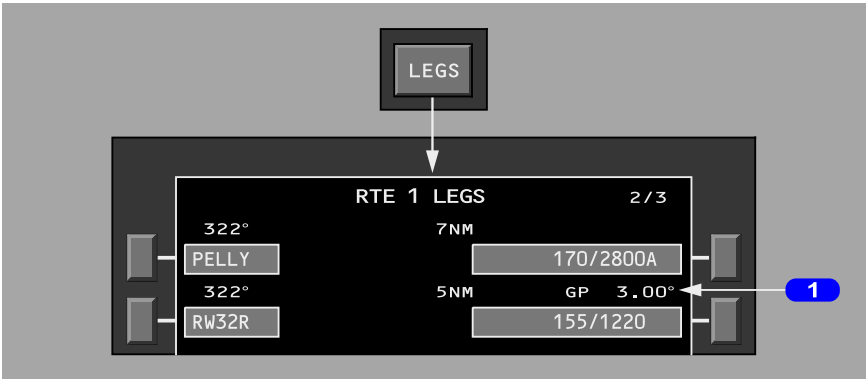
Select—

- selects transition for entry into the route
- deletes all other transitions
- displays INTC prompt for selected transition.

9 Final Approach Fix Intercept (XXXXX INTC)

Selecting the prompt displays a modified RTE LEGS page with an intercept course to the approach transition fix (usually the IAF) for the selected approach.

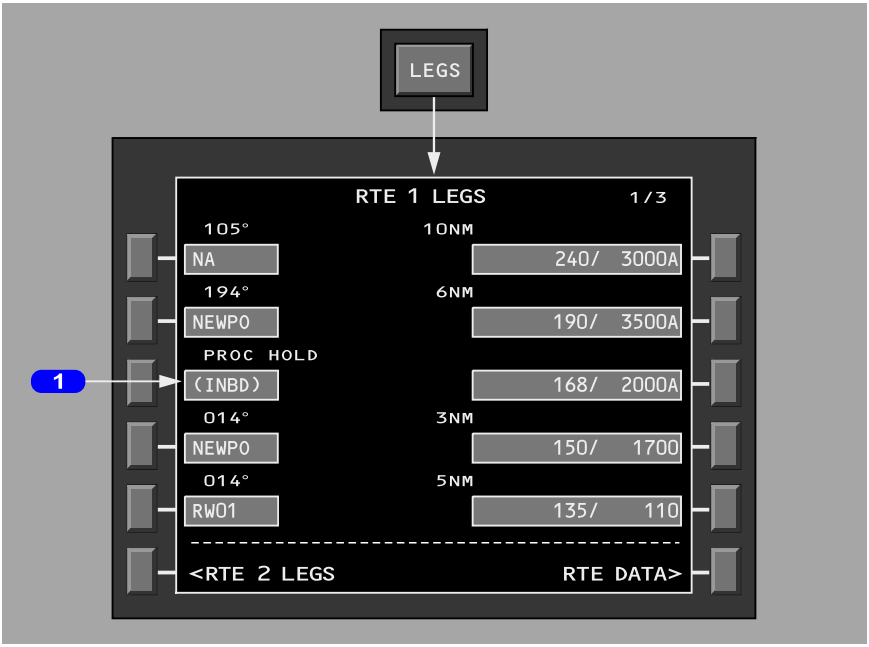
Arrivals Legs Page



1 Glidepath Display

Displays the published glidepath angle from the FMC database for the selected approach to the runway.

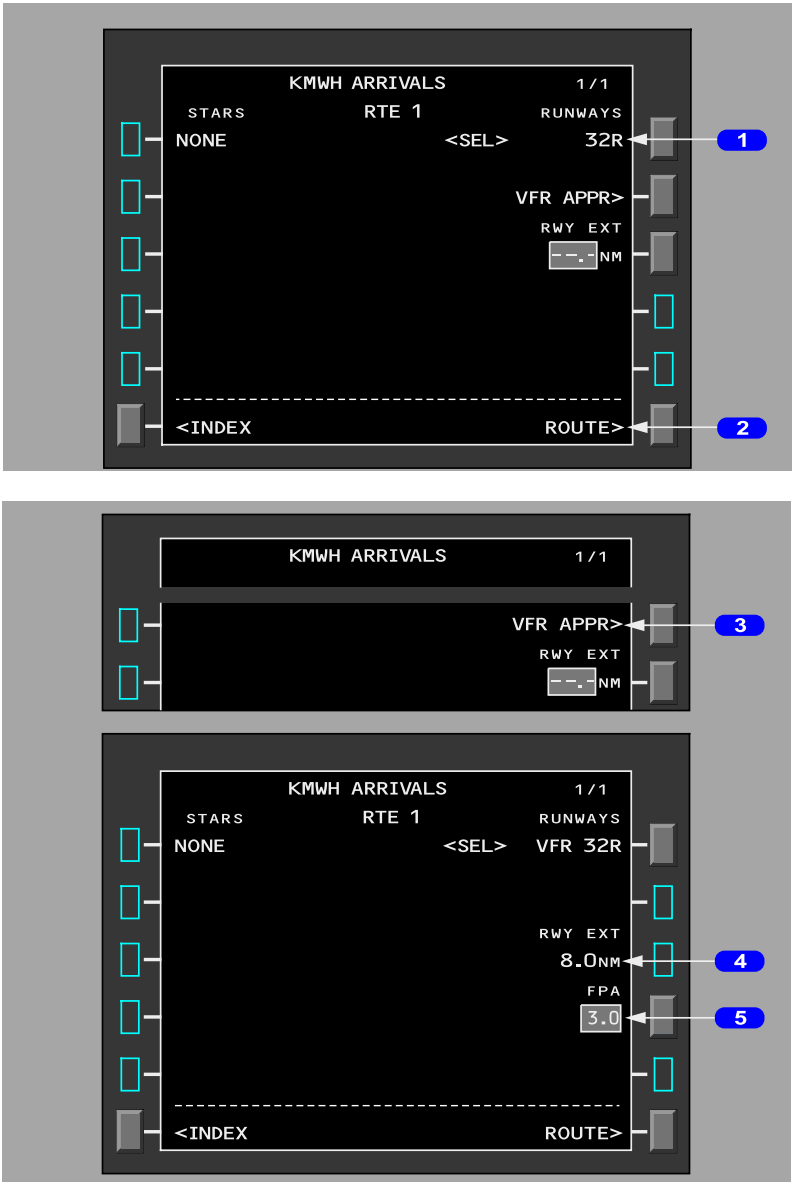
Procedure Hold (in lieu of procedure turn) Legs Page

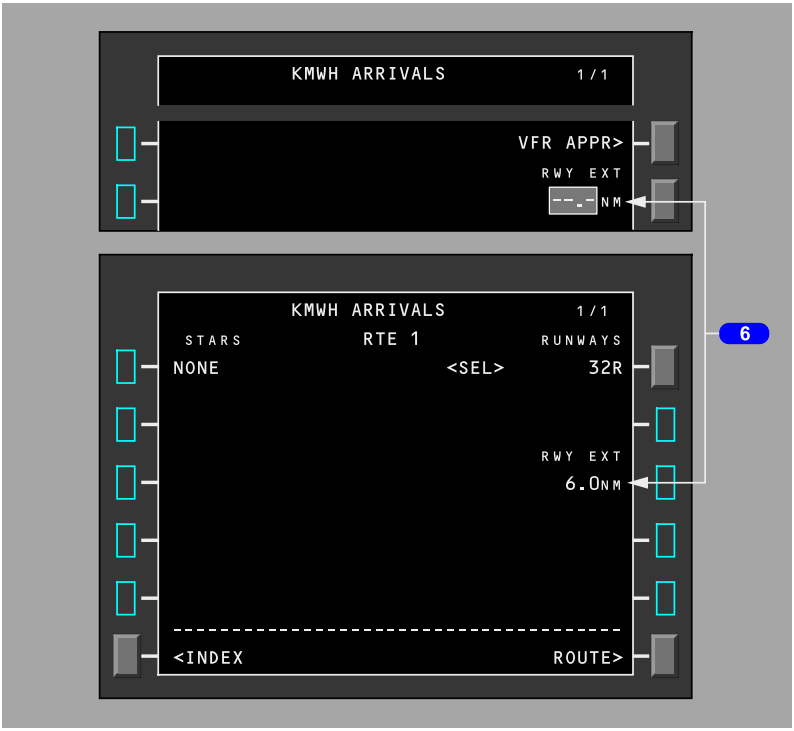


1 Inbound Waypoint

A conditional waypoint (“INBD”) is created at the end of the procedure turn. This waypoint displays on the ND as a small circle. The next line displays inbound heading and distance to the holding fix. The procedure hold is not displayed on a Hold page.

Arrivals Page—VFR Approaches





1 RUNWAYS

Displays a list of runways for destination airport.

Select—

- selects runway for entry into the route
- deletes previously selected approach
- allows selection of VFR approach or entry of RWY EXT data
- deletes all other runways and approaches
- displays approach intercept fix for selected runway.

2 ROUTE

Select—displays the active route page 2/X.

3 VFR Approach (VFR APPR)

Select—makes a transition waypoint, FAXXX at 8 NM and 2000 feet above the runway.

Creates a descent constraint 50 feet above runway threshold.

Displays when a VFR approach is in navigation database for selected runway.

LNAV and VNAV guidance to the runway is available. VNAV programs arrival at the FAF at 170 knots.

4 Runway Extension (RWY EXT)

After VFR APPR selected, displays RWY EXT 8.0 NM; RWY EXT can not be modified.

5 Flight Path Angle (FPA)

Displays flight path angle. Displays only after VFR APPR is selected.

Default is 3.0º. Valid entries are from 2.4º to 3.7º.

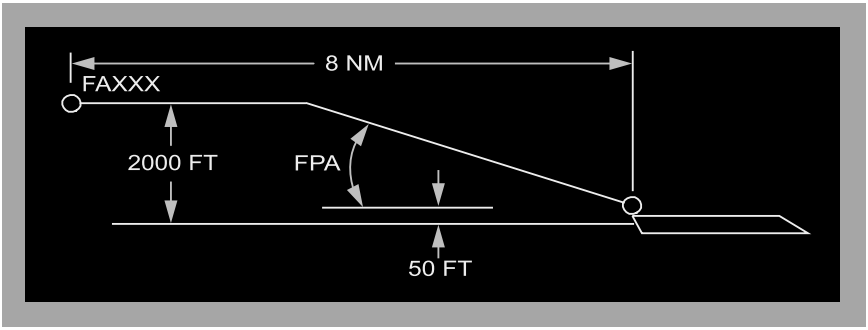
6 Runway Extension (RWY EXT)

Valid entries are from 1.0 to 25.0 miles from the runway threshold.

Entry allowed if VFR APPR is not selected. Entry removes VFR APPR prompt. Example shows 6 NM entered.

Makes waypoint RXYYY, where YYY is the runway; example: RX32R. Makes a route discontinuity before and after the waypoint.

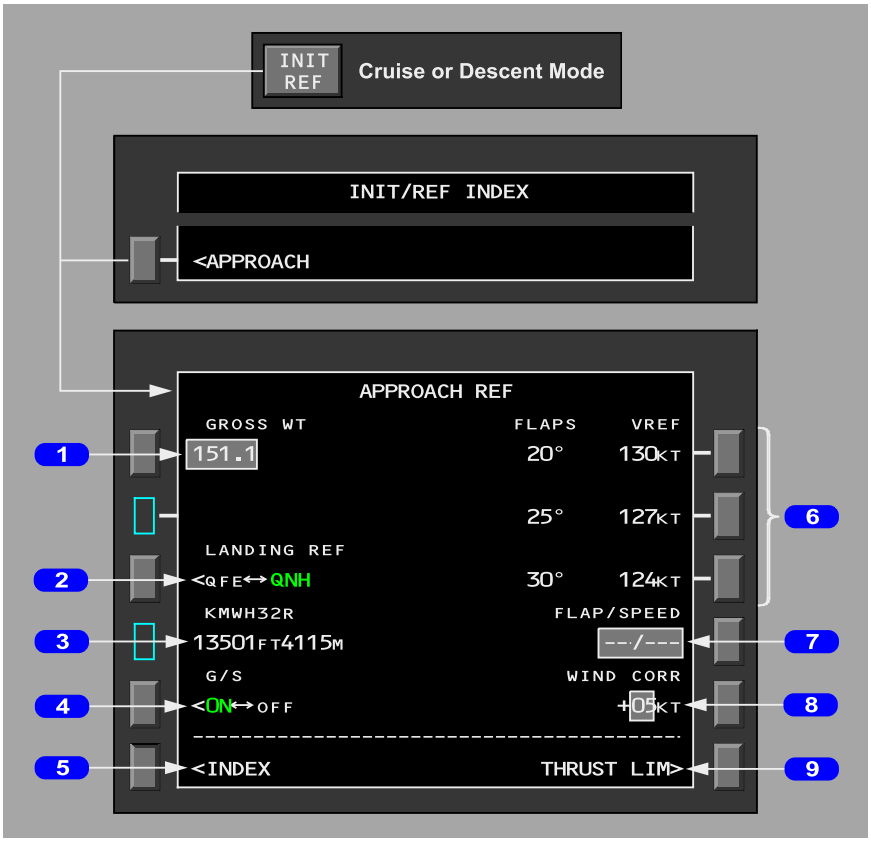
VFR Approach Path



The VFR approach is a level path until the VNAV descent path is intercepted. The descent path begins at the FAXXX waypoint altitude and terminates at the runway threshold at 50 feet. Default values display in RWY EXT and FPA.

Approach Reference Page

The approach reference page displays approach planning data and approach reference speed (VREF) selection.



1 Gross Weight (GROSS WT)

FMC calculated airplane gross weight usually displays.

Manual entry is allowed in case the FMC calculated gross weight is unavailable or invalid, or to allow previewing recommended approach speeds at other than the calculated FMC gross weight. The manually entered gross weight becomes the FMC calculated gross weight when a different page is selected and the APPROACH REF page is reselected. Permanent changes to gross weight result in recalculation of all performance data and may only be made on the PERF INIT page.

Displays boxes when gross weight is not available from the FMC.

Valid entry is XXX.X.

2 Landing Reference (LANDING REF)

Landing reference is selectable between QNH and QFE. Usually, QNH is the operating mode.

The active mode displays in large green font. The inactive mode displays in small white font.

Selecting QFE sets the cabin pressurization schedule, and the destination landing altitude indication to zero altitude. With the landing reference set to QFE, changing the barometric setting from STD to QFE changes the PFD altitude tape background color to green. With QFE selected and climb phase active, changing the barometric setting from QFE to STD causes the landing reference to toggle from QFE to QNH and the green background color is removed. (See QFE Operation on page SP.10.1 for additional information.)

3 Runway Length

The displayed runway reference changes based on route progress. The destination runway is the reference when the present position is more than halfway to the destination or more than 400 NM from the origin airport. The origin airport runway is the reference when less than halfway or less than 400 NM from the origin airport.

Displays length of the new destination runway following a change of destination on the ROUTE page or following execution of a DIVERT.

Displays the length in feet and meters of the referenced runway.

4 Glideslope (G/S)

Select—toggles glideslope ON and OFF.

Line is blank if active route does not contain a localizer based approach.

Defaults to ON (green) when an ILS or IGS approach is in the active route.

Defaults to OFF (green) when a LOC, SDF, LDA or B/CRS approach is in the active route.

5 INDEX

Select—displays the INIT/REF INDEX page.

6 FLAPS VREF

A gross weight is necessary for VREF speed calculation. Select the applicable line select key to select the correct VREF speed. The three VREF speeds are based on landing flap setting.

Displays the calculated reference speed for flaps 20°, 25°, and 30°.

Display is blank prior to having a valid gross weight on the PERF INIT page or entering gross weight on this page.

7 FLAP/SPEED

The flap position and VREF speed is entered for landing.

The VREF speed displays on the PFD.

Deletion of the data removes VREF from the PFD.

8 Wind Correction (WIND CORR)

Displays wind correction to be applied to approach speed.

Defaults to 5 KTs.

Valid entry is a speed from 0 to 20 KTs.

9 Thrust Limit (THRUST LIM)

Select—displays the THRUST LIM page.

Alternate Airport Diversions

ALTN page 1/2 data aids the flight crew in finding a suitable alternate airport. The page displays four airports in an ETA sequence. Each airport on the list has an XXXX ALTN page with more data. Select the XXXX ALTN page by selecting the associated right LSK. ALTN LIST page 2/2 may contain a list of uplinked alternate airports.

Three alternate airport uplinks can be received. ALTN page 1/2 can get an uplink for the entire page or for just the ALTN INHIB line. ALTN LIST page 2/2 can receive an uplink of alternate airport names.

Alternate Page 1/2

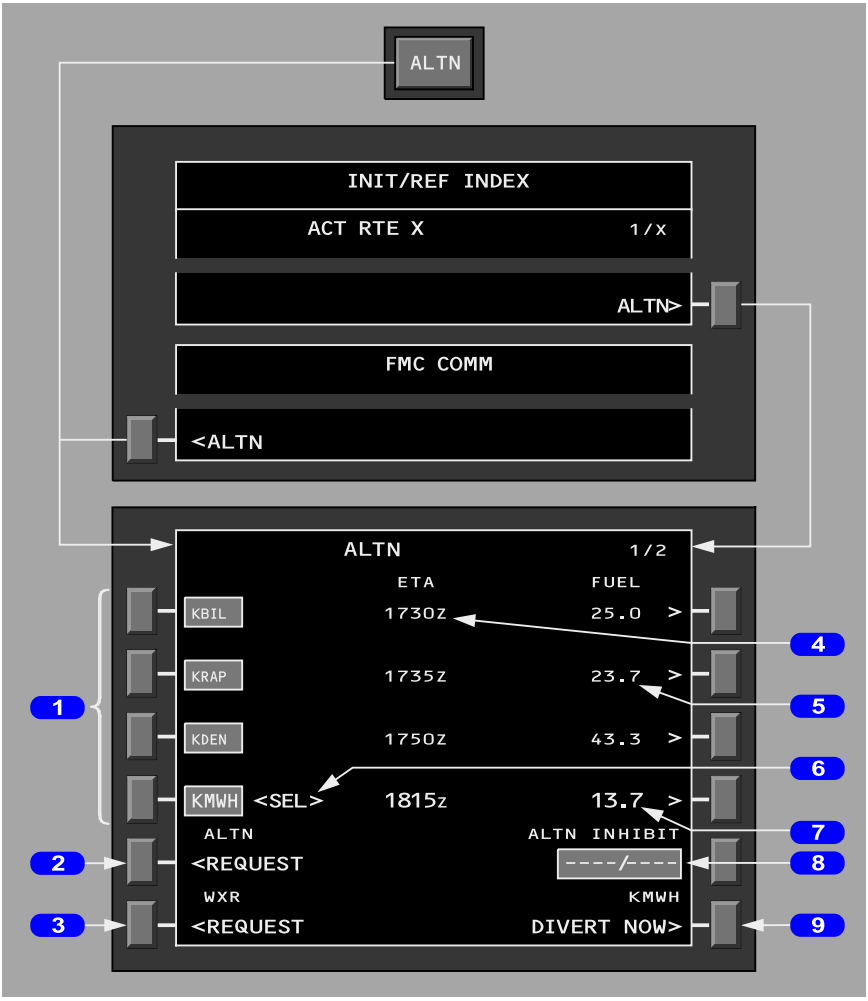
The first alternate page displays alternate airport data. An alternate airport can be selected to change the flight plan destination.

The source of alternate airports can be:

- an uplink directly to this page
- automatic selection from the ALTN LIST page
- automatic selection from the navigation database
- manual entry.

Alternate airports automatically selected from the alternate list or the navigation database display in small font. Alternate airports are displayed on the ND in cyan, when within the displayed map range. The letter A inside the airport symbol identifies it as one of the alternates shown on ALTN page 1/2. In map mode, the selected airport displays at all times. In plan mode, or in map mode with

APRT selected, all four alternates shown on ALTN page 1/2 are displayed. When the 1280 mile map range is selected, alternates that are out of map range are displayed as directional arrows with the ICAO identifier and distance in NM.



1 Alternate Airports

Displays the identifier of the four alternate airports in ETA order when airborne; and, in distance order when on the ground.

Valid manual entry is an airport from the navigation database.

A manual entry into a field displaying a small font value overwrites the small font value, but does not delete it from the Alternates Candidates list. After predictions are complete, the overwritten small font value is placed on the list according to ETA order. A manual entry into a field displaying a large font value overwrites the large font value. Manual entries display in large font.

The DELETE function key can be used to remove manually entered alternate airports from the ALTN page.

2 Alternate Request (ALTN REQUEST)

Select—transmits a datalink request for a preferred list of alternates (up to four).

Uplinked airports display in ETA order but are assigned a preference number by the transmitting site. The CDU help window message ALTN UPLINK is displayed when the alternate airport data arrives.

3 Weather Request (WXR REQUEST)

Select—transmits a datalink request for alternate airport weather data.

4 ETA

ETA is calculated based on the routing, altitude, and speed displayed on the XXXX ALTN page.

Displays the alternate airport ETA.

Blank when airplane is on the ground.

5 FUEL

Predicted arrival fuel is calculated based on the routing, altitude, and speed displayed on the XXXX ALTN page. The message UNABLE FUEL displays in the FUEL column if the predicted arrival fuel is less than zero.

Displays the alternate airport predicted arrival fuel.

Blank when airplane is on the ground.

6 Selected (<SEL>)

The selected alternate is identified with an <A> or <SEL> to the right of the airport identifier.

The FMC selects the alternate airport with the earliest ETA. FMC selected alternates display <A> to the right of the airport identifier.

A manual selection of an alternate airport is made by selecting the line select key left of the airport identifier. Manually selected alternates display <SEL> to the right of the airport identifier.

The selected alternate identifier displays in the line title of the DIVERT NOW prompt.

Entering a new airport into the list of four does not select the new airport.

Use the DELETE function key on a manually selected alternate to remove <SEL>. The automatic selection function selects a new alternate.

7 Alternate Select

Select—displays the XXXX ALTN page for the alternate airport adjacent to the > prompt.

8 Alternate Inhibit (ALTN INHIBIT)

An airport is not one of the four alternate airports if entered into the alternate inhibit line.

One or two airports can be entered.

Alternate inhibits can be manually entered or uplinked. The inhibited airports may be uplinked with the ALTN UPLINK or separately. If uplinked separately, the CDU help window message ALTN INHIBIT UPLINK is displayed.

Valid entries are airports from the navigation database.

9 DIVERT NOW

Selecting DIVERT NOW displays the route from the present position to the selected alternate using the route displayed on the XXXX ALTN page for the diversion airport. The details of the route can be confirmed or modified before the diversion is executed.

Execution of the diversion:

- changes the route destination airport
- includes the route modification into the active flight plan
- deletes all parts of the original route that are not part of the diversion
- if a descent path exists, deletes all descent constraints (the CDU help window message DESCENT PATH DELETED displays when DIVERT NOW is selected).

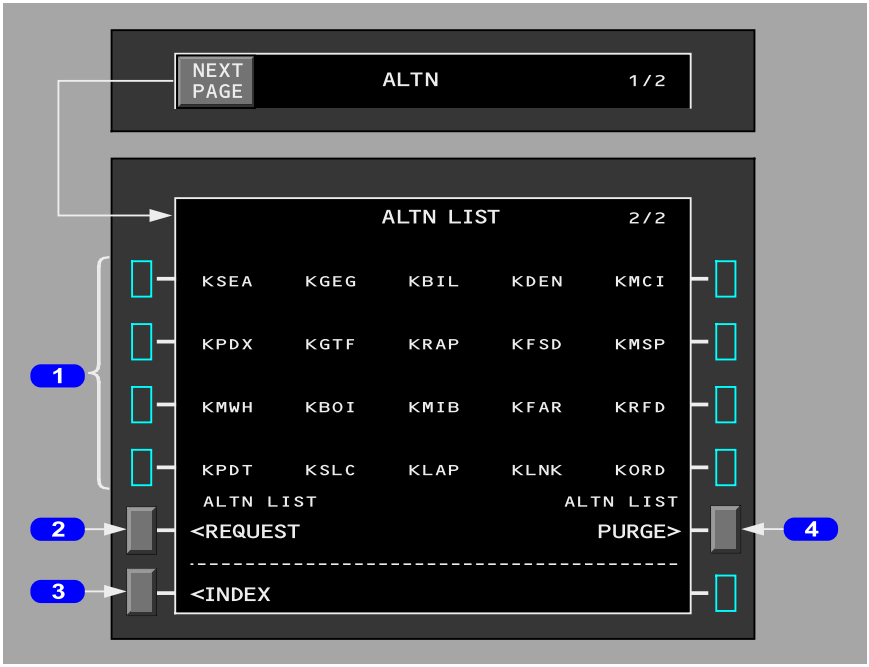
After a divert is executed the XXXX ALTN page is not updated until all CDU displays are selected off of the XXXX ALTN page.

Select—

- makes an LNAV route modification for a divert to the selected alternate
- displays the MOD XXXX ALTN page for the selected alternate
- displays SELECTED with DIVERT XXXX in the line title
- blank on ground
- blank in the air when a diversion is not permitted.

Alternate List Page 2/2

The second alternate page displays a list of previously uplinked alternate airports. The alternates on the ALTN 1/2 page are selected from this list or from the navigation database when a list does not exist.



1 Alternate Airports List

These four lines contain up to 20 airports from which alternates can be selected and displayed on ALTN page 1/2 when preferred uplinked airports do not use all four lines.

The list is uplinked directly to this page. No manual entry is allowed. Manual airport entries are accomplished on the ALTN 1/2 page.

2 Alternate List Request (ALTN LIST REQUEST)

Select—transmits a datalink request for an alternate airport list uplink.

3 INDEX

Select—displays the INIT/REF INDEX page.

4 Alternate List Purge/Confirm (ALTN LIST PURGE/CONFIRM)

When no list exists, alternate airports can be selected from the navigation database.

Selecting the PURGE prompt arms the purge function and displays a CONFIRM prompt before the list is deleted.

Select—deletes all airports from the list.

A new list must be uplinked after a purge.

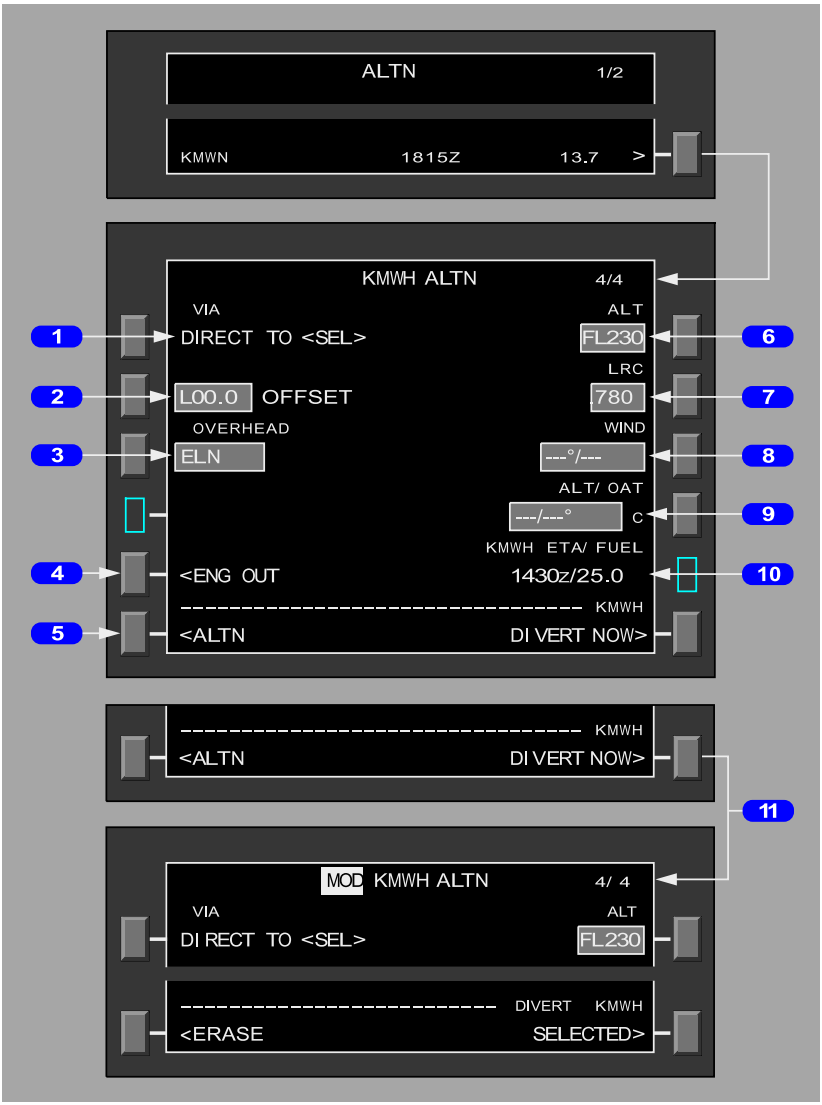
XXXX Alternate Page

Each of the four alternate airports displayed on the ALTN page 1/2 has a related XXXX ALTN page. The XXXX ALTN pages display specific data about alternate airports, the route used for a diversion, and the conditions on which the ETA and fuel calculations are based. All data on the page is related to the alternate airport displayed in the page title.

Three route options to the airport can be selected:

- DIRECT TO—direct to alternate
- OFFSET—flight plan route with an offset
- OVERHEAD—flight plan route to a waypoint, then direct to alternate.

The selected route option has an effect on ETA and fuel remaining. It is identified by <SEL>. Selection of a route option for one alternate selects the same route option for the other three alternates.



1 VIA DIRECT TO

Select—selects DIRECT TO route option.

All flight plan waypoints are deleted.

2 VIA OFFSET

Select—

- with scratchpad empty, selects OFFSET route option
- with offset data in scratchpad, enters offset data. Does not select offset option.

Entry and exit to the offset is the same as for the RTE page offset. Flight plan waypoints are retained.

3 VIA OVERHEAD

Select—

- with scratchpad empty, selects OVERHEAD option
- with overhead data in scratchpad, enters overhead data. Does not select overhead route option.

Displays active waypoint in flight plan.

The waypoints up to the selected or entered overhead waypoint are retained, then routing is direct to the alternate airport. All waypoints after overhead waypoint are deleted.

Enter any waypoint in the active or modified route.

4 Engine Out (ENG OUT)

This prompt performs the same function as described on the cruise page in the FMC Cruise section. It can be selected before or after the diversion is selected.

5 Alternate (ALTN)

Select—displays the ALTN 1/2 page.

6 Altitude (ALT)

Entry of any valid altitude or flight level into this line causes a recomputation of ETA and arrival fuel. Altitude entries do not become part of the diversion modification. Altitude entries apply to all four alternates.

Displays the altitude for which ETA and arrival fuel are calculated.

Altitude entries may be accompanied by one of the following CDU help window messages:

- MAX ALT FLXXX is displayed when entered cruise altitude is greater than maximum altitude (XXX)
- UNABLE CRZ ALT is displayed when the computed top of descent is before top of climb.

7 Speed (SPD)

Entry of speed or Mach number into this line causes a recomputation of ETA and arrival fuel. Speed entries do not become part of the diversion modification. Speed entries apply to all four alternates.

Speed modes available are:

- CO (company speed)
- ECON (economy)
- EO (engine out)
- EO LRC (engine out long range cruise)
- LRC (long range cruise)
- any CAS or Mach.

8 WIND

Entry of data causes recomputation of ETA and arrival fuel. A wind entry may be made for each of the four alternates. A wind entry applies to only one alternate.

Valid entry is a direction in degrees/speed in knots from 1 to 250.

9 Altitude/Outside Air Temperature (ALT/OAT)

Entry of data into these lines causes a recomputation of ETA and arrival fuel. A separate ALT/OAT entry may be made for each of the four alternates.

Displays the OAT for a specific altitude.

Valid entry is an altitude/temperature in degrees Centigrade.

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.

Displays UNABLE FUEL if the fuel prediction for the alternate airport is less than zero.

Displays UNABLE ALT when:

- the entered altitude for an alternate is above the calculated maximum altitude for that alternate
- the entered altitude is above the airplane and the airplane would be past the top of descent for the alternate if it attained the entered altitude
- conditions for UNABLE FUEL and UNABLE ALT both occur.

11 XXXX DIVERT NOW

This prompt performs the same function as described on the ALTN 1/2 page.

Note: After a divert is executed, the XXXX ALTN page data is not updated until all CDU displays change to a page other than the XXXX ALTN page.

Holding

The FMC computes holding patterns with constant radius turns based on current wind and FMC commanded airspeed. The pattern size is limited to FAA or ICAO protected airspace. In LNAV, the AFDS tracks the holding pattern using up to a 30° 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° offset angle.

Holding Entry

Airplane track to the holding fix determines the entry type; direct, teardrop, or parallel. To make efficient use of the holding airspace, lateral guidance may direct the initial turn to the holding pattern prior to crossing the holding fix (fly-by). The holding entry path displays on the ND. For all holding entry types, lateral guidance directs the airplane to fly-by or fly-over the holding fix and to remain on the holding side of the inbound holding course. Depending on the entry track for a direct entry, the flight path may extend slightly beyond the displayed outbound holding turn. For teardrop and parallel entries, the flight path remains within the confines of the depicted holding pattern displayed on the ND. Remaining within the prescribed holding airspace requires the airplane to be at holding airspeed at the holding fix.

Hold Page (First Hold)

The hold page is used to enter a holding pattern in the route.

When the flight plan does not contain a holding pattern, selecting the HOLD function key displays the RTE X LEGS page with the HOLD AT line.

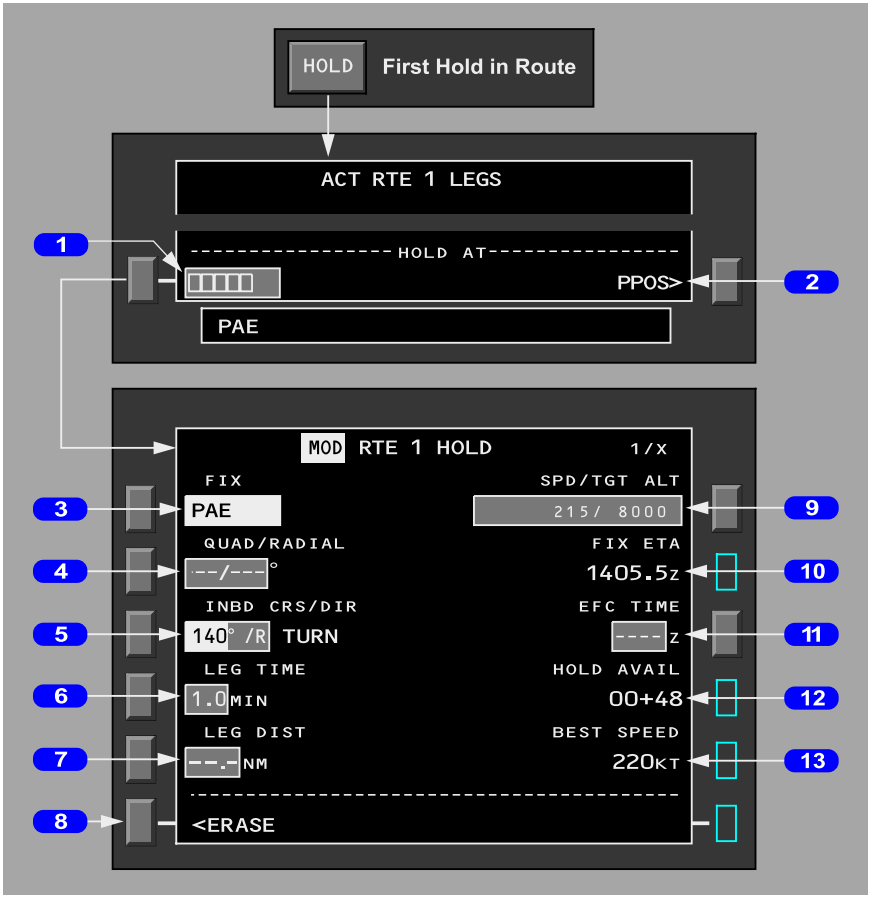
Two versions of the hold page are possible:

- an airway or procedure holding pattern
- a flight crew–entered holding pattern.

The holding page displays actual or default data about the holding pattern.

Entries modify the route. Modifications can be erased or executed.

Active holding patterns are magenta on the ND.



1 HOLD AT

Displays boxes to enter the holding fix: a RTE LEGS, database, or pilot-defined waypoint; a navaid or airport identifier; or a FAF already in the flight plan.

Entering a holding fix displays the RTE X HOLD page.

2 HOLD AT Present Position (PPOS)

Select—

- creates a holding pattern at present position
- execution establishes the holding fix at the position when EXEC is selected and displays RTE HOLD.

3 Holding FIX

Displays the holding fix.

4 Quadrant/Radial (QUAD/RADIAL)

Normally displays dashes.

Valid entry is X/XXX, XX/XXX, or /XXX. Example: NW/330.

Entry changes INBD CRS/DIR to agree.

5 Inbound Course/Direction (INBD CRS/DIR)

Displays inbound course and turn direction.

Valid entry is XXX (inbound course), XXX/X (inbound course/turn direction), /X or X (turn direction).

Entry changes QUAD/RADIAL to agree.

Displays magenta when the holding fix is the active waypoint.

Displays T if mag/true reference is in TRUE.

6 Leg Time (LEG TIME)

Displays 1.0 MIN (minute) at or below 14,000 feet.

Displays 1.5 MIN above 14,000 feet.

Displays dashes when an entry made on LEG DIST line.

Valid entry is X, X.X, or.X.

When climbing/descending through 14,000 feet with VNAV active and the SPD/TGT ALT at 1R displays in large font, the FMC adjusts the leg time (1.0 MIN at or below 14,000 feet; 1.5 MIN above 14,000 feet).

7 Leg Distance (LEG DIST)

Normally displays dashes. Allows entry of leg distance for hold.

Entry displays dashes on LEG TIME line.

Valid entry is X, XX, X.X or XX.X, where X is any integer.

8 ERASE

Erases all FMC modifications.

9 Speed/Target Altitude (SPD/TGT ALT)

Dashes display or fix speed/altitude constraint from the RTE LEGS page.

Manual entries are in large font.

During cruise, entry of a target altitude lower than CRZ ALT modifies the DESCENT page and displays a T/D. After T/D, the DESCENT page remains active unless a new cruise altitude is entered.

Speed or altitude may be entered.

Note: When descending to a HOLD with VNAV active and the entry altitude is expected to be above the clearance holding altitude, the clearance altitude must be entered in 1R to prevent the airplane from leveling when sequencing the holding fix.

10 FIX ETA

With no EFC TIME entry, displays time the airplane will next pass the holding fix.

With EFC TIME entry, displays time the airplane will pass the holding fix after the EFC time. The FMC uses this time to calculate downtrack ETAs and fuel values based on departing the holding fix at the new FIX ETA.

11 Expect Further Clearance Time (EFC TIME)

Normally displays dashes.

Valid entry is XXXX (time).

Entry changes performance predictions for the route after holding.

12 Hold Available (HOLD AVAIL)

Displays holding time available before requiring reserve fuel to reach the destination.

13 BEST SPEED

Displays the best holding speed for the airplane gross weight, altitude, and flap setting.

Note: May exceed ICAO limit speed.

HOLD Page (Existing Hold)

When one or more holding patterns exist in the route, select the HOLD key to display the hold page for the first holding pattern. When the hold is the next LNAV event, active commands display in magenta. Holding parameters can be monitored and changed on this page. New holding patterns are added using the NEXT HOLD prompt.

Most holding patterns are part of a procedure or airway and remain active until the flight crew executes an exit from holding. This may be accomplished in one of two ways:

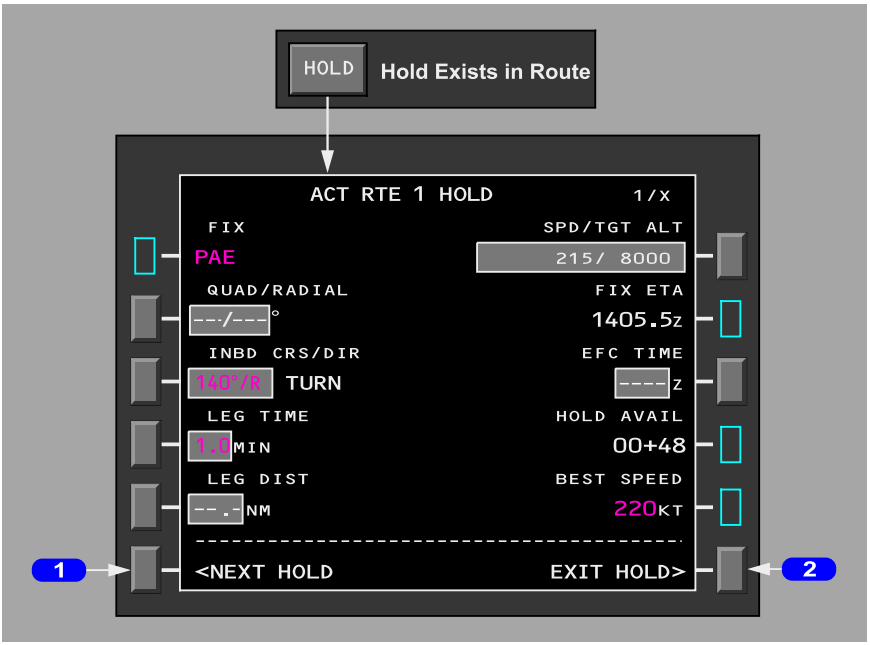
- on the ACT RTE LEGS page, deleting or bypassing the HOLD AT waypoint causes LNAV to command a direct to the next waypoint

- on the ACT RTE HOLD page, selecting and executing EXIT HOLD> causes LNAV to command the airplane to continue in the holding pattern until arriving at the holding fix, at which time the airplane exits the holding pattern.

Following execution of the exit hold, only the remaining portion of the holding pattern back to the holding fix displays. Exit from the holding pattern may occur prior to crossing the holding fix (“fly-by”) if the course to the next waypoint is not closely aligned with the holding inbound course. The exiting flight path remains within the confines of the protected holding airspace. The exit flight path displays on the ND.

The FMC automatically commands an exit from some holding patterns in procedures under the following conditions:

- for instrument approach holding patterns designed as a course reversal in lieu of a procedure turn, the airplane exits holding upon arrival at the holding fix inbound. Header at 1L displays PROC HOLD
- for some holding patterns in SIDs, the airplane exits holding when arriving at an altitude. Header at 1L displays HOLD AT.



1 NEXT HOLD

Select—displays a new hold page for a new holding pattern entry.

2 EXIT HOLD

Select—

- arms a holding pattern exit
- EXIT ARMED displays in shaded white; when executed, airplane returns to the holding fix via the inbound course for holding pattern exit.

Introduction

In the unlikely event that an unrecoverable loss of all displays or loss of all three FMCs occurs, a backup navigation capability is available through the Tuning and Control Panel (TCP). Under normal power conditions pushing the NAV key on any of the three TCPs accesses the alternate navigation capability. When on standby power, only the left (Captain's) TCP is available for alternate navigation use. Back-up navigation information is displayed on the TCPs, and the ISFD, allowing the aircrew to safely land at the nearest suitable airport.

When alternate navigation is in use, LNAV and VNAV are not available. Autopilot and autothrottles may be available.

Alternate Navigation Waypoint

The TCPs do not have a performance or navigation database. A single waypoint may be manually entered by the flight crew on the ALTN NAV page.

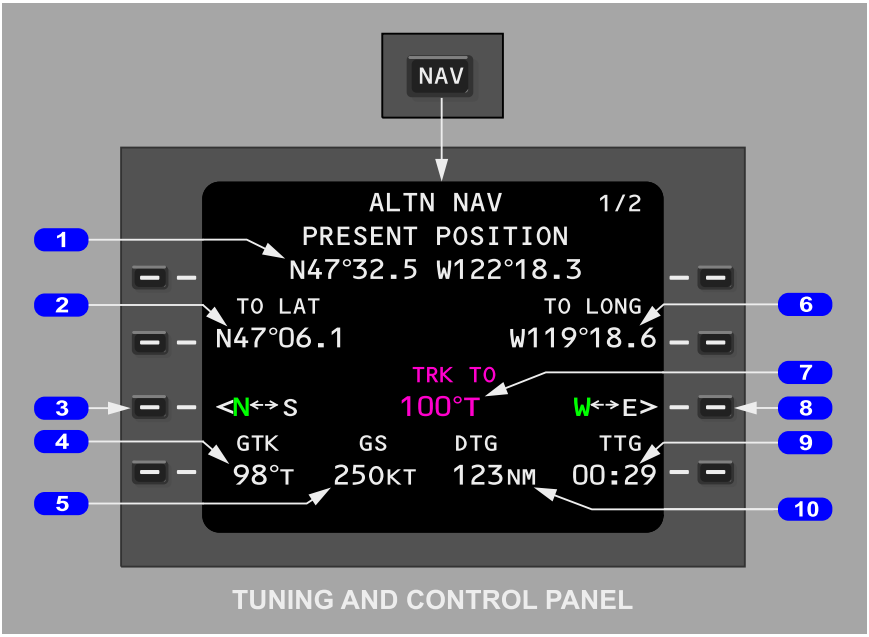
Alternate Navigation TCP Pages

The alternate navigation system operates from two TCP pages:

- ALTN NAV
- ALTN NAV RADIO.

Alternate Navigation Page

The ALTN NAV page provides a stand-alone single waypoint navigation capability. Once the waypoint's latitude and longitude have been entered at LSK 2 L/R, flight progress information to the waypoint is then displayed. The waypoint must be manually updated as required.



1 Present Position

Displays current left integrated navigation receiver latitude and longitude to the nearest tenth of a minute.

2 To Latitude (TO LAT)

Enter a TO waypoint latitude into the TCP scratchpad:

- select N or S on the latitude hemisphere selection key
- enter latitude in degrees (D) and minutes (M) using DDMM.M format
- default is current latitude hemisphere.

Line select into the TO LAT field.

3 Hemispherical Selection Key (Latitude)

Push—toggles between northern and southern hemispheres.

Selection is displayed in large green font.

Default is current latitude hemisphere.Ground Track (GTK)

4 Ground Track (GTK)

Displays current left integrated navigation receiver true ground track to the nearest whole degree.

5 Groundspeed (GS)

Displays current left integrated navigation receiver true groundspeed to the nearest whole knot.

6 To Longitude (TO LONG)

Enter a TO waypoint longitude into the TCP scratchpad:

- select W or E on the longitude hemisphere selection key (default is the current longitude hemisphere)
- enter longitude in degrees (D) and minutes (M) using DDDMM.M format.

Line select into the TO LONG field.

7 Track To (TRK TO)

Displays true track from current airplane position to entered waypoint in whole degrees.

Displayed in magenta font.

8 Hemispherical Selection Key (Longitude)

Push—toggles between western and eastern hemispheres.

Default is current longitude hemisphere.

Selection is displayed in large green font.

9 Time To Go (TTG)

Displays time to go from current airplane position to entered waypoint, based on current airplane groundspeed.

Displayed in hours (H) and minutes (M) using HH:MM format.

Accuracy better than or equal to 1 minute.

10 Distance To Go (DTG)

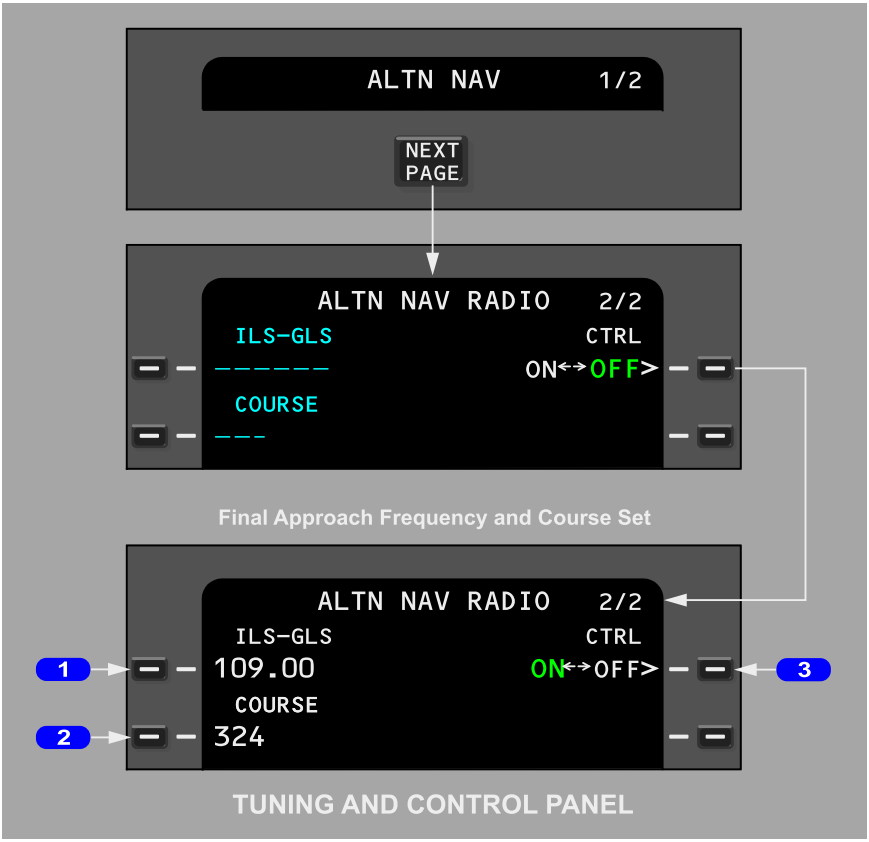
Displays distance to go from current airplane position to entered waypoint in nautical miles.

Accuracy better than or equal to 10 nautical miles.

Alternate Navigation Radio Page

The ALTN NAV RADIO page provides a backup means of tuning the ILS frequency and course or GLS channel into the left integrated navigation receiver (INR). Left side ILS or GLS deviations are then displayed on the ISFD.

Note: When alternate navigation is selected ON and the EICAS advisory message TCP ALTN NAV is displayed, it is possible to have the left and right ILS or GLS tuned to different frequencies/channels. Pilots must ensure that the correct ILS frequencies or GLS channels are tuned for the approach being flown. The PFD approach data block will always display the tuned ILS frequency or GLS channel or the received ident for the on-side system.



1 ILS-GLS

Push—enters an ILS frequency or GLS channel from the scratchpad when in backup mode. Entry format must be NNN.NN for an ILS frequency or NNNNN for a GLS channel.

Defaults to most recently tuned ILS frequency or GLS channel if available.

Cyan when inactive.

White when active.

2 Course

Push—enters an ILS course from the scratchpad when in backup mode.

Defaults to most recently tuned ILS course if available.

Cyan when inactive.

White when active.

Not used when a GLS channel has been entered at LSK 1L.

3 Control (CTRL)

Push—alternately selects backup navigation tuning ON (enabled) and OFF (disabled).

ON—

- ON displayed in large green font
- ILS-GLS and COURSE change color from cyan to white
- ILS frequency and course or GLS channel may be tuned into the left INR
- EICAS advisory message TCP ALTN NAV displayed
- ISFD displays left INR ILS or GLS deviations.

OFF—

- OFF displayed in large green font
- ILS-GLS and COURSE change color from white to cyan
- ILS and GLS may not be tuned from the ALTN NAV RADIO page
- EICAS advisory message TCP ALTN NAV removed from view
- Tuning of the left ILS and left GLS controlled by the FMC.

EICAS Messages

The following EICAS messages can display.

Message	Level	Aural	Condition
ADS-B OUT	Advisory		The ADS-B Out function is inoperative.
AHRU ALIGN MODE L	Memo		The left AHRU is in the Align mode.
AHRU ALIGN MODE L +R	Memo		The left and right AHRUs are in the Align mode.
AHRU ALIGN MODE R	Memo		The right AHRU is in the Align mode.
AHRU ATT MODE L, R	Advisory		The AHRU is only providing pitch and roll guidance.
FMC	Advisory		All 3 FMCs are failed.
FMC HOLD AIRSPACE	Advisory		The FMC calculated holding pattern is larger than the holding pattern airspace protection.
FMC INTERCEPT HDG	Advisory		Both of these occur: • LNAV is armed • the airplane is not on an intercept heading to the active leg.
FMC MESSAGE	Advisory		An alerting message is in the CDU help window.
FMC PERF UNAVAIL	Advisory		VNAV is selected and one or more of these is not entered: • gross weight • cost index • cruise altitude.
FMC RUNWAY DISAGREE	Caution	Beeper	The airplane is not on the FMC origin runway when takeoff is attempted.
FMC UNABLE RTA	Advisory		The FMC is unable to reach the RTA fix at the Required Time of Arrival.
FMC VERIFY POSITION	Advisory		The inputs to the FMC position disagree.

Message	Level	Aural	Condition
GPS	Advisory		Both GPS receivers are failed.
INSUFFICIENT FUEL	Advisory		FMC estimated fuel at the destination is less than the entered RESERVES fuel.
IRU ALIGN MODE L	Memo		The left IRU is in the Align mode.
IRU ALIGN MODE L +R	Memo		The left and right IRUs are in the Align mode.
IRU ALIGN MODE R	Memo		The right IRU is in the Align mode.
IRU/AHRU MOTION	Advisory		The airplane moves while the IRS aligns.
IRU ATT MODE L, R	Advisory		The IRU is only providing pitch and roll guidance.
LNAV BANK ANGLE LIM	Advisory		The airplane may not follow an LNAV turn because bank angle is limited by available thrust or buffet.
NAV AIR DATA SYS	Caution	Beeper	An error is detected in the air data system.
NAV AIR DATA SYS	Advisory		An error is detected in the air data system.
NAV AIRSPEED DATA	Advisory		An error is detected in the airspeed data.
NAV APPROACH GLS	Advisory		Both GLS systems are failed.
NAV APPROACH ILS	Advisory		Both ILS systems are failed.
NAV INERTIAL SYS	Caution	Beeper	The IRS cannot supply correct attitude, position, track, heading, and groundspeed data.
NAV IRU	Advisory		Both IRUs are inoperative.
NAV SINGLE GPS	Advisory		Only a single GPS is operating.
NAV UNABLE RNP	Caution	Beeper	The actual navigational performance is not sufficient.
RWY/APP CRS ERROR	Advisory		The selected ILS course and the FMC runway course disagree.
RWY/APP TUNE ERROR	Advisory		One of these occurs: • the tuned ILS frequency and the FMC runway frequency disagree

TQA to TQE, TWA,B

TQF

Message	Level	Aural	Condition
			• the tuned GLS channel and the FMC runway channel disagree.
SINGLE FMC	Advisory		Only a single FMC is operating.
SGL SOURCE APPROACH	Caution	Beeper	Both pilots' displays use the same ILS or GLS source.
SINGLE SOURCE FD	Advisory		Both PFDs and HUDs use the same flight director source.
TCP ALTN NAV	Advisory		The tuning and control panel alternate navigation control is used.
TRANSPONDER	Advisory		The transponders are failed.
TRANSPONDER PANEL	Advisory		One of these occurs: • the transponder panel is failed • TCP backup control of the transponder is used.
VNAV STEP CLIMB	Advisory		A FMC-predicted or manually-entered VNAV step climb point has sequenced and the climb has not started.
WEATHER RADAR SYS	Advisory		The weather radar system is inoperative.

FMC Messages

FMC messages indicate: degraded system operation, data input errors, or datalink status. The messages are categorized as:

- alerting messages
- communications messages
- advisory messages
- entry–error advisory messages.

Some of the CDU help window messages clear automatically when the condition is removed. Others, such as INVALID ENTRY, INVALID DELETE and NOT IN DATABASE must be manually cleared using the CLR MSG key. The CDU help window messages display according to their level of importance. A less important message replaces another message in the CDU help window when the CLR MSG key is pushed or for some messages when the condition is corrected.

The EICAS displays the advisory message FMC MESSAGE when there is an FMC alerting message. The EICAS displays the message •FMC when there is an FMC communications message. Clear the message or correct the condition to cancel the message.

FMC Alerting Messages

FMC alerting messages:

- display in the CDU help window
- cause the EICAS advisory message FMC MESSAGE to display.

Some CDU help window messages clear automatically when the condition is removed. Others must be manually cleared using the CLR MSG key.

Help Window Title	Condition	Help Window Text
ALIGNMENT REINITIATED	IRU alignment has automatically restarted due to airplane motion disturbing the alignment process or due to the crew entered initial position failing the internal comparison tests.	IRS ALIGNMENT FAILED AUTOMATICALLY RESTARTED
CHECK ALT TGT	VNAV is selected when the airplane is between the MCP window altitude and the FMC target altitude. VNAV holds level flight.	VNAV TARGET ALTITUDE AND MCP ALTITUDE DISAGREE RESET MCP OR MODIFY VNAV ALTITUDE TARGET
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. Also displayed if the AMI is incompatible with current Operational Program Config (OPC) file. This is a maintenance function.	INVALID AMI VALUE(S) VERIFY AMI **Note:** Once the CDU help window message is cleared, it does not display again for that load.
CHECK CONSTRAINT XXXXXXX	The modified vertical path is incompatible with VNAV.	For departure: CONFLICT WITH ALTITUDE CONSTRAINT ON XXXXXXX REVISE CONSTRAINT ON LEGS PAGE For arrival: NO PREDICTIONS DUE TO CONFLICT WITH

Help Window Title	Condition	Help Window Text
		ALTITUDE CONSTRAINT ON XXXXXXX REVISE CONSTRAINT ON LEGS PAGE
CLIMB FORECAST Page 1/2 and 2/2.	Entry equals a displayed wind altitude on page 1/2 fields 2L, 3L, 4L, 5L or page 2/2 fields 1L, 2L, 3L, 4L or 5L.	ALTITUDE DATA EXISTS RANGE: <minalt> TO FL500 FORMAT: 280 FL280 15000 9000 0800 0050
CLIMB FORECAST Page 1/2 and 2/2.	Entry equals a displayed wind altitude on page 1/2 fields 2L, 3L, 4L, 5L or page 2/2 fields 1L, 2L, 3L, 4L or 5L.	WIND ALT/TEMP DATA ALT RANGE: <minalt> TO FL500 TEMP RANGE: <mintemp> TO <maxtemp> FORMAT: 0100/ 1100/15 390/-50 FL025 FL185/-40 /-5
CLIMB FORECAST Page 1/2 and 2/2.	Entry of invalid format or range into page 1/2 fields 2R, 3R, 4R, 5R or page 2/2 fields 1R, 2R, 3R, 4R or 5R.	WIND DIRECTION/SPEED DIRECTION RANGE: 000 TO 360 SPEED RANGE: <minwindspeed> TO <maxwindspeed> FORMAT: 090/105 090/ /105
DESCENT FORECAST Page 1/2.	Entry of invalid format or range into field 1L.	TRANS LVL RANGE: <minalt> TO <maxalt> FORMAT: 280 FL280 15000 9000 0800 0050
DESCENT FORECAST Page 1/2.	Entry of invalid format or range into field 1R.	TAI ON ALT RANGE: <minalt> TO <maxalt> FORMAT: 280 FL280 15000 9000 0800 0050
DESCENT FORECAST Page 1/2 and 2/2.	Entry equals a displayed wind altitude on page 1/2 fields 2L, 3L, 4L, 5L or page 2/2 fields 1L, 2L, 3L, 4L or 5L.	ALTITUDE DATA EXISTS RANGE: <minalt> TO FL500 FORMAT: 280 FL280 15000 9000 0800 0050
DESCENT FORECAST Page 1/2 and 2/2.	Entry equals a displayed wind altitude on page 1/2 fields 2L, 3L, 4L, 5L or page 2/2 fields 1L, 2L, 3L, 4L or 5L.	WIND ALT/TEMP DATA ALT RANGE: <minalt> TO FL500 TEMP RANGE: <mintemp> TO <maxtemp> FORMAT: 0100/ 1100/15 390/-50 FL025 FL185/-40 /-5
DESCENT FORECAST Page 1/2 and 2/2.	Entry of invalid format or range into page 1/2 fields 2R, 3R, 4R, 5R or page 2/2 fields 1R, 2R, 3R, 4R or 5R.	WIND DIRECTION/SPEED DIRECTION RANGE: 000 TO 360 SPEED RANGE: <minwindspeed> TO <maxwindspeed> FORMAT: 090/105 090/ /105

Help Window Title	Condition	Help Window Text
DESCENT PATH DELETED	VNAV active and all waypoint altitude constraints defining the descent profile deleted.	ALL DESCENT CONSTRAINTS DELETED ERASE MOD OR ENTER NEW CONSTRAINT **Note:** This message displays before execution of the modification which deletes the descent path.
DESCENT PATH DELETED	VNAV active and all waypoint altitude constraints defining the descent profile deleted.	ALL DESCENT CONSTRAINTS DELETED ERASE MOD OR ENTER NEW CONSTRAINT **Note:** This message displays before execution of the modification which deletes the descent path.
DISCONTINUITY	LNAV active and the route is not defined after the waypoint (except when the waypoint is before a manually terminated leg, such as FM, VM, HM legs). FM—a course from a fix to a flight crew entered manual route termination. VM—a heading leg from a fix to a flight crew entered manual route termination. HM—a holding pattern to a flight crew entered manual route termination.	LNAV IN HEADING HOLD MODIFY ACTIVE WAYPOINT
DRAG REQUIRED	VNAV active and additional drag required or autothrottle off and less thrust required to maintain the VNAV descent path.	UNABLE TO MAINTAIN VNAV DESCENT SPEED EXTEND SPEEDBRAKES AS REQUIRED

Help Window Title	Condition	Help Window Text
END OF OFFSET	LNAV active and two minutes prior to end of active route offset. AFDS maintains last heading if active route offset overflown.	APPROACHING END OF OFFSET MODIFY FLIGHT PLAN TO CONTINUE OFFSET
END OF ROUTE	LNAV active and end of active route overflown. AFDS maintains last heading.	PASSING LAST WAYPOINT IN ACTIVE ROUTE MODIFY ROUTE
END OF RTA	RTA waypoint sequenced, and RTA waypoint is within 200 nm of end of descent and flight phase is not descent.	CONFIRM SPEED ON VNAV PAGE
ENTER INERTIAL POSITION	The crew entered present position did not pass one of the IRU comparison checks, or the IRU is ready to transition to NAV and has not received a present position.	INERTIAL REFERENCE SYSTEM REQUIRES POSITION TO COMPLETE ALIGNMENT ENTER POSITION ON POS INIT 1/4
FMC APP MODE UNAVAIL-GP	Approach has no published glidepath for FMC to use.	SELECTED APPROACH HAS NO GLIDE PATH ANGLE CONFIRM APPROACH SELECTION
FMC APP MODE UNAVAIL-QFE	Attempting to use IAN procedures while QFE landing reference enabled.	FMC APPROACH GUIDANCE NOT AVAILABLE WITH QFE SELECTED
FMC APP/TUNE DISAGREE	Attempting to use IAN procedures while ILS/ GLS is being tuned and G/S selected ON.	LANDING SYSTEM TUNING NOT COMPATIBLE WITH SELECTED APPROACH CHANGE APPROACH OR DELETE LANDING SYSTEM TUNING
INERTIAL/ORIGIN DISAGREE	The computed present position differs from the entered origin airport.	VALID IRS POSITION DISAGREES WITH ACTIVE ORIGIN AIRPORT POSITION VERIFY INERTIAL POSITION OR ORIGIN AIRPORT

Help Window Title	Condition	Help Window Text
INSUFFICIENT FUEL	A pending route modification causes the computed fuel burn to exceed the total fuel on board, less reserves.	MODIFICATION REQUIRES MORE FUEL THAN AVAILABLE REVIEW MOD
LIMIT ALT FLXXX	The flight crew or FMC selected altitude is greater than the VNAV limit altitude.	SELECTED ALTITUDE IS ABOVE VNAV ALTITUDE LIMIT MODIFY CRUISE ALTITUDE OR VNAV TARGET SPEED
NAV DATA OUT OF DATE	The clock calendar date is after the active navigation database valid calendar cycle.	CURRENT DATE NOT IN DATA BASE RANGE SELECT NEW DATA BASE ON IDENT PAGE
NAV INVALID–TUNE XXXX	RNAV or VOR approach procedures must have a specific navaid tuned. It is either not tuned or a valid signal is not being received.	APPROACH NAVAID NOT TUNED VERIFY NAV RADIO PAGE TUNING
NO ACTIVE ROUTE	LNAV selected and no active route activated.	LNAV NOT AVAILABLE ACTIVATE AND EXECUTE ROUTE
PREDICTIONS UNAVAILABLE	FMC performance predictions are not available for remainder of flight.	PERFORMANCE PREDICTIONS INHIBITED FOR DURATION OF FLIGHT MAINTENANCE REQUIRED
RESET MCP ALT	2 minutes prior to the top of descent point with VNAV active and MCP not set to altitude below cruise altitude.	MCP ALTITUDE IS SET TO CRUISE ALT SET LOWER ALTITUDE TO ENABLE VNAV DESCENT
RTA FIX DELETED	RTA fix has been deleted from the modified flight plan.	MODIFICATION DELETES EXISTING RTA FIX TO RETAIN RTA ERASE MOD
RTA LIMITS page	Entry into fields 2L, 3L or 4L greater than or equal to the corresponding MAXIMUM SPEED, if it exists.	MINIMUM SPEED MUST BE LESS THAN OR EQUAL TO MAXIMUM SPEED

Help Window Title	Condition	Help Window Text
RTA LIMITS page	Entry into fields 2R, 3R or 4R less than or equal to the corresponding MINIMUM SPEED, if it exists.	MAXIMUM SPEED MUST BE GREATER THAN OR EQUAL TO MINIMUM SPEED
RTA LIMITS page	Entry of invalid format or range into field 2L or 4L.	MINIMUM SPEED CAS RANGE: <mincas> TO <maxcas> MACH RANGE: <minmach> TO <maxmach> FORMAT: .84 .800/289 310 289/.8
RTA LIMITS page	Entry of invalid format or range into field 3L.	MINIMUM SPEED MACH RANGE: <minmach> TO <maxmach> FORMAT: .84 .800 .210 .8
RTA LIMITS page	Entry of invalid format or range into field 2R or 4R.	MAXIMUM SPEED CAS RANGE: <mincas> TO <maxcas> MACH RANGE: <minmach> TO <maxmach> FORMAT: .84 .800/289 310 289/.8
RTA LIMITS page	Entry of invalid format or range into field 3R.	MAXIMUM SPEED MACH RANGE: <minmach> TO <maxmach> FORMAT: .84 .800 .210 .8
RTA LIMITS page	Entry of invalid range into field 5LR.	RTA THRESHOLD RANGE: 6 TO 99
RTA PROGRESS page 3/4	Entry of invalid format or range into field 1R.	REQUIRED TIME OF ARRIVAL FORMAT: HHMMSS OR HHMM 0910 235620A 020025B A - AT OR AFTER TIME OR B - AT OR BEFORE TIME
RTA PROGRESS page 3/4	Entry of invalid format or range into field 3R.	TAKEOFF TIME OR SPEED SEGMENT END TIME FORMAT: HHMMSS OR HHMM 0910 235620 0200
TAKEOFF FLAPS DELETED	Deletion of entered thrust reduction flap value results in invalidating takeoff flap setting.	DELETION OF ENTERED THRUST REDUCTION INVALIDATED TAKEOFF FLAPS ENTER VALID TAKEOFF FLAPS
TAKEOFF SPEEDS DELETED	Selected V speeds are invalid.	SPEEDS DELETED DUE TO CHANGE IN TAKEOFF CONDITIONS ON THE FMC

Help Window Title	Condition	Help Window Text
		ENTER SPEEDS ON TAKEOFF REF PAGE
THRUST REQUIRED	VNAV active, autothrottle disconnected, and additional thrust required to track VNAV descent path and maintain speed.	UNABLE TO MAINTAIN VNAV DESCENT SPEED ADD THRUST OR ENGAGE AUTOTHROTTLE
T/O ENGINE OUT	Engine failure detected but not verified during VNAV takeoff. Aircraft is above flap retraction altitude with perf initialized.	FMC HAS DETECTED AN ENGINE FAILURE SELECT ENG OUT> TO CONFIRM SELECT <ALL ENG TO CANCEL
UNABLE FLXXX AT RTA FIX	Predicted crossing altitude at RTA fix less than FLXXX, but predicted ETA within tolerance.	VNAV WILL NOT ATTAIN ALTITUDE AT RTA FIX RTA TIME WILL BE MET REVIEW RTA CONDITIONS
UNABLE NEXT ALT	VNAV active and climb not sufficient to comply with waypoint altitude constraint.	NEXT CLIMB CONSTRAINT NOT ATTAINABLE REVISE CLIMB SPEED OR MODIFY CONSTRAINT
UNABLE TO SEND MSG	Airplane is unable to transmit downlink message as commanded by crew or airplane is unable to automatically send message at required time for planned event.	TEMPORARY COMMUNICATION SYSTEM INTERRUPT RESEND MESSAGE
VERIFY RNP—PROG 4/X	The default RNP has changed due to a change in flight phase and the crew has previously entered a larger RNP value than the default on PROG page 4/X.	ENTERED VALUE GREATER THAN DEFAULT RNP OR LESS THAN ANP CONFIRM RNP ON RNP PROGRESS PAGE 4
VERIFY VERT RNP—PROG 4/X	The default Vertical RNP has changed due to flight phase and the crew has previously	ENTERED VALUE GREATER THAN DEFAULT VERTICAL RNP OR LESS THAN VERTICAL ANP

Help Window Title	Condition	Help Window Text
	entered a larger RNP value than the default vertical RNP on PROG page 4/X.	CONFIRM VERTICAL RNP ON RNP PROGRESS PAGE 4
VIA OFFSET INVALID	Flight conditions invalidate the modification with a divert to an alternate airport via OFFSET.	OFFSET ROUTING IS NO LONGER VALID FOR THE SELECTED ALTERNATE
WIND page	Entry of invalid format or range into fields 1L, 2L, 3L or 4L.	WIND ALT/TEMP DATA ALT RANGE: <minalt> TO FL500 TEMP RANGE: <mintemp> TO <maxtemp> FORMAT: 0100/ 1100/15 390/-50 FL025 FL185/-40 /-50

FMC Communications Messages

FMC communications messages:

- display in the CDU help window
- cause the EICAS communications message •FMC to display
- cause the communications aural high–low chime to sound.

Help Window Title	Condition	Help Window Text
ALTN UPLINK	Up to four company–preferred alternate airports and associated data has been received and is available for preview on the ALTN page.	ALTERNATE AIRPORT DATA READY TO ACCEPT OR REJECT ON ALTN PAGE 1/X
ALTN INHIBIT UPLINK	A company list of up to two alternate airports, which is inhibited from automatic selection and displayed on the ALTN page, has been received and is available for preview on the ALTN page.	INHIBITED ALTERNATE AIRPORT LIST READY TO ACCEPT OR REJECT ON ALTN PAGE 1/X
ALTN LIST UPLINK	A company list of up to 20 alternate airports has been received	ALTERNATE AIRPORT LIST ON ALTN PAGE 2/X

Help Window Title	Condition	Help Window Text
	and is available on the ALTN LIST page.	
CLB FORECAST UPLINK READY	Climb forecast data has been received and is available for loading on the CLIMB FORECAST page.	CLIMB FORECAST DATA READY TO LOAD OR PURGE ON CLB FORECAST PAGE
DES FORECST UPLINK READY	Descent forecast data has been received and is available for loading on the DESCENT FORECAST page.	DESCENT FORECAST DATA READY TO LOAD OR PURGE ON DES FORECAST PAGE
FLT NUMBER UPLINK	A new flight number has been received and is available on the RTE page 1/X.	FLIGHT NUMBER LOADED ON RTE PAGE 1
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.	CANNOT USE LOADED RUNWAY/INTERSECTION OR RUNWAY/POSITION SHIFT FOR TAKEOFF UNDER CURRENT CONDITIONS
PARTIAL ROUTE X UPLINK	Part of the route uplink received is ready for loading. Some of the route uplink was rejected.	SOME ROUTE DATA REJECTED REVIEW LOADED DATA ON RTE PAGE EXECUTE OR ERASE
PERF INIT UPLINK	Performance initialization data has been received and is available for preview on the PERF INIT page.	PERFORMANCE DATA READY TO ACCEPT OR REJECT ON PERF INIT PAGE
ROUTE X UPLINK READY	A new route or route modification has been received and is available for loading on the RTE X page.	FLIGHT PLAN IS READY TO LOAD OR PURGE ON RTE PAGE
ROUTE X UPLINK LOADING	A route uplink has been received and	FLIGHT PLAN LOADING PLEASE WAIT

Help Window Title	Condition	Help Window Text
	is loading into the inactive route.	
TAKEOFF DATA LOADED	The crew has entered a new runway on the TAKEOFF REF page, which matches a runway from a previous takeoff uplink; or the crew has selected a different takeoff thrust on the THRUST LIM page or the crew has selected alternate takeoff thrust on the TAKEOFF REF page 2/2. Data displayed on the TAKEOFF REF page along with the ACCEPT> <REJECT prompts.	RUNWAY OR THRUST SETTING CHANGED TAKEOFF DATA READY TO ACCEPT OR REJECT ON TAKEOFF REF PAGES
TAKEOFF DATA UPLINK	A takeoff uplink, (contains data for a runway), which matches the takeoff runway, has been received and is available for preview on the TAKEOFF REF page 1/2 & 2/2 and THRUST LIM page.	TAKEOFF DATA READY TO ACCEPT OR REJECT ON TAKEOFF REF PAGES
TAKEOFF DATA UPLINK	A takeoff uplink has been received without an active departure runway or the departure runway does not match the entered departure runway.	TAKEOFF DATA RECEIVED FOR ALTERNATE RUNWAY CONFIRM ACTIVE RUNWAY
WIND DATA READY	Wind data has been received and is available for loading on the RTE DATA page.	LOAD ON RTE DATA PAGE

FMC Advisory Messages

FMC advisory messages display in the CDU help window.

Help Window Title	Condition	Help Window Text
ATC RTE CLEARANCE UPLINK	ATC route clearance uplink ready to be loaded into FMC for review. This message also displays a LOAD select button in the CDU help window. Selection of the LOAD button clears the message.	SELECT LOAD FMC TO MODIFY RTE
DELETE	DELETE key pushed. The word DELETE is displayed in the scratchpad.	None, message displayed in scratchpad.
HOLD AT XXXXX	A waypoint not contained in the active route is entered into the HOLD AT box on the RTE LEGS page, after selection of the HOLD function key. Selection of HOLD AT XXXXX into a RTE LEGS page waypoint line makes a holding fix at the XXXXX waypoint.	None, message displayed in scratchpad.
INVALID ALTN UPLINK	A company preferred list of alternate airports and associated alternate data has been received but the data is not valid and can not be displayed.	ALTERNATE AIRPORT DATA UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID ALTN LIST UPLINK	A company list of up to 20 alternate airports has been received but the data is not	ALTERNATE AIRPORT LIST UPLINK REJECTED DUE TO MESSAGE ERROR

Help Window Title	Condition	Help Window Text
	valid and cannot be displayed.	
INVALID FLT NO UPLINK	A new flight number has been received but the data is not valid and cannot be displayed.	FLIGHT NUMBER UPLINK REJECTED DUE TO FAILED ERROR CHECK
INVALID FORECAST UPLINK	Descent forecast data has been received but the data is not valid and cannot be displayed.	FORECAST DATA UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID PERF INIT UPLINK	Performance initialization data has been received but the data is not valid and cannot be displayed.	PERFORMANCE DATA UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID ROUTE UPLINK	A new flight plan route or modification to the active flight plan route has been received but the data is not valid and cannot be displayed.	FLIGHT PLAN UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID TAKEOFF UPLINK	Takeoff data for up to six runways or runway–intersection pairs has been received but the data is not valid and cannot be displayed.	TAKEOFF DATA UPLINK REJECTED DUE TO MESSAGE ERROR
INVALID WIND DATA UPLINK	En route wind data has been received but the data is not valid and cannot be displayed.	WIND DATA UPLINK REJECTED DUE TO MESSAGE ERROR
MAX ALT FLXXX	Entered speed or altitude would cause cruise altitude to be greater than max altitude.	CDU help window text varies and is specific to entry error made.
MIN VSPEEDS UNAVAILABLE	The FMC cannot verify the entered takeoff speeds meet	FMC UNABLE TO COMPUTE MINIMUM SPEEDS FOR

Help Window Title	Condition	Help Window Text
	minimum performance margins. Manually verify takeoff speeds from an approved source of performance information.	CURRENT CONDITIONS VERIFY VSPEEDS
NON WGS-84 AIRPORT	The departure or destination airport in the active flight plan is not surveyed to the WGS-84 standard (or equivalent).	For departure: DEPARTURE RUNWAY NOT SURVEYED TO GPS STANDARD RUNWAY DISAGREE EICAS CAUTION NOT AVAILABLE FOR TAKEOFF For destination: DESTINATION AIRPORT NOT SURVEYED TO GPS STANDARD DISABLE GPS UPDATING FOR APPROACH UNLESS OTHER PROCEDURES ARE APPROVED
RESET MCP APP MODE	A change in the expected approach or G/S ON/OFF is made with an approach mode armed or engaged.	CHANGE IN SELECTED APPROACH RESET APPROACH MODE FOR VALID DATA
UNABLE CRZ ALT	Performance predicts a zero cruise time at the entered cruise altitude.	COMPUTED TOP OF DESCENT IS BEFORE TOP OF CLIMB CONFIRM CRUISE ALTITUDE
UNABLE TO LOAD CLEARANCE	ATC clearance contains invalid data or requires an active route.	CDU help window text varies and is specific to entry error made.
XXXXXXX—MAX ALT FLXXX or XXXXXXX—MAX ALT XXXXX	Predicted altitude at a waypoint with a Cruise Speed Segment or RTA will be above maximum altitude.	ALTITUDE PREDICTED AT <XXXXXXX> IS ABOVE MAXIMUM ALTITUDE FOR PLANNED CRUISE SPEED CONFIRM PLANNED CRUISE SPD

FMC Entry Error Messages

FMC entry–error messages:

- display in the CDU help window
- push the CLR MSG key or for some messages enter a corrected entry on the CDU to clear the message.

Help Window Title	Condition	Help Window Text
APP TUNE INHIBITED-MCP	ILS or GLS tuning is inhibited with autopilot engaged, approach switch (on MCP) selected and localizer or glideslope captured; and crew attempts to enter and execute a new runway or approach; or crew attempts to enter a new ILS frequency or GLS channel on the NAV RADIO page.	DISENGAGE A/P AND FLIGHT DIRECTOR TO ENABLE TUNING
CRS REVERSAL AT FA FIX	A conflict exists between the default final approach (FA) waypoint (result of a runway or VFR approach selection) and the flight plan before it.	ACTIVE ROUTE REVERSES DIRECTION AT THE FINAL APPROACH WAYPOINT MODIFY ROUTE TO FA FIX
ENG OUT SID MOD	An engine failure is sensed after takeoff before the flaps are fully retracted; the FMC has automatically loaded an available engine out standard instrument departure as a route modification to the active route.	ENGINE OUT DETECTED EO DEPARTURE ROUTE LOADED EXECUTE TO COMPLY
IN NAV DATA BASE	Attempted entry into SUPP NAV DATA airport waypoint or navaid field already in NDB.	ENTERED IDENTIFIER ALREADY EXISTS IN NAV DATA BASE REVISE ENTERED IDENTIFIER
INVALID DELETE	Deletion of selected data is not allowed.	SELECTED LINE CAN NOT BE DELETED
INVALID ENTRY	Attempted entry into a CDU field is not properly formatted.	CDU help window text varies and is specific to entry error made.

Help Window Title	Condition	Help Window Text
NO OFFSET AT LEG XXXXXXX	Entered start of offset waypoint in 2L is not valid.	ENTERED OFFSET START WAYPOINT NOT VALID FOR OFFSET CONFIRM OFFSET
NO OFFSET AT LEG XXXXXXX	Entered end of offset waypoint in 3L is not valid.	OFFSET END WAYPOINT ENDS AT FIRST NON-OFFSETABLE LEG
NO SLOP AT LEG XXXXXXX	Entered SLOP start waypoint in 4R is not valid.	ENTERED SLOP START WAYPOINT NOT VALID FOR SLOP CONFIRM SLOP START
NO SLOP AT LEG XXXXXXX	Entered SLOP start waypoint in 5R is not valid.	SLOP END WAYPOINT ENDS AT FIRST NON-OFFSETABLE LEG
NOT IN DATABASE	Search of Nav Database and route did not result in finding the required data.	CDU help window text varies and is specific to item not found.
NOT IN FLIGHT PLAN	Entered start of offset waypoint is not in flight plan.	START OFFSET WAYPOINT CORRECT FORMAT BUT NOT IN CURRENT FLIGHT PLAN
OFFSET DELETED	Flight plan modification deletes start leg of a downpath offset causing the downpath offset to be deleted.	CONFIRM MODIFICATION OR ENTER NEW OFFSET ON LATERAL OFFSET PAGE
OFFSET ENDS AT YYYYYYY	Non-offsetable leg exists prior to the entered end waypoint. A flight plan change results in a non-offsetable leg existing between the start and end waypoints of an existing offset. Offset end waypoint is deleted and the new offset end waypoint is YYYYYYY.	END OF OFFSET CHANGED
ROUTE FULL	The route is filled to the allowable capacity.	WAYPOINT STORAGE CAPACITY HAS BEEN REACHED MODIFY ROUTE
RUNWAY N/A FOR SID	Selected runway not compatible with SID.	RUNWAY CAN NOT BE USED WITH ENTERED DEPARTURE

Help Window Title	Condition	Help Window Text
		PROCEDURE CONFIRM RUNWAY
SLOP ENDS AT YYYYYYY	Flight plan modification results in a non-offsetable leg existing between start and end waypoints of an existing SLOP.	END OF OFFSET CHANGED
SLOP OFFSET DELETED	Flight plan modification deletes start leg of a SLOP offset.	START WAYPOINT DELETED ENTER NEW START ON LATERAL OFFSET PAGE
SLOP TRANSITION	SLOP offset is transitioned ON or OFF due to an RNP ON or RNP OFF condition resulting in a flight plan modification not initiated from the LATERAL OFFSET page. The Help window shows: LOAD SLOP - initiates flight plan modification to insert SLOP and displays Lateral Offset page. Modification can be executed or erased.	ENTERING OR EXITING RNP SLOP OFFSET REGION SELECT LOAD AND REVIEW MOD ON LATERAL OFFSET PAGE
STANDBY ONE	The FMC temporarily prevents further CDU inputs.	FMC PROCESSING LAST ENTRY PLEASE WAIT
UNABLE FLIGHT PLAN ENTRY	Attempted flight plan entry is incompatible with loaded navigation database.	ENTRY NOT ACCEPTED WITH CURRENT NAV DATA BASE CHANGE IDENTIFIER
VERIFY RNP ENTRY	The entered RNP value is greater than the default RNP value for the present flight phase or, less than the present Actual Navigation Performance.	ENTERED VALUE GREATER THAN DEFAULT RNP OR LESS THAN ANP CONFIRM RNP
VERIFY VERT RNP ENTRY	Entered vertical RNP value is greater than	ENTERED VALUE GREATER THAN DEFAULT VERTICAL RNP

Help Window Title	Condition	Help Window Text
	the default vertical RNP for the current flight phase, or less than the present ANP.	OR LESS THAN VERTICAL ANP CONFIRM VERTICAL RNP

Fuel
Chapter 12
Table of Contents

Controls and Indicators 12.10

Fuel System 12.10.1

Fuel Jettison System 12.10.2

Fuel Indications 12.10.3

Normal Fuel Indications 12.10.3

Expanded Fuel Indications 12.10.4

Fuel Jettison Indications 12.10.5

Fuel Synoptic Display 12.10.6

Fuel Synoptic Indications 12.10.7

System Description 12.20

Introduction 12.20.1

Fuel Quantity 12.20.1

Fuel Temperature 12.20.1

Fuel Pumps 12.20.1

Fuel Pump Operation 12.20.2

Suction Feed 12.20.2

Fuel Crossfeed 12.20.3

Fuel Balance System 12.20.3

Fuel Imbalance 12.20.3

Fuel Tank Locations and Capacities 12.20.4

Fuel Tank Locations 12.20.4

Fuel Tank Capacities 12.20.4

Fuel System Schematic 12.20.5

APU Fuel Feed 12.20.6

Fuel Jettison 12.20.6

Fuel Jettison Schematic 12.20.7

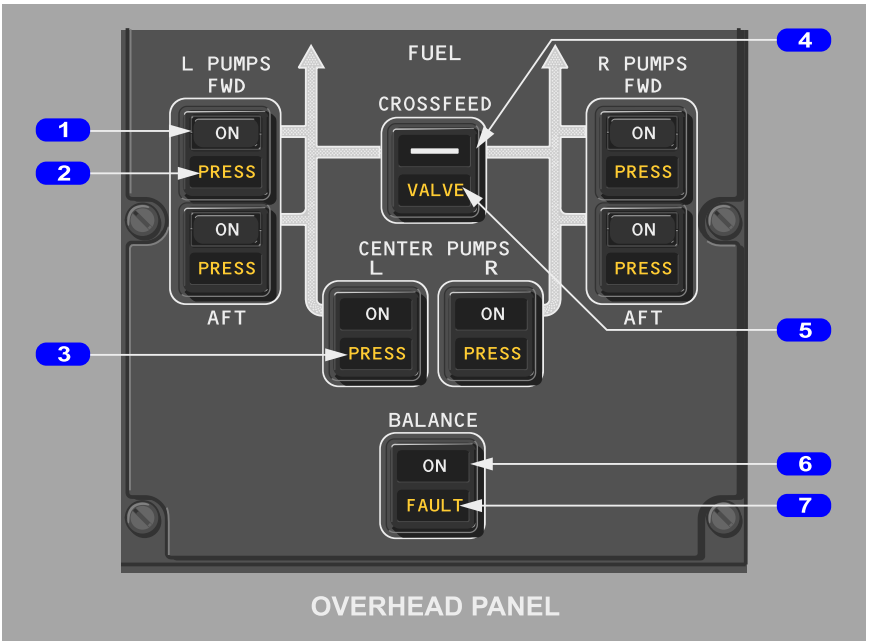
Nitrogen Generation System 12.20.7

EICAS Messages 12.30

FMS EICAS and CDU Fuel Messages 12.30.1

Fuel System EICAS Messages 12.30.1

Fuel System



1 Fuel Pump Switches

ON—the fuel pump is selected ON.

Off (ON not visible)—the fuel pump is selected off.

2 Forward and Aft Fuel Pump Pressure (PRESS) Lights

Illuminated (amber)—fuel pump output pressure is low.

3 Center Fuel Pump Pressure (PRESS) Lights

Illuminated (amber)—

- fuel pump output pressure is low with the pump selected ON
- illumination is inhibited when the center tank fuel pump switch is selected off.

4 CROSSFEED Switch

On (bar visible)—the crossfeed valve is selected open.

Off (bar not visible)—the crossfeed valve is selected closed.

5 CROSSFEED VALVE Light

Illuminated (amber)—the crossfeed valve is not in the selected position.

6 BALANCE Switch

ON—the balance system is selected on.

Off (ON not visible)—

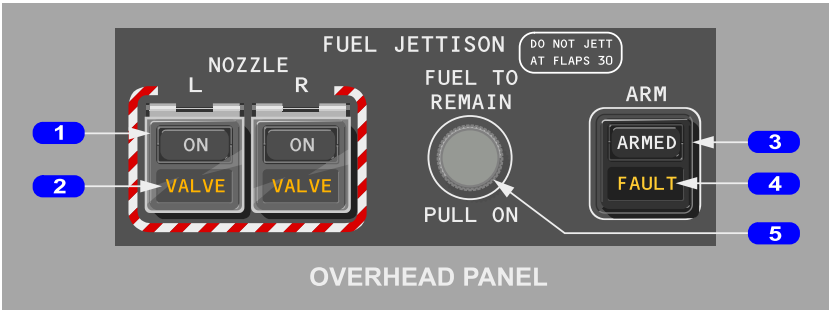
- system is not commanded ON
- off is manually selected
- fuel balance is automatically commanded off for one of the following:
  - fuel is balanced
  - jettison system is active
  - FUEL DISAGREE message is displayed
  - FUEL QTY LOW message is displayed
  - airplane is on ground and either engine running.

7 Fuel BALANCE FAULT Light

Illuminated (amber)—

- a system fault has occurred
- fuel balance system is inoperative.

Fuel Jettison System



1 Fuel Jettison NOZZLE Switches

ON—

- the jettison nozzle valve is selected open in flight
- if in flight and jettison is armed, opens main tank defuel/isolation valves and center tank jettison isolation valves.

Off (ON not visible)—the jettison nozzle valve is selected closed.

2 Fuel Jettison Nozzle VALVE Lights

Illuminated (amber)—the jettison nozzle valve is not in the selected position.

3 Fuel Jettison ARM Switch

ARMED—
- arms the jettison system
- initializes fuel–to–remain at the MLW fuel quantity.

Off (ARMED not visible)—disarms the jettison system.

4 Fuel Jettison FAULT Light

Illuminated (amber)—
- a system fault has occurred
- fuel jettison is inoperative.

5 FUEL TO REMAIN Selector

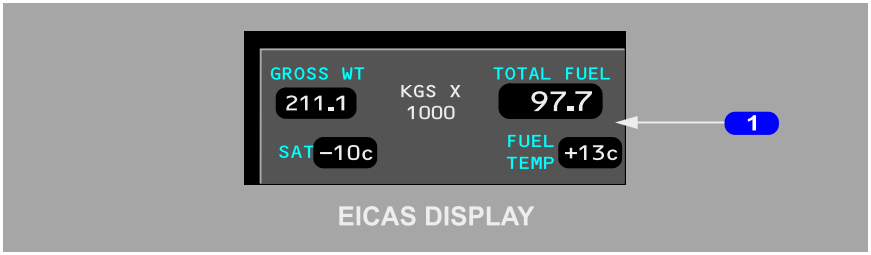
PULL ON—changes the mode from MLW (maximum landing weight) to MAN (manual).

Rotate—
- clockwise to increase the MANUAL fuel-to-remain quantity
- counterclockwise to decrease the MANUAL fuel-to-remain quantity.

Push—automatically selects the MLW fuel-to-remain quantity.

Fuel Indications

Normal Fuel Indications

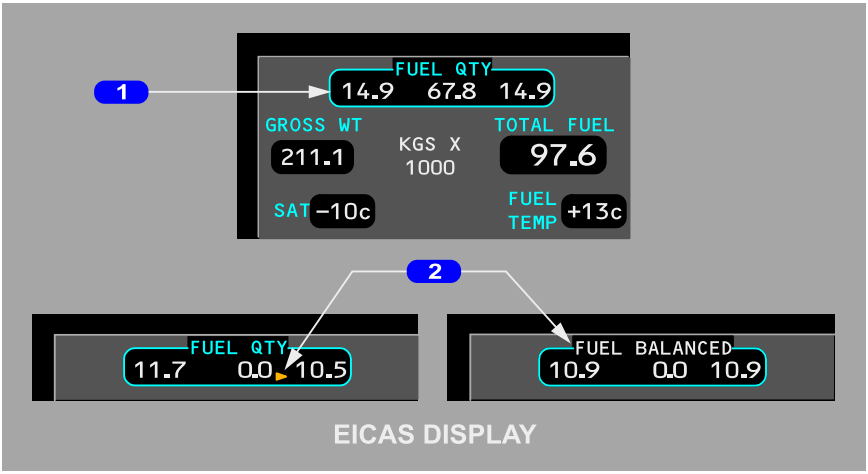


1 Normal Fuel Indications

Total fuel quantity (kilograms × 1000).

Fuel temperature (deg. C).

Expanded Fuel Indications



1 Expanded Fuel Indications

The expanded FUEL QTY display (left main, center, and right main tank quantities) appears for any of the following conditions:

- crossfeed valve open
- one or more fuel tank quantity indications are inoperative
- the FUEL IN CENTER alert message is displayed (center tank quantity is amber)
- the FUEL QTY LOW alert message is displayed (low main tank quantity is amber)
- the FUEL LOW CENTER alert message is displayed (low center tank quantity is amber)
- the FUEL FLOW ENG alert message is displayed
- the INSUFFICIENT FUEL alert message is displayed (total fuel quantity is amber)
- the FUEL IMBALANCE alert message is displayed
- the airplane is on the ground and both engine(s) off
- the balance system is active
- the balance system is selected on and fuel is already balanced.

2 Fuel Imbalance Indications

A fuel imbalance pointer is displayed on the expanded fuel quantity display next to the low tank quantity for the following imbalance conditions.

A solid amber fuel imbalance pointer is displayed if the FUEL IMBALANCE message is displayed.

A solid white fuel imbalance pointer is displayed if:

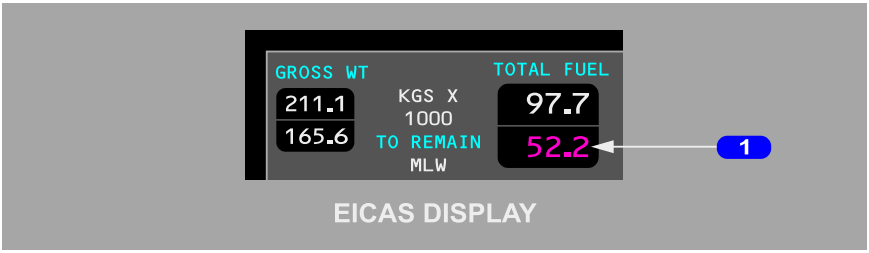
- the FUEL IMBALANCE message is not displayed and the main tank fuel differs by more than 100 kilograms, and
- either the crossfeed valve is open or the balance system is ON.

The difference in fuel quantity which causes the FUEL IMBALANCE message to be displayed varies with total main tank fuel quantity.

The pointer flashes if fuel balance or crossfeed is going in the wrong direction.

When fuel is back in balance within 100 kilograms between the main tanks and the crossfeed valve is open or the balance system is ON, FUEL BALANCED replaces FUEL QTY on the expanded fuel quantity display and flashes for 5 seconds.

Fuel Jettison Indications



1 Fuel Jettison Indications

Fuel to remain (fuel jettison ARMED):

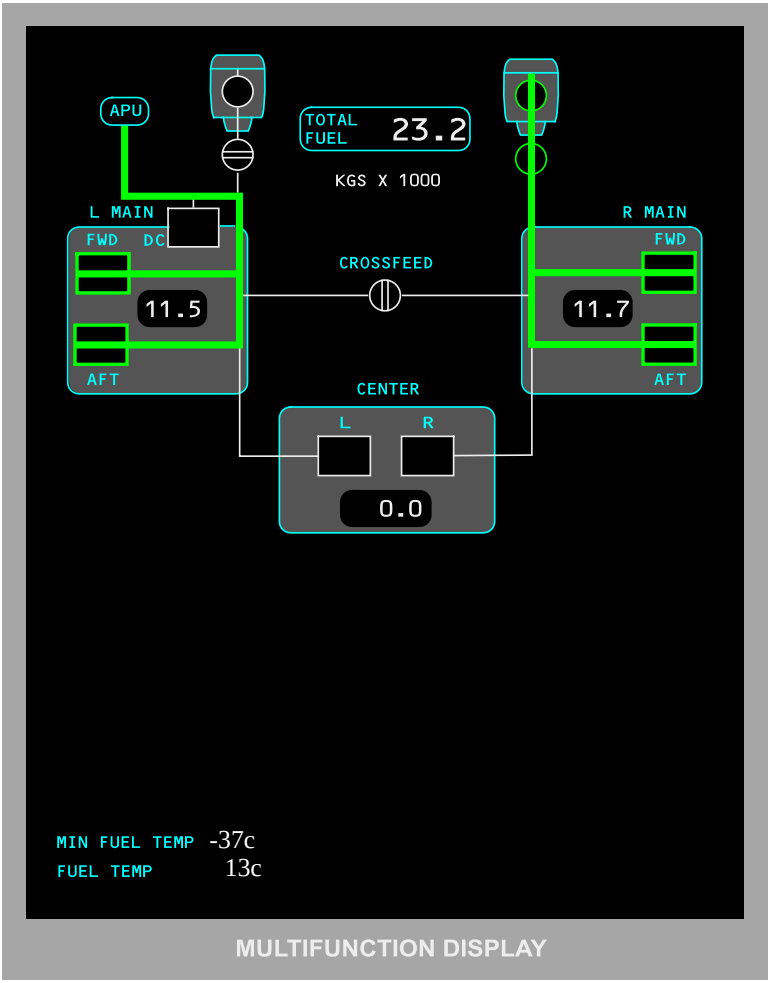
- the fuel to remain defaults to a fuel quantity that leaves the airplane at maximum landing weight (MLW) when jettison is complete
- the fuel to remain display replaces the fuel temperature and static air temperature displays.

Fuel to remain MAN (manual) selection is displayed:

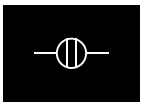
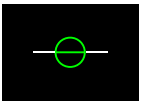
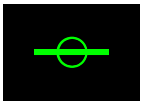
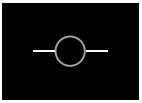
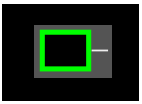
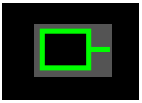
- fuel jettison system is ARMED
- the FUEL TO REMAIN selector is pulled on
- the quantity to remain can be changed by rotating FUEL TO REMAIN selector.

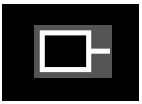
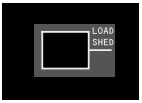
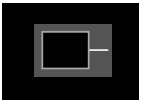
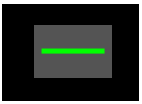
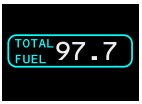
Fuel Synoptic Display

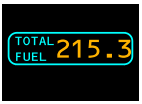
The fuel synoptic is displayed by pushing the systems (SYS) display switch, then selecting the FUEL synoptic key. (See Display Select Panel on page 10.10.51 for additional information.)

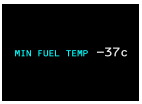


Fuel Synoptic Indications

Symbol	Indication	Description
	Fuel Valve (white)	Fuel valve is closed.
	Fuel Valve (green)	Fuel valve is in transit.
	Fuel Valve (green)	Fuel valve is in open.
	Fuel Valve (amber with crossout)	Fuel valve is failed. Valve is commanded open but remains closed.
	Fuel Valve (amber with crossout)	Fuel valve is failed. Valve is commanded closed but remains open or in transit.
	Fuel Valve (gray)	Fuel valve state is invalid.
	Fuel Pump (green rectangle)	Fuel pump switch is ON.
	Fuel Pump (green rectangle with line)	Fuel pump switch is ON and pressure sensor detects pressure greater than 7 to 8 psig.

Symbol	Indication	Description
	Fuel Pump (white rectangle)	Fuel pump switch is OFF.
	Fuel Pump load shed (white)	Fuel pump switch is ON and pump has been load shed.
	Fuel Pump (amber rectangle with crossout)	Fuel pump failed or pump switch is ON and pressure sensor detects pressure less than 7 to 8 psig. Also shown following automatic shutoff of center tanks.
	Fuel Pump (gray rectangle)	Fuel pump state is invalid.
	Normal Fuel Feed (green)	Fuel line is pressurized. Pressure sensor detects pressure greater than 7 to 8 psig.
	Suction Feed (amber)	Fuel line is unpressurized and suction flow is occurring.
	Total Fuel (white)	Normal indication.
	Total Fuel (blank)	Invalid indication or any individual tank quantity blank.

Symbol	Indication	Description
	Total Fuel (amber)	INSUFFICIENT FUEL alert message is displayed.
	Main Tank Quantity (white)	Normal indication.
	Main Tank Quantity (amber)	Fuel tank quantity is low. FUEL QTY LOW message is displayed.
	Tank Quantity (blank)	Tank quantity is invalid.
	Center Tank Quantity (white)	Normal indication.
	Center Tank Quantity (amber)	FUEL IN CENTER message is displayed.
	Center Tank Quantity (amber)	Center fuel tank quantity is low. FUEL LOW CENTER message is displayed.
	Pointer (amber)	FUEL IMBALANCE is displayed. The pointer is displayed next to the tank with the lower quantity.

Symbol	Indication	Description
	Pointer (white)	The crossfeed switch is ON or the balance switch is ON and the main tank quantities differ by more than 200 lbs (or 100 kgs). The pointer is displayed next to the tank with the lower quantity.
	Fuel Balanced (white)	Balanced indication. The fuel balanced indication flashes once fuel is within 200 lbs (or 100 kgs) of balanced.
	Minimum Fuel Temperature (temperature displayed white)	Normal indication. The Minimum Fuel Temperature is the Fuel Freeze Temperature plus 3 degrees C.
	Minimum Fuel Temperature (temperature displayed as blank)	Invalid indication.
	Fuel Temperature (temperature displayed white)	Normal indication. The fuel temperature displayed white is the lowest of three tank temperatures.
	Fuel Temperature (temperature displayed amber)	High fuel temperature indication when no "-" is displayed. Low fuel temperature indication when "–" is displayed.
	Fuel Temperature (temperature displayed as blank)	Invalid indication.

Introduction

The fuel system supplies fuel to the engines and the APU. The fuel is contained in a center tank, and left and right main tanks.

(See Engine Fuel System on page 7.20.13 for additional information.)

Fuel Quantity

Fuel quantity is measured by sensors in each tank. Total fuel quantity is displayed on the primary EICAS display. Tank quantities and total fuel quantity are displayed on the FUEL synoptic display.

Expanded fuel indications showing the left main, center, and right main tank quantities are displayed when non-normal conditions occur.

Due to the unique shape of the 787 composite wing, fuel quantity indications can fluctuate significantly during high pitch maneuvers, such as takeoff and go-around, especially at low fuel loads.

Fuel Temperature

Fuel temperature is displayed on the primary EICAS display. The temperature is normally displayed in white. It is displayed in amber when the fuel temperature approaches maximum or the fuel freeze temperature entered on the flight management system CDU. During jettison, the TO REMAIN quantity replaces the EICAS display static air temperature and fuel temperature indications.

Fuel temperature and minimum fuel temperature are also displayed on the fuel synoptic display.

Fuel Pumps

Each fuel tank contains two AC–powered fuel pumps. A single pump can supply sufficient fuel to operate one engine under all conditions.

The two center tank fuel pumps are override/jettison pumps. These pumps have a higher output pressure than the left and right main tank fuel pumps. The center tank pumps override the main tank pumps so that center tank fuel is used before wing tank fuel.

When the main tank fuel pump switches are off, the switch PRESS lights illuminate and the EICAS advisory messages FUEL PUMP (L, R, FWD, or AFT) display. When the center fuel pump switches are off, the switch PRESS lights and pump pressure EICAS messages are inhibited.

When less than all engines/generators are operating, there may not be sufficient electrical power to operate all fuel pumps. In such cases, the fuel system

automatically determines the best pumps to operate depending on how much electrical power is available. Certain fuel pumps may be load shed until enough electrical power is available. The indications that a fuel pump has load shed are that the pump switch PRESS light is illuminated and the pump is labeled LOAD SHED on the fuel synoptic.

The left main tank contains a DC–powered fuel pump. It has no controls or indicators, other than the fuel synoptic display. The DC pump operates automatically to provide fuel to the APU when AC power is not available and the APU selector is ON.

Surge tanks are provided in each wing, outboard of each main tank. Fuel in the surge tanks and fuel remaining in the refueling manifold is drained into the main tanks.

Fuel Pump Operation

Before start, the main tank pump switches should all be pushed ON. If the FUEL IN CENTER message is displayed, the center tank pump switches should also be pushed ON.

During flight, when the FUEL LOW CENTER message displays, the center tank pump switches should be pushed off. The condition statement for this message is contained in Section 12.30, Fuel System EICAS Messages.

If a center pump has low output pressure, the fuel pump switch PRESS light illuminates and the message FUEL PUMP CENTER (L or R) displays.

With the main tank pumps ON, a scavenge system operates automatically to transfer any remaining center tank fuel to the main tanks. Fuel transfer begins when either main tank quantity is less than approximately 16,000 kilograms (depending on fuel density) and the center tank pumps are off. The system is inhibited if the engine is on suction feed.

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 eventually depletes after reaching cruise altitude. The depletion time is dependent upon airplane altitude, fuel temperature, and type of fuel. Once the dissolved air is depleted, the engine should effectively operate on suction feed.

Fuel pressure can be provided from a main tank with operating fuel pumps to both engines by opening the fuel crossfeed valve. Continued crossfeed use results in a progressive fuel imbalance.

Fuel Crossfeed

The fuel manifolds are arranged so that any fuel tank pump can supply either engine. The crossfeed valve is closed during normal operations. The closed crossfeed valve isolates the left and right systems. The valve can be opened to feed an engine from the opposite fuel tank. If the valve position does not agree with the switch position, the CROSSFEED switch VALVE light illuminates and the EICAS advisory message FUEL CROSSFEED displays.

Fuel Balance System

Fuel can be transferred from main tank to main tank using the fuel balance system. Fuel transfer is initiated by pushing the fuel balance switch ON. Fuel from the higher quantity main tank is transferred through its defuel/jettison valve to the lower quantity main tank through its inboard refuel valve. Transfer stops automatically when fuel is balanced.

Anytime the fuel balance system is selected ON and balance is not achieved, the balance system shuts down, the BALANCE switch FAULT light illuminates, and the EICAS advisory message FUEL BALANCE SYS is displayed. This occurs if there is a system failure or if the system is functional but inhibited.

Fuel balance operation is inhibited for the any of the following reasons:

- refueling, defueling and ground transfer of fuel (using the refueling control panel)
- prior to engine start and the APU is off
- the fuel balance system is failed
- a center tank pump is on
- on the ground and one or both engines are running
- in flight and the fuel jettison system is active, or the FUEL DISAGREE or FUEL QTY LOW message shows.

Fuel Imbalance

When the fuel quantity in left and right main tanks differ by a predetermined quantity, the EICAS alert message FUEL IMBALANCE displays.

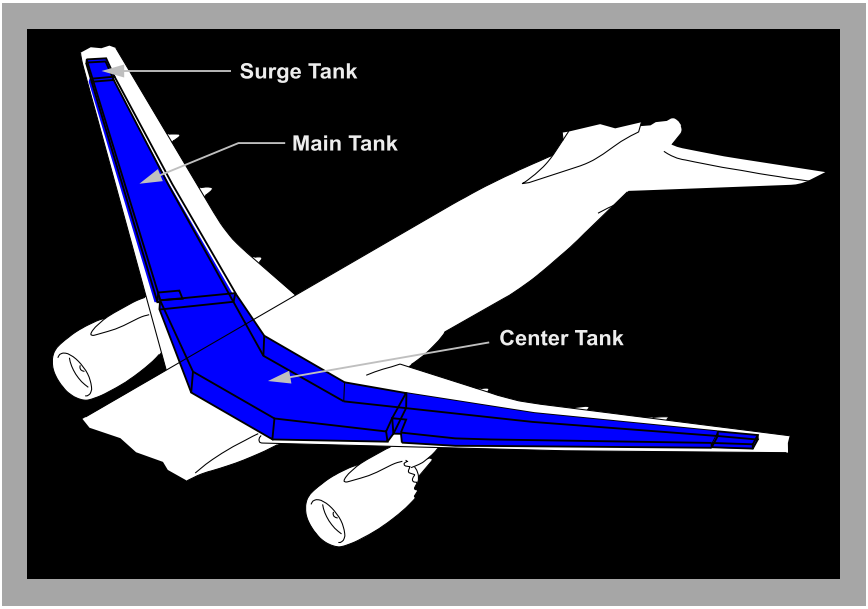
Fuel balancing is accomplished by using either the fuel balance system or the manual crossfeed.

Manual crossfeed is initiated by opening the crossfeed valve and turning off the fuel pump switches for the fuel tank that has the lower quantity. Crossfeed may be done in any phase of flight.

The fuel balance system is initiated by pushing the fuel balance switch. The fuel balance system may be used in any phase of flight. It can be used on the ground if the engines are shutdown and the APU is running.

Fuel Tank Locations and Capacities

Fuel Tank Locations



Fuel Tank Capacities

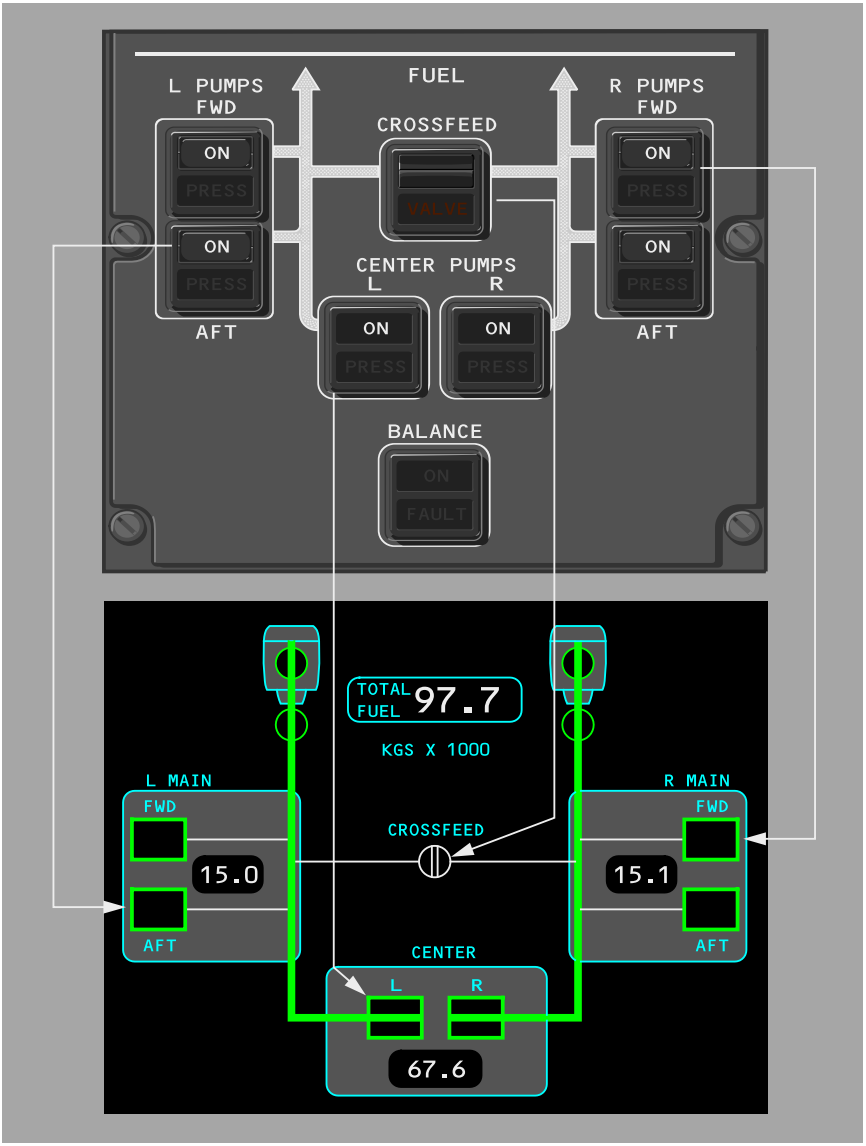
TQA to TQF

Tank	Liters	Kilograms*
Left Main	21,085	16,929
Right Main	21,085	16,929
Center	84,036	67,472
Total	126,206	101,330
*** Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter.**		

TWA,B

Tank	Liters	Kilograms*
Left Main	20,895	16,776
Right Main	20,895	16,776
Center	84,566	67,899
Total	126,356	101,451
*** Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter.**		

Fuel System Schematic



APU Fuel Feed

APU fuel is supplied from the left fuel manifold. APU fuel can be provided by any AC fuel pump supplying fuel to the left fuel manifold or by the left main tank DC fuel pump.

On the ground, with the APU switch ON and no AC power available, the DC pump runs automatically. With AC power available, the left aft AC fuel pump operates automatically, regardless of fuel pump switch position, and the DC fuel pump turns off.

Fuel Jettison

The fuel jettison system allows jettison from all fuel tanks. Fuel jettison is accomplished by opening the center tank jettison isolation valves and the main tank defuel/isolation valves. Fuel flows into the jettison/refuel manifold and is then jettisoned overboard through jettison nozzle valves inboard of each aileron.

Fuel jettison is initiated by pushing the FUEL JETTISON ARM switch to select ARMED. The jettison system automatically sets the fuel-to-remain to the maximum landing weight (MLW) fuel quantity. The TO REMAIN quantity replaces fuel temperature on the EICAS display.

Pull on and rotate the TO REMAIN selector to manually decrease or increase the TO REMAIN quantity.

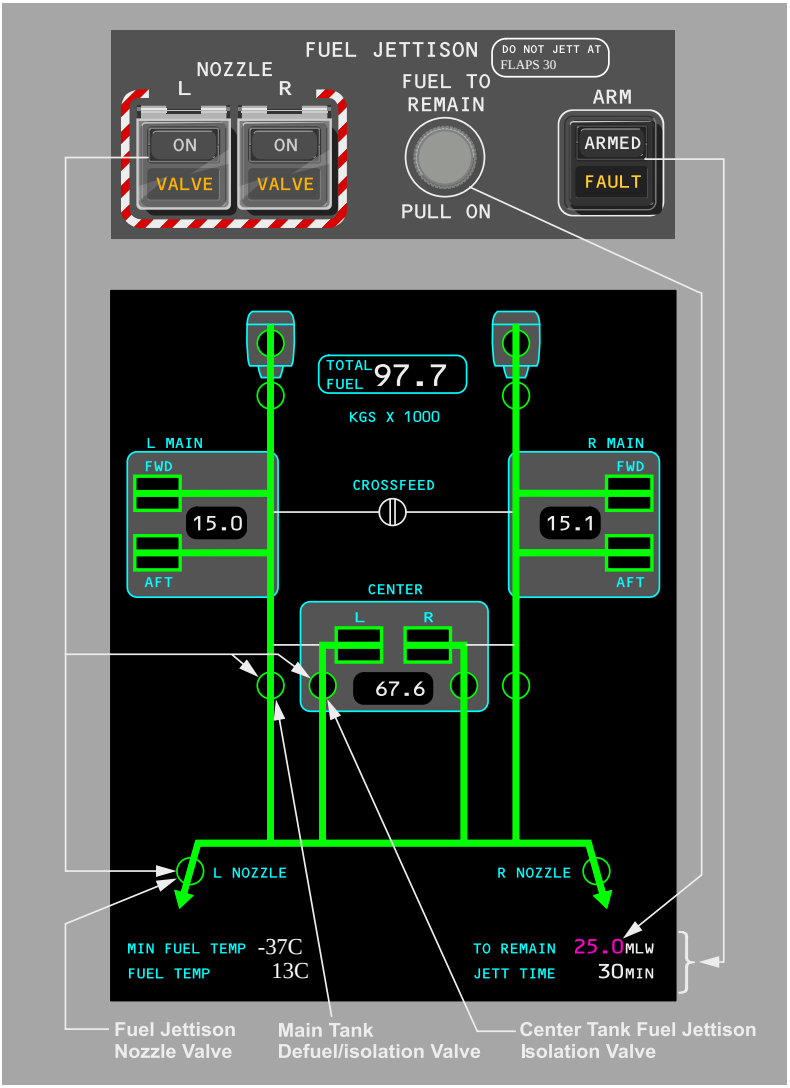
In flight, when the FUEL JETTISON ARM switch is armed and either fuel jettison NOZZLE switch is pushed ON, the defuel/isolation valves and jettison isolation valves open. The fuel system automatically positions the valves as required to jettison fuel based on the selected TO REMAIN quantity.

The nozzles cannot open on the ground, regardless of switch positions.

In flight, jettison time is displayed in minutes on the fuel synoptic when the jettison arm switch is positioned on while in the air. Jettison automatically stops when a value just above the FUEL TO REMAIN quantity is reached. The system closes the defuel/isolation valves and the jettison isolation valves.

At least 3900 kilograms of fuel remains in each main tank after jettison is complete.

Fuel Jettison Schematic



Nitrogen Generation System

The Nitrogen Generation System (NGS) provides automatic full time flammability protection for the fuel system. It generates nitrogen enriched air to displace fuel

vapors in all fuel tanks. The nitrogen enriched air minimizes fuel flammability during normal flight and ground operations.

FMS EICAS and CDU Fuel Messages

The Flight Management System may generate INSUFFICIENT FUEL as either an EICAS message or CDU help window message.

For additional information

- See Fuel Monitoring on page 11.32.3
- See EICAS Messages on page 11.60.1
- See FMC Alerting Messages on page 11.60.4.

Fuel System EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
FUEL AUTO JETTISON	Caution	Beeper	One of these occurs: • the total fuel quantity is less than the FUEL TO REMAIN and a jettison nozzle valve is open • the fuel jettison automatic shutoff is failed.
FUEL BALANCE ON	Memo		The fuel balance function is on.
FUEL BALANCE SYS	Advisory		One of these occurs: • the fuel balance system is failed • a center tank pump is on • on the ground and one or both engines are running • in flight and the fuel jettison system is active, or the FUEL DISAGREE or FUEL QTY LOW message shows.
FUEL CROSSFEED	Advisory		The fuel crossfeed valve is not in the commanded position.
FUEL CROSSFEED ON	Memo		The FUEL CROSSFEED switch is in the ON position.
FUEL DISAGREE	Advisory		The totalizer fuel quantity and the FMC calculated fuel quantity disagree.
FUEL FLOW ENG L, R	Advisory		Engine fuel flow is abnormally high.

Message	Level	Aural	Condition
FUEL IMBALANCE	Advisory		There is a fuel imbalance between the main tanks.
FUEL IN CENTER	Advisory		The center tank fuel quantity is at the level where the pump switches must be ON.
FUEL JETT NOZZLE L, R	Advisory		The jettison nozzle valve is not in the commanded position.
FUEL JETTISON v	Advisory		The main tank fuel jettison system is failed.
FUEL JETTISON SYS	Caution	Beeper	One of these occurs: • the fuel jettison system is failed • the fuel to remain selector is ON and the fuel jettison system is not armed.
FUEL LOW CENTER	Advisory		The center tank fuel quantity is at the level where the pump switches must be off.
FUEL PRESS ENG L, R	Caution	Beeper	The engine is on suction feed.
FUEL PRESS ENG L +R	Advisory		Fuel pressure to both engines is low on the ground with the engines shut down.
FUEL PUMP CENTER L, R	Advisory		The center fuel pump pressure is low.
FUEL PUMP CTR L+R	Advisory		Both center fuel pump pressures are low.
FUEL PUMP L AFT, FWD	Advisory		The left fuel pump pressure is low.
FUEL PUMP R AFT, FWD	Advisory		The right fuel pump pressure is low.
FUEL QTY LOW	Caution	Beeper	The fuel quantity is low in a main tank.
FUEL TEMP HIGH	Advisory		Fuel temperature is near the maximum.
FUEL TEMP LOW	Advisory		Fuel temperature is near the minimum.

Message	Level	Aural	Condition
FUEL UNUSABLE CTR	Advisory		Center tank fuel is unusable due to faults in one or more of the following: • center tank pumps • crossfeed valve • center tank scavenge system • fuel balance system • fuel quantity indicating system.
FUEL VALVE APU	Advisory		The APU fuel valve is not in the commanded position.

Hydraulics Chapter 13
Table of Contents

Controls and Indicators 13.10

Hydraulic Panel 13.10.1

Hydraulic System Indications 13.10.2

Status Display 13.10.3

Hydraulic Synoptic Display 13.10.4

Synoptic Indication Symbology 13.10.5

Miscellaneous Hydraulic System Controls 13.10.9

Engine Fire Panel 13.10.9

Flight Control Surface Lockout Switches 13.10.9

System Description 13.20

Introduction 13.20.1

Left and Right Hydraulic Systems 13.20.1

Left and Right Hydraulic System Primary Pumps 13.20.1

Left and Right Hydraulic System Demand Pumps 13.20.1

Center Hydraulic System 13.20.2

Center Hydraulic System Electric Pumps 13.20.2

Center Hydraulic System Non-Normal Operation 13.20.2

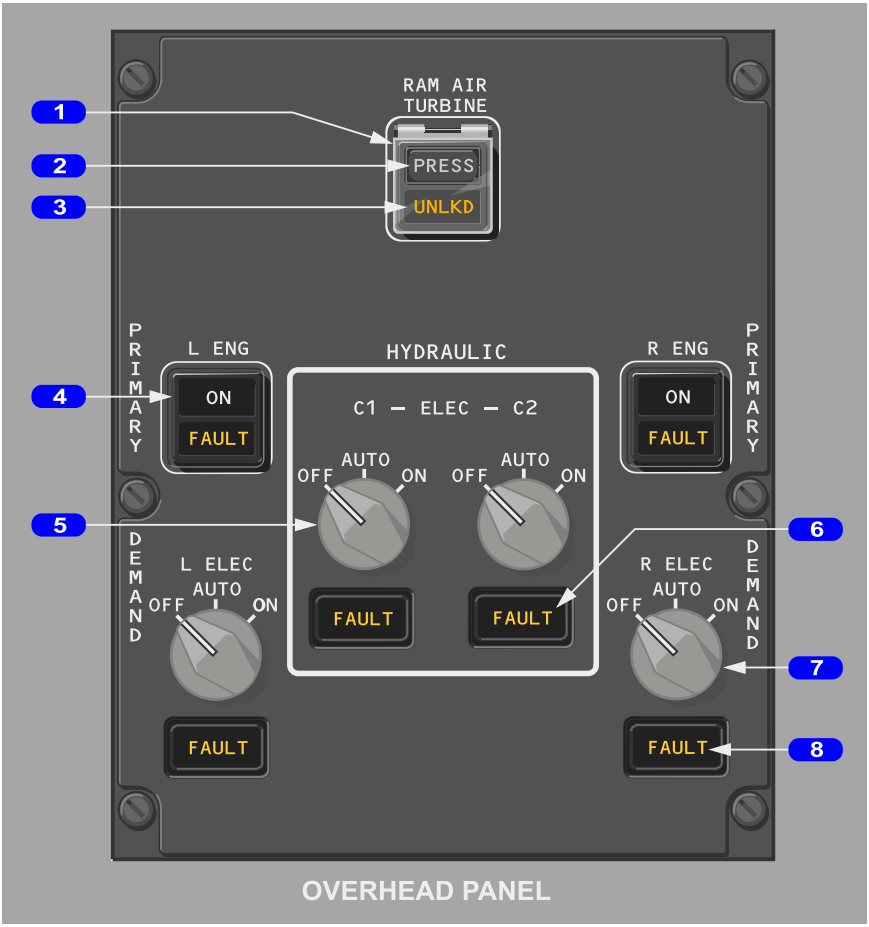
Ram Air Turbine (RAT) 13.20.3

Hydraulic Systems Schematic 13.20.4

EICAS Messages 13.30

Hydraulics, Ram Air Turbine EICAS Messages 13.30.1

Hydraulic Panel



1 RAM AIR TURBINE Switch

Push—deploys the RAT.

2 Ram Air Turbine Pressure (PRESS) Light

Illuminated (white)—

- the RAT is deployed

- center system primary flight control hydraulic pressure is greater than 3,000 psi.

3 Ram Air Turbine Unlocked (UNLKD) Light

Illuminated (amber)—the RAT is not in the stowed position.

4 Left/Right Engine (L/R ENG) PRIMARY Pump Switches

ON—the engine-driven hydraulic pump pressurizes the related left or right hydraulic system when engine starts.

Off (ON not visible)—the engine-driven hydraulic pump is turned off and depressurized.

5 C1/C2 Electrical (C1/C2 ELEC) Pump Selectors

ON—the pump runs continuously.

AUTO—Pumps alternate as a primary pump and a demand pump. The primary pump operates continuously and the demand pump operates during high system demand.

OFF—the pump is off.

6 C1 and C2 Pump FAULT Lights

Illuminated (amber)—

- low primary pump pressure
- excessive primary pump fluid temperature, or
- pump selected OFF.

7 DEMAND (L/R ELEC DEMAND) Pump Selectors

ON—the pump runs continuously.

AUTO—the pump operates when system and/or primary pump(s) pressure is low, or when control logic anticipates a large system demand.

OFF—the pump is off.

8 Demand Pump FAULT Lights

Illuminated (amber)—

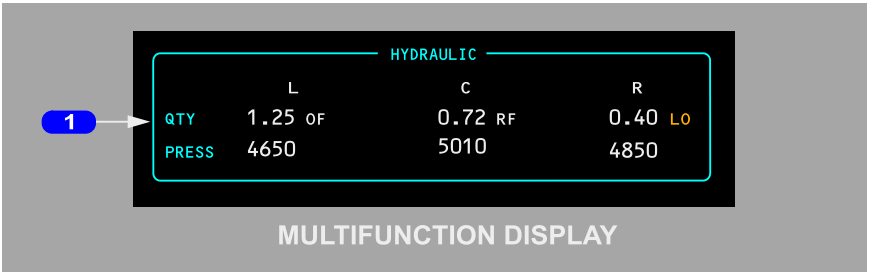
- low demand pump pressure
- excessive demand pump fluid temperature, or
- demand pump is selected OFF.

Hydraulic System Indications

Hydraulic system indications are displayed by pushing the systems (SYS) display switch, then selecting either the status (STAT) synoptic key or the hydraulic

(HYD) synoptic key. (See Display Select Panel on page 10.10.51 for additional information.)

Status Display



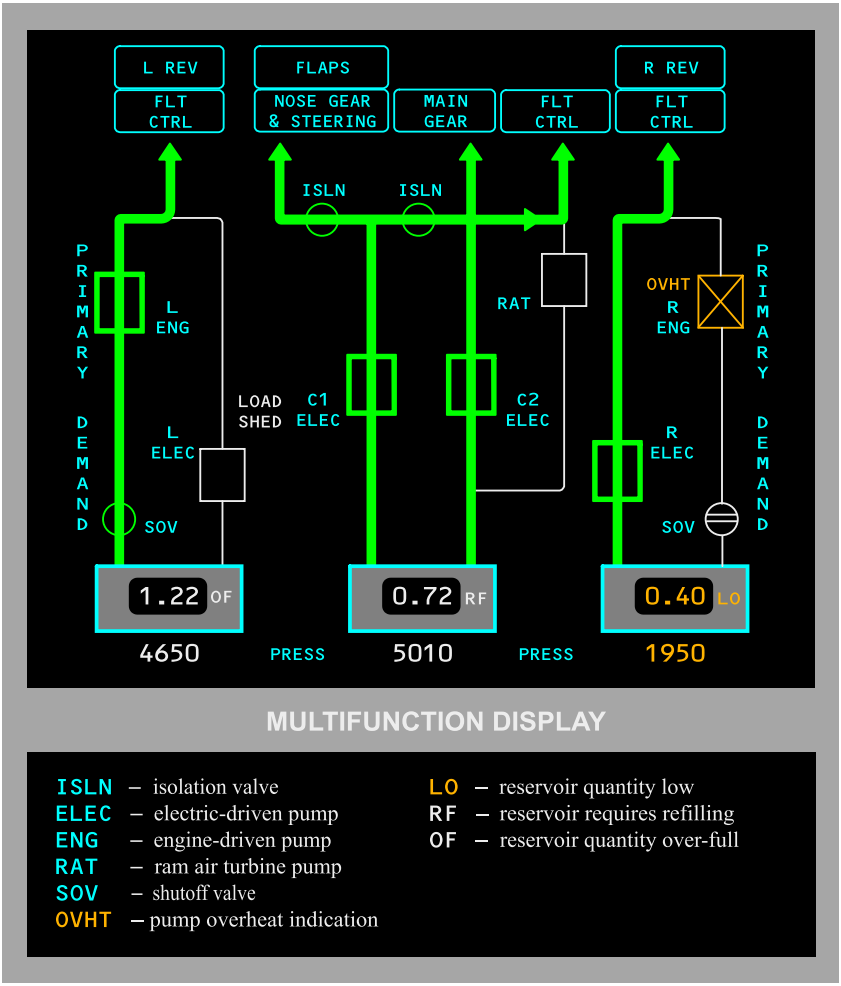
1 Hydraulic Display

Quantity (QTY)—

- displays system reservoir quantity as a percentage of the normal service level (1.00 is the normal service level)
- LO (amber)—displayed when the reservoir quantity is low
- OF (white)—displayed when the reservoir is over-full (inhibited in flight)
- RF (white)—displayed when the reservoir requires refilling (inhibited in flight).

Pressure (PRESS)—displays hydraulic system pressure in pounds per square inch.

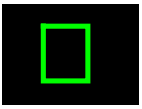
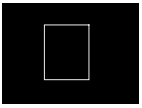
Hydraulic Synoptic Display



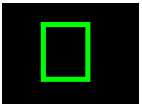
Note: The Nose Gear Isolation Valve (NGIV) and the Reserve Steering Isolation Valve (RSIV) are shown on the synoptic page. The Alternate Extend Isolation Valve (AEIV) is not shown.

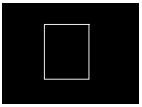
Synoptic Indication Symbology

Electric Motor Pump (EMP) Synoptic Indications

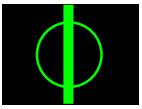
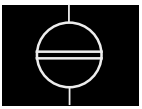
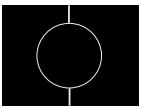
Symbol	Condition	Description
	EMP on (green)	Pump output pressure exceeds 2,000 psi.
	EMP off (white)	Pump output pressure less than or equal to 2,000 psi and pump is commanded off.
	EMP failed (amber)	Pump output pressure less than or equal to 2,000 psi when commanded on.
	EMP invalid on (white, low intensity)	Signal(s) from pump are invalid or missing.

Engine Driven Pump (EDP) Synoptic Indications

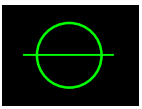
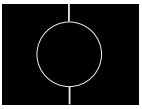
Symbol	Condition	Description
	EDP on (green)	Pump output pressure 2,150 psi or greater.
	EDP off (white)	Pump output pressure less than 2,150 psi and pump is commanded off.

Symbol	Condition	Description
	EDP failed (amber)	Pump output pressure less than 2,150 psi, engine primary pump switch is ON and engine is running.
	EDP invalid on (white, low intensity)	Signal(s) from pump are invalid or missing.

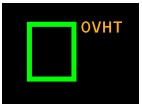
EDP Shutoff Valves (SOV) Synoptic Indications

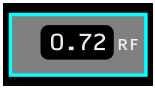
Symbol	Condition	Description
	Valve open (green)	Engine fire handle not pulled.
	Valve closed (white)	Engine fire handle pulled.
	Valve failed closed (amber)	
	Valve failed open (amber)	
	Valve invalid (white, low intensity)	

Isolation Valve (ISLN) Synoptic Indications

Symbol	Condition	Description
	Valve open (green)	
	Valve closed (white)	
	Valve failed open (amber)	Valve open when commanded closed.
	Valve failed closed (amber)	Valve closed when commanded open and center hydraulic system pressure greater than 3,000 psi.
	Valve invalid (white, low intensity)	Signal(s) from valve are invalid or missing.

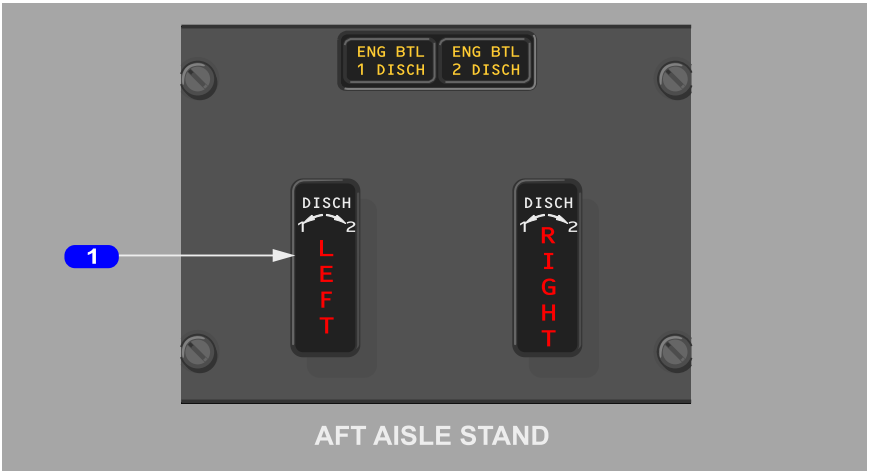
Miscellaneous Synoptic Indications

Indication	Condition	Description
	Pump overheat	Pump temperature exceeds limit.
	Load shed indication	Pump has received load shed command.

Indication	Condition	Description
	Flow lines (green with arrow end or white solid)	Green flow lines with directional arrow display if a pump is on and no valves upstream or downstream are closed. Narrow white lines are unpressurized.
	Normal system pressure (white)	System pressure 3,000 psi or greater.
	Low system pressure (amber)	System pressure less than 3,000 psi.
	Low quantity (amber LO)	Hydraulic reservoir quantity is low.
	Refill quantity (white RF)	Hydraulic reservoir requires refilling. Inhibited in flight.
	Overfill (white OF)	Hydraulic reservoir is overfilled. Inhibited in flight.

Miscellaneous Hydraulic System Controls

Engine Fire Panel



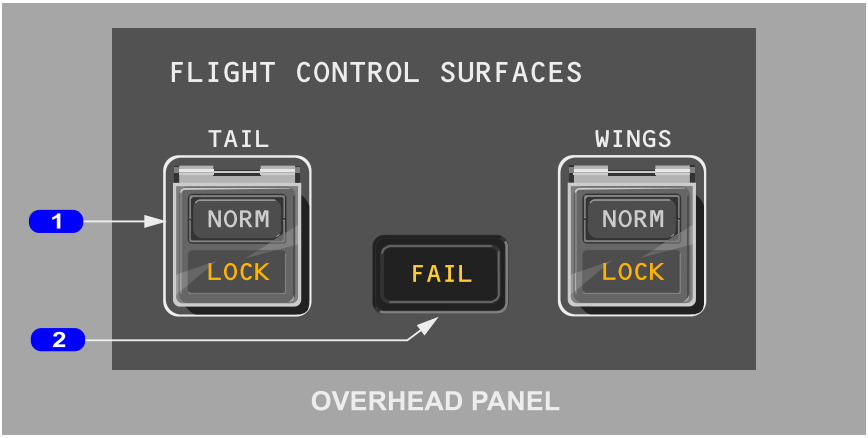
1 Engine Fire Switches

Pull—

- closes the engine–driven pump hydraulic supply shutoff valve
- depressurizes the engine–driven pump.

Flight Control Surface Lockout Switches

Note: No flight crew normal or non–normal procedures require operation of the flight control surface lockout switches. These switches are for ground maintenance use only.



1 FLIGHT CONTROL SURFACES Lockout Switches (TAIL/WINGS)

NORM—associated flight control surface electronically unlocked.

LOCK—associated flight control surface electronically locked.

2 FLIGHT CONTROL SURFACES Lockout FAIL Light

Illuminated (amber)—the system lockout has failed.

Introduction

The airplane has three independent 5000 psi hydraulic systems: left, right, and center. The hydraulic systems power the:

- flight controls
- landing gear
- leading edge slats
- nose gear steering
- thrust reversers
- trailing edge flaps.

Flight control system components are distributed so that any one hydraulic system can provide adequate airplane controllability.

Hydraulic fluid is supplied to each hydraulic pump from the associated system reservoir. The reservoirs are pressurized by pump outlet pressure.

Left and Right Hydraulic Systems

The left and right hydraulic systems are identical. They differ only in the components they power.

The left hydraulic system powers:

- flight controls
- the left engine thrust reverser
- right and left wing spoilers.

The right hydraulic system powers:

- flight controls
- the right engine thrust reverser
- right and left wing spoilers.

Left and Right Hydraulic System Primary Pumps

The left and right hydraulic systems each have a primary pump. The left and right primary pumps are engine–driven by the related left and right engines.

Left and Right Hydraulic System Demand Pumps

The left and right hydraulic systems each have a demand pump. The demand pumps are electric motor–driven (EMPs). The demand pumps provide supplementary hydraulic power for periods of high system demand. The demand pumps also provide a backup hydraulic power source for the engine–driven primary pumps.

The pumps are controlled by the ELEC DEMAND L and R pump selectors. In the ON position, the demand pump runs continuously. In the AUTO position, the L and R demand pumps operate under the following conditions:

- system low pressure, or
- on the ground, for the first three minutes after the second engine is started, or
- from takeoff thrust set to flaps retracted, or
- during descent and landing, from gear down or RA less than 1,000 feet, to groundspeed less than 40 knots, or
- thrust reverser operation.

Center Hydraulic System

The center hydraulic system powers:

- flight controls
- landing gear actuation
- leading edge slats
- nose gear steering
- right and left wing spoilers
- trailing edge flaps.

The ram air turbine (RAT) only provides hydraulic power to the center hydraulic system primary flight controls.

Center Hydraulic System Electric Pumps

Two electric motor-driven pumps (EMPs) provide hydraulic power sources for the center hydraulic system. The C1 and C2 ELEC pump selectors control pump operation. The two center pumps alternate as a primary pump and demand pump. The primary pump operates continuously after the second engine is started. The center demand pump operates under the following conditions:

- system low pressure, or
- on the ground for the first three minutes after the second engine is started, or
- from takeoff thrust set until radio altitude exceeds 2,000 feet
- flaps or slats are in motion, or
- during descent from when the gear lever is down and radio altitude is less than 2,000 feet until groundspeed is less than 60 knots.

Center Hydraulic System Non-Normal Operation

The center hydraulic system has isolation functionality in the event of a leak. The isolation function uses a Nose Gear Isolation Valve (NGIV), Reserve Steering Isolation Valve (RSIV), Alternate Extend Isolation Valve (AEIV) and a reservoir standpipe. The hydraulic isolation systems ensure the flight crew can lower the landing gear and that nose wheel steering is operational for landing, roll-out and

taxi. The isolation valves operate automatically and cannot be controlled by the crew.

There are certain airplane failure modes which require one or more of the demand pumps, left, right or center to load shed to allow the electrical system to provide power to other systems. The indication is LOAD SHED showing on the hydraulic synoptic next to the demand pump symbol.

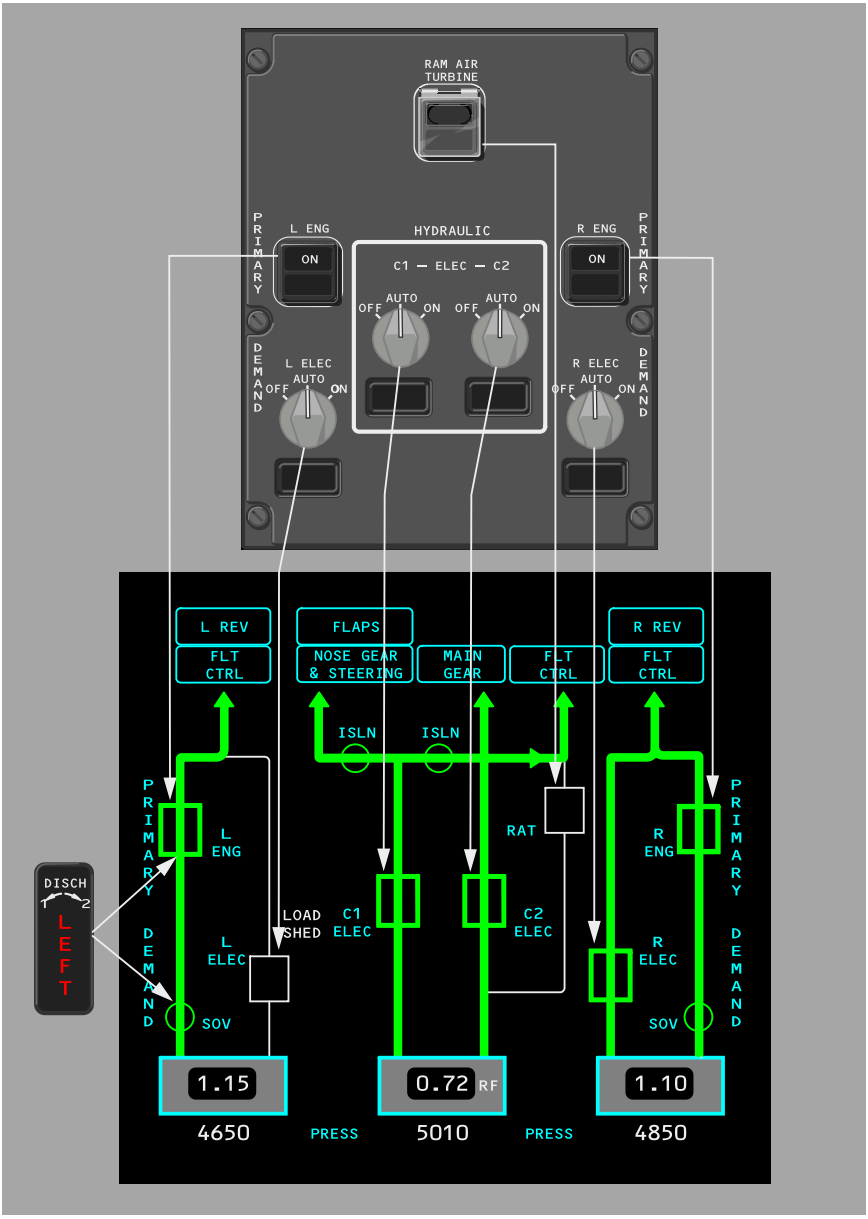
Ram Air Turbine (RAT)

The RAT, when deployed, provides 5,000 psi hydraulic power to the primary flight controls connected to the center hydraulic system. The RAT provides hydraulic and electrical power throughout the flight envelope. (See Ram Air Turbine (RAT) Generator on page 6.20.3 for additional information.) In flight, the RAT deploys automatically if any of the following occur:

- both engines have failed
- all three hydraulic system pressures are low
- loss of all electrical power to captain's and first officer's flight instruments
- loss of all four EMPs and faults in the flight control system occur on approach
- loss of all four EMPs and an engine fails on takeoff or landing.

The RAT can be deployed manually by pushing the RAM AIR TURBINE switch on the hydraulic panel. A spring-loaded actuator is used to deploy the RAT either automatically or manually. Once deployed, the RAT cannot be stowed in flight.

Hydraulic Systems Schematic



Hydraulics, Ram Air Turbine EICAS Messages

The following EICAS messages can be displayed.

Message	Level	Aural	Condition
HYD OVERHEAT C1	Advisory		The C1 pump temperature is high.
HYD OVERHEAT C2	Advisory		The C2 pump temperature is high.
HYD OVERHEAT DEM L, R	Advisory		The demand pump temperature is high.
HYD OVERHEAT PRI L, R	Advisory		The primary pump temperature is high.
HYD PRESS C1	Advisory		The C1 pump pressure is low.
HYD PRESS C2	Advisory		The C2 pump pressure is low.
HYD PRESS DEM L, R	Advisory		The demand pump pressure is low when commanded on.
HYD PRESS PRI L, R	Advisory		The primary pump pressure is low.
HYD PRESS SYS C	Caution	Beeper	The center hydraulic system pressure is low.
HYD PRESS SYS L	Caution	Beeper	The left hydraulic system pressure is low.
HYD PRESS SYS L+C	Caution	Beeper	The left and center hydraulic system pressures are low.
HYD PRESS SYS L+C +R	Caution	Beeper	All hydraulic system pressures are low.
HYD PRESS SYS L+R	Caution	Beeper	The left and right hydraulic system pressures are low.
HYD PRESS SYS R	Caution	Beeper	The right hydraulic system pressure is low.
HYD PRESS SYS R+C	Caution	Beeper	The right and center hydraulic system pressures are low.
HYD QTY LOW C, L, R	Advisory		The hydraulic quantity is low.
RAT UNLOCKED	Advisory		The ram air turbine is not stowed and locked.

Landing Gear — Chapter 14
Table of Contents

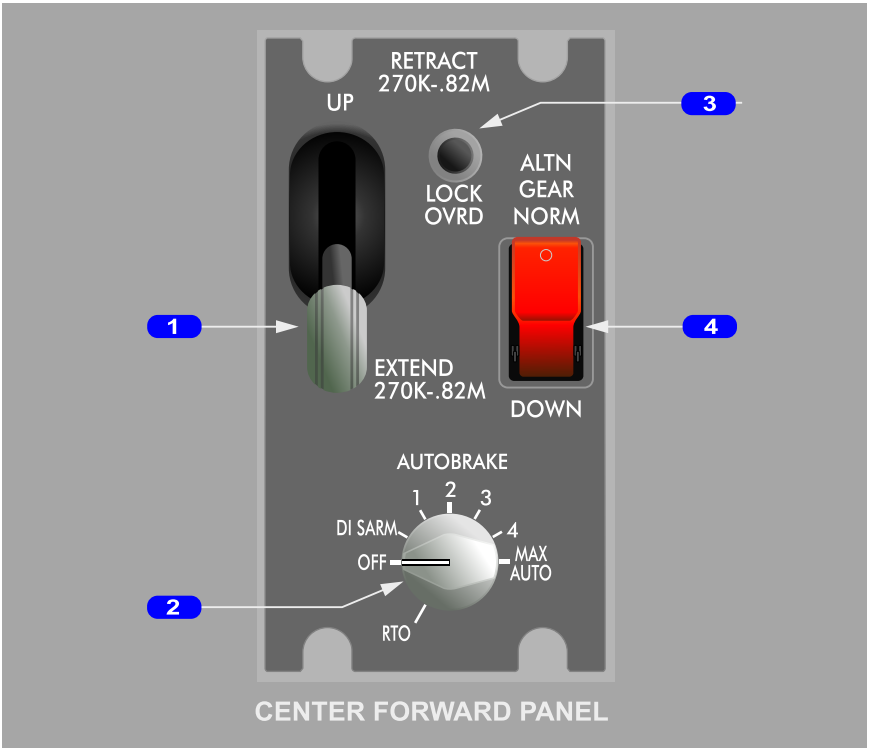
Controls and Indicators 14.10
Landing Gear Panel 14.10.1
Nose Wheel Steering Tillers 14.10.2
Brake System 14.10.3
Rudder/Brake Pedals 14.10.3
Parking Brake Lever 14.10.4
Landing Gear System Indications 14.10.5
Landing Gear Position Indications 14.10.5
Gear Synoptic Display 14.10.6
Synoptic Indication Symbology 14.10.7

System Description 14.20
Introduction 14.20.1
Air/Ground Sensing System 14.20.1
Landing Gear Operation 14.20.1
Landing Gear Retraction 14.20.1
Landing Gear Extension 14.20.2
Landing Gear Alternate Extension 14.20.2
Nosewheel Steering 14.20.3
Brake System 14.20.3
Electric Brake System 14.20.3
Antiskid Protection 14.20.3
Autobrake System 14.20.4
Taxi Brake Release 14.20.5
Parking Brake 14.20.5
Brake Temperature Indication 14.20.6
Tire Pressure Indication 14.20.6

EICAS Messages 14.30
Landing Gear EICAS Messages 14.30.1
Brakes 14.30.1

Landing Gear 14.30.1

Landing Gear Panel



1 Landing Gear Lever

UP—the landing gear retracts.

DN—the landing gear extends.

2 AUTOBRAKE Selector

OFF—deactivates and resets the autobrake system.

DISARM—

- disengages the autobrake system
- releases brake pressure.

1, 2, 3, 4, MAX AUTO—selects the desired deceleration rate.

RTO—automatically applies maximum brake pressure when the thrust levers are retarded to idle above 85 knots.

3 Landing Gear Lever Lock Override (LOCK OVRD) Switch

Push—releases the landing gear lever lock.

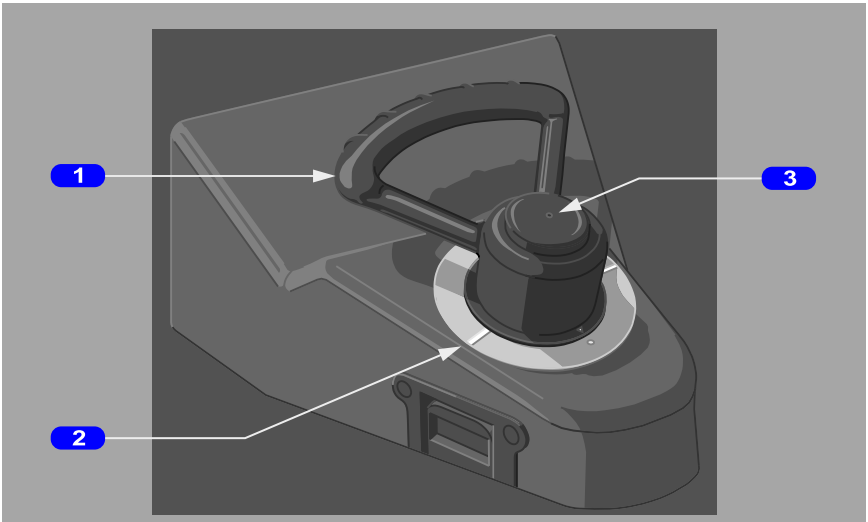
4 Alternate Gear (ALTN GEAR) Switch

NORM—the landing gear lever operates normally.

DOWN—the landing gear extends by the alternate extension system.

Note: Alternate extension may be selected with the landing gear lever in any position.

Nose Wheel Steering Tillers



1 Nose Wheel Steering Tiller

Rotate—

- turns the nose wheels up to 70° in either direction
- is summed with rudder pedal steering inputs.

2 Tiller Position Indicator

Shows tiller displacement from the straight–ahead, neutral position.

There are three marks on the tiller assembly. The center mark identifies the neutral position of the tiller, while the other two identify the maximum left and right displacements.

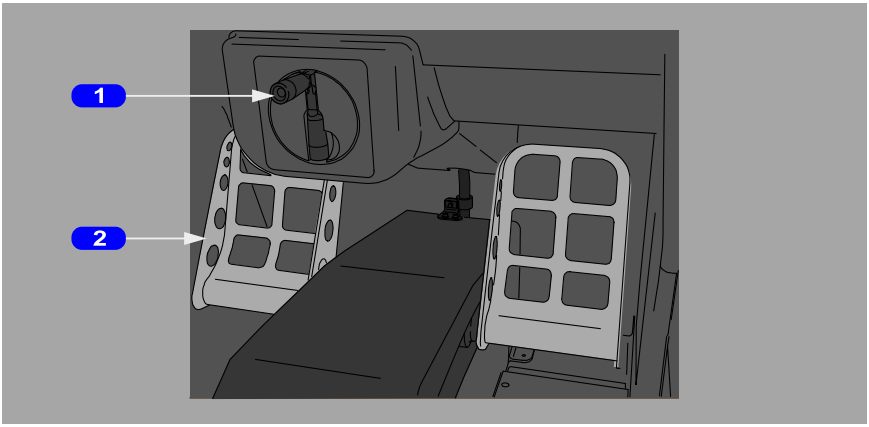
3 Rudder Pedal Steering Disconnect Switch

A rudder pedal disconnect switch is provided to temporarily disable the rudder pedal inputs.

Note: The switch is used during a flight controls freedom of motion check. The switch must be held down to function and is spring loaded to the out position.

Brake System

Rudder/Brake Pedals



1 Rudder Pedal Adjust Crank

Adjusts the rudder pedals forward or aft.

Note: To avoid inadvertent rudder pedal movement, the crank handle should be stowed when not in use.

2 Rudder/Brake Pedals

Push the full pedal—turns the nose wheel up to 8º in either direction.

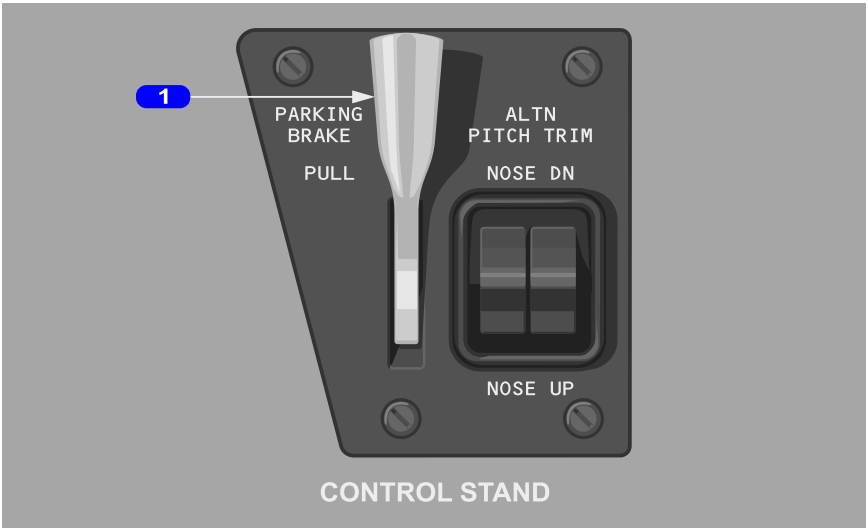
Push the top of the pedals—actuates the wheel brakes.

For additional information:

- See Rudder Trim Control on page 9.10.5
- See Normal Mode Yaw Control on page 9.20.15

- See Secondary and Direct Mode Yaw Control on page 9.20.18.

Parking Brake Lever



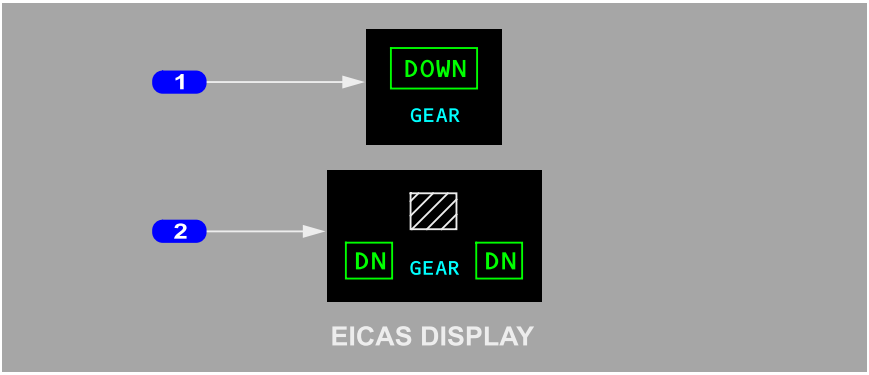
1 Parking Brake Lever

Pull—sets the parking brake when both brake pedals are simultaneously depressed.

Release—simultaneously depress both brake pedals.

Landing Gear System Indications

Landing Gear Position Indications



1 Gear Position Indication (Normal Display)

DOWN (green)—all landing gear are down and locked.

Crosshatched (white)—one or more landing gear are in transit.

UP (white)—all landing gear are up and locked (blanks after 10 seconds).

Empty box (white)—all landing gear position indicators are inoperative.

2 Expanded Gear Position Indication (Non–Normal Display)

DN (green)—the associated landing gear is down and locked.

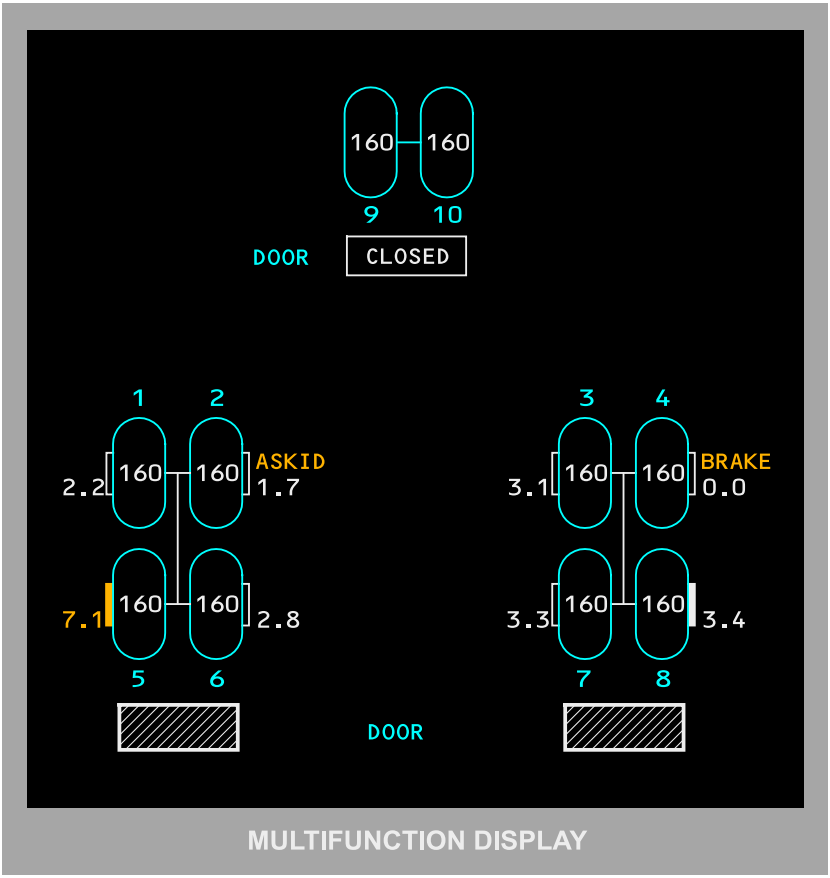
Crosshatched (white)—the associated landing gear is in transit.

UP (white)—the associated landing gear is up and locked.

Empty box(es) (white)—the associated landing gear position indicators are inoperative.

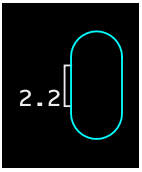
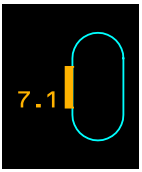
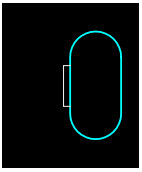
Gear Synoptic Display

The landing gear synoptic is displayed by pushing the systems (SYS) display switch, then selecting the landing gear (GEAR) synoptic key. (See Display Select Panel on page 10.10.51 for additional information.)



Synoptic Indication Symbology

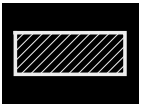
Brake Indications

Symbol	Condition	Description
	Brake Normal (white)	Brake temperature value in normal range from 0.0 to 4.9.
	Hottest Brake (solid white)	Brake temperature value from 3.0 to 4.9. Only one hottest brake symbol per truck is displayed at any time.
	Brake Overheat (solid amber)	Brake temperature value from 5.0 to 9.9. Multiple brake overheat symbols may appear simultaneously. **Note:** EICAS advisory message BRAKE TEMP is displayed.
	Brake Signal Invalid (white, low intensity)	Brake temperature value reads invalid.
	Brake Inoperative (amber)	Indicates loss of brake function or brake deactivation on the associated wheel.
	Antiskid Inoperative (amber)	Indicates antiskid fault on the associated wheel.

Tire Pressure Indications

Symbol	Condition	Description
	Tire Pressure Normal (white)	
	Tire Pressure Abnormal (amber)	Indicates respective tire pressure in abnormal high or low range. **Note:** EICAS advisory message TIRE PRESS is displayed.

Gear Door Indications

Symbol	Condition	Description
	Door Closed	Indicates respective gear door is closed. **Note:** Nose gear doors indicate closed when the gear is down.
	Door In Transit	Indicates respective gear door is in-transit.
	Door signal invalid (white, low intensity)	Indicates respective gear door sensor reads invalid.

Introduction

The airplane has two main landing gear and a single nose gear. The nose gear is a conventional two–wheel steerable unit. Each main gear has four wheels in tandem pairs.

Hydraulic power for retraction, extension, and steering is supplied by the center hydraulic system. An alternate extension system is also provided.

The Electro-Mechanical Brake System has four Electric Brake Actuator Controllers (EBACs) and thirty-two Electric Brake Actuators (EBAs), four per wheel brake. Autobrake and antiskid protection are provided. A brake temperature monitor system displays the temperature for each brake on the GEAR synoptic.

A tire pressure monitor system displays pressure for each tire on the GEAR synoptic.

Air/Ground Sensing System

In-flight and ground operation of various airplane systems are controlled by the air/ground sensing system.

The system receives air/ground logic signals from sensors located on each main landing gear beam. These signals are used to configure the airplane systems to the appropriate air or ground status.

Landing Gear Operation

The landing gear are normally controlled by the landing gear lever. On the ground, the lever is held in the DN position by an automatic lever lock. The lever lock can be manually overridden by pushing and holding the landing gear lever LOCK OVERRIDE switch. In flight, the lever lock is automatically released through air/ground sensing.

Landing Gear Retraction

TWA.B

To improve performance, an early doors function automatically pre-opens the main landing gear doors one second after lift-off and prior to the pilot moving the gear lever to the UP position. If the pilot does not move the gear lever to UP within 30 seconds, the main gear doors return to the closed position. During a touch-and-go, the early doors function does not activate until the airplane has been on the ground for more than 30 seconds.

When the landing gear lever is placed in the UP position the gear retraction sequence is started. The EICAS landing gear position indication display changes from a green DOWN indication to a white crosshatch in-transit indication as the landing gear retract into the wheel wells. After retraction, the landing gear are

held up by uplocks. The EICAS landing gear position indication changes to UP for 10 seconds and then blanks. With the landing gear retracted and all doors closed, the landing gear hydraulic system is automatically depressurized.

If any gear is not up and locked up after the normal transit time, the EICAS caution message GEAR DISAGREE is displayed. The EICAS gear position indication changes to the expanded non–normal format, with the affected gear displayed as in–transit or down, if the gear never unlocked from the down position. The EICAS advisory message GEAR DOOR is displayed if any hydraulically actuated door is not closed after normal transit time.

Landing Gear Extension

When the landing gear lever is moved to DN, the landing gear doors open, the gear are unlocked, and the in–transit indication is displayed on the EICAS landing gear position indication.

The gear free–fall without hydraulic power to the down and locked position. The downlocks are powered to the locked position, all hydraulically actuated gear doors close, and the main gear trucks hydraulically tilt to the flight position. When all gear are down and locked, the EICAS gear position indication displays DOWN.

The EICAS caution message GEAR DISAGREE is displayed if any gear is not locked down (side and drag brace on the same main gear not locked, or nose gear drag brace not locked) after the normal transit time. The EICAS gear position indication changes to the expanded non–normal format, with the affected gear displayed as in transit (or UP if the gear never unlocked from the up position).

If only one brace on a main gear is locked (either drag or side brace not locked) after the normal transit time, the EICAS caution message GEAR DRAG BRACE L, R or GEAR SIDE BRACE L, R is displayed for the affected gear. The EICAS gear position indication changes to the expanded non–normal format, with the affected gear displayed as in transit. The EICAS advisory message GEAR DOOR displays if any hydraulically actuated door is not closed after the normal transit time.

Landing Gear Alternate Extension

The alternate landing gear extension system uses a dedicated DC powered electric hydraulic pump and center hydraulic system fluid to extend the landing gear. Selecting DOWN on the ALTERNATE GEAR switch releases all door and gear uplocks. The landing gear free–fall to the down and locked position. The landing gear lever position has no effect on landing gear alternate extension.

The EICAS landing gear position indication displays the expanded gear position indication when the alternate extension system is used. During alternate extension, the EICAS message GEAR DOOR is displayed because all the hydraulically powered gear doors remain open.

Following an alternate extension, the landing gear can be retracted by the center hydraulic system, if it is operating. Select DN then UP with the gear lever to retract the landing gear.

Nosewheel Steering

The airplane is equipped with nosewheel steering powered by the center hydraulic system.

Primary steering control is provided by a nosewheel steering tiller for each pilot. Limited steering control is available through the rudder pedals. The tillers can turn the nosewheels up to 70º 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 nosewheels up to 8º in either direction. Tiller inputs are summed with rudder pedal inputs.

Brake System

Each main gear wheel has a multiple disc carbon brake. The nosewheels have no brakes. The brake system includes:

- antiskid protection
- autobrake system
- electric brake system
- parking brake.

Electric Brake System

The brake system is powered by four electric brake power supply units. The brake pedals provide independent control of the left and right brakes.

Four Electric Brake Actuators (EBAs) are provided on each main landing gear wheel brake to control the application of braking force to the carbon disc. The EBAs are controlled by an Electric Brake Actuator Controller (EBAC). There are four EBACs that control all eight main wheel brakes, each EBAC controlling the brake force of a fore–aft wheel pair.

Antiskid Protection

Antiskid protection is provided on an individual main gear wheel basis. When a wheel speed sensor detects a skid, the braking force is reduced until skidding stops.

Touchdown and hydroplaning protection is provided using airplane inertial groundspeed. Locked wheel protection is provided using a comparison with other wheel speeds.

The EICAS advisory message ANTISKID is displayed if an antiskid fault affecting the brake system is detected or if the system is completely inoperative.

Autobrake System

The autobrake system provides automatic braking at preselected deceleration rates for landing and full pressure for rejected takeoff. Antiskid system protection is provided during autobrake operation.

EICAS memo messages display the selected autobrake settings:

- AUTOBRAKE 1 through 4
- AUTOBRAKE MAX
- AUTOBRAKE RTO.

The EICAS advisory message AUTOBRAKE is displayed if the autobrake system is disarmed or inoperative, the AUTOBRAKE selector is OFF but the system is armed, or an RTO is initiated above 85 knots but autobraking has not been applied.

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, and
- groundspeed is above 85 knots, and
- both thrust levers are retarded to idle.

Maximum braking is obtained in this mode. If an RTO is initiated at or below 85 knots, the RTO autobrake function does not operate.

Landing

Five levels of deceleration can be selected for landing. On dry runways, the maximum autobrake deceleration rate in the landing mode is less than that produced by full pedal braking.

After landing, autobrake application begins when:

- both thrust levers are retarded to idle, and
- the wheels have spun up.

Autobrake application occurs slightly after main gear touchdown. If MAX AUTO is selected, deceleration is limited to the AUTOBRAKE 4 level until pitch angle is less than one degree, then deceleration is increased to the MAX AUTO level. The deceleration level can be changed (without disarming the system) by rotating the selector.

To maintain the selected airplane deceleration rate, autobrake pressure is reduced as other controls, such as thrust reversers and spoilers, contribute to total deceleration. The system provides braking to a complete stop or until it is disarmed.

Autobrake—Disarm

The autobrake system disarms and the EICAS advisory message AUTOBRAKE is displayed if any of the following occur:

- pedal braking applied
- either thrust lever advanced after landing
- speedbrake lever is moved to the DOWN detent after the speedbrakes have deployed on the ground
- DISARM or OFF position selected on the AUTOBRAKE selector
- autobrake fault
- normal antiskid system fault
- loss of inertial data from the Inertial Reference Units (IRUs).

When the autobrake system disarms after landing, the AUTOBRAKE selector automatically moves to the DISARM position, and removes power from the autobrake system.

When the autobrake system disarms during takeoff, the AUTOBRAKE selector remains in the RTO position, but automatically moves to OFF after takeoff.

Taxi Brake Release

During each manual brake application, the brake control system applies one-half of the brakes on each main landing gear (if wheel speeds are less than 70 knots). TQA,B,C

During each manual brake application, the brake control system applies one-half of the brakes on each main landing gear (if wheel speeds are less than 30 knots). TQD,E,F, TWA,B

The system sequences through alternating wheel pairs at each brake application, reducing the number of brake applications by each brake. The brake pedal must be fully released to transition to the other two brakes on a main landing gear. This extends service life and reduces brake sensitivity during taxi.

All active brakes are applied for a heavy brake application, landing rollout, RTO, or when setting the parking brake.

Parking Brake

The parking brake is set by fully depressing both brake pedals, pulling the parking brake lever up, then releasing the pedals.

The parking brake electric actuators are clamped in position during parking brake application and require no active power to maintain the clamping force. The parking brake system has a "park and adjust" feature which monitors the condition of the brakes after application and adjusts the clamping force as needed during brake cooling.

The parking brake is released by depressing the pedals until the parking brake lever releases.

When the parking brake is set, the EICAS memo message PARKING BRAKE SET is displayed. If the parking brake is set and either engine is set to takeoff thrust, the takeoff configuration aural alert sounds and the EICAS warning message CONFIG PARKING BRAKE is displayed.

Brake Temperature Indication

Wheel brake temperatures are displayed on the GEAR synoptic display. Numerical values related to wheel brake temperature are displayed adjacent to each wheel/brake symbol. These values range from 0.0 to 9.9 in increments of 0.1. The values tend to increase after the brakes are used.

Normal range values of 0 to 4.9 are white. For values of 3.0 to 4.9, the brake symbol for the hottest brake on each main gear truck becomes solid white. An EICAS advisory message, BRAKE TEMP, displays when any brake registers 5.0 or higher on the gear synoptic display until all brake temperatures are below 3.0. The brake temperature value blanks when invalid brake temperature data or faults are detected in the brake temperature system.

Tire Pressure Indication

Tire pressures are displayed inside each individual gear symbol on the GEAR synoptic. Normal values are depicted in white. Above or below normal range values are depicted in amber.

The EICAS advisory message TIRE PRESS is displayed if any tire pressure is above or below normal range, or there is an excessive pressure difference between two tires on the same axle.

Landing Gear EICAS Messages

The following EICAS messages can be displayed.

Note: Configuration warning messages are covered in Chapter 15, Warning Systems.

Brakes

Message	Level	Aural	Condition
ANTISKID	Advisory		An antiskid system fault occurs.
AUTOBRAKE	Advisory		One of these occurs: • the autobrake system is disarmed • the autobrake system is failed.
AUTOBRAKE 1	Memo		Autobrake level 1 is selected.
AUTOBRAKE 2	Memo		Autobrake level 2 is selected.
AUTOBRAKE 3	Memo		Autobrake level 3 is selected.
AUTOBRAKE 4	Memo		Autobrake level 4 is selected.
AUTOBRAKE MAX	Memo		Autobrake MAX is selected.
AUTOBRAKE RTO	Memo		Autobrake RTO is selected.
BRAKE TEMP	Advisory		One or more brake temperatures are high.
BRAKES	Advisory		One or more of these occur: • two or more brakes arefailed • a dragging brake is detected.
PARKING BRAKE SET	Memo		The parking brake is set.
TIRE PRESS	Advisory		One or more tire pressures are not normal.

Landing Gear

Message	Level	Aural	Condition
GEAR CONTROL	Advisory		A landing gear normal extension fault occurs.
GEAR DISAGREE	Caution	Beeper	The gear position disagrees with the landing gear lever position.

Message	Level	Aural	Condition
GEAR DOOR	Advisory		One or more gear doors are not closed.
GEAR DRAG BRACE L, R	Caution	Beeper	The main gear is down with the drag brace unlocked.
GEAR SIDE BRACE L, R	Caution	Beeper	The main gear is down with the side brace unlocked.
NOSE WHEEL STEERING	Advisory		A nose wheel steering fault occurs.
STEERING LOCKED OUT	Memo		Steering is locked out because the airplane is in the tow mode.
TILLER L, R	Caution	Beeper	The tiller is failed.
VMO GEAR DOWN	Memo		Vmo value is set for dispatch with the landing gear extended.

Warning Systems — Chapter 15
Table of Contents

Controls and Indicators 15.10

Engine Indication and Crew Alerting System (EICAS) 15.10.1
EICAS Messages 15.10.1
EICAS Event Record Switch 15.10.3
Display Select Panel (DSP) 15.10.3
Status Display 15.10.5
System Displays by Phase of Flight 15.10.6
System Menu Amber Text 15.10.6
Alerts Displayed on the PFD 15.10.8
Alerts Displayed on the HUD 15.10.9
Master WARNING/CAUTION Reset Switches and Lights 15.10.9
Aural Cancel Switch (Alerting and Transponder Control Panel) 15.10.10
Aural Cancel Control (Tuning and Control Panel) 15.10.11
Traffic Alert and Collision Avoidance System (TCAS) 15.10.12
TCAS Controls (Alerting and Transponder Control Panel) 15.10.12
TCAS Controls (Tuning and Control Panel) 15.10.13
TCAS Display Selection 15.10.14
TCAS Traffic and Alert Message TRAFFIC Display 15.10.15
TCAS PFD Vertical Guidance 15.10.18
TCAS HUD Vertical Guidance 15.10.19
Ground Proximity Warning System (GPWS) Controls 15.10.20
Tuning and Control Panel (TCP) 15.10.20
Alerting and Transponder Control Panel (ATP) 15.10.21
Glideslope (G/S) Inhibit Control (Tuning and Control Panel) 15.10.22
GPWS Look-Ahead Terrain Alerting Display and Annunciations 15.10.23
Predictive Windshear (PWS) Display and Annunciations 15.10.30

System Description 15.20

Introduction 15.20.1

Engine Indication and Crew Alerting System (EICAS) 15.20.1

System Alert Level Definitions 15.20.1

EICAS Messages 15.20.2

Aurals, Master WARNING/CAUTION Switches and Lights 15.20.4

Flight Deck Panel Annunciator Lights 15.20.10

Airspeed Alerts 15.20.10

Stall Warning 15.20.10

Airspeed Low 15.20.10

Takeoff V1 Airspeed 15.20.10

Thrust Asymmetry Minimum Speed (TAMS) 15.20.10

Overspeed Warning 15.20.10

Tail Strike Detection System 15.20.11

Takeoff And Landing Configuration Warning System 15.20.11

Takeoff Configuration Warnings 15.20.11

Landing Configuration Warnings 15.20.12

Configuration Warning System Non-normal Operation 15.20.13

MCP Selected Altitude Alert 15.20.13

Approaching MCP Selected Altitude 15.20.13

Departing MCP Selected Altitude 15.20.13

MCP Selected Altitude Alert Inhibits 15.20.14

500 Foot Callout 15.20.14

Crew Alertness Monitor 15.20.14

Traffic Alert and Collision Avoidance System (TCAS) 15.20.14

Resolution Advisories (RA) and Display 15.20.15

Traffic Advisories (TA) and Display 15.20.15

Proximate Traffic Display 15.20.16

Other Traffic Display 15.20.16

TCAS HUD and PFD Vertical Guidance 15.20.16

TCAS ND Messages 15.20.17

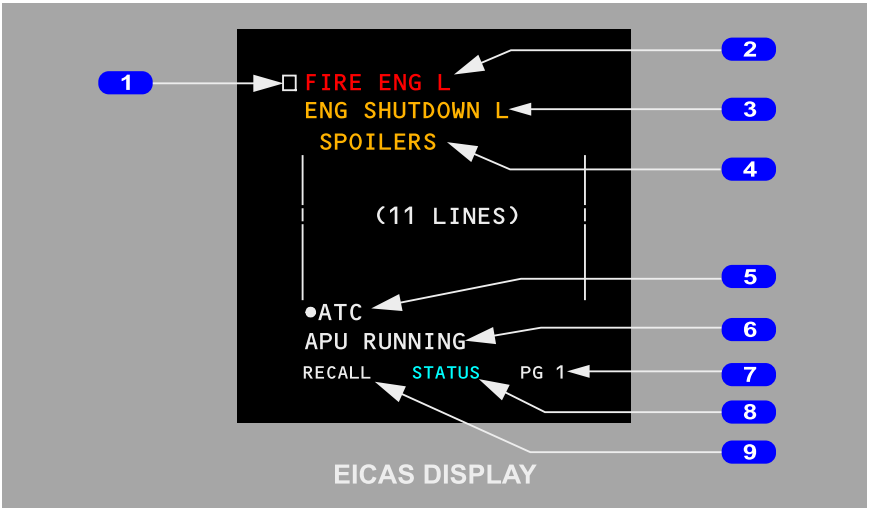
TCAS Voice Annunciations 15.20.17
TCAS Normal Operation 15.20.19
TCAS Non-Normal Operation 15.20.19
Ground Proximity Warning System (GPWS) 15.20.19
Introduction 15.20.19
GPWS Look–Ahead Obstacle and Terrain Mode 15.20.20
GPWS Look-Ahead Obstacle and Terrain Alerts 15.20.23
GPWS Immediate Alerts 15.20.24
Bank Angle Voice Annunciations 15.20.25
Altitude Voice Annunciations During Approach 15.20.25
GPWS Windshear Alert and PWS 15.20.26
Alert Inhibits 15.20.29
Alert Messages Inhibited During Normal System Operation 15.20.29
Alert Messages Inhibited By Other Alert Messages 15.20.29
Voice Annunciation Inhibits 15.20.29
ND Display Alert Inhibits and Automatic Display 15.20.30
Alerts Inhibited Before Engine Start and After Shutdown 15.20.31
Alerts Inhibited During Engine Start 15.20.31
Alerts Inhibited During Takeoff 15.20.31
Alerts Inhibited During Landing 15.20.35
AURAL CANCEL Switch 15.20.36
EICAS Event Record 15.20.36

EICAS Messages 15.30

Warning Systems EICAS Messages 15.30.1
Airspeed 15.30.1
Altitude Alert and GPWS 15.30.1
Configuration 15.30.1
Pilot Response 15.30.2
Tailstrike 15.30.2
TCAS 15.30.2

Engine Indication and Crew Alerting System (EICAS)

EICAS Messages



1 Checklist Icon

Displayed (white)—

- indicates that a checklist exists for this message
- no longer displayed when checklist complete
- no longer displayed when inhibited by checklist of another message.

2 Warning Messages

Displayed (red)—

- highest priority alert messages
- red alert messages remain displayed and cannot be canceled by pushing the CANC/RCL switch.

3 Caution Messages

Displayed (amber)—

- next highest priority alert messages after warning messages
- amber alert messages can be canceled or recalled by pushing the CANC/RCL switch.

4 Advisory Messages

Displayed (amber)—

- lowest priority alert messages; indented one space
- amber alert messages can be canceled or recalled by pushing the CANC/RCL switch.

5 Communication Messages

Displayed (white)—

- preceded by white dot
- COMM low messages indented one space
- cannot be canceled by pushing the CANC/RCL switch.

6 Memo Messages

Displayed (white)—

- reminder of selected state of controls or systems
- cannot be canceled by pushing the CANC/RCL switch
- EICAS alert messages have display priority over memo messages; some or all memo messages not displayed on current EICAS message page if insufficient message lines are available below alert messages.

7 Page (PG) Number

Displayed (white)—

- more than one page of alert or memo messages exists
- indicates number of page selected.

8 STATUS Cue

Displayed (cyan)—

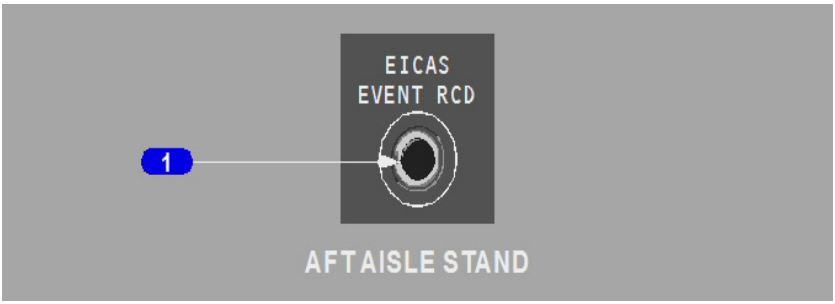
- new status message exists
- no longer displayed when status display selected.

9 RECALL Indication

Displayed (white)—

- when CANC/RCL switch pushed
- remains displayed for one second after switch released.

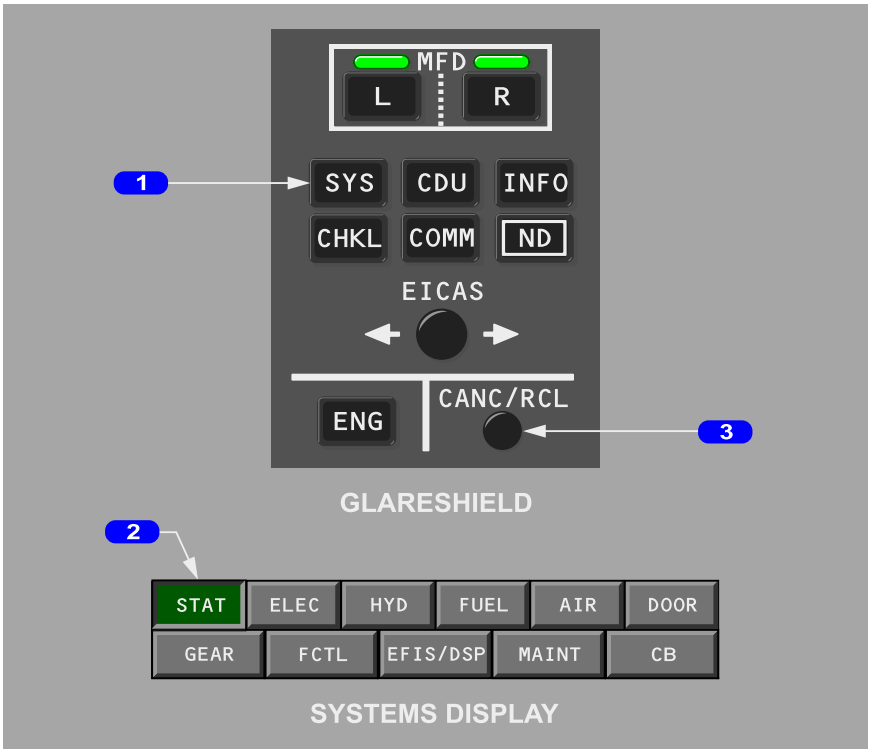
EICAS Event Record Switch



1 EICAS EVENT Record (RCD) Switch

Push—records up to five EICAS events into memory.

Display Select Panel (DSP)



1 System (SYS) Display Switch

Push—displays system display on selected MFD.

2 Status (STAT) Display Key

Selected (green)—displays status display on selected MFD.

3 Cancel/Recall (CANC/RCL) Switch

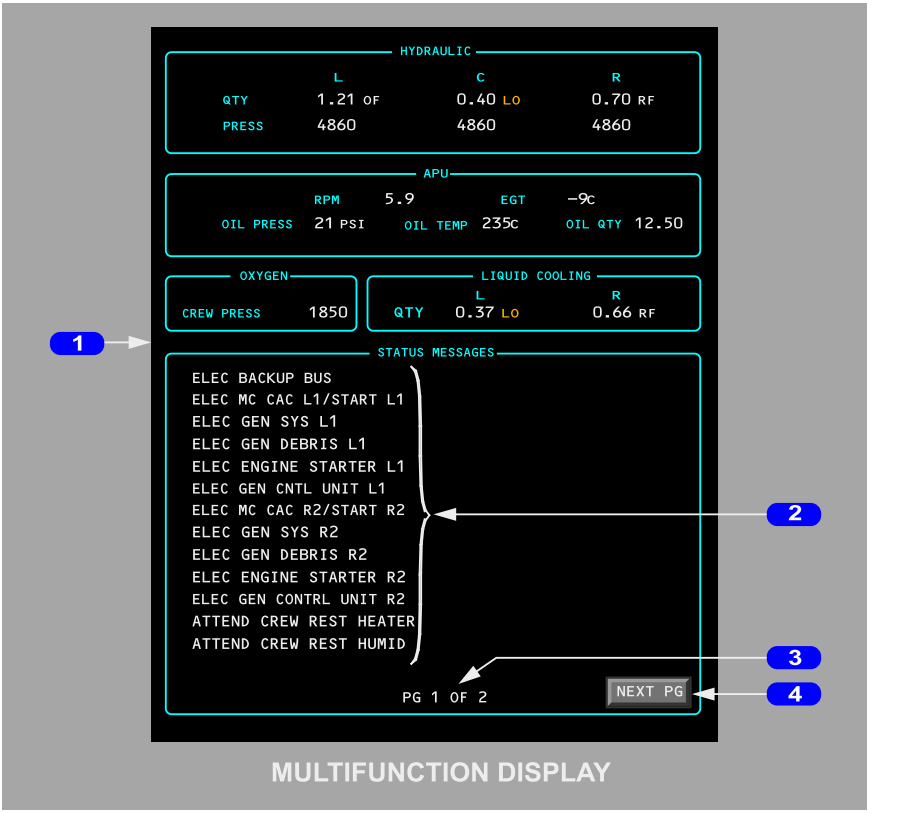
Push (when EICAS caution or advisory messages displayed)—

- displays the next page of EICAS messages when additional pages exist
- cancels caution and advisory messages when last page displayed; warning, memo, and communications messages remain displayed
- cancels red box for any engine parameter previously exceeded when the exceedance no longer exists.

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.

Status Display



1 Status Display

Displays hydraulic, APU, oxygen system and cooling liquid indications and status messages.

2 Status Messages

Status messages indicate equipment faults requiring MEL reference for dispatch.

3 Page (PG) Number

Displayed—

- additional pages of status messages exist
- displays number of page selected.

4 Next Page (NEXT PG)

Select—displays the next page of status messages.

System Displays by Phase of Flight

The airplane phase of flight will control which system display is shown when the system (SYS) display switch is pushed:

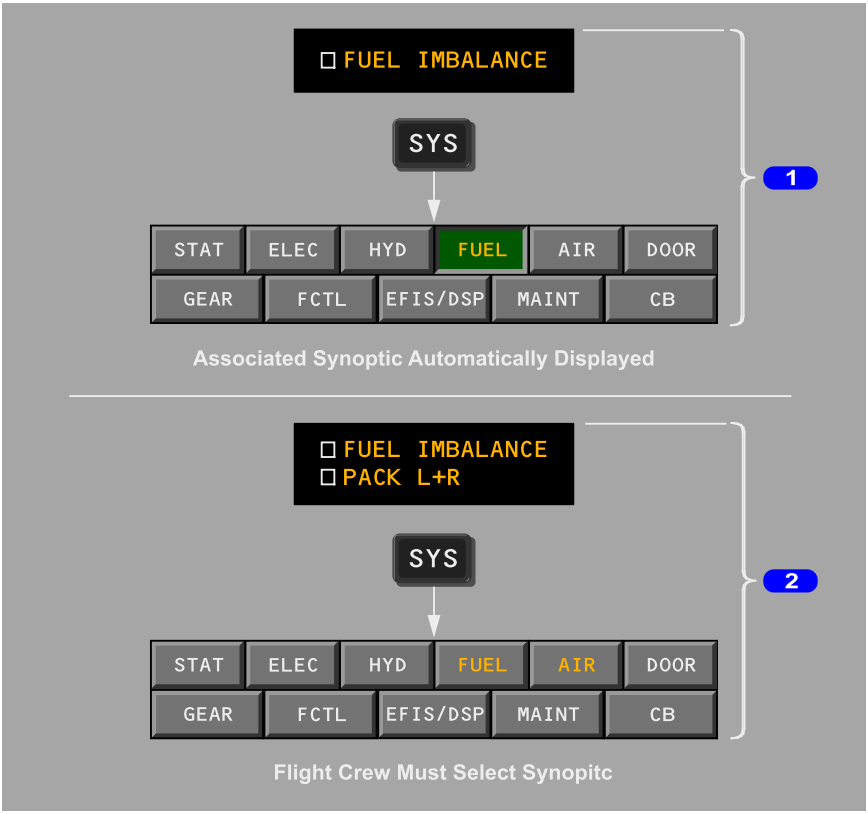
- On the ground before engine start—status (STAT) display
- On the ground after engine start—flight controls (FCTL) synoptic
- In flight—fuel (FUEL) synoptic
- On the ground after landing—status (STAT) display.

System Menu Amber Text

System menu text changes color to amber whenever an EICAS caution message associated with a synoptic is triggered. The following menu items display this behavior:

- AIR
- DOOR
- ELEC
- FCTL
- FUEL
- GEAR

- HYD.



1 Single EICAS Message

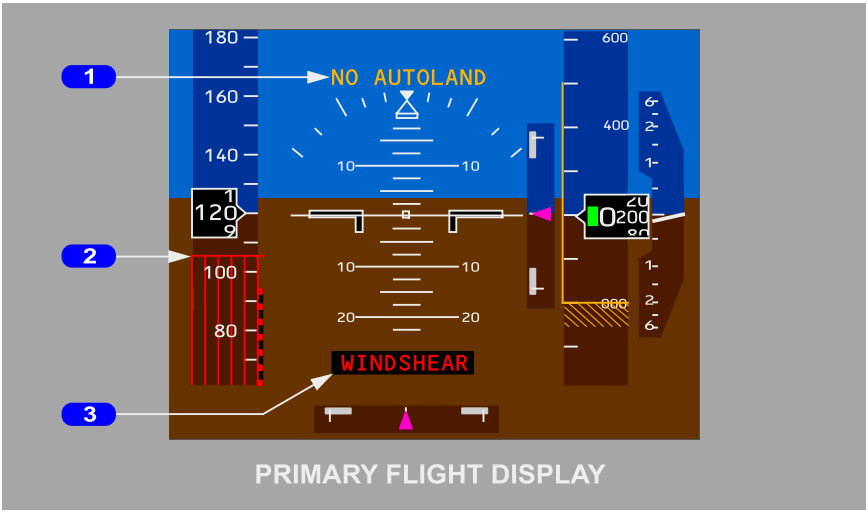
When a single EICAS message associated with a synoptic is triggered, the synoptic becomes the default display upon selection of the Display Select Panel SYS key. The menu text for the displayed synoptic is displayed in amber.

2 Multiple EICAS Messages

When more than one EICAS message exists for multiple system synoptics, only the system menu is displayed. The menu text associated with the EICAS messages is displayed in amber. The flight crew then has to select the desired system synoptic.

Note: If a system page is already displayed and a subsequent SYS synoptic trigger activates, the displayed page remains as selected with the appropriate system menu text changing color to amber.

Alerts Displayed on the PFD



1 Autopilot Engaged Alert

NO AUTOLAND (amber)—The autoland system is not available. Displayed when the airplane descends below 100 feet radio altitude during an approach in which the autopilot is flying a FMC computed glidepath.

2 Thrust Asymmetry Minimum Speed

Indicates the minimum control speed for operation with a large thrust asymmetry.

3 Time Critical Warnings

ENG FAIL (red)—ENGINE FAIL alert is occurring.

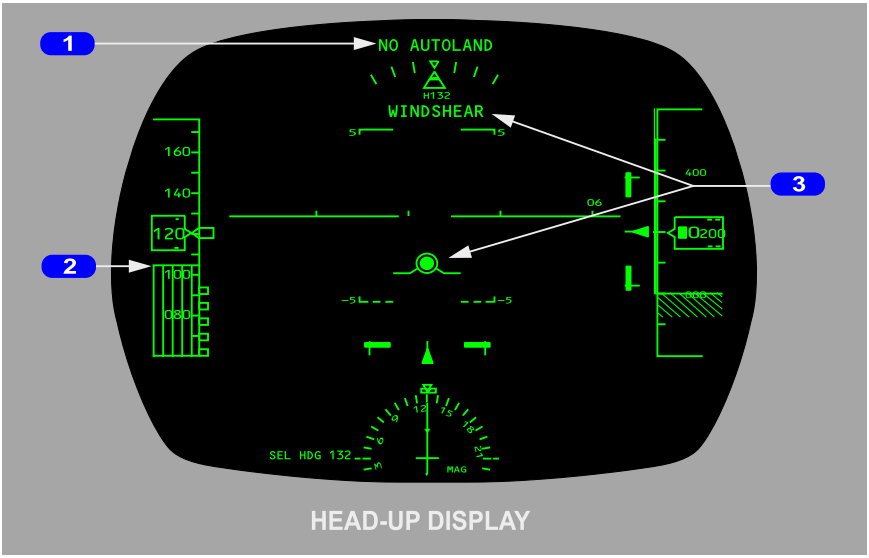
PULL UP (red)—PULL UP alert is occurring.

SPEEDBRAKE (red)—SPEEDBRAKE alert is occurring.

WINDSHEAR (red)—

- predictive WINDSHEAR AHEAD alert or immediate WINDSHEAR alert is occurring
- all other GPWS alerts inhibited.

Alerts Displayed on the HUD



1 Autopilot Engaged Alert

The NO AUTOLAND alert displayed on the PFD is also displayed on the HUD.

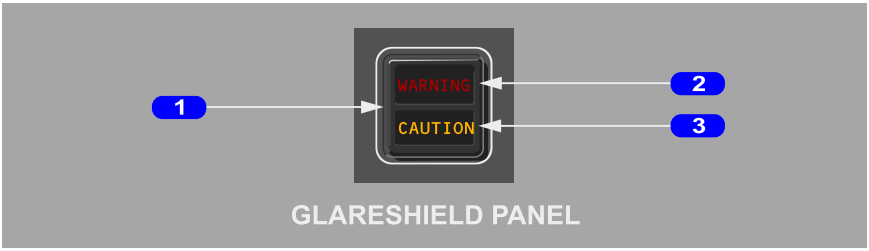
2 Thrust Asymmetry Minimum Speed

The TAMS display on the PFD speed tape is also displayed on the HUD.

3 Time Critical Warnings

All time critical warnings displayed on the PFD are also displayed on the HUD.

Master WARNING/CAUTION Reset Switches and Lights



1 Master WARNING/CAUTION Reset Switch

Push—

- extinguishes master WARNING lights
- extinguishes master CAUTION lights
- silences the aural that accompanies the EICAS warning messages:
  - CABIN ALTITUDE
  - CONFIG GEAR, if displayed because landing gear not down and locked, any thrust lever at idle, and radio altitude less than 800 feet
  - FIRE
  - PILOT RESPONSE (as configured by the airline)
  - STABILIZER
  - EVACUATION.

2 Master WARNING Light

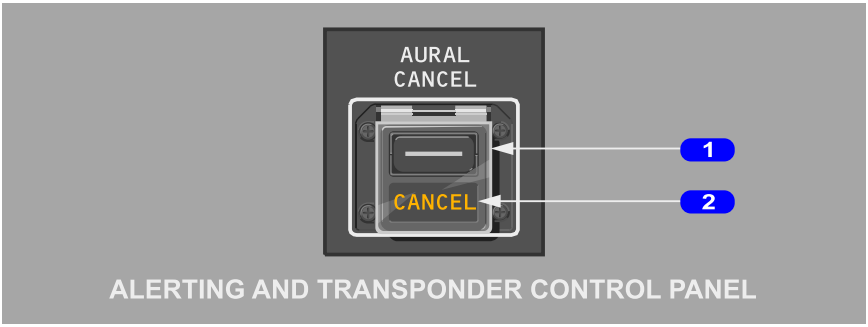
Illuminated (red)—

- new EICAS warning message displayed, or
- ENGINE FAIL, PULL UP, or WINDSHEAR alert displayed on PFD.

3 Master CAUTION Light

Illuminated (amber)—new EICAS caution message displayed.

Aural Cancel Switch (Alerting and Transponder Control Panel)



1 AURAL CANCEL Switch

Push (momentary)—

- cancels the active aural alert while the condition causing the alert remains active
- EICAS advisory message AURAL CANCELED shows while an aural alert is being canceled.

2 CANCEL Light

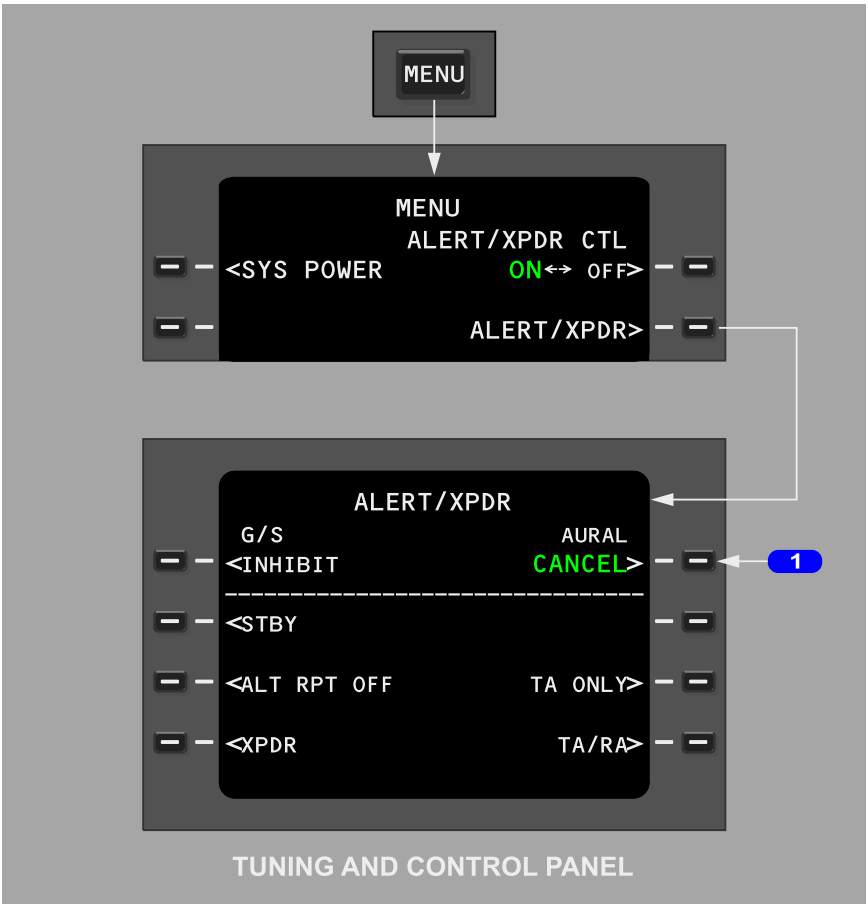
Illuminated (amber)—

- an aural alert is being canceled
- extinguishes when no aural alerts are being canceled.

The cancel function resets when—

- the condition that caused the aural alert is no longer active, or
- on the ground and both engines are shut down, or
- airplane power is cycled off and then on.

Aural Cancel Control (Tuning and Control Panel)



1 Aural Cancel (AURAL CANCEL)

Push—

- cancels the active aural alert while the condition causing the alert remains active
- EICAS advisory message AURAL CANCELED shows while an aural alert is being canceled
- CANCEL shows in large green font when an aural alert is being canceled, and reverts to small white font when an aural alert is no longer being canceled.

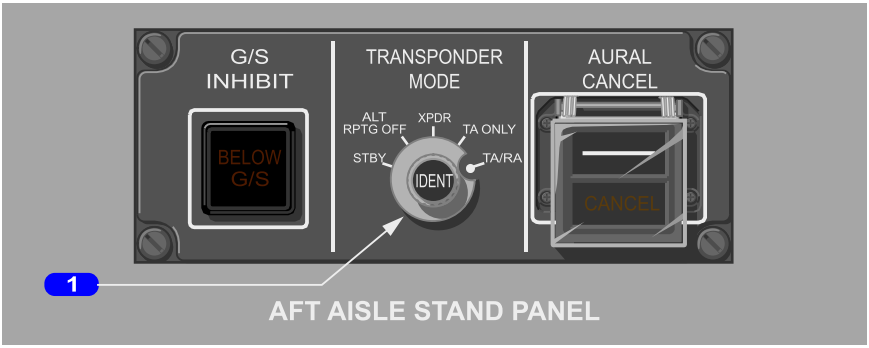
Note: With ALERT/XPDR CTL set to ON, the ATP no longer controls the aural cancel function.

The cancel function resets when—

- the condition that caused the aural alert is no longer active, or
- on the ground and both engines are shut down, or
- airplane power is cycled off and then on.

Traffic Alert and Collision Avoidance System (TCAS)

TCAS Controls (Alerting and Transponder Control Panel)



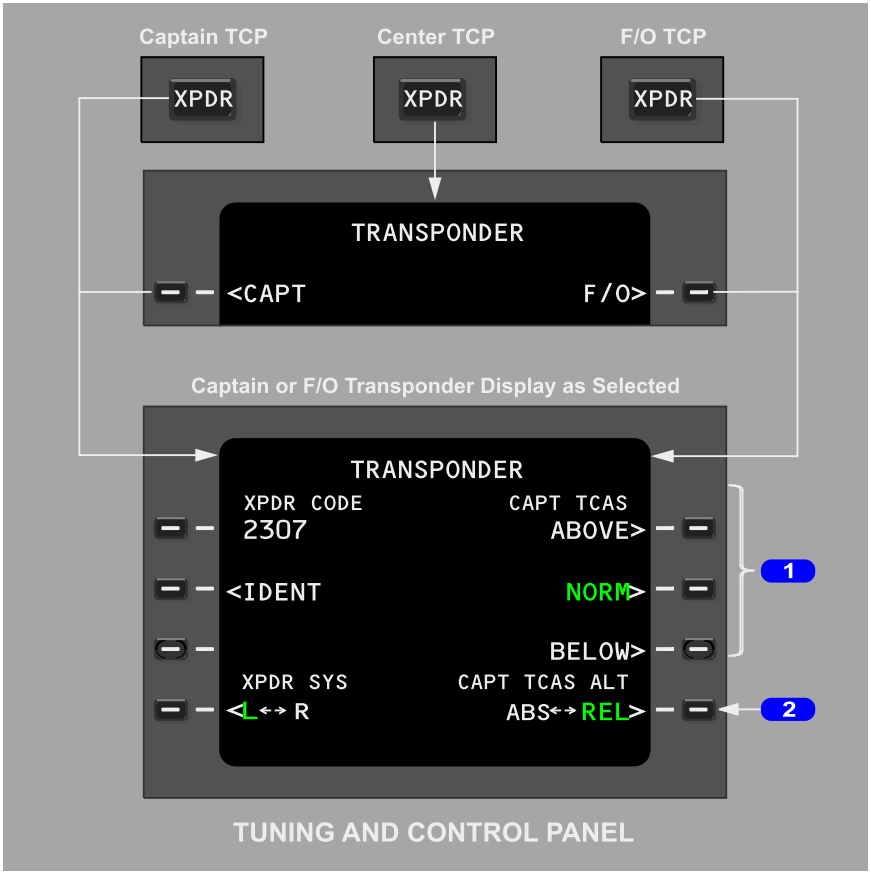
1 Transponder Mode Selector

TA ONLY (traffic advisory)—

- transponder, ADS-B (Out), and TCAS TA modes enabled
- all airplanes that would have been predicted as a RA are predicted as a TA.

TA/RA (traffic advisory/resolution advisory)—transponder, ADS-B (Out), TCAS TA and RA modes enabled.

TCAS Controls (Tuning and Control Panel)



1 XXXX TCAS Display

Push—selects the desired TCAS display mode.

ABOVE—displays TCAS traffic vertically from 2,700 feet below to 9,900 feet above current flight altitude.

NORM (normal)—displays TCAS traffic vertically from 2,700 feet below to 2,700 feet above current flight altitude.

BELOW—displays TCAS traffic vertically from 9,900 feet below to 2,700 feet above current flight altitude.

The selected mode is highlighted in large green font.

2 XXXX TCAS Altitude (ALT)

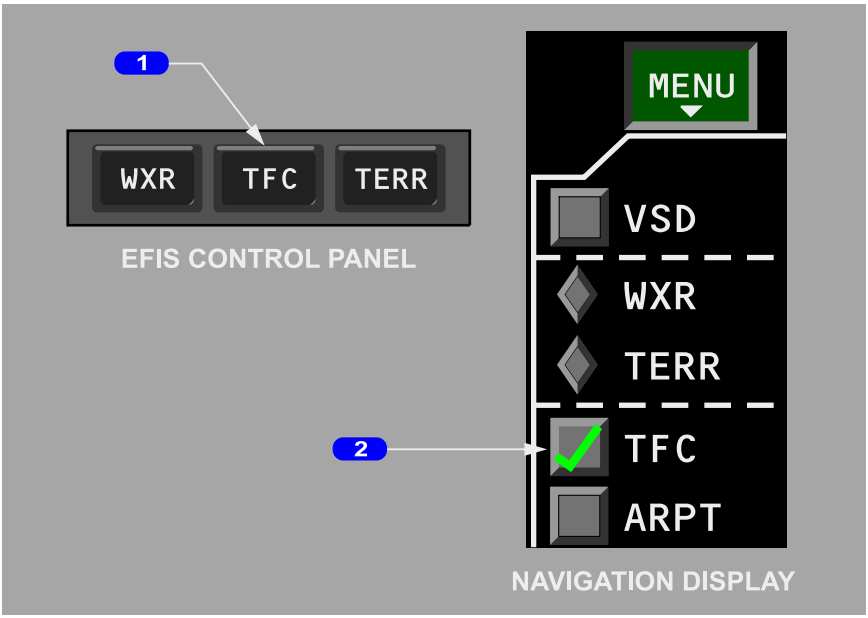
Push—toggles traffic altitude readings between absolute altitude and relative altitude.

ABS (absolute)—traffic absolute altitude readings show.

REL (relative)—traffic relative altitude readings show.

The selected mode is highlighted in large green font.

TCAS Display Selection



1 Traffic (TFC) Switch

Push—

- selection applied to both the navigation display and the PFD mini-map
- traffic within approximately 40 nm shows
- TFC shows in cyan on the lower left of navigation display and mini-map
- traffic data shows in MAP or MAP CTR modes.

Second push—deselects traffic display.

2 Traffic (TFC) Data Menu Selection

Selected—

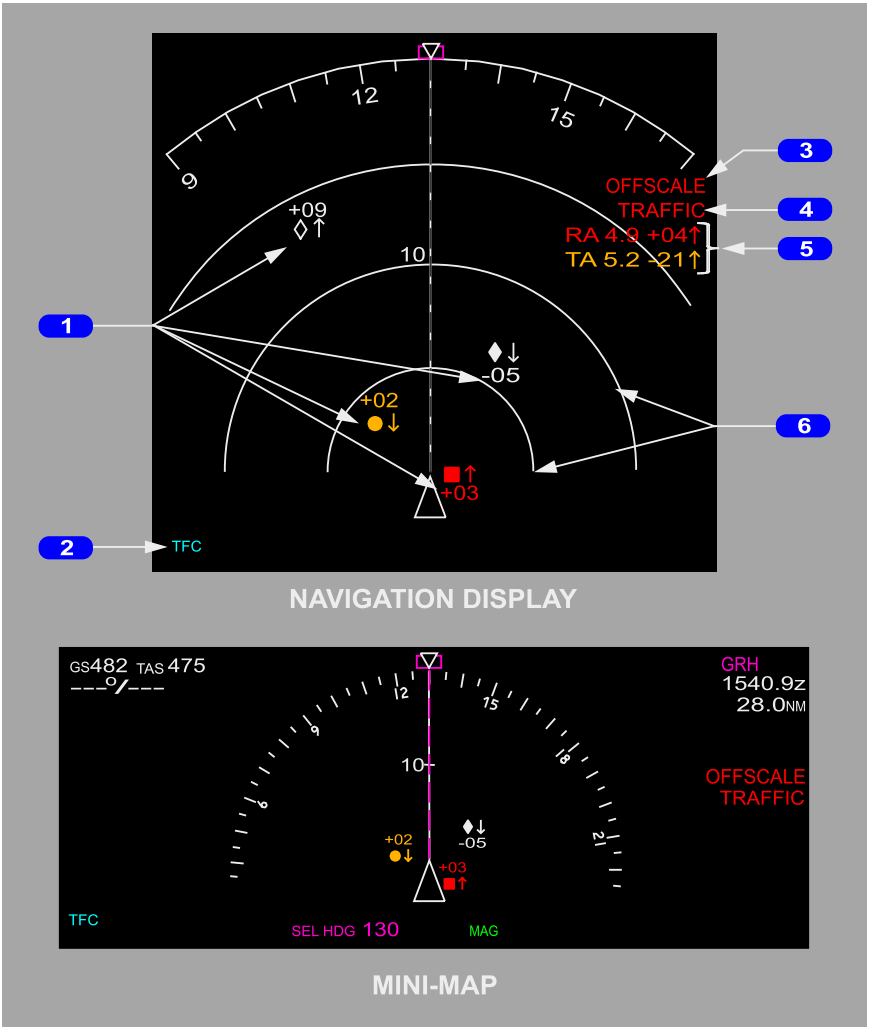
- traffic data applied to navigation display only
- traffic data shows in MAP or MAP CTR modes
- TFC shows in cyan on the lower left of display.

TCAS Traffic and Alert Message TRAFFIC Display

Shows when TFC selected and respective ND is in MAP or MAP CTR mode. (See TCAS on page L.10.6 for additional information.)

Shows automatically when:

- a RA or TA is occurring, and
- TFC not selected on either ND, and
- respective ND is in MAP or MAP CTR mode.



1 Traffic Targets

Indicates relative position of traffic:

- filled red square indicates a resolution advisory (RA)
- filled amber circle indicates a traffic advisory (TA)
- filled white diamond indicates proximate traffic
- unfilled white diamond indicates other traffic

- number is relative or absolute altitude (as selected) of traffic in hundreds of feet; not displayed when altitude unknown
- vertical motion arrow indicates traffic climbing or descending at 500 feet per minute or greater; not displayed for vertical motion less than 500 feet per minute.

2 TCAS Mode Annunciations

TFC (cyan)—

- TCAS traffic display enabled
- TCAS traffic displayed in MAP or MAP CTR modes.

TA ONLY (cyan)—

- TCAS cannot provide RAs
- all traffic that would have been RAs are predicted as TAs.

3 OFFSCALE Message

OFFSCALE (red)—RA is beyond selected map range.

OFFSCALE (amber)—TA is beyond selected map range.

4 TRAFFIC Alert Message

Displayed in all ND modes and ranges, whether TCAS traffic is displayed or not.

TRAFFIC (red)—RA is occurring.

TRAFFIC (amber)—TA is occurring, and RA is not occurring.

5 TCAS No Bearing Messages

RA (red)—data tag displayed for no-bearing RA.

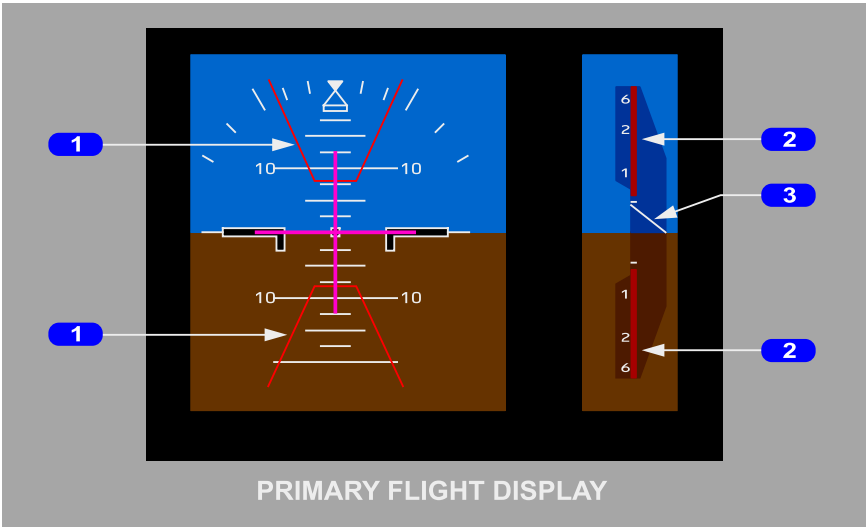
TA (amber)—data tag displayed for no-bearing TA.

Data tag contains distance, altitude, and vertical motion arrow.

6 TCAS/Weather Radar Range Arcs

Displayed when TCAS or weather radar selected; replace range scale tics.

TCAS PFD Vertical Guidance



1 RA Pitch Region To Avoid (red outlined)

Displayed: (red)—RA is occurring.

Note: For a single RA, only one red outlined RA pitch region, either above or below, is displayed at a time. For two or more RAs, two red outlined RA pitch regions may be displayed.

To ensure vertical separation, the center of the airplane symbol must be outside the red outlined RA pitch regions to avoid.

2 RA Vertical Speed Region to Avoid (red)

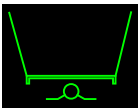
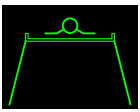
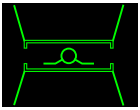
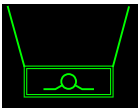
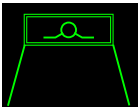
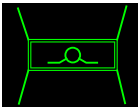
To ensure vertical separation, vertical speed must be outside the red RA vertical speed region to avoid.

3 Vertical Speed Pointer

Red—present vertical speed does not ensure RA traffic is avoided.

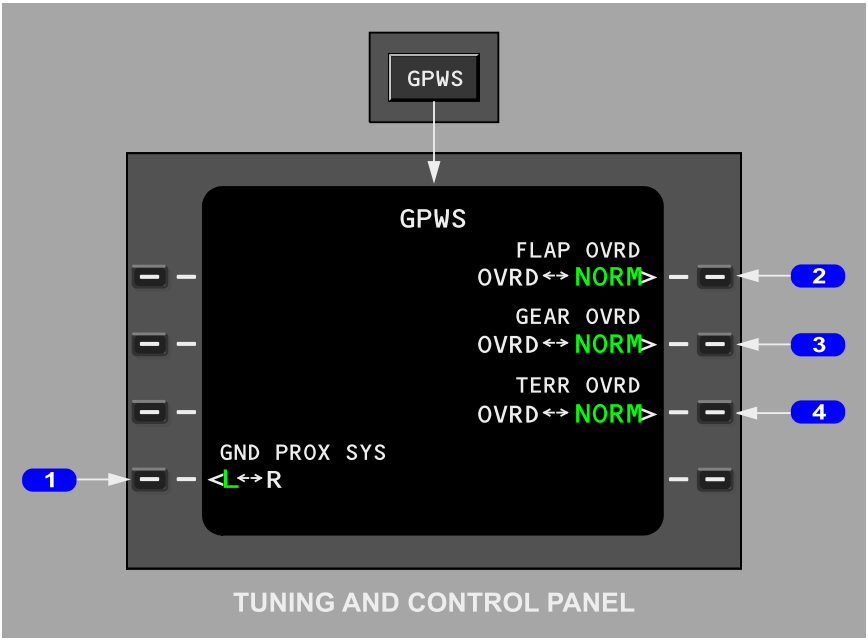
White—present vertical speed ensures RA traffic is avoided.

TCAS HUD Vertical Guidance

SYMBOL	NAME	REMARKS
	Down preventive	Area(s) inside the lines indicate the pitch region(s) to avoid in order to resolve the traffic conflict. The flight path symbol should be positioned outside the pitch command area(s) to ensure traffic avoidance. A double-lined box indicates a corrective action is required, and represents TCAS maneuver guidance to maintain or increase separation from the traffic.
	Up preventive	
	Up and down preventive	
	Descend corrective	
	Climb corrective	
	Combined corrective	

Ground Proximity Warning System (GPWS) Controls

Tuning and Control Panel (TCP)



1 Ground Proximity System (GND PROX SYS)

Push—toggles the ground proximity warning system between the left (L) and right (R) systems.

Defaults to the left system.

If a fault is detected the system automatically switches to the other side.

Selection is displayed in large green font.

2 Ground Proximity Flap Override (FLAP OVRD)

Push—toggles between normal and override settings.

OVRD—

- inhibits TOO LOW FLAPS and TOO LOW TERRAIN alerts
- EICAS advisory message GPWS FLAP OVRD is displayed
- resets automatically after landing 10 minutes after cabin door is opened.

NORM—all flap inhibits removed.

Selection is displayed in large green font.

3 Ground Proximity Gear Override (GEAR OVRD)

Push—toggles between normal and override settings.

OVRD—

- inhibits TOO LOW GEAR and TOO LOW TERRAIN alerts
- inhibits CONFIG GEAR warning message
- EICAS advisory message GPWS GEAR OVRD is displayed
- resets automatically after landing 10 minutes after cabin door is opened.

NORM—all gear inhibits removed.

Selection is displayed in large green font.

4 Ground Proximity Terrain Override (TERR OVRD)

Push—toggles between normal and override settings.

OVRD—

- inhibits look-ahead terrain alerts and display
- EICAS advisory message GPWS TERR OVRD is displayed
- amber VSD TERR OVRD flag displayed on vertical situation display
- resets automatically after landing 10 minutes after cabin door is opened.

NORM—all terrain inhibits removed.

Selection is displayed in large green font.

Alerting and Transponder Control Panel (ATP)



1 Ground Proximity Glideslope Inhibit (G/S INHIBIT)

The BELOW G/S light illuminates when the GPWS senses excessive deviation below the ILS or GLS glideslope or the FMC generated flight path angle.

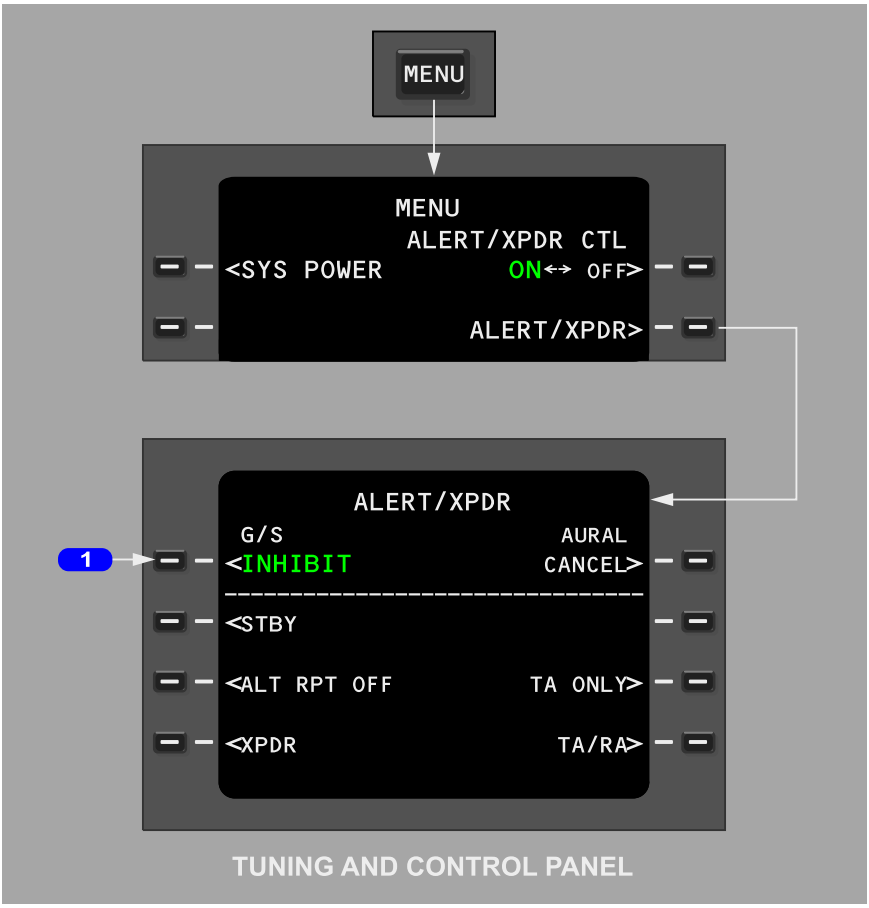
Push (amber BELOW G/S light illuminated)—

- inhibits GLIDESLOPE alert when pushed below 1,000 feet radio altitude
- extinguishes the BELOW G/S light.

The inhibit function resets when:

- on the ground, or
- after a touch and go landing, or
- after a go-around, or
- when deselected by the flight crew.

Glideslope (G/S) Inhibit Control (Tuning and Control Panel)



1 Ground Proximity Glideslope Inhibit (G/S INHIBIT)

Push—

- inhibits GLIDESLOPE alert when pushed below 1,000 feet radio altitude
- INHIBIT displayed in large green font.

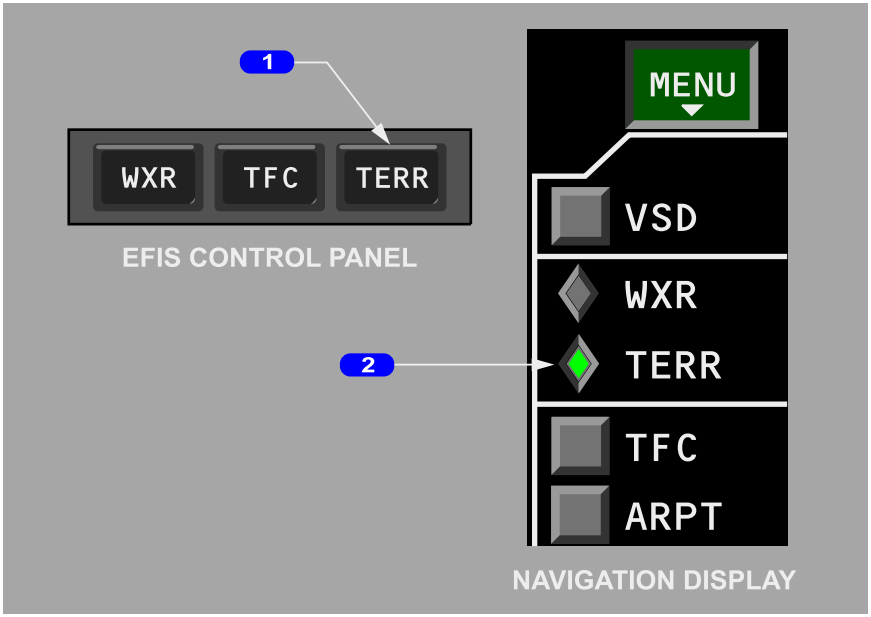
The inhibit function resets when:

- on the ground, or
- after a touch and go landing, or
- after a go-around, or
- when deselected by the flight crew.

Note: With ALERT/XPDR CTL set to ON, the ATP no longer controls the G/S INHIBIT function.

GPWS Look-Ahead Terrain Alerting Display and Annunciations

GPWS Terrain Display Selection



1 Terrain (TERR) Map Switch

Push—

- selection applied to both the navigation display and the PFD mini-map

- TERR displayed in cyan on the left center of navigation display and mini-map
- terrain data displayed in MAP or MAP CTR modes
- deselects weather radar display regardless of switch position.

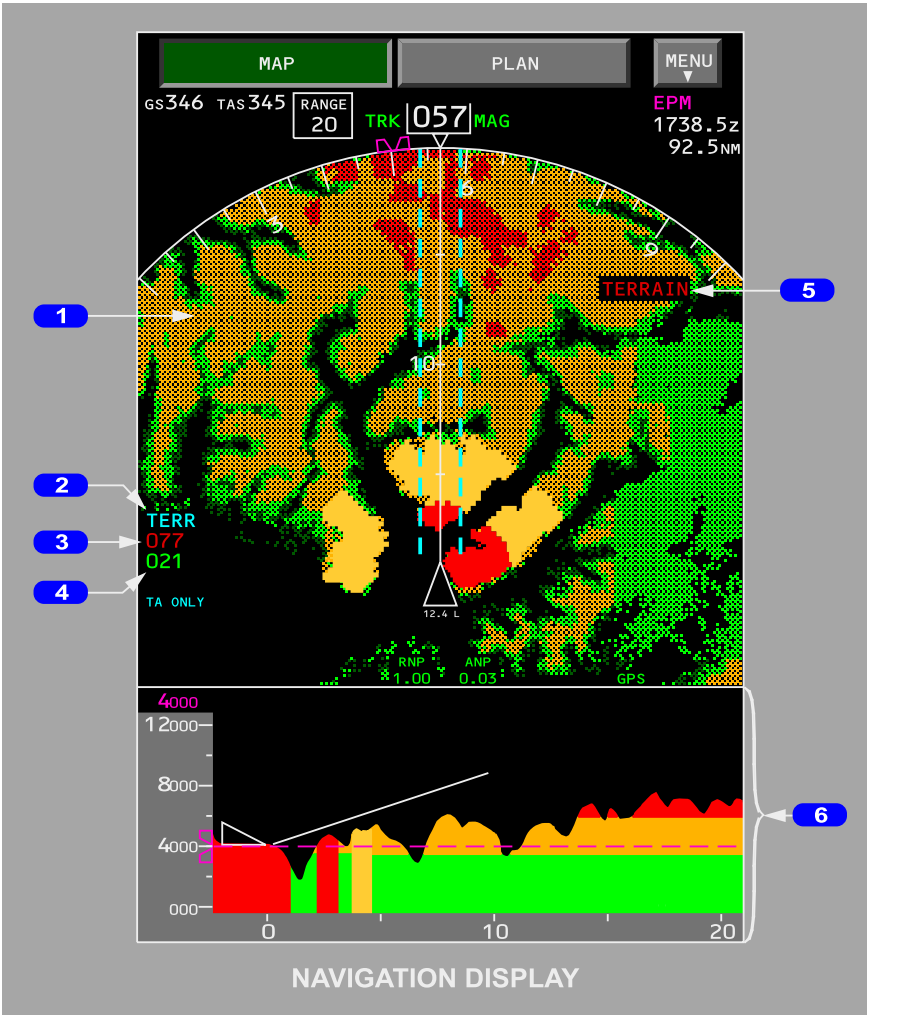
Second push—deselects terrain map display.

2 Terrain (TERR) Map Menu Selection

Selected—

- selection applied to navigation display only
- TERR displayed in cyan on the left center of display
- terrain data displayed in MAP or MAP CTR modes
- replaces weather radar display.

Terrain Display



1 Lateral Map Terrain Display

When the airplane is 500 feet or more above the highest terrain peaks or obstacles in the selected display range, terrain peaks and obstacles are depicted based on their elevation. The following color patterns will be displayed:

- solid green—highest obstacles or terrain peaks displayed

- high density dotted green—intermediate height obstacles or terrain peaks displayed
- low density dotted green—lowest obstacles or terrain peaks displayed.

When the airplane is less than 500 feet above the highest terrain peaks or obstacles in the selected display range, terrain peaks or obstacles are depicted in varying densities of green, amber, and red. The following color patterns will be displayed:

- low density dotted green—terrain from 2,000 feet below to 1,000 feet below airplane altitude
- high density dotted green—terrain from 1,000 feet below to 500 feet (250 feet with gear down) below airplane altitude
- low density dotted amber—terrain less than 500 feet (250 feet with gear down) below to 1,000 feet above airplane altitude
- high density dotted amber—terrain 1,000 feet to 2,000 feet above airplane altitude
- dotted red—terrain more than 2,000 feet above airplane altitude
- dotted magenta—no terrain data available
- solid amber—look-ahead terrain caution alert is occurring
- solid red—look-ahead terrain warning alert is occurring.

Notes:

1. When descending at a rate greater than 1,000 feet per minute, the display will depict a 30 second advanced preview of terrain and obstacles. As a result, color contours may appear when the airplane is at relative heights greater than those specified above.
2. In areas without terrain data, look-ahead terrain alerting and display functions are not available. GPWS immediate alerts function normally.
3. Terrain within approximately 400 feet of the nearest airport runway elevation is not displayed.

Displayed automatically when:

- a look-ahead terrain alert occurs, and
- TERR not selected on either ND, and
- respective ND is in MAP or MAP CTR mode.

2 Terrain Mode Annunciation

TERR (cyan)—Terrain display enabled.

3 Highest Elevation of Obstacle or Terrain Displayed

Indicates the absolute height of the highest terrain or obstacle displayed on the ND and mini-map in hundreds of feet above sea level (MSL). The color (amber, green, or red) matches the color of corresponding obstacle or terrain being displayed.

4 Lowest Elevation of Obstacle or Terrain Displayed

Indicates the absolute height of the lowest terrain or obstacle displayed on the ND and mini-map in hundreds of feet above sea level (MSL). The color green matches the color of corresponding obstacle or terrain being displayed.

5 OBSTACLE and TERRAIN Annunciation

OBSTACLE (amber)—obstacle caution alert is occurring.

OBSTACLE (red)—obstacle warning alert is occurring.

TERRAIN (amber)—look-ahead terrain caution alert is occurring.

TERRAIN (red)—look-ahead terrain warning alert is occurring.

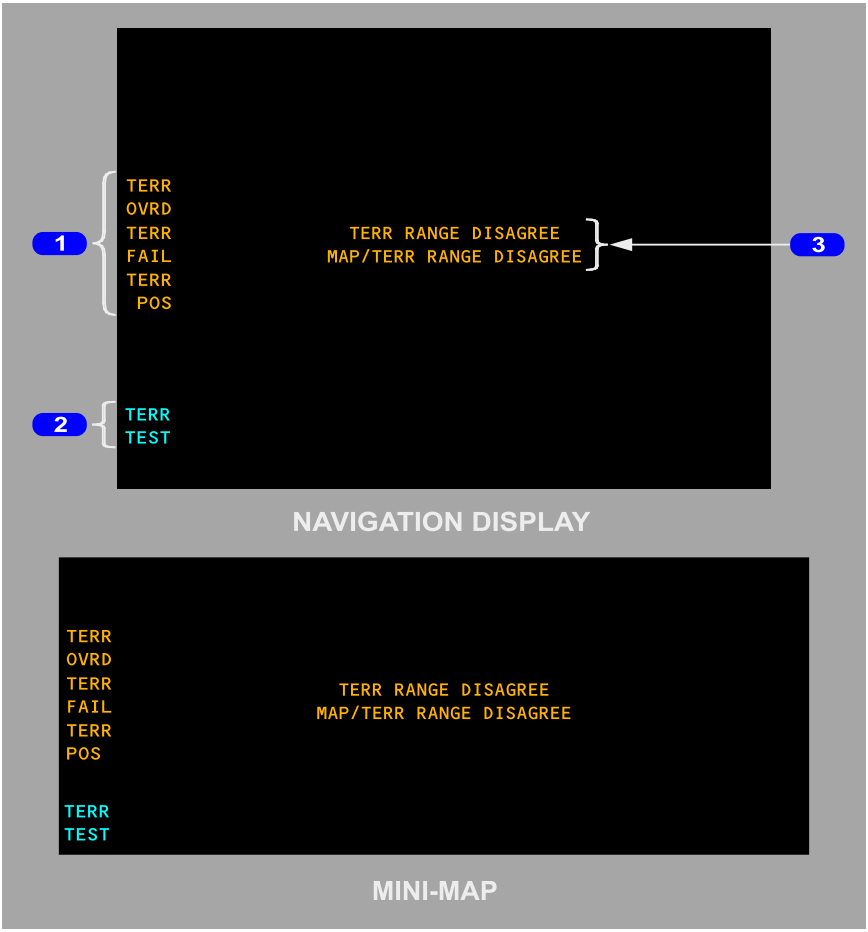
Displayed in all navigation display modes.

6 VSD Terrain Display

Depicts the highest terrain within the enroute corridor:

- highest points of the terrain below and ahead of the airplane
- terrain is depicted so the actual altitude separation between the airplane and terrain is shown
- VSD terrain uses the same color coding that is used to depict GPWS on the lateral map:
  - green: terrain is more than 500 feet (250 feet if gear is down) below the airplane
  - amber: terrain ranges from 500 below (250 feet gear down) to 2,000 feet above the airplane
  - red: terrain more than 2,000 feet above the airplane.

Terrain Navigation Display Annunciations



1 Terrain Status Annunciation

TERR FAIL (amber)—Look-ahead terrain alerting and display failed.

TERR OVRD (amber)—TERR OVRD selected from the GPWS page of the TCP.

TERR POS (amber)—Look-ahead terrain alerting and display unavailable due to GPS position uncertainty. During time between GPS position failure and display of TERR POS message, IRS provides position for look-ahead terrain alerting and display.

2 Terrain Mode Annunciation

TERR TEST (cyan)—GPWS operating in self–test mode.

3 Terrain Range Status Annunciation

TERR RANGE DISAGREE (amber)—

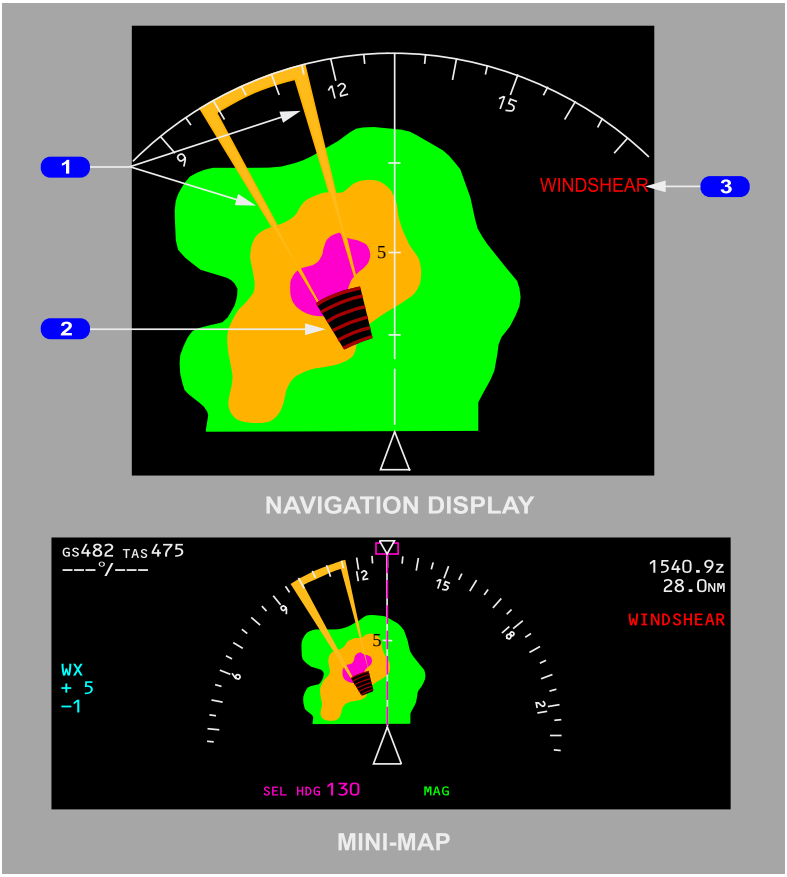
- terrain display enabled, and
- terrain output range disagrees with range selected by EFIS control panel.

MAP/TERR RANGE DISAGREE (amber)—

- terrain display enabled, and
- terrain output range disagrees with range selected by EFIS control panel, and
- map display output range disagrees with range selected by EFIS control panel.

See Ground Proximity Warning System (GPWS) on page 15.20.19 for additional information.

Predictive Windshear (PWS) Display and Annunciations



1 PWS Radials

Displayed (amber)—

- PWS alert is occurring
- extend from PWS symbol to help locate windshear event.

2 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 or MAP CTR mode.

When terrain display is selected and PWS alert occurs, weather radar display replaces terrain display.

3 WINDSHEAR Annunciation

WINDSHEAR (amber)—PWS caution alert is occurring.

WINDSHEAR (red)—PWS warning alert is occurring.

Displayed in all navigation display modes.

Introduction

Warning systems consist of:

- airspeed alerts
- crew alertness monitor (as configured by the airline)
- engine indication and crew alerting system (EICAS)
- ground proximity warning system (GPWS)
- MCP selected altitude alerts
- tail strike detection system
- takeoff and landing configuration warning system
- traffic alert and collision avoidance system (TCAS)
- windshear alerts.

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. EICAS information may be displayed on the inboard or outboard MFD as desired by the flight crew.

System Alert Level Definitions

Time Critical Warnings	Time critical warnings alert the crew of a non-normal operational condition requiring immediate crew awareness and corrective action to maintain safe flight. Master warning lights, voice alerts, and PFD and HUD indications or stick shakers announce time critical conditions.
Warnings	Warnings alert the crew to a non-normal operational or system condition requiring immediate crew awareness and corrective action.
Cautions	Cautions alert the crew to a non-normal operational or system condition requiring immediate crew awareness. Corrective action may be required.
Advisories	Advisories alert the crew to a non-normal operational or system condition requiring routine crew awareness. Corrective action may be required.

EICAS Messages

Systems conditions and configuration information is provided to the crew by four types of EICAS messages:

- EICAS alert messages are the primary method to alert the crew to non-normal conditions
- EICAS communication messages direct the crew to normal communication conditions and messages
- EICAS memo messages are crew reminders of certain flight crew selected normal conditions
- EICAS status messages indicate equipment faults which may affect airplane dispatch capability.

An EICAS alert, communications, or memo message is no longer displayed when the respective condition no longer exists.

EICAS Alert Messages

From after engine start until engine shut down, EICAS alert messages are the primary means to alert the crew to non-normal conditions which may impact other operations during the flight.

There is a non-normal procedure for each EICAS alert message. The procedure for every EICAS alert message is included as a checklist in the QRH. Procedures for some EICAS alert messages have steps to reconfigure airplane systems. A rectangular symbol [ ] prefaces an alert message that has procedural steps. The rectangular symbol [ ] also prefaces EICAS alert messages for checklists that have notes or information of which the crew must be made aware.

EICAS alert messages are grouped into three priority levels: warning, caution, and advisory. Prioritization is an aid to flight crew decision making when more than one EICAS alert message is displayed.

EICAS warning messages are displayed red and EICAS caution and advisory messages are displayed amber. Red EICAS alert messages remain displayed and cannot be canceled by pushing the CANC/RCL switch. Amber EICAS alert messages can be canceled and recalled by pushing the CANC/RCL switch.

EICAS Communication Messages

EICAS communication messages direct crew attention to normal communication conditions which may require crew attention. There is a crew action for each EICAS communications message.

EICAS communications messages are grouped into three priority levels: high, medium, and low. Prioritization is an aid to flight crew decision making when more than one message is displayed.

EICAS communications messages are displayed in white below EICAS alert messages. Communication messages can not be cancelled by pushing the CANC/RCL switch.

EICAS Memo Messages

EICAS memo messages are crew reminders of certain flight crew selected normal conditions. They are displayed in white at the bottom of the last page of EICAS alert messages on the primary EICAS display.

Pushing the CANC/RCL switch when the last page of EICAS alert messages is displayed ensures all current memo messages have been displayed.

EICAS Status Messages

All EICAS status messages are listed in the Dispatch Deviation Guide (DDG) or airline equivalent and provide a cross reference to the Minimum Equipment List (MEL) for dispatch capability.

Display and Manipulation of EICAS Messages

If more than one EICAS alert message is displayed, the messages are displayed in a list which is grouped by priority level. EICAS warning messages are displayed in red at the top of the message list.

EICAS caution messages are displayed in amber below the lowest warning message. EICAS advisory messages are displayed in amber below the lowest caution message and are indented one character so they may be distinguished from EICAS caution messages.

The most recent EICAS alert message is displayed at the top of its priority group and all messages move down one display line. If a message is no longer displayed because the respective system non-normal condition no longer exists, all messages previously displayed move up one display line.

If there are more messages in the list than can be displayed on one page, multiple pages are created and numbered sequentially. The page number is normally displayed at the bottom of each list. Multiple pages of EICAS caution and advisory messages can be displayed one page at a time by pushing the CANC/RCL switch. If there are more EICAS warning messages in the list than can be displayed on one page, no page number is displayed and it is not possible to display other pages. In all other cases, pushing the CANC/RCL switch displays the next page of EICAS caution and advisory messages. EICAS warning messages are displayed at the top of each page.

Pushing the CANC/RCL switch when the last page of the list is displayed causes all EICAS caution and advisory messages to be no longer displayed.

EICAS alert messages for new system non-normal conditions are displayed on the page being viewed.

For example, if page three is displayed and an EICAS caution message is displayed because a new system non-normal occurs, the message is displayed immediately below any EICAS warning messages. If the CANC/RCL switch is subsequently pushed to redisplay page one, the message is displayed as the first EICAS caution message on page one.

When no EICAS caution or advisory messages are displayed, pushing the CANC/RCL switch 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 top of the memo messages.

The STATUS cue is displayed on primary EICAS when a new EICAS status message is displayed.

Aurals, Master WARNING/CAUTION Switches and Lights

Aurals and two master WARNING and CAUTION lights call attention to the following alerts.

In the following table, parenthesis ( ) describe crew action to silence the aural or extinguish the light while the alert is occurring.

Aural	Light	Calls Attention To:
Voice annunciation: LEVEL OFF, LEVEL OFF	None	RA pitch regions to avoid on PFD and HUD. Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: AIRSPEED, AIRSPEED	Master WARNING lights (Extinguish by pushing Master WARNING/ CAUTION Reset switch)	TAMS indication on speed tape. Airspeed at or below Thrust Asymmetry Minimum Speed.
Altitude voice annunciations	None	Altitude voice annunciations during approach.
Bell (Silence by pushing Master WARNING/CAUTION Reset switch)	Master WARNING lights (Extinguish by pushing Master WARNING/ CAUTION Reset switch)	EICAS warning message: FIRE APU FIRE CARGO AFT, FWD FIRE ENG L, R FIRE WHEEL WELL.

Aural	Light	Calls Attention To:
Beeper	Master CAUTION lights (Extinguish by pushing Master WARNING/ CAUTION Reset switch)	New EICAS caution message, except: ENG SHUTDOWN ENG SHUTDOWN L ENG SHUTDOWN R.
Beeper	None	Altitude deviation from selected MCP altitude. New EICAS caution message: ALTITUDE ALERT. Amber box surrounds current altitude on PFD.
Voice annunciation: CAUTION TERRAIN	Master CAUTION light Amber CAUTION TERRAIN EICAS message	Amber TERRAIN message and terrain display on NDs and mini-maps.
Voice annunciation: CAUTION OBSTACLE	Master CAUTION light Amber CAUTION OBSTACLE EICAS message	Amber OBSTACLE on both NDs and mini-maps.
Voice annunciation: CLEAR OF CONFLICT	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message, and TCAS RA Traffic display on NDs and mini-maps are no longer displayed.
Voice annunciation: CLIMB, CLIMB	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: CLIMB, CLIMB NOW, CLIMB, CLIMB NOW	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.

Aural	Light	Calls Attention To:
Voice annunciation: DESCEND, CROSSING DESCEND, DESCEND, CROSSING DESCEND	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: DESCEND, DESCEND	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: DESCEND, DESCEND NOW, DESCEND, DESCEND NOW	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: DON'T SINK	Master CAUTION light Amber DON'T SINK EICAS message	GPWS immediate alert.
Siren, followed by voice annunciation: ENGINE FAIL	Master WARNING lights (Extinguish by pushing Master WARNING/ CAUTION Reset switch)	Red ENG FAIL on both PFDs. ENG FAIL on both HUDs.
Voice annunciation: GLIDESLOPE	Master CAUTION light Amber GLIDESLOPE EICAS message Amber BELOW G/S on Alerting and Transponder Control Panel	GPWS immediate alert.
High-low chime	None	New EICAS medium level communication message.
Voice annunciation: INCREASE CLIMB, INCREASE CLIMB	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: INCREASE DESCENT, INCREASE DESCENT	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and

Aural	Light	Calls Attention To:
		TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: MAINTAIN VERTICAL SPEED, MAINTAIN	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: MONITOR RADAR DISPLAY	Master CAUTION light Amber MONITOR RADAR DISP EICAS message	Amber WINDSHEAR message and PWS display on NDs and mini-maps.
Voice annunciation: MONITOR VERTICAL SPEED	None	RA pitch regions to avoid on PFD and HUD, Red TRAFFIC message and TCAS RA Traffic display on NDs and mini-maps.
Voice annunciation: OBSTACLE, OBSTACLE PULL UP	Master WARNING lights	GPWS immediate alert. Red TERRAIN on NDs and mini-maps. Red PULL UP on both PFDs. PULL UP on both HUDs.
Voice annunciation: PULL UP	Master WARNING lights (Extinguish by pushing Master WARNING/ CAUTION Reset switch)	Red PULL UP on both PFDs. PULL UP on both HUDs.
Voice annunciation: SINK RATE	Master CAUTION light Amber SINK RATE EICAS message	GPWS immediate alert.
Voice annunciation: SINK RATE, PULL UP	Master WARNING lights	GPWS immediate alert. Red PULL UP on both PFDs. PULL UP on both HUDs.

Aural	Light	Calls Attention To:
Siren	Master WARNING lights (Extinguish by pushing Master WARNING/ CAUTION Reset switch)	EICAS warning message: CONFIG DOORS CONFIG FLAPS CONFIG PARKING BRAKE CONFIG RUDDER CONFIG SPOILERS CONFIG STABILIZER OVERSPEED.
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 (as configured by the airline) STABILIZER EVAC COMMAND.
Siren (If caused by Thrust lever at idle, silence by pushing Master WARNING/CAUTION Reset switch)	Master WARNING lights (If caused by Thrust lever at idle, extinguish by pushing Master WARNING/CAUTION Reset switch)	EICAS warning message CONFIG GEAR for: • thrust lever at idle, and • radio altitude less than 800 feet, and • gear not down and locked or • flaps set to landing, and • gear not downand locked.
Voice annunciation: SPEEDBRAKE, SPEEDBRAKE	Master WARNING light	Red SPEEDBRAKE on both PFDs. SPEEDBRAKE on both HUDs.
Voice annunciation: TERRAIN	Master CAUTION light Amber TERRAIN EICAS message	GPWS immediate alert.
Voice annunciation: TERRAIN, PULL UP	Master WARNING lights	GPWS immediate alert. Red PULL UP on both PFDs.

Aural	Light	Calls Attention To:
		PULL UP on both HUDs.
Voice annunciation: TERRAIN, TERRAIN	None	GPWS immediate alert.
Voice annunciation: TERRAIN, TERRAIN, PULL UP	Master WARNING lights (Extinguish by pushing Master WARNING/ CAUTION Reset switch)	GPWS immediate alert and mini-maps. Red PULL UP on both PFDs. PULL UP on both HUDs.
Voice annunciation: TOO LOW, FLAPS	Master CAUTION light Amber TOO LOW FLAPS EICAS message	GPWS immediate alert.
Voice annunciation: TOO LOW, GEAR	Master CAUTION light Amber TOO LOW GEAR EICAS message	GPWS immediate alert.
Voice annunciation: TOO LOW, TERRAIN	Master CAUTION light Amber TOO LOW TERRAIN EICAS message	GPWS immediate alert.
Voice annunciation: TRAFFIC, TRAFFIC	None	Amber TRAFFIC message and TCAS TA. Traffic display on NDs and mini-maps.
Voice annunciation: VEE ONE	None	Airspeed at V1 during takeoff.
Voice annunciation: WINDSHEAR AHEAD GO AROUND, WINDSHEAR AHEAD	Master WARNING lights (Extinguish by pushing Master WARNING/ CAUTION Reset switch)	Red WINDSHEAR on both PFDs. WINDSHEAR on both HUDs. Red WINDSHEAR message and PWS display on NDs and mini-maps.
Siren, followed by voice annunciation: WINDSHEAR, WINDSHEAR, WINDSHEAR	Master WARNING lights (Extinguish by pushing Master WARNING/	Reactive windshear warning. Red WINDSHEAR on both PFDs. WINDSHEAR on both HUDs.

Aural	Light	Calls Attention To:
	CAUTION Reset switch)	

Flight Deck Panel Annunciator Lights

Flight deck panel annunciator lights are used with EICAS messages to:

- help locate and identify affected systems and controls
- reduce potential for error.

Airspeed Alerts

Stall Warning

Warning of an impending stall is provided by left and right stick shakers, which independently vibrate the left and right control columns.

Airspeed Low

The EICAS caution message AIRSPEED LOW is displayed and the box around the current airspeed indication on the PFD is highlighted amber when airspeed is below minimum maneuvering speed.

This indication is accompanied by a beeper and Master WARNING/CAUTION light.

Takeoff V1 Airspeed

The voice annunciation VEE ONE sounds when airspeed reaches V1 during takeoff.

Thrust Asymmetry Minimum Speed (TAMS)

TAMS is displayed on the speed tape to provide pilots with situational awareness of the minimum control speed for operation with a large thrust asymmetry.

TAMS varies with weight and CG but will always be at least 10 knots above minimum control speed during takeoff or go-around.

When airspeed decreases to TAMS, the AIRSPEED, AIRSPEED aural sounds and the Master WARNING light illuminates.

Overspeed Warning

The EICAS warning message OVERSPEED is displayed if airspeed is greater than VMO/MMO. The message remains displayed until airspeed is reduced below VMO/MMO.

This indication is accompanied by a siren and Master WARNING light.

Tail Strike Detection System

The tail strike alert system detects ground contact which could damage the airplane pressure hull. A two inch blade target and two frangible wires are installed on the aft body of the airplane. The EICAS caution message TAIL STRIKE is displayed when a tail strike is detected.

This indication is accompanied by a beeper and Master CAUTION light.

Takeoff And Landing Configuration Warning System

The takeoff and landing configuration warning system alerts the crew that the airplane is not configured for normal takeoff or normal landing.

Takeoff Configuration Warnings

The takeoff configuration warning function is armed when:

- airplane is on the ground, and
- FUEL CONTROL switches are in RUN position, and
- either engine thrust is in takeoff range, and
- thrust reversers are not unlocked or deployed, and
- airspeed is less than V1.

Takeoff configuration warnings consist of:

- illumination of the master warning lights, and
- activation of the aural warning siren, and
- display of applicable EICAS warning CONFIG message. Warning messages are:

Warning Message	Configuration
CONFIG DOORS	Cargo and/or passenger doors are not secured and locked and either engine's thrust is in the takeoff range on the ground.
CONFIG FLAPS	Leading edge and/or trailing edge flaps are not in takeoff position and either engine's thrust is in the takeoff range on the ground.
CONFIG PARKING BRAKE	Parking brake is set and either engine's thrust is in the takeoff range on the ground.
CONFIG RUDDER	Rudder Trim not centered when either engine’s thrust is in the takeoff range on the ground.
CONFIG SPOILERS	Speedbrake lever is not DOWN when either engine’s thrust is in the takeoff range on the ground.

Warning Message	Configuration
CONFIG STABILIZER	Stabilizer not within the green band when either engine's thrust is in the takeoff range on the ground.

Takeoff configuration warnings are inhibited at V1.

When a takeoff configuration warning occurs, pushing either Master WARNING/CAUTION reset switch resets the Master WARNING lights but does not silence the siren or clear the EICAS alert message. If thrust is decreased below takeoff range and airspeed is less than V1 but the airplane is still not configured for takeoff, the Master WARNING lights are extinguished and the siren is silenced. The CONFIG message remains displayed for 10 seconds after thrust is reduced to aid in identifying the takeoff configuration.

Landing Configuration Warnings

The landing configuration warning system alerts the crew the landing gear is not extended for landing. The EICAS warning message CONFIG GEAR is displayed if:

- the airplane is in flight, and
- any landing gear is not down and locked, and
- any of the following configurations exist:
  - either thrust lever closed and radio altitude less than 800 feet, or
  - FLAP lever in landing position.

If the message is displayed because a Thrust lever is closed at low radio altitudes, pushing either Master WARNING/CAUTION reset switch silences the siren and extinguishes the Master WARNING lights. The message remains displayed until the Thrust levers are advanced or landing gear is down and locked.

If the message is displayed because the FLAP lever is in landing position, the siren cannot be silenced by pushing a Master WARNING/CAUTION reset switch and the message remains displayed. The siren sounds and the message is displayed until the landing gear is down and locked or GEAR OVRD is selected to OVRD on the GPWS page of the TCP.

Speedbrake Lever Extended Beyond ARMED During Landing

In flight, the EICAS caution message SPEEDBRAKE EXTENDED alerts the crew if:

- the SPEEDBRAKE lever is extended beyond ARMED with airplane radio altitude 15 feet or greater, and one or more of the following conditions:
  - radio altitude is 800 feet or less, or
  - FLAP lever in landing position, or
  - thrust lever angle 5° or more above idle stop for 15 seconds.

When SPEEDBRAKE EXTENDED message is displayed in flight, pushing either Master WARNING/CAUTION Reset switch silences the siren and extinguishes the Master CAUTION lights. The EICAS message remains displayed until the SPEEDBRAKE lever is DOWN or at ARMED.

Speedbrake Warning During Rollout

The SPEEDBRAKE warning alerts the crew that the speedbrake has not deployed during landing or during a rejected takeoff. The warning is displayed on both PFDs and both HUDs and is accompanied by a Master WARNING light and aural SPEEDBRAKE, SPEEDBRAKE.

The SPEEDBRAKE warning occurs when:

- the airplane is on the ground, and
- both thrust levers not in the takeoff thrust position, and
- the groundspeed exceeds 85 knots, and
- the speedbrake lever position is less than 35º, and
- all the above occur together for 1 second.

The warning is automatically reset when any of the above conditions are no longer met.

Configuration Warning System Non-normal Operation

If the takeoff and landing warning system fails, the EICAS advisory message CONFIG WARNING SYS is 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 WARNING SYS message, the CONFIG messages may not be correct.

MCP Selected Altitude Alert

Altitude alerting is provided when approaching or departing the altitude selected in the MCP altitude window.

Approaching MCP Selected Altitude

At 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 caution message ALTITUDE ALERT is displayed, and a highlighted amber box is displayed around the current altitude. The message and amber highlight 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

MCP selected altitude alerts are inhibited when:

- glideslope captured, or
- landing flaps selected and landing gear down and locked.

500 Foot Callout

An aural callout of “FIVE HUNDRED” is announced on approach when radio altitude transitions through 500 feet, and any of the following conditions are met:

- flight path is not within ±2 dots of a valid glideslope beam, or
- flight path is not within ±2 dots of a valid localizer beam, or
- no valid localizer signal is received, or
- no valid glideslope signal is received, or
- glideslope inhibit switch is actuated.

Crew Alertness Monitor

The Crew Alertness Monitor is configured (enabled/disabled) by the airline. When enabled, the FMC continuously monitors switch action on the MCP, EFIS control panel, display select panel, CDUs, and radio transmitter microphone switches. When a predefined time elapses after the last switch action was detected, the EICAS advisory message PILOT RESPONSE is displayed.

If there is still no switch action after a brief time, the EICAS caution message PILOT RESPONSE is displayed.

If there is still no switch action the EICAS warning message PILOT RESPONSE is displayed.

The PILOT RESPONSE message is no longer displayed after pushing any monitored switch.

The PILOT RESPONSE message is inhibited during climb below 20,000 feet when flaps are not up.

Traffic Alert and Collision Avoidance System (TCAS)

TCAS alerts the crew to possible conflicting traffic. TCAS interrogates operating transponders in other airplanes, tracks the other airplanes by analyzing the transponder replies, and predicts the flight paths and positions. TCAS provides TCAS ND messages, voice annunciations, PFD vertical flight path guidance, and traffic displays of the other airplanes to the flight crew. Neither ND messages, voice annunciations, PFD vertical guidance, nor traffic display is provided for other airplanes that do not have operating transponders. TCAS operation is independent of ground–based air traffic control.

TCAS identifies a three–dimensional airspace around the airplane where a high likelihood of traffic conflict exists. The dimensions of this airspace are contingent upon the closure rate with conflicting traffic.

TCAS provides:

- resolution advisory (RA) and display
- traffic advisory (TA) and display
- proximate traffic display
- other traffic display.

TCAS messages and TCAS traffic symbols can be displayed on the ND and mini-map. TCAS messages and TCAS traffic symbols cannot be displayed on the ND in plan mode.

TCAS messages TRAFFIC, TA ONLY, and TCAS TEST may be displayed in all ND modes.

Resolution Advisories (RA) and Display

An RA is a prediction that another airplane will enter the TCAS conflict airspace within approximately 15 to 35 seconds. If altitude data from the other airplane is not available, no RA can be provided.

When TCAS predicts an RA:

- the TCAS red message TRAFFIC is displayed on the ND
- a TCAS voice annunciation sounds
- TCAS PFD vertical guidance is displayed.

When the TCAS cyan message TFC is displayed on the ND, and the RA is within the display range of the ND, the TCAS RA Traffic symbol and its accompanying data tag is displayed on the ND.

The TCAS RA Traffic symbol is a filled red square. The RA data tag contains the altitude and the vertical motion arrow.

For no–bearing RAs, the red RA label is displayed below the red message, TRAFFIC, and the RA data tag information is displayed to the right of the label. The RA red data tag contains the distance, altitude, and the vertical motion arrow.

When the RA is further from the airplane than the ND range currently displayed, the TCAS red message OFFSCALE is displayed on the ND.

Traffic Advisories (TA) and Display

A TA is a prediction that another airplane will enter the conflict airspace in 20 to 48 seconds. TAs assist the flight crew in establishing visual contact with the other airplane.

When TCAS predicts a TA:

- the TCAS amber message TRAFFIC is displayed on the ND
- the TCAS voice annunciation TRAFFIC, TRAFFIC sounds once.

When the TCAS cyan message TFC is displayed on the ND and the TA is within the display range of the ND, the TCAS TA Traffic symbol and its accompanying data tag are displayed on the ND.

The TA Traffic symbol is a filled amber circle. The TA data tag contains the altitude and the vertical motion arrow.

For no–bearing TAs, the amber TA label is displayed below the TRAFFIC message, and the TA data tag information is displayed to the right of the label. The TA labels are displayed below the RA labels. The TA data tag contains the distance, altitude, and vertical motion arrow.

When the TA is further from the airplane than the ND range currently displayed, the TCAS amber message OFFSCALE is displayed on the ND.

Proximate Traffic Display

Proximate traffic is another airplane that is neither an RA or a TA but is within:

- six miles, and
- 1,200 feet vertically.

When the TCAS cyan message TFC is displayed on the ND, and the Proximate Traffic is within the ND display range, the TCAS Proximate Traffic symbol is displayed on the ND.

The TCAS Proximate Traffic symbol is a filled white diamond. If the other airplane is providing altitude data, the Proximate Traffic data tag is displayed on the ND. The proximate traffic data tag contains the altitude and vertical motion arrow.

Other Traffic Display

Other Traffic airplane is an airplane that is within the ND display limits but is neither an RA, a TA, or a proximate traffic airplane. When TCAS is not receiving and processing altitude data from the Other Traffic airplane the Other Traffic airplane becomes a Proximate Traffic airplane automatically when within six miles.

When the TCAS cyan message TFC is displayed on the ND and the Other Traffic is within the ND display range, then the TCAS Other Traffic symbol is displayed on the ND.

The TCAS Other Traffic symbol is a hollow white diamond. When TCAS is receiving and processing altitude data from the Other Traffic airplane, a data tag like that described in Proximate Traffic Display is displayed.

TCAS HUD and PFD Vertical Guidance

When TCAS predicts an RA, TCAS vertical guidance is displayed on both the HUD and PFD for a maneuver to ensure vertical separation. Traffic avoidance is ensured by adjusting or maintaining a pitch attitude and vertical speed outside the displayed RA regions.

If the traffic airplane also has TCAS and a mode S transponder, TCAS vertical guidance is coordinated with the traffic airplanes TCAS.

TCAS ND Messages

The ND annunciates various messages to alert the crew of TCAS system status. (See Navigation Displays (NDs) on page 10.40.1 for additional information).

TCAS Voice Annunciations

Voice Annunciation	Condition	Response
LEVEL OFF, LEVEL OFF	Present pitch attitude and vertical speed are within the RA regions.	Reduce vertical speed to zero. Adjust pitch attitude and vertical speed to remain outside the RA regions.
CLEAR OF CONFLICT	TCAS PFD vertical guidance is no longer displayed and traffic changes to a TA symbol. Separation is increasing and the RA will not occur. However, the voice annunciation does not sound if TCAS can no longer predict the track of the RA airplane.	Attempt to visually locate traffic.
CLIMB, CLIMB	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the RA regions.	Increase pitch attitude and vertical speed to remain outside the RA regions.
CLIMB, CLIMB NOW, CLIMB, CLIMB NOW	Existing RA, previous TCAS vertical guidance was to descend. Present pitch attitude and vertical speed are within the RA regions.	
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the RA regions.	Increase pitch attitude and vertical speed to remain outside the RA regions.

Voice Annunciation	Condition	Response
	Airplane will climb through the altitude of the traffic.	
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the RA regions. Airplane will descend through the altitude of the traffic.	Decrease pitch attitude and vertical speed to remain outside the RA regions.
DESCEND, DESCEND	New RA, initial voice annunciation. Present pitch attitude and vertical speed are within the RA regions.	
DESCEND, DESCEND NOW, DESCEND, DESCEND NOW	Existing RA, previous TCAS vertical guidance was to climb. Present pitch attitude and vertical speed are within the RA regions.	
INCREASE CLIMB, INCREASE CLIMB	Existing RA, TCAS requires change in vertical rate. Present pitch attitude and vertical speed are within the RA regions.	Adjust pitch attitude and vertical speed to remain outside the RA regions.
INCREASE DESCENT, INCREASE DESCENT		
MAINTAIN VERTICAL SPEED CROSSING, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the RA regions. Airplane will pass through the altitude of the traffic.	Continue to keep pitch attitude and vertical speed outside the RA regions.
MAINTAIN VERTICAL SPEED, MAINTAIN	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the RA regions.	Continue to keep pitch attitude and vertical speed outside the RA regions.

Voice Annunciation	Condition	Response
MONITOR VERTICAL SPEED	New RA, initial voice annunciation. Present pitch attitude and vertical speed are outside the RA regions.	Continue to keep pitch attitude and vertical speed outside the RA regions.
TRAFFIC, TRAFFIC	New TA, initial voice annunciation.	Attempt to visually locate traffic.

TCAS Normal Operation

TCAS is controlled from the Alerting and Transponder Control panel (ATP). TA/RA is normally selected. However, it is sometimes necessary to select TA ONLY to prevent nuisance RAs.

TA ONLY is selected during engine out operations to prevent RAs when adequate thrust is not available to follow the RA commands.

TCAS Non-Normal Operation

The EICAS advisory message TCAS OFF is displayed if TCAS is not operating. The message is inhibited below 400 feet radio altitude. No TCAS RA guidance is displayed on the PFDs, no TCAS traffic symbols are displayed on the NDs or mini-maps, and no TCAS voice alerts sound. An amber TCAS OFF message is displayed on the NDs and mini-maps.

The EICAS advisory message TCAS RA (CAPTAIN or F/O) is displayed if TCAS cannot display RA guidance on the respective PFD. The ND and mini-map traffic displays and voice alerts are unaffected.

The EICAS advisory message TCAS is displayed if TCAS cannot display TCAS RA guidance on either PFD, and cannot display TCAS traffic symbols on the NDs or mini-maps. TCAS voice alerts do not occur. An amber TCAS FAIL message is displayed on the NDs and mini-maps.

Ground Proximity Warning System (GPWS)

Introduction

GPWS provides immediate alerts, and look-ahead obstacle and terrain alerts for potentially hazardous flight conditions involving imminent impact with the obstacles and the ground.

GPWS immediate alerts are based on radio altitude, barometric altitude, ADRS, glideslope deviation, and airplane configuration. GPWS alerts are provided for:

- altitude loss after takeoff or go-around, or
- excessive and severe descent rate, or
- excessive terrain closing rate, or
- unsafe terrain clearance when not in the landing configuration, or

- excessive deviation below ILS glideslope, or
- excessive deviation below IAN glide path, or
- windshear.

GPWS provides bank angle voice annunciations and altitude voice annunciations during approach.

GPWS also provides look-ahead terrain mode alerts by monitoring obstacle and terrain proximity using a world-wide terrain and obstacle database. Proximate obstacle and terrain data may be displayed on the NDs, VSDs, and mini-maps. If there is a potential obstacle or terrain hazard, GPWS look-ahead alerts are provided based on estimated time to impact.

Estimated time to impact is based on airplane position, barometric altitude, present track, vertical path, and groundspeed. FMC VNAV and LNAV path is not considered in the estimated time to impact.

Note: Obstacles or terrain ahead of the airplane may exceed available climb performance. A GPWS caution or warning does not guarantee obstacle or terrain clearance.

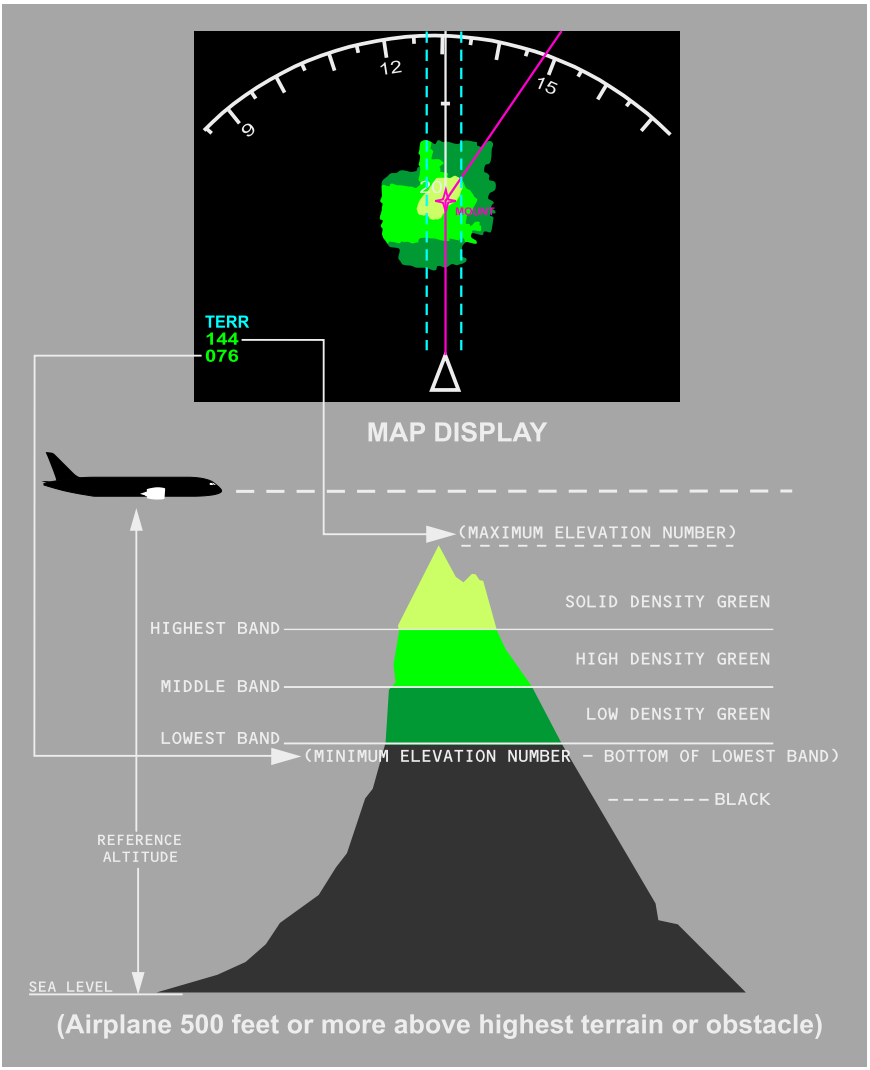
GPWS Look–Ahead Obstacle and Terrain Mode

A GPWS terrain database contains detailed terrain and man-made obstacle data. Terrain and obstacle data is not designed to be used as an independent navigation aid.

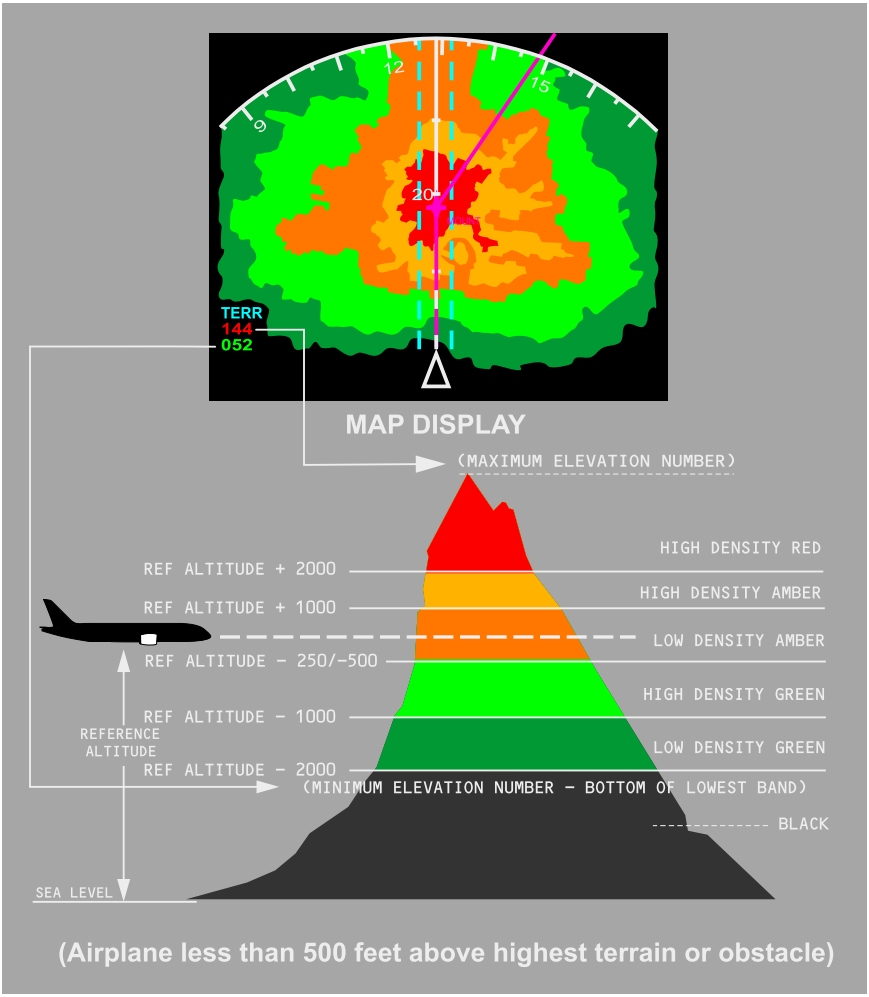
Selecting the ND TERR switch on the EFIS control panel displays obstacles, terrain, and the TERR indication on the NDs and mini-maps. Terrain and obstacles can also be displayed on the ND only (excluding mini-map) by selecting TERR on the ND drop-down menu.

The elevation of the highest and lowest terrain or obstacle is displayed on the ND in hundreds of feet above sea level (MSL) below the TERR indication. The color of each value corresponds to the color of the respective contour depicted.

When the airplane is 500 feet or more above the highest terrain or obstacle in the selected display range, terrain peaks and obstacles are depicted independent of airplane altitude by three shaded contours of green. The highest terrain or obstacles are depicted by solid green, intermediate height terrain or obstacles are depicted by high density dotted green, and the lowest height terrain or obstacles are depicted by low density dotted green.



When the airplane is less than 500 feet above the highest terrain peaks or obstacles in the selected display range, obstacles and terrain peaks are depicted in varying densities of green, amber, and red, depending on the airplane height relative to the terrain or obstacle.



(See Terrain Display on page 15.10.25 for additional information.)

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 are not displayed at the same time.

The terrain display is correlated to GPS position, or to IRS position if GPS position is intermittently unavailable.

Terrain and weather radar cannot be simultaneously displayed on the same ND or mini-map, although, for example, a pilot can display weather on his ND, and terrain on his mini-map. When one pilot selects terrain and the other pilot selects weather radar, each display updates on alternating sweeps. All other navigation displays can be simultaneously displayed with terrain data.

GPWS Look-Ahead Obstacle and Terrain Alerts

Voice Annunciation	Visual Indications	Description
CAUTION OBSTACLE	Master CAUTION lights Amber CAUTION OBSTACLE EICAS message Amber OBSTACLE on the NDs and mini-maps	40 to 60 seconds from projected impact with obstacle. Push the TERR OVRD (line select) soft key to OVRD on the GPWS page of the TCP to inhibit the alert.
CAUTION TERRAIN	Master CAUTION lights Amber CAUTION TERRAIN EICAS message Amber TERRAIN on the NDs and mini-maps	40 to 60 seconds from projected impact with terrain. Push the TERR OVRD (line select) soft key to OVRD on the GPWS page of the TCP to inhibit the alert.
OBSTACLE, OBSTACLE PULL UP	Master WARNING lights Red OBSTACLE on the NDs and mini-maps	20 to 30 seconds from projected impact with obstacle. Push the TERR OVRD (line select) soft key to OVRD on the GPWS page of the TCP to inhibit the alert.
TERRAIN TERRAIN (Whoop, Whoop) PULL UP	Master WARNING lights Red PULL UP on both PFDs PULL UP on both HUDs Red TERRAIN on the NDs and mini-maps	20 to 30 seconds from projected impact with terrain. Push the TERR OVRD (line select) soft key to OVRD on the GPWS page of the TCP to inhibit the alert.
TOO LOW, TERRAIN	Master CAUTION lights	Descent below safe altitude while too far from any airport in the terrain database.

Voice Annunciation	Visual Indications	Description
	Amber TOO LOW TERRAIN EICAS message	Push the TERR OVRD (line select) soft key to OVRD on the GPWS page of the TCP to inhibit the alert.

GPWS Immediate Alerts

Voice Annunciation	Visual Indications	Description
DON'T SINK	Master CAUTION light Amber DON'T SINK EICAS message	Altitude loss with flaps and/or gear up after takeoff or go-around.
GLIDESLOPE	Master CAUTION light Amber GLIDESLOPE EICAS message Amber BELOW G/S displayed on G/S INHIBIT switch	Excessive deviation below glideslope or glidepath. Volume and repetition rate increase as deviation increases. Pushing the G/S INHIBIT switch on the ATP inhibits the alert when pushed below 1,000 feet radio altitude.
PULL UP	Master WARNING lights Red PULL UP message on both PFDs PULL UP on both HUDs	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	Master CAUTION light Amber SINK RATE EICAS message	Excessive descent rate.
TERRAIN	Master CAUTION light Amber TERRAIN EICAS message Amber TERRAIN on the NDs and mini-maps	Excessive terrain closing rate.
TOO LOW, FLAPS	Master CAUTION light Amber TOO LOW FLAPS EICAS message	Unsafe terrain clearance with flaps not in landing configuration at low altitude and airspeed.

Voice Annunciation	Visual Indications	Description
		Push the FLAP OVRD (line select) soft key to OVRD on the GPWS page of the TCP to inhibit the alert.
TOO LOW, GEAR	Master CAUTION light Amber TOO LOW GEAR EICAS message	Unsafe terrain clearance with gear not in landing configuration at low altitude and airspeed. Push the GEAR OVRD (line select) soft key to OVRD on the GPWS page of the TCP to inhibit the alert.
TOO LOW, TERRAIN	Master CAUTION light Amber TOO LOW TERRAIN EICAS message	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. Push the FLAP OVRD (line select) soft key to OVRD on the GPWS page of the TCP to inhibit the alert when the alert is due to flaps not in landing position. Push the GEAR OVRD (line select) soft key to OVRD on the GPWS page of the TCP to inhibit the alert, when the alert is due to gear not down.

Bank Angle Voice Annunciations

The voice alert BANK ANGLE sounds if bank angle exceeds 35°, 40°, and 45°.

The voice alert BANK ANGLE also sounds at low altitudes during takeoff and landing for bank angles as small as 10°.

Altitude Voice Annunciations During Approach

GPWS provides the following altitude voice annunciations during approach:

- 2,500 feet—TWENTY-FIVE HUNDRED
- 1,000 feet—ONE THOUSAND
- 500 feet—FIVE HUNDRED (see 500 Foot Callout on page 15.20.14.)
- 100 feet—ONE HUNDRED
- 50 feet—FIFTY
- 40 feet—FORTY
- 30 feet—THIRTY
- 20 feet—TWENTY

- 10 feet—TEN.

Approaching Minimums Voice Annunciation

GPWS provides the voice annunciation PLUS HUNDRED at 100 feet above the altitude set by the Captain's MINS selector on the EFIS Control Panel.

Minimums Voice Annunciation

GPWS provides the voice annunciation MINIMUMS at the altitude set by the Captain's MINS selector on the EFIS Control Panel.

GPWS Windshear Alert and PWS

Windshear alerts are enabled during takeoff, approach, and landing:

- GPWS provides an immediate windshear alert when an excessive downdraft or tailwind is occurring
- PWS provides windshear alerts when an excessive windshear condition is detected ahead of the airplane.

PWS Alert System

Weather radar uses radar imaging to detect disturbed air ahead of the airplane.

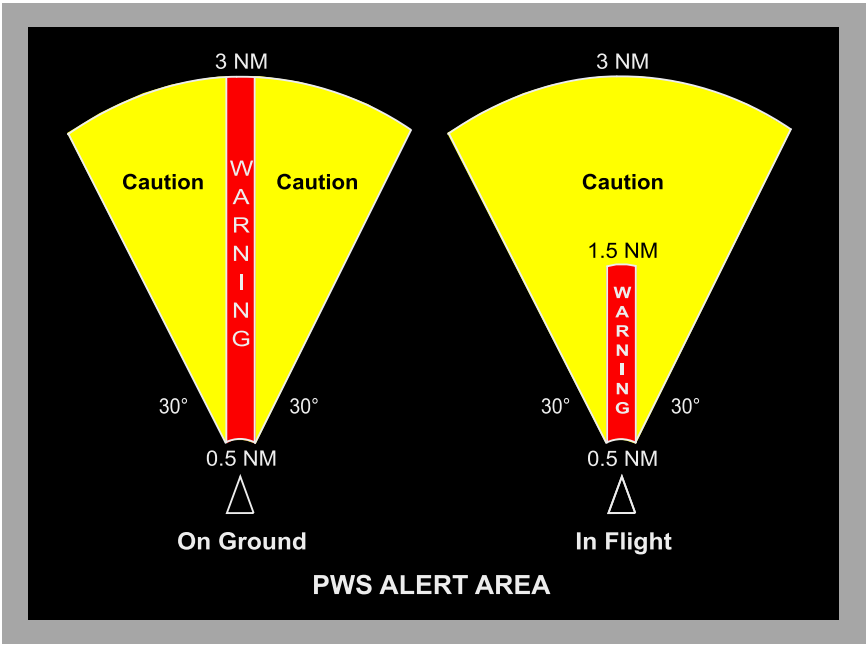
PWS alerts are enabled approximately 12 seconds after weather radar begins scanning for windshear.

When PWS is scanning for windshear, radar antenna scan sweep is reduced.

Prior to takeoff, PWS alerts can be enabled by pushing the WXR switch on the EFIS control panel. On the ground with the WXR switch pushed or not pushed, weather radar begins scanning for windshear when the thrust of either engine is in the takeoff range and thrust reversers are not unlocked or deployed.

In flight with the WXR switch pushed or not pushed, weather radar begins scanning for windshear below 2,300 feet radio altitude and PWS alerts are enabled below 1,200 feet radio altitude.

When windshear is not predicted by PWS, weather radar returns are displayed only when the WXR on the EFIS control panel is pushed.



PWS Alerts

Voice Annunciation	Visual Indications	Description
GO AROUND, WINDSHEAR AHEAD	Master WARNING lights Red WINDSHEAR on both PFDs Red WINDSHEAR message on the NDs and mini-maps RED, BLACK and YELLOW windshear	Windshear predicted within 1.5 miles nd directly ahead of the airplane. Enabled during approach, below 1,200 feet radio altitude. Windshear position displayed by PWS symbol on the NDs and mini-maps.
Notes: 1. Weather radar provides windshear alerts for windshear events containing some level of moisture or particulate matter. 2. Weather radar detects microbursts and other windshears with similar characteristics. Weather radar does not provide alerting for all types of windshear. The flight crew must continue to rely on traditional windshear avoidance methods.		

Voice Annunciation	Visual Indications	Description
	symbol on the NDs and mini-maps WINDSHEAR on both HUDs	
MONITOR RADAR DISPLAY	Amber WINDSHEAR message on the NDs and mini-maps RED, BLACK and YELLOW windshear symbol on the NDs and mini-maps Amber MONITOR RADAR DISP EICAS message	Windshear predicted within 3 miles and ahead of the airplane. Enabled during takeoff and approach, below 1,200 feet radio altitude. Windshear position displayed by PWS symbol on the NDs and mini-maps.
WINDSHEAR AHEAD	Master WARNING lights Red WINDSHEAR on both PFDs Red WINDSHEAR message on the NDs and mini-maps RED, BLACK and YELLOW windshear symbol on the NDs and mini-maps WINDSHEAR on both HUDs	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 NDs and mini-maps.

Notes:
1. Weather radar provides windshear alerts for windshear events containing some level of moisture or particulate matter.
2. Weather radar detects microbursts and other windshears with similar characteristics. Weather radar does not provide alerting for all types of windshear. The flight crew must continue to rely on traditional windshear avoidance methods.

Immediate Windshear Alerts

Voice Annunciation	Visual Indications	Description
(Siren)	Master WARNING lights	Excessive windshear detected by GPWS.

Voice Annunciation	Visual Indications	Description
WINDSHEAR, WINDSHEAR, WINDSHEAR	Red WINDSHEAR on both PFDs WINDSHEAR on both HUDs	Enabled below 1,500 feet radio altitude. GPWS windshear detection begins at rotation.

Alert Inhibits

Alerts are inhibited when they are operationally unnecessary or inappropriate. Alerts are inhibited during normal system operation, and during part of the takeoff and landing to prevent distracting the crew.

GPWS immediate windshear alert inhibits all PWS, TCAS, and other GPWS alerts.

When TA/RA is selected on the transponder panel and a GPWS or PWS warning alert occurs, TCAS automatically inhibits RA mode. During the inhibit, all airplanes that would have been predicted as an RA are predicted as a TA. When GPWS and PWS warning alerts are no longer occurring, the RA mode inhibit ends.

Alert Messages Inhibited During Normal System Operation

Certain EICAS alert messages are time delayed, even though related flight deck panel annunciator lights are illuminated. Time delay inhibits prevent normal in-transit indications from being displayed as EICAS alert messages. For example, valves are generally only sensed open or closed, not in-transit. When a valve is in-transit, the message indicating the valve has failed to open or close is inhibited to allow the valve time to move to the commanded position. If the valve is not in the commanded position at the end of the inhibit time delay, the respective EICAS alert message is displayed.

Alert Messages Inhibited By Other Alert Messages

Some EICAS alert messages are inhibited if another related alert message is displayed. For example, individual hydraulic pump pressure messages are inhibited if a hydraulic system pressure message is displayed.

Voice Annunciation Inhibits

Voice annunciations for warning alerts inhibit new voice annunciations for caution alerts.

All voice annunciations are prioritized to aid flight crew decision making when more than one alert could occur.

ND Display Alert Inhibits and Automatic Display

Alert displays on the NDs are prioritized to aid flight crew decision making when more than one alert occurs. The displays are also prioritized when neither ND is in MAP or MAP CTR mode.

Immediate windshear alert inhibits the automatic display of a new TCAS, look-ahead terrain, or PWS alerts.

TCAS traffic can be displayed concurrently with either TERR and WXR display.

New TCAS TRAFFIC TA or RA alerts:

- when both NDs are in MAP or MAP CTR mode and a new TCAS TA or RA alert occurs, TFC is selected automatically for both NDs and TCAS traffic is displayed on both NDs
- when only one ND is in MAP or MAP CTR mode and a new TCAS TA or RA alert occurs, TFC is selected automatically for that ND and TCAS traffic is displayed. The ND not in MAP or MAP CTR mode is armed for TCAS display and TFC will be selected automatically when MAP or MAP CTR mode is selected
- when neither ND is in MAP or MAP CTR mode and a new TCAS TA or RA alert occurs, both NDs are armed for TCAS display and TFC will be selected automatically when MAP or MAP CTR mode is selected.

New look-ahead terrain alerts:

- when both NDs are in MAP or MAP CTR mode and a new look-ahead terrain alert occurs, TERR is selected automatically for both NDs
- when only one ND is in MAP or MAP CTR mode and a new look-ahead terrain alert occurs, TERR is selected automatically for that ND. The ND not in MAP or MAP CTR mode is armed for TERR display and TERR will be selected automatically when MAP or MAP CTR mode is selected. TERR is disarmed by selecting WXR prior to selecting MAP or MAP CTR mode
- when neither ND is in MAP or MAP CTR mode and a new look-ahead terrain alert occurs, both NDs are armed for TERR display and TERR will be selected automatically when MAP or MAP CTR mode is selected. TERR is disarmed for either ND by selecting WXR prior to selecting MAP or MAP CTR mode on the respective ND.

New PWS alerts:

- when both NDs are in MAP or MAP CTR mode and a new PWS alert occurs, WXR is selected automatically for both NDs
- when only one ND is in MAP or MAP CTR mode and a new PWS alert occurs, WXR is selected automatically for that ND. The ND not in MAP or MAP CTR mode is armed for WXR display and WXR will be selected automatically when MAP or MAP CTR mode is selected. WXR is disarmed by selecting TERR prior to selecting MAP or MAP CTR mode
- when neither ND is in MAP or MAP CTR mode and a new PWS alert occurs, both NDs are armed for WXR display and WXR will be selected

automatically when MAP or MAP CTR mode is selected. WXR is disarmed by selecting TERR prior to selecting MAP or MAP CTR mode.

Alerts Inhibited Before Engine Start and After Shutdown

Alert Inhibited	For Message	Inhibit Occurs
Master CAUTION lights Beeper	For all EICAS caution messages	On the ground, and both FUEL CONTROL switches in CUTOFF.
Respective EICAS messages: ELEC GEN DRIVE L1, L2, R1, R2 ELEC GEN OFF L1, L2, R1, R2 ENG OIL PRESS L, R HYD PRESS PRI L, R	For EICAS caution messages: ENG SHUTDOWN L ENG SHUTDOWN R ENG SHUTDOWN	On the ground, and FUEL CONTROL switch in CUTOFF or Engine Fire Switch pulled.

Alerts Inhibited During Engine Start

Alert Inhibited	Inhibit Begins	Inhibit Ends
All new EICAS caution and advisory messages, except: APU LIMIT APU SHUTDOWN ENG AUTOSTART L, R ENG FUEL VALVE L, R ENG SHUTDOWN L, R ENG STARTERS L, R ENG START CUTOUT L, R OVERHEAT ENG L,R	Engine START selector to START	Engine reaches idle RPM, or start is aborted.

Alerts Inhibited During Takeoff

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
TCAS TA voice alerts	TCAS TAs	On ground	Approximately 600 feet radio altitude.

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
All TCAS RAs	TCAS RAs are inhibited When RA selected on panel, TCAS switches automatically to TA only mode and TCAS message TA ONLY is displayed on the NDs and mini-maps	On ground	Approximately 1,100 feet radio altitude.
TCAS DESCEND RAs	Alerts are inhibited	On ground	Approximately 1,200 feet radio altitude.
Red ENG FAIL on both PFDs ENG FAIL on both HUDs	Engines not producing commanded thrust and rate of thrust increase insufficient; same condition as EICAS messages ENG THRUST L, R	Engine start	65 knots airspeed.
EICAS caution message ENG THRUST L, R	Messages are inhibited	Engine start	Six knots before V1.
STATUS cue	All EICAS status messages	Engine start	30 minutes after lift-off or FMC sets Cruise flight mode or any engine shutdown after engine start.
All EICAS communication alerts (message and chime) except: CABIN ALERT	Messages are inhibited	Either engine in takeoff thrust range	400 feet radio altitude or 20 seconds after lift-off, whichever occurs first, or on the ground and thrust on both engines reduced below takeoff thrust range.

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
Master CAUTION lights Beeper If the Master CAUTION lights illuminate before reaching 80 knots airspeed, they continue to be illuminated when 80 knots airspeed is exceeded and cannot be extinguished until the inhibit ends. If new EICAS caution messages are displayed during the inhibit, the beeper sounds and the Master CAUTION lights illuminate when the inhibit ends.	New EICAS caution messages displayed during inhibit	80 knots airspeed	400 feet radio altitude or 20 seconds after lift-off, whichever occurs first. If rejected takeoff initiated above 80 knots, inhibit continues until airspeed is less than 75 knots.
All EICAS advisory messages	Messages are inhibited	80 knots airspeed	400 feet radio altitude or 20 seconds after lift-off, whichever occurs first, or if takeoff thrust not selected on both engines. If rejected takeoff initiated above 80 knots, inhibit continues until airspeed is less than 75 knots.
New PWS caution alerts	Messages are inhibited	80 knots airspeed	400 feet radio altitude.
New PWS warning alerts	Messages are inhibited	100 knots airspeed	50 feet radio altitude.
New red ENG FAIL on both PFDs New ENG FAIL on both HUDs	EICAS caution message ENG THRUST L, R	Six knots before V1	Landing.
Master WARNING lights	New EICAS warning messages	V1 or rotation,	400 feet radio altitude or 25 seconds

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
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 sounds when the inhibit ends.	FIRE displayed during inhibit.	whichever occurs first.	after inhibit began, whichever occurs first.
Master WARNING lights Siren If the Master WARNING lights illuminate and siren sounds before reaching V1, they continue to be illuminated and sound when V1 is exceeded If new EICAS warning messages are displayed during the inhibit, the siren sounds when the inhibit ends.	New EICAS warning messages displayed during inhibit, except FIRE	V1 or rotation, whichever occurs first.	400 feet radio altitude or 25 seconds after inhibit began, whichever occurs first.
EICAS warning messages CONFIG for takeoff configuration warnings	Messages are inhibited	V1 or rotation, whichever occurs first.	Landing.
Master WARNING lights Siren	EICAS warning message CONFIG GEAR for landing configuration warnings.	Gear unlock for retraction	800 feet radio altitude or 140 seconds after inhibit began, whichever occurs first.
All PWS alerts	Messages are inhibited	Above 1,200 feet radio altitude	Below 1,200 feet radio altitude.

Alerts Inhibited During Landing

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
All PWS alerts	Alerts are inhibited	Above 1,200 feet radio altitude	Below 1,200 feet radio altitude.
TCAS INCREASE DESCENT RAs	Alerts are inhibited	Approximately 1,450 feet radio altitude	Go-around at approximately 1,650 feet radio altitude.
TCAS DESCEND RAs	Alerts are inhibited	Approximately 1,000 feet radio altitude	Go-around at approximately 1,200 feet radio altitude.
All TCAS RAs	Alerts are inhibited When RA selected on panel, TCAS switches automatically to TA only mode and TCAS message TA ONLY is displayed on the NDs and mini-maps	Approximately 1,000 feet radio altitude	Go-around at approximately 900 feet radio altitude.
All EICAS communication messages, except: CABIN ALERT	Messages are inhibited	800 feet radio altitude	75 knots airspeed.
STATUS cue	All EICAS status messages	800 feet radio altitude	75 knots airspeed.
TCAS voice alerts	TCAS TAs	Approximately 400 feet radio altitude	Go-around at approximately 600 feet radio altitude.
EICAS alert message WINDSHEAR SYS	Message is inhibited	400 feet radio altitude	80 knots airspeed.
New PWS caution alerts	Alerts are inhibited	400 feet radio altitude	80 knots airspeed.
Master CAUTION lights Beeper	All EICAS caution messages, except: AUTOPILOT	LAND 2 or LAND 3	75 knots airspeed, or 40 seconds elapse, or 800 feet radio altitude.

Alert Inhibited	For Message	Inhibit Begins	Inhibit Ends
	AUTOTHROTTLE DISC SPEEDBRAKE EXTENDED	displayed on PFD, and 200 feet radio altitude	
New PWS warning alerts	Alerts are inhibited	50 feet radio altitude	100 knots airspeed.

AURAL CANCEL Switch

An AURAL CANCEL momentary action switch located on the Alerting and Transponder Control Panel enables the flight crew to cancel any active false or nuisance aural alert.

The aural alert remains canceled as long as the condition causing the alert remains active. When the condition that caused the alert is no longer active, the canceling function resets. If the same condition becomes active again, the aural alert will sound again. Subsequent aural alerts for other fault conditions are not affected, and need to be canceled separately, if necessary.

An amber CANCEL light illuminates and an EICAS advisory message AURAL CANCELED shows to indicate an aural alert is being canceled. The light and message extinguish when the aural alert is no longer being canceled. The aural cancel function resets for all conditions when the airplane is on the ground and both engines are shutdown, or when airplane power is cycled Off and then On.

In the event the Alerting and Transponder Control Panel fails, the Tuning Control Panel provides a backup AURAL CANCEL soft key.

For additional information:

- See Aural Cancel Switch (Alerting and Transponder Control Panel) on page 15.10.10
- See Aural Cancel Control (Tuning and Control Panel) on page 15.10.11.

EICAS Event Record

Pushing the EICAS EVENT RCD switch records currently displayed engine indications and additional EICAS maintenance information. Up to five events may be recorded by the first five pushes. The system also records out of limit parameters and related conditions automatically when a system parameter is exceeded.

Warning Systems EICAS Messages

The following EICAS messages can be displayed.

Airspeed

Message	Level	Aural	Condition
AIRSPEED LOW	Caution	Beeper	Airspeed is less than minimum maneuvering speed.
OVERSPEED	Warning	Siren	Airspeed is more than Vmo/Mmo.

Altitude Alert and GPWS

Message	Level	Aural	Condition
ALTITUDE ALERT	Caution	Beeper	A deviation from the MCP set altitude occurs.
ALTITUDE CALLOUTS	Advisory		Altitude and minimums voice callouts during approach are not available.
GND PROX SYS	Advisory		A ground proximity warning system fault occurs.
GPWS FLAP OVRD	Advisory		The GPWS flap override is set to OVRD.
GPWS GEAR OVRD	Advisory		The GPWS gear override is set to OVRD.
GPWS TERR OVRD	Advisory		The GPWS terrain override is set to OVRD.
G/S ALERT INHIBITED	Memo		The flight crew has inhibited the Glideslope aural warning.
TERR POS	Advisory		Terrain position data is lost.
WINDSHEAR SYS	Advisory		A windshear system fault occurs.

Configuration

Message	Level	Aural	Condition
CONFIG DOORS	Warning	Siren	An entry, forward cargo, or aft cargo door is not closed and latched and locked during takeoff.

Message	Level	Aural	Condition
CONFIG FLAPS	Warning	Siren	The flaps are not in a takeoff position during takeoff.
CONFIG GEAR	Warning	Siren	A landing gear is not down and locked and one of these occurs: • below 800 feet radio altitude and a thrust lever is at idle • the flaps are in a landing position.
CONFIG PARKING BRAKE	Warning	Siren	The parking brake is set during takeoff.
CONFIG RUDDER	Warning	Siren	Rudder trim is not centered during takeoff.
CONFIG SPOILERS	Warning	Siren	The speedbrake lever is not down during takeoff.
CONFIG STABILIZER	Warning	Siren	The stabilizer is not in the greenband during takeoff.
CONFIG WARNING SYS	Advisory		A configuration warning system fault occurs.

Pilot Response

Message	Level	Aural	Condition
AURAL CANCELED	Advisory		The crew canceled the aural alert.
PILOT RESPONSE	Advisory		Pilot action is not detected during a specified time.

Tailstrike

Message	Level	Aural	Condition
TAIL STRIKE	Caution	Beeper	The tail hits the runway.

TCAS

Message	Level	Aural	Condition
TCAS	Advisory		TCAS is failed.
TCAS OFF	Advisory		TCAS modes TA or TA/RA are not selected.
TCAS RA CAPTAIN, F/O	Advisory		TCAS cannot show RA guidance on the affected PFD and HUD.