



WARNING

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737-300/ -400/ -500

Flight Crew
Operations Manual

The Boeing Company

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Preface

Model Identification

Chapter 0

Section 1

General

The airplanes listed in the table below are covered in the Flight Crew Operations Manual (FCOM). The table information is used to distinguish data peculiar to one or more, but not all of the airplanes. Where data applies to all airplanes listed, no reference is made to individual airplanes.

Airplane number is supplied by the operator. Registry number is supplied by the national regulatory agency. Serial and tabulation number are supplied by Boeing.

Airplane Number	Registry Number	Serial Number	Tab Number	Model Miscellaneous Data
1	BE300	BE300	BE300	737-300
2	BE400	BE400	BE400	737-400
3	BE500	BE500	BE500	737-500

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Preface

Introduction

Chapter 0

Section 2

General

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

- provide the necessary operating limitations, procedures, performance, and systems information the flight crew needs to safely and efficiently operate the 737 airplane during all anticipated airline operations
- serve as a comprehensive reference for use during transition training for the 737 airplane
- serve as a review guide for use in recurrent training and proficiency checks
- provide necessary operational data from the FAA approved airplane flight manual (AFM) to ensure that legal requirements are satisfied
- establish standardized procedures and practices to enhance Boeing operational philosophy and policy.

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

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

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

This manual is structured in a two volume format with a quick reference handbook (QRH). Volume 1 includes operational limitations, normal procedures, supplementary procedures, dispatch performance data, and inflight performance data. Volume 2 contains systems information. The QRH contains all checklists necessary for normal and non-normal procedures as well as inflight performance data.

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

This manual 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 FCOM does not contain basic flight information that is considered prerequisite training.

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

Boeing Commercial Airplanes

Commercial Aviation Services

Attn: 737 Manager, Flight Technical Data

P. O. Box 3707, M/C 20-89

Seattle, Washington 98124-2207 USA

E-mail: FlightTraining@Boeing.com

Telephone: (206) 662-4000

Fax: (206) 662-4743

Organization

The FCOM is organized in the following manner.

Volume 1

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

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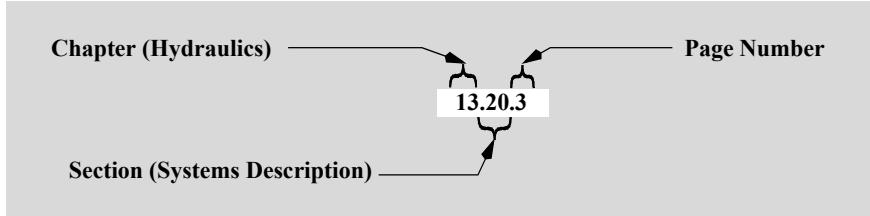
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Quick Reference Handbook (QRH) – The QRH covers normal checklists, non-normal checklists, operational information, performance information necessary for inflight use (PI) on an expedited basis, and maneuvers.

Page Numbering

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

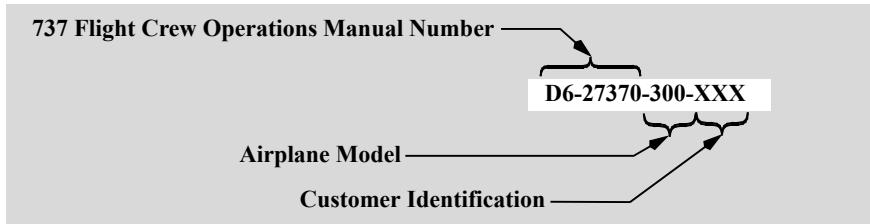
Example Page Number



Page Identification

Each page is identified by a customer document number and a page date. The customer document number is composed of the general 737 FCOM number, D6-27370-, and is followed by the customer identification. The page date is the date of publication of the manual or the most recent revision date.

Example Page Identification



Warnings, Cautions, and Notes

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

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

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

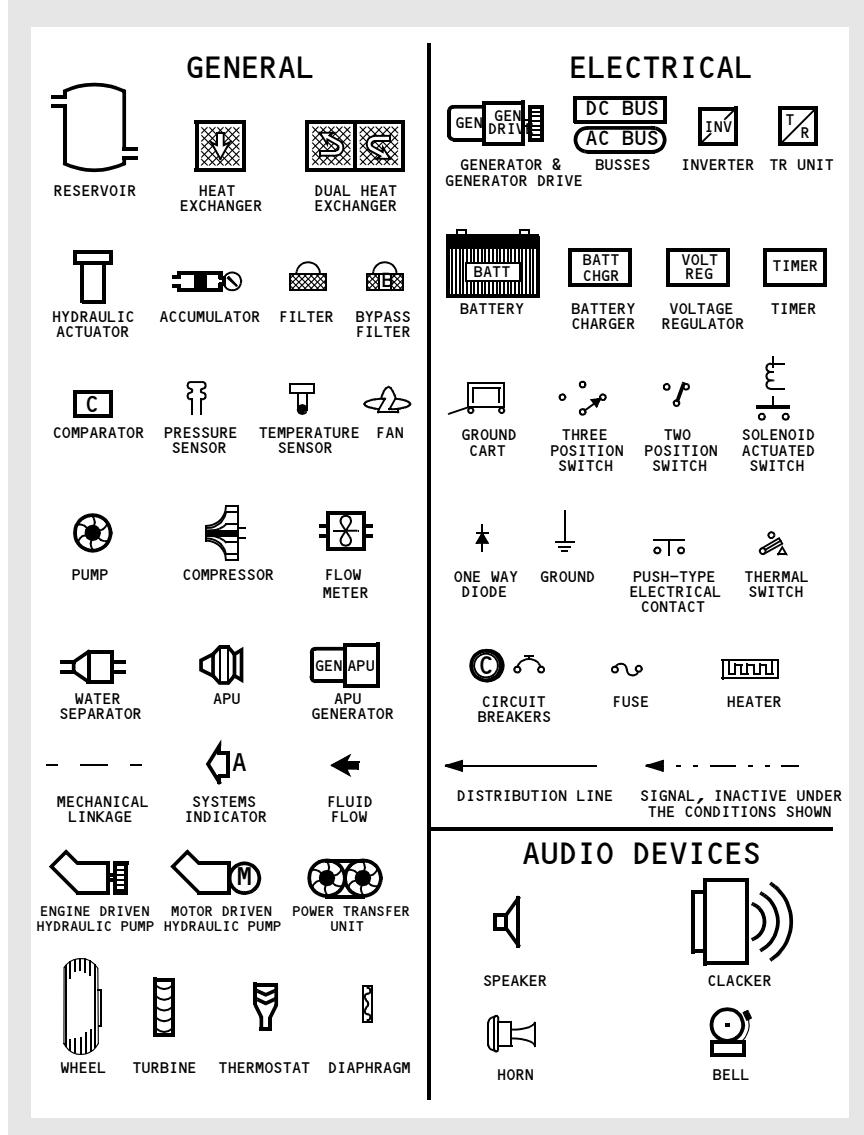
Note: An operating procedure, technique, etc., considered essential to emphasize. Information contained in notes may also be safety related.

Flight Crew Operations Manual Configuration

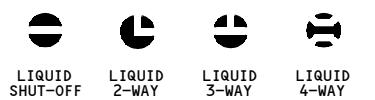
Customer airplane configuration determines the data provided in this manual. The Boeing Company keeps a list of each airplane configuration as it is built and modified through the service bulletin process. The FCOM does not reflect customer originated modifications without special contract provisions.

Schematic Symbols

Symbols shown are those which may not be identified on schematic illustrations.



VALVES



LIQUID
SHUT-OFF



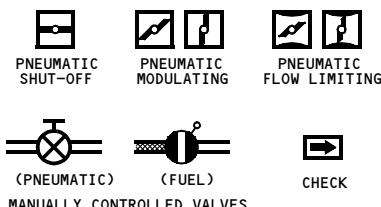
LIQUID
2-WAY



LIQUID
3-WAY



LIQUID
4-WAY



PNEUMATIC
SHUT-OFF



PNEUMATIC
MODULATING



PNEUMATIC
FLOW LIMITING



(PNEUMATIC)

(FUEL)



CHECK



SHUTTLE



REMOTELY
CONTROLLED
RELIEF

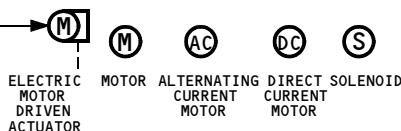


RELIEF



REGULATED
RELIEF &
BYPASS

MOTORS AND SOLENOIDS



ELECTRIC
MOTOR
DRIVEN
ACTUATOR



MOTOR



ALTERNATING
CURRENT
MOTOR

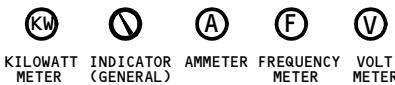


DIRECT
CURRENT
MOTOR



SOLENOID

INDICATORS



KILOWATT
METER



INDICATOR
(GENERAL)



AMMETER



FREQUENCY
METER



VOLT
METER

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Preface

Abbreviations

Chapter 0

Section 3

General

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

A	
AC	Alternating Current
ACARS	Aircraft Communications Addressing and Reporting System
ACP	Audio Control Panel
ACT	Active
ADF	Automatic Direction Finder
ADM	Air Data Module
AED	Automatic External Defibrillator
AFDS	Autopilot Flight Director System
AFM	Airplane Flight Manual (FAA approved)
AGL	Above Ground Level
AI	Anti-Ice
AIL	Aileron
ALT	Altitude
ALTN	Alternate
AM	Amplitude Modulation
ANP	Actual Navigation Performance
ANT	Antenna
AOA	Angle of Attack

A/P	Autopilot
APP	Approach
APU	Auxiliary Power Unit
ARINC	Aeronautical Radio, Incorporated
ARPT	Airport
ARTE	Above Runway Threshold Elevation
A/T	Autothrottle
ATA	Actual Time of Arrival
ATC	Air Traffic Control
ATT	Attitude
AUTO	Automatic
AVAIL	Available
B	
BARO	Barometric
BRT	Bright
BTL DISCH	Bottle Discharge (fire extinguishers)
B/C	Back Course
C	
C	Captain Celsius Center

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CAA/JAA	Civil Aviation Authority/Joint Aviation Authority	EGPWS	Enhanced Ground Proximity Warning System
CANC/RCL	Cancel/Recall	EGT	Exhaust Gas Temperature
CB	Circuit Breaker	ELEC	Electrical
CDU	Control Display Unit	ELEV	Elevator
CG	Center of Gravity	ENG	Engine
CHKL	Checklist	EXEC	Execute
CLB	Climb	EXT	Extend
COMM	Communication	E/E	Electrical and Electronic
CON	Continuous	F	
CONFIG	Configuration	F	Fahrenheit
CRZ	Cruise	FCTL	Flight Control
CTL	Control	F/D or FLT DIR	Flight Director
D		FMC	Flight Management Computer
DC	Direct Current	FMS	Flight Management System
DDG	Dispatch Deviations Guide	F/O	First Officer
DEP ARR	Departure Arrival	FPA	Flight Path Angle
DES	Descent	FPV	Flight Path Vector
DISC	Disconnect	G	
DME	Distance Measuring Equipment	GA	Go-Around
DSPL	Display	GEN	Generator
E		GPS	Global Positioning System
E/D	End of Descent	GPWS	Ground Proximity Warning System
EEC	Electronic Engine Control	G/S	Glide Slope
EFIS	Electronic Flight Instrument System	H	
		HDG	Heading

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Preface -
Abbreviations

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HDG REF	Heading Reference	MEL	Minimum Equipment List
HDG SEL	Heading Select	MIN	Minimum
HPA	Hectopascals	MMO	Maximum Mach Operating Speed
HUD	Head-Up Display	MOD	Modify
I		MTRS	Meters
IAS	Indicated Airspeed	N	
IDENT	Identification	NAV RAD	Navigation Radio
IN	Inches	ND	Navigation Display
IND LTS	Indicator Lights	NM	Nautical Miles
ILS	Instrument Landing System	NORM	Normal
INBD	Inboard	N1	Low Pressure Rotor Speed
INOP	Inoperative	N2	High Pressure Rotor Speed
INTC CRS	Intercept Course	O	
ISLN	Isolation	OHU	Overhead Unit
K		OVHD	Overhead
K	Knots	OVRD	Override
KGS	Kilograms	P	
L		PASS	Passenger
L	Left	PERF INIT	Performance Initialization
LBS	Pounds	PF	Pilot Flying
LDG ALT	Landing Altitude	PFC	Primary Flight Computers
LIM	Limit	PM	Pilot Monitoring
LNAV	Lateral Navigation	PNL	Panel
M		POS	Position
MAG	Magnetic	POS INIT	Position Initialization
MAN	Manual	PRI	Primary
MCP	Mode Control Panel		
MDA	Minimum Descent Altitude		

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PWS	Predictive Windshear System	TDZE	Touch Down Zone Elevation
R			T/D
R	Right	TFC	Traffic
RA	Radio Altitude Resolution Advisory	THR HOLD	Throttle Hold
RECIRC	Recirculation	TO	Takeoff
REF	Reference	TO/GA	Takeoff/Go-Around
RET	Retract	U	
RF	Refill	UPR DSPL	Upper Display
RNP	Required Navigation Performance	UTC	Universal Time Coordinated
RVSM	Reduced Vertical Separation Minimum	V	
S			VA
S/C	Step Climb	VMO	Maximum Operating Speed
SEL	Select	VNAV	Vertical Navigation
SPD	Speed	VOR	VHF Omnidirectional Range
STA	Station	VR	Rotation Speed
STAB	Stabilizer	VREF	Reference Speed
STAT	Status	VTK	Vertical Track
STD	Standard	V/S	Vertical Speed
T			V1
T or TRU	True	V2	Takeoff Decision Speed
T or TK or TRK	Track	W	
TA	Traffic Advisory	WPT	Waypoint
TAT	Total Air Temperature	WXR	Weather Radar
TCAS	Traffic Alert and Collision Avoidance System	X	
		XTK	Cross Track

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Preface

Revision Record

Chapter 0

Section 4

Revision Transmittal Letter

To: All holders of The Boeing Company 737 Flight Crew Operations Manual (FCOM), Boeing Document Number D6-27370-400E-TBCE.

Subject: Flight Crew Operations Manual Revision.

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

Revision Record

No.	Revision Date	Date Filed	No.	Revision Date	Date Filed
0	February 13, 1998		1	June 12, 1998	
2	December 4, 1998		3	June 11, 1999	
4	December 3, 1999		5	June 9, 2000	
6	December 1, 2000		7	June 8, 2001	
8	December 7, 2001		9	June 7, 2002	
10	December 6, 2002		11	June 6, 2003	
12	December 5, 2003		13	June 4, 2004	
14	December 3, 2004		15	June 3, 2005	
16	December 2, 2005		17	June 9, 2006	
18	December 8, 2006		19	June 8, 2007	
20	December 7, 2007		21	August 18, 2008	
22	December 5, 2008		23	June 12, 2009	
24	December 4, 2009		25	June 18, 2010	

General

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

The revision date is the approximate date the manual is approved for printing. The revision is mailed a few weeks after this date.

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

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

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

Filing Instructions

Consult the List of Effective Pages (0.5). Pages identified with an asterisk (*) are either replacement pages or new (original) issue pages. Remove corresponding old pages and replace or add new pages. Remove pages that are marked DELETED; there are no replacement pages for deleted pages.

Be careful when inserting changes not to throw away pages from the manual that are not replaced. Using the List of Effective Pages (0.5) can help determine the correct content of the manual.

Revision Highlights

This section (0.4) replaces the existing section 0.4 in your manual.

Throughout the manual, airplane effectiveness may be updated to reflect coverage as listed on the Preface - Model Identification page, or to show service bulletin airplane effectiveness. Highlights are not supplied.

This manual is published from a database; the text and illustrations are marked with configuration information. Occasionally, because the editors rearrange the database markers, or mark items with configuration information due to the addition of new database content, some customers may receive revision bars on content that appears to be unchanged. Pages may also be republished without revision bars due to slight changes in the flow of the document.

Chapter NP - Normal Procedures

Section 21 - Amplified Procedures

Descent Procedure

NP.21.40 - Deleted a line that was added to the Descent Procedure by error.

Chapter SP - Supplementary Procedures

Section 11 - Flight Management, Navigation

Flight Management

SP.11.13 - Made changes for readability and simplification.

Section 15 - Warning Systems

Ground Proximity Warning System (GPWS) Test

SP.15.1 - Re-instated the Ground Proximity Warning System (GPWS) test, previously included in the Flight Deck Preparation - First Officer normal procedure, as a supplementary procedure.

Chapter PD - Performance Dispatch

Section 10 - Table of Contents

PD.TOC.10.1 - 737-300 CFM56-3_22K KG FAA was added as Section 10.

Section 20 - Table of Contents

PD.TOC.20.1 - 737-400 CFM56-3_23.5K KG FAA was added as Section 20.

Section 22 - Landing

Landing Field Limit Weight - Dry Runway

PD.22.1 - Revised manual speedbrakes correction.

Landing Field Limit Weight - Wet Runway

PD.22.4 - Revised manual speedbrakes correction.

Section 30 - Table of Contents

PD.TOC.30.1 - 737-500 CFM56-3_20K KG FAA was added as Section 30.

Chapter PI - Performance Inflight

Section 10 - Table of Contents

PI.TOC.10.1 - 737-300 CFM56-3_22K KG FAA was added as Section 10.

Section 10 - General

General

PI.10.1 - 737-300 CFM56-3_22K KG FAA was added as Section 10.

Section 20 - Table of Contents

PI.TOC.20.1 - 737-400 CFM56-3_23.5K KG FAA was added as Section 20.

Section 22 - Advisory Information

Non-Normal Configuration Landing Distance

PI.22.4-11 - Revised Non-Normal Configuration Landing Distance Data.
New data include Slope and Approach Speed Adjustments. Also changed the weight Reference Distance is based on to match reference weight of preceding Normal Configuration Landing Distance Data.

Section 30 - Table of Contents

PI.TOC.30.1 - 737-500 CFM56-3_20K KG FAA was added as Section 30.

Section 32 - Advisory Information

Non-Normal Configuration Landing Distance

PI.32.4-11 - Revised Non-Normal Configuration Landing Distance Data.
New data include Slope and Approach Speed Adjustments. Also changed the weight Reference Distance is based on to match reference weight of preceding Normal Configuration Landing Distance Data.

Chapter 10 - Flight Instruments, Displays

Section 30 - Electronic Flight Instrument System (EFIS)

EFIS Control Panel

10.30.3 - Added ADF pointer head and tail text to the VOR/ADF description for clarification.

Section 30 - Electronic Flight Instrument System

Center MAP Mode

10.30.18 - Corrected Center MAP Full Rose display illustration to eliminate erroneous callout pointer, and added Track-Up Full Rose label..

EHSI System Failure Flags and Annunciations

10.30.55 - Added EHSI System Failure Flags and Annunciations for EFIS Control Panel's 312 or 352 by configuration.

10.30.55 - Added EHSI Failure Flags and Annunciations illustration for EFIS Control Panel -352 with "as installed" RNP annunciation by configuration.

Section 40 - EFIS System Description

EFIS Control Panel

10.40.9-10 - Added EFIS Control Panel selectable display modes description by configuration.

10.40.9 - Added text for mixed fleet configuration.

10.40.10 - Deleted EFIS Control Panel text description by configuration.

FULL and EXP NAV Modes (as installed)

10.40.10 - Added FULL and EXP NAV Modes (as installed) title to reflect mixed fleet configuration.

10.40.10 - Deleted pure fleet FULL and EXP NAV Modes title due to mixed fleet configuration.

Chapter 11 - Flight Management, Navigation

Section 60 - FMC/CDU Messages

FMC Alerting Messages

11.60.4 - Revised GPS Invalid alert.

11.60.5 - Added GPS Invalid alert for dual GPS.

Chapter 14 - Landing Gear

Section 20 - System Description

Nose Wheel Steering

14.20.3 - Revised nose wheel steering description for clarification.

Chapter 15 - Warning Systems

Section 10 - Controls and Indicators

Takeoff Configuration and Cabin Altitude Warning Lights

15.10.3 - Added T/O Configuration and Cabin Altitude Warning Lights, as installed.

Section 20 - System Description

Intermittent Cabin Altitude/Configuration Warning

15.20.5 - Paragraph added for clarification of warning.

15.20.5 - Added Takeoff Configuration and Cabin Altitude warning lights, as installed.

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V1V2 List of Effective Pages

Chapter 0

Section 5

Page	Date	Page	Date
Volume 1			
* Title Page	June 18, 2010	Normal Procedures (cont)	
* Copyright	June 18, 2010	NP.11.6-7	December 5, 2008
0.TOC.0.1-2	December 4, 2009	NP.11.8	June 9, 2006
* 0.1.1-2	June 18, 2010	NP.21.1-5	June 12, 2009
0.2.1	June 12, 2009	NP.21.6-7	August 18, 2008
* 0.2.2-3	June 18, 2010	NP.21.8-27	June 12, 2009
0.2.4	December 4, 2009	NP.21.28	December 4, 2009
0.2.5-6	August 18, 2008	NP.21.29-34	June 12, 2009
0.3.1-4	August 18, 2008	NP.21.35-38	December 4, 2009
Revision Record (tab)			
* 0.4.1-6	June 18, 2010	NP.21.39	June 12, 2009
List of Effective Pages			
* 0.5.1-10	June 18, 2010	* NP.21.40	June 18, 2010
Bulletins (tab)			
* 0.6.1-2	June 18, 2010	NP.21.41-42	June 12, 2009
* 0.6.3-4	Deleted	NP.21.43-44	December 4, 2009
Limitations (tab)			
L.TOC.0.1-2	August 18, 2008	NP.21.45	June 12, 2009
L.10.1-2	December 8, 2006	NP.21.46-47	December 4, 2009
L.10.3-5	December 7, 2007	NP.21.48	June 12, 2009
L.10.6	December 5, 2008	NP.21.49-50	December 4, 2009
L.10.7-8	August 18, 2008	NP.21.51-52	June 12, 2009
Normal Procedures (tab)			
NP.TOC.0.1-2	December 4, 2009	NP.21.53-56	December 4, 2009
* NP.11.1-4	June 18, 2010	Supplementary Procedures (tab)	
NP.11.5	August 18, 2008	* SP.TOC.0.1-6	June 18, 2010
		SP.05.1	December 5, 2008
		SP.05.2	December 1, 2000
		SP.1.1	June 6, 2003
		SP.1.2	June 4, 2004
		SP.1.3-6	August 18, 2008
		SP.1.7-8	December 5, 2008
		SP.2.1	June 4, 2004
		SP.2.2	June 12, 2009

* = Revised, Added, or Deleted

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Supplementary Procedures (cont)		Supplementary Procedures (cont)	
SP.2.3-6	June 4, 2004	SP.16.5-22	June 12, 2009
SP.2.7	August 18, 2008	Performance - Dispatch (tab)	
SP.2.8	June 12, 2009	PD.TOC.1-2	August 18, 2008
SP.2.9	December 4, 2009	* PD.TOC.10.1-2	June 18, 2010
SP.2.10	August 18, 2008	PD.10.1-6	June 3, 2005
SP.3.1	June 4, 2004	PD.11.1-8	June 3, 2005
SP.3.2	December 2, 2005	PD.11.9-12	December 5, 2008
SP.4.1	December 8, 2006	PD.12.1-2	June 3, 2005
SP.4.2-6	December 4, 2009	PD.12.3-4	December 2, 2005
* SP.5.1-2	June 18, 2010	PD.12.5	June 9, 2006
SP.6.1	June 9, 2006	PD.12.6-8	December 2, 2005
SP.6.2	June 8, 2007	PD.13.1-3	August 18, 2008
SP.6.3-5	August 18, 2008	PD.13.4-5	June 12, 2009
SP.6.6	June 8, 2007	PD.13.6	June 3, 2005
SP.7.1	August 18, 2008	* PD.TOC.20.1-2	June 18, 2010
SP.7.2-5	June 12, 2009	PD.20.1-8	December 2, 2005
SP.7.6-8	August 18, 2008	PD.21.1-8	June 3, 2005
SP.8.1	August 18, 2008	PD.21.9-12	December 5, 2008
SP.8.2	December 1, 2000	* PD.22.1	June 18, 2010
* SP.10.1-2	June 18, 2010	PD.22.2-3	June 3, 2005
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* SP.11.5-22	June 18, 2010	PD.22.5-6	June 3, 2005
SP.12.1	December 8, 2006	PD.22.7	June 9, 2006
SP.12.2-3	December 2, 2005	PD.22.8	December 8, 2006
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* SP.15.1-2	June 18, 2010	PD.23.1-3	August 18, 2008
SP.16.1	June 12, 2009	PD.23.4-5	June 12, 2009
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SP.16.3	June 12, 2009	* PD.TOC.30.1-2	June 18, 2010
SP.16.4	December 4, 2009	PD.30.1-8	December 2, 2005

* = Revised, Added, or Deleted

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Page	Date	Page	Date
Performance - Dispatch (cont)			
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737 Flight Crew Operations Manual

Preface

Bulletin Record

Chapter 0

Section 6

General

The Boeing Company issues flight crew operations manual bulletins as required. Bulletins transmit temporary information which must be issued before the next formal revision to the flight crew operations manual or information of interest to all operators.

Bulletins are numbered sequentially for each operator. Each new bulletin is recorded in this record when received and filed as instructed. A bulletin may not apply to all airplane models. When appropriate, the next formal flight crew operations manual revision will include an updated bulletin record page.

Bulletin status is defined as follows:

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

The record below should be accomplished by the person revising the material.

Number	Subject	Ref. No. (CS3-)	Date	Status
TBCE-1	EFIS Display Blanking		06-16-1995	IE
TBCE-2	Standby Horizon Indicator Display		06-16-1995	IE
TBCE-3	Nonselected MCP Setting Changes		06-16-1995	IE
TBCE-4	Auxiliary Power Unit (APU) Starting		06-16-1995	IE
TBCE-5	BLEED TRIP OFF Light Illuminating During A No Engine Bleed Takeoff		06-16-1995	IE
TBCE-6 R1	Runaway Stabilizer Procedure		09-20-1995	IE

Number	Subject	Ref. No. (CS3-)	Date	Status
TBCE-12	Maneuvering Speeds for 737-100/200/300/400/500		12-03-1999	IE
TBCE-16 R1	Trailing Edge Flaps - Outboard Flap Carriage Spindle Fractures	3494	02-01-2005	IE
TBCE-18	Main Landing Gear (MLG) Actuator Beam Fracture and/or MLG Actuator Beam Arm Fracture	3517	03-22-2005	IE
TBCE-24	FMC Lockup with Selection of a Standard Instrument Departure (SID) on Missed Approach (FMC Update U10.0 and later)	3973	01-11-2008	IE
TBCE-25 R1	Cabin Altitude Warning Indications and Procedures Briefing	4125	06-15-2009	IE
TBCE-26	Instrument Approach Procedures with an FMC Missed Approach Altitude Constraint Above 10,000 feet MSL	4254	04-27-2009	IE
TBCE-27	Inflight Elevator Tab Vibration	4280	06-16-2009	IE
TBCE-29	VNAV Not to Be Used for Approach Operations with FMC Update U10.8 Installed	4322	07-01-2009	IE



Flight Crew Operations Manual Bulletin for The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207



737

Number: TBCE-1

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: EFIS Display Blanking

Reason: This bulletin provides information contained in Red Bulletin 737-300 87-6R1, dated April 15, 1992, which advised flight crews of possible EFIS display blanking as a result of momentary power interruption.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Several operators reported occurrences of EFIS Display Unit blanking. The problem was noted upon the application of electrical power following a power interruption (such as an electrical bus transfer).

The EFIS Display Unit blanking is due to a software error in the EFIS Symbol Generator and it is triggered when loss of cooling is sensed during a momentary power interruption (intentional or failure-associated). The likelihood of blanking is higher during ground operations, since power interruptions are more frequent, but the possibility of blanking in flight exists as a result of an engine loss, generator failure, or intentional bus transfer. If blanking occurs, the display will remain blank until corrective action is taken.

Display Unit blanking occurs only infrequently and normal operation is always regainable by cycling the EFIS Instrument Transfer Switch on the forward overhead panel. Service Bulletin 737-34-1220 was issued to eliminate the problem.

Until incorporation of Service Bulletin 737-34-1220 is completed, the following procedure is recommended.

To restore normal operation if EFIS Display Unit blanking occurs following a momentary power interruption, cycle the EFIS Instrument Transfer Switch on the forward overhead panel (i. e., move the switch from NORMAL to BOTH ON 1 or BOTH ON 2, then return to NORMAL).

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-1 "IN EFFECT" (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified that all affected airplanes in the operator's fleet have been modified by Boeing Service Bulletin 737-34-1220. If the operator does not plan to modify all the airplanes and would like to have the contents of this Bulletin incorporated in the Operations Manual, please advise Boeing accordingly.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
 Commercial Aviation Services
 ATTN: 737 Manager, Flight Technical Data
 P. O. Box 3707, M/C 20-89
 Seattle, Washington 98124-2207 USA

Email: flighttraining@boeing.com
Telephone: (206) 662-4000
Fax: (206) 662-4743



Flight Crew Operations Manual Bulletin for The Boeing Company

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



737

Number: TBCE-2

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: Standby Horizon Indicator Display

Reason: This bulletin provides information contained in Red Bulletin 737-300 88-9R1, dated April 15, 1992, which advised flight crews of a Localizer Pointer display anomaly when a VOR is tuned.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

The Standby Horizon Indicator can display misleading information when the #1 VHF NAV radio is tuned to a VOR frequency and the Standby Horizon Indicator ILS selector is tuned to ILS or BCRS. Under these conditions the localizer pointer will show an inaccurate display and the Localizer Flag will NOT come into view. An inappropriate course correction may result.

Corrective action requires an airplane wiring change and a modification to the Standby Horizon Indicator. Boeing Service Bulletin 737-34-1244 was issued to address these changes.

Until modifications are complete, to prevent incorrect interpretation of the information displayed on the Standby Horizon Indicator, the ILS selector should normally be left in the OFF position. The selector should be moved from the OFF position only when an ILS, Localizer, or Localizer Backcourse approach is made. If an approach is made, the flight crew must verify that the VHF navigation radio is tuned to the correct frequency by aurally identifying the station prior to commencing the approach.

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-2 "IN EFFECT" (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified that all affected airplanes in the operator's fleet have been modified by Boeing Service Bulletin 737-34-1244. If the operator does not plan to modify all the airplanes and would like to have the contents of this Bulletin incorporated in the Operations Manual, please advise Boeing accordingly.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
Commercial Aviation Services
ATTN: 737 Manager, Flight Technical Data
P. O. Box 3707, M/C 20-89
Seattle, Washington 98124-2207 USA

Email: flighttraining@boeing.com
Telephone: (206) 662-4000
Fax: (206) 662-4743



Flight Crew Operations Manual Bulletin for The Boeing Company

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



737

Number: TBCE-3

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: Nonselected MCP Setting Changes

Reason: This bulletin provides information contained in Red Bulletin 737-300 90-2R1, dated April 15, 1992, which advised flight crews that nonselected changes in MCP settings can occur on 737 airplanes equipped with SP-300 autopilots.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

There are several reported instances of nonselected changes in the ALT, IAS/MACH and/or V/S display windows on the SP-300 autopilot Mode Control Panel (MCP). Changes in altitude of more than 1000 feet have been reported.

Two causes for these undesired changes in the MCP were identified: inductively coupled transients (EMI) and electrical power interrupts.

The FAA issued an AD, 88-NM-115-AD, requiring, as an interim action, the following information to be incorporated into the Limitations Section of the FAA approved Airplane Flight Manual (AFM).

Boeing issued Service Bulletin 737-22A1098, dated January 17, 1991, to correct the conditions which caused nonselected changes in the MCP display windows.

NPRM 91-NM-215-AD was then issued directing the removal of the AFM limitation upon completion of the service bulletin.

Autopilot Limitations

For airplanes with SP-300 autopilot Mode Control Panel (MCP), flight crews must use the following procedures:

1. Check MCP settings after any electrical power interruptions.
2. Following change in ALT selection in the MCP window, check the ALT display to ensure desired altitude is displayed:
3. Closely monitor altitude during all altitude changes to ensure that the autopilot captures and levels off at the desired altitude.

NOTE: Standard "callouts," crew coordination, and cross-checking of MCP settings and flight instruments are necessary to detect any nonselected MCP display changes.

Recommended Operating Procedures

Until Service Bulletin 737-22A1098 is incorporated, flight crews should be made aware of the following recommended operating procedures:

UNCOMMANDDED MCP SETTING CHANGES

The MCP selected and displayed settings may change without command and with no alert warning.

Anytime electrical power is interrupted:

MCP Settings.....CHECK AND RESET AS
NECESSARY

Anytime the MCP selected altitude is changed:

MCP Altitude.....CHECK AND RESET AS
NECESSARY

Closely monitor the altimeter during all altitude changes to ensure the autopilot acquires and levels off at the correct altitude. Use standard callouts and crew coordination, and cross-check MCP settings with flight instruments to detect any uncommanded MCP changes.

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-3 "IN EFFECT" (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified that all affected airplanes in the operator's fleet have been modified by Service Bulletin 737-22A1098. If the operator does not plan to modify all the airplanes and would

Flight Crew Operations Manual Bulletin No. TBCE-3, dated June 16, 1995 (continued)

like to have the contents of this Bulletin incorporated in the Operations Manual, please advise Boeing accordingly.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
Commercial Aviation Services
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P. O. Box 3707, MS 20-89
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Flight Crew Operations Manual Bulletin for The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207



737

Number: TBCE-4

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: Auxiliary Power Unit (APU) Starting

Reason: This bulletin provides information contained in Red Bulletin 737-500 90-4R2, dated September 30, 1991, which advised flight crews of the requirement for a qualified ground observer to monitor subsequent starts following unsuccessful Auxiliary Power Unit (APU) ground start.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

On January 22, 1990 an operator of a Boeing Model 737 series airplane experienced significant fire damage to the empennage. The damaged area was reported to be the elevator, trim tab and tail cone. This damage was due to Auxiliary Power Unit (APU) torching following an unsuccessful first start attempt. A previous incident occurred on March 17, 1989. Empennage damage similar to that of the most recent incident was reported.

A torching APU start occurs when leftover fuel from a previous unsuccessful start attempt does not drain from the APU properly and ignites during a subsequent start attempt. When a torching start occurs, the accumulated fuel in the APU tailpipe is consumed and the APU operation is otherwise normal. If unburned fuel mist is blown back onto the empennage surfaces during the initial unsuccessful start attempt, it is possible that a fire on the external surfaces of the empennage could occur if torching occurred during the next start attempt.

The only means to detect the torching start and/or flames on the empennage surfaces is by an external observer. By the time the observer communicates to the

crew that a torching start has occurred, the excess fuel will most likely be consumed and the torching ceased. Unless the operator sees the evidence that a fire exists on the empennage surface, no other flight crew action is required except for a normal APU shutdown to allow the required inspections of the airplane surfaces.

If the observer sees fire on the airplane surfaces, the flight crew should advise the tower and request fire equipment. In this instance, the APU can be shut down either by normal procedures since the APU fire extinguishing system would not be effective to combat either the APU torching or the external surface fire.

Inflight starting of the APU is not impaired because the fuel vapors are carried away from the airplane. Torching of any leftover fuel in the APU exhaust area will not damage the airplane.

The Federal Aviation Administration (FAA) issued an Airworthiness Directive (AD) effective March 12, 1990 requiring that after an unsuccessful ground start the APU be placarded to prohibit ground operation or that any subsequent APU ground start attempts be monitored by a "qualified ground observer".

The Boeing Company designed a modified system to improve draining of leftover fuel after an unsuccessful APU start. These modifications are described under Administrative Information below.

Operating Instructions

For airplanes with unmodified APU drain systems, the following procedures apply:

1. Following any unsuccessful APU start attempt, the subsequent APU ground start attempt(s) must be monitored by a qualified ground observer to assure that the airplane is not damaged due to torching.
2. The placard may be removed and APU ground starting resumed without an observer following appropriate maintenance action to determine and resolve the cause of the unsuccessful ground start, or successful ground or inflight starting and operation is accomplished.

NOTE: Inflight starting and operating of the APU is not impacted by this action.

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-4 "IN EFFECT" (IE)

This Operations Manual Bulletin will be cancelled after Boeing is notified that all affected airplanes in the operator's fleet have been modified by one of the following methods:

1. Installation of a Garrett GTCP 85-129 APU with PRR 33890-86 incorporated (installs a modified drain system on airplanes at production line number 20161 and on).
 2. Incorporation of Service Bulletin 737-49-1073 (installs the modified drain system on airplanes delivered prior to incorporation of PRR 33890-86).
 3. Installation of the Sundstrand APS 2000 alternative APU (includes the modified drain system).
 4. Installation of the Garrett GTCP 36-280 alternative APU (includes the modified drain system).

The FAA has approved the above four options as acceptable means of compliance to the above Airworthiness Directive. If the operator does not plan to modify all of the airplanes and would like to have the content of this Bulletin incorporated in the Operations Manual, please advise Boeing accordingly.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
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Flight Crew Operations Manual Bulletin for The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207



737

Number: TBCE-5

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: BLEED TRIP OFF Light Illuminating During A No Engine Bleed Takeoff

Reason: This bulletin provides information contained in Red Bulletin 737-400 92-3R1, dated October 30, 1992, which informed flight crews that a BLEED TRIP OFF light may illuminate during a No Engine Bleed Takeoff.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Several operators reported that during a No Engine Bleed Takeoff the BLEED TRIP OFF light illuminated. The illumination occurs because a relief valve, specifically built into the pneumatic system to limit duct pressure upstream of the bleed valve during a No Engine Bleed Takeoff, does not have enough flow capacity to limit pressure in the duct below the overpressure switch activation point. Activation of the overpressure switch causes the BLEED TRIP OFF light to illuminate. The bleed system can be reset if duct pressure falls below the overpressure switch point. Duct pressure can be reduced by selecting the engine anti-ice ON.

A minimum altitude of 1500 feet AGL or when obstacle clearance height has been attained is established to maintain consistency with the existing Operations Manual Supplementary Normal No Engine Bleed Takeoff and Landing procedure and to minimize crew work load during the initial takeoff phase of flight.

The maximum TAT restriction set for anti-ice use to facilitate bleed trip reset was increased from 10°C (50°F) to 38°C (100°F). This increase is acceptable for this interim procedure due to the limited actuation time.

Service Bulletin 3214446-36-1575, released in January 1993, provided instructions for replacement of the current relief valve with a new higher capacity relief valve.

Operating Instructions

Until Service Bulletin 3214446-36-1575 is incorporated, the following operating instructions are recommended:

If the BLEED TRIP OFF light illuminates during a No Engine Bleed Takeoff and normal reset is not possible:

Accomplish the following at a minimum of 1500 feet (AGL) or when obstacle clearance height has been attained and TAT is 38°C (100°F) or below.

ENGINE ANTI-ICE SWITCH (Affected Side).....ON

TRIP RESET
SWITCH.....RESET

CABIN PRESSURIZATION
SYSTEM.....RECONFIGURE

Reset the cabin pressurization system to normal configuration.

ENGINE ANTI-ICE SWITCH(ES).....AS
REQUIRED

If the BLEED TRIP OFF light remains illuminated:

Accomplish the BLEED TRIP OFF Checklist.

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-5 "IN EFFECT" (IE)

This Operations Manual Bulletin will be cancelled after Boeing is notified that all affected airplanes in the operator's fleet have been modified by Service Bulletin 3214446-36-1575. If the operator does not plan to modify all the airplanes and would like to have the contents of this Bulletin incorporated in the Operations Manual, please advise Boeing accordingly.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

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Flight Crew Operations Manual Bulletin for The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207



737

Number: TBCE-6 R1

Date: September 20, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: Runaway Stabilizer Procedure

Reason: This is a reissue of TBCE-6, which notified operators of an intermittent stabilizer trim system anomaly and provided additional guidance when accomplishing the Runaway Stabilizer procedure. The purpose of this reissue is to provide service bulletin information and closing action for the OM bulletin.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Four operators have reported instances of excessive stabilizer trim system coasting (stabilizer trim wheel continues to rotate) after the control wheel stabilizer trim switches have been activated and released. The reports indicate that when the pilot released the trim switches, the stabilizer trim wheel coasted up to 40 turns (four units of trim). In some instances the trim wheel stopped moving in the commanded direction and then rotated up to 40 turns in the opposite direction.

The stabilizer trim main electric motor turns in only one direction. It drives the stabilizer trim actuator through two electro-magnetic clutches. One clutch is engaged for nose-up trim and the other is engaged for nose-down trim. Boeing examination of a suspect clutch showed that the reported coasting and/or reverse coasting of the stabilizer manual trim wheel was due to intermittent jamming of a clutch disc in one of the clutch assemblies. As a result, the electric motor will remain mechanically connected to the stabilizer trim mechanical actuator gear system after the control wheel stabilizer trim switches have been released.

With flaps down, the electric motor can continue to rotate up to 40 additional turns of the manual trim wheel after electrical power has been removed. With flaps up, manual trim wheel coasting is not significant because of the reduced trim motor speed. The autopilot trim system, which uses a motor that turns in either direction and drives the stabilizer trim through a single clutch, does not exhibit this problem.

Boeing Service Bulletin 737-27A1191, dated October 13, 1994, and revision dated November 3, 1994, provide instructions to replace the stabilizer trim electric actuator on the stabilizer trim control system.

Recommended Operating Procedures

The current Runaway Stabilizer procedure will effectively inhibit and limit an out of trim condition. Normal pilot reaction to a runaway stabilizer of opposing the runaway with main electric trim in addition to control column force will initially resolve a runaway. The Runaway Stabilizer Checklist recall action, "STABILIZER TRIM CUTOUT SWITCHES...CUTOUT" will isolate the malfunction if the runaway was caused by the main electric trim or autopilot trim systems. The stabilizer trim cutout switches only remove electrical power to the electric motors.

If the trim wheel continues to rotate after this action has been taken, the recall action "STABILIZER TRIM WHEEL....GRASP AND HOLD" will prevent further runaway or coasting. If the electric motor remains mechanically connected to the stabilizer trim mechanical actuator gear system because of a clutch malfunction, actuating the stabilizer trim cutout switches to cutout will not immediately stop the trim wheel rotation. Grasping the trim wheel will stop the rotation more quickly than allowing the trim wheel to coast to a stop, keeping the airplane more in trim.

In accordance with the procedure, trim the stabilizer manually for the remainder of the flight.

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-6 R1 "IN EFFECT" (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified that all affected airplanes in the operator's fleet have been modified by Boeing Service Bulletin 737-27A1191. If the operator does not plan to modify all the airplanes and would like to have the contents of this Bulletin incorporated in the Operations Manual, please advise Boeing accordingly.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

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Flight Crew Operations Manual Bulletin for The Boeing Company

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



737

Number: TBCE-12

Date: December 03, 1999

Document Effectivity: D6-27370-400E-TBCE

Subject: Maneuvering Speeds for 737-100/200/300/400/500

Reason: Revise the Boeing Recommended Maneuvering Speeds

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

In March 1999, the FAA released a Flight Standards Information Bulletin for Air Transportation (FSAT) number 99-2, titled "Maneuvering Speeds and Recovery Procedures for Boeing 737 Airplanes." The FSAT recommended that "For the interim period and prior to completion of fleet retrofit" (of a redesigned rudder power control unit (PCU) and the installation of both a digital yaw damper system and a rudder pressure reducer (RPR)), "that all Block Speeds for flap settings of UP, 1, 5, and 10...be increased by at least 10 knots and that these increased speeds be used in lieu of the published Block Speeds."

Boeing issued an Operations Manual Bulletin (OMB), dated May 28, 1999, that provided revised Block Speeds to be used in compliance with the FSAT pending installation of the RPR. Boeing also advised that analysis of crossover speeds with the RPR installed was in work, and upon completion of analysis updated Block Speeds would be provided. Boeing has completed this analysis. The purpose of this bulletin is to provide updated Block (maneuvering) Speeds for 737 airplanes with the RPR installed. This bulletin does not apply to the 737-600/700/800.

The maneuvering speeds recommended by Boeing are referred to as Block Speeds. Block Speeds are provided for a specific flap setting and a range of weights. The lateral-directional static balance speed has been referred to as

“crossover” speed. This is the airspeed that requires full lateral (roll) control from the ailerons and spoilers to counteract roll due to yaw caused by a full rudder input. At speeds slower than the crossover speed, with full rudder input, the roll induced by the rudder starts to exceed the lateral control authority.

The Rudder Pressure Reducer (RPR) lowers hydraulic pressure to the rudder PCU during non-critical phases of flight, thereby limiting the amount of rudder deflection. Reduced rudder deflection lowers the speed at which crossover may occur. The crossover speed is not a fixed speed but varies as a function of g load and CG. Reducing g load lowers the crossover speed. As described in the Uncommanded Yaw and Roll non-normal checklist, if uncommanded yaw or roll is experienced, maintain control of the airplane with all available flight controls. If roll is uncontrollable, immediately reduce pitch attitude (angle of attack) and increase speed. Unloading the airplane by decreasing back pressure on the control column improves roll control effectiveness.

Analysis of the effect of the RPR determined that Block Speed changes are not required for the 737-100/200 (see Table 1). Block Speed changes are only required for 737-300/400/500 flaps 5 and flaps 10 (see Table 2). For all other flap positions, the crossover speed is below the Block Speed, and a maneuvering airspeed adjustment is not required. Until the RPR is installed and is operable, the Block Speeds provided in Table 3 should be followed for all 737's.

Increasing Block Speeds during takeoff is not required due to the relatively short operating time at speeds below the crossover speed. In heavyweight return to land situations where the revised Block Speed is equal to the flap placard speed for the next flap position, Boeing recommends slowing below the Block Speed as necessary to protect the flap placard speed prior to flap extension. Airspeeds specified by non-normal procedures should be followed instead of Table 2 or Table 3 Block Speeds. If dispatch is required with the RPR inoperative, Boeing recommends using Table 3 speeds during approach maneuvering.

Speed tape equipped airplanes can use the “F” speeds for flap retraction. For approach operations using VNAV, speeds calculated by the FMC are based on gross weight and therefore may be below the Table 2 or Table 3 speeds. Pilots should use Speed Intervention mode (if installed) to follow the revised Block Speeds while remaining in VNAV. For airplanes without Speed Intervention, some other pitch mode is required for Block Speed compliance. FMC Update 10.3 will incorporate VNAV maneuvering speeds compatible with the crossover speeds with RPR operating.

Simulator software is available to incorporate revised aerodynamic data that more accurately model lateral-directional control static balance conditions. These updates are complete, and revised data are available for each 737 model by contacting Boeing Special Services Contract Manager at telephone 206-766-2418 or fax 425-237-1706.

Boeing, the FAA, and the NTSB conducted additional engineering simulator testing of the hypothetical rudder reversal and rate jams with the RPR installed. The NTSB was concerned that flight crews might believe a rudder jam or restriction was resolved and the non-normal procedure was complete if the rudder was centered by continuous rudder pedal pressure. After simulating this scenario it was agreed that it would be obvious to a flight crew that the procedure is not complete if the rudder centered but required significant rudder pedal force. As a result, the Jammed or Restricted Rudder non-normal procedure is not changed by installation of the RPR.

An airline industry team consisting of airplane manufacturers, regulators, and various airline operators developed an Airplane Upset Recovery Training Aid dated October, 1998. This document was sent to all airlines and provides an excellent source of information about recovery from an upset event regardless of the cause. We believe training in accordance with the Airplane Upset Recovery Training Aid would be more beneficial than training specifically for a full rudder deflection anomaly.

Operating Instructions

Tables 1 and 3 provide 737-100/200 Block Speeds to be used when the RPR is operating (Table 1) or when the RPR is not installed or not operating (Table 3). Tables 2 and 3 provide Block Speeds for the 737-300/400/500 to be used when the RPR is operating (Table 2) or when the RPR is not installed or not operating (Table 3).

Note: Operators with mixed fleets can use 737-300/400/500 tables for their 737-100/200's

Table 1
737-100/200 (With RPR installed (Service Bulletin 737-27A1206))

FLAP POSITION	UP TO 117,000 LBS (53,070 KGS)
FLAPS UP	210
FLAPS 1	190
FLAPS 5	170
FLAPS 10	160
FLAPS 15	150
FLAPS 25	140

Table 2

737-300/400/500 (With RPR installed (Service Bulletin 737-27A1206))

FLAP POSITION	UP TO 117,000 LBS (53,070 KGS)	ABOVE 117,000 LBS (53,070 KGS) UP TO 138,500 LBS (62,823 KGS)	ABOVE 138,500 LBS (62,823 KGS)
FLAPS UP	210	220	230
FLAPS 1	190	200	210
FLAPS 5	180	190	200
FLAPS 10	170	180	190
FLAPS 15	150	160	170
FLAPS 25	140	150	160

Table 3

737-100/200/300/400/500 (With RPR deactivated or not installed)

FLAP POSITION	UP TO 117,000 LBS (53,070 KGS)	ABOVE 117,000 LBS (53,070 KGS) UP TO 138,500 LBS (62,823 KGS)	ABOVE 138,500 LBS (62,823 KGS)
FLAPS UP	220	230	240
FLAPS 1	200	210	220
FLAPS 5	190	200	210
FLAPS 10	170	180	190
FLAPS 15	150	160	170
FLAPS 25	140	150	160

Administrative Information

This bulletin cancels Operations Manual Bulletin TBCE-11, dated May 28, 1999. Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the FCOM Bulletin Record to show bulletin TBCE-11 "CANCELLED" (CANC) and bulletin TBCE-12 "IN EFFECT" (IE).

This bulletin will be cancelled after Boeing is notified that all affected airplanes in your fleet have been modified by SB 737-27A1206.

The Block Speeds provided by this Operations Manual Bulletin will be incorporated in a future revision to the Operations Manual.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
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Flight Crew Operations Manual Bulletin for The Boeing Company

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



737

Number: TBCE-16 R1

Date: February 01, 2005

Document Effectivity: D6-27370-400E-TBCE

Subject: Trailing Edge Flaps - Outboard Flap Carriage Spindle Fractures

Reason: To inform flight crews of outboard trailing edge flap carriage spindle fractures that could cause mid-flap displacement with associated inflight roll-off. In addition, to inform flight crews to report any unexpected roll-off condition to maintenance. The purpose of this reissue is to amend the operating instruction.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Boeing has received reports of outboard mid-flap carriage spindle fractures from operators of 737-100 through -500 airplanes. Two carriage assemblies move on independent flap tracks and connect each outboard trailing edge mid-flap to the wing. Fractures have been found in varying locations along the length of the carriage spindle, which connects the carriage assembly to the mid-flap. A fracture can result in the displacement of the associated flap from the carriage assembly.

This displacement can cause a change in the flap angle of attack resulting in airplane roll-off as the flaps extend. An airplane roll-off condition that requires one unit or more of rudder trim and/or 2.5 units or more of aileron trim to maintain wings level flight when the flaps are extended can be an indication of a spindle fracture. The flight deck flap indications are normal.

A fractured spindle will not cause roll changes when the trailing edge flaps are fully retracted. Roll changes should be minimal at flap positions 1, 2, 5, and 10. Depending upon the location of the fracture, roll changes are expected to be more pronounced as the flaps extend to 15 or greater. If one carriage spindle fractures

at the critical location, the pilot can compensate for it with aileron and/or rudder inputs. However, if both the inboard and outboard spindles on an outboard flap fracture in the critical location, a large potentially uncontrollable rolling moment could occur.

Operating Instructions

During flap operation at flaps 15 or greater with normal flap indications, if an unexpected roll-off occurs stop flap extension. If the roll-off requires one unit or more of rudder trim and/or 2.5 units or more of aileron trim to maintain wings level flight, retract flaps to flaps 1. Land using flaps 1 and Vref 40 + 30 knots. Report the roll-off condition to maintenance.

Administrative Information

This bulletin replaces bulletin TBCE-16, dated November 17, 2003. Discard bulletin TBCE-16. Revise the Bulletin Record to show TBCE-16 as "CANCELLED" (CANC).

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-16 R1 "IN EFFECT" (IE).

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

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

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Flight Crew Operations Manual Bulletin for The Boeing Company

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



737

Number: TBCE-18

Date: March 22, 2005

Document Effectivity: D6-27370-400E-TBCE

Subject: Main Landing Gear (MLG) Actuator Beam Fracture and/or MLG Actuator Beam Arm Fracture

Reason: This bulletin informs flight crews of a potential uncommanded control wheel roll input and/or control wheel jam or large increase in control wheel forces during landing gear retraction due to a MLG actuator beam and/or MLG actuator beam arm fracture.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

There have been five (5) reported cases of MLG actuator beam fractures and nine (9) reported cases of MLG actuator beam arm fractures. After takeoff and during landing gear retraction, a fracture allows the MLG actuator to extend beyond its normal position and contact the spoiler and/or aileron cables. Contact with these cables can cause an uncommanded control wheel roll input with subsequent airplane roll, and/or a control wheel jam or a large increase in control wheel forces.

One operator reported an occurrence in which, after takeoff and during landing gear retraction, the airplane experienced an uncommanded control wheel roll input. An almost full opposite sustained control wheel input, using considerable force by both pilots, was required to correct the airplane roll. The crew was advised that the flight spoilers on one wing were fully raised. They also observed the illumination of a MLG red indicator light. They lowered the landing gear and noted that the roll problem diminished. Only a small amount of aileron was required to maintain straight and level flight. The flight was terminated and a normal landing was performed. Ground inspection of the MLG found fractured

MLG actuator beam components along with damaged spoiler and aileron cables. Several hydraulic tubes were also crushed.

Corrective action for the MLG actuator beam fracture and MLG actuator beam arm fracture is being developed and will be provided to operators as soon as it is complete.

Operating Instructions

If, during or immediately after landing gear retraction, an uncommanded roll and/or control wheel jam or large increase in control wheel forces is experienced, extend the landing gear. Plan to land at the nearest suitable airport.

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-18 "IN EFFECT" (IE).

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

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Flight Crew Operations Manual Bulletin for The Boeing Company

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



737

Number: TBCE-24

Date: January 11, 2008

Document Effectivity: D6-27370-400E-TBCE

Subject: FMC Lockup with Selection of a Standard Instrument Departure (SID) on Missed Approach (FMC Update U10.0 and later)

Reason: This bulletin informs flight crews of the potential for the FMC to lockup following selection of a SID during a missed approach procedure.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

During simulator testing, a Boeing flight crew experienced an FMC lockup and subsequent reset following selection of an engine out (EO) standard instrument departure (SID) procedure while flying an LNAV missed approach. The FMC reset shortly after the lockup and all entered data was retained. The crew was able to select the desired active waypoint and re-capture the LNAV route by using the INTC ARC function.

Further discussions with GE Aerospace have determined the problem can occur when the leg after the active waypoint in the flight plan for the missed approach is an arc leg, and a SID (normal or EO) is selected to create a modified flight plan.

This anomaly exists in FMC Update U10.0 and later. The anomaly will be corrected in FMC Update U10.8.

Boeing recommends operators evaluate this information to determine if it is applicable to their flight operations. A decision can then be made as to whether it is necessary to release this bulletin to Flight Crew.

Operating Instructions

Do not select a SID (normal SID or EO SID) while flying an LNAV missed approach procedure.

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-24 "IN EFFECT" (IE).

This FCOM bulletin will remain in effect until Boeing is informed that all affected airplanes in your fleet have FMC Update U10.8 installed.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
 Commercial Aviation Services
 ATTN: 737 Manager, Flight Technical Data
 P. O. Box 3707, M/C 20-89
 Seattle, Washington 98124-2207 USA

Email: flighttraining@boeing.com
Telephone: (206) 662-4000
Fax: (206) 662-4743



Flight Crew Operations Manual Bulletin for The Boeing Company

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



737

Number: TBCE-25 R1

Date: June 15, 2009

Document Effectivity: D6-27370-400E-TBCE

Subject: Cabin Altitude Warning Indications and Procedures Briefing

Reason: This revision is to inform flight crews that the FAA has agreed to an Alternative Method of Compliance (AMOC) to the takeoff briefing mandated by AD 2008-23-07. The requirement to don oxygen masks only applies when the intermittent warning horn sounds and the airplane flight altitude is above 10,000 feet MSL.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

The B737 cabin altitude warning system consists of an intermittent warning horn that sounds when cabin altitude exceeds 10,000 feet. Both the cabin altitude warning and takeoff configuration warning use the same intermittent horn.

Following a fatal accident in August 2005, the FAA initiated planned Airworthiness Directive (AD) action to provide additional cabin altitude warning information for B737 flight crews.

To support this planned AD, Boeing has designed a change to the warning system to provide separate "CABIN ALTITUDE" and "TAKEOFF CONFIG" warning lights to accompany the existing dual-purpose intermittent warning horn. This design change is now available on production airplanes. Service bulletin information to support the planned AD will become available in mid-2009.

To help mitigate any possible confusion associated with the B737 cabin altitude warning system, the FAA issued AD 2006-13-13 which required changes to the

AFM procedures in Section 2 for responding to the intermittent cabin altitude/configuration warning horn. These AFM changes and associated Flight Crew Operations Manual (FCOM) Quick Reference Handbook (QRH) non-normal checklist changes were intended to make it easier for flight crews to determine whether the intermittent horn was sounding for cabin altitude or for takeoff configuration.

The FAA believed, however, that additional interim action was necessary until such time as the new warning lights could be fully implemented in the B737 fleet.

In mid-2008, the FAA determined that the most practical interim solution was to issue AD 2008-23-07. This AD requires flight crews to brief cabin altitude warning indications and procedures as part of the takeoff briefing before engine start on the first flight of the day or following a flight crew member change. This briefing is required in any B737 in which the CABIN ALTITUDE and TAKEOFF CONFIG lights are not installed, or are installed but not activated.

Following further discussions, the FAA has agreed that a need exists for crews to recognize the difference between an intermittent warning horn sounding in flight below 10,000 feet MSL, as opposed to sounding at or above 10,000 feet MSL. In flight below 10,000 feet MSL, the intermittent warning horn is associated with an inflight failure of the Air-Ground Sensor switch. At or above 10,000 feet MSL, sounding of the intermittent warning horn requires the crew to immediately don oxygen masks and set regulators to 100%.

The FAA has therefore approved an Alternative Method of Compliance (AMOC) to the Emergency Procedures mandated by AD 2006-13-13 and to the Takeoff Briefing mandated by AD 2008-23-07. The AMOC was approved by FAA Approval Letter 130S-09-134a dated April 28, 2009.

AD 2006-13-13

The current WARNING HORN – CABIN ALTITUDE OR CONFIGURATION Emergency Procedure in the AFM will be revised as follows:

1. The title will be changed to WARNING HORN OR WARNING LIGHT – CABIN ALTITUDE OR TAKEOFF CONFIGURATION.
2. The condition statement and the procedure will include reference to the CABIN ALTITUDE and TAKEOFF CONFIG lights.
3. The requirement to don oxygen masks, establish crew communications and do the CABIN ALTITUDE or Rapid Depressurization checklist will only apply if the intermittent warning horn sounds or a CABIN ALTITUDE light illuminates in flight at an airplane flight altitude above 10,000 feet MSL.
4. Reference to the steady horn in the condition statement will be deleted. The corresponding step in the procedure will be deleted.

A new AFM Emergency Procedure, LANDING CONFIGURATION, will be created to direct crews to assure correct landing configuration if the steady horn sounds in flight.

The current WARNING HORN – CABIN ALTITUDE OR CONFIGURATION QRH non-normal checklist will be revised in a future revision of the FCOM QRH to include the changes defined in the AMOC. In addition, a new checklist, titled LANDING CONFIGURATION will be added. The QRH checklists may not be an exact replica of the AFM procedures, but will be written for consistency with the Boeing format.

AD 2008-23-07

The Cabin Altitude Warning Takeoff Briefing in Section 3 of the AFM will be revised to clarify that immediate donning of oxygen masks and accomplishment of the subsequent memory item steps from the WARNING HORN OR WARNING LIGHT – CABIN ALTITUDE OR TAKEOFF CONFIGURATION non-normal checklist are only required if the intermittent warning horn sounds in flight at an aircraft flight altitude above 10,000 feet MSL.

The Takeoff briefing in the Before Start Procedure in the Normal Procedures section of the FCOM will be updated in a future revision to reflect this change.

Operating Instructions

To further reduce the risk of flight crew incapacitation due to hypoxia following loss of cabin pressurization, cabin altitude warning indications and memory item procedures must be briefed on airplanes in which the CABIN ALTITUDE and TAKEOFF CONFIG lights are not installed, or are installed but not activated. This briefing will be included as an additional item on the Takeoff briefing before engine start for the first flight of the day or following any change of either flight crew member.

The briefing must include the following:

- Whenever the intermittent warning horn sounds in flight at an airplane flight altitude above 10,000 feet MSL:
 1. Immediately, don oxygen masks and set regulators to 100%.
 2. Establish crew communications.
 3. Do the CABIN ALTITUDE WARNING or Rapid Depressurization non-normal checklist.
- Both pilots must verify on the overhead Cabin Altitude Panel that the cabin altitude is stabilized at or below 10,000 feet before removing oxygen masks.

Operators may want to seek an Alternative Method of Compliance (AMOC) to develop a new crew briefing or to utilize current approved briefings to meet the compliance of this AD.

Administrative Information

This bulletin replaces bulletin TBCE-25, dated December 12, 2008. Discard bulletin TBCE-25. Revise the Bulletin Record to show TBCE-25 as "CANCELLED" (CANC).

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-25 R1 "IN EFFECT" (IE).

This FCOM bulletin will remain in effect until Boeing is informed that all affected airplanes in your fleet have the CABIN ALTITUDE and TAKEOFF CONFIG lights installed and activated.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
 Commercial Aviation Services
 ATTN: 737 Manager, Flight Technical Data
 P. O. Box 3707, M/C 20-89
 Seattle, Washington 98124-2207 USA

Email: flighttraining@boeing.com
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Flight Crew Operations Manual Bulletin for The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207



737

Number: TBCE-26

Date: April 27, 2009

Document Effectivity: D6-27370-400E-TBCE

Subject: Instrument Approach Procedures with an FMC Missed Approach Altitude Constraint Above 10,000 feet MSL

Reason: This bulletin informs flight crews of an anomaly associated with approaches having a missed approach with an altitude constraint above 10,000 feet MSL in the FMC.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

During simulator testing, an anomaly was identified when attempting to fly an instrument approach using VNAV for an RNAV (RNP) procedure having a missed approach point with an altitude constraint above 10,000 feet MSL.

The FMC builds the descent path upward and back in the direction of the Final Approach Fix (FAF) by starting at the location of the missed approach waypoint (MAP) and its associated altitude constraint. The FMC calculates this path using the coded Glide Path (GP) angle, also called the vertical angle. The MAP is normally shown on the LEGS page as an RWxx or MXxx waypoint. When the MAP is the runway threshold, the altitude constraint is typically the threshold elevation plus threshold crossing height.

For a missed approach point with an altitude constraint above 10,000 feet MSL, the FMC does not consider the altitude constraint to be valid. The FMC uses the airport elevation rather than the MAP altitude as the starting altitude for path construction. The difference between the missed approach point altitude constraint and the airport elevation results in an incorrect VNAV path.

This anomaly exists in FMC Updates U7.1 and later. The anomaly will be corrected in FMC Update U11, currently scheduled for release in the 4th quarter of 2010.

Boeing recommends operators evaluate this information to determine if it is applicable to their flight operations by reviewing their approach procedures to airports with an elevation above 9000 feet. A decision can then be made as to whether it is necessary to release this bulletin to Flight Crew.

Operating Instructions

1. On an approach procedure that has a missed approach point with an altitude constraint above 10,000 feet MSL, do not use VNAV after the Final Approach Fix (FAF). LNAV or other appropriate roll modes may be used through the approach procedure.
2. Do not use the VNAV path deviation indication on the MAP display or the Vertical Deviation (VERT DEV) information on the FMC Descent page for descent rate guidance after passing the FAF.
3. Ensure compliance with each minimum altitude constraint on the final approach segment (step-down fixes).

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-26 "IN EFFECT" (IE).

This FCOM bulletin will remain in effect until Boeing is informed that all affected airplanes in your fleet have FMC Update U11 installed.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
 Commercial Aviation Services
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 P. O. Box 3707, M/C 20-89
 Seattle, Washington 98124-2207 USA

Email: flighttraining@boeing.com
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Flight Crew Operations Manual Bulletin for The Boeing Company

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



737

Number: TBCE-27

Date: June 16, 2009

Document Effectivity: D6-27370-400E-TBCE

Subject: Inflight Elevator Tab Vibration

Reason: This bulletin informs 737-100/-200/-300/-400/-500 flight crews of the potential for elevator tab vibration that may lead to significant structural damage.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

Boeing has received multiple reports of in-service vibration on 737-100/200/300/400/500 airplanes caused by worn or failed elevator tab assemblies. In one event, the flight crew experienced the partial loss of a right hand elevator and tab. The loss was discovered following several flight sectors in which aft cabin vibration was noted by the flight crew.

Flight crews should be aware that there are many causes of airframe vibration, including free-play in movable surfaces, system or engine malfunctions, and environmental factors. These most recent reports of in-flight vibration have been identified as resulting from worn or improperly installed hardware in the elevator tab system. In some cases, airframe vibration was reported on multiple flights over an extended period of time before identification and corrective actions were accomplished.

Elevator tab vibration can occur during any phase of flight and is characterized as a clearly noticeable moderate to severe vertical motion in the flight deck and aft cabin. This vibration is characterized as a low frequency vertical vibration in which motion of items attached to airplane structure, such as sun visors, may be noticeable. In some cases, pilots have reported feeling vibration in the control

column and rudder pedals as this vertical motion is transmitted through the structure and cables to the controls. If the cause of the vibration is suspected to be due to empennage control surfaces, the discrepancy should be corrected prior to further revenue flight.

Boeing recommends that operators aggressively investigate, identify, and correct the cause of the vibration prior to returning the airplane to revenue service. If exposed to recurrent or chronic vibration, control surfaces can experience significant structural damage.

Additional maintenance guidance is provided in the latest version of Boeing Service Bulletin 737-55A1070.

Operating Instructions

If vibration is suspected due to the elevator tab, reduce airspeed smoothly until the vibration stops, using the thrust levers and pitch attitude. Do not use speed brakes or change airplane configuration to reduce airspeed. Do not reduce airspeed below the minimum speed for the existing flap setting and gross weight. Consider landing at the nearest suitable airport.

Stay at or below the reduced airspeed at which the vibration stopped for the rest of the flight. Limit bank angle to 15° until below 20,000 feet.

Do not deploy the speedbrakes for the remainder of the flight.

Flaps and landing gear can be extended normally during the approach and landing. The speedbrake can be armed for landing.

The vibration occurrence should be reported to maintenance for resolution before further flight. The logbook entry should emphasize that the vibration is suspected to be in the area of the elevator tab and tab control system.

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-27 "IN EFFECT" (IE).

This FCOM bulletin will be revised to include Service Bulletin information when available.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
Commercial Aviation Services
ATTN: 737 Manager, Flight Technical Data
P. O. Box 3707, M/C 20-89
Seattle, Washington 98124-2207 USA

Email: flighttraining@boeing.com
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Flight Crew Operations Manual Bulletin for The Boeing Company

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



737

Number: TBCE-29

Date: July 01, 2009

Document Effectivity: D6-27370-400E-TBCE

Subject: VNAV Not to Be Used for Approach Operations with FMC Update U10.8 Installed

Reason: This bulletin informs flight crews that VNAV approaches are no longer authorized with FMC Update U10.8 software installed.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

An operator with FMC Update U10.8 installed has reported incidents in which an inappropriate STEEP DESCENT AFTER XXXXX message is displayed, where XXXXX is the name of a waypoint in the flight plan. Upon reaching the specified waypoint, the autoflight system commands the airplane to descend below the expected path on approach. GE has been able to reproduce the anomaly and has identified that the issue is due to incorrect prediction logic.

The VNAV descent path is predicted backwards, starting at the destination and ending at cruise altitude. GE has determined that an error in FMC Update U10.8 results in the VNAV path being built to the wrong waypoint, specifically to a waypoint with an AT constraint upstream of the waypoint where the steep descent takes place.

This can occur during descent or approach where a waypoint with an AT OR ABOVE constraint is between two waypoints with AT constraints. It is possible that an error in the prediction logic will calculate an incorrect path between the AT waypoints that is lower than the published navigation database (NDB) path. Under these conditions, the published NDB path is not honored, and after

sequencing the waypoint with the AT OR ABOVE constraint, the aircraft may attempt to dive to capture the incorrect predicted path.

During analysis, it was determined that the STEEP DESCENT message may not always be displayed when this anomaly occurs. The STEEP DESCENT message only indicates that the vertical path discrepancy is 200 feet or more. A discrepancy of less than 200 feet will not be annunciated by the STEEP DESCENT message.

This anomaly exists only in FMC Update U10.8; VNAV approaches can still be flown with FMC Update U10.7 and earlier. A correction to the software is planned for U10.8A.

Operating Instructions

With FMC Update U10.8 installed, do not fly any instrument approach using VNAV.

Use a conventional approach, if available. If an RNAV approach without GP or VNAV guidance is absolutely required, consider flying the approach using V/S by selecting the approach procedure from the arrivals page of the FMC. Do not use the VNAV path deviation indication on the map display for descent rate guidance. Ensure compliance with all minimum altitude constraints on the approach (step-down fixes).

LNAV is still available. IAN and VSD are not affected by this anomaly.

Administrative Information

Insert this bulletin behind the FCOM Bulletin Record Page in Volume 1 of your FCOM. Amend the FCOM Bulletin Record Page to show Bulletin TBCE-29 "IN EFFECT" (IE).

This FCOM bulletin will remain in effect until Boeing is informed that all affected airplanes in your fleet have FMC Update U10.7 and earlier, or U10.8A installed.

Please send all correspondence regarding FCOM bulletin status to one of the following addresses:

Mailing Address: Boeing Commercial Airplanes
 Commercial Aviation Services
 ATTN: 737 Manager, Flight Technical Data
 P. O. Box 3707, M/C 20-89
 Seattle, Washington 98124-2207 USA

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DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Limitations

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Limitations**Operating Limitations****Chapter L****Section 10****General**

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

Airplane General**Operational Limitations**

Runway slope	+/- 2%
Maximum Takeoff and Landing Tailwind Component	10 knots
Maximum speeds	Observe Vmo pointer and gear/flap placards
Turbulent airspeed	280 KIAS/.73M*
Maximum flight operational latitude	73° North and 60° South
Maximum Operating Altitude	37,000 feet
Maximum Takeoff and Landing Altitude	8,400 feet
* whichever is lower.	

Verify that an operational check of the flight deck door access system (as installed) has been accomplished according to approved procedures once each flight day.

Non-AFM Operational Information

Note: The following items are not AFM limitations but are provided for flight crew information.

On revenue flights, the escape slide retention bar (girt bar) must be installed during taxi, takeoff and landing.

The maximum demonstrated takeoff and landing crosswind is 35 knots.

Altitude Display Limits for RVSM Operations

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

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

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

Field Elevation	Max Difference Between Captain & F/O	Max Difference Between Captain or F/O & Field Elevation
Sea Level	40 feet	75 feet
5,000 feet	45 feet	75 feet
10,000 feet	50 feet	75 feet

Weight Limitations

737-300 Airplanes

Maximum Taxi Weight	135,500 lbs (61,461 kgs)
Maximum Takeoff Weight (1)	135,000 lbs (61,234 kgs)
Maximum Landing Weight (2)	114,000 lbs (51,709 kgs)
Maximum Zero Fuel Weight	106,500 lbs (48,307 kgs)

737-400 Airplanes

Maximum Taxi Weight	139,000 lbs (63,049 kgs)
Maximum Takeoff Weight (1)	138,500 lbs (62,822 kgs)
Maximum Landing Weight (2)	121,000 lbs (54,844 kgs)
Maximum Zero Fuel Weight	113,000 lbs (51,255 kgs)

737-500 Airplanes

Maximum Taxi Weight	125,000 lbs (56,699 kgs)
Maximum Takeoff Weight (1)	124,500 lbs (56,472 kgs)
Maximum Landing Weight (2)	110,000 lbs (49,894 kgs)
Maximum Zero Fuel Weight	102,500 lbs (46,493 kgs)

All Airplanes

C. G. Limits	Use approved weight and balance system
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- (1) May be further restricted by takeoff, enroute, and landing performance.
(2) May be further restricted by field length or climb limit.
-

Air Systems

The maximum cabin differential pressure (relief valves) is 8.65 psi.

Non-AFM Operational Information

Note: The following items are not AFM limitations but are provided for flight crew information.

With engine bleed air switches ON, do not operate the air conditioning packs in HIGH for takeoff, approach or landing.

Anti-Ice, Rain

Engine TAI must be on when icing conditions exist or are anticipated, except during climb and cruise below -40°C SAT.

Autopilot/Flight Director System

Use of aileron trim with autopilot engaged is prohibited.

Do not engage the autopilot for takeoff below 1000 feet AGL

For single channel operation during approach, the autopilot shall not remain engaged below 50 feet AGL.

See AFM limitations on automatic landing.

Maximum and minimum glideslope angles for autoland are 3.25 degrees and 2.5 degrees respectively.

Autoland capability may only be used with flaps 30 or 40 and both engines operative.

Communications

Do not use VHF-3 for ATC Communications with ACARS operational.

Note: The following limitation is applicable to airplanes which have not incorporated the effects of Honeywell service bulletin 4051600-22-0023 which installs a Honeywell flight control computer to correct the VHF-2 squelch break anomaly.

Because of unacceptable electromagnetic interference between the flight control computer, the EFIS symbol generator, and the VHF-2 antenna, do not use VHF-2 on 120.000 MHz or 120.005 MHz as a primary means of communication. If frequency 120.000 MHz or 120.005 MHz is required, use VHF-1.

On airplanes equipped with Rockwell/Collins Model HFS-700 and/or HFS-900 communication transceivers, flights predicated on the use of the following HF frequencies are prohibited:

- 11.133 MHz
- 22.434 MHz
- 22.683 MHz
- 22.766 MHz

Aircraft Communications Addressing and Reporting System

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

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

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

Electrical Power

Non-AFM Operational Information

Note: The following items are not AFM limitations but are provided for flight crew information.

Maximum generator drive oil temperature: 157° C

Engines and APU

Engine Limit Display Markings

Maximum and minimum limits are red.

Caution limits are amber.

General Engine Limitations

Maximum time limit for takeoff thrust	5 minutes
Maximum N1 RPM	106%
Maximum N2 RPM	105%
Maximum Takeoff EGT	930° C
Maximum Continuous EGT	895° C
Maximum Start EGT	725° C
Minimum Oil Pressure	13 psi
Maximum Oil Temperature	165° C maximum 160° C – 165° C allowable for 15 minutes 160° C maximum continuous

Engine Ignition

Continuous ignition must be on (ENGINE START switch in the CONT position) during takeoff and landing and during engine anti–ice operations.

PMC

Both PMC's must be either OFF or ON for takeoff.

Reverse Thrust

Intentional selection of reverse thrust in flight is prohibited.

Non–AFM Operational Information

Note: The following items are not AFM limitations but are provided for flight crew information.

Pneumatic pressure (prior to starter engagement): minimum 30 psig at sea level, decreasing 1/2 psig per 1,000 ft. above sea level.

APU

Maximum start EGT is 760° C.

Maximum continuous EGT is 710° C.

With APU bleed + electrical load, maximum altitude is 10,000 ft.

With APU bleed, maximum altitude is 17,000 ft.

With APU electrical load, maximum altitude is 35,000 ft.

APU can operate up to 37,000 ft.

Non-AFM Operational Information

Note: The following items are not AFM limitations but are provided for flight crew information.

APU bleed valve must be closed when:

- ground air connected and isolation valve open
- engine no. 1 bleed valve open
- isolation valve and engine no. 2 bleed valve open.

APU bleed valve may be open during engine start, but avoid engine power above idle.

If there are multiple aborted start attempts, five minutes cooling is required between the second and third start attempt. A wait of one hour is required after the third start attempt.

Flight Controls

Maximum flap extension altitude is 20,000 ft.

In flight, do not extend the SPEED BRAKE lever beyond the FLIGHT DETENT.

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.

Non-AFM Operational Information

Note: The following items are not AFM limitations but are provided for flight crew information.

Do not deploy the speedbrakes in flight at radio altitudes less than 1,000 feet.

Alternate flap duty cycle:

- When extending or retracting flaps with the ALTERNATE FLAPS position switch, allow 15 seconds after releasing the ALTERNATE FLAPS position switch before moving the switch again to avoid damage to the alternate flap motor clutch.
- After a completed extend/retract cycle, i.e., 0 to 15 and back to 0, allow 5 minutes cooling before attempting another extension.

Flight Management, Navigation

For airplanes with FMC update earlier than U7.2:

During VOR approaches, one pilot must have raw data from the VOR associated with the approach displayed in the EHSI VOR/ILS mode no later than final approach fix.

Non-AM Operational Information

Note: The following items are not AFM limitations but are provided for flight crew information.

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

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

Fuel

Do not reset a tripped fuel pump circuit breaker.

Maximum fuel temperature is 49° C.

Minimum fuel temperature is fuel freeze point +3° C or -45° C, whichever is higher.

Fuel Balance

Lateral imbalance between main tanks 1 and 2 must be scheduled to be zero. Random fuel imbalance must not exceed 1,000 lbs (453 kgs) for taxi, takeoff, flight or landing.

Fuel Loading

Main tanks 1 and 2 must be scheduled to be full if center tank contains more than 1,000 lbs (453 kgs).

Landing Gear

Non-AFM Operational Information

Note: The following items are not AFM limitations but are provided for flight crew information.

Do not apply brakes until after touchdown.

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Normal Procedures

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Normal Procedures

Introduction

Chapter NP

Section 11

General

This chapter gives:

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

Normal Procedures Philosophy and Assumptions

Normal procedures verify for each phase of flight that:

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

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

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

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

Normal procedures also assume coordination with the ground crew before:

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

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

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

Configuration Check

It is the crew member's responsibility to verify correct system response. Before engine start, use system lights to verify each system's condition or configuration. After engine start, the master caution system alerts the crew to warnings or cautions away from the normal field of view.

If there is an incorrect configuration or response:

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

Before engine start, use individual system lights to verify the system status. If an individual system light indicates an improper condition:

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

If, during or after engine start, a red warning or amber caution light illuminates:

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

If, during recall, an amber caution illuminates and then extinguishes after a master caution reset:

- check the DDPG or the operator equivalent
- the respective non-normal checklist is not needed

Crew Duties

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

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

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

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

The general PF phase of flight responsibilities are:

- taxiing
- flight path and airspeed control

- airplane configuration
- navigation

The general PM phase of flight responsibilities are:

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

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

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

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

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

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

Control Display Unit (CDU) Procedures

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

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

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

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

Autopilot Flight Director System (AFDS) Procedures

The crew must always monitor:

- airplane course

- vertical path
- speed

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

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

- autopilot
- flight director
- autothrottle

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

- course
- vertical path
- thrust
- speed

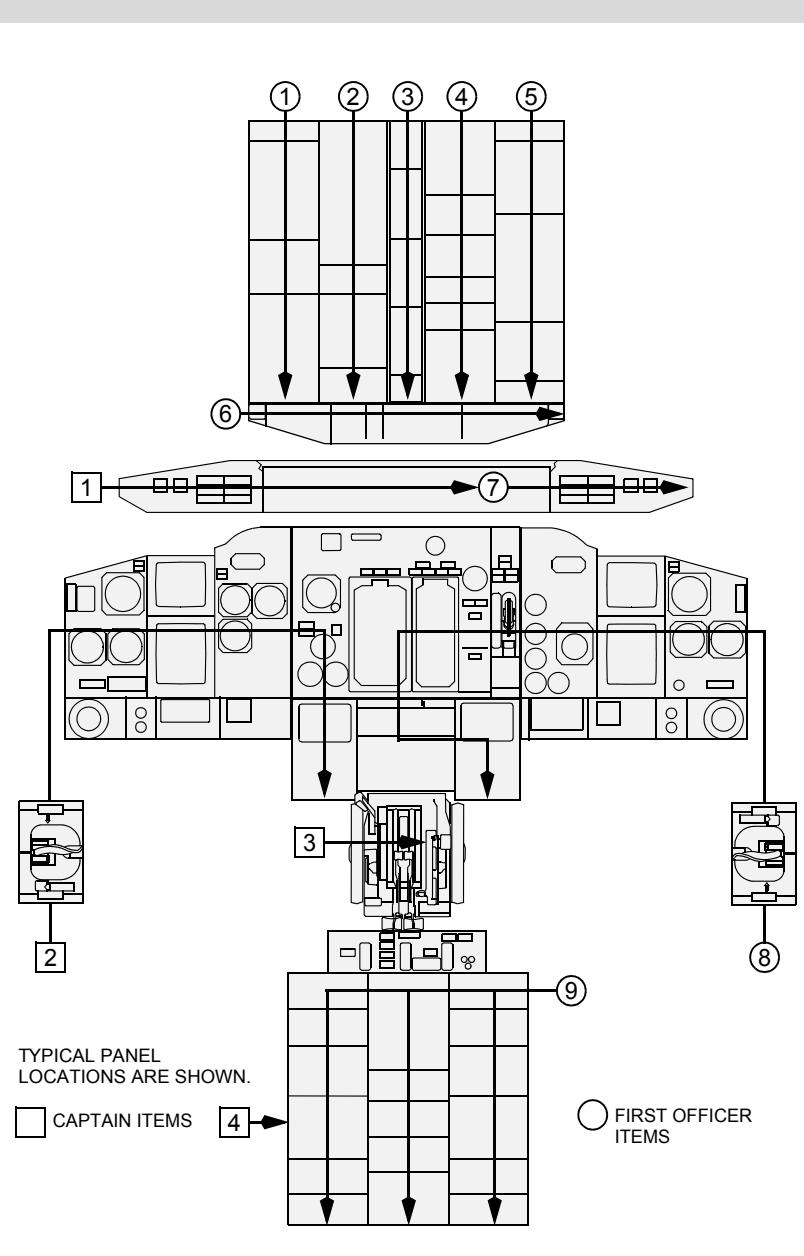
Announcing changes on the FMA and thrust mode display when they occur is a good CRM practice.

Scan Flow and Areas of Responsibility

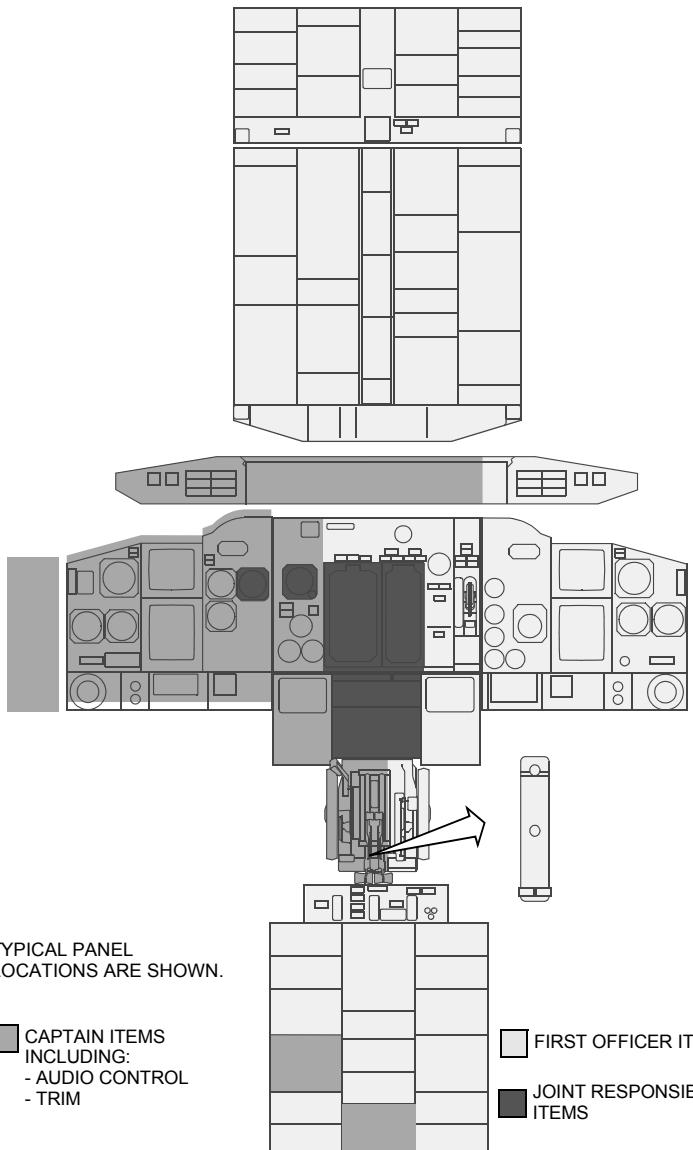
The scan flow and areas of responsibility diagrams shown below are representative and may not match the configuration of your airplane.

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

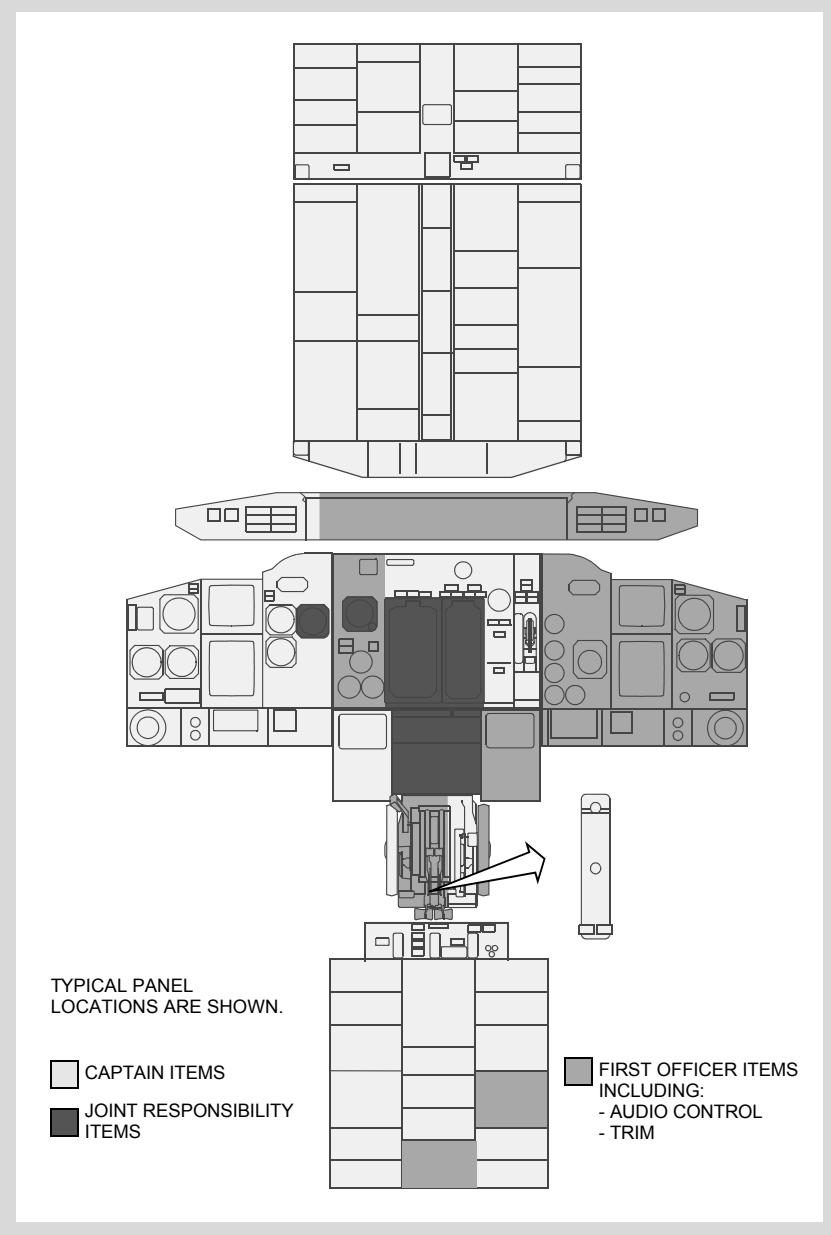
Preflight and Postflight Scan Flow



Areas of Responsibility - Captain as Pilot Flying or Taxiing



Areas of Responsibility - First Officer as Pilot Flying or Taxiing



Intentionally
Blank

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Normal Procedures

Amplified Procedures

Chapter NP

Section 21

Preliminary Preflight Procedure - Captain or First Officer

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

A full IRS alignment is recommended before each flight. If time does not allow a full alignment, do the Fast Realignment supplementary procedure.

IRS mode selectors OFF, then NAV

Verify that the ON DC lights illuminate then extinguish.

Verify that the ALIGN lights are illuminated.

Verify that the following are sufficient for flight:

- oxygen pressure
- hydraulic quantity
- engine oil quantity

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

Maintenance documents Check

FLIGHT DECK ACCESS SYSTEM
switch (as installed) Guard closed

Emergency equipment Check

Fire extinguisher – Checked and stowed

Crash axe – Stowed

Escape ropes – Stowed

Other needed equipment – Checked and stowed

SERVICE INTERPHONE switch OFF

ENGINE panel Set

Verify that the REVERSER lights are extinguished.

PMC switches – ON

Verify that the INOP lights are extinguished.

Verify that the LOW IDLE light is extinguished.

Oxygen panel Set

Note: PASSENGER OXYGEN switch activation causes deployment of the passenger oxygen masks.

PASSENGER OXYGEN switch - Guard closed

Verify that the PASS OXY ON light is extinguished.

Flight recorder switch Guard closed

Circuit breakers (P6 panel) Check

Crew oxygen valve Open

Manual gear extension access door Closed

Circuit breakers (control stand, P18 panel) Check

Rain repellent Check

Verify that the float is above the line and shutoff valve handle is in the vertical position.

Parking brake As needed

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

CDU Preflight Procedure - Captain and First Officer

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

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

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

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

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

Initial Data Set

IDENT page:

Verify that the MODEL is correct.

Verify that the ENG RATING is correct.

Verify that the navigation data base ACTIVE date range is current.

POS INIT page:

Verify that the time is correct.

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

Navigation Data Set

ROUTE page:

Enter the ORIGIN.

Enter the route.

Enter the FLIGHT NUMBER.

Activate and execute the route.

DEPARTURES page:

Select the runway and departure routing.

Execute the runway and departure routing.

LEGS page:

Verify or enter the correct RNP for the departure.

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

Performance Data Set

PERF INIT page:

CAUTION: Do not enter the ZFW into the GW boxes.

Doing so causes the FMC to calculate performance data with significant errors.

Enter the ZFW.

Verify that the FUEL on the CDU, the dispatch papers, and the fuel quantity indicators agree.

(U6 and later) If refueling is not complete, enter the PLAN trip fuel as needed.

Verify that the fuel is sufficient for flight.

Verify that the gross weight and cruise CG (GW/CRZ CG) on the CDU and the dispatch papers agree.

Thrust mode display:

Verify that TO shows.

TAKEOFF REF page:

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

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

Select a full or a derated climb thrust as needed.

Enter the CG.

Verify that a trim value is shown.

Select or enter the takeoff V speeds.

Verify that the preflight is complete.

Exterior Inspection

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

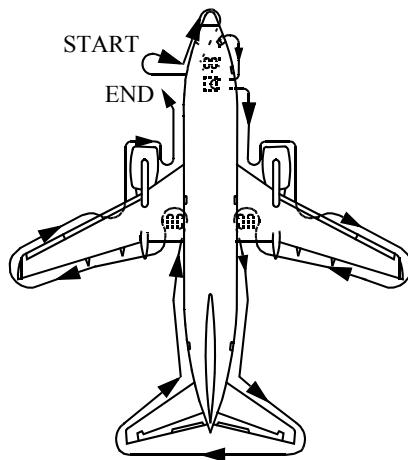
Items at each location may be checked in any sequence.

Use the detailed inspection route below to check that:

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

For cold weather operations see the Supplementary Procedures.

Inspection Route



Left Forward Fuselage

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

Doors and access panels (not in use) Latched

Nose

Radome Check

Conductor straps - Secure

Forward E and E door Secure

Nose Wheel Well

Tires and wheels Check

Exterior light Check

Gear strut and doors Check

Nose wheel steering assembly Check

Nose gear steering lockout pin As needed

Gear pin As needed

Nose wheel spin brake (snubbers) In place

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

Right Wing Root, Pack, and Lower Fuselage

Ram air deflector door Extended

Pack and pneumatic access doors Secure

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

Exterior lights Check

Leading edge flaps Check

Number 2 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 flaps and slats Check

Fuel measuring sticks Flush and secure

Wing Surfaces Check

Fuel tank vent Check

Right Wing Tip and Trailing Edge

Position and strobe lights Check

Static discharge wicks Check

Aileron 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 Secure

Gear pin As needed

Right Main Wheel Well

APU FIRE CONTROL handle Up

Wheel well Check

Right Aft Fuselage

Doors and access panels (not in use)	Latched
Negative pressure relief door	Closed
Outflow valve	Check
Probes, sensors, ports, vents, and drains (as applicable)	Check
APU air inlet	Open
APU fire bottle	Check
	Verify that the red and yellow discs show.

Tail

Vertical stabilizer and rudder	Check
Elevator feel probes	Check
Tail skid (as installed)	Check
	Verify that the tail skid is not damaged.

Horizontal stabilizer and elevator	Check
Static discharge wicks	Check
Strobe light	Check
APU cooling air inlet and exhaust outlet	Check

Left Aft Fuselage

Doors and access panels (not in use)	Latched
Probes, sensors, ports, vents, and drains (as applicable)	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	Secure

Gear pin As needed

Left Main Wheel Well

Wheel well Check

Engine fire bottle pressure Check

Left Wing Tip and Trailing Edge

Aileron and trailing edge flaps Check

Static discharge wicks Check

Position and strobe lights Check

Left Wing and Leading Edge

Fuel tank vent Check

Wing Surfaces Check

Fuel measuring sticks Flush and secure

Leading edge flaps and slats Check

Access panels Latched

Number 1 Engine

Exhaust area and tailcone Check

Thrust reverser Stowed

Fan blades, probes, and spinner Check

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

Access panels Latched

Left Wing Root, Pack, and Lower Fuselage

Leading edge flaps Check

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

Exterior lights Check

Pack and pneumatic access doors Secure

Ram air deflector door Extended

Preflight Procedure – First Officer

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

Flight control panel Check

FLIGHT CONTROL switches – Guards closed

Verify that the flight control LOW PRESSURE lights are illuminated.

Flight SPOILER switches – Guards closed

YAW DAMPER switch – ON

Verify that the YAW DAMPER light is extinguished.

Verify that the standby hydraulic LOW QUANTITY light is extinguished.

Verify that the standby hydraulic LOW PRESSURE light is extinguished.

For those airplanes with Rudder System Enhancement Program (RSEP) modification, verify that the STBY RUD ON light is extinguished.

ALTERNATE FLAPS master switch – Guard closed

ALTERNATE FLAPS position switch – OFF

Verify that the FEEL DIFF PRESS light is extinguished.

Verify that the SPEED TRIM FAIL light is extinguished.

Verify that the MACH TRIM FAIL light is extinguished.

Verify that the AUTO SLAT FAIL light is extinguished.

Instrument and NAV transfer switches Set

VHF NAV transfer switch – NORMAL

IRS transfer switch – NORMAL

EFI transfer switch – NORMAL

Fuel panel Set

Verify that the FUEL VALVE CLOSED lights are illuminated dim.

Verify that the FILTER BYPASS lights are extinguished.

CROSSFEED selector – Closed

Verify that the VALVE OPEN light is extinguished.

FUEL PUMP switches – OFF

Verify that the center tank fuel pump LOW PRESSURE lights are extinguished.

Verify that the main tank fuel pump LOW PRESSURE lights are illuminated.

Electrical panel Set

BATTERY switch – Guard closed

GALLEY power switch – ON

STANDBY POWER switch – Guard closed

Verify that the STANDBY PWR OFF light is extinguished.

Generator drive DISCONNECT switches – Guards closed

Verify that the LOW OIL PRESSURE lights are illuminated.

Verify that the HIGH OIL TEMP lights are extinguished.

BUS TRANSFER switch – Guard closed

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the BUS OFF lights are extinguished.

Verify that the GEN OFF BUS lights are illuminated.

Overheat and fire protection panel Check

Do this check if the flight crew did not do the Electrical Power Up supplementary procedure. This check is needed once per flight day.

Verify that the engine No. 1, APU, and engine No. 2 fire switches are in.

Alert ground personnel before the following test is accomplished:

OVERHEAT DETECTOR switches – NORMAL

TEST switch – Hold to FAULT/INOP

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Verify that the FAULT light is illuminated.

If the FAULT light fails to illuminate, the fault monitoring system is inoperative.

Verify that the APU DET INOP light is illuminated.

Do not run the APU if the APU DET INOP light does not illuminate.

Note: The fire warning light flashes and the horn sounds on the APU ground control panel when this test is done with the APU running. This can be mistaken by the ground crew as an APU fire.

TEST switch – Hold to OVHT/FIRE

Verify that the fire warning bell sounds.

Verify that the master FIRE WARN lights are illuminated.

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Master FIRE WARN light – Push

Verify that the master FIRE WARN lights are extinguished.

Verify that the fire warning bell cancels.

Verify that the engine No. 1, APU and engine No. 2 fire switches stay illuminated.

Verify that the ENG 1 OVERHEAT and ENG 2 OVERHEAT lights stay illuminated.

Verify that the WHEEL WELL light stays illuminated.

EXTINGUISHER TEST switch – Check

TEST Switch – Position to 1 and hold.

Verify that the three green extinguisher test lights are illuminated.

TEST Switch – Release

Verify that the three green extinguisher test lights are extinguished.

Repeat for test position 2.

APU switch (as needed) START

Note: If extended APU operation is needed on the ground, position an AC operated fuel pump ON. If fuel is loaded in the center tank, position the left center tank fuel pump switch ON to prevent a fuel imbalance before takeoff.

CAUTION: Center tank fuel pump switches should be positioned ON only if the fuel quantity in the center tank exceeds 453 kgs/1000 lbs.

CAUTION: Do not operate the center tank fuel pumps with the flight deck unattended.

Note: Whenever the APU is operating and AC electrical power is on the airplane busses, operate at least one fuel boost pump to supply fuel under pressure to the APU to extend the service life of the APU fuel control unit.

When the APU GEN OFF BUS light is illuminated:

APU GENERATOR bus switches – ON

Verify that the BUS OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

Lavatory SMOKE light (as installed) Verify extinguished

EQUIPMENT COOLING switches NORM

Verify that the OFF lights are extinguished.

EMERGENCY EXIT LIGHTS switch Guard closed

Verify that the NOT ARMED light is extinguished.

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**Normal Procedures -
Amplified Procedures**

Passenger signs	Set
NO SMOKING switch – AUTO or ON	
FASTEN BELTS switch – AUTO or ON	
Windshield WIPER selector	OFF
Verify that the windshield wipers are stowed.	
WINDOW HEAT switches	ON
Position switches ON at least 10 minutes before takeoff.	
Verify that the OVERHEAT lights are extinguished.	
Verify that the ON lights are illuminated (except at high ambient temperatures.)	
PITOT STATIC switches	OFF
Verify that all lights are illuminated.	
WING ANTI-ICE switch	OFF
Verify that the VALVE OPEN lights are extinguished.	
ENGINE ANTI-ICE switches	OFF
Verify that the COWL ANTI-ICE lights are extinguished.	
Verify that the COWL VALVE OPEN lights are extinguished.	
Hydraulic panel.....	Set
ENGINE HYDRAULIC PUMPS switches – ON	
Verify that the LOW PRESSURE lights are illuminated.	
ELECTRIC HYDRAULIC PUMPS switches – OFF	
Verify that the OVERHEAT lights are extinguished.	
Verify that the LOW PRESSURE lights are illuminated.	

Air conditioning panel Set

AIR TEMPERATURE source selector – As needed

Verify that the DUCT OVERHEAT lights are extinguished
(737-300/500)

TRIM AIR switch (737-400) – ON

Verify that the ZONE TEMP lights are extinguished (737-400)

Temperature selectors – As needed

Verify that the RAM DOOR FULL OPEN lights are illuminated.

RECIRCULATION FAN switch(es) – AUTO

Air conditioning PACK switches – One switch AUTO or HIGH, one switch OFF

ISOLATION VALVE switch – AUTO

Engine BLEED air switches – ON

APU BLEED air switch – ON

Verify that the DUAL BLEED light is illuminated.

Verify that the PACK/PACK TRIP OFF lights are extinguished.

Verify that the WING–BODY OVERHEAT lights are extinguished.

Verify that the BLEED TRIP OFF lights are extinguished.

Cabin pressurization panel Set

Verify that the AUTO FAIL light is extinguished.

Verify that the OFF SCHED DESCENT light is extinguished.

FLIGHT ALTITUDE indicator – Cruise altitude

LANDING ALTITUDE indicator – Destination field elevation

CABIN Rate selector– Index

CABIN ALTITUDE indicator– 200 feet below destination field elevation

FLT/GRD switch – GRD

Pressurization mode selector – AUTO

Verify that the STANDBY light is extinguished.

Verify that the MANUAL light is extinguished.

Lighting panel Set

LANDING light switches – RETRACT and OFF

RUNWAY TURNOFF light switches – OFF

TAXI light switch – OFF

Ignition select switch IGN L or R

Alternate the ignition select switch position on subsequent starts.

ENGINE START switches OFF

Lighting panel Set

LOGO light switch – As needed

POSITION/STROBE light switch – OFF

ANTI-COLLISION light switch – OFF

WING illumination switch – As needed

WHEEL WELL light switch – As needed

NAV MODE selector (as installed) As needed

Select FMC, ANS-L or ANS-R as needed for navigation system to be used for departure.

Mode control panel Set

COURSE(S) – Set

FLIGHT DIRECTOR switch – ON

Move the switch for the pilot flying to ON first.

Oxygen Test and set

Crew oxygen pressure – Check

Verify that the pressure is sufficient for dispatch.

Oxygen mask – Stowed and doors closed

RESET/TEST switch – Push and hold

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

EMERGENCY/TEST selector – Push and hold

Continue to hold the RESET/TEST switch down and push the EMERGENCY/TEST selector for 5 seconds. Verify that the yellow cross shows continuously in the flow indicator.

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

If the oxygen cylinder valve is not in the full open position, pressure can:

- decrease rapidly, or
- decrease more than 100 psig, or
- increase slowly back to normal.

Release the RESET/TEST switch and the EMERGENCY/TEST selector. Verify that the yellow cross does not show in the flow indicator.

Normal/100% selector – 100%

Marker beacon lights Test

Clock Set

Disengage light TEST switch Hold to 1

Verify that the A/P light is illuminated steady amber.

Verify that the A/T light is illuminated steady amber.

Verify that the FMC light is illuminated steady amber.

Disengage light TEST switch Hold to 2

Verify that the A/P light is illuminated steady red.

Verify that the A/T light is illuminated steady red.

Verify that the FMC light is illuminated steady amber.

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

Flight instruments Check

Set the altimeter.

Airspeed cursor control - Push

Verify that the flight instrument indications are correct.

Verify that only these flags are shown:

- TCAS OFF (as installed)
- expected RDMI flags

Verify that the flight mode annunciations are correct:

- autothrottle mode is blank
- pitch mode is blank
- roll mode is blank
- AFDS status is FD

GROUND PROXIMITY panel Check

FLAP INHIBIT switch – Guard closed

GEAR INHIBIT switch – Guard closed

Verify that the INOP light is extinguished.

Landing gear panel Set

LANDING GEAR lever – DN

Verify that the green landing gear indicator lights are illuminated.

Verify that the red landing gear indicator lights are extinguished.

TAKEOFF CONFIG light (as installed) Verify extinguished

CABIN ALTITUDE light (as installed) Verify extinguished

ANTISKID switch	Guard closed
Verify that the ANTISKID INOP light is extinguished	
AUTO BRAKE select switch	RTO
Verify that the AUTO BRAKE DISARM light is extinguished	
REVERSER UNLOCKED lights	Verify extinguished
A/T LIM light	Verify extinguished
START VALVE OPEN lights	Verify extinguished
LOW OIL PRESSURE lights	Verify illuminated
OIL FILTER BYPASS lights	Verify extinguished
Engine instrument primary panel	Set
N1 manual set knob – Push	
FUEL USED RESET switch – Push	
Engine instruments	Check
Verify that the primary and secondary engine indications show existing conditions.	
Hydraulic quantity indications	Above RF
CARGO FIRE panel (as installed)	Check
This check is needed once per flight day or following a flight crew change.	
DETECTOR SELECT switches – NORM	
TEST switch – Push	
Verify that the fire warning bell sounds.	
Verify that the master FIRE WARN lights are illuminated.	
Master FIRE WARN light – Push	

- Verify that the master FIRE WARN lights are extinguished.
- Verify that the fire warning bell cancels.
- Verify that the FWD and AFT lights stay illuminated.
- Verify that the DETECTOR FAULT light stays extinguished.
- Verify that the green EXTINGUISHER test lights stay illuminated.
- Verify that the DISCH light stays illuminated.
- EFIS control panel Set
- Decision height selector – As needed
- Mode selector – MAP
- Range selector – As needed
- TRAFFIC switch (as installed) – As needed
- WEATHER RADAR – Off
- Verify that the weather radar indications are not shown on the MAP.
- Map switches – As needed
- VHF communications radios Set
- VHF NAVIGATION radios Set for departure
- Audio control panel Set
- ADF radios Set
- HF radios Set
- WARNING: Do not key HF radio while airplane is being fueled.
Injury to personnel or fire may result.**
- WEATHER RADAR panel Set
- Verify that the weather radar indications are not shown.
- Transponder panel Set
- STABILIZER TRIM override switch Guard closed

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.

Verify a positive horizontal (fore and aft) seat lock.

Rudder pedals Adjust

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

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.

Lights Test

Master LIGHTS TEST and DIM switch – TEST

The fire warning lights are not checked during this test. Use individual test switches or push to test features to check lights which do not illuminate during the light test. Use scan flow to verify that all other lights are flashing or illuminated. Verify that all system annunciator panel lights are illuminated.

Master LIGHTS TEST and DIM switch – As needed

NAV MODE selector (as installed) As needed

Select FMC, ANS-L or ANS-R as needed for navigation system to be used for departure.

Mode control panel Set

COURSE(S) – Set

FLIGHT DIRECTOR switch – ON

Move the switch for the pilot flying to ON first.

Bank angle selector – As needed

Autopilot DISENGAGE bar – UP

Oxygen Test and set

Crew oxygen pressure – Check

Verify that the pressure is sufficient for dispatch.

Oxygen mask – Stowed and doors closed

RESET/TEST switch – Push and hold

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

EMERGENCY/TEST selector – Push and hold

Continue to hold the RESET/TEST switch down and push the EMERGENCY/TEST selector for 5 seconds. Verify that the yellow cross shows continuously in the flow indicator.

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

If the oxygen cylinder valve is not in the full open position, pressure can:

- decrease rapidly, or
- decrease more than 100 psig, or
- increase slowly back to normal.

Release the RESET/TEST switch and the EMERGENCY/TEST selector. Verify that the yellow cross does not show in the flow indicator.

Normal/100% selector – 100%

Marker beacon lights Test

Marker beacon switch As needed

Clock Set

NOSE WHEEL STEERING switch Guard closed

Disengage light TEST switch Hold to 1

Verify that the A/P light is illuminated steady amber.

Verify that the A/T light is illuminated steady amber.

Verify that the FMC light is illuminated steady amber.

Disengage light TEST switch Hold to 2

Verify that the A/P light is illuminated steady red.

Verify that the A/T light is illuminated steady red.

Verify that the FMC light is illuminated steady amber.

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

Flight instruments Check

Set the altimeter.

Airspeed cursor control - Push

Verify that the flight instrument indications are correct.

Verify that only these flags are shown:

- TCAS OFF (as installed)
- expected RDMI flags

Verify that the flight mode annunciations are correct:

- autothrottle mode is blank
- pitch mode is blank
- roll mode is blank
- AFDS status is FD

Standby instruments Check

Standby altimeter – Set

Verify that the flight instrument indications are correct.

Verify that no flags are shown.

Standby horizon – Set

Gyro caging control – Pull, then release

Approach mode selector – As needed

Verify that the flight instrument indications are correct.

Verify that no flags are shown.

STAB OUT OF TRIM light Verify extinguished

SPEEDBRAKE lever DOWN detent

Verify that the SPEED BRAKE DO NOT ARM light is extinguished.

Verify that the SPEED BRAKE ARMED light is extinguished.

Verify that the SPEED BRAKE light is extinguished.

Reverse thrust levers Down

Forward thrust levers Closed

FLAP lever Set

Set the flap lever to agree with the flap position.

Verify that the FLAP LOAD RELIEF light is extinguished.

Parking brake Set

Verify that the parking brake warning light is illuminated

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

Engine start levers CUTOFF

STABILIZER TRIM cutout switches NORMAL

EFIS control panel	Set
Decision height selector – As needed	
Mode selector – MAP	
Range selector – As needed	
TRAFFIC switch (as installed) – As needed	
WEATHER RADAR – Off	
Verify that the weather radar indications are not shown on the MAP.	
Map switches – As needed	
VHF communications radios	Set
VHF NAVIGATION radios	Set for departure
Audio control panel	Set
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.	
Verify a positive horizontal (fore and aft) seat lock.	
Rudder pedals	Adjust
Adjust the rudder pedals to allow full rudder pedal and brake pedal movement.	
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

Verify that the CAB DOOR UNLOCKED/LOCK FAIL light is extinguished.

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

CDU display Set C, F/O

Normally the PF selects the TAKEOFF REF page.

Normally the PM selects the LEGS page.

N1 bugs Check C, F/O

Verify that the N1 reference bugs are correct.

IAS bugs Set C, F/O

Verify that the speed bugs are at V1, VR, V2 + 15, and flaps up maneuvering speed.

MCP Set C

AUTOTHROTTLE ARM switch – ARM

IAS/MACH selector – Set V2

Initial heading – 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.

As part of the takeoff briefing for the first flight of the day and following a change of either flight crew member, cabin altitude warning indications and memory item procedures must be briefed on airplanes in which the CABIN ALTITUDE and TAKEOFF CONFIG lights are not installed, or are installed but not activated. The briefing must contain the following information:

Whenever the intermittent warning horn sounds in flight at an airplane flight altitude above 10,000 feet MSL:

1. Immediately, don oxygen masks and set regulators to 100%.
2. Establish crew communications.
3. Do the CABIN ALTITUDE WARNING or Rapid Depressurization non-normal checklist.

Both pilots must verify on the overhead Cabin Altitude Panel that the cabin altitude is stabilized at or below 10,000 feet before removing oxygen masks.

Exterior doors Verify closed F/O

Flight deck windows Closed and locked C, 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:

Verify that the nose gear steering lockout pin is installed, or, if the nose gear steering lockout pin is not used, depressurize hydraulic system A during the hydraulic panel set step C, F/O

Fuel panel Set F/O

If the center tank fuel quantity exceeds 1000 pounds/460 kilograms:

LEFT and RIGHT CENTER FUEL PUMPS switches – ON

Verify that the LOW PRESSURE lights illuminate momentarily and then extinguish.

If a LOW PRESSURE light stays illuminated turn off the affected CENTER FUEL PUMPS switch.

AFT and FORWARD FUEL PUMPS switches – ON

Verify that the LOW PRESSURE lights are extinguished.

Hydraulic panel..... Set F/O

If pushback is needed and the nose gear steering lockout pin is not installed:

**WARNING: Do not pressurize hydraulic system A.
Unwanted tow bar movement can occur.**

System A HYDRAULIC PUMP switches – OFF

Verify that the system A pump LOW PRESSURE lights are illuminated.

System B electric HYDRAULIC PUMP switch – ON

Verify that the system B electric pump LOW PRESSURE light is extinguished.

Verify that the brake pressure is 2,800 psi minimum.

Verify that the system B pressure is 2,800 psi minimum.

If pushback is not needed, or if pushback is needed and the nose gear steering lockout pin is installed:

Electric HYDRAULIC PUMP switches – ON

Verify that the electric pump LOW PRESSURE lights are extinguished.

Verify that the brake pressure is 2,800 psi minimum.

Verify that the system A and B pressures are 2,800 psi minimum.

ANTI COLLISION light switchON F/O

Trim Set C

Check each trim for freedom of movement.

Stabilizer trim – ____ UNITS

Set the trim for takeoff.

Verify that the trim is in the green band.

Aileron trim – 0 units

Rudder trim – 0 units

Call “BEFORE START CHECKLIST.” C

Do the BEFORE START checklist. F/O

Pushback or Towing Procedure

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

Establish communications with ground handling personnel. C

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

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

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

When pushback or towing is complete:

Verify that the tow bar is disconnected C

Verify that the nose gear steering lockout pin is removed C

System A HYDRAULIC PUMPS switches – ON F/O

Verify that the system A pump LOW PRESSURE lights are extinguished.

Verify that the system A pressure is 2800 psi minimum.

Engine Start Procedure

Air conditioning PACK switches OFF F/O

Start pressure ____ psi F/O

The minimum start pressure at sea level is 30 psi. Decrease the minimum start pressure 0.5 psi for each 1,000 feet above sea level.

Start sequence Announce C

Call "START ____ ENGINE" C

ENGINE START switch GRD F/O

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

When N1 rotation is seen and N2 is at 25%, or (if 25% N2 is not possible), at maximum motoring and a minimum of 20% N2:

Note: Maximum motoring occurs when N2 acceleration is less than 1% in approximately 5 seconds.

Engine start lever IDLE C

Monitor fuel flow and EGT indications. C, F/O

At 46% N2, verify that the ENGINE START switch moves to OFF. If not, move the ENGINE START switch to OFF. F/O

Verify that the START VALVE OPEN light extinguishes when the ENGINE START switch moves to OFF. F/O

Call: "STARTER CUTOUT." F/O

Monitor N1, N2, EGT, fuel flow and oil pressure for normal indications while the engine accelerates to a stable idle. C, F/O

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

Starter duty cycle:

- Do not exceed 2 minutes during each start attempt
- A minimum of 20 seconds is needed between the first and second start attempts
- A minimum of three minutes is needed between the second and subsequent start attempts.

Normal engine start considerations:

- do not move an engine start lever to idle early or a hot start can occur
- keep a hand on the engine start lever while monitoring RPM, EGT and fuel flow until stable
- if fuel is shutoff accidentally (by closing the engine start lever) do not reopen the engine start lever in an attempt to restart the engine
- failure of the ENGINE START switch to stay in GRD until the starter cutout RPM can cause a hot start. Do not re-engage the ENGINE START switch until engine RPM is below 20% N2.

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

- the N1 or N2 does not increase or increases very slowly after the EGT increases
- there is no oil pressure indication by the time that the engine is stable at idle
- the EGT does not increase by 10 seconds after the engine start lever is moved to IDLE
- the EGT quickly nears or exceeds the start limit

Before Taxi Procedure

GENERATOR 1 and 2 switches	ON	F/O
PITOT HEAT switches	ON	F/O
WING ANTI-ICE switch	As needed	F/O
ENGINE ANTI-ICE switches	As needed	F/O
PACK switches	AUTO	F/O
ISOLATION VALVE switch	AUTO	F/O
APU BLEED air switch.....	OFF	F/O
FLT/GRD switch	FLT	F/O
APU switch	OFF	F/O
ENGINE START switches	CONT	F/O
Engine start levers	IDLE detent	C
Verify that the ground equipment is clear.		C, F/O
Call "FLAPS ____" as needed for takeoff.		C
Flap lever	Set takeoff flaps	F/O
Verify that the LE FLAPS EXT green light is illuminated.		
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 nose wheel steering wheel 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 As needed F/O

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

Recall Check C, F/O

Verify that all system annunciator panel lights illuminate and then extinguish.

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 requirement:

- verify an increase in engine oil temperature before takeoff

Engine warm up recommendations:

- run the engines for at least 2 minutes
- use a thrust setting normally used for taxi operations.

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.	
Call "BEFORE TAKEOFF CHECKLIST."	Do the BEFORE TAKEOFF checklist.

Takeoff Procedure

Pilot Flying	Pilot Monitoring
	Update the runway position as needed.
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..
	On TCAS equipped airplanes, 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 INBOARD LANDING light switches to ON.
Advance the thrust levers to approximately 40% N1. Allow the engines to stabilize.	
Push the TO/GA switch.	
Verify that the correct takeoff thrust is set.	

Pilot Flying	Pilot Monitoring
	<p>Monitor the engine instruments during the takeoff. Call out any abnormal indications.</p> <p>Adjust takeoff thrust before 60 knots as needed.</p> <p>During strong headwinds, if the thrust levers do not advance to the planned takeoff thrust by 60 knots, manually advance the thrust levers.</p>
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 incitations.
Verify 80 knots and call "CHECK".	Call "80 KNOTS."
Verify V1 speed.	Call "V1".
At VR, rotate toward 15° pitch attitude. After liftoff, follow F/D commands.	At VR, call "ROTATE." Monitor airspeed and vertical speed.
Establish a positive rate of climb.	
	Verify a positive rate of climb on the altimeter and call "POSITIVE RATE."
Verify a positive rate of climb on the altimeter and call "GEAR UP."	
	Set the landing gear lever to UP.
Above 400 feet radio altitude, call for a roll mode as needed.	Select and verify the roll mode.
At thrust reduction height, call "SET CLIMB THRUST."	

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Pilot Flying	Pilot Monitoring
	Push the N1 switch.
Verify that climb thrust is set.	
At acceleration height, call for flaps up maneuvering speed.	
	Set the flaps up maneuvering speed.
Verify acceleration. Call "FLAPS ____" according to the flap retraction schedule.	
	Set the FLAP lever as directed. Monitor flaps and slats retraction.
After flaps and slats retraction is complete, call "VNAV."	
	Push the VNAV switch.
Engage the autopilot when above the minimum altitude for autopilot engagement:	
	After flap retraction is complete: <ul style="list-style-type: none">• Set or verify that the engine bleeds and air conditioning packs are operating• Set the engine start switches as needed• Set the AUTO BRAKE select switch to OFF• Set the landing gear lever to OFF after landing gear retraction is complete
Call "AFTER TAKEOFF CHECKLIST."	

Pilot Flying	Pilot Monitoring
	Do the AFTER TAKEOFF checklist.

CAUTION: Do not allow the shoulder harness straps to retract quickly. Buckles can pull or damage circuit breakers.

Takeoff Flap Retraction Speed Schedule

Takeoff Flaps	At & below 117,000 lbs (53,070 kgs)	Above: 117,000 lbs (53,070 kgs) up to 138,500 lbs (62,823 kgs)	Above: 138,500 lbs (62,823 kgs)	Select Flaps
15	V2 + 15 170 or F 190 or F	V2 + 15 180 or F 200 or F	V2 + 15 190 or F 210 or F	5 1 UP
5	V2 + 15 190 or F	V2 + 15 200 or F	V2 + 15 210 or F	1 UP
1 (737-300)	190	200	210	UP
Limit bank angle to 15° until reaching V2 + 15				
“F” = Minimum flap retraction speed for next flap setting on speed tape display.				

Climb and Cruise Procedure

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

Pilot Flying	Pilot Monitoring
	At or above 10,000 feet MSL, set the LANDING light switches to OFF.
	Set the passenger signs as needed.
At transition altitude, set and crosscheck the altimeters to standard.	
	During climb, set both center tank fuel pump switches to OFF when both center tank fuel pump LOW PRESSURE lights illuminate.
	When established in a level flight attitude, if the center tank contains usable fuel and the center tank fuel pump switches are OFF, set both center tank fuel pump switches to ON again. Set both center tank fuel pump switches to OFF when both center tank fuel pump LOW PRESSURE lights illuminate.
	During an ETOPS flight, additional steps must be done. See the ETOPS supplementary procedure in SP.1.
	Before the top of descent, modify the active route as needed for the arrival and approach. Verify or enter correct RNP for arrival.

Descent Procedure

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

Complete the Descent Procedure by 10,000 feet MSL.

Pilot Flying	Pilot Monitoring
	Set both center tank fuel pump switches to OFF when both center tank fuel pump LOW PRESSURE lights illuminate.
	Verify that pressurization is set to landing altitude.
Review the system annunciator lights.	Recall and review the system annunciator lights.
Verify VREF on the APPROACH REF page.	Enter VREF on the APPROACH REF page.
Set bugs at VREF, (-300/500) VREF+15, (-400) VREF + 20, and flaps up maneuvering speed.	
Set the DH REF/radio altimeter minimums as needed for the approach.	
Set or verify the navigation radios and course for the approach.	
	Set the AUTO BRAKE select switch 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

If a flaps 15 landing is needed because of performance:

GROUND PROXIMITY

FLAP INHIBIT switch FLAP INHIBIT F/O

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

Flap Extension Schedule

Current Flap Position	At Speed (knots) a* / b* / c*	Select Flaps	Command Speed for Selected Flaps a* / b* / c*
Up	210 - 220 - 230	1	190 - 200 - 210
1	190 - 200 - 210	5	180 - 190 - 200
5	180 - 190 - 200	10	170 - 180 - 190
10	170 - 180 - 190	15	150 - 160 - 170
15	150 - 160 - 170	25	140 - 150 - 160
25	140 - 150 - 160	30 or 40	(VREF30 or VREF40) + wind additives

a* = At and below 117,000 lbs/53,070 kgs

b* = Above 117,000 lbs/53,070 kgs and up to 138,500 lbs/62,823 kgs

c* = Above 138,500 lbs/62,823 kgs

Landing Procedure - ILS

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. Monitor flaps and slats extension.
When on localizer intercept heading: <ul style="list-style-type: none">• Verify that the ILS is tuned and identified• Verify that LOC and G/S pointers are shown.	
Arm the APP mode. Engage the other autopilot.	
Use HDG SEL to intercept the final approach course as needed.	
Verify that the localizer is captured.	
	Call "GLIDE SLOPE ALIVE."
At glide slope alive, call: <ul style="list-style-type: none">• "GEAR DOWN"• "FLAPS 15"	Set the landing gear lever to DN. Verify that the green landing gear indicator lights are illuminated. Set the flap lever to 15. Set the engine start switches to CONT.
Set the speedbrake lever to ARM. Verify that the SPEEDBRAKE ARMED light is illuminated.	
At glide slope capture, call "FLAPS__" as needed for landing.	Set the flap lever as directed.
Set the missed approach altitude on the MCP.	
Call "LANDING CHECKLIST."	Do the LANDING checklist.

Pilot Flying	Pilot Monitoring
At the final approach fix or OM, verify the crossing altitude.	
Monitor the approach.	
Verify the AFDS status at 500 feet radio altitude.	

Landing Procedure - Instrument Approach Using VNAV

Non-ILS approaches using VNAV require FMC U7.1 or later.

Use the autopilot during the approach to give:

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

This procedure is not authorized using QFE.

Pilot Flying	Pilot Monitoring
	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. Monitor flaps and slats extension.
The recommended roll modes for the final approach are: <ul style="list-style-type: none">• for a RNAV or GPS approach, use LNAV• for a LOC-BC, VOR or NDB approach, use LNAV• for a LOC, SDF, or LDA approach, use LNAV or VOR/LOC.	
	Verify that the VNAV glide path angle is shown on the final approach segment of the LEGS page.
When on the final approach course intercept heading for LOC, LOC-BC, SDF, or LDA approaches: <ul style="list-style-type: none">• verify that the localizer is tuned and identified• verify that the LOC pointer is shown.	
Use LNAV or arm the VOR/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 or HDG SEL to intercept the final approach course as needed.	

Pilot Flying	Pilot Monitoring
Verify that LNAV is engaged or that the VOR/LOC is captured.	
Approximately 2 NM before the final approach fix and after ALT HOLD or VNAV PTH is annunciated: <ul style="list-style-type: none">• verify that the autopilot is engaged• set DA(H) or MDA(H) on the MCP• select or verify VNAV.	Call "APPROACHING GLIDE PATH."
Approaching glide path, call: <ul style="list-style-type: none">• "GEAR DOWN"• "FLAPS 15"	Set the landing gear lever to DN. Verify that the green landing gear indicator lights are illuminated. Set the flap lever to 15. Set the engine start switches to CONT.
Set the speedbrake lever to ARM. Verify that the SPEEDBRAKE ARMED light is illuminated.	
Beginning the final approach descent, call "FLAPS ____" as needed for landing.	Set the flap lever as directed.
Call "LANDING CHECKLIST."	Do the LANDING checklist.
At the final approach fix, verify the crossing altitude and crosscheck the altimeters.	
Monitor the approach..	
When approximately 300 feet above DA(H) or MDA(H), set the missed approach altitude on the MCP.	
Note: When the missed approach altitude is set, the autopilot pitch mode reverts to CWS P.	

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Pilot Flying	Pilot Monitoring
Continue the final approach descent using the vertical deviation scale and pointer as reference.	
If suitable visual reference is established at DA(H), MDA(H), or the missed approach point, disengage the autopilot and autothrottle. Maintain the glide path to landing.	

Go-Around and Missed Approach Procedure

Pilot Flying	Pilot Monitoring
At the same time: <ul style="list-style-type: none">• push the TO/GA switch• call "FLAPS 15".	Position the flap lever to 15 and monitor flap retraction.
Verify: <ul style="list-style-type: none">• the rotation to go-around attitude• that the thrust increases.	
	Verify that the thrust is sufficient for the go-around or adjust as needed.
Verify a positive rate of climb on the altimeter and call "GEAR UP."	Verify a positive rate of climb on the altimeter and call "POSITIVE RATE." Set the landing gear lever to UP.
	Verify that missed approach altitude is set.
Above 400 feet, select appropriate roll mode and verify proper mode annunciation.	Observe mode annunciation.
If needed, call "TUNE NAV RADIOS FOR MISSED APPROACH."	Tune the navigation radios as directed.
Verify that the missed approach route is tracked.	
At acceleration height, call "FLAPS ____" according to the flap retraction schedule.	Set the flap lever as directed. Monitor flaps and slats retraction.
After flap retraction to the planned flap setting, select LVL CHG. VNAV may be selected if the flaps are up.	
Verify that climb thrust is set.	

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Pilot Flying	Pilot Monitoring
Verify that the missed approach altitude is captured.	
	<p>Set the landing gear lever to OFF after landing gear retraction is complete.</p> <p>Set the engine start switches as needed.</p>
Call “AFTER TAKEOFF CHECKLIST.”	Do the AFTER TAKEOFF checklist.

Landing Roll Procedure

Pilot Flying	Pilot Monitoring
Disengage the autopilot. Control the airplane manually.	
Verify that the thrust levers are closed Verify that the SPEEDBRAKE lever is UP. Without delay, fly the nose wheel smoothly onto the runway.	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 thrust levers are moved, a full stop landing must be made. If an engine stays in reverse, safe flight is not possible.	
Without delay, move the reverse thrust levers to the interlocks and hold light pressure until the interlocks release. Then apply reverse thrust as needed.	
By 60 knots, start movement of the reverse thrust levers to be at the reverse idle detent before taxi speed.	Call "60 KNOTS."
After the engines are at reverse idle, move the reverse thrust levers full down.	
Before taxi speed, disarm the autobrake. Use manual braking as needed.	

After Landing Procedure

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

Engine cooldown recommendations:

- Run the engines for at least 3 minutes
- Use a thrust setting normally used for taxi operations
- Routine cooldown times less than 3 minutes are not recommended.

Pilot Flying	Pilot Monitoring
The captain moves or verifies that the SPEEDBRAKE lever is DOWN.	
	Start the APU, as needed.
	Set the PITOT STATIC HEAT switches to OFF.
	Set the Flight/Ground switch to GRD.
	Set the exterior lights as needed.
	Set the ENGINE START switches to OFF.
	Set the AUTO BRAKE select switch to OFF.
	Set the flap lever to UP.
	Set the transponder mode selector as needed. At airports where ground tracking is not available, select STBY. At airports equipped to track airplanes on the ground, select an active transponder setting, but not a TCAS mode.
Set the weather radar to OFF.	

Shutdown Procedure

Start the Shutdown Procedure after taxi is complete.

Parking brake Set C or F/O

Verify that the parking brake warning light is illuminated.

Electrical power Set F/O

If APU power is needed:

Verify that the APU GENERATOR OFF BUS light is illuminated.

APU GENERATOR bus switches – ON

Verify that the BUS OFF lights are extinguished.

If external power is needed:

Verify that the GRD POWER AVAILABLE light is illuminated.

GRD POWER switch – ON

Verify that the BUS OFF lights are extinguished.

Engine start levers CUTOFF C

Operate the engines at or near idle thrust for a minimum of three minutes before shutdown to thermally stabilize the engines and reduce undercowl soak-back temperatures. Taxi thrust can be considered idle thrust for this purpose.

If idle reverse thrust or no reverse thrust is used during the landing rollout, the three minute period can begin when thrust is reduced to idle for landing.

Routine cooldown times of less than three minutes before engine shutdown can cause engine degradation.

If towing is needed:

Establish communications with ground handling personnel C

WARNING: If the nose gear steering lockout pin is not installed and hydraulic system A is pressurized, any change to electrical or hydraulic power with the tow bar connected may cause unwanted tow bar movement.

Verify that the nose gear steering lockout pin is installed, or, if the nose gear steering lockout pin is not used C

System A HYDRAULIC PUMP switches – OFF

Verify that the system A pump LOW PRESSURE lights are illuminated.

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

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

Set or release the parking brake as directed by ground handling personnel C or F/O

FASTEN BELTS switch OFF F/O

ANTI COLLISION light switch OFF F/O

FUEL PUMP switches OFF F/O

CAUTION: Do not operate the center tank fuel pumps with the flight deck unattended.

CAUTION: Center tank fuel pump switches should be positioned ON only if the fuel quantity in the center tank exceeds 453 kgs/1000 lbs.

GALLEY power switch As needed F/O

WING ANTI-ICE switch OFF F/O

ENGINE ANTI-ICE switches OFF F/O

Hydraulic panel	Set	F/O
ENGINE HYDRAULIC PUMPS switches - ON		
ELECTRIC HYDRAULIC PUMPS switches - OFF		
RECIRCULATION FAN switch(es)	As needed	F/O
Air conditioning PACK switches	Set	F/O
One air conditioning PACK switch - AUTO or HIGH		
Other air conditioning PACK switch - OFF		
ISOLATION VALVE switch	AUTO	F/O
Engine BLEED air switches	ON	F/O
APU BLEED air switch	ON	F/O
Exterior lights switches	As needed	F/O
FLIGHT DIRECTOR switches	OFF	C, F/O
Transponder mode selector	STBY	F/O
After the wheel chocks are in place:		
Parking brake – Release		C or F/O
APU switch	As needed	F/O
Flight deck door (as installed)	Unlock	
Verify that the CABIN DOOR UNLOCKED light is illuminated.		
Call “SHUTDOWN CHECKLIST.”		C
Do the SHUTDOWN checklist.		F/O

Secure Procedure

IRS mode selectors	OFF	F/O
EMERGENCY EXIT LIGHTS switch.....	OFF	F/O
WINDOW HEAT switches.....	OFF	F/O
Air conditioning PACK switches.....	OFF	F/O
Call "SECURE CHECKLIST."		C
Do the SECURE checklist.		F/O

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Supplementary Procedures

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**Supplementary Procedures
Introduction****Chapter SP
Section 05****General**

This section contains procedures (adverse weather operation, engine crossbleed start, and so on) that are accomplished as required rather than routinely performed on each flight.

Supplementary procedures may be required because of adverse weather, unscheduled maintenance or as a result of a procedure referenced in a Non-Normal Checklist. Additionally, some may be performed if the flight crew must accomplish preflight actions normally performed by maintenance personnel.

At the discretion of the captain, procedures may be performed by memory, by reviewing the procedure prior to accomplishment, or by reference to the procedure during its accomplishment.

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.

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Supplementary Procedures

Chapter SP

Airplane General, Emer. Equip., Doors, Windows Section 1

Interior Inspection

Emergency exit lights	Check
Passenger signs	Check
Service and entry doors	Check
Escape slides	Check pressure
Emergency exits	Check
Wing upper surfaces	Check
Lavatory fire extinguishers	Check
Emergency equipment	Check
Check availability and condition of emergency equipment, as required.	

Flight Deck Door Access System Test

Flight deck access system switch	NORM
Flight deck door	Open
Flight deck door lock selector	AUTO
Emergency access code	Enter
ENT key	Push
Verify alert sounds.	
Verify AUTO UNLK light illuminates.	
Flight deck door lock selector	DENY
Verify AUTO UNLK light extinguishes.	
Flight deck door lock selector	UNLKD
Flight deck access system switch	OFF
Verify LOCK FAIL light illuminates.	

-
- Flight deck access system switch NORM
Guard - Down
Verify LOCK FAIL light extinguishes.
-

Water System Draining

In the event the passenger water system becomes contaminated, or the airplane is to be parked in freezing temperatures for an extended period, it may be necessary to completely drain the system to prevent damage to the water lines or other equipment.

The system may be drained either by pressure or by gravity.

Pressure Draining:

- APU ON
APU bleed switch ON
This will pressurize the water tank. If the APU is not usable, an external pneumatic cart may be used by positioning the Isolation Valve switch OPEN. The tank may also be pressurized through a valve on the external servicing panel.

- Water Heaters OFF

CAUTION: Failure to do this could cause damage to the heaters when the water is drained.

- Tank drain valve OPEN
Shutoff/Drain valves DRAIN

When water stops flowing from outlets:

- Tank Drain valve CLOSE
Shutoff/Drain valves ON
Allow 2 minutes for the pressure to stabilize. To exhaust residual water, turn each shutoff/drain valve to DRAIN and then ON. Open each water faucet, galley water drain shutoff valve and coffee maker drain for 2 minutes, and then close. Depressurize the water tank by deactivating the air pressure source.

Gravity Draining:

Water Heaters	OFF
Fill and Overflow valve	OPEN
Tank Drain valve	OPEN
Shutoff/Drain valves	DRAIN
When water stops flowing from outlets:	
Fill and Overflow valve	CLOSE
Tank Drain valve	CLOSE
Shutoff/Drain valves	ON
Open each lavatory faucet and galley outlet to drain residual water.	

Forward Airstair Operation

WARNING: Use care not to fall from the airstair platform when operating the forward entry door. The small platform area and bad weather can make the door difficult to operate.

CAUTION: Do not move airplane with stair extended.

CAUTION: Operation of airstair in winds exceeding 40 knots is not recommended.

Interior Control

WARNING: Open entry door to cocked position to allow clear visibility of area outside airplane to prevent injury to personnel. Do not open door beyond cocked position while operating airstair.

To Extend:

Forward Entry Door	Open to Cocked Position
When operating the airstair from the interior control panel, the forward entry door must be open to the cocked position. Safety circuits prevent airstair operation if the entry door is closed.	

Control Switch	EXTEND
----------------------	--------

Note: For interior standby operation, the battery switch must be ON.

Hold until extension is complete.

The STAIRS OPERATING light illuminates during extension until the airstair is fully extended.

Note: The STAIRS OPERATING light will not illuminate with loss of AC power.

Control switch Release

Handrail Extensions Engage

Release latch and pull inboard and up, extend and engage on supports at sides of forward entry doorway.

To Retract:

Handrail Extensions Disengage

Disengage from door supports, depress latch at base of forward extension to permit retraction within upper segment of handrail. Slide right and left extensions down along upper rails. Stowing in appropriate stowage points provides circuit continuity for energizing retract relay.

CAUTION: Use of the standby control switch bypasses all safety circuits. Airstair handrail extensions must be stowed or substantial damage could result.

Control switch RETRACT

Hold until retraction is complete.

The STAIRS OPERATING light illuminates during retraction until the airstair door is fully closed.

Note: The STAIRS OPERATING light will not illuminate with loss of AC power.

Control switch Release

Exterior Control

To Extend:

Control Handle Push Button to Extend Handle

Control Handle Rotate to Extend

Hold control handle in position until entire extension cycle is complete.

Control Handle Release

Forward entry door Open to cocked position

WARNING: Extend and connect the airstair aft handrail to protect against falling and to prevent injuries to personnel.

Aft handrail extension Engage

Release latch and pull inward and up, extend and engage on the support at the side of the forward entry door.

WARNING: Step down the airstair as the forward entry door moves to the open position to prevent injuries to personnel.

Forward entry door Fully open

Forward handrail extension Engage

Release latch and pull inboard and up, extend and engage on the support side of the forward entry door.

To Retract:

WARNING: Do not disengage the airstair aft handrail at this time. Injuries to personnel can occur during forward entry door operations if the aft handrail is disengaged.

Forward handrail extension Disengage

Disengage from door support, depress latch at base of forward extension to permit retraction within upper segment of handrail. Slide extension down along the upper rail. Stowing in appropriate stowage points provides circuit continuity for energizing retract relay.

WARNING: Step down the airstair as the forward entry door moves to the cocked position to prevent injuries to personnel.

Forward entry door Close to cocked position

Aft handrail extension Disengage

Disengage from door support, depress latch at base of forward extension to permit retraction within upper segment of handrail. Slide extension down along the upper rail. Stowing in appropriate stowage points provides circuit continuity for energizing retract relay.

Forward entry door Fully close

CAUTION: Use of the standby control switch bypasses all safety circuits. Airstair handrail extension must be stowed or substantial damage could result.

Control Handle Rotate to Retract

When airstair is retracted and airstair door is fully closed, release and stow handle.

Oxygen Mask Microphone Test

MASK-BOOM switch MASK

Flight interphone transmitter selector switch Push

Speaker switch ON

RESET/TEST Push and hold

EMERGENCY/TEST selector Push and hold

Push-to-Talk switch I/C

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

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

Push-to-Talk switch Release

RESET/TEST Release

EMERGENCY/TEST selector Release

Speaker switch As needed

MASK-BOOM switch BOOM

ETOPS

Operators conducting ETOPS are required to comply with appropriate regulations. An operator must have an ETOPS configured and approved airplane, and approved flight operations and maintenance programs in place to support ETOPS.

APU Operation

Unless otherwise authorized, start the APU before the ETOPS segment. The APU must be on for the entire ETOPS segment.

Fuel Crossfeed Valve Check

During the last hour of cruise, do the following steps:

- Crossfeed selector Open
Verify that the VALVE OPEN light illuminates bright, then dim.
- Crossfeed selector Close
Verify that the VALVE OPEN light illuminates bright, then extinguishes.

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737 Flight Crew Operations Manual

Supplementary Procedures Air Systems

Chapter SP Section 2

Wing–Body Overheat Test

- Wing–body OVHT TEST switch Push
Hold for a minimum of 5 seconds.
- Both WING–BODY OVERHEAT lights – illuminated
- MASTER CAUTION – illuminated
- AIR COND system annunciator – illuminated
- Wing–body OVHT TEST switch Release
- Both WING–BODY OVERHEAT lights – extinguished
- MASTER CAUTION lights – extinguished
- AIR COND system annunciator – extinguished

External Air Cart Use

CAUTION: The BAT switch should always be on when using the airplane air conditioning system since the protective circuits are DC. This ensures protection in the event of loss of AC power.

- Note:** For engine start with a ground air source, see section SP. 7.
- APU BLEED air switch OFF
- ISOLATION VALVE switch OPEN
- RECIRC FAN switch(es) AUTO
- PACK switch(es) AUTO or HIGH
The operation of two packs from one air source is permitted
provided the external air cart can maintain 20 psi minimum with
both packs operating.
- (737-400) Trim air switch ON
- Cabin temperature selectors AUTO
Set for desired temperature.

Duct pressure 20 psi min.

If external air cannot hold 20 psi minimum and the APU is operating:

ISOLATION VALVE switch AUTO

APU BLEED air switch ON

APU supplies left pack and external air source supplies right pack.

Ground Conditioned Air Use

Before connecting ground conditioned air:

PACK switches OFF

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

After disconnecting ground conditioned air:

PACK switches As required

Using the APU for Heating (on the ground/engines shut down)

Under extremely cold conditions, both packs may be used for more rapid heating.

ISOLATION VALVE switch OPEN

During right pack operation only, under cold conditions, if the left PACK TRIP OFF light illuminates, position the recirculation fan OFF until the cabin temperature stabilizes.

Isolated Pack Operation during Engine Start

To improve cabin air quality between starting the first and second engine:

CAUTION: Moving engine BLEED air switches while a starter is engaged can damage the starter.

Engine No. 2 Start

After engine No. 2 stabilized:

ISOLATION VALVE switch CLOSE

Right PACK switch AUTO

Duct pressure Stabilized

Engine No. 1 Start

After engine No. 1 stabilized:

ISOLATION VALVE switch AUTO

Auto Trip and Standby Check

Pack switches OFF

Pressurization mode selector AUTO

FLT/GND switch GRD

Cabin Altitude indicator 500 feet above field elevation

Captain and First Officer
altimeters Set

Cabin Rate selector Index

Verify pressurization mode lights extinguish and the Outflow Valve Position indicator is at OPEN.

FLT/GND switch FLT

Verify Outflow Valve Position indicator moves toward CLOSE.

Pressurization mode selector Check

Verify the AUTO FAIL and STANDBY lights illuminated and the Outflow Valve Position indicator moves toward OPEN.

Cabin Altitude indicator 500 feet below field elevation

Verify the Outflow Valve Position indicator moves toward CLOSE.

FLT/GND switch GRD

Verify the AUTO FAIL and STANDBY lights extinguished and the Outflow Valve Position indicator moves toward OPEN.

FLT/GND switch FLT

Verify Outflow Valve Position indicator moves toward CLOSE.

Auto Trip and Manual Check

Note: This test must be performed immediately after the Auto Trip and Standby Check to test excessive pressurization rates. If the initial CHECK input has cleared (approximately 30 seconds) the AUTO FAIL and STANDBY lights do not illuminate.

Pack switches	OFF
Pressurization mode selector	AUTO
AUTO FAIL light – illuminated	
STANDBY light - illuminated	
Pressurization mode selector	MAN AC
AUTO FAIL light - extinguished	
STANDBY light - extinguished	
MANUAL light - illuminated	
Outflow valve switch	Hold OPEN
Verify Valve Position indicator moves toward OPEN.	
Outflow valve switch	Hold CLOSE
Verify Valve Position indicator moves toward CLOSE.	
Pressurization Mode selector	MAN DC
MANUAL light - illuminated	
Outflow valve switch	Hold OPEN
Verify Valve Position indicator moves toward OPEN.	
Outflow valve switch	Hold CLOSE
Verify Valve Position indicator moves toward CLOSE.	
FLT/GRD switch	GRD
Pressurization mode selector	AUTO
Verify Valve Position indicator moves toward OPEN.	
MANUAL light - extinguished	

Standby Mode Operation

Before start:

Pressurization mode selector	STBY
Standby light - illuminated	
Cabin Altitude indicator	Set

CAB ALT - takeoff field elevation minus 200 feet

Cabin Rate selector Index

FLT/GND switch GRD

Verify the Outflow Valve Position indicator is full OPEN.

After Start:

Air Conditioning Pack switches AUTO

FLT/GRD switch FLT

After takeoff:

Cabin Altitude indicator Set

Check the placard below the pressurization module for the cabin altitude corresponding to the planned flight altitude. Reset CAB ALT to this altitude.

Cabin Rate selector Adjust

Maintain normal proportional climb rate.

Cruise:

Cabin Altitude indicator Reset

Reset CAB ALT using the placard for flight altitude changes greater than 1000 feet.

Before descent:

Cabin Altitude indicator Set

CAB ALT - landing field elevation minus 200 feet

Descent:

Cabin Rate selector Adjust

Maintain normal proportional descent rate (300-500 fpm.)

After landing:

FLT/GRD switch GRD

Manual Mode Operation

CAUTION: Switch actuation to the manual mode causes an immediate response by the outflow valve. Full range of motion of the outflow valve can take up to 20 seconds.

Pressurization mode selector MAN

MANUAL light – illuminated

CABIN/FLIGHT ALTITUDE placard Check

Determine the desired cabin altitude.

If a higher cabin altitude is desired:

Outflow valve switch (momentarily) OPEN

Verify the outflow valve position indicator moves right, cabin altitude climbs at the desired rate, and differential pressure decreases. Repeat as necessary.

If a lower cabin altitude is desired:

Outflow valve switch (momentarily) CLOSE

Verify the outflow valve position indicator moves left, cabin altitude descends at the desired rate, and differential pressure increases. Repeat as necessary.

During Descent

Thrust lever changes should be made as slowly as possible to prevent excessive pressure bumps.

Outflow valve switch (momentarily) CLOSE

During descent, intermittently position the outflow valve switch toward CLOSE, observing cabin altitude decrease as the airplane descends.

Before entering the landing pattern, slowly position the outflow valve to full open to depressurize the airplane. Verify differential pressure is zero.

Pressurization Control Operation – Landing at Alternate Airport

At top of descent:

- CAB ALT indicatorSET
Set CAB ALT to new destination airport elevation minus 200 feet.
- LAND ALT indicatorReset
Reset to new destination field elevation.
-

Automatic Pressurization Control – Landing Airport Elevation Above 6000 Feet

Do the normal Preflight Procedure - First Officer except as modified below:

Prior to takeoff.

- LAND ALT indicator6000 feet
CAB ALT indicator6000 feet

At initial descent or approximately 20 minutes prior to landing:

- LAND ALT indicator Destination field elevation
CAB ALT indicatorReset
Reset CAB ALT to destination airport elevation minus 200 feet.

Unpressurized Takeoff and Landing

When making a no engine bleed takeoff or landing with the APU inoperative:

Takeoff

- PACK switchesAUTO
ISOLATION VALVE switchCLOSE
Engine BLEED air switchesOFF

CAB ALT indicator	2000 feet above field elevation
Cabin Rate selector	Index
Pressurization mode selector	STBY
FLT/GRD switch	FLT

After Takeoff

Note: If engine failure occurs, do not position engine BLEED air switches ON until reaching 1500 feet or until obstacle clearance height has been attained.

At not less than 400 feet, and prior to 2000 feet above field elevation:

Engine No. 2 BLEED air switch	ON
-------------------------------------	----

When CABIN rate of CLIMB indicator stabilizes:

Engine No. 1 BLEED air switch	ON
-------------------------------------	----

ISOLATION VALVE switch	AUTO
------------------------------	------

Pressurization Mode selector	AUTO
------------------------------------	------

Landing

When below 10,000 feet:

CAB ALT indicator	1500 feet above field elevation
-------------------------	---------------------------------

Cabin Rate Selector	Index
---------------------------	-------

Pressurization Mode selector	STBY
------------------------------------	------

When starting the turn to final approach:

Engine BLEED air switches	OFF
---------------------------------	-----

Avoid high rates of descent for passenger comfort.

No Engine Bleed Takeoff and Landing

When making a no engine bleed takeoff or landing with the APU operating.

Takeoff

Note: If anti-ice is required for taxi, configure for a “No Engine Bleed Takeoff” just prior to takeoff.

Note: If anti-ice is not required for taxi, configure for a “No Engine Bleed Takeoff” just after engine start.

Right PACK switch	AUTO
ISOLATION VALVE switch	CLOSE
Left PACK switch	AUTO
Engine No. 1 BLEED air switch	OFF
APU BLEED air switch.....	ON
Engine No. 2 BLEED air switch	OFF
(737-400) Trim air switch.....	ON
WING ANTI-ICE switch.....	OFF

The WING ANTI-ICE switch must remain OFF until the engine BLEED air switches are repositioned to ON and the ISOLATION VALVE switch is repositioned to AUTO.

After Takeoff

Note: If engine failure occurs, do not position engine BLEED air switches ON until reaching 1500 feet or until obstacle clearance height has been attained.

Engine No. 2 BLEED air switch	ON
APU BLEED air switch.....	OFF
When CABIN rate of CLIMB indicator stabilizes:	

Engine No. 1 BLEED air switch	ON
ISOLATION VALVE switch	AUTO

Landing

If additional go-around thrust is desired configure for a “No Engine Bleed Landing.”

When below 10,000 feet:

WING ANTI-ICE switch	OFF
Right PACK switch	AUTO
ISOLATION VALVE switch	CLOSE
Left PACK switch	AUTO
Engine No. 1 BLEED air switch	OFF
APU BLEED air switch	ON
Engine No. 2 BLEED air switch	OFF

Supplementary Procedures

Anti-Ice, Rain

Chapter SP

Section 3

Anti-Ice Operation

Requirements for use of anti-ice and operational procedures for engine and wing anti-ice are contained in Supplementary Procedures, Adverse Weather, section SP.16.

Rain Repellent Use

Do not actuate rain repellent unless windshield wipers are operating and medium or heavy rain conditions exist.

CAUTION: Do not use rain repellent in an attempt to clean a dry, dirty windshield. If rain repellent is inadvertently applied, do not use the windshield wipers until required for rain removal.

Inflight operation:

Windshield Wiper selector Desired position
Rain Repellent switches Push and hold momentarily (one at a time)

Rain repellent may be used any time rain intensity requires the use of windshield wipers.

One application of repellent should be sufficient for an entire takeoff or landing. Additional applications may be required for takeoff or landing in very heavy rain.

Window Heat System Tests

Overheat Test

The overheat test simulates an overheat condition to check the overheat warning function of the window heat system.

WINDOW HEAT switches ON
WINDOW HEAT TEST switch OVHT
OVERHEAT lights – On

ON lights – Extinguish

Lights extinguish after approximately 1 minute.

MASTER CAUTION – On

ANTI-ICE system annunciator – On

WINDOW HEAT switches Reset

Position the WINDOW HEAT switches OFF, then ON.

Power Test

The power test verifies operation of the window heat system. The test may be accomplished when any of the window heat ON lights are extinguished and the associated WINDOW HEAT switch is ON.

WINDOW HEAT switches ON

Note: Do not perform the power test when all ON lights are illuminated

WINDOW HEAT TEST switch PWR TEST

The controller is forced to full power, bypassing normal temperature control. Overheat protection is still available.

WINDOW HEAT ON lights Illuminated

If any ON light remains extinguished, the window heat system is inoperative. Observe the maximum airspeed limit of 250 kts below 10,000 feet.

Supplementary Procedures Automatic Flight

Chapter SP Section 4

Level Change Climb/Descent

ALTITUDE selector Set desired altitude

Note: If a new MCP altitude is selected while in ALT ACQ, the AFDS engages in V/S and the existing vertical speed is maintained.

LVL CHG switch Push

Verify FMA display:

Thrust mode (climb) – N1

Thrust mode (descent) – RETARD then ARM

Pitch mode – MCP SPD

IAS/MACH selector Set desired speed

Vertical Speed (V/S) Climb/Descent

ALTITUDE selector Set desired altitude

Note: If a new MCP altitude is selected while in ALT ACQ, the AFDS engages in V/S and the existing vertical speed is maintained.

V/S thumbwheel Set desired vertical speed

Verify FMA display:

Thrust mode (climb or descent) – MCP SPD

Pitch mode – V/S

IAS/MACH selector Set desired speed

To transition to the vertical speed mode from another engaged climb or descent mode:

V/S mode switch Push

V/S climb mode engages at existing V/S.

V/S thumbwheel Set desired vertical speed

Verify FMA display:

Thrust mode (climb or descent) – MCP SPD

Pitch mode – V/S

IAS/MACH selector Set desired speed

Note: During V/S climb or descent, ALT ACQ and ALT HOLD occur automatically at the selected altitude.

Altitude Hold

Altitude HOLD switch Push

Verify FMA display:

Pitch mode – ALT HOLD

Heading Select

Heading selector Set desired heading

Heading select switch Push

Verify FMA display:

Roll mode – HDG SEL

VOR Navigation

VHF NAV radio(s) Tune and identified

COURSE selector Set desired course

When on an intercept heading to the VOR course:

VOR LOC mode switch Push

Verify VOR LOC armed mode annunciates.

A/P automatically captures the VOR course.

Verify VOR LOC engaged mode annunciates upon course capture.

Note: If change to a localizer frequency is desired when captured in the VOR mode, disengage VOR LOC mode prior to selection of the localizer. VOR LOC mode can then be reengaged.

Instrument Approach using Vertical Speed (V/S)

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

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

Recommended roll modes:

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

Note: Do not use the VOR/LOC AFDS mode when conducting VOR approaches if the VOR/DME station elevation is more than 5000 feet MSL, if there is no co-located DME transmitter available at the VOR station to be used or when the DME is invalid for any other reason.

Note: (FMC U7.1 and earlier) During VOR approaches, one pilot must have raw data from the VOR associated with the approach displayed in the HSI VOR/ILS mode no later than the final approach fix.

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

RNP appropriate for approach (if required) Verify/Enter
[Allows appropriate alerting to occur if ANP exceeds RNP.]

Before descent to MDA(H):

MCP altitude Set

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

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

At descent point:

Desired V/S Set

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

Verify V/S mode annunciates.

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 a missed approach.

After a suitable visual reference is established:

A/P disengage switch Push

Disengage the autopilot before descending below MDA(H).

A/T disengage switch Push

Disengage the autothrottle before descending below MDA(H).

Circling Approach

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

MCP altitude selector Set

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

Accomplish an instrument approach, establish suitable visual reference and level off at MCP altitude.

Verify ALT HLD mode annunciates.

MCP altitude selector Set missed approach altitude

HDG SEL switch Push

Verify HDG SEL mode annunciates.

Intercepting the landing profile:

- Autopilot disengage switch Push
Autothrottle disengage switch Push

Intentionally
Blank

Supplementary Procedures Communications

Chapter SP Section 5

Aircraft Communication Addressing and Reporting System (ACARS)

The following procedures are applicable to the noted ACARS functions from the company pages.

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 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 values are different, the flight crew must not accept the D-ATIS altimeter setting.

Oceanic Clearances

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

Weight and Balance

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

Takeoff Data

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

Cockpit Voice Recorder Test

Test switch Push

After a slight delay:

Monitor indicator Green band

A tone may be heard through a headset plugged into the headset jack.

Test switch Release

**Supplementary Procedures
Electrical****Chapter SP
Section 6****Electrical Power Up**

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

BATTERY switch	Guard closed
STANDBY POWER switch	Guard closed
ALTERNATE FLAPS master switch	Guard closed
Windshield WIPER selector(s)	OFF
ELECTRIC HYDRAULIC PUMPS switches	OFF
LANDING GEAR lever	DN

Verify that the green landing gear indicator lights are illuminated.

Verify that the red landing gear indicator lights are extinguished.

WEATHER RADAR	Off
---------------------	-----

If external power is needed:

Verify that the GRD POWER AVAILABLE light is illuminated.

GRD POWER switch – ON

Verify that the BUS OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the STANDBY PWR OFF light is extinguished.

If APU power is needed:

Verify that the engine No. 1, APU and the engine No. 2 fire switches are in.

Alert ground personnel before the following test is accomplished.

OVHT DET switches – NORMAL

TEST switch – Hold to FAULT/INOP

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Verify that the FAULT light is illuminated.

If the FAULT light fails to illuminate, the fault monitoring system is inoperative.

Verify that the APU DET INOP light is illuminated.

Do not run the APU if the APU DET INOP light does not illuminate.

TEST switch – Hold to OVHT/FIRE

Verify that the fire warning bell sounds.

Verify that the master FIRE WARN lights are illuminated.

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Master FIRE WARN light – Push

Verify that the master FIRE WARN lights are extinguished.

Verify that the fire warning bell cancels.

Verify that the engine No. 1, APU and the engine No. 2 fire switches stay illuminated.

Verify that the ENG 1 OVERHEAT and ENG 2 OVERHEAT lights stay illuminated.

Extinguisher test switch – Check

TEST switch - Position to 1 and hold

Verify that the three green extinguisher test lights are illuminated.

TEST switch - Release

Verify that the three green extinguisher test lights are extinguished.

Repeat for test position 2.

APU - Start

Note: If extended APU operation is needed on the ground, position an AC operated fuel pump ON. If fuel is loaded in the center tank, position the left center tank fuel pump switch ON to prevent a fuel imbalance before takeoff.

CAUTION: Center tank fuel pump switches should be positioned ON only if the fuel quantity in the center tank exceeds 453 kgs/1000 lbs.

CAUTION: Do not operate the center tank fuel pumps with the flight deck unattended.

Note: Whenever the APU is operating and AC electrical power is on the airplane busses, operate at least one fuel boost pump to supply fuel under pressure to the APU to extend the service life of the APU fuel control unit.

When the APU GEN OFF BUS light is illuminated:

APU GENERATOR bus switches - ON

Verify that the BUS OFF lights are extinguished.

Verify that the TRANSFER BUS OFF lights are extinguished.

Verify that the STANDBY PWR OFF light is extinguished.

Verify that the APU MAINT light is extinguished.

Verify that the APU LOW OIL PRESSURE light is extinguished.

Verify that the APU FAULT light is extinguished.

Verify that the APU OVER SPEED light is extinguished.

Wheel well fire warning system Test

Test switch – Hold to OVHT/FIRE

Verify that the fire warning bell sounds.

Verify that the master FIRE WARN lights are illuminated.

Verify that the MASTER CAUTION lights are illuminated.

Verify that the OVHT/DET annunciator is illuminated.

Fire warning BELL CUTOUT switch – Push

Verify that the master FIRE WARN lights are extinguished.

Verify that the fire warning bell cancels.

Verify that the WHEEL WELL light stays illuminated.

Electrical Power Down

This procedure assumes the Secure procedure is complete.

If APU was operating:

It is recommended that the APU be operated for one full minute with no pneumatic load prior to shutdown.

APU switch and/or GRD POWER switch OFF

If APU was operating:

Delay approximately 20 seconds after APU shutdown for the APU door to close to assure the APU will start on the next flight.

BATTERY switch OFF

Standby Power Test

Battery switch ON

AC-DC meter selectors STBY PWR

APU GEN No. 2 switch or GRD PWR switch OFF

Turn OFF appropriate switch depending on power source in use.

Removes power from TR 3.

STANDBY POWER switch OFF

Check STANDBY PWR OFF light illuminated.

AC-DC voltmeters Zero

STANDBY POWER switch BAT

Check STANDBY PWR OFF Light extinguished

AC-DC voltmeters Check

AC voltmeter 115 +/- 5 volts

DC voltmeter 26 +/- 4 volts

Frequency meter Check

Check frequency meter for normal indication: 400 +/- 10 CPS.

STANDBY POWER switch AUTO

APU GEN No. 2 switch or GRD PWR switch ON

Intentionally
Blank

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Supplementary Procedures Engines, APU

Chapter SP Section 7

Battery Start

(With APU bleed or ground air available)

Maintenance documents Check

FLIGHT DECK ACCESS SYSTEM
switch (as installed) Guard closed

BATTERY switch Guard closed

ELECTRIC HYDRAULIC PUMPS switches OFF

LANDING GEAR lever DN

Verify that the green landing gear indicator lights are illuminated.

Verify that the red landing gear indicator lights are extinguished.

Weather radar Off

Emergency equipment Check

Fire extinguisher - Checked and stowed

Crash axe - Stowed

Escape ropes - Stowed

Other needed equipment - Checked and stowed.

Flight recorder switch Guard closed

Circuit breakers (P6 panel) Check

Crew oxygen valve Open

Rain repellent Check

Verify that the float is above the line and shutoff valve handle is in the vertical position.

Circuit breakers (control stand, P18 panel) Check

Accomplish the Interior and Exterior Inspection if required, except for items requiring electrical or hydraulic power.

Verify that the oxygen pressure is sufficient for flight.

Accomplish the following Preflight Procedure - First Officer items:

Overheat and fire protection panel Check

OVERHEAT DETECTOR switches - NORMAL

TEST switch - Hold to FAULT/INOP

TEST switch - Hold to OVHT/FIRE

EXTINGUISHER TEST switch - Check

APU switch

(bleed air source, if available) START

On the captain's command, the first officer reads and the captain does the following items:

Oxygen Test and set

Standby power BAT

GALLEY power switch ON

EMERGENCY EXIT LIGHTS switch Guard closed

Passenger signs Set

HYDRAULIC PUMP switches ON

Air conditioning panel Set

PACK switches - One switch AUTO or HIGH, one switch OFF

Engine BLEED air switches - ON

APU BLEED air switch - ON

SPEED BRAKE lever DOWN detent

Reverse thrust levers Down

Forward thrust levers Closed

Parking brake Set

Note: The wheels should be chocked in case the brake pressure has bled down.

Engine start levers CUTOFF

Papers Aboard

When cleared for Engine Start, do the following:

Air conditioning PACK switches OFF

ANTICOLLISION light switch ON

Ignition select switch IGN-R

Engine Start

Engine No. 1 start Accomplish

Only N1, N2, EGT and fuel flow indications are displayed.

Generator 1 switch ON

IRS mode selectors OFF, then NAV

Verify that the ON DC lights illuminate, then extinguish.

Verify that the ALIGN lights are illuminated.

FMC/CDU Set IRS position

Verify that the following are sufficient for flight:

- hydraulic quantity
- engine oil quantity

WARNING: If engine No. 1 was started using a ground air source, to minimize the hazard to ground personnel, the external air should be disconnected and engine No. 2 started using the Engine Crossbleed Start procedure.

Engine No. 2 start Accomplish

Generator 2 switch ON

Cabin pressurization panel Set

FLIGHT ALTITUDE indicator - Cruise altitude

LANDING ALTITUDE indicator - Destination field elevation

CABIN rate selector - Index

CABIN ALTITUDE indicator - 200 feet below destination field elevation

FLT/GRD switch - GRD

Pressurization mode selector - AUTO

Verify that the STANDBY light is extinguished.

Verify that the MANUAL light is extinguished.

Complete the Preliminary Preflight Procedure - Captain or First Officer by doing the following items:

SERVICE INTERPHONE switch OFF

ENGINE panel Set

Verify that the REVERSER lights are extinguished.

PMC switches – ON

Verify that the INOP lights are extinguished.

Verify that the LOW IDLE light is extinguished.

Oxygen panel Set

CREW OXYGEN pressure indicator - Check

Verify that the pressure meets dispatch requirements.

Note: PASSENGER OXYGEN switch activation causes deployment of the passenger oxygen masks.

PASSENGER OXYGEN switch - Guard closed

Verify that the PASS OXY ON light is extinguished.

Manual gear extension access door Closed

Accomplish the normal CDU Preflight Procedure - Captain and First Officer, Preflight Procedure - First Officer, Preflight Procedure - Captain, Before Start Procedure and Before Taxi Procedure to ensure that the flight deck preparation is complete.

BEFORE TAXI checklist Accomplish

IRS alignment Complete

The airplane is ready for taxi. Refer to the normal checklists for subsequent checks.

Engine Crossbleed Start

Prior to using this procedure, ensure that the area to the rear is clear.

Engine BLEED air switches ON

APU BLEED air switch OFF

PACK switches OFF

ISOLATION VALVE switch AUTO

Ensures bleed air supply for engine start.

Engine thrust lever

(operating engine) Advance thrust lever until bleed
duct pressure indicates 30 PSI

Non-operating engine Start

Use normal start procedures with crossbleed air.

After starter cutout, adjust thrust on both engines, as required.

High Altitude Airport Engine Start (above 8400 feet)

For airplanes certified for operation at high altitude airports, accomplish the following:

Ignition select switch Both

Engine start Accomplish

The minimum start pressure is 30 psi minus .5 psi for each 1000 feet above sea level. An indication of N1 rotation plus a minimum of 20% N2 are required prior to introducing fuel to the engine. Engine acceleration will be much slower than during starts at lower altitudes. The engine start switch must be held to the GRD position until N2 RPM reaches 50%.

CAUTION: Do not attempt to re-engage the starter above 20% N2 if it is inadvertently allowed to cut out at 46% N2.

Note: Fuel fogging from the engine exhaust may occur during a normal high altitude airport start.

PMC off Takeoff and Climb

This procedure must be accomplished only if PMC OFF performance data is available for the type of engines installed.

- PMC switches OFF
FMC/CDU TAKEOFF REF page Select
OAT Enter
Enter the actual airport ambient temperature.

Note: N1 RPM will increase as speed increases during takeoff. The RPM increase could be as much as 7% depending on temperature and pressure altitude. The takeoff performance figures for PMC OFF account for the RPM change. DO NOT reduce thrust during takeoff unless engine parameters exceed other limits.

(CFM 56-3 engines operating at 22,000 pounds of takeoff thrust)

- SEL TEMP Enter

With air conditioning pack switches AUTO for takeoff:

If OAT is 50°F to 73°F (10°C to 23°C) and PA is 6,000 to 10,000 feet, enter 73°F (23°C) for SEL TEMP.

With air conditioning pack switches OFF for takeoff:

If OAT is 50°F to 81°F (10°C to 27°C) and PA is 3,000 to 10,000 feet, enter 81°F (27°C) for SEL TEMP.

If the above parameters are not applicable, do not enter SEL TEMP. In this case, takeoff may be accomplished using OAT for temperature reference.

If FMC is inoperative or not used:

- N1 cursors Set
Set full rated thrust value for PMC OFF.

Takeoff thrust Set
Set thrust manually or with autothrottle by 60 knots.

After takeoff

Thrust levers (if required) Adjust

The N1 setting should be monitored throughout the climb, and the thrust levers reset as necessary. The pilot not flying will compute the thrust setting for cruise speed schedule prior to reaching cruise altitude.

Starting with Ground Air Source (AC electrical power available)

Engine No. 1 must be started first.

When cleared to start:

APU BLEED air switch OFF

Engine No. 1 start Accomplish

Use normal start procedures.

WARNING: To minimize the hazard to ground personnel, the external air should be disconnected, and engine No. 2 started using the Engine Crossbleed Start procedure.

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**Supplementary Procedures
Fire Protection****Chapter SP
Section 8****Fire and Overheat System Test with an Inoperative Loop**

To determine the specific inoperative loop:

OVHT DET switches A

Test switch OVHT/FIRE

If the FAULT light remains extinguished and both ENG OVERHEAT lights and engine fire switches illuminate, loop A is good.

If the FAULT light illuminates and one of the ENG OVERHEAT lights and corresponding engine fire switch remain extinguished, there is a fault in loop A of the detection system of that engine.

OVHT DET switches B

Test switch OVHT/FIRE

If the FAULT light remains extinguished and both ENG OVERHEAT lights and engine fire switches illuminate, loop B is good.

If the FAULT light illuminates and one of the ENG OVERHEAT lights and corresponding engine fire switch remain extinguished, there is a fault in loop B of the detection system of that engine.

OVHT DET switches As required

Select the good loop for each engine (NORMAL if both loops tested good).

Test switch OVHT/FIRE

If the test is successful, leave the fire panel in this configuration for flight.

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**Supplementary Procedures
Flight Instruments****Chapter SP
Section 10****Altimeter Difference**

Note: If flight in RVSM airspace is planned, use the RVSM table in the limitations section.

This procedure is accomplished when there is a noticeable difference between the altimeters. Accomplish this procedure in stabilized level flight or on the ground.

Altimeters Set

The reference barometric setting for this check is field barometric pressure or standard barometric pressure (29.92 in Hg or 1013 mb) as appropriate. Perform the following for all altimeters:

- First rotate the Baro Set knob clockwise to a higher barometric setting than the reference.
- Then rotate the Baro Set knob counterclockwise back to the reference barometric setting.

Altimeters Crosscheck

Maximum differences between the altimeter readings:

ALTITUDE	ELEC/ELEC	ELEC/STBY
Sea level	50 feet	60 feet
5,000 feet	50 feet	80 feet
10,000 feet	60 feet	120 feet *
15,000 feet	70 feet	see note
20,000 feet	80 feet	see note
25,000 feet	100 feet	see note
30,000 feet	120 feet	see note
35,000 feet	140 feet	see note
40,000 feet	160 feet	see note

* For the 737-400, the maximum ELEC/STBY altimeter difference is 200 feet at an altitude of 10,000 feet.

Note: Above 10,000 feet and .4 Mach, position error causes the tolerance to diverge rapidly and direct crosscheck becomes inconclusive. Between 10,000 feet and 29,000 feet, differences greater than 400 feet should be suspect and verified by ground maintenance checks. Between 29,000 feet and the maximum operating altitude, differences greater than 500 feet should be suspect and verified by ground maintenance checks.

If it is not possible to identify which altimeter is indicating the correct altitude:

ATC Notify

QFE Operation

This procedure is accomplished when ATC altitude assignments are referenced to QFE altimeter settings.

Note: Do not use LNAV or VNAV below transition altitude/level. Altitudes in the navigation database are not referenced to QFE. Use only raw data for navigation.

Altimeters Set

Set altimeters to QFE when below transition altitude/level.

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

Landing Altitude Indicator Set at zero

Cabin Altitude Indicator Set at -200

**Supplementary Procedures
Flight Management, Navigation****Chapter SP
Section 11****Tests****Transponder Test**

Transponder switch TEST

Check that the FAIL light illuminates.

Check that all code segments illuminate. Verify that no error codes exist.

Verify "TCAS SYSTEM TEST - OK" aural sounds.

Aural Alerts	Definition
"TCAS SYSTEM TEST FAIL"	Test failed. Maintenance required.
"TCAS SYSTEM TEST OK"	Test complete. System operable.

Weather Radar Test

EHSI mode selector Expanded scale mode except PLAN

TEST ON

WXR ON

Verify test pattern consists of the following colors:

- Green
- Yellow
- Red
- Magenta.

Verify no fault messages are present.

IRS**Align Light(s) Flashing**

Do not move IRS Mode selector to OFF except where called for in procedure.

POS INIT page Select

Set IRS position Enter present position

Enter present position using the most accurate latitude and longitude available. If the present position is being entered via the CDU and a position is already displayed on the SET IRS POS line, enter new position over displayed position.

If ALIGN light continues to flash:

Set IRS position Enter present position

Re-enter same present position.

If ALIGN light continues to flash after re-entry:

IRS OFF

Rotate IRS Mode Selector to OFF and verify ALIGN light extinguished.

Note: Light must be extinguished before continuing with procedure (approximately 30 seconds.)

IRS NAV

Rotate IRS Mode Selector to NAV and verify ALIGN light illuminated.

Set IRS position Enter

Enter present position. If ALIGN light flashes, re-enter same present position over displayed position.

Note: Approximately ten minutes are required for alignment.

If ALIGN light continues to flash, maintenance action is required.

Fast Realignment

Prior to commencing this procedure the airplane must be parked and not moved until the procedure is completed and the ALIGN lights extinguished.

FMC/CDU POS INIT page Select
Enter the correct present position (PPOS) into the scratch pad. Use the most accurate PPOS available.

IRS mode selector ALIGN
Observe ALIGN light illuminates steadily.

FMC/CDU POS INIT page Select

Press line select key (LSK) 4R when box prompts appear. Confirm that the box prompts are replaced by the entered present position. If ALIGN light flashes then re-enter the same position into the scratch pad even if it is already displayed under the SET IRS POS line.
Press LSK 4R. (Box prompts are not required for present position re-entry.)

IRS mode selector NAV

Observe ALIGN light extinguished within 30 seconds.

If ALIGN light continues to flash, then refer to the section on IRS ALIGN light flashing.

Note: If time permits it is preferable to perform a full alignment of the IRS. A more precise alignment will result.

If the mode selector is accidentally switched to OFF or ATT, position mode selector to OFF, wait for ALIGN light(s) to extinguish, then perform full alignment procedure.

High Latitude Alignment

This procedure should be followed when aligning the IRS systems at latitudes greater than 70° 12.0 and less than 78° 15.0.

IRS mode selectors ALIGN

Position Initialization page Set

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

The IRS mode selectors must be in ALIGN for a minimum of 17 minutes.

IRS mode selectors NAV

IRS Entries

Present Position Entry

IRS mode selector NAV

ALIGN lights must be illuminated (steady or flashing).

IRS display selector PPOS

Latitude Enter

Key-in latitude in the data display, beginning with N or S, then press the ENT Key (the Cue Lights extinguish).

Longitude Enter

Key-in longitude in the data display, beginning with E or W, then press the ENT key (the cue lights extinguish). Observe that proper latitude and longitude are displayed and that the ALIGN light is not flashing.

Heading – Enter Through CDU

FMC/CDU POS INIT page Select

Enter the correct heading into the CDU scratch pad then press line select key 5R. Verify entered heading appears on line 5R. Select HDG on the IRS display selector and verify that the entered heading is displayed on the navigation displays.

Heading – Enter through ISDU

IRS display selector HDG

Press the H key to initiate a heading entry.

Key-in present magnetic heading. Press the ENT key (the cue lights extinguish). Observe proper heading displayed on the navigation displays.

Inadvertent Selection of Attitude Mode (while on the ground)

Inadvertent selection of the attitude mode may be due to physically overpowering the switch during turn-on, or the result of a faulty switch where the flight crew cannot accurately determine which mode is selected. If the ATT position is selected inadvertently when switching to NAV, the IRS must be turned off, and after the ALIGN lights extinguish, a full alignment must be initiated.

Flight Management

Lateral Navigation Using the FMC/CDU

Direct To or Intercept Course (overwrite)

RTE LEGS page Select

On page 1/XX, line 1L, enter the desired waypoint over the presently active waypoint.

Observe INTC CRS prompt in line 6R.

If intercepting a leg to the waypoint, enter the desired intercept course in the INTC CRS line.

Correct any ROUTE DISCONTINUITY if the entered waypoint was not in the original flight plan.

EXEC key Push

Observe the MOD RTE LEGS page changes to ACT.

LNAV may disengage after execution of an intercept leg to a waypoint. If LNAV disengages, turn to a heading to satisfy LNAV capture criteria.

Direct To (DIR/INTC key)

DIR INTC key Push

Observe DIRECT TO box prompts displayed in line 6L.

Enter the desired waypoint on the DIRECT TO line. Observe the waypoint automatically transfers to line 1L.

Correct any ROUTE DISCONTINUITY if the entered waypoint was not in the original flight plan.

EXEC key Push

Observe the MOD RTE LEGS page changes to ACT.

Intercept Leg To (DIR/INTC key)

DIR INTC key Push

Observe INTC LEG TO box prompts displayed in line 6R.

Enter the desired waypoint on the INTC LEG TO line. Observe the waypoint automatically transfers to line 1L.

Observe INTC CRS prompt displayed in line 6R. Enter the desired intercept course in the INTC CRS line. Observe the desired course is displayed on line 6R but, with magnetic variation differences, in line 1.

Correct any ROUTE DISCONTINUITY if the entered waypoint was not in the original flight plan.

EXEC key Push

Observe the MOD RTE LEGS page changes to ACT.

LNAV may disengage after execution of an intercept leg to a waypoint. If LNAV disengages, turn to a heading to satisfy LNAV capture criteria, as described in Chapter 11, and then engage LNAV.

Route Modification

RTE LEGS or RTE page Select

Line select existing waypoints in the desired sequence.

Key-in any new waypoints in the scratch Pad and line select into the flight plan. Correct any ROUTE DISCONTINUITIES.

EXEC key Push

Observe the MOD RTE or MOD RTE LEGS page changes to ACT.

Linking a Route Discontinuity

Correct the ROUTE DISCONTINUITY by entering or deleting waypoints in a sequence that provides a continuous flight-plan path.

EXEC key Push

Observe the MOD RTE or MOD RTE LEGS page changes to ACT.

Determining ETA and Distance to Cross Radial (Bearing) or Distance From a Fix

FIX INFO page Select

Enter the identifier of the reference waypoint (normally an off-route waypoint) onto the FIX line. Enter the desired radial or distance from the FIX on a RAD/DIS line, or line select the ABM prompt if the desired radial from the FIX is perpendicular to the present route/course.

Time and distance to go Check

Check ETA and DTG, as desired.

Note: If ETA and DTG are not displayed, the fix entered is not on the current planned route or it has already been passed.

Changing Destination

RTE page Select

Enter the new destination over the original DEST. Enter desired routing to the new destination using the RTE, RTE LEGS, and ARRIVALS pages, as appropriate. Correct any ROUTE DISCONTINUITY.

EXEC key Push

Observe the MOD RTE or MOD RTE LEGS page changes to ACT.

Note: If destination is changed during climb, performance predictions may be blanked if the new flight plan is incompatible with the entered cruise altitude. Correct by entering a lower CRZ ALT on the CLB page.

Entering Holding Fix Into Route

HOLD key Push

If the RTE HOLD page is displayed, observe the NEXT HOLD prompt. Line select 6L until the (RTE LEGS) HOLD AT page is displayed.

Observe that HOLD AT box prompts and the PPOS prompt (if in flight) are displayed. Enter the holding fix in line 6L, or line select PPOS.

If the holding fix is a waypoint in the active route, or PPOS was selected, observe the MOD RTE HOLD page displayed. If the holding fix is a waypoint not in the active route, observe the message HOLD AT XXXXX displayed in the scratch pad. Enter the holding fix into the route by line selecting in the desired waypoint sequence. Observe the MOD RTE HOLD page displayed. If displayed holding details are incorrect or inadequate, enter correct information on the appropriate line(s).

EXEC key Push

Observe the MOD RTE HOLD page changes to RTE HOLD (ACT RTE HOLD if holding at PPOS).

Exiting Holding Pattern

HOLD key Push

Observe EXIT HOLD prompt displayed.

EXIT HOLD line select key Push

Observe EXIT HOLD prompt changes to EXIT ARMED.

EXEC key Push

Observe that EXIT ARMED is highlighted in reverse video and LNAV flight returns to the holding fix and resumes the active route.

Note: The holding pattern may be exited by performing a DIRECT TO modification if desired. In this case, the flight path may not return to the holding fix before proceeding to the selected waypoint.

Entering Created Waypoints on the Route or Route Legs Pages

Note: Created waypoints are stored in the temporary navigation data base for one flight only.

RTE or RTE LEGS page Select

Using any of the following methods, key into the scratch pad the parameters which define the new created waypoint (the place identifiers must already be stored in one of the FMC data bases):

- Place bearing/distance (for example, SEA250/40);
- Place bearing/place bearing (for example, SEA180/ELN270);
- Along-track displacement (for example, SEA/-10);
- Latitude and longitude (for example, N4731.8W12218.3).

Enter into the route by line selecting to the appropriate waypoint sequence.

Repeat the above steps to define additional created waypoints as desired. Correct any ROUTE DISCONTINUITY.

EXEC key Push

Observe the MOD RTE or MOD RTE LEGS page changes to ACT (for an inactive route, ACTIVATE and EXECute on the RTE or RTE LEGS page).

Along Track Displacement

RTE LEGS page Select

Line select the reference waypoint to the scratch pad. Add a “/” and the + or - distance desired. (EX: SEA/15 for a point 15 miles downtrack from SEA.)

Line select the reference waypoint. (The FMC will automatically position the created waypoint to the appropriate position.)

EXEC key Push

Observe the MOD RTE LEGS page change to ACT.

Entering Created Waypoints on the Nav Data Pages

Note: Created waypoints entered on the SUPP NAV DATA pages (permitted on the ground only) are stored in the supplemental navigation data base for an indefinite time period; those entered on the REF NAV DATA pages are stored in the temporary navigation data base for one flight only.

INIT/REF key Push

Observe the INDEX prompt displayed.

INIT/REF INDEX page Select

Observe the NAV DATA prompt displayed. To access the SUPP NAV DATA page, key SUPP into the scratch pad.

NAV DATA page Select

If the SUPP NAV DATA page is selected, observe the EFF FRM date line displayed. Enter the current or appropriate date on line 3R and EXECute.

Enter a crew-assigned identifier on either the WPT IDENT, NAVAID IDENT, or AIRPORT IDENT line, as appropriate. Use the navaid category only for stations with DME.

DATA Enter

For a WPT IDENT entry, define the waypoint with entries for either latitude and longitude, or with entries for REF IDENT and RADIAL/DIST (the REF IDENT identifier must already be stored in one of the FMC data bases).

For a NAVAID IDENT or AIRPORT IDENT entry, enter appropriate data.

The EXEC key illuminates when data has been entered into all box prompts.

EXEC key Push

Repeat the above steps to define additional created waypoints as desired. To enter a new identifier in the same category, simply overwrite the previous identifier.

Note: To enter a created waypoint into the flight plan, key the identifier into the scratch pad and follow the route modification procedure.

Deleting Created Waypoints on the Nav Data Pages

INIT/REF key Push
Observe the INDEX prompt displayed.

INIT/REF INDEX page Select
Observe the NAV DATA prompt displayed. (U3 and on) To access the SUPP NAV DATA page, key SUPP into the scratch pad.

NAV DATA page Select
Enter the identifier on either the WPT IDENT, NAVAID IDENT, or AIRPORT IDENT line, as appropriate.

DATA Delete
Press the DEL Key and then line select the identifier. Observe the EXEC Key illuminate.

EXEC Key Push
Data previously entered is deleted. Observe NAV DATA page displayed with prompts.

Entering a Crossing Radial (Bearing) or Distance from a Fix as a Route Waypoint

FIX INFO page Select

Enter the identifier of the reference waypoint (normally an off-route waypoint) onto the FIX line. Enter the desired radial or distance from the FIX on a RAD/DIS line, or line select the ABM prompt if the desired radial or distance from the FIX is perpendicular to the present route/course.

Line select the desired intersection (lines 2L–5L) into the scratch pad and observe the new created waypoint displayed as FIX/Radial/Distance.

RTE LEGS page Select

Line select the new created waypoint, displayed in the scratch pad, to the desired waypoint sequence.

Repeat the above steps to define additional created waypoints as desired. Correct any ROUTE DISCONTINUITIES.

EXEC key Push

Observe the MOD RTE LEGS page changes to ACT.

Note: These created waypoints are stored in the temporary navigation data base for one flight only.

Inhibiting VOR/DME Stations

For airplanes with U3.1 to U6.2

Note: This procedure provides the capability to inhibit the use of specific navaid stations.

INIT/REF key Push

Observe the INDEX prompt displayed.

INIT/REF INDEX page Select

Observe the NAV DATA prompt displayed.

REF NAV DATA page Select

Enter desired identifier in 4L-4R for DME INHIBIT and 5L-5R for VOR INHIBIT.

Inhibiting VOR/DME stations

For airplanes with U7.0 and on

Note: This procedure provides the capability to inhibit the use of specific navaid stations. It also provides the capability of selecting the use of VOR or DME for position updating.

PROG page Select
Observe the NAV STATUS prompt displayed.

NAV STATUS page Select
NAV OPTIONS page Select (NEXT/PREV page of NAV STATUS page)

Enter desired identifier in 1L-1R for DME INHIBIT and 2L-2R for VOR INHIBIT. To select the ON or OFF UPDATE function, line select 3L for DME UPDATE and 4L for VOR UPDATE.

Entering a Lateral Offset (U7 and greater)

RTE page Select
Observe the OFFSET prompt displayed.

LATERAL OFFSET page Select
Observe dash prompts for OFFSET DIST.

OFFSET DIST Enter
Enter desired offset distance using format Lxx or Rxx for left or right offset up to 99 nm. Observe the dash prompts for START WAYPOINT and END WAYPOINT.

START/END WAYPOINT Enter
If no start/end waypoint is entered, offset will begin/end at first/last valid offset leg.

FMC Navigation Check

If the IRS NAV ONLY, VERIFY POSITION or UNABLE REQUIRED NAV PERFORMANCE – RNP message is shown in the CDU scratch pad, or course deviation is suspected, do the following as necessary to ensure navigation accuracy:

Ensure that one VOR is operating in the AUTO tuning mode so that the FMC can update its position if navaids are available. Check the (prior to U7) PROGRESS or (U7 and on) NAV STATUS page to ensure that radio updating is occurring. In some cases, it may be necessary to switch both VOR's to the AUTO mode to achieve radio updating.

Determine the actual airplane position using raw data from the VHF navigation or ADF radios and compare that position with the FMC position. (Use the FIX page.)

If radio navaids are unavailable, compare the FMC position with the IRS positions using the POS REF page of the FMC CDU. If the two IRS positions are in agreement and the FMC position is significantly different, the FMC position is probably unreliable. The POS SHIFT page may be used to shift the FMC position to one of the IRS positions. This is accomplished by line selecting the IRS or radio position and then pressing the EXEC Key.

Confirm actual position with ATC radar or visual reference points if available.

Navigate using the most accurate information available. The possibilities are: LNAV (continue to monitor FMC position using VOR/ADF raw data displays on the non-flying pilot's EHSI).

CAUTION: Navigating in the LNAV mode with an unreliable FMC position may result in significant navigation errors.

Conventional VOR/ADF procedures. Radar vectors from ATC. Dead reckoning from last known position. Use of visual references.

Lateral Navigation Using the AN/CDU (as installed)**Entering Active FMC Flight Plan into AN/CDU**

INIT/REF key Push
Observe the INDEX prompt is displayed.

INIT REF INDEX page Select

Press the INDEX prompt. Observe the INIT REF INDEX page displayed and the IRS NAV prompt in line (5R).

IRS LEGS page Select

Press the IRS NAV prompt. Observe the IRS LEGS page displayed and the prompt in line 5L: CROSSLOAD prompt if an active FMC flight plan exists; LAST FMC PLAN prompt if the FMC has failed and an active FMC flight plan existed prior to the failure.

FMC flight plan Enter

Line select 5L to display the active (or most recent) flight plan. A maximum of 20 waypoints can be displayed. Undefined procedural legs contained in the FMC flight plan are bypassed in the AN/CDU flight plan. Modify the flight plan if desired.

EXEC key Push

Observe the IRS LEGS page changes to ACT.

Note: If the present FMC flight plan exceeds 20 waypoints: Repeat the above procedure during flight to update the AN/CDU flight plan with additional waypoints.

Manual Entry of AN/CDU Flight Plan

INIT/REF key Push

Observe the INDEX prompt is displayed.

INIT REF INDEX page Select

Press the INDEX prompt. Observe the INIT REF INDEX page displayed and the IRS NAV prompt in line (5R).

IRS LEGS page Select

Key any of the following into the scratch pad:

- For a crew assigned identifier, key in the identifier (6 characters maximum) followed by latitude and longitude (for example, SIMONE/N4802.2W12241.3).
- For an AN/CDU assigned identifier, key in only latitude and longitude (for example, S3618.5E14136.9). The AN/CDU assigns a sequential identifier WPT01, etc.
- If repeating an identifier which is already in the flight plan, key in only the identifier (for example, SEA).

Enter each waypoint into the route by line selecting to the desired sequence. A maximum of 20 waypoints can be in the flight plan at any one time. If required, additional waypoints can be entered as the flight progresses.

EXEC key Push

Observe the IRS LEGS page changes to ACT.

Proceeding Direct to a Waypoint

IRS LEGS page Select

Key any of the following into the scratch pad:

- For a crew assigned identifier, key in the identifier (6 characters maximum) followed by latitude and longitude (for example, SIMONE/N4802.2W12241.3).
- For an AN/CDU assigned identifier, key in only latitude and longitude (for example, S3618.5E14136.9). The AN/CDU assigns a sequential identifier WPT01, etc.
- If repeating an identifier which is already in the flight plan, key in only the identifier (for example, SEA).

On page 1/XX, line 1L, enter the desired waypoint over the presently active waypoint.

EXEC key Push

Observe the MOD IRS LEGS page changes to ACT.

Route Modification

- IRS LEGS page Select
Line select existing waypoints in the desired sequence.
Key in any new waypoints in the scratch pad and line select into the flight plan.
- EXEC key Push
Observe the MOD IRS LEGS page changes to ACT.

Vertical Navigation Using the FMC/CDU

Temporary Level Off During Climb or Descent (Not at FMC Cruise Altitude)

- MCP altitude selector Set desired altitude
Verify ALT HOLD is annunciated on the flight mode indicator when leveling at the selected MCP altitude.
MCP N1 light extinguishes if leveling from a climb.
N1 limit changes to CRZ if leveling from a climb.

To continue climb or descent:

- MCP altitude selector Set desired altitude
VNAV switch Push
Climb or descent is initiated. Mode annunciations appear as initial climb or descent.

Entering Waypoint Speed and Altitude Restriction (On Climb or Descent Legs Only)

- RTE LEGS page Select
Key-in the desired speed and altitude, or speed only (followed by /), or altitude only, into the scratch pad.
Minimum speed values permitted are 210 knots for climb waypoints and 150 knots for descent waypoints.
An altitude followed by A or B signifies a requirement to be “at or above” or “at or below” that altitude at the waypoint (for example, key-in 220A or 240B).
Line select to the desired waypoint line.

EXEC key Push

Observe the MOD RTE LEGS page changes to ACT.

Note: This changes any prior speed and altitude restriction at this waypoint.

Deleting Waypoint Speed and Altitude Restriction

RTE LEGS page Select

Press the DEL key to enter DELETE in the scratch pad. Line select to the appropriate waypoint line.

EXEC key Push

Observe the MOD RTE LEGS page changes to ACT and the restriction is deleted and replaced with an FMC predicted value (small size characters).

Changing Speed and/or Altitude Restriction During Climb or Descent

CLB/DES page Select

Press the DEL key to enter DELETE in the scratch pad, or key-in the desired speed and altitude in the scratch pad. Line select to the SPD REST line.

EXEC key Push

Observe the MOD CLB or MOD DES page changes to ACT (or pre-planned) and the restriction is changed or deleted.

Changing Climb/Cruise/Descent Speed Schedule

CLB/CRZ/DES page Select

Select the prompt for the desired climb/cruise/descent schedule, or key-in the desired speed in the scratch pad and line select to the TGT SPD line.

EXEC key Push

Observe the MOD CLB, MOD CRZ, or MOD DES page changes to ACT (or pre-planned) and the new speed schedule is specified.

Early Descent

MCP altitude selector Set

Set next level-off altitude.

DES page Select

Line select the CAPTURE prompt.

EXEC key Push

Observe the MOD DES page changes to ACT. Observe descent is initiated (if VNAV engaged).

Note: For a PATH DES, this will result in a 1000 FPM rate of descent until the planned path is intercepted. For a SPD DES, this will result in an idle thrust normal rate of descent.

Step Climb or Descent From Cruise

MCP altitude selector Set

Set new level-off altitude.

FLT ALT indicator Set

Set new level-off altitude.

CRZ page Select

Enter new altitude on the CRZ ALT line. The display changes to MOD CRZ CLB or MOD CRZ DES.

If the desired climb/descent speed is different from the displayed cruise speed; manually enter the desired TGT SPD, or use access prompts to select the desired CLB/DES page.

EXEC key Push

Observe the MOD CRZ CLB/MOD CRZ DES page (or other selected MOD CLB/MOD DES page) changes to ACT. Observe climb/descent is initiated at the TGT SPD (if VNAV engaged).

Performance and Progress Functions of the FMC/CDU

Determining ETA And Fuel Remaining For New Destination

RTE page Select

Enter the new destination over the original DEST. Enter correct routing to the new destination using the RTE, RTE LEGS, and ARRIVALS pages, as appropriate. Correct any ROUTE DISCONTINUITY.

PROGRESS page Select

Observe the new destination with a MOD title. Check ETA and FUEL remaining.

RTE page Select

EXEC or ERASE the new destination/routing, as desired. Observe the MOD RTE page changes to ACT.

Estimated Wind Entries For Cruise Waypoints

RTE LEGS page Select

Observe the DATA prompt displayed.

RTE DATA page Select

Enter the estimated true wind direction/speed on the appropriate line(s).

Step Climb Evaluation

CRZ page Select

Enter the desired step climb altitude on the STEP TO line. If known, enter the estimated average true wind direction/speed for the desired step climb altitude on the ACTUAL or EST WIND line.

Step climb savings Determine

Observe the fuel SAVINGS/PENALTY and FUEL AT _____ (destination) lines to determine if a higher cruise altitude is advantageous.

If step climb fuel savings are significant, use the appropriate climb procedure to initiate climb to the higher altitude when NOW is displayed on the STEP POINT line.

Note: Step climb evaluations do not consider buffet margin limits. If the altitude entered for the step climb evaluation is higher than the maximum altitude for flight with an adequate buffet margin, the message "MAX ALT FLXXX" will be displayed in the scratch pad. Ensure that the new cruise altitude entered for the climb is at or below the MAX ALT displayed in the message in order to maintain a safe buffet margin.

Entering Descent Forecasts

DES page Select

Observe the FORECAST prompt displayed.

DES FORECASTS page Select

Verify the TRANS LVL and revise if required. Enter anticipated TAI ON/OFF altitudes if appropriate. Enter average ISA DEV forecast for descent and destination QNH.

Enter forecast descent WINDs (for up to three different altitudes)

EXEC key Push

Observe the MOD DES FORECASTS page changes to ACT.

RTA Navigation Using the FMC/CDU

Note: An active FMC flight plan complete with all performance data must exist before the required time of arrival (RTA) mode can be used.

Entering an RTA Waypoint and Time

RTA PROGRESS page Select

On PROGRESS page 2, line 1L, enter the flight plan waypoint where the required time of arrival is applicable. Observe the MOD RTA PROGRESS page displayed with the computed ETA, for the entered waypoint, displayed under RTA in line 1R.

RTA Enter

Enter into line 1R, the required time of arrival in hours, minutes and seconds using a six-digit number; (Examples: 174530, 1745, 1745.5). Observe MOD RTA PROGRESS page displayed with pertinent data for complying with entered RTA. Observe EXEC key illuminated.

EXEC key Push

Observe the ACT RTA PROGRESS page displayed.

Entering Speed Restrictions For RTA Navigation

PERF LIMITS page Select

Enter minimum or maximum speed restriction for RTA navigation in lines 2, 3, or 4 depending on phase of flight. Observe RTA parameters change to reflect new limits (RTA PROGRESS page) and EXEC key illuminated.

EXEC key Push
Observe MOD PERF LIMITS page change to ACT PERF LIMITS page.

Note: Entered restrictions on line 2, 3 and 4, also restrict other navigation modes such as ECON.

Entering New Time Error Tolerances For RTA Navigation

PERF LIMITS page Select
Enter desired time error tolerance (6 to 30 seconds) for the RTA waypoint on line 1L (Example: 25). Observe MOD PERF LIMITS page displayed and EXEC key illuminated.

EXEC Key Push
Observe the ACT PERF LIMITS page displayed.

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Supplementary Procedures

Fuel

Chapter SP

Section 12

Fuel Balancing

If an engine fuel leak is suspected:

Accomplish the ENGINE FUEL LEAK Checklist.

Maintain main tank No. 1 and No. 2 fuel balance within limitations.

Note: Fuel pump pressure should be supplied to the engines at all times. At high altitude, without fuel pump pressure, thrust deterioration or engine flameout may occur.

If the center tank contains fuel:

Center tank fuel pump switches OFF

Crossfeed selector Open

Fuel pump switches (low tank) OFF

When quantities are balanced:

Fuel pump switches (main tank) ON

Center tank fuel pump switches ON

Crossfeed selector Close

If the center tank contains no fuel:

Crossfeed selector Open

Fuel pump switches (low tank) OFF

When quantities are balanced:

Fuel pump switches ON

Crossfeed selector Close

Refueling

Fuel Load Distribution

Main tanks No. 1 and No. 2 should normally be serviced equally until full. Additional fuel is loaded into the center tank until the desired fuel load is reached.

Note: Main tanks No. 1 and No. 2 must be scheduled to be full if the center tank contains more than 1000 pounds (453 kilograms) of fuel. With less than 1000 pounds (453 kilograms) of center tank fuel, partial main tank fuel may be loaded provided the effects of balance have been considered.

Fuel Pressure

Apply from a truck or fuel pit. A nozzle pressure of 50 psi provides approximately 300 U.S. gallons/1136 liters per minute.

Normal Refueling

When a full fuel load is required, the fuel shutoff system closes the fueling valves automatically when the tanks are full. When a partial fuel load is required, the fuel quantity indicators are monitored and the fueling valves are closed by manually positioning the fueling valve switches to CLOSED when the desired fuel quantity is aboard the airplane.

Refueling with Battery Only

When the APU is inoperative and no external power source is available, refueling can be accomplished as follows:

Battery switch ON

Standby power switch BAT

The battery operates the entire fueling system normally, including the gages and fuel shutoff system. The only limitation during this type of operation is the battery life.

Refueling with No AC or DC Power Source Available

When it becomes necessary to refuel with the APU inoperative, the aircraft battery depleted, and no external power source available, refueling can still be accomplished:

Fueling hose nozzle Attached to the refueling receptacle

Fueling valves Open for the tanks to be refueled

Note: Main tanks No. 1 and No. 2, and the center tank refueling valves each have a red override button that must be pressed and held while fuel is being pumped into the tank. Releasing the override button allows the spring in the valve to close the valve.

Caution must be observed not to overfill a tank, since there is no automatic fuel shutoff during manual operation. When the desired amount of fuel has been pumped into the tanks, the refueling valves for the respective tanks can be released. Main tanks No. 1 and No. 2 may also be refueled through filler ports over the wing. It is not possible to refuel the center tank externally.

Ground Transfer of Fuel

Fuel can be transferred from one tank to another tank by using the appropriate fuel pumps, the defueling valve and the crossfeed valve. AC power must be available. To transfer fuel from the main tanks to the center tank:

Main tank fuel pump switches ON

Crossfeed selector Open

Manual defueling valve Open

Center tank fueling valve switch OPEN

Fuel transfer Monitor

The center tank fuel quantity indicator shows an increase in fuel.

The main tank indicators show a decrease in fuel.

Center tank fueling valve switch CLOSED

When the required amount of fuel has been transferred, the switch is closed at the fueling panel.

Manual defueling valve Close

Crossfeed selector Close

Main tank fuel pump switches OFF

Main Tanks Refill

Refueling panel and defuel panel access doors Close

Fuel Crossfeed Valve Check

Crossfeed selector Open

Verify Crossfeed VALVE OPEN light illuminates bright and then
dim.

Crossfeed selector Close

Verify Crossfeed VALVE OPEN light illuminates bright and then
extinguishes.

Fuel Quantity Indicators Test

Note: With a fuel quantity indicator inoperative, a zero fuel quantity
input will be sent to the fuel summation unit causing a possible
FMC gross weight error.

Fuel quantity test switch Push and hold

Hold until the fuel quantity indicators drive to zero and “ERR 4” is
displayed.

Note: Do not push the QTY TEST switch when the airplane is being
fueled. This will cause inaccurate indications at the external
fueling panel.

Fuel quantity test switch Release

Releasing the test switch initiates a self-test. The fuel quantity
indicators display:

All segments for two seconds

Blank for two seconds

Stored error codes (if any) for two seconds each

Indicator full scale value for two seconds

Actual fuel quantity.

Supplementary Procedures Warning Systems

Chapter SP Section 15

Ground Proximity Warning System (GPWS) Test

Verify IRS alignment is complete.

Verify that the guards are closed for all GROUND PROXIMITY INHIBIT switches.

Ground proximity SYS TEST switch Push momentarily

Verify the following:

- BELOW G/S, PULL UP and GPWS INOP lights illuminate
- WINDSHEAR light (as installed) illuminates
- EADI WINDSHEAR message (as installed) shows
- “GLIDESLOPE”, “WHOOP, WHOOP, PULL UP” and “WINDSHEAR” (as installed) aurals sound

Note: If the test switch is held until the aurals begin, additional GPWS aural warnings are tested.

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Supplementary Procedures

Adverse Weather

Chapter SP

Section 16

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
- Takeoffs are not recommended when slush, wet snow, or standing water depth is more than 1/2 inch (13mm) or dry snow depth is more than 4 inches (102 mm).

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°C or below and any of the following exist:

- visible moisture (clouds, fog with visibility of one statute mile (1600m) 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 or wing anti-ice when OAT (on the ground) or TAT (in-flight) is above 10°C.

Exterior Inspection

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

Do the normal Exterior Inspection with the following additional steps:

Surfaces Check

Takeoff with light coatings of frost, up to 1/8 inch (3mm) in thickness on lower wing surfaces due to cold fuel, is allowable; however, all leading edge devices, all control surfaces, tab surfaces, upper wing surfaces and control balance cavities 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.

Control balance cavities Check

Check drainage after snow removal. Puddled water may freeze in flight.

Pitot probes and static ports Check

Verify that all pitot probes and static ports 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 valve, are free of snow and ice.

If the APU is operating, verify that the outflow valve is fully open.

Engine inlets Check

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

Verify that the fan is free to rotate.

Snow or ice that accumulates on the fan spinner or fan blades during extended shutdown periods must be removed by maintenance or other means before engine start.

Snow or ice that accumulates on the fan spinner or fan blades as a result of operation in icing conditions, such as during approach or taxi in, is allowed if the fan is free to rotate and the snow or ice is removed using the ice shedding procedure during taxi out and before setting takeoff thrust.

Fuel tank vents Check

Verify 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 and cooling air inlet 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:

Under extremely cold conditions, both packs may be used for more rapid heating:

APU switch START F/O

Air conditioning PACK switches AUTO F/O

ISOLATION VALVE switch OPEN F/O

APU BLEED air switch ON F/O

Note: Keep all doors to the airplane closed as much as possible.

(737-300/500) During right pack operation only, under cold conditions, if the left PACK TRIP OFF light illuminates, position the recirculation fan OFF until the cabin temperature stabilizes.

Do the following step after completing the normal Preflight Procedure - First Officer:

PITOT HEAT switches ON

Verify that all pitot static heat lights are extinguished.

Engine Start Procedure

Do the normal Engine Start Procedure with the following modifications:

- If ambient temperature is below -35°C, idle the engine for two minutes before changing thrust lever position.
- Several minutes may be needed for oil pressure to reach the normal operating pressure. During this period, oil pressure may go above the normal range and the FILTER BYPASS light may illuminate. Operate the engine at idle thrust until oil pressure returns to the normal range.
- If the oil pressure remains above the normal range after the oil temperature has stabilized within limits, shut down the engine.

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.

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 START switches CONT F/O

ENGINE ANTI-ICE switches ON F/O

Verify that the COWL VALVE OPEN lights illuminate bright, then dim.

Verify that the COWL ANTI-ICE lights are extinguished.

Note: If the COWL VALVE OPEN lights remain illuminated bright with engines at IDLE, position APU BLEED air switch to OFF and increase thrust slightly (up to a maximum of 30% N1).

When engine anti-ice is no longer needed:

ENGINE ANTI-ICE switches OFF F/O

Verify that the COWL VALVE OPEN lights illuminate bright, then extinguish.

ENGINE START switches OFF

Wing Anti-ice Operation - On the Ground

Use wing anti-ice during all ground operations between engine start and takeoff when icing conditions exist or are anticipated, unless the airplane is, or will be protected by the application of Type II or Type IV fluid in compliance with an approved ground de-icing program.

WARNING: Do not use wing anti-ice as an alternative for ground de-icing/anti-icing. Close inspection is still needed to ensure that no frost, snow or ice is adhering to the wing, leading edge devices, stabilizer, control surfaces or other critical airplane components at takeoff.

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

When wing anti-ice is needed:

WING ANTI-ICE switch ON F/O

Verify that the L and R VALVE OPEN lights illuminate bright, then dim.

Note: The wing anti-ice VALVE OPEN lights may cycle bright/dim due to the control valves cycling closed/open in response to thrust setting and duct temperature logic.

When wing anti-ice is no longer needed:

WING ANTI-ICE switch OFF F/O

Verify that the L and R VALVE OPEN lights illuminate bright, then extinguish.

Before Taxi Procedure

Do the normal Before Taxi Procedure with the following modifications:

GENERATOR 1 and 2 switches ON F/O

Normally the generator drives will stabilize within one minute, although due to cold oil, up to five minutes may be needed to produce steady power.

Flight controls Check C

An increase in control forces can be expected at low temperatures.

CAUTION: The flap position indicator and the leading edge devices annunciator panel should be closely observed for positive movement. If the flaps should stop, the flap lever should be placed immediately in the same position as indicated.

Flaps Check F/O

Move the flaps from Flaps up to Flaps 40 back to Flaps up (i.e., full travel) to ensure freedom of movement.

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

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

CAUTION: When operating the engines over significant amounts of standing de-icing or anti-icing fluid, limit thrust to the minimum required. Excessive ingestion of de-icing or anti-icing fluid can cause the fluid to build up on the engine compressor blades resulting in compressor stalls and engine surges.

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

Check that the area behind the airplane is clear.

C

Run-up to a minimum of 70% N1 for approximately 30 seconds duration at intervals no greater than 30 minutes.

C

Note: Fan blade ice build up is cumulative. If the fan spinner and fan blades were not deiced prior to taxi out, the time the engines were operating during the taxi in should be included in the 30 minute interval.

If airport surface conditions and the concentration of aircraft do not allow the engine thrust level to be increased to 70% N1, then set a thrust level as high as practical and time at that thrust level.

C

Note: When operating in conditions of freezing rain, freezing drizzle, freezing fog or heavy snow, run-ups to a minimum of 70% N1 for approximately 1 second duration at intervals no greater than 10 minutes enhance ice shedding.

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 decrease in lift and increase in drag, however, the effects are temporary. Use the normal takeoff rotation rate.

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

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

WARNING: Ensure that the stabilizer trim wheel handles are stowed before using electric trim to avoid personal injury.

Stabilizer trimFull APL NOSE DOWN C

Trim the airplane to the electrical APL NOSE DOWN limit. Then continue trimming manually to the manual APL NOSE DOWN limit. The full nose down position prevents de-icing fluid and slush run-off from entering the stabilizer balance panel cavity.

If the engines are running:

FLT/GRD switchGRD F/O

Reduces possible pressure changes when the Engine BLEED air switches are turned OFF.

Engine BLEED air switchesOFF F/O

Reduces the possibility of fumes entering the air conditioning system.

APU BLEED air switchOFF F/O

Reduces the possibility of fumes entering the air conditioning system.

After de-icing/anti-icing is completed:

APUAs needed F/O

Wait approximately one minute after de-icing is completed to turn engine BLEED air switches on to ensure all de-icing fluid has been cleared from the engines:

Engine BLEED air switchesON F/O

If the engines are running:

FLT/GRD switchFLT F/O

Stabilizer trim ____ UNITS C

Verify that the stabilizer trim is set for takeoff.

Before Takeoff Procedure

Do the normal Before Takeoff Procedure with the following modifications:

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, or standing water, or icing conditions, or because of exterior de-icing/anti-icing.

Verify that the LE FLAPS EXT green light is illuminated.

Takeoff Procedure

Do the normal Takeoff Procedure with the following modification:

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

Run-up to a minimum of 70% N1 for approximately 30 seconds and confirm stable engine operation before the start of the takeoff roll.

Engine Anti-Ice Operation - In Flight

Engine anti-ice must be ON during all flight operations when icing conditions exist or are anticipated, except during climb and cruise when the temperature is below -40°C SAT. Engine anti-ice must be ON before, and during descent in all icing conditions, including temperatures below -40°C SAT.

When operating in areas of possible icing, activate engine anti-ice before entering icing conditions.

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 TAT is above 10°C

When engine anti-ice is needed:

ENGINE START switches CONT PM

ENGINE ANTI-ICE switches ON PM

Verify that the COWL VALVE OPEN lights illuminate bright, then dim.

Verify that the COWL ANTI-ICE lights are extinguished.

Note: If the COWL VALVE OPEN lights remain illuminated bright with engines at IDLE, increase thrust slightly (up to a minimum of 30% N1).

When engine anti-ice is no longer needed:

ENGINE ANTI-ICE switches OFF PM

Verify that the COWL VALVE OPEN lights illuminate bright, then extinguish.

ENGINE START switches OFF PM

Fan Ice Removal

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

Severe icing can usually be avoided by a change in altitude and/or airspeed. If flight in moderate to severe icing conditions cannot be avoided, do the following on both engines, one engine at a time at approximately 15 minute intervals:

Thrust Increase PF

Increase thrust to a minimum of 80% N1 for approximately 1 second to ensure the fan blades and spinner are clear of ice.

Engine vibration may occur due to fan blade/spinner icing. If engine vibration continues after increasing thrust, do the following on both engines, one engine at a time:

ENGINE START switch FLT PM

Thrust Adjust PF

Adjust thrust to 45% N1. After approximately five seconds, increase thrust lever slowly to a minimum of 80% N1.

Note: Engine vibration may reduce to a low level before 80% N1 is reached, however, thrust increase must continue to a minimum of 80% N1 to remove ice from the fan blades.

Note: Engine vibration may indicate full scale prior to shedding ice, however, this has no adverse effect on the engine.

If vibration does not decrease, do the procedure for HIGH ENGINE VIBRATION "If not in icing conditions."

Wing Anti-ice Operation - In Flight

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

In flight, the wing anti-ice system may be used as a de-icer or as an anti-icer. The primary method is to use it as a de-icer by allowing ice to accumulate before turning wing anti-ice on. This procedure provides the cleanest airfoil surface, the least possible runback ice formation, and the least thrust and fuel penalty. Normally it is not necessary to shed ice periodically unless extended flight through icing conditions is necessary (holding).

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

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

CAUTION: Use of wing anti-ice above approximately FL350 may cause bleed trip off and possible loss of cabin pressure.

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

When wing anti-ice is needed:

WING ANTI-ICE switch ON PM

Verify that the L and R VALVE OPEN lights illuminate bright, then dim.

When wing anti-ice is no longer needed:

WING ANTI-ICE switch OFF PM

Verify that the L and R VALVE OPEN lights illuminate bright, then extinguish.

Cold Temperature Altitude Corrections

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

Apply the altitude correction table when needed:

- no corrections are needed for reported temperatures above 0°C or if the airport temperature is at or above the minimum published temperature for the procedure being flown
- do not correct altimeter barometric reference settings
- ATC assigned altitudes or flight levels should not be adjusted for temperature when under radar control
- corrections apply to QNH and QFE operations
- 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
- subtract the elevation of the altimeter barometric reference setting source (normally the departure or destination airport elevation) from the published minimum altitude to be flown to determine “height above altimeter reference source”
- enter the table with Airport Temperature and with “height above altimeter reference source”. Read the correction where these two entries intersect. Add the correction to the published minimum altitude to be flown to determine the corrected indicated altitude to be flown. To correct an altitude above the altitude in the last column, use linear extrapolation (e.g., to correct 6000 feet or 1800 meters, use twice the correction for 3000 feet or 900 meters, respectively). The corrected altitude must always be greater than the published minimum altitude
- if the corrected indicated altitude to be flown is between 100 foot increments, set the MCP altitude to the closest 100 foot increment above the corrected indicated altitude to be flown.

Altitude Correction Table (Heights and Altitudes in Feet)

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

Altitude Correction Table (Heights and Altitudes in Meters)

Airport Temp °C	Height Above Altimeter Reference Source											
	60 m	90 m	120 m	150 m	180 m	210 m	240 m	270 m	300 m	450 m	600 m	900 m
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

Approach and Landing

If ice formations are observed on the airplane surfaces, (wings, windshield wipers, window frames, etc.):

VREF Add 10 knots PF

This ensures maneuvering capability.

Note: The combined airspeed corrections for ice formations, steady wind and gust should not exceed a maximum of 20 knots.

Note: To prevent increased landing distance due to high airspeed, bleed off airspeed in excess of VREF+5 knots+gust correction when below 200 feet AGL. Maintain the gust correction to touchdown.

After Landing Procedure

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

CAUTION: When operating the engines over significant amounts of standing de-icing or anti-icing fluid, limit thrust to the minimum required. Excessive ingestion of de-icing or anti-icing fluid can cause the fluid to build up on the engine compressor blades resulting in compressor stalls and engine surges.

Do the normal After Landing Procedure with the following modifications:

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

Do not retract the flaps to less than flaps 15 until the flap areas have been checked to be free of contaminants.

Engine anti-ice must be selected ON and remain on during all ground operations when icing conditions exist or are anticipated.

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 START switches	CONT	F/O
ENGINE ANTI-ICE switches	ON	F/O

Verify that the COWL VALVE OPEN lights illuminate bright, then dim.

Verify that the COWL ANTI-ICE lights are extinguished.

Note: If the COWL VALVE OPEN lights remain illuminated bright with engines at IDLE, increase thrust slightly (up to a maximum of 30% N1).

When engine anti-ice is no longer needed:

ENGINE ANTI-ICE switches	OFF	F/O
Verify that the COWL VALVE OPEN lights illuminate bright, then extinguish.		

ENGINE START switches	OFF	F/O
-----------------------------	-----	-----

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

Check that the area behind the airplane is clear. C

Run-up to a minimum of 70% N1 for approximately 30 seconds duration at intervals no greater than 30 minutes. C

If airport surface conditions and the concentration of aircraft do not allow the engine thrust level to be increased to 70% N1, then set a thrust level as high as practical and time at that thrust level. C

Note: When operating in conditions of freezing rain, freezing drizzle, freezing fog or heavy snow, run-ups to a minimum of 70% N1 for approximately 1 second duration at intervals no greater than 10 minutes should be considered.

Shutdown Procedure

Do the following step before starting the normal Shutdown Procedure:

After landing in icing conditions:

WARNING: Ensure that the stabilizer trim wheel handles are stowed before using electric trim to avoid personal injury.

Stabilizer trim Set 0 to 2 units C

Prevents melting snow and ice from running into balance bay areas. Water in these areas can freeze and lock controls. With flaps retracted, this requires approximately eight hand wheel turns of manual trim.

Secure Procedure

Do the normal Secure Procedure with the following modifications:

If the airplane will be attended and warm air circulation throughout the cargo E/E compartments is desired:

CAUTION: Do not leave the interior unattended with a pack operating and all doors closed. With the airplane in this configuration, accidental closure of the main outflow valve can cause unscheduled pressurization of the airplane.

APU	Start	F/O
APU GENERATOR bus switches	ON	F/O
One PACK switch	AUTO	F/O
ISOLATION VALVE switch	AUTO	F/O
Pressurization mode selector	MAN AC	F/O
FLT/GRD	GRD	F/O
Outflow valve switch	OPEN	F/O
Prevents aircraft pressurization.		

Note: The airplane must be parked into the wind when the outflow valve is full open.

APU BLEED air switch	ON	F/O
----------------------------	----	-----

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

Pressurization mode selector	MAN AC	F/O
Outflow valve	CLOSE	F/O
Position the outflow valve 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 normally done by maintenance personnel, and include, but are not limited to:

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

Hot Weather Operation

During ground operation the following considerations will help keep the airplane as cool as possible:

- If cooling air is available from an outside source, the supply should be plugged in immediately after engine shutdown and should not be removed until just prior to engine start
- Keep all doors and windows, including cargo doors, closed as much as possible

- Electronic components which contribute to a high temperature level in the flight deck should be turned off while not needed
- Open all passenger cabin gasper outlets and close all window shades on the sun-exposed side of the passenger cabin.

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

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

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

During flight planning consider the following:

- High temperatures inflict performance penalties which must be taken into account on the ground before takeoff
- Alternate takeoff procedures (No Engine Bleed Takeoff, Improved Climb Performance, etc.)

Moderate to Heavy Rain, Hail or Sleet

Flights should be conducted to avoid thunderstorm or hail activity. If visible moisture is present at high altitude, avoid flight over the storm cell. (Storm cells that do not produce visible moisture at high altitude may be overflowed safely.) To the maximum extent possible, moderate to heavy rain, hail or sleet should also be avoided.

If moderate to heavy rain, hail or sleet is encountered:

ENGINE START switches CONT

Autothrottle Disengage

Thrust Levers Adjust Slowly

If thrust changes are necessary, move the thrust levers slowly.

Avoid changing thrust lever direction until engines have stabilized at a selected setting. Maintain an increased minimum thrust setting.

IAS/MACH Use a slower speed

Using a slower speed improves engine tolerance to heavy precipitation intake.

Consider starting the APU (if available).

Turbulence

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

Passenger signs ON

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

Severe Turbulence

Yaw Damper ON

Autothrottle Disengage

AUTOPILOT CWS

A/P status annunciators display CWS for pitch and roll.

Note: If sustained trimming occurs, disengage the autopilot.

ENGINE START switches FLT

Thrust Set

Set thrust as needed for the phase of flight. Change thrust setting only if needed to modify an unacceptable speed trend.

PHASE OF FLIGHT	AIRSPEED
CLIMB	280 KIAS or .73 Mach
CRUISE	Use FMC recommended thrust settings. If the FMC is inoperative, refer to the Unreliable Airspeed page in the Performance-Inflight section of the QRH for approximate N1 settings that maintain near optimum penetration airspeed.
DESCENT	.73 Mach/280/250 KIAS. If severe turbulence is encountered at altitudes below 15,000 feet and the airplane gross weight is less than the maximum landing weight, the airplane may be slowed to 250 knots in the clean configuration.

Note: If an approach must be made into an area of severe turbulence, delay flap extension as long as possible. The airplane can withstand higher gust loads in the clean configuration.

Windshear

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

Avoidance

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

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

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

Precautions

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

Takeoff

- Use maximum takeoff thrust instead of reduced thrust
- For optimum takeoff performance, use flaps 5, 10 or 15 unless limited by obstacle clearance and/or climb gradient
- Use the longest suitable runway provided it is clear of areas of known windshear
- 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 flight path instruments and call out any deviations from normal
- Should airspeed fall below the trim airspeed, unusual control column forces may be required to maintain the desired pitch attitude. Stick shaker must be respected at all times

Approach and Landing

- Use flaps 30 for landing
- Establish a stabilized approach no lower than 1000 feet above the airport to improve windshear recognition capability
- Use the most suitable runway that avoids the areas of suspected windshear and is compatible with crosswind or tailwind limitations. Use ILS G/S, VNAV path or VASI/PAPI indications to detect flight path deviations and help with timely detection of windshear
- If the autothrottle is disengaged, or is planned to be disengaged prior to landing, add an appropriate airspeed correction (correction applied in the same manner as gust), up to a maximum of 20 knots

- Avoid large thrust reductions or trim changes in response to sudden airspeed increases as these may 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 the autopilot and autothrottle for the approach may provide more monitoring and recognition time.

Recovery

Accomplish the Windshear Escape Maneuver found in Non-Normal Maneuvers section of this manual.

DO NOT USE FOR FLIGHT

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Performance Dispatch

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Performance Dispatch**Chapter PD****Takeoff****Section 10****Takeoff Field Corrections - Dry Runway****Slope Corrections**

FIELD LENGTH AVAILABLE (FT)	SLOPE CORRECTED FIELD LENGTH (FT)									
	RUNWAY SLOPE (%)									
	-2.0	-1.5	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	
4200	4330	4290	4260	4230	4200	4060	3920	3780	3640	
4600	4750	4710	4680	4640	4600	4430	4260	4090	3920	
5000	5180	5130	5090	5040	5000	4800	4590	4390	4190	
5400	5600	5550	5500	5450	5400	5170	4930	4700	4460	
5800	6030	5970	5910	5860	5800	5530	5270	5000	4740	
6200	6450	6390	6330	6260	6200	5900	5600	5310	5010	
6600	6880	6810	6740	6670	6600	6270	5940	5610	5280	
7000	7300	7220	7150	7070	7000	6640	6280	5920	5560	
7400	7720	7640	7560	7480	7400	7010	6610	6220	5830	
7800	8150	8060	7970	7890	7800	7380	6950	6530	6100	
8200	8570	8480	8390	8290	8200	7740	7290	6830	6380	
8600	9000	8900	8800	8700	8600	8110	7620	7140	6650	
9000	9420	9320	9210	9110	9000	8480	7960	7440	6920	
9400	9850	9740	9620	9510	9400	8850	8300	7750	7200	
9800	10270	10160	10040	9920	9800	9220	8630	8050	7470	
10200	10700	10570	10450	10320	10200	9590	8970	8360	7740	
10600	11120	10990	10860	10730	10600	9950	9310	8660	8020	
11000	11550	11410	11270	11140	11000	10320	9640	8970	8290	
11400	11970	11830	11690	11540	11400	10690	9980	9270	8560	
11800	12400	12250	12100	11950	11800	11060	10320	9580	8830	

Wind Corrections

SLOPE CORRECTED FIELD LENGTH (FT)	SLOPE & WIND CORRECTED FIELD LENGTH (FT)							
	WIND COMPONENT (KTS)							
-15	-10	-5	0	10	20	30	40	
4200	2280	2920	3560	4200	4400	4610	4840	5080
4600	2640	3290	3950	4600	4810	5030	5270	5510
5000	3000	3670	4330	5000	5220	5450	5690	5940
5400	3370	4050	4720	5400	5630	5870	6120	6370
5800	3730	4420	5110	5800	6040	6290	6540	6800
6200	4090	4800	5500	6200	6450	6700	6970	7230
6600	4460	5170	5890	6600	6860	7120	7390	7660
7000	4820	5550	6270	7000	7270	7540	7820	8090
7400	5190	5920	6660	7400	7680	7960	8240	8530
7800	5550	6300	7050	7800	8090	8380	8670	8960
8200	5910	6670	7440	8200	8500	8790	9090	9390
8600	6280	7050	7830	8600	8910	9210	9520	9820
9000	6640	7430	8210	9000	9320	9630	9940	10250
9400	7000	7800	8600	9400	9730	10050	10370	10680
9800	7370	8180	8990	9800	10130	10460	10790	11110
10200	7730	8550	9380	10200	10540	10880	11220	11540
10600	8090	8930	9760	10600	10950	11300	11640	11970
11000	8460	9300	10150	11000	11360	11720	12070	12400
11400	8820	9680	10540	11400	11770	12140	12490	12840
11800	9180	10060	10930	11800	12180	12550	12920	13270

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****Sea Level Pressure Altitude**

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 LB)										
	OAT (°C)										
	-40	14	18	22	24	26	28	30	42	46	50
4600	55.1	50.1	49.8	49.5	49.3	49.2	49.0	48.8	45.8	44.8	43.9
5000	57.3	52.3	51.9	51.6	51.4	51.3	51.1	50.9	47.9	46.9	45.9
5400	59.4	54.3	53.9	53.6	53.4	53.3	53.1	52.9	49.8	48.7	47.7
5800	61.4	56.2	55.8	55.5	55.3	55.1	55.0	54.8	51.6	50.5	49.5
6200	63.3	58.0	57.6	57.3	57.1	56.9	56.7	56.6	53.3	52.2	51.2
6600	65.0	59.6	59.3	58.9	58.8	58.6	58.4	58.2	54.9	53.9	52.8
7000	66.7	61.2	60.9	60.5	60.3	60.2	60.0	59.8	56.4	55.4	54.3
7400	68.2	62.7	62.3	61.9	61.7	61.6	61.4	61.2	57.8	56.7	55.6
7800	69.8	64.1	63.8	63.4	63.2	63.0	62.8	62.6	59.1	58.0	56.9
8200	71.3	65.5	65.2	64.8	64.6	64.4	64.2	64.0	60.5	59.4	58.2
8600	72.7	66.8	66.5	66.1	65.9	65.7	65.5	65.3	61.7	60.6	59.4
9000	74.0	68.1	67.7	67.3	67.1	66.9	66.7	66.5	62.9	61.7	60.5
9400	75.2	69.2	68.8	68.4	68.2	68.0	67.8	67.6	63.9	62.8	61.6
9800	76.0	70.3	69.9	69.5	69.3	69.1	68.9	68.7	65.0	63.8	62.6
10200	76.0	71.4	71.0	70.6	70.4	70.2	70.0	69.8	66.0	64.8	63.6
10600	76.0	72.5	72.0	71.6	71.4	71.2	71.0	70.8	67.0	65.8	64.6
11000	76.0	73.5	73.1	72.7	72.5	72.2	72.0	71.8	68.0	66.7	65.5
CLIMB LIMIT WT (1000 KG)	64.4	63.7	63.5	63.5	63.4	63.4	63.3	63.2	57.5	55.7	54.0

With engine bleed for packs off, increase field limit weight by 350 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 200 kg.

With engine and wing anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 825 kg.

2000 FT Pressure Altitude

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	14	18	22	24	26	28	30	42	46	50
4600	52.1	47.4	47.1	46.8	46.6	46.4	46.0	45.5	42.6	41.7	40.7
5000	54.3	49.5	49.1	48.8	48.7	48.5	48.0	47.5	44.6	43.6	42.7
5400	56.3	51.4	51.1	50.7	50.6	50.4	49.9	49.4	46.4	45.4	44.4
5800	58.3	53.2	52.9	52.6	52.4	52.2	51.7	51.2	48.1	47.2	46.1
6200	60.1	55.0	54.7	54.3	54.1	54.0	53.5	52.9	49.8	48.8	47.8
6600	61.8	56.6	56.3	56.0	55.8	55.6	55.1	54.5	51.4	50.4	49.4
7000	63.4	58.2	57.8	57.5	57.3	57.1	56.6	56.1	52.9	51.8	50.8
7400	64.9	59.5	59.2	58.8	58.7	58.5	57.9	57.4	54.1	53.1	52.0
7800	66.4	61.0	60.6	60.2	60.1	59.9	59.3	58.8	55.4	54.4	53.3
8200	67.8	62.3	62.0	61.6	61.4	61.2	60.7	60.1	56.7	55.6	54.5
8600	69.2	63.6	63.2	62.8	62.6	62.5	61.9	61.3	57.9	56.8	55.7
9000	70.4	64.8	64.4	64.0	63.8	63.6	63.0	62.5	59.0	57.9	56.7
9400	71.6	65.8	65.5	65.1	64.9	64.7	64.1	63.5	60.0	58.9	57.7
9800	72.7	66.9	66.5	66.1	65.9	65.8	65.2	64.6	61.0	59.9	58.7
10200	73.8	68.0	67.6	67.2	67.0	66.8	66.2	65.6	62.0	60.9	59.7
10600	74.9	69.0	68.6	68.2	68.0	67.8	67.2	66.6	62.9	61.8	60.6
11000	76.0	70.0	69.6	69.2	69.0	68.8	68.2	67.5	63.9	62.7	61.5
CLIMB LIMIT WT (1000 KG)	61.2	60.6	60.5	60.4	60.4	60.3	59.4	58.5	53.0	51.3	49.7

With engine bleed for packs off, increase field limit weight by 350 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 200 kg.

With engine and wing anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 825 kg.

737 Flight Crew Operations Manual

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****4000 FT Pressure Altitude**

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
-40	14	18	22	24	26	28	30	42	46	50	
4600	49.5	44.9	44.6	44.4	43.9	43.4	43.0	42.5	39.6	38.6	37.2
5000	51.6	47.0	46.7	46.4	45.9	45.4	45.0	44.5	41.5	40.5	39.1
5400	53.6	48.9	48.5	48.2	47.8	47.3	46.8	46.3	43.2	42.2	40.8
5800	55.5	50.6	50.3	50.0	49.5	49.0	48.5	48.1	44.9	43.9	42.4
6200	57.2	52.4	52.0	51.7	51.2	50.7	50.2	49.7	46.6	45.5	44.0
6600	58.9	54.0	53.6	53.3	52.8	52.3	51.8	51.3	48.1	47.0	45.5
7000	60.5	55.5	55.1	54.8	54.3	53.8	53.3	52.8	49.5	48.4	46.9
7400	61.9	56.8	56.4	56.1	55.6	55.1	54.6	54.0	50.7	49.6	48.0
7800	63.4	58.2	57.8	57.5	56.9	56.4	55.9	55.4	52.0	50.8	49.2
8200	64.8	59.5	59.1	58.8	58.2	57.7	57.2	56.6	53.2	52.0	50.4
8600	66.1	60.7	60.3	60.0	59.4	58.9	58.3	57.8	54.3	53.1	51.5
9000	67.3	61.8	61.5	61.1	60.6	60.0	59.4	58.9	55.3	54.2	52.5
9400	68.4	62.9	62.5	62.2	61.6	61.0	60.5	59.9	56.4	55.2	53.5
9800	69.5	63.9	63.5	63.2	62.6	62.1	61.5	60.9	57.3	56.1	54.4
10200	70.6	64.9	64.5	64.2	63.6	63.0	62.5	61.9	58.2	57.0	55.3
10600	71.6	65.9	65.5	65.2	64.6	64.0	63.4	62.8	59.1	57.9	56.1
11000	72.6	66.9	66.5	66.1	65.5	64.9	64.3	63.8	60.0	58.7	56.9
CLIMB LIMIT WT (1000 KG)	58.6	58.0	57.9	57.8	57.0	56.1	55.2	54.2	48.8	47.1	45.0

With engine bleed for packs off, increase field limit weight by 350 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 200 kg.

With engine and wing anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 825 kg.

6000 FT Pressure Altitude

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
-40	14	18	22	24	26	28	30	42	46	50	
4600	46.6	42.3	42.0	41.2	40.7	40.3	39.8	39.4	36.5	35.3	34.0
5000	48.6	44.3	44.0	43.1	42.6	42.2	41.7	41.3	38.3	37.1	35.8
5400	50.6	46.1	45.8	44.9	44.4	43.9	43.5	43.0	40.0	38.7	37.4
5800	52.4	47.8	47.5	46.6	46.1	45.6	45.2	44.7	41.6	40.3	39.0
6200	54.1	49.5	49.2	48.3	47.8	47.3	46.8	46.3	43.2	41.9	40.5
6600	55.8	51.1	50.8	49.8	49.3	48.8	48.3	47.9	44.7	43.4	42.0
7000	57.3	52.5	52.2	51.3	50.8	50.3	49.8	49.3	46.0	44.7	43.3
7400	58.6	53.8	53.5	52.5	52.0	51.5	51.0	50.5	47.2	45.8	44.4
7800	60.0	55.1	54.8	53.8	53.3	52.7	52.2	51.7	48.4	47.0	45.6
8200	61.4	56.4	56.1	55.0	54.5	54.0	53.5	52.9	49.5	48.1	46.7
8600	62.6	57.5	57.2	56.2	55.6	55.1	54.6	54.0	50.6	49.2	47.7
9000	63.8	58.6	58.3	57.3	56.7	56.2	55.6	55.1	51.6	50.2	48.6
9400	64.9	59.7	59.3	58.3	57.7	57.2	56.6	56.1	52.5	51.1	49.6
9800	65.9	60.7	60.3	59.3	58.7	58.2	57.6	57.1	53.5	52.0	50.5
10200	67.0	61.6	61.3	60.2	59.6	59.1	58.5	58.0	54.3	52.9	51.3
10600	68.0	62.6	62.2	61.1	60.5	60.0	59.4	58.8	55.2	53.7	52.1
11000	69.0	63.5	63.1	62.0	61.4	60.9	60.3	59.7	56.0	54.5	52.9
CLIMB LIMIT WT (1000 KG)	55.4	55.0	54.7	53.2	52.5	51.7	50.8	50.0	45.2	43.3	41.5

With engine bleed for packs off, increase field limit weight by 350 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 200 kg.

With engine and wing anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 825 kg.

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****8000 FT Pressure Altitude**

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
-40	14	18	22	24	26	28	30	42	46	50	
4600	43.7	39.7	38.9	38.0	37.6	37.1	36.7	36.3	33.2	32.1	31.0
5000	45.7	41.6	40.8	39.9	39.4	39.0	38.5	38.1	35.0	33.8	32.7
5400	47.5	43.3	42.5	41.6	41.1	40.7	40.2	39.8	36.6	35.4	34.2
5800	49.3	45.0	44.2	43.2	42.8	42.3	41.9	41.4	38.2	36.9	35.7
6200	51.0	46.6	45.8	44.8	44.4	43.9	43.4	43.0	39.7	38.4	37.2
6600	52.6	48.2	47.3	46.4	45.9	45.4	44.9	44.5	41.2	39.9	38.7
7000	54.1	49.6	48.7	47.8	47.3	46.8	46.3	45.8	42.5	41.2	39.9
7400	55.4	50.8	49.9	48.9	48.4	47.9	47.5	47.0	43.5	42.2	41.0
7800	56.7	52.1	51.1	50.1	49.6	49.2	48.7	48.2	44.7	43.3	42.0
8200	58.0	53.3	52.3	51.3	50.8	50.3	49.8	49.3	45.7	44.4	43.1
8600	59.2	54.4	53.4	52.4	51.9	51.4	50.9	50.4	46.7	45.4	44.0
9000	60.3	55.5	54.5	53.4	52.9	52.4	51.9	51.4	47.7	46.3	45.0
9400	61.3	56.5	55.5	54.4	53.9	53.4	52.9	52.3	48.6	47.2	45.9
9800	62.4	57.4	56.4	55.4	54.8	54.3	53.8	53.3	49.5	48.1	46.7
10200	63.4	58.4	57.4	56.3	55.7	55.2	54.7	54.1	50.3	48.9	47.5
10600	64.3	59.2	58.2	57.1	56.6	56.0	55.5	54.9	51.1	49.7	48.2
11000	65.2	60.1	59.1	58.0	57.4	56.9	56.3	55.8	51.9	50.4	49.0
CLIMB LIMIT WT (1000 KG)	52.2	51.7	50.4	48.9	48.0	47.4	46.5	45.9	41.4	39.8	38.1

With engine bleed for packs off, increase field limit weight by 350 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 200 kg.

With engine and wing anti-ice on, decrease field limit weight by 250 kg and climb limit weight by 825 kg.

737 Flight Crew Operations Manual

Takeoff Obstacle Limit Weight**Flaps 5****Sea Level 30°C & Below, Zero Wind****Based on engine bleed for packs on and anti-ice off**

OBSTACLE HEIGHT (FT)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)										
	DISTANCE FROM BRAKE RELEASE (1000 FT)										
8	10	12	14	16	18	20	22	24	26	28	30
10	61.1										
50	55.9	60.7	63.8								
100	52.1	56.5	59.9	62.2	64.3						
150	49.0	53.6	56.8	59.4	61.5	63.1	64.4				
200	46.7	51.2	54.5	57.1	59.2	61.0	62.4	63.5	64.4		
250	44.7	49.1	52.5	55.2	57.3	59.1	60.7	61.9	62.9	63.7	64.4
300	41.4	47.3	50.7	53.5	55.6	57.4	59.0	60.4	61.5	62.4	63.2
350		45.8	49.1	51.9	54.1	55.9	57.5	58.9	60.2	61.2	62.0
400		44.1	47.6	50.4	52.7	54.6	56.2	57.6	58.8	60.0	60.9
450		40.4	46.3	49.0	51.4	53.4	55.0	56.4	57.6	58.8	59.8
500			45.1	47.8	50.1	52.1	53.9	55.3	56.5	57.7	58.7
550			43.9	46.7	49.0	51.0	52.8	54.3	55.5	56.6	57.7
600				39.9	45.6	47.9	50.0	51.7	53.3	54.6	55.7
650					44.6	47.0	49.0	50.8	52.3	53.7	54.8
700					43.6	46.1	48.0	49.8	51.4	52.8	54.0
750						38.8	45.2	47.2	49.0	50.5	51.9
800							44.2	46.4	48.1	49.7	51.1
850								42.6	45.6	47.3	48.9
900									44.8	46.6	48.2
950										44.0	45.9
1000											41.6

Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.

Takeoff Obstacle Limit Weight**Flaps 5****OAT Adjustments**

OAT (°C)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)							
	36	40	44	48	52	56	60	64
30 & Below	0	0	0	0	0	0	0	0
32	-0.5	-0.6	-0.6	-0.7	-0.8	-0.8	-0.9	-1.0
34	-1.0	-1.1	-1.3	-1.4	-1.5	-1.6	-1.8	-1.9
36	-1.5	-1.7	-1.9	-2.1	-2.3	-2.5	-2.7	-2.9
38	-2.0	-2.2	-2.5	-2.8	-3.0	-3.3	-3.5	-3.8
40	-2.5	-2.8	-3.1	-3.5	-3.8	-4.1	-4.4	-4.8
42	-3.0	-3.4	-3.8	-4.2	-4.5	-4.9	-5.3	-5.7
44	-3.5	-4.0	-4.4	-4.9	-5.3	-5.7	-6.2	-6.6
46	-4.0	-4.5	-5.0	-5.6	-6.1	-6.6	-7.1	-7.6
48	-4.5	-5.1	-5.7	-6.3	-6.8	-7.4	-8.0	-8.5
50	-5.1	-5.7	-6.3	-7.0	-7.6	-8.2	-8.8	-9.5

Pressure Altitude Adjustments

ALT (FT)	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)							
	36	40	44	48	52	56	60	64
S.L. & Below	0	0	0	0	0	0	0	0
1000	-1.3	-1.5	-1.7	-1.8	-2.0	-2.1	-2.3	-2.4
2000	-2.7	-3.0	-3.3	-3.6	-3.9	-4.2	-4.5	-4.9
3000	-3.9	-4.3	-4.8	-5.2	-5.6	-6.0	-6.5	-6.9
4000	-5.2	-5.7	-6.2	-6.8	-7.3	-7.8	-8.4	-8.9
5000	-6.2	-6.8	-7.5	-8.2	-8.9	-9.6	-10.3	-11.0
6000	-7.1	-8.0	-8.9	-9.7	-10.6	-11.4	-12.3	-13.1
7000	-8.1	-9.2	-10.2	-11.2	-12.2	-13.2	-14.2	-15.2
8000	-9.1	-10.3	-11.5	-12.6	-13.8	-15.0	-16.1	-17.3

Wind Adjustments

WIND (KTS)	OAT & ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)							
	36	40	44	48	52	56	60	64
15 TW	-8.4	-8.1	-7.9	-7.6	-7.4	-7.1	-6.9	-6.7
10 TW	-5.6	-5.4	-5.3	-5.1	-4.9	-4.8	-4.6	-4.4
5 TW	-2.8	-2.7	-2.6	-2.5	-2.5	-2.4	-2.3	-2.2
0	0	0	0	0	0	0	0	0
10 HW	0.8	0.7	0.7	0.6	0.5	0.5	0.4	0.3
20 HW	1.6	1.5	1.3	1.2	1.1	0.9	0.8	0.6
30 HW	2.4	2.2	2.0	1.8	1.6	1.4	1.2	1.0
40 HW	3.3	3.0	2.7	2.5	2.2	1.9	1.7	1.4

With engine bleed for packs off, increase weight by 450 kg.

With engine anti-ice on, decrease weight by 1150 kg.

With engine and wing anti-ice on, decrease weight by 2650 kg.

Performance Dispatch**Chapter PD****Enroute****Section 11****Long Range Cruise Maximum Operating Altitude****Max Cruise Thrust****ISA + 10°C and Below**

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	-10	34100	33200	32300	30700	29200
62	31500	-11	34700	33800	33000	31400	29900
60	32200	-13	35400	34500	33700	32100	30600
58	32900	-14	36100	35300	34400	32800	31400
56	33700	-16	36900	36000	35200	33600	32100
54	34400	-18	37000	36700	35900	34400	32900
52	35200	-19	37000	37000	36700	35200	33700
50	36100	-21	37000	37000	37000	36000	34500
48	36900	-21	37000	37000	37000	36800	35400
46	37000	-21	37000	37000	37000	37000	36300
44	37000	-21	37000	37000	37000	37000	37000

ISA + 15°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	-4	34100	33200	32300	30700	29200
62	31500	-6	34700	33800	33000	31400	29900
60	32200	-7	35400	34500	33700	32100	30600
58	32900	-9	36100	35300	34400	32800	31400
56	33700	-10	36900	36000	35200	33600	32100
54	34400	-12	37000	36700	35900	34400	32900
52	35200	-14	37000	37000	36700	35200	33700
50	36100	-16	37000	37000	37000	36000	34500
48	36900	-16	37000	37000	37000	36800	35400
46	37000	-16	37000	37000	37000	37000	36300
44	37000	-16	37000	37000	37000	37000	37000

ISA + 20°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	1	33600*	33200	32300	30700	29200
62	31500	0	34400*	33800	33000	31400	29900
60	32200	-2	35300*	34500	33700	32100	30600
58	32900	-3	36100	35300	34400	32800	31400
56	33700	-5	36800*	36000	35200	33600	32100
54	34400	-7	37000	36700	35900	34400	32900
52	35200	-8	37000	37000	36700	35200	33700
50	36100	-10	37000	37000	37000	36000	34500
48	36900	-10	37000	37000	37000	36800	35400
46	37000	-10	37000	37000	37000	37000	36300
44	37000	-10	37000	37000	37000	37000	37000

*Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.

737 Flight Crew Operations Manual

**Long Range Cruise Trip Fuel and Time
Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
273	254	238	223	211	200	190	181	173	166	159	
535	501	471	445	421	400	381	364	348	334	321	
798	749	704	666	631	600	572	547	524	503	484	
1059	995	938	887	841	800	764	730	699	671	646	
1320	1241	1170	1107	1051	1000	955	914	875	840	808	
1580	1487	1403	1328	1261	1200	1146	1096	1050	1008	970	
1840	1733	1635	1549	1471	1400	1337	1279	1225	1176	1132	
2100	1978	1867	1769	1681	1600	1528	1462	1401	1345	1294	
2360	2223	2099	1989	1890	1800	1720	1646	1577	1514	1457	
2620	2469	2332	2210	2100	2000	1911	1829	1753	1683	1620	
2881	2715	2564	2431	2310	2200	2102	2012	1928	1852	1783	
3142	2961	2797	2651	2520	2400	2293	2195	2104	2021	1946	
3403	3207	3030	2872	2730	2600	2485	2378	2280	2190	2108	
3664	3454	3262	3092	2940	2800	2676	2561	2456	2359	2271	
3925	3700	3495	3313	3150	3000	2868	2745	2632	2528	2434	
4186	3946	3728	3534	3360	3200	3059	2928	2807	2697	2597	
4447	4192	3961	3755	3570	3400	3250	3111	2983	2866	2760	

737 Flight Crew Operations Manual

Long Range Cruise Trip Fuel and Time**Reference Fuel and Time Required**

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		37	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	1.5	0:38	1.5	0:38	1.5	0:38	1.5	0:38	1.5	0:38
400	2.6	1:06	2.5	1:06	2.5	1:06	2.5	1:06	2.4	1:06
600	3.7	1:35	3.6	1:34	3.5	1:33	3.4	1:34	3.4	1:34
800	4.7	2:03	4.6	2:02	4.5	2:01	4.4	2:02	4.4	2:02
1000	5.8	2:31	5.7	2:29	5.6	2:29	5.4	2:30	5.4	2:30
1200	7.0	2:59	6.8	2:57	6.6	2:57	6.5	2:58	6.4	2:58
1400	8.1	3:27	7.9	3:25	7.7	3:25	7.5	3:26	7.5	3:27
1600	9.2	3:54	9.0	3:52	8.8	3:52	8.6	3:54	8.5	3:55
1800	10.4	4:22	10.1	4:20	9.8	4:20	9.7	4:22	9.6	4:23
2000	11.6	4:49	11.2	4:47	10.9	4:48	10.7	4:50	10.7	4:51
2200	12.8	5:17	12.4	5:15	12.1	5:16	11.9	5:18	11.9	5:19
2400	14.0	5:44	13.6	5:43	13.2	5:43	13.0	5:46	13.0	5:47
2600	15.2	6:11	14.7	6:10	14.4	6:11	14.2	6:14		
2800	16.4	6:39	15.9	6:38	15.6	6:39	15.4	6:42		
3000	17.7	7:06	17.2	7:05	16.8	7:07	16.6	7:10		
3200	18.9	7:33	18.4	7:33	18.0	7:35	17.8	7:38		
3400	20.2	8:01	19.7	8:00	19.2	8:02	19.1	8:06		

Fuel Required Adjustments (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	LANDING WEIGHT (1000 KG)					
	30	35	40	45	50	55
2	-0.3	-0.2	-0.1	0.0	0.1	0.3
4	-0.7	-0.5	-0.2	0.0	0.3	0.7
6	-1.0	-0.7	-0.3	0.0	0.5	1.1
8	-1.3	-0.9	-0.5	0.0	0.7	1.5
10	-1.7	-1.1	-0.6	0.0	0.9	2.0
12	-2.0	-1.4	-0.7	0.0	1.1	2.6
14	-2.3	-1.6	-0.8	0.0	1.4	3.2
16	-2.7	-1.8	-0.9	0.0	1.7	3.9
18	-3.0	-2.1	-1.1	0.0	2.0	4.6
20	-3.3	-2.3	-1.2	0.0	2.3	5.4
22	-3.7	-2.6	-1.3	0.0	2.6	6.2

Based on 280/.74 climb, Long Range Cruise speed and .74/250 descent.

Long Range Cruise Step Climb
Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
813	759	712	670	633	600	570	543	519	496	476	
1074	1005	945	891	843	800	761	726	694	664	637	
1336	1252	1178	1112	1053	1000	952	909	869	833	799	
1597	1498	1410	1333	1263	1200	1143	1091	1044	1001	961	
1859	1744	1643	1553	1473	1400	1334	1274	1219	1169	1123	
2120	1990	1876	1774	1683	1600	1525	1457	1395	1338	1285	
2381	2237	2109	1995	1892	1800	1716	1640	1570	1506	1447	
2642	2483	2341	2215	2102	2000	1907	1823	1746	1675	1609	
2903	2728	2574	2436	2312	2200	2098	2006	1921	1843	1771	
3164	2974	2806	2656	2522	2400	2289	2189	2096	2012	1933	
3424	3220	3039	2877	2731	2600	2481	2372	2272	2180	2096	
3685	3466	3271	3098	2941	2800	2672	2555	2447	2349	2258	
3945	3711	3504	3318	3151	3000	2863	2738	2623	2517	2420	
4206	3957	3736	3538	3361	3200	3054	2921	2799	2686	2582	
4466	4202	3968	3759	3570	3400	3245	3104	2974	2855	2745	

Trip Fuel and Time Required

AIR DIST (NM)	TRIP FUEL (1000 KG)					TIME (HRS:MIN)	
	LANDING WEIGHT (1000 KG)						
	30	35	40	45	50		
600	2.7	2.9	3.2	3.4	3.7	1:34	
800	3.5	3.8	4.1	4.4	4.8	2:03	
1000	4.3	4.6	5.0	5.4	5.9	2:31	
1200	5.1	5.5	5.9	6.4	7.0	2:59	
1400	5.9	6.3	6.8	7.4	8.2	3:27	
1600	6.7	7.2	7.8	8.5	9.3	3:55	
1800	7.5	8.1	8.8	9.6	10.5	4:24	
2000	8.3	9.0	9.8	10.7	11.7	4:52	
2200	9.2	9.9	10.8	11.8	12.9	5:20	
2400	10.0	10.8	11.8	13.0	14.2	5:48	
2600	10.9	11.8	12.8	14.1	15.5	6:15	
2800	11.8	12.7	13.9	15.3	16.8	6:43	
3000	12.6	13.7	15.0	16.5	18.1	7:11	
3200	13.5	14.7	16.1	17.7	19.5	7:39	
3400	14.4	15.7	17.2	19.0	20.8	8:07	

Based on 280/.74 climb, Long Range Cruise speed and .74/250 descent.

Valid for all pressure altitudes with 4000 ft step climb to 2000 ft above optimum altitude.

737 Flight Crew Operations Manual

Short Trip Fuel and Time**Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
91	78	69	61	55	50	46	42	39	37	34	
157	141	128	117	108	100	93	87	82	77	73	
224	204	187	173	161	150	141	133	125	119	113	
290	266	246	228	213	200	188	178	169	160	153	
355	327	304	284	266	250	236	224	212	202	193	
420	389	362	339	318	300	284	269	256	244	233	
485	450	420	394	371	350	332	315	300	286	274	
550	511	478	449	423	400	379	361	344	328	314	
615	573	536	504	476	450	427	406	388	370	355	
681	635	595	559	528	500	475	452	431	412	395	

Trip Fuel and Time Required

AIR DIST (NM)		LANDING WEIGHT (1000 KG)						TIME (HRS:MIN)
		30	35	40	45	50	55	
50	FUEL (1000 KG)	0.5	0.6	0.6	0.6	0.7	0.7	0:14
	ALT (FT)	13000	13000	11000	11000	11000	11000	
100	FUEL (1000 KG)	0.8	0.9	0.9	1.0	1.0	1.1	0:22
	ALT (FT)	25000	23000	23000	21000	19000	19000	
150	FUEL (1000 KG)	1.0	1.1	1.2	1.3	1.3	1.4	0:30
	ALT (FT)	35000	35000	33000	27000	27000	25000	
200	FUEL (1000 KG)	1.2	1.3	1.4	1.5	1.6	1.7	0:37
	ALT (FT)	37000	37000	35000	35000	35000	33000	
250	FUEL (1000 KG)	1.4	1.5	1.6	1.7	1.8	2.0	0:44
	ALT (FT)	37000	37000	37000	37000	35000	35000	
300	FUEL (1000 KG)	1.6	1.7	1.8	2.0	2.1	2.3	0:51
	ALT (FT)	37000	37000	37000	37000	35000	35000	
350	FUEL (1000 KG)	1.8	1.9	2.1	2.2	2.4	2.5	0:58
	ALT (FT)	37000	37000	37000	37000	35000	35000	
400	FUEL (1000 KG)	2.0	2.1	2.3	2.4	2.6	2.8	1:05
	ALT (FT)	37000	37000	37000	37000	35000	35000	
450	FUEL (1000 KG)	2.2	2.3	2.5	2.7	2.9	3.1	1:12
	ALT (FT)	37000	37000	37000	37000	35000	35000	
500	FUEL (1000 KG)	2.3	2.5	2.7	2.9	3.2	3.4	1:20
	ALT (FT)	37000	37000	37000	37000	35000	35000	

Based on 280/.74 climb, Long Range Cruise speed and .74/250 descent.

Holding Planning

Flaps Up

WEIGHT (1000 KG)	TOTAL FUEL FLOW (KG/HR)								
	PRESSURE ALTITUDE (FT)								
	1500	5000	10000	15000	20000	25000	30000	35000	37000
62	2860	2790	2710	2660	2630	2630	2620		
60	2790	2710	2640	2580	2550	2540	2530		
58	2710	2640	2560	2500	2460	2460	2440		
56	2640	2560	2480	2420	2380	2370	2360	2400	
54	2560	2490	2400	2340	2300	2290	2270	2300	
52	2490	2410	2330	2260	2220	2210	2190	2200	
50	2410	2340	2250	2190	2140	2120	2100	2110	2140
48	2340	2260	2180	2110	2060	2040	2020	2020	2050
46	2270	2190	2100	2030	1980	1960	1940	1940	1950
44	2190	2120	2030	1960	1910	1880	1850	1850	1870
42	2130	2060	1980	1900	1840	1800	1770	1770	1780
40	2080	2010	1930	1850	1790	1740	1710	1700	1710
38	2030	1960	1880	1800	1740	1690	1650	1640	1640
36	1980	1920	1830	1760	1690	1640	1600	1580	1590

This table includes 5% additional fuel for holding in a racetrack pattern.

737 Flight Crew Operations Manual

Crew Oxygen Requirements**Required Pressure (PSI) for 39 Cubic ft. Cylinder**

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	
50	122	1335		1950
45	113	1315		1915
40	104	1290		1885
35	95	1270		1855
30	86	1250		1825
25	77	1230		1795
20	68	1210		1765
15	59	1190		1735
10	50	1170		1705
5	41	1150		1675
0	32	1130		1645
-5	23	1110		1615
-10	14	1090		1585

Required Pressure (PSI) for 76 Cubic ft. Cylinder

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	4
50	122	735	1050	1370
45	113	725	1035	1345
40	104	715	1020	1325
35	95	700	1005	1300
30	86	690	990	1280
25	77	680	970	1260
20	68	670	955	1240
15	59	655	940	1220
10	50	645	920	1200
5	41	635	905	1175
0	32	620	890	1155
-5	23	610	875	1130
-10	14	600	860	1110

Required Pressure (PSI) for 114/115 Cubic ft. Cylinder

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	4
50	122	530	735	945
45	113	520	725	930
40	104	510	715	915
35	95	505	700	900
30	86	495	690	885
25	77	485	680	870
20	68	480	670	860
15	59	470	655	840
10	50	460	645	830
5	41	455	635	815
0	32	445	620	800
-5	23	440	610	785
-10	14	430	600	770

ENGINE INOP**MAX CONTINUOUS THRUST****Net Level Off Weight****Engine Bleed to Packs ON (Auto), Anti-Ice OFF**

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 KG)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
30	34.3	33.6	32.8
28	37.2	36.3	35.4
26	40.1	39.1	38.0
24	43.0	41.9	40.6
22	45.9	44.6	43.2
20	48.8	47.4	45.8
18	51.9	50.3	48.6
16	55.1	53.3	51.4
14	58.3	56.4	54.2
12	61.5	59.6	57.1
10	64.7	62.7	59.9
8	67.9	65.8	62.7

Bleed Adjustments

BLEED CONFIGURATION	WEIGHT ADJUSTMENT (KG)
ENGINE A/I ON	-2000
ENGINE AND WING A/I ON	-6300
ENGINE BLEED TO PACKS OFF (BELOW 17000 FT)	+1700

ALL ENGINES**LRC Cruise Critical Fuel Reserves****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
279	258	241	226	212	200	189	180	171	163	156	
570	526	487	454	425	400	377	357	339	323	308	
862	793	734	683	639	600	566	535	507	483	460	
1154	1060	980	912	852	800	754	713	676	642	612	
1446	1327	1227	1141	1066	1000	942	890	844	802	764	
1737	1595	1473	1369	1279	1200	1130	1068	1012	962	917	
2029	1862	1720	1598	1493	1400	1318	1246	1180	1122	1069	
2321	2129	1967	1827	1706	1600	1506	1423	1349	1282	1221	
2613	2396	2213	2056	1919	1800	1695	1601	1517	1441	1373	

Critical Fuel (1000 KG)

AIR DIST (NM)	WEIGHT AT CRITICAL POINT (1000 KG)						
	35	40	45	50	55	60	65
200	1.7	1.7	1.8	1.9	1.9	2.0	2.1
300	2.4	2.5	2.6	2.7	2.8	2.9	3.0
400	3.1	3.2	3.3	3.5	3.6	3.7	3.9
500	3.8	4.0	4.1	4.3	4.4	4.6	4.7
600	4.6	4.7	4.9	5.1	5.3	5.4	5.6
700	5.3	5.5	5.7	5.9	6.1	6.3	6.5
800	6.0	6.2	6.4	6.7	6.9	7.1	7.4
900	6.7	6.9	7.2	7.4	7.7	8.0	8.2
1000	7.4	7.7	7.9	8.2	8.5	8.8	9.1
1100	8.1	8.4	8.7	9.0	9.3	9.6	9.9
1200	8.8	9.1	9.4	9.8	10.1	10.5	10.8
1300	9.5	9.8	10.2	10.5	10.9	11.3	11.6
1400	10.2	10.6	10.9	11.3	11.7	12.1	12.5
1500	10.9	11.3	11.7	12.0	12.5	12.9	13.3
1600	11.6	12.0	12.4	12.8	13.2	13.7	14.1
1700	12.2	12.7	13.1	13.5	14.0	14.5	15.0
1800	12.9	13.4	13.8	14.3	14.8	15.3	15.8

Based on: Emergency descent to 10000 ft, level cruise at 10000 ft, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included. Includes APU fuel burn.

Adjustments:

- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
- Increase fuel required 0.5% per 10°C above ISA.
- When icing conditions are forecast, use the greater of engine and wing anti-ice on (3%) for the total forecast time or engine and wing anti-ice on and ice drag (18%) for 10% of the forecast time.

Compare the critical fuel reserves required for all engines cruise, engine inoperative cruise, and engine inoperative driftdown and use the higher of the three.

ENGINE INOP**LRC Cruise Critical Fuel Reserves****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
286	263	244	227	213	200	189	179	169	161	154	
586	536	494	458	427	400	376	355	336	319	304	
887	810	745	689	642	600	564	531	502	477	453	
1188	1083	995	920	856	800	751	708	669	634	603	
1488	1356	1245	1151	1070	1000	938	884	835	792	753	
1789	1629	1495	1382	1285	1200	1126	1060	1002	950	903	
2090	1902	1746	1613	1499	1400	1313	1237	1169	1108	1053	
2391	2176	1996	1844	1713	1600	1501	1413	1335	1265	1202	
2691	2449	2246	2075	1928	1800	1688	1589	1502	1423	1352	

Critical Fuel (1000 KG)

AIR DIST (NM)	WEIGHT AT CRITICAL POINT (1000 KG)						
	35	40	45	50	55	60	65
200	1.5	1.5	1.6	1.7	1.8	1.8	1.9
300	2.1	2.2	2.3	2.4	2.5	2.6	2.8
400	2.7	2.8	3.0	3.1	3.3	3.5	3.6
500	3.3	3.5	3.7	3.9	4.1	4.3	4.5
600	4.0	4.2	4.4	4.6	4.8	5.1	5.3
700	4.6	4.8	5.1	5.4	5.6	5.9	6.1
800	5.2	5.5	5.8	6.1	6.4	6.7	6.9
900	5.9	6.1	6.5	6.8	7.1	7.4	7.8
1000	6.5	6.8	7.1	7.5	7.8	8.2	8.6
1100	7.1	7.4	7.8	8.2	8.6	9.0	9.4
1200	7.7	8.0	8.5	8.9	9.3	9.7	10.2
1300	8.4	8.7	9.1	9.6	10.0	10.5	11.0
1400	9.0	9.3	9.8	10.3	10.8	11.3	11.8
1500	9.6	9.9	10.4	11.0	11.5	12.0	12.5
1600	10.3	10.5	11.1	11.6	12.2	12.7	13.3
1700	10.9	11.2	11.7	12.3	12.9	13.5	14.1
1800	11.5	11.8	12.3	13.0	13.6	14.2	14.8

Based on: Emergency descent to 10000 ft, level cruise at 10000 ft, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included. Includes APU fuel burn.

Adjustments:

- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
- Increase fuel required 0.5% per 10°C above ISA.
- When icing conditions are forecast, use the greater of engine and wing anti-ice on (5%) for the total forecast time or engine and wing anti-ice on and ice drag (34%) for 10% of the forecast time.

Compare the critical fuel reserves required for all engines cruise, engine inoperative cruise, and engine inoperative driftdown and use the higher of the three.

ENGINE INOP**LRC Driftdown Critical Fuel Reserves****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
270	252	236	223	210	200	190	181	172	165	158
543	506	475	447	422	400	379	361	345	330	316
817	762	714	671	633	600	56.9	542	517	494	473
1094	1019	953	896	845	800	759	722	688	658	630
1372	1277	1194	1121	1057	1000	948	902	860	821	786
1651	1535	1435	1347	1269	1200	1137	1081	1030	984	942
1931	1795	1676	1573	1481	1400	1326	1261	1201	1147	1097
2211	2054	1918	1799	1693	1600	1516	1440	1372	1310	1253
2492	2314	2160	2025	1905	1800	1705	1619	1542	1472	1408

Critical Fuel (1000 KG)

AIRDIST (NM)	WEIGHT AT CRITICAL POINT (1000 KG)						
	35	40	45	50	55	60	65
200	1.4	1.5	1.5	1.6	1.7	1.7	1.8
300	1.8	1.9	2.1	2.2	2.3	2.4	2.6
400	2.3	2.4	2.6	2.8	3.0	3.2	3.4
500	2.7	2.9	3.1	3.4	3.6	3.9	4.2
600	3.1	3.4	3.7	4.0	4.3	4.6	5.0
700	3.5	3.8	4.2	4.5	4.9	5.3	5.8
800	3.9	4.3	4.7	5.1	5.6	6.0	6.6
900	4.3	4.7	5.2	5.7	6.2	6.8	7.3
1000	4.7	5.2	5.7	6.3	6.8	7.5	8.1
1100	5.1	5.6	6.2	6.8	7.5	8.2	8.9
1200	5.5	6.1	6.7	7.4	8.1	8.8	9.7
1300	5.9	6.5	7.2	8.0	8.7	9.5	10.4
1400	6.2	7.0	7.7	8.5	9.3	10.2	11.2
1500	6.6	7.4	8.2	9.1	9.9	10.9	11.9
1600	7.0	7.8	8.7	9.6	10.6	11.6	12.7
1700	7.4	8.3	9.2	10.2	11.2	12.2	13.4
1800	7.7	8.7	9.7	10.7	11.8	12.9	14.1

Based on: Driftdown to and cruise at level off altitude, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included. Includes APU fuel burn.

Adjustments:

- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
- Increase fuel required 0.5% per 10°C above ISA.
- When icing conditions are forecast, use the greater of the engine and wing anti-ice on (13%) for the total forecast time or engine and wing anti-ice on and ice drag (45%) for 10% of the forecast time.

Compare the critical fuel reserves required for all engines cruise, engine inoperative cruise, and engine inoperative driftdown and use the higher of the three.

Intentionally
Blank

Performance Dispatch

Landing

Chapter PD

Section 12

Landing Field Limit Weight - Dry Runway

Flaps 40

Anti-skid Operative and Automatic Speedbrakes

Category "A" Brakes

Wind Corrected Field Length (FT)

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
3000			2690	3000	3210	3400	3600	3780
3400		2790	3070	3400	3620	3830	4040	4240
3800	2880	3130	3440	3800	4030	4260	4480	4700
4200	3190	3470	3810	4200	4440	4680	4920	5160
4600	3510	3820	4180	4600	4850	5110	5360	5620
5000	3830	4160	4550	5000	5270	5530	5800	6080
5400	4140	4500	4920	5400	5680	5960	6250	6540
5800	4460	4850	5290	5800	6090	6380	6690	6990
6200	4780	5190	5660	6200	6500	6810	7130	7450
6600	5090	5530	6030	6600	6910	7240	7570	7910
7000	5410	5880	6400	7000	7330	7660	8010	8370
7400	5730	6220	6780	7400	7740	8090	8450	8830
7800	6050	6560	7150	7800	8150	8510	8890	9290
8200	6360	6910	7520	8200	8560	8940	9330	9750
8600	6680	7250	7890	8600	8970	9370	9780	10210
9000	7000	7590	8260	9000	9380	9790	10220	10670
9400	7310	7940	8630	9400	9800	10220	10660	11120
9800	7630	8280	9000	9800	10210	10640	11100	
10200	7950	8620	9370	10200	10620	11070		
10600	8270	8970	9740	10600	11030			

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
3400	36.4	34.4			
3800	41.8	39.4	37.3	35.1	
4200	47.1	44.5	42.1	39.6	37.6
4600	51.8	49.3	46.9	44.2	41.9
5000	55.3	53.4	51.2	48.7	46.2
5400	58.3	56.5	54.6	52.6	50.2
5800	61.1	59.2	57.3	55.5	53.6
6200	63.7	61.8	59.9	58.0	56.1
6600	66.2	64.2	62.1	60.2	58.3
7000		66.2	64.1	62.1	60.2
7400			65.9	63.9	61.9
7800			67.7	65.6	63.6
8200				67.3	65.2
8600					66.7

Decrease field limit weight by 7700 kg when using manual speedbrakes.

Landing Field Limit Weight - Dry Runway**Flaps 40****Anti-skid Inoperative and Manual Speedbrakes****Category "A" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5000				5000	5360	5780	6240	6740
5400			4730	5400	5780	6200	6660	7160
5800			5120	5800	6190	6620	7080	7570
6200		4860	5500	6200	6610	7040	7500	7990
6600	4630	5230	5890	6600	7020	7460	7920	8400
7000	4990	5610	6280	7000	7440	7880	8350	8820
7400	5360	5990	6670	7400	7850	8310	8770	9230
7800	5720	6360	7060	7800	8260	8730	9190	9650
8200	6080	6740	7440	8200	8680	9150	9610	10060
8600	6450	7110	7830	8600	9090	9570	10030	10480
9000	6810	7490	8220	9000	9510	9990	10460	10900
9400	7180	7870	8610	9400	9920	10410	10880	11310
9800	7540	8240	8990	9800	10340	10840	11300	11730
10200	7910	8620	9380	10200	10750	11260	11720	12140
10600	8270	8990	9770	10600	11170	11680	12140	12560
11000	8640	9370	10160	11000	11580	12100	12570	12970
11400	9000	9750	10550	11400	11990	12520	12990	13390
11800	9360	10120	10930	11800	12410	12950	13410	13800
12200	9730	10500	11320	12200	12820	13370	13830	14220
12600	10090	10870	11710	12600	13240	13790	14250	14630

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
5800	34.8				
6200	38.0	35.8			
6600	41.2	38.8	36.5	34.4	
7000	44.4	41.8	39.4	37.1	35.0
7400	47.6	44.8	42.3	39.8	37.6
7800	50.5	47.8	45.2	42.6	40.2
8200	53.4	50.5	47.9	45.4	42.8
8600	56.3	53.3	50.5	47.9	45.3
9000	59.2	56.1	53.2	50.4	47.8
9400	62.1	58.9	55.9	52.9	50.2
9800	64.9	61.6	58.5	55.3	52.6
10200	67.7	64.2	61.1	57.8	54.9
10600		66.9	63.6	60.3	57.2
11000			66.1	62.8	59.6
11400				65.2	61.8
11800				67.7	64.1
12200					66.4

737 Flight Crew Operations Manual

Landing Field Limit Weight - Wet Runway**Flaps 40****Anti-skid Operative and Automatic Speedbrakes****Category "A" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
3000			3050	3000	3220	3440	3640	3830
3400			3400	3400	3640	3860	4080	4290
3800		3110	3420	3800	4050	4290	4520	4750
4200	3170	3450	3790	4200	4460	4710	4960	5210
4600	3490	3790	4170	4600	4870	5140	5410	5670
5000	3810	4140	4540	5000	5280	5570	5850	6130
5400	4120	4480	4910	5400	5690	5990	6290	6590
5800	4440	4820	5280	5800	6110	6420	6730	7050
6200	4760	5170	5650	6200	6520	6840	7170	7500
6600	5070	5510	6020	6600	6930	7270	7610	7960
7000	5390	5860	6390	7000	7340	7690	8050	8420
7400	5710	6200	6760	7400	7750	8120	8490	8880
7800	6030	6540	7130	7800	8170	8550	8940	9340
8200	6340	6880	7500	8200	8580	8970	9380	9800
8600	6660	7230	7880	8600	8990	9400	9820	10260
9000	6980	7570	8250	9000	9400	9820	10260	10720
9400	7290	7920	8620	9400	9810	10250	10700	11180
9800	7610	8260	8990	9800	10230	10670	11140	11630
10200	7930	8600	9360	10200	10640	11100	11580	12090
10600	8250	8940	9730	10600	11050	11530	12030	12550

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
3800	35.2				
4200	39.8	37.6	35.5		
4600	44.4	42.0	39.7	37.4	35.4
5000	48.9	46.4	43.9	41.3	39.2
5400	52.7	50.4	48.0	45.3	42.9
5800	55.6	53.8	51.6	49.1	46.6
6200	58.2	56.4	54.6	52.5	50.2
6600	60.7	58.8	56.9	55.1	53.2
7000	63.0	61.1	59.2	57.3	55.4
7400	65.2	63.2	61.2	59.3	57.4
7800	67.3	65.1	63.1	61.1	59.1
8200		66.8	64.7	62.7	60.7
8600			66.3	64.2	62.3
9000			67.8	65.7	63.7
9400				67.2	65.1
9800					66.4
10200					67.7

Decrease field limit weight by 7700 kg when using manual speedbrakes.

Landing Field Limit Weight - Wet Runway**Flaps 40****Anti-skid Inoperative and Manual Speedbrakes****Category "A" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5000				5390	5850	6380	6980	
5400				5400	5810	6270	6800	7390
5800				5800	6220	6700	7220	7810
6200			5430	6200	6630	7120	7650	8220
6600			5820	6600	7050	7540	8070	8640
7000		5460	6200	7000	7460	7960	8490	9050
7400		5840	6590	7400	7880	8380	8910	9470
7800	5510	6220	6980	7800	8290	8800	9330	9880
8200	5880	6590	7370	8200	8710	9230	9760	10300
8600	6240	6970	7750	8600	9120	9650	10180	10710
9000	6610	7340	8140	9000	9540	10070	10600	11130
9400	6970	7720	8530	9400	9950	10490	11020	11540
9800	7330	8100	8920	9800	10360	10910	11440	11960
10200	7700	8470	9310	10200	10780	11330	11870	12370
10600	8060	8850	9690	10600	11190	11760	12290	12790
11000	8430	9220	10080	11000	11610	12180	12710	13200
11400	8790	9600	10470	11400	12020	12600	13130	13620
11800	9160	9980	10860	11800	12440	13020	13550	14030
12200	9520	10350	11250	12200	12850	13440	13980	14450
12600	9890	10730	11630	12600	13270	13860	14400	14860

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
6600	34.3				
7000	37.1	35.0			
7400	39.9	37.6	35.4		
7800	42.6	40.1	37.8	35.6	
8200	45.4	42.8	40.3	38.0	35.9
8600	48.1	45.4	42.9	40.4	38.1
9000	50.7	47.9	45.4	42.8	40.4
9400	53.2	50.3	47.7	45.2	42.6
9800	55.7	52.7	50.0	47.4	44.8
10200	58.3	55.2	52.3	49.6	47.0
10600	60.8	57.6	54.7	51.8	49.1
11000	63.2	60.0	56.9	53.9	51.2
11400	65.7	62.3	59.2	56.0	53.2
11800		64.6	61.4	58.2	55.3
12200		67.0	63.6	60.3	57.3
12600			65.8	62.5	59.3
13000				64.6	61.3
13400				66.8	63.3
13800					65.2
14200					67.2

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Landing Climb Limit Weight**Valid for approach with Flaps 15 and landing with Flaps 40****Based on engine bleed for packs on and anti-ice off**

AIRPORT OAT (°C)	LANDING CLIMB LIMIT WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
-1000	0	2000	4000	6000	8000	
54	55.0	53.9				
52	56.1	54.9				
50	57.2	56.0	51.7			
48	58.0	56.8	52.5			
46	58.8	57.7	53.4	49.3		
44	59.7	58.6	54.2	50.2		
42	60.6	59.5	55.1	51.0	47.3	
40	61.5	60.4	56.0	51.7	48.2	
38	62.6	61.3	56.8	52.7	48.9	45.0
36	63.6	62.2	57.7	53.6	49.7	45.8
34	64.7	63.2	58.6	54.5	50.5	46.6
32	65.7	64.1	59.5	55.4	51.3	47.4
30	65.8	65.1	60.5	56.4	52.2	48.2
28	65.8	65.3	61.5	57.3	53.0	48.9
26	65.9	65.4	62.4	58.3	53.8	49.6
24	65.9	65.4	62.4	59.3	54.6	50.3
22	66.0	65.5	62.5	60.0	55.4	51.0
20	66.0	65.5	62.5	60.1	56.2	51.7
18	66.0	65.6	62.6	60.1	57.1	52.5
16	66.0	65.6	62.6	60.2	57.2	53.4
14	66.0	65.7	62.7	60.2	57.2	54.1
12	66.0	65.7	62.7	60.3	57.2	54.1
10	66.0	65.7	62.7	60.3	57.3	54.1
-40	66.0	66.0	63.4	61.0	57.9	54.7

With engine bleed for packs off, increase weight by 1250 kg.

With engine anti-ice on, decrease weight by 400 kg.

With engine and wing anti-ice on, decrease weight by 5500 kg.

When operating in icing conditions during any part of the flight with forecast landing temperature below 8°C, decrease weight by 5100 kg.

ENGINE INOP

ADVISORY INFORMATION

GO-AROUND THRUST

Go-Around Climb Gradient**Flaps 15****Based on engine bleed for packs on and anti-ice off****Reference Go-Around Gradient (%)**

OAT (°C)	REFERENCE GO-AROUND GRADIENT (%)				
	PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
50	3.39	2.33	1.12	0.12	
46	3.86	2.72	1.71	0.66	
42	4.31	3.16	2.07	1.18	0.11
38	4.75	3.61	2.56	1.57	0.56
34	5.27	4.07	3.04	2.00	0.98
30	5.81	4.55	3.53	2.41	1.37
26	5.84	5.03	3.97	2.81	1.74
22	5.87	5.06	4.40	3.22	2.11
18	5.90	5.09	4.42	3.63	2.48
14	5.93	5.11	4.45	3.64	2.83
10	5.94	5.14	4.47	3.66	2.85

Gradient Adjustment for Weight (%)

WEIGHT (1000 KG)	REFERENCE GO-AROUND GRADIENT (%)						
	0	1	2	3	4	5	6
60	-2.00	-2.22	-2.45	-2.67	-2.89	-3.12	-3.34
55	-1.34	-1.48	-1.63	-1.77	-1.92	-2.06	-2.21
50	-0.50	-0.55	-0.60	-0.65	-0.71	-0.76	-0.81
47.5	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	0.61	0.67	0.74	0.80	0.87	0.94	1.01
40	2.03	2.24	2.45	2.67	2.89	3.12	3.36
35	3.97	4.37	4.78	5.21	5.66	6.13	6.62

Gradient Adjustment for Speed (%)

SPEED (KIAS)	WEIGHT ADJUSTED GO-AROUND GRADIENT (%)													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13
VREF	-0.55	-0.59	-0.63	-0.66	-0.69	-0.71	-0.72	-0.73	-0.73	-0.73	-0.72	-0.7	-0.67	-0.64
VREF+5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VREF+10	0.19	0.20	0.21	0.22	0.23	0.24	0.24	0.25	0.26	0.26	0.27	0.27	0.27	0.27
VREF+20	0.47	0.48	0.50	0.51	0.52	0.53	0.53	0.53	0.53	0.52	0.51	0.50	0.49	0.47
VREF+30	0.56	0.57	0.58	0.58	0.58	0.57	0.56	0.54	0.52	0.49	0.46	0.42	0.38	0.33

With engine bleed for packs off, increase gradient by 0.3%.

With engine anti-ice on, decrease gradient by 0.1%.

With engine and wing anti-ice on, decrease gradient by 1.2%.

When operating in icing conditions during any part of the flight with forecast landing temperatures below 8°C, decrease gradient by 0.8%.

737 Flight Crew Operations Manual

Quick Turnaround Limit Weight
Flaps 40

AIRPORT OAT		LIMIT WEIGHT (1000 KG)					
		AIRPORT PRESSURE ALTITUDE (FT)					
°C	°F	-1000	0	2000	4000	6000	8000
54	129	55.1	54.2	52.3			
50	122	55.5	54.5	52.6	50.8	49.0	
45	113	56.0	54.9	53.0	51.2	49.4	47.6
40	104	56.4	55.4	53.5	51.6	49.8	48.0
35	95	56.9	55.8	53.9	52.0	50.2	48.4
30	86	57.3	56.3	54.3	52.4	50.5	48.8
25	77	57.8	56.8	54.8	52.8	51.0	49.2
20	68	58.3	57.2	55.2	53.2	51.4	49.6
15	59	58.9	57.7	55.7	53.7	51.8	50.0
10	50	59.4	58.2	56.2	54.2	52.3	50.4
5	41	59.9	58.8	56.7	54.7	52.7	50.9
0	32	60.4	59.3	57.2	55.1	53.2	51.3
-5	23	61.0	59.9	57.7	55.7	53.7	51.8
-10	14	61.6	60.5	58.3	56.2	54.2	52.3
-15	5	62.2	61.1	58.9	56.7	54.7	52.8
-20	-4	62.8	61.7	59.4	57.3	55.3	53.2
-30	-22	63.5	62.9	60.7	58.5	56.4	54.3
-40	-40	63.5	63.5	62.0	59.8	57.6	55.5
-50	-58	63.5	63.5	63.4	61.1	59.0	56.8
-54	-65	63.5	63.5	63.5	61.7	59.5	57.3

Increase weight by 500 kg per 1% uphill slope. Decrease weight by 850 kg per 1% downhill slope.

Increase weight by 1350 kg per 10 knots headwind. Decrease weight by 6050 kg per 10 knots tailwind.

After landing at weights exceeding those shown below adjusted for slope and wind, wait at least 53 minutes and then check that wheel thermal plugs have not melted before executing a takeoff.

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Performance Dispatch

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Chapter PD

Section 13

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 the data presented in this chapter and that contained in the approved Airplane Flight Manual, the Flight Manual shall always take precedence.

Takeoff

The maximum allowable takeoff weight will be the least of the Field, Climb and Obstacle Limit Weights as determined from the tables shown. Tire and Brake Energy Limits 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 provide corrections to the field length available for the effects of runway slope and wind component along the runway. Enter the Slope Correction table with the available field length and runway slope to determine the slope corrected field length. Now enter the Wind Correction table 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 conditions and show both Field and Climb Limit Weights. Enter the appropriate table 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.

Obstacle Limit Weight

The Reference Obstacle Limit Weight table provides obstacle limit weights for reference airport conditions based on obstacle height above the runway surface and distance from brake release. Enter the adjustment tables to adjust the reference Obstacle Limit Weight for the effects of

OAT, pressure altitude and wind as indicated. In the case of multiple obstacles, enter the tables successively with each obstacle and determine the most limiting weight.

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 this table considers both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude.

The altitudes shown in the table are limited to the maximum certified altitude of 37000 ft.

Long Range Cruise Trip Fuel and Time

Long Range Cruise Trip Fuel and Time tables are provided to determine trip time and fuel required to destination. Data is based on economy climb and descent speeds, and Long Range Cruise with normal engine bleed for air conditioning. 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 to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time tables. Next, enter the Reference Fuel and Time table with air distance from the Ground to Air Miles Conversion table and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment table with the Reference Fuel and the planned landing weight to obtain the adjustment to the fuel required at the planned landing weight.

Long Range Cruise Step Climb Trip Fuel and Time

The Long Range Cruise Step Climb Trip Fuel and Time tables are provided to determine trip time and fuel required to destination when flying a step climb profile. Step climb profiles are based on 4000 ft step climbs to keep the flight within 2000 ft of the optimum altitude for the current cruise weight. To determine trip fuel and time, enter the Ground to Air Miles

737 Flight Crew Operations Manual

Conversion table and determine air distance as discussed above. Then enter the Trip Fuel and Time Required table 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. Obtain air distance from the upper table using the ground distance and wind component to the alternate. Enter the Trip Fuel and Time table with air distance and read trip fuel required for the expected landing weight, together with time to alternate at right. For distances greater than shown or other altitudes, use the Long Range Cruise Trip Fuel and Time tables.

Holding Planning

This table provides total fuel flow information necessary for planning flaps up holding and reserve fuel requirements. Data is based on the FMC holding speed schedule which is the higher of the maximum endurance and flaps up maneuver speeds. As noted, the fuel flow is based on flight in a racetrack holding pattern. For holding in straight and level flight, reduce table values by 5%.

Flight Crew Oxygen Requirements

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. The oxygen quantity associated with the above requirements is achieved with the minimum dispatch oxygen cylinder pressure.

To determine the minimum dispatch oxygen cylinder pressure, enter the appropriate flight crew oxygen table with the number of crew plus observers using oxygen and read the minimum cylinder pressure required for the appropriate cylinder temperature.

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 1000 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.

Extended Operations - LRC Critical Fuel Reserves

ETOPS regulations require that flights conducted over a route that contains a point further than one hour's time at "normal one-engine-inoperative speed" from an adequate airport comply with rules specific to extended operations for airplanes with more than two engines. This section provides reserve fuel planning information for the "Critical Fuel Diversion Scenario".

ETOPS regulations require reserve planning to include a "Critical Fuel Diversion Scenario" calculation. The information shown is the fuel required to satisfy the flight profile described below the tables. This information is shown for all engines operating and one engine inoperative at Long Range Cruise (LRC). There are two engine-inoperative scenarios, a decompression scenario and a driftdown scenario. The decompression scenario assumes an engine failure, loss of pressurization, emergency descent, and subsequent cruise at 10000 ft. The driftdown scenario assumes an engine failure without loss of pressurization, where the airplane "drifts down" to the thrust limited level-off altitude for the remainder of the diversion.

The ETOPS critical fuel required is the greater of the all-engine fuel or the engine-inoperative fuel. The ETOPS critical fuel required is compared to the amount of fuel that is predicted to be onboard the airplane at the critical point. If the fuel required by the ETOPS critical fuel reserves of the route exceeds the amount of fuel predicted, the fuel load must be adjusted accordingly. The data does not include an allowance for performance deterioration. However, regulations require a 5% allowance for performance deterioration, unless a value has been established by the operator for in-service deterioration.

To determine the ETOPS critical fuel required, enter the Ground to Air Mile Conversion table with the forecast wind (factored if applicable) and ground distance to diversion airport from critical point, to obtain air distance. Then enter the Critical Fuel table with air distance and expected weight at the critical point and read the required fuel. Apply the noted fuel adjustments for non-standard conditions, as necessary. When using a wind forecasting model acceptable to the FAA (such as the World Area Forecast System, WAFS), regulations allow the wind factor applied in this step to be 5% of the forecast wind (increase headwinds, decrease tailwinds), as

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indicated in the note below the chart. However, if an FAA-acceptable wind forecasting model is not used, the ETOPS critical fuel must be increased by 5%, instead of factoring the forecast winds.

Landing

Tables are provided for determining the maximum landing weight as limited by field length or climb requirements for a single landing flap.

Maximum landing weight is the lowest of the field length limit weight, climb limit weight, or maximum certified landing weight.

Landing Field Limit Weight

For expected runway condition and anti-skid system configuration, obtain wind corrected field length by entering the Wind Component table with field length available and wind component along the runway. Now enter the Landing Field Limit Weight table with wind corrected field length and pressure altitude to read field limit weight.

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.

Go-Around Climb Gradient

Enter the Reference Go-Around Gradient table with airport OAT and pressure altitude to determine the reference go-around gradient. Then adjust the reference gradient for airplane weight and speed using the tables provided to determine the weight and speed adjusted go-around gradient. Apply the necessary corrections for engine bleed configuration and icing conditions as noted.

Quick Turnaround Limit Weight

Enter the 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.

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Performance Dispatch

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737-400 CFM56-3_23.5K KG FAA

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Performance Dispatch**Chapter PD****Takeoff****Section 20****Takeoff Field Corrections - Dry Runway****Slope Corrections**

FIELD LENGTH AVAILABLE (FT)	SLOPE CORRECTED FIELD LENGTH (FT)								
	RUNWAY SLOPE (%)								
-2.0	-1.5	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0	
4200	4360	4320	4280	4240	4200	4020	3850	3670	3500
4600	4780	4730	4690	4640	4600	4390	4180	3980	3770
5000	5190	5140	5100	5050	5000	4760	4520	4280	4040
5400	5610	5550	5500	5450	5400	5130	4860	4580	4310
5800	6020	5970	5910	5860	5800	5500	5190	4890	4580
6200	6440	6380	6320	6260	6200	5860	5530	5190	4860
6600	6850	6790	6730	6660	6600	6230	5860	5500	5130
7000	7270	7200	7130	7070	7000	6600	6200	5800	5400
7400	7680	7610	7540	7470	7400	6970	6540	6100	5670
7800	8100	8020	7950	7870	7800	7340	6870	6410	5950
8200	8510	8430	8360	8280	8200	7700	7210	6710	6220
8600	8930	8850	8760	8680	8600	8070	7540	7020	6490
9000	9340	9260	9170	9090	9000	8440	7880	7320	6760
9400	9760	9670	9580	9490	9400	8810	8220	7630	7030
9800	10170	10080	9990	9890	9800	9180	8550	7930	7310
10200	10590	10490	10390	10300	10200	9540	8890	8230	7580
10600	11000	10900	10800	10700	10600	9910	9220	8540	7850
11000	11420	11310	11210	11100	11000	10280	9560	8840	8120
11400	11830	11730	11620	11510	11400	10650	9900	9150	8390
11800	12250	12140	12020	11910	11800	11020	10230	9450	8670

Wind Corrections

SLOPE CORRECTED FIELD LENGTH (FT)	SLOPE & WIND CORRECTED FIELD LENGTH (FT)							
	WIND COMPONENT (KTS)							
-15	-10	-5	0	10	20	30	40	
4200	1780	2590	3390	4200	4390	4610	4830	5080
4600	2170	2980	3790	4600	4810	5030	5270	5510
5000	2550	3370	4180	5000	5230	5460	5700	5950
5400	2930	3760	4580	5400	5640	5890	6130	6390
5800	3320	4150	4970	5800	6060	6310	6570	6820
6200	3700	4530	5370	6200	6470	6740	7000	7260
6600	4090	4920	5760	6600	6890	7170	7440	7690
7000	4470	5310	6160	7000	7310	7600	7870	8130
7400	4850	5700	6550	7400	7720	8020	8300	8560
7800	5240	6090	6950	7800	8140	8450	8740	9000
8200	5620	6480	7340	8200	8550	8880	9170	9440
8600	6000	6870	7730	8600	8970	9300	9610	9870
9000	6390	7260	8130	9000	9380	9730	10040	10310
9400	6770	7650	8520	9400	9800	10160	10470	10740
9800	7150	8040	8920	9800	10220	10590	10910	11180
10200	7540	8420	9310	10200	10630	11010	11340	11620
10600	7920	8810	9710	10600	11050	11440	11770	12050
11000	8300	9200	10100	11000	11460	11870	12210	12490
11400	8690	9590	10500	11400	11880	12290	12640	12920
11800	9070	9980	10890	11800	12300	12720	13080	13360

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****Sea Level Pressure Altitude**

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	0	14	18	22	26	30	32	36	40	50
4500	54.5	50.7	49.6	49.3	48.9	48.6	48.3	47.8	46.8	45.7	42.7
4600	55.1	51.3	50.2	49.9	49.6	49.3	49.0	48.4	47.4	46.2	43.3
5000	57.5	53.6	52.4	52.1	51.8	51.5	51.1	50.6	49.5	48.3	45.3
5400	59.8	55.7	54.5	54.2	53.9	53.5	53.2	52.7	51.5	50.3	47.2
5800	61.9	57.8	56.5	56.2	55.8	55.5	55.2	54.6	53.4	52.2	49.0
6200	63.9	59.7	58.4	58.0	57.7	57.4	57.0	56.4	55.3	54.0	50.7
6600	65.8	61.5	60.2	59.8	59.5	59.1	58.8	58.2	57.0	55.7	52.3
7000	67.6	63.2	61.9	61.5	61.2	60.8	60.4	59.8	58.6	57.3	53.9
7400	69.3	64.8	63.5	63.1	62.7	62.4	62.0	61.4	60.1	58.8	55.3
7800	70.9	66.4	65.0	64.6	64.3	63.9	63.5	62.9	61.6	60.3	56.7
8200	72.4	67.8	66.4	66.1	65.7	65.3	64.9	64.3	63.0	61.6	58.0
8600	73.9	69.2	67.8	67.4	67.0	66.6	66.2	65.6	64.3	62.9	59.2
9000	75.3	70.5	69.0	68.6	68.3	67.9	67.5	66.8	65.5	64.1	60.3
9400	76.0	71.8	70.3	69.9	69.5	69.1	68.7	68.1	66.7	65.3	61.5
9800	76.0	73.0	71.5	71.1	70.7	70.3	69.9	69.2	67.9	66.4	62.6
10200	76.0	74.2	72.7	72.3	71.9	71.5	71.1	70.4	69.0	67.5	63.6
10600	76.0	75.4	73.8	73.4	73.0	72.6	72.2	71.5	70.1	68.5	64.6
11000	76.0	76.0	74.9	74.5	74.1	73.7	73.2	72.5	71.1	69.6	65.6
CLIMB LIMIT WT (1000 KG)	67.6	67.5	67.4	67.4	67.3	67.3	67.3	66.3	64.2	61.9	56.2

With engine bleed for packs off, increase field limit weight by 400 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 1100 kg and climb limit weight by 140 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

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Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****2000 FT Pressure Altitude**

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)									
	OAT (°C)									
-40	0	14	18	22	26	30	32	36	40	50
4500	51.7	48.1	47.0	46.7	46.4	46.1	45.0	44.5	43.5	42.5
4600	52.3	48.7	47.6	47.3	47.0	46.7	45.6	45.1	44.1	43.1
5000	54.6	50.9	49.7	49.4	49.1	48.8	47.7	47.2	46.1	45.1
5400	56.8	52.9	51.8	51.4	51.1	50.8	49.7	49.1	48.0	47.0
5800	58.8	54.9	53.7	53.3	53.0	52.7	51.5	51.0	49.9	48.8
6200	60.8	56.7	55.5	55.2	54.8	54.5	53.3	52.7	51.6	50.5
6600	62.6	58.5	57.2	56.9	56.5	56.2	55.0	54.4	53.2	52.1
7000	64.3	60.1	58.9	58.5	58.2	57.8	56.6	56.0	54.8	53.6
7400	65.9	61.7	60.4	60.0	59.7	59.3	58.1	57.5	56.3	55.1
7800	67.5	63.2	61.9	61.5	61.2	60.8	59.6	58.9	57.7	56.5
8200	69.0	64.6	63.3	62.9	62.5	62.2	60.9	60.3	59.0	57.8
8600	70.4	65.9	64.5	64.1	63.8	63.4	62.1	61.5	60.2	59.0
9000	71.7	67.2	65.8	65.4	65.0	64.6	63.3	62.6	61.3	60.1
9400	73.0	68.4	67.0	66.6	66.2	65.8	64.5	63.8	62.5	61.2
9800	74.3	69.6	68.1	67.8	67.4	67.0	65.6	64.9	63.6	62.3
10200	75.5	70.7	69.3	68.9	68.5	68.1	66.7	66.0	64.6	63.3
10600	76.0	71.8	70.3	69.9	69.5	69.1	67.7	67.0	65.7	64.3
11000	76.0	72.9	71.4	71.0	70.6	70.2	68.7	68.0	66.6	65.3
CLIMB LIMIT WT (1000 kg)	65.0	64.9	64.8	64.8	64.7	64.7	62.6	61.5	59.5	57.5
										51.5

With engine bleed for packs off, increase field limit weight by 400 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 1100 kg and climb limit weight by 140 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****4000 FT Pressure Altitude**

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	0	14	18	22	26	30	32	36	40	50
4500	48.8	45.4	44.3	44.0	43.7	42.8	41.9	41.4	40.5	39.4	35.8
4600	49.4	46.0	44.9	44.6	44.3	43.4	42.5	42.0	41.0	39.9	36.3
5000	51.6	48.1	47.0	46.7	46.3	45.4	44.5	43.9	42.9	41.8	38.1
5400	53.7	50.0	48.9	48.6	48.3	47.3	46.3	45.8	44.7	43.6	39.8
5800	55.7	51.9	50.8	50.4	50.1	49.1	48.1	47.6	46.5	45.3	41.4
6200	57.5	53.7	52.5	52.2	51.8	50.8	49.8	49.3	48.1	46.9	42.9
6600	59.3	55.4	54.2	53.8	53.5	52.5	51.4	50.8	49.7	48.5	44.4
7000	61.0	57.0	55.8	55.4	55.1	54.0	52.9	52.4	51.2	50.0	45.8
7400	62.5	58.5	57.2	56.9	56.5	55.5	54.4	53.8	52.6	51.4	47.1
7800	64.1	60.0	58.7	58.3	58.0	56.9	55.8	55.2	54.0	52.7	48.4
8200	65.5	61.3	60.0	59.7	59.3	58.2	57.1	56.5	55.3	53.9	49.6
8600	66.8	62.5	61.2	60.8	60.5	59.4	58.2	57.6	56.4	55.0	50.6
9000	68.0	63.7	62.4	62.0	61.6	60.5	59.3	58.7	57.5	56.1	51.6
9400	69.3	64.9	63.5	63.2	62.8	61.6	60.4	59.8	58.5	57.1	52.6
9800	70.5	66.1	64.7	64.3	63.9	62.7	61.5	60.9	59.6	58.2	53.5
10200	71.7	67.1	65.7	65.3	65.0	63.8	62.5	61.9	60.6	59.1	54.4
10600	72.8	68.2	66.8	66.4	66.0	64.8	63.5	62.9	61.5	60.1	55.3
11000	73.8	69.2	67.8	67.4	67.0	65.7	64.5	63.8	62.5	61.0	56.2
CLIMB LIMIT WT (1000 KG)	62.1	61.9	61.8	61.8	61.7	59.9	58.0	57.0	54.9	52.9	46.2

With engine bleed for packs off, increase field limit weight by 400 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 1100 kg and climb limit weight by 140 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

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Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****6000 FT Pressure Altitude**

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)									
	OAT (°C)									
-40	0	14	18	22	26	30	32	36	40	50
4500	46.0	42.8	41.8	41.5	40.7	39.9	39.0	38.5	37.5	36.5
4600	46.6	43.3	42.3	42.1	41.3	40.4	39.5	39.0	38.0	36.9
5000	48.7	45.3	44.3	44.0	43.2	42.3	41.4	40.9	39.8	38.8
5400	50.7	47.2	46.2	45.9	45.0	44.2	43.2	42.6	41.6	40.5
5800	52.6	49.0	48.0	47.7	46.8	45.9	44.9	44.3	43.2	42.1
6200	54.4	50.7	49.6	49.3	48.5	47.5	46.5	45.9	44.8	43.6
6600	56.1	52.4	51.2	50.9	50.0	49.1	48.0	47.5	46.3	45.1
7000	57.7	53.9	52.8	52.5	51.5	50.6	49.5	48.9	47.8	46.5
7400	59.2	55.4	54.2	53.9	53.0	52.0	50.9	50.3	49.1	47.9
7800	60.7	56.8	55.6	55.3	54.4	53.4	52.2	51.6	50.4	49.2
8200	62.0	58.1	56.9	56.6	55.6	54.6	53.4	52.8	51.6	50.4
8600	63.3	59.3	58.0	57.7	56.7	55.7	54.5	53.9	52.7	51.4
9000	64.5	60.4	59.2	58.8	57.8	56.8	55.6	55.0	53.7	52.4
9400	65.7	61.5	60.3	59.9	58.9	57.8	56.6	56.0	54.7	53.4
9800	66.8	62.6	61.3	61.0	60.0	58.9	57.6	57.0	55.7	54.3
10200	67.9	63.7	62.4	62.0	61.0	59.9	58.6	58.0	56.6	55.3
10600	69.0	64.7	63.3	63.0	61.9	60.8	59.6	58.9	57.5	56.2
11000	70.0	65.6	64.3	63.9	62.9	61.7	60.5	59.8	58.4	57.0
CLIMB LIMIT WT (1000 KG)	59.1	59.0	58.8	58.8	57.3	55.6	53.8	52.9	50.9	48.9
										41.5

With engine bleed for packs off, increase field limit weight by 400 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 1100 kg and climb limit weight by 140 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****8000 FT Pressure Altitude**

CORRECTED FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	0	14	18	22	26	30	32	36	40	50
4500	43.2	40.2	39.2	38.5	37.7	36.9	36.1	35.6	34.6	33.3	28.6
4600	43.8	40.7	39.7	39.0	38.2	37.4	36.6	36.1	35.0	33.7	29.0
5000	45.8	42.7	41.6	40.9	40.1	39.3	38.4	37.8	36.8	35.4	30.6
5400	47.7	44.5	43.4	42.6	41.8	41.0	40.1	39.5	38.4	37.1	32.1
5800	49.5	46.2	45.1	44.3	43.5	42.6	41.7	41.1	40.0	38.6	33.5
6200	51.2	47.9	46.7	45.9	45.1	44.2	43.2	42.7	41.5	40.1	34.8
6600	52.9	49.4	48.3	47.5	46.6	45.7	44.7	44.1	43.0	41.5	36.1
7000	54.4	50.9	49.8	48.9	48.0	47.1	46.1	45.5	44.3	42.8	37.4
7400	55.9	52.4	51.2	50.3	49.4	48.5	47.4	46.9	45.7	44.1	38.6
7800	57.3	53.7	52.5	51.6	50.7	49.8	48.7	48.2	46.9	45.4	39.8
8200	58.6	55.0	53.7	52.8	51.9	50.9	49.9	49.3	48.0	46.5	40.8
8600	59.8	56.1	54.8	53.9	53.0	52.0	50.9	50.3	49.0	47.4	41.6
9000	61.0	57.2	55.9	55.0	54.0	53.0	51.9	51.3	50.0	48.4	42.5
9400	62.1	58.2	56.9	56.0	55.0	54.0	52.9	52.3	50.9	49.3	43.3
9800	63.2	59.3	58.0	57.0	56.0	55.0	53.8	53.2	51.9	50.2	44.1
10200	64.2	60.3	58.9	58.0	57.0	55.9	54.8	54.1	52.8	51.1	44.9
10600	65.3	61.2	59.9	58.9	57.9	56.8	55.6	55.0	53.6	51.9	45.6
11000	66.2	62.1	60.8	59.8	58.8	57.7	56.5	55.8	54.5	52.7	46.4
CLIMB LIMIT WT (1000 KG)	56.0	55.8	55.7	54.4	53.0	51.5	49.8	48.9	47.1	44.9	37.0

With engine bleed for packs off, increase field limit weight by 400 kg and climb limit weight by 1000 kg.

With engine anti-ice on, decrease field limit weight by 1100 kg and climb limit weight by 140 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

737 Flight Crew Operations Manual

Takeoff Obstacle Limit Weight**Flaps 5****Sea Level 30°C & Below, Zero Wind****Based on engine bleed for packs on and anti-ice off**

OBSTACLE HEIGHT (FT)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)										
	DISTANCE FROM BRAKE RELEASE (1000 FT)										
8	10	12	14	16	18	20	22	24	26	28	30
10	62.2	67.7									
50	56.9	62.2	66.1								
100	53.2	58.3	62.1	65.0	67.1	68.7					
150	50.4	55.4	59.2	62.1	64.2	66.0	67.5	68.7			
200	48.1	53.0	56.8	59.6	61.9	63.8	65.4	66.7	67.7	68.6	
250	45.5	50.9	54.7	57.4	59.9	61.9	63.6	64.9	66.1	67.1	68.6
300	40.8	49.1	52.9	55.6	58.1	60.2	61.9	63.4	64.6	65.6	66.5
350		47.4	51.2	54.0	56.5	58.7	60.4	61.9	63.2	64.3	65.2
400		44.8	49.4	52.5	55.1	57.2	59.1	60.6	61.9	63.1	64.0
450		40.1	48.0	51.1	53.7	55.9	57.8	59.4	60.7	61.9	62.9
500			46.7	49.8	52.5	54.7	56.6	58.2	59.6	60.8	61.9
550			42.7	48.7	51.3	53.5	55.4	57.1	58.5	59.8	60.9
600				47.6	50.2	52.4	54.4	56.0	57.5	58.8	59.9
650				46.4	49.2	51.4	53.4	55.1	56.5	57.8	59.0
700				41.9	48.2	50.4	52.4	54.1	55.6	56.9	58.1
750					47.3	49.5	51.5	53.2	54.7	56.1	57.3
800					45.7	48.6	50.6	52.4	53.9	55.2	56.5
850					40.8	47.8	49.8	51.5	53.1	54.5	55.7
900						47.0	49.0	50.7	52.3	53.7	54.9
950						44.5	48.2	50.0	51.5	53.0	54.2
1000						39.6	47.5	49.2	50.8	52.2	53.5

Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.

Takeoff Obstacle Limit Weight**Flaps 5****OAT Adjustments**

OAT (°C)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)						
	44	48	52	56	60	64	68
30 & Below	0	0	0	0	0	0	0
32	-0.6	-0.7	-0.8	-0.9	-0.9	-1.0	-1.1
34	-1.3	-1.4	-1.6	-1.7	-1.8	-2.0	-2.1
36	-1.9	-2.1	-2.4	-2.6	-2.8	-3.0	-3.2
38	-2.6	-2.9	-3.1	-3.4	-3.7	-4.0	-4.2
40	-3.2	-3.6	-3.9	-4.3	-4.6	-5.0	-5.3
42	-3.9	-4.4	-4.8	-5.2	-5.6	-6.1	-6.5
44	-4.6	-5.2	-5.7	-6.2	-6.7	-7.2	-7.7
46	-5.4	-5.9	-6.5	-7.1	-7.7	-8.3	-8.9
48	-6.1	-6.7	-7.4	-8.1	-8.7	-9.4	-10.1
50	-6.8	-7.5	-8.3	-9.0	-9.8	-10.5	-11.3

Pressure Altitude Adjustments

ALT (FT)	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)						
	44	48	52	56	60	64	68
S.L. & Below	0	0	0	0	0	0	0
1000	-1.6	-1.7	-1.9	-2.0	-2.2	-2.3	-2.4
2000	-3.2	-3.5	-3.7	-4.0	-4.3	-4.6	-4.9
3000	-4.7	-5.1	-5.5	-5.9	-6.3	-6.8	-7.2
4000	-6.2	-6.7	-7.3	-7.8	-8.4	-8.9	-9.5
5000	-7.5	-8.2	-8.9	-9.6	-10.2	-10.9	-11.6
6000	-8.9	-9.7	-10.5	-11.3	-12.1	-12.9	-13.7
7000	-10.2	-11.1	-12.0	-12.9	-13.9	-14.8	-15.7
8000	-11.5	-12.5	-13.6	-14.6	-15.6	-16.7	-17.7

Wind Adjustments

WIND (KTS)	OAT & ALT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)						
	44	48	52	56	60	64	68
15 TW	-10.7	-10.3	-9.9	-9.4	-9.0	-8.5	-8.1
10 TW	-7.2	-6.9	-6.6	-6.3	-6.0	-5.7	-5.4
5 TW	-3.6	-3.4	-3.3	-3.1	-3.0	-2.8	-2.7
0	0	0	0	0	0	0	0
10 HW	0.8	0.7	0.6	0.6	0.5	0.5	0.4
20 HW	1.6	1.4	1.3	1.2	1.0	0.9	0.8
30 HW	2.4	2.2	2.0	1.8	1.6	1.4	1.2
40 HW	3.2	2.9	2.6	2.4	2.1	1.8	1.6

With engine bleed for packs off, increase weight by 400 kg.

With engine anti-ice on, decrease weight by 1450 kg.

Performance Dispatch**Chapter PD****Enroute****Section 21****Long Range Cruise Maximum Operating Altitude****Max Cruise Thrust****ISA + 10°C and Below**

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20(33°)	1.25(36°)	1.30(39°)	1.40(44°)	1.50(45°)
68	29500	-7	32800	31900	31000	29400	27900
66	30100	-8	33400	32500	31700	30000	28500
64	30800	-10	34100	33200	32300	30700	29200
62	31500	-11	34700	33800	33000	31400	29900
60	32200	-13	35400	34500	33700	32100	30600
58	32900	-14	36100	35300	34400	32800	31400
56	33700	-16	36900	36000	35200	33600	32100
54	34400	-18	37000	36700	35900	34400	32900
52	35200	-19	37000	37000	36700	35200	33700
50	36100	-21	37000	37000	37000	36000	34500
48	36900	-21	37000	37000	37000	36800	35400
46	37000	-21	37000	37000	37000	37000	36300
44	37000	-21	37000	37000	37000	37000	37000

ISA + 15°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20(33°)	1.25(36°)	1.30(39°)	1.40(44°)	1.50(48°)
68	29500	-1	32400*	31900	31000	29400	27900
66	30100	-3	33200*	32500	31700	30000	28500
64	30800	-4	34000*	33200	32300	30700	29200
62	31500	-6	34700	33800	33000	31400	29900
60	32200	-7	35400	34500	33700	32100	30600
58	32900	-9	36100	35300	34400	32800	31400
56	33700	-10	36900	36000	35200	33600	32100
54	34400	-12	37000	36700	35900	34400	32900
52	35200	-14	37000	37000	36700	35200	33700
50	36100	-16	37000	37000	37000	36000	34500
48	36900	-16	37000	37000	37000	36800	35400
46	37000	-16	37000	37000	37000	37000	36300
44	37000	-16	37000	37000	37000	37000	37000

ISA + 20°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20(33°)	1.25(36°)	1.30(39°)	1.40(44°)	1.50(48°)
68	29500	4	31500*	31500*	31000	29400	27900
66	30100	3	32400*	32400*	31700	30000	28500
64	30800	1	33300*	33200	32300	30700	29200
62	31500	0	34100*	33800	33000	31400	29900
60	32200	-2	35000*	34500	33700	32100	30600
58	32900	-3	35900*	35300	34400	32800	31400
56	33700	-5	36600*	36000	35200	33600	32100
54	34400	-7	37000	36700	35900	34400	32900
52	35200	-8	37000	37000	36700	35200	33700
50	36100	-10	37000	37000	37000	36000	34500
48	36900	-10	37000	37000	37000	36800	35400
46	37000	-10	37000	37000	37000	37000	36300
44	37000	-10	37000	37000	37000	37000	37000

*Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.

Long Range Cruise Trip Fuel and Time Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
273	254	238	223	211	200	190	181	173	166	160	
535	501	471	445	421	400	381	364	348	334	322	
797	748	704	666	631	600	573	548	525	503	484	
1058	995	938	887	841	800	764	731	700	672	646	
1319	1241	1170	1107	1051	1000	955	914	875	840	808	
1579	1486	1402	1328	1261	1200	1146	1097	1051	1009	971	
1839	1732	1634	1548	1471	1400	1338	1280	1226	1177	1133	
2099	1977	1866	1768	1681	1600	1529	1462	1401	1346	1295	
2359	2223	2099	1989	1890	1800	1720	1645	1577	1514	1457	
2619	2469	2332	2210	2100	2000	1911	1829	1753	1683	1620	
2880	2715	2564	2431	2310	2200	2103	2012	1929	1852	1783	
3141	2961	2797	2651	2520	2400	2294	2196	2105	2021	1946	
3402	3207	3029	2872	2730	2600	2485	2379	2281	2191	2109	
3663	3453	3262	3092	2940	2800	2677	2562	2457	2360	2272	
3924	3700	3495	3313	3150	3000	2868	2746	2633	2529	2435	
4185	3946	3728	3534	3360	3200	3059	2929	2809	2698	2598	
4446	4192	3960	3755	3570	3400	3251	3112	2984	2867	2760	

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Long Range Cruise Trip Fuel and Time**Reference Fuel and Time Required**

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)							
	29		31		33		35	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	1.5	0:38	1.5	0:38	1.5	0:38	1.5	0:38
400	2.6	1:06	2.6	1:06	2.5	1:05	2.5	1:06
600	3.7	1:35	3.6	1:34	3.5	1:33	3.5	1:34
800	4.8	2:03	4.7	2:01	4.6	2:01	4.5	2:02
1000	5.9	2:31	5.8	2:29	5.6	2:29	5.5	2:30
1200	7.1	2:59	6.9	2:57	6.7	2:57	6.6	2:58
1400	8.2	3:26	8.0	3:24	7.8	3:24	7.6	3:26
1600	9.4	3:54	9.1	3:52	8.9	3:52	8.7	3:54
1800	10.6	4:21	10.2	4:20	10.0	4:20	9.8	4:22
2000	11.7	4:49	11.4	4:47	11.1	4:48	10.9	4:50
2200	13.0	5:16	12.6	5:15	12.3	5:15	12.0	5:18
2400	14.2	5:44	13.8	5:42	13.4	5:43	13.2	5:46
2600	15.4	6:11	15.0	6:10	14.6	6:11	14.4	6:14
2800	16.7	6:38	16.2	6:37	15.8	6:39	15.6	6:42
3000	17.9	7:06	17.4	7:05	17.0	7:06	16.8	7:10
3200	19.2	7:33	18.7	7:32	18.3	7:34	18.1	7:38
3400	20.5	8:00	20.0	8:00	19.5	8:02	19.4	8:06

Fuel Required Adjustments (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	LANDING WEIGHT (1000 KG)						
	30	35	40	45	50	55	60
2	0.0	0.1	0.1	0.0	0.1	0.2	0.4
4	-0.5	-0.3	-0.1	0.0	0.2	0.5	0.7
6	-1.0	-0.6	-0.3	0.0	0.3	0.7	1.1
8	-1.3	-0.9	-0.4	0.0	0.6	1.3	2.3
10	-1.7	-1.1	-0.6	0.0	0.9	2.0	3.5
12	-2.0	-1.3	-0.7	0.0	1.1	2.6	4.7
14	-2.3	-1.6	-0.8	0.0	1.4	3.2	5.9
16	-2.7	-1.8	-0.9	0.0	1.7	3.8	7.1
18	-3.0	-2.1	-1.0	0.0	1.9	4.4	8.3
20	-3.4	-2.3	-1.2	0.0	2.2	5.1	9.5
22	-3.7	-2.5	-1.3	0.0	2.5	5.7	10.7

Based on 280/.74 climb, Long Range Cruise and .74/250 descent.

Long Range Cruise Step Climb

Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
813	759	712	670	633	600	570	543	519	496	476	
1074	1005	944	891	843	800	761	726	694	664	637	
1335	1251	1177	1111	1053	1000	952	909	869	833	800	
1596	1497	1410	1332	1263	1200	1143	1092	1045	1001	962	
1856	1743	1642	1553	1472	1400	1334	1275	1220	1170	1124	
2117	1989	1875	1773	1682	1600	1525	1458	1395	1338	1286	
2378	2234	2107	1994	1892	1800	1717	1641	1571	1507	1448	
2638	2480	2340	2214	2102	2000	1908	1824	1746	1676	1610	
2899	2726	2572	2435	2311	2200	2099	2007	1922	1844	1773	
3159	2971	2804	2655	2521	2400	2290	2190	2098	2013	1935	
3419	3217	3037	2876	2731	2600	2481	2373	2273	2182	2097	
3679	3462	3269	3096	2941	2800	2672	2556	2449	2351	2260	
3939	3707	3501	3316	3150	3000	2863	2739	2624	2519	2422	
4199	3952	3733	3537	3360	3200	3055	2922	2800	2688	2585	
4459	4198	3965	3757	3570	3400	3246	3105	2976	2857	2747	

Trip Fuel and Time Required

AIR DIST (NM)	TRIP FUEL (1000 KG)							TIME (HRS:MIN)	
	LANDING WEIGHT (1000 KG)								
	30	35	40	45	50	55	60		
600	2.8	3.0	3.2	3.4	3.7	4.0	4.3	1:34	
800	3.6	3.8	4.1	4.4	4.8	5.2	5.6	2:02	
1000	4.4	4.7	5.0	5.5	6.0	6.4	6.9	2:30	
1200	5.2	5.6	6.0	6.5	7.1	7.7	8.3	2:59	
1400	6.0	6.4	6.9	7.5	8.3	8.9	9.7	3:27	
1600	6.8	7.3	7.9	8.6	9.4	10.2	11.1	3:55	
1800	7.6	8.2	8.9	9.7	10.6	11.5	12.5	4:22	
2000	8.5	9.1	9.9	10.8	11.9	12.9	13.9	4:50	
2200	9.3	10.1	10.9	12.0	13.1	14.2	15.4	5:18	
2400	10.2	11.0	12.0	13.1	14.4	15.6	16.9	5:46	
2600	11.1	12.0	13.0	14.3	15.7	17.1	18.5	6:14	
2800	12.0	12.9	14.1	15.5	17.0	18.5	20.0	6:42	
3000	12.9	13.9	15.2	16.7	18.3	20.0	21.6	7:09	
3200	13.8	14.9	16.3	18.0	19.7	21.5	23.2	7:37	
3400	14.7	16.0	17.5	19.2	21.1	23.0	24.9	8:05	

Based on .74 climb, Long Range Cruise and .74/.250 descent.

Valid for all pressure altitudes with 4000 ft step climb to 2000 ft above optimum altitude.

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Short Trip Fuel and Time**Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
90	78	68	61	55	50	46	42	39	37	35	
158	141	128	117	108	100	93	87	82	77	73	
224	204	187	173	161	150	141	132	125	119	113	
290	266	246	228	213	200	188	178	169	160	153	
356	328	304	284	266	250	236	223	212	202	193	
420	389	362	339	318	300	284	269	256	244	233	
485	450	420	394	371	350	332	315	300	286	274	
549	511	478	449	423	400	379	361	344	329	315	
615	573	536	504	475	450	427	406	388	371	355	
681	635	595	559	528	500	475	452	431	412	395	

Trip Fuel and Time Required

AIR DIST (NM)		LANDING WEIGHT (1000 KG)						TIME (HRS:MIN)
		35	40	45	50	55	60	
50	FUEL (1000 KG) ALT (FT)	0.6 13000	0.6 11000	0.6 11000	0.7 11000	0.7 9000	0.7 9000	0:13
	FUEL (1000 KG) ALT (FT)	0.9 23000	0.9 23000	1.0 21000	1.0 21000	1.1 19000	1.1 19000	0:22
100	FUEL (1000 KG) ALT (FT)	1.1 35000	1.2 31000	1.2 29000	1.3 27000	1.4 25000	1.5 25000	0:30
	FUEL (1000 KG) ALT (FT)	1.3 37000	1.4 37000	1.5 35000	1.6 35000	1.7 33000	1.8 31000	0:37
150	FUEL (1000 KG) ALT (FT)	1.5 37000	1.6 37000	1.7 37000	1.8 35000	2.0 35000	2.1 33000	0:45
	FUEL (1000 KG) ALT (FT)	1.7 37000	1.8 37000	2.0 37000	2.1 35000	2.2 35000	2.4 33000	0:51
200	FUEL (1000 KG) ALT (FT)	1.9 37000	2.1 37000	2.2 37000	2.4 35000	2.5 35000	2.7 33000	0:58
	FUEL (1000 KG) ALT (FT)	2.1 37000	2.3 37000	2.4 37000	2.6 35000	2.8 35000	3.0 33000	1:05
250	FUEL (1000 KG) ALT (FT)	2.3 37000	2.5 37000	2.7 37000	2.9 35000	3.1 35000	3.3 33000	1:12
	FUEL (1000 KG) ALT (FT)	2.5 37000	2.7 37000	2.9 37000	3.2 35000	3.4 35000	3.7 33000	1:20
300	FUEL (1000 KG) ALT (FT)	2.7 37000	2.9 37000	3.1 37000	3.4 35000	3.7 35000	4.0 33000	1:28
	FUEL (1000 KG) ALT (FT)	2.9 37000	3.1 37000	3.3 37000	3.6 35000	3.9 35000	4.2 33000	1:36
350	FUEL (1000 KG) ALT (FT)	3.1 37000	3.3 37000	3.5 37000	3.8 35000	4.1 35000	4.4 33000	1:44
	FUEL (1000 KG) ALT (FT)	3.3 37000	3.5 37000	3.7 37000	4.0 35000	4.3 35000	4.6 33000	1:52
400	FUEL (1000 KG) ALT (FT)	3.5 37000	3.7 37000	3.9 37000	4.2 35000	4.5 35000	4.8 33000	1:59
	FUEL (1000 KG) ALT (FT)	3.7 37000	3.9 37000	4.1 37000	4.4 35000	4.7 35000	5.0 33000	2:07
450	FUEL (1000 KG) ALT (FT)	3.9 37000	4.1 37000	4.3 37000	4.6 35000	4.9 35000	5.2 33000	2:14
	FUEL (1000 KG) ALT (FT)	4.1 37000	4.3 37000	4.5 37000	4.8 35000	5.1 35000	5.4 33000	2:22
500	FUEL (1000 KG) ALT (FT)	4.3 37000	4.5 37000	4.7 37000	5.0 35000	5.3 35000	5.6 33000	2:30

Based on 280/.74 climb, Long Range Cruise and .74/250 descent.

Holding Planning

Flaps Up

WEIGHT (1000 KG)	TOTAL FUEL FLOW (KG/HR)								
	PRESSURE ALTITUDE (FT)								
	1500	5000	10000	15000	20000	25000	30000	35000	37000
68	3070	3040	3000	2960	2930	2920	2940		
66	2990	2950	2910	2880	2840	2840	2840		
64	2910	2870	2830	2790	2760	2750	2750		
62	2830	2780	2750	2710	2670	2670	2660		
60	2750	2700	2660	2620	2590	2580	2570		
58	2670	2620	2580	2540	2500	2500	2480		
56	2590	2540	2500	2460	2420	2410	2390	2420	
54	2510	2460	2420	2370	2340	2330	2310	2320	
52	2430	2380	2340	2290	2260	2240	2220	2230	
50	2360	2300	2260	2210	2180	2160	2130	2140	2160
48	2290	2220	2180	2130	2100	2080	2050	2050	2070
46	2210	2150	2100	2050	2010	2000	1970	1960	1980
44	2140	2080	2030	1970	1930	1920	1890	1880	1890
42	2080	2020	1970	1920	1870	1840	1800	1800	1810
40	2030	1970	1920	1860	1810	1780	1740	1730	1730

This table includes 5% additional fuel for holding in a racetrack pattern.

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Crew Oxygen Requirements**Required Pressure (PSI) for 39 Cubic Foot Cylinder**

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	
50	122	1335		1950
45	113	1315		1915
40	104	1290		1885
35	95	1270		1855
30	86	1250		1825
25	77	1230		1795
20	68	1210		1765
15	59	1190		1735
10	50	1170		1705
5	41	1150		1675
0	32	1130		1645
-5	23	1110		1615
-10	14	1090		1585

Required Pressure (PSI) for 76 Cubic Foot Cylinder

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	4
50	122	735	1050	1370
45	113	725	1035	1345
40	104	715	1020	1325
35	95	700	1005	1300
30	86	690	990	1280
25	77	680	970	1260
20	68	670	955	1240
15	59	655	940	1220
10	50	645	920	1200
5	41	635	905	1175
0	32	620	890	1155
-5	23	610	875	1130
-10	14	600	860	1110

Required Pressure (PSI) for 114/115 Cubic Foot Cylinder

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	4
50	122	530	735	945
45	113	520	725	930
40	104	510	715	915
35	95	505	700	900
30	86	495	690	885
25	77	485	680	870
20	68	480	670	860
15	59	470	655	840
10	50	460	645	830
5	41	455	635	815
0	32	445	620	800
-5	23	440	610	785
-10	14	430	600	770

ENGINE INOP**MAX CONTINUOUS THRUST****Net Level Off Weight**

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 KG)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
30	36.2	35.6	34.8
28	39.2	38.5	37.5
26	42.3	41.2	40.2
24	45.3	44.2	42.9
22	48.5	47.2	45.7
20	51.6	50.2	48.4
18	55.1	53.3	51.4
16	58.3	56.2	54.2
14	61.3	59.3	57.0
12	64.5	62.3	59.8
10	67.7	65.4	62.7
8		68.3	65.5

Bleed Adjustments

BLEED CONFIGURATION	WEIGHT ADJUSTMENT (KG)
ENGINE A/I ON	-1950
ENGINE AND WING A/I ON	-6650
ENGINE BLEED TO PACKS OFF (BELOW 17000 FT)	+3500

ALL ENGINES**LRC Cruise Critical Fuel Reserves****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)					600	TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
281	260	242	226	212		189	179	170	162	155
570	525	487	454	425		378	357	339	323	308
858	790	732	682	638		566	536	508	484	461
1146	1055	977	910	851		754	714	677	644	614
1435	1320	1222	1138	1064		943	892	846	805	768
1723	1585	1467	1366	1278		1131	1070	1015	966	921
2011	1850	1712	1594	1491		1320	1248	1184	1126	1074
2300	2115	1957	1822	1704		1508	1426	1353	1287	1227
2588	2380	2202	2050	1917		1697	1605	1522	1447	1380

Critical Fuel (1000 KG)

AIR DIST (NM)	WEIGHT AT CRITICAL POINT (1000 KG)							
	35	40	45	50	55	60	65	70
200	1.9	2.0	2.0	2.1	2.1	2.2	2.3	2.3
300	2.7	2.7	2.8	2.9	3.0	3.1	3.2	3.3
400	3.4	3.5	3.6	3.7	3.8	4.0	4.1	4.2
500	4.1	4.2	4.4	4.5	4.7	4.8	5.0	5.1
600	4.8	5.0	5.2	5.3	5.5	5.7	5.9	6.1
700	5.6	5.8	6.0	6.2	6.4	6.6	6.8	7.0
800	6.3	6.5	6.7	6.9	7.2	7.4	7.6	7.9
900	7.0	7.2	7.5	7.7	8.0	8.3	8.5	8.8
1000	7.7	7.9	8.2	8.5	8.8	9.1	9.4	9.7
1100	8.5	8.7	9.0	9.3	9.6	9.9	10.3	10.6
1200	9.2	9.4	9.7	10.1	10.4	10.8	11.1	11.5
1300	9.9	10.1	10.5	10.9	11.2	11.6	12.0	12.4
1400	10.7	10.9	11.2	11.6	12.0	12.4	12.8	13.2
1500	11.4	11.6	12.0	12.4	12.8	13.2	13.7	14.1
1600	12.1	12.3	12.7	13.1	13.6	14.1	14.5	15.0
1700	12.8	13.0	13.4	13.9	14.4	14.9	15.4	15.9
1800	13.6	13.8	14.1	14.7	15.2	15.7	16.2	16.7

Based on: Emergency descent to 10000 ft, level cruise at 10000 ft, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included. Includes APU fuel burn.

Adjustments:

- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
- Increase fuel required 0.5% per 10°C above ISA.
- When icing conditions are forecast, use the greater of engine and wing anti-ice on (3%) for the total forecast time or engine and wing anti-ice on and ice drag (18%) for 10% of the forecast time.

Compare the critical fuel reserves required for all engines cruise, engine inoperative cruise, and engine inoperative driftdown and use the higher of the three.

ENGINE INOP**LRC Cruise Critical Fuel Reserves****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
289	265	245	228	213	200	188	178	169	161	153	
589	538	496	459	427	400	376	354	335	318	303	
890	812	746	690	642	600	563	531	502	476	452	
1191	1085	996	921	856	800	751	707	668	634	602	
1492	1358	1247	1152	1071	1000	938	883	835	791	752	
1793	1632	1497	1383	1285	1200	1126	1060	1001	949	902	
2094	1905	1748	1614	1499	1400	1313	1236	1168	1107	1051	
2395	2179	1998	1845	1714	1600	1500	1412	1334	1264	1201	
2696	2452	2248	2076	1928	1800	1688	1589	1501	1422	1351	

Critical Fuel (1000 KG)

AIR DIST (NM)	WEIGHT AT CRITICAL POINT (1000 KG)						
	35	40	45	50	55	60	65
200	1.7	1.8	1.8	1.9	2.0	2.1	2.1
300	2.4	2.5	2.6	2.7	2.8	2.9	3.0
400	3.0	3.1	3.3	3.4	3.6	3.7	3.9
500	3.6	3.8	4.0	4.2	4.3	4.5	4.7
600	4.3	4.5	4.7	4.9	5.1	5.4	5.6
700	4.9	5.2	5.4	5.7	5.9	6.2	6.4
800	5.6	5.8	6.1	6.4	6.7	7.0	7.2
900	6.2	6.5	6.8	7.1	7.4	7.7	8.1
1000	6.8	7.1	7.5	7.8	8.2	8.5	8.9
1100	7.5	7.7	8.1	8.5	8.9	9.3	9.7
1200	8.1	8.4	8.8	9.2	9.7	10.1	10.5
1300	8.7	9.0	9.5	10.0	10.4	10.9	11.3
1400	9.4	9.7	10.2	10.7	11.2	11.6	12.1
1500	10.0	10.3	10.8	11.4	11.9	12.4	12.9
1600	10.7	10.9	11.5	12.0	12.6	13.1	13.7
1700	11.3	11.6	12.1	12.7	13.3	13.9	14.5
1800	11.9	12.2	12.8	13.4	14.0	14.6	15.3

Based on: Emergency descent to 10000 ft, level cruise at 10000 ft, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included. Includes APU fuel burn.

Adjustments:

- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
- Increase fuel required 0.5% per 10°C above ISA.
- When icing conditions are forecast, use the greater of engine and wing anti-ice on (5%) for the total forecast time or engine and wing anti-ice on and ice drag (32%) for 10% of the forecast time.

Compare the critical fuel reserves required for all engines cruise, engine inoperative cruise, and engine inoperative driftdown and use the higher of the three.

ENGINE INOP**LRC Driftdown Critical Fuel Reserves****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)					600	TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
269	251	236	223	210		190	181	173	165	158
541	505	474	446	422		380	362	345	330	317
814	760	712	670	633		569	542	518	495	474
1089	1015	951	895	844		759	723	689	659	632
1365	1272	1191	1119	1056		949	903	861	823	788
1642	1529	1431	1345	1268		1138	1083	1032	987	945
1920	1787	1671	1570	1480		1327	1263	1204	1150	1101
2198	2045	1912	1795	1692		1517	1442	1375	1313	1257
2477	2303	2153	2021	1904		1706	1622	1546	1476	1413

Critical Fuel (1000 KG)

AIR DIST (NM)	WEIGHT AT CRITICAL POINT (1000 KG)						
	35	40	45	50	55	60	65
200	1.5	1.6	1.6	1.7	1.8	1.9	1.9
300	1.9	2.1	2.2	2.3	2.4	2.6	2.7
400	2.4	2.5	2.7	2.9	3.1	3.3	3.5
500	2.8	3.0	3.2	3.5	3.7	4.0	4.3
600	3.2	3.5	3.8	4.1	4.4	4.7	5.0
700	3.6	4.0	4.3	4.6	5.0	5.4	5.8
800	4.0	4.4	4.8	5.2	5.6	6.1	6.6
900	4.4	4.9	5.3	5.8	6.3	6.8	7.4
1000	4.8	5.3	5.8	6.3	6.9	7.5	8.1
1100	5.2	5.8	6.3	6.9	7.5	8.1	8.9
1200	5.6	6.2	6.8	7.5	8.1	8.8	9.6
1300	6.0	6.7	7.3	8.0	8.7	9.5	10.4
1400	6.4	7.1	7.8	8.5	9.3	10.1	11.1
1500	6.8	7.5	8.3	9.1	9.9	10.8	11.8
1600	7.1	7.9	8.8	9.6	10.5	11.5	12.5
1700	7.5	8.4	9.2	10.1	11.1	12.1	13.3
1800	7.9	8.8	9.7	10.7	11.7	12.8	14.0

Based on: Driftdown to and cruise at level off altitude, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included. Includes APU fuel burn.

Adjustments:

- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
- Increase fuel required 0.5% per 10°C above ISA.
- When icing conditions are forecast, use the greater of the engine and wing anti-ice on (12%) for the total forecast time or engine and wing anti-ice on and ice drag (45%) for 10% of the forecast time.

Compare the critical fuel reserves required for all engines cruise, engine inoperative cruise, and engine inoperative driftdown and use the higher of the three.

Intentionally
Blank

Performance Dispatch

Landing

Chapter PD

Section 22

Landing Field Limit Weight - Dry Runway

Flaps 40

Anti-skid Operative and Automatic Speedbrakes

Category "A" Brakes

Wind Corrected Field Length (FT)

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
3000			2780	3000	3230	3440	3640	3820
3400	2700	2910	3140	3400	3630	3860	4070	4270
3800	3000	3230	3500	3800	4040	4270	4490	4710
4200	3300	3560	3860	4200	4440	4680	4920	5150
4600	3600	3880	4220	4600	4850	5100	5350	5590
5000	3910	4210	4570	5000	5250	5510	5770	6030
5400	4210	4540	4930	5400	5660	5930	6200	6480
5800	4510	4860	5290	5800	6070	6340	6620	6920
6200	4810	5190	5650	6200	6470	6750	7050	7360
6600	5120	5510	6010	6600	6880	7170	7480	7800
7000	5420	5840	6370	7000	7280	7580	7900	8240
7400	5720	6170	6730	7400	7690	8000	8330	8680
7800	6030	6490	7080	7800	8090	8410	8750	9130
8200	6330	6820	7440	8200	8500	8820	9180	9570
8600	6630	7140	7800	8600	8900	9240	9610	10010
9000	6930	7470	8160	9000	9310	9650	10030	10450
9400	7240	7800	8520	9400	9710	10060	10460	10890
9800	7540	8120	8880	9800	10120	10480	10880	11330
10200	7840	8450	9230	10200	10520	10890	11310	
10600	8140	8770	9590	10600	10930	11310		

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
3400	35.6	33.6			
3800	41.2	38.9	36.8	34.6	32.4
4200	46.8	44.2	41.8	39.4	36.9
4600	52.4	49.5	46.9	44.3	41.5
5000	55.9	54.0	51.9	49.1	46.1
5400	59.1	57.1	55.3	53.4	50.7
5800	62.2	60.1	58.2	56.2	54.2
6200	65.1	63.0	61.0	58.9	56.8
6600	67.9	65.5	63.4	61.3	59.2
7000		67.9	65.6	63.4	61.3
7400			67.7	65.4	63.4
7800			69.8	67.4	65.1
8200				69.3	66.8
8600					68.6

Decrease field limit weight by 8050 kg when using manual speedbrakes.

Landing Field Limit Weight - Dry Runway**Flaps 40****Anti-skid Operative and Automatic Speedbrakes****Category "B" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
3000			2760	3000	3140	3350	3530	3730
3400		2840	3120	3400	3560	3780	3980	4200
3800	2880	3180	3490	3800	3980	4220	4430	4660
4200	3190	3510	3850	4200	4390	4650	4880	5130
4600	3500	3850	4220	4600	4810	5080	5330	5590
5000	3810	4180	4580	5000	5230	5510	5780	6060
5400	4130	4520	4950	5400	5650	5940	6220	6520
5800	4440	4860	5310	5800	6070	6380	6670	6990
6200	4750	5190	5680	6200	6490	6810	7120	7450
6600	5060	5530	6040	6600	6910	7240	7570	7920
7000	5380	5870	6410	7000	7330	7670	8020	8380
7400	5690	6200	6770	7400	7750	8100	8470	8850
7800	6000	6540	7130	7800	8170	8540	8920	9310
8200	6310	6880	7500	8200	8590	8970	9360	9780
8600	6630	7210	7860	8600	9010	9400	9810	10240
9000	6940	7550	8230	9000	9430	9830	10260	10710
9400	7250	7880	8590	9400	9850	10260	10710	11170
9800	7570	8220	8960	9800	10260	10700	11160	11640
10200	7880	8560	9320	10200	10680	11130	11610	12100
10600	8190	8890	9690	10600	11100	11560	12060	

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
3000	31.0				
3400	36.6	34.6	32.7	30.8	
3800	42.2	40.0	37.8	35.6	33.6
4200	47.8	45.3	42.8	40.4	38.2
4600	53.2	50.6	47.9	45.3	42.7
5000	57.5	55.6	52.9	50.1	47.3
5400	60.7	58.8	56.9	54.5	51.7
5800	63.6	61.5	59.5	57.6	55.6
6200	66.3	64.1	62.0	59.9	57.9
6600	68.8	66.5	64.3	62.1	60.1
7000	71.1	68.8	66.5	64.3	62.1
7400	73.5	71.1	68.6	66.4	64.0
7800		73.4	70.7	68.3	66.0
8200			72.7	70.1	67.7
8600				72.0	69.4
9000				73.8	71.1
9400					72.8

Decrease field limit weight by 8200 kg when using manual speedbrakes.

737 Flight Crew Operations Manual

Landing Field Limit Weight - Dry Runway**Flaps 40****Anti-skid Inoperative and Manual Speedbrakes****Category "A" OR "B" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5000				5000	5380	5750	6130	6600
5400			4620	5400	5790	6170	6560	7040
5800			5020	5800	6200	6590	6980	7480
6200		4810	5410	6200	6600	7010	7420	7920
6600	4610	5180	5810	6600	7010	7430	7850	8360
7000	4980	5560	6200	7000	7420	7850	8280	8800
7400	5350	5940	6590	7400	7830	8270	8710	9240
7800	5720	6310	6990	7800	8240	8690	9140	9680
8200	6080	6690	7380	8200	8640	9110	9570	10120
8600	6450	7070	7780	8600	9050	9530	10000	10560
9000	6820	7440	8170	9000	9460	9950	10430	11000
9400	7190	7820	8570	9400	9870	10370	10860	11440
9800	7550	8200	8960	9800	10280	10790	11290	11880
10200	7920	8570	9350	10200	10680	11210	11710	12320
10600	8290	8950	9750	10600	11090	11630	12150	12760
11000	8660	9330	10140	11000	11500	12050	12580	13200
11400	9030	9700	10540	11400	11910	12470	13010	13640
11800	9390	10080	10930	11800	12320	12890	13440	14080
12200	9760	10460	11330	12200	12720	13310	13860	14520
12600	10130	10830	11720	12600	13130	13730	14300	14960

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
5800	34.0	32.2			
6200	37.3	35.3	33.3		
6600	40.6	38.5	36.3	34.2	32.6
7000	43.9	41.6	39.2	37.0	35.2
7400	47.2	44.7	42.2	39.8	37.8
7800	50.5	47.8	45.2	42.6	40.4
8200	53.9	50.9	48.1	45.4	42.9
8600	57.2	54.1	51.1	48.2	45.5
9000	60.6	57.3	54.1	51.0	48.1
9400	64.0	60.5	57.1	53.9	50.7
9800	67.6	63.8	60.2	56.7	53.4
10200		67.1	63.2	59.6	56.1
10600			66.3	62.5	58.8
11000			69.4	65.5	61.5
11400				68.5	64.3
11800					67.2

Landing Field Limit Weight - Wet Runway**Flaps 40****Anti-skid Operative and Automatic Speedbrakes****Category "A" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
3000				3000	3260	3490	3710	3900
3400			3160	3400	3660	3910	4130	4340
3800	3020	3250	3510	3800	4070	4320	4560	4780
4200	3320	3580	3870	4200	4470	4730	4990	5230
4600	3620	3900	4230	4600	4880	5150	5410	5670
5000	3930	4230	4590	5000	5280	5560	5840	6110
5400	4230	4560	4950	5400	5690	5980	6260	6550
5800	4530	4880	5310	5800	6090	6390	6690	6990
6200	4830	5210	5660	6200	6500	6800	7120	7440
6600	5140	5530	6020	6600	6900	7220	7540	7880
7000	5440	5860	6380	7000	7310	7630	7970	8320
7400	5740	6190	6740	7400	7710	8050	8390	8760
7800	6040	6510	7100	7800	8120	8460	8820	9200
8200	6350	6840	7460	8200	8520	8870	9250	9640
8600	6650	7160	7810	8600	8930	9290	9670	10090
9000	6950	7490	8170	9000	9340	9700	10100	10530
9400	7250	7820	8530	9400	9740	10120	10520	10970
9800	7560	8140	8890	9800	10150	10530	10950	11410
10200	7860	8470	9250	10200	10550	10940	11380	11850
10600	8160	8790	9610	10600	10960	11360	11800	12290

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
3800	34.3	32.3			
4200	39.2	36.9	34.9	32.9	
4600	44.0	41.5	39.3	37.0	34.7
5000	48.9	46.1	43.7	41.2	38.6
5400	53.3	50.7	48.1	45.4	42.6
5800	56.3	54.3	52.3	49.6	46.6
6200	59.0	57.1	55.2	53.3	50.6
6600	61.7	59.7	57.7	55.8	53.8
7000	64.3	62.2	60.2	58.2	56.1
7400	66.8	64.5	62.4	60.4	58.2
7800	69.1	66.6	64.4	62.3	60.2
8200		68.7	66.3	64.0	62.0
8600			68.1	65.8	63.7
9000			69.9	67.5	65.2
9400				69.2	66.7
9800					68.3
10200					69.8

Decrease field limit weight by 8050 kg when using manual speedbrakes.

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Landing Field Limit Weight - Wet Runway**Flaps 40****Anti-skid Operative and Automatic Speedbrakes****Category "B" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
3000			3130	3140	3370	3560	3770	
3400			3400	3560	3800	4010	4230	
3800		3170	3490	3800	3970	4230	4460	4700
4200	3180	3510	3860	4200	4390	4660	4910	5160
4600	3490	3850	4220	4600	4810	5100	5350	5630
5000	3800	4180	4590	5000	5230	5530	5800	6090
5400	4110	4520	4950	5400	5650	5960	6250	6560
5800	4430	4850	5320	5800	6070	6390	6700	7020
6200	4740	5190	5680	6200	6490	6820	7150	7490
6600	5050	5530	6040	6600	6910	7260	7600	7950
7000	5360	5860	6410	7000	7330	7690	8040	8420
7400	5680	6200	6770	7400	7750	8120	8490	8890
7800	5990	6540	7140	7800	8170	8550	8940	9350
8200	6300	6870	7500	8200	8590	8980	9390	9820
8600	6610	7210	7870	8600	9010	9420	9840	10280
9000	6930	7550	8230	9000	9420	9850	10290	10750
9400	7240	7880	8600	9400	9840	10280	10740	11210
9800	7550	8220	8960	9800	10260	10710	11180	11680
10200	7860	8550	9330	10200	10680	11140	11630	12140
10600	8180	8890	9690	10600	11100	11580	12080	12610

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
3400	30.4				
3800	35.3	33.3	31.5		
4200	40.2	38.0	35.9	33.9	31.9
4600	45.0	42.6	40.3	38.0	35.9
5000	49.9	47.3	44.7	42.2	39.9
5400	54.5	51.8	49.1	46.4	43.8
5800	57.9	56.0	53.4	50.6	47.8
6200	60.7	58.7	56.8	54.5	51.6
6600	63.2	61.1	59.1	57.2	55.1
7000	65.6	63.4	61.3	59.2	57.2
7400	67.8	65.5	63.3	61.2	59.1
7800	69.8	67.6	65.3	63.1	61.0
8200	71.9	69.6	67.2	65.0	62.8
8600	73.9	71.5	69.0	66.7	64.4
9000		73.5	70.8	68.4	66.1
9400			72.6	70.0	67.6
9800				71.6	69.1
10200				73.2	70.6
10600					72.1
11000					73.5

Decrease field limit weight by 8200 kg when using manual speedbrakes.

Landing Field Limit Weight - Wet Runway**Flaps 40****Anti-skid Inoperative and Manual Speedbrakes****Category "A" OR "B" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5000				5420	5820	6240	6770	
5400				5400	5830	6240	6670	7200
5800				5800	6240	6660	7100	7650
6200			5310	6200	6650	7090	7530	8080
6600			5700	6600	7050	7500	7960	8520
7000		5400	6090	7000	7460	7920	8390	8970
7400		5780	6490	7400	7870	8340	8820	9400
7800	5500	6160	6880	7800	8280	8770	9250	9840
8200	5860	6530	7280	8200	8690	9180	9680	10290
8600	6230	6910	7670	8600	9090	9600	10110	10720
9000	6600	7290	8070	9000	9500	10020	10540	11160
9400	6970	7660	8460	9400	9910	10440	10970	11610
9800	7340	8040	8860	9800	10320	10870	11400	12050
10200	7700	8420	9250	10200	10730	11290	11830	12490
10600	8070	8790	9640	10600	11130	11700	12260	12930
11000	8440	9170	10040	11000	11540	12130	12690	13370
11400	8810	9550	10430	11400	11950	12550	13120	13810
11800	9170	9920	10830	11800	12360	12960	13550	14240
12200	9540	10300	11220	12200	12770	13390	13980	14690
12600	9910	10680	11620	12600	13170	13800	14410	15130

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
6600	33.5				
7000	36.3	34.5	32.5		
7400	39.2	37.2	35.0	33.1	
7800	42.1	39.9	37.6	35.5	33.8
8200	45.0	42.6	40.2	38.0	36.0
8600	47.9	45.3	42.8	40.4	38.3
9000	50.8	48.0	45.3	42.8	40.5
9400	53.7	50.7	47.9	45.3	42.8
9800	56.6	53.5	50.5	47.7	45.0
10200	59.5	56.3	53.1	50.1	47.3
10600	62.4	59.1	55.7	52.6	49.5
11000	65.5	61.8	58.4	55.1	51.8
11400	68.6	64.7	61.0	57.6	54.1
11800		67.6	63.7	60.1	56.5
12200			66.4	62.6	58.8
12600			69.1	65.2	61.2
13000				67.8	63.6
13400					66.1
13800					68.6

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Landing Climb Limit Weight**Valid for approach with Flaps 15 and landing with Flaps 40****Based on engine bleed for packs on and anti-ice off**

AIRPORT OAT (°C)	LANDING CLIMB LIMIT WEIGHT (1000KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
-1000	0	2000	4000	6000	8000	
54	56.6	54.8				
52	57.6	55.9				
50	58.7	57.1	53.1			
48	59.8	58.2	54.2			
46	60.8	59.3	55.3	50.6		
44	61.9	60.4	56.4	51.7		
42	63.0	61.6	57.4	52.8	48.9	
40	64.1	62.8	58.4	53.8	49.9	
38	65.2	64.0	59.3	54.9	50.9	47.2
36	66.2	65.2	60.3	55.9	51.9	48.1
34	67.3	66.2	61.4	56.9	52.9	49.0
32	68.3	67.3	62.4	57.9	53.9	49.9
30	68.3	68.4	63.5	58.9	54.9	50.9
28	68.4	68.4	64.7	59.8	55.8	51.7
26	68.4	68.4	65.7	60.8	56.7	52.6
24	68.4	68.4	65.8	61.8	57.5	53.3
22	68.4	68.5	65.8	62.7	58.3	54.1
20	68.4	68.5	65.9	62.7	59.0	54.8
18	68.5	68.5	65.9	62.8	59.8	55.5
16	68.5	68.5	65.9	62.8	59.8	56.1
14	68.5	68.5	65.9	62.8	59.8	56.7
12	68.5	68.6	65.9	62.9	59.8	56.8
10	68.5	68.6	66.0	62.9	59.9	56.8
-40	68.7	68.8	66.3	63.3	60.3	57.3

With engine bleed for packs off, increase weight by 1200 kg.

With engine anti-ice on, decrease weight by 1350 kg.

With engine and wing anti-ice on, decrease weight by 4850 kg.

When operating in icing conditions during any part of the flight with forecast landing temperature below 8°C, decrease weight by 5110 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease weight by 50 kg.

ENGINE INOP

ADVISORY INFORMATION

GO-AROUND THRUST

Go-Around Climb Gradient**Flaps 15****Based on engine bleed for packs on and anti-ice off****Reference Go-Around Gradient (%)**

OAT (°C)	PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
50	3.13	1.98	0.60		
46	3.71	2.68	1.43	0.27	
42	4.29	3.20	2.03	1.06	
38	4.88	3.70	2.56	1.56	0.62
34	5.42	4.19	3.07	2.06	1.07
30	5.94	4.72	3.56	2.54	1.54
26	5.95	5.25	4.03	2.98	1.96
22	5.96	5.26	4.48	3.37	2.33
18	5.97	5.27	4.49	3.74	2.66
14	5.97	5.28	4.50	3.75	2.97
10	5.98	5.28	4.51	3.76	2.98

Gradient Adjustment for Weight (%)

WEIGHT (1000 KG)	REFERENCE GO-AROUND GRADIENT (%)						
	0	1	2	3	4	5	6
65	-2.49	-2.76	-3.01	-3.25	-3.50	-3.76	-4.03
60	-1.88	-2.07	-2.25	-2.42	-2.59	-2.78	-2.98
55	-1.05	-1.16	-1.26	-1.35	-1.45	-1.55	-1.66
50	0.00	0.00	0.00	0.00	0.00	0.00	0.00
45	1.17	1.28	1.40	1.54	1.67	1.81	1.93
40	2.71	2.97	3.25	3.54	3.84	4.15	4.45
35	4.77	5.23	5.71	6.21	6.72	7.27	7.84

Gradient Adjustment for Speed (%)

SPEED (KIAS)	WEIGHT ADJUSTED GO-AROUND GRADIENT (%)													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13
VREF	-0.47	-0.49	-0.51	-0.52	-0.53	-0.54	-0.54	-0.54	-0.54	-0.53	-0.52	-0.51	-0.49	-0.47
VREF+5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VREF+10	0.26	0.27	0.27	0.27	0.28	0.29	0.29	0.30	0.30	0.30	0.30	0.29	0.28	0.26
VREF+20	0.60	0.60	0.59	0.60	0.60	0.61	0.62	0.62	0.63	0.62	0.61	0.60	0.57	0.54
VREF+30	0.76	0.73	0.70	0.67	0.64	0.61	0.57	0.54	0.50	0.46	0.43	0.39	0.35	0.31

With engine bleed for packs off, increase gradient by 0.3%.

With engine anti-ice on, decrease gradient by 0.3%.

With engine and wing anti-ice on, decrease gradient by 1.2%.

When operating in icing conditions during any part of the flight with forecast landing temperatures below 8°C, decrease gradient by 0.8%.

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Quick Turnaround Limit Weight**Flaps 40****Category "A" Brakes**

AIRPORT OAT (°C)	LIMIT WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
-1000	0	2000	4000	6000	8000	
54	55.2	54.4				
50	55.6	54.7	52.9			
45	56.1	55.2	53.3	51.4		
40	56.6	55.7	53.7	51.8	49.9	
35	57.2	56.1	54.2	52.2	50.3	48.5
30	57.7	56.6	54.6	52.6	50.7	48.9
25	58.2	57.1	55.0	53.1	51.1	49.3
20	58.7	57.6	55.5	53.5	51.6	49.7
15	59.3	58.1	56.1	54.0	52.1	50.1
10	59.8	58.7	56.6	54.5	52.5	50.6
5	60.4	59.3	57.2	55.1	53.0	51.0
0	61.0	59.9	57.8	55.6	53.5	51.5
-5	61.7	60.5	58.3	56.2	54.0	52.0
-10	62.3	61.1	58.9	56.8	54.6	52.5
-15	63.0	61.8	59.5	57.3	55.2	53.0
-20	63.7	62.4	60.1	57.8	55.8	53.6
-30	65.1	63.8	61.4	59.1	56.9	54.7
-40	66.6	65.3	62.8	60.3	58.2	56.0
-50	68.4	67.0	64.5	62.0	59.6	57.4
-54	69.0	67.7	65.2	62.7	60.2	57.9

Increase weight by 550 kg per 1% uphill slope. Decrease weight by 1200 kg per 1% downhill slope.

Increase weight by 1400 kg per 10 knots headwind. Decrease weight by 7700 kg per 10 knots tailwind.

After landing at weights exceeding those shown above, adjusted for slope and wind, wait at least 53 minutes and check that wheel thermal plugs have not melted before executing a takeoff.

Quick Turnaround Limit Weight**Flaps 40****Category "B" Brakes**

AIRPORT OAT (°C)	LIMIT WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
	-1000	0	2000	4000	6000	8000
54	61.1	59.9				
50	61.4	60.3	58.1			
45	62.0	60.8	58.6	56.5		
40	62.5	61.4	59.1	56.9	54.8	
35	63.1	61.9	59.6	57.4	55.3	53.2
30	63.6	62.5	60.1	57.9	55.8	53.7
25	64.2	63.0	60.7	58.4	56.3	54.1
20	64.8	63.6	61.2	58.9	56.8	54.6
15	65.4	64.2	61.8	59.5	57.3	55.1
10	66.1	64.8	62.4	60.1	57.8	55.6
5	66.7	65.5	63.0	60.6	58.4	56.1
0	67.4	66.1	63.6	61.2	58.9	56.7
-5	68.1	66.8	64.3	61.9	59.5	57.2
-10	68.8	67.5	65.0	62.5	60.1	57.8
-15	69.5	68.2	65.7	63.2	60.7	58.4
-20	70.3	69.0	66.4	63.9	61.4	59.0
-30	71.5	70.3	67.8	65.3	62.7	60.3
-40	70.7	70.3	69.4	66.8	64.2	61.6
-50	70.3	70.3	70.3	68.3	65.7	63.1
-54	70.3	70.3	70.3	69.0	66.3	63.7

Increase weight by 600 kg per 1% uphill slope. Decrease weight by 1100 kg per 1% downhill slope.

Increase weight by 1500 kg per 10 knots headwind. Decrease weight by 6850 kg per 10 knots tailwind.

After landing at weights exceeding those shown above, adjusted for slope and wind, wait at least 53 minutes and check that wheel thermal plugs have not melted before executing a takeoff.

Performance Dispatch

Text

Chapter PD

Section 23

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 the data presented in this chapter and that contained in the approved Airplane Flight Manual, the Flight Manual shall always take precedence.

Takeoff

The maximum allowable takeoff weight will be the least of the Field, Climb and Obstacle Limit Weights as determined from the tables shown. Tire and Brake Energy Limits 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 provide corrections to the field length available for the effects of runway slope and wind component along the runway. Enter the Slope Correction table with the available field length and runway slope to determine the slope corrected field length. Now enter the Wind Correction table 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 conditions and show both Field and Climb Limit Weights. Enter the appropriate table 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.

Obstacle Limit Weight

The Reference Obstacle Limit Weight table provides obstacle limit weights for reference airport conditions based on obstacle height above the runway surface and distance from brake release. Enter the adjustment tables to adjust the reference Obstacle Limit Weight for the effects of

OAT, pressure altitude and wind as indicated. In the case of multiple obstacles, enter the tables successively with each obstacle and determine the most limiting weight.

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 this table considers both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude.

The altitudes shown in the table are limited to the maximum certified altitude of 37000 ft.

Long Range Cruise Trip Fuel and Time

Long Range Cruise Trip Fuel and Time tables are provided to determine trip time and fuel required to destination. Data is based on economy climb and descent speeds, and Long Range Cruise with normal engine bleed for air conditioning. 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 to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time tables. Next, enter the Reference Fuel and Time table with air distance from the Ground to Air Miles Conversion table and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment table with the Reference Fuel and the planned landing weight to obtain the adjustment to the fuel required at the planned landing weight.

Long Range Cruise Step Climb Trip Fuel and Time

The Long Range Cruise Step Climb Trip Fuel and Time tables are provided to determine trip time and fuel required to destination when flying a step climb profile. Step climb profiles are based on 4000 ft step climbs to keep the flight within 2000 ft of the optimum altitude for the current cruise weight. To determine trip fuel and time, enter the Ground to Air Miles

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Conversion table and determine air distance as discussed above. Then enter the Trip Fuel and Time Required table 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. Obtain air distance from the upper table using the ground distance and wind component to the alternate. Enter the Trip Fuel and Time table with air distance and read trip fuel required for the expected landing weight, together with time to alternate at right. For distances greater than shown or other altitudes, use the Long Range Cruise Trip Fuel and Time tables.

Holding Planning

This table provides total fuel flow information necessary for planning flaps up holding and reserve fuel requirements. Data is based on the FMC holding speed schedule which is the higher of the maximum endurance and flaps up maneuver speeds. As noted, the fuel flow is based on flight in a racetrack holding pattern. For holding in straight and level flight, reduce table values by 5%.

Flight Crew Oxygen Requirements

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. The oxygen quantity associated with the above requirements is achieved with the minimum dispatch oxygen cylinder pressure.

To determine the minimum dispatch oxygen cylinder pressure, enter the appropriate flight crew oxygen table with the number of crew plus observers using oxygen and read the minimum cylinder pressure required for the appropriate cylinder temperature.

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 1000 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.

Extended Operations - LRC Critical Fuel Reserves

ETOPS regulations require that flights conducted over a route that contains a point further than one hour's time at "normal one-engine-inoperative speed" from an adequate airport comply with rules specific to extended operations for airplanes with more than two engines. This section provides reserve fuel planning information for the "Critical Fuel Diversion Scenario".

ETOPS regulations require reserve planning to include a "Critical Fuel Diversion Scenario" calculation. The information shown is the fuel required to satisfy the flight profile described below the tables. This information is shown for all engines operating and one engine inoperative at Long Range Cruise (LRC). There are two engine-inoperative scenarios, a decompression scenario and a driftdown scenario. The decompression scenario assumes an engine failure, loss of pressurization, emergency descent, and subsequent cruise at 10000 ft. The driftdown scenario assumes an engine failure without loss of pressurization, where the airplane "drifts down" to the thrust limited level-off altitude for the remainder of the diversion.

The ETOPS critical fuel required is the greater of the all-engine fuel or the engine-inoperative fuel. The ETOPS critical fuel required is compared to the amount of fuel that is predicted to be onboard the airplane at the critical point. If the fuel required by the ETOPS critical fuel reserves of the route exceeds the amount of fuel predicted, the fuel load must be adjusted accordingly. The data does not include an allowance for performance deterioration. However, regulations require a 5% allowance for performance deterioration, unless a value has been established by the operator for in-service deterioration.

To determine the ETOPS critical fuel required, enter the Ground to Air Mile Conversion table with the forecast wind (factored if applicable) and ground distance to diversion airport from critical point, to obtain air distance. Then enter the Critical Fuel table with air distance and expected weight at the critical point and read the required fuel. Apply the noted fuel adjustments for non-standard conditions, as necessary. When using a wind forecasting model acceptable to the FAA (such as the World Area Forecast System, WAFS), regulations allow the wind factor applied in this step to be 5% of the forecast wind (increase headwinds, decrease tailwinds), as

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indicated in the note below the chart. However, if an FAA-acceptable wind forecasting model is not used, the ETOPS critical fuel must be increased by 5%, instead of factoring the forecast winds.

Landing

Tables are provided for determining the maximum landing weight as limited by field length or climb requirements for a single landing flap.

Maximum landing weight is the lowest of the field length limit weight, climb limit weight, or maximum certified landing weight.

Landing Field Limit Weight

For expected runway condition and anti-skid system configuration, obtain wind corrected field length by entering the Wind Component table with field length available and wind component along the runway. Now enter the Landing Field Limit Weight table with wind corrected field length and pressure altitude to read field limit weight.

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.

Go-Around Climb Gradient

Enter the Reference Go-Around Gradient table with airport OAT and pressure altitude to determine the reference go-around gradient. Then adjust the reference gradient for airplane weight and speed using the tables provided to determine the weight and speed adjusted go-around gradient. Apply the necessary corrections for engine bleed configuration and icing conditions as noted.

Quick Turnaround Limit Weight

Enter the 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.

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Performance Dispatch

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Performance Dispatch**Chapter PD****Takeoff****Section 30****Takeoff Field Corrections - Dry Runway****Slope Corrections**

FIELD LENGTH AVAILALBLE (FT)	SLOPE CORRECTED FIELD LENGTH (FT)								
	RUNWAY SLOPE (%)								
	-2.0	-1.5	-1.0	-0.5	0.0	0.5	1.0	1.5	2.0
4200	4320	4290	4260	4230	4200	4070	3940	3810	3680
4600	4760	4720	4680	4640	4600	4430	4270	4100	3940
5000	5190	5140	5100	5050	5000	4800	4600	4400	4190
5400	5620	5570	5510	5460	5400	5160	4930	4690	4450
5800	6060	5990	5930	5860	5800	5530	5250	4980	4710
6200	6490	6420	6350	6270	6200	5890	5580	5270	4970
6600	6920	6840	6760	6680	6600	6260	5910	5570	5220
7000	7360	7270	7180	7090	7000	6620	6240	5860	5480
7400	7790	7690	7600	7500	7400	6980	6570	6150	5740
7800	8220	8120	8010	7910	7800	7350	6900	6450	6000
8200	8660	8540	8430	8310	8200	7710	7230	6740	6250
8600	9090	8970	8850	8720	8600	8080	7550	7030	6510
9000	9520	9390	9260	9130	9000	8440	7880	7330	6770
9400	9960	9820	9680	9540	9400	8810	8210	7620	7020
9800	10390	10240	10100	9950	9800	9170	8540	7910	7280
10200	10820	10670	10510	10360	10200	9530	8870	8200	7540
10600	11260	11090	10930	10760	10600	9900	9200	8500	7800
11000	11690	11520	11350	11170	11000	10260	9530	8790	8050
11400	12120	11940	11760	11580	11400	10630	9860	9080	8310
11800	12560	12370	12180	11990	11800	10990	10180	9380	8570

Wind Corrections

SLOPE CORR'D FIELD LENGTH (FT)	SLOPE & WIND CORRECTED FIELD LENGTH (FT)							
	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
4200	2650	3160	3680	4200	4420	4650	4880	5110
4600	3000	3530	4070	4600	4840	5070	5310	5550
5000	3350	3900	4450	5000	5250	5500	5740	5980
5400	3710	4270	4840	5400	5660	5920	6170	6420
5800	4060	4640	5220	5800	6080	6350	6600	6850
6200	4410	5010	5600	6200	6490	6770	7030	7290
6600	4760	5380	5990	6600	6900	7190	7460	7720
7000	5120	5740	6370	7000	7320	7620	7900	8150
7400	5470	6110	6760	7400	7730	8040	8330	8590
7800	5820	6480	7140	7800	8150	8460	8760	9020
8200	6170	6850	7520	8200	8560	8890	9190	9460
8600	6530	7220	7910	8600	8970	9310	9620	9890
9000	6880	7590	8290	9000	9390	9740	10050	10330
9400	7230	7950	8680	9400	9800	10160	10480	10760
9800	7580	8320	9060	9800	10210	10580	10910	11200
10200	7940	8690	9450	10200	10630	11010	11340	11630
10600	8290	9060	9830	10600	11040	11430	11770	12060
11000	8640	9430	10210	11000	11450	11850	12200	12500
11400	8990	9800	10600	11400	11870	12280	12630	12930
11800	9350	10160	10980	11800	12280	12700	13060	13370

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****Sea Level Pressure Altitude**

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
-40	14	18	22	24	26	28	30	42	46	50	
4000	48.0	43.8	43.5	43.2	43.1	42.9	42.8	42.6	40.0	39.1	38.2
4200	49.2	44.9	44.6	44.3	44.2	44.0	43.9	43.7	41.1	40.1	39.2
4600	51.7	47.1	46.8	46.5	46.4	46.2	46.1	45.9	43.1	42.1	41.2
5000	53.9	49.3	48.9	48.6	48.5	48.3	48.1	48.0	45.1	44.1	43.1
5400	56.1	51.2	50.9	50.6	50.4	50.2	50.1	49.9	46.9	45.9	44.8
5800	58.1	53.1	52.8	52.4	52.2	52.1	51.9	51.7	48.7	47.6	46.5
6200	60.0	54.9	54.5	54.2	54.0	53.8	53.6	53.5	50.3	49.2	48.0
6600	61.9	56.6	56.2	55.8	55.7	55.5	55.3	55.1	51.9	50.7	49.5
7000	63.6	58.2	57.8	57.4	57.3	57.1	56.9	56.7	53.4	52.2	51.0
7400	65.3	59.7	59.3	59.0	58.8	58.6	58.4	58.2	54.8	53.5	52.3
7800	66.9	61.2	60.8	60.5	60.3	60.1	59.9	59.7	56.2	54.9	53.7
8200	68.5	62.6	62.2	61.8	61.6	61.4	61.2	61.0	57.5	56.2	54.9
8600	69.9	63.9	63.5	63.1	62.9	62.7	62.5	62.3	58.7	57.4	56.1
9000	71.2	65.2	64.8	64.4	64.2	63.9	63.7	63.5	59.8	58.5	57.2
9400	72.6	66.4	66.0	65.6	65.4	65.2	64.9	64.7	61.0	59.6	58.3
9800	73.9	67.6	67.2	66.8	66.5	66.3	66.1	65.9	62.1	60.7	59.4
10200	75.1	68.7	68.3	67.9	67.7	67.4	67.2	67.0	63.1	61.7	60.4
10600	76.3	69.8	69.4	69.0	68.7	68.5	68.3	68.1	64.1	62.7	61.3
CLIMB LIMIT WT (1000 KG)	57.0	56.5	56.5	56.4	56.3	56.3	56.2	56.2	51.5	49.8	48.1

With engine bleed for packs off, increase field limit weight by 500 kg and climb limit weight by 1100 kg.

With engine anti-ice on, decrease field limit weight by 450 kg and climb limit weight by 170 kg.

With engine and wing anti-ice on*, decrease field limit weight by 450 kg and climb limit weight by 690 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

*Wing anti-ice decrement is only applicable to airplanes without the auto wing anti-ice shutoff system.

737 Flight Crew Operations Manual

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****2000 FT Pressure Altitude**

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
-40	14	18	22	24	26	28	30	42	46	50	
4000	45.8	41.7	41.4	41.1	41.0	40.8	40.5	40.1	37.8	37.0	36.2
4200	47.0	42.8	42.5	42.2	42.0	41.9	41.5	41.1	38.8	37.9	37.1
4600	49.3	44.9	44.6	44.3	44.2	44.0	43.6	43.2	40.8	39.9	39.0
5000	51.5	47.0	46.6	46.3	46.2	46.0	45.6	45.2	42.6	41.7	40.8
5400	53.6	48.8	48.5	48.2	48.0	47.9	47.4	47.0	44.4	43.4	42.5
5800	55.5	50.6	50.3	50.0	49.8	49.6	49.2	48.7	46.0	45.0	44.1
6200	57.4	52.3	52.0	51.6	51.5	51.3	50.8	50.4	47.6	46.6	45.6
6600	59.1	53.9	53.6	53.2	53.1	52.9	52.4	51.9	49.0	48.0	47.0
7000	60.8	55.5	55.1	54.8	54.6	54.4	53.9	53.4	50.5	49.4	48.4
7400	62.4	57.0	56.6	56.2	56.0	55.9	55.4	54.9	51.8	50.7	49.7
7800	64.0	58.4	58.0	57.6	57.5	57.3	56.8	56.3	53.1	52.0	50.9
8200	65.5	59.8	59.4	59.0	58.8	58.6	58.1	57.6	54.4	53.3	52.1
8600	66.8	61.0	60.6	60.2	60.0	59.8	59.3	58.8	55.5	54.4	53.2
9000	68.1	62.2	61.8	61.4	61.2	61.0	60.5	59.9	56.6	55.5	54.3
9400	69.4	63.4	63.0	62.6	62.4	62.2	61.6	61.1	57.7	56.5	55.3
9800	70.6	64.5	64.1	63.7	63.5	63.3	62.7	62.2	58.8	57.6	56.4
10200	71.8	65.6	65.2	64.8	64.6	64.3	63.8	63.2	59.8	58.6	57.3
10600	72.9	66.7	66.2	65.8	65.6	65.4	64.8	64.3	60.7	59.5	58.3
CLIMB LIMIT WT (1000 KG)	55.6	55.1	55.0	54.9	54.9	54.8	54.2	53.6	49.4	47.9	46.3

With engine bleed for packs off, increase field limit weight by 500 kg and climb limit weight by 1100 kg.

With engine anti-ice on, decrease field limit weight by 450 kg and climb limit weight by 170 kg.

With engine and wing anti-ice on*, decrease field limit weight by 450 kg and climb limit weight by 690 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

*Wing anti-ice decrement is only applicable to airplanes without the auto wing anti-ice shutoff system.

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****4000 FT Pressure Altitude**

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	14	18	22	24	26	28	30	42	46	50
4000	44.2	40.1	39.9	39.6	39.5	39.3	39.2	39.0	36.3	35.5	34.2
4200	45.3	41.2	40.9	40.6	40.5	40.4	40.2	40.0	37.2	36.5	35.1
4600	47.6	43.3	43.0	42.7	42.6	42.4	42.3	42.0	39.2	38.3	36.9
5000	49.7	45.2	44.9	44.6	44.5	44.3	44.2	43.9	41.0	40.1	38.6
5400	51.7	47.1	46.8	46.4	46.3	46.1	46.0	45.7	42.6	41.8	40.2
5800	53.6	48.8	48.5	48.2	48.0	47.8	47.7	47.4	44.2	43.3	41.7
6200	55.3	50.4	50.1	49.8	49.6	49.5	49.3	49.0	45.7	44.8	43.1
6600	57.1	52.0	51.7	51.3	51.2	51.0	50.8	50.5	47.2	46.2	44.5
7000	58.7	53.5	53.2	52.8	52.6	52.5	52.3	52.0	48.5	47.6	45.8
7400	60.2	54.9	54.6	54.2	54.0	53.9	53.7	53.4	49.8	48.8	47.0
7800	61.8	56.3	56.0	55.6	55.4	55.2	55.1	54.7	51.1	50.1	48.3
8200	63.2	57.6	57.3	56.9	56.7	56.5	56.3	56.0	52.3	51.3	49.4
8600	64.5	58.8	58.5	58.1	57.9	57.7	57.5	57.2	53.4	52.3	50.4
9000	65.8	60.0	59.6	59.2	59.0	58.8	58.7	58.3	54.5	53.4	51.5
9400	67.0	61.1	60.8	60.4	60.2	60.0	59.8	59.4	55.5	54.4	52.5
9800	68.2	62.2	61.8	61.5	61.3	61.1	60.9	60.5	56.5	55.4	53.4
10200	69.3	63.3	62.9	62.5	62.3	62.1	61.9	61.5	57.5	56.4	54.4
10600	70.4	64.3	63.9	63.5	63.3	63.1	62.9	62.5	58.5	57.3	55.3
CLIMB LIMIT WT (1000 KG)	55.4	54.9	54.8	54.8	54.7	54.7	54.6	54.3	49.0	47.4	44.7

With engine bleed for packs off, increase field limit weight by 500 kg and climb limit weight by 1100 kg.

With engine anti-ice on, decrease field limit weight by 450 kg and climb limit weight by 170 kg.

With engine and wing anti-ice on*, decrease field limit weight by 450 kg and climb limit weight by 690 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

*Wing anti-ice decrement is only applicable to airplanes without the auto wing anti-ice shutoff system.

737 Flight Crew Operations Manual

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****6000 FT Pressure Altitude**

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
	-40	14	18	22	24	26	28	30	42	46	50
4000	41.5	37.7	37.5	37.2	37.1	36.9	36.5	36.1	33.6	32.4	31.1
4200	42.6	38.7	38.5	38.2	38.1	37.9	37.5	37.1	34.5	33.3	31.9
4600	44.7	40.7	40.4	40.2	40.1	39.8	39.4	39.0	36.3	35.0	33.6
5000	46.7	42.6	42.3	42.0	41.9	41.7	41.2	40.8	38.0	36.7	35.2
5400	48.6	44.3	44.0	43.7	43.6	43.4	42.9	42.4	39.6	38.2	36.7
5800	50.4	45.9	45.7	45.4	45.2	45.0	44.5	44.0	41.1	39.6	38.1
6200	52.1	47.5	47.2	46.9	46.8	46.5	46.0	45.5	42.5	41.0	39.4
6600	53.7	49.0	48.7	48.4	48.2	47.9	47.4	46.9	43.8	42.3	40.6
7000	55.3	50.4	50.1	49.8	49.6	49.3	48.8	48.3	45.1	43.6	41.8
7400	56.7	51.8	51.4	51.1	51.0	50.7	50.1	49.6	46.3	44.7	43.0
7800	58.2	53.1	52.7	52.4	52.3	52.0	51.4	50.9	47.5	45.9	44.1
8200	59.5	54.3	54.0	53.6	53.5	53.2	52.6	52.1	48.6	47.0	45.1
8600	60.7	55.4	55.1	54.8	54.6	54.3	53.7	53.2	49.7	48.0	46.1
9000	61.9	56.6	56.2	55.9	55.7	55.4	54.8	54.2	50.7	48.9	47.0
9400	63.1	57.6	57.3	56.9	56.8	56.4	55.9	55.3	51.7	49.9	48.0
9800	64.3	58.7	58.3	58.0	57.8	57.5	56.9	56.3	52.6	50.8	48.9
10200	65.3	59.7	59.3	59.0	58.8	58.5	57.9	57.3	53.5	51.7	49.7
10600	66.4	60.7	60.3	59.9	59.7	59.4	58.8	58.2	54.4	52.6	50.6
CLIMB LIMIT WT (1000 KG)	52.8	52.3	52.2	52.2	52.1	51.9	51.1	50.3	45.2	43.0	40.4

With engine bleed for packs off, increase field limit weight by 500 kg and climb limit weight by 1100 kg.

With engine anti-ice on, decrease field limit weight by 450 kg and climb limit weight by 170 kg.

With engine and wing anti-ice on*, decrease field limit weight by 450 kg and climb limit weight by 690 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

*Wing anti-ice decrement is only applicable to airplanes without the auto wing anti-ice shutoff system.

Takeoff Field & Climb Limit Weights - Dry Runway**Flaps 5****8000 FT Pressure Altitude**

CORR'D FIELD LENGTH (FT)	FIELD LIMIT WEIGHT (1000 KG)										
	OAT (°C)										
-40	14	18	22	24	26	28	30	42	46	50	
4000	38.6	35.1	34.8	34.4	33.9	33.5	33.1	32.7	30.4	29.3	28.3
4200	39.6	36.1	35.7	35.3	34.8	34.4	34.0	33.5	31.2	30.1	29.0
4600	41.6	37.9	37.6	37.1	36.6	36.2	35.8	35.3	32.9	31.7	30.6
5000	43.5	39.7	39.3	38.8	38.4	37.9	37.5	37.0	34.4	33.3	32.1
5400	45.2	41.3	40.9	40.4	39.9	39.5	39.0	38.5	35.9	34.7	33.4
5800	46.9	42.9	42.5	42.0	41.4	41.0	40.5	39.9	37.3	36.0	34.7
6200	48.5	44.3	43.9	43.4	42.9	42.4	41.9	41.3	38.5	37.2	35.9
6600	50.0	45.7	45.3	44.8	44.2	43.7	43.2	42.6	39.8	38.4	37.1
7000	51.5	47.1	46.6	46.1	45.5	45.0	44.5	43.9	41.0	39.6	38.2
7400	52.9	48.3	47.9	47.3	46.7	46.2	45.7	45.1	42.1	40.7	39.2
7800	54.2	49.6	49.1	48.5	47.9	47.4	46.9	46.2	43.2	41.7	40.3
8200	55.5	50.7	50.3	49.7	49.1	48.5	48.0	47.3	44.2	42.7	41.2
8600	56.6	51.8	51.3	50.7	50.1	49.5	49.0	48.3	45.1	43.6	42.1
9000	57.7	52.8	52.4	51.7	51.1	50.5	50.0	49.3	46.1	44.5	43.0
9400	58.8	53.9	53.4	52.7	52.1	51.5	50.9	50.3	47.0	45.4	43.9
9800	59.9	54.8	54.4	53.7	53.1	52.5	51.9	51.2	47.9	46.3	44.7
10200	60.9	55.8	55.3	54.7	54.0	53.4	52.8	52.1	48.7	47.1	45.5
10600	61.9	56.7	56.2	55.6	54.9	54.3	53.7	53.0	49.5	47.9	46.3
CLIMB LIMIT WT (1000 KG)	49.4	48.9	48.6	48.0	47.2	46.4	45.6	44.7	40.5	38.5	36.5

With engine bleed for packs off, increase field limit weight by 500 kg and climb limit weight by 1100 kg.

With engine anti-ice on, decrease field limit weight by 450 kg and climb limit weight by 170 kg.

With engine and wing anti-ice on*, decrease field limit weight by 450 kg and climb limit weight by 690 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease climb limit weight by 50 kg.

*Wing anti-ice decrement is only applicable to airplanes without the auto wing anti-ice shutoff system.

737 Flight Crew Operations Manual

Takeoff Obstacle Limit Weight**Flaps 5****Sea Level 30°C & Below, Zero Wind****Based on engine bleed for packs on and anti-ice off**

OBSTACLE HEIGHT (FT)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)										
	DISTANCE FROM BRAKE RELEASE (1000 FT)										
8	10	12	14	16	18	20	22	24	26	28	30
10	57.0	60.8									
50	51.7	55.5	57.9	59.4	60.2	60.8	61.3				
100	47.8	51.7	54.4	56.3	57.6	58.5	59.2	59.8	60.3	60.7	61.0
150	45.1	48.9	51.8	53.8	55.3	56.5	57.5	58.2	58.8	59.3	59.7
200	42.9	46.7	49.6	51.7	53.4	54.7	55.8	56.7	57.4	58.0	58.5
250	40.9	44.8	47.6	49.8	51.7	53.1	54.3	55.3	56.1	56.8	57.4
300	39.2	43.2	46.0	48.2	50.1	51.7	53.0	54.0	54.9	55.7	56.3
350		41.7	44.5	46.8	48.7	50.3	51.7	52.8	53.8	54.6	55.3
400		40.3	43.2	45.5	47.4	49.1	50.5	51.7	52.7	53.6	54.3
450		38.7	42.0	44.3	46.3	47.9	49.4	50.6	51.7	52.6	53.4
500			40.9	43.2	45.2	46.9	48.4	49.6	50.7	51.7	52.5
550			39.8	42.3	44.2	45.9	47.4	48.7	49.8	50.8	51.7
600				37.4	41.3	43.3	45.0	46.5	47.8	48.9	49.9
650					40.4	42.5	44.2	45.7	47.0	48.1	49.2
700					39.5	41.6	43.4	44.9	46.2	47.3	48.4
750						40.8	42.6	44.1	45.4	46.6	47.6
800						40.1	41.9	43.4	44.7	45.9	47.0
850						39.3	41.2	42.7	44.1	45.2	46.3
900							40.5	42.1	43.4	44.6	45.7
950							39.8	41.4	42.8	44.0	45.1
1000							38.9	40.8	42.2	43.4	44.5

Obstacle height must be calculated from lowest point of the runway to conservatively account for runway slope.

Takeoff Obstacle Limit Weight**Flaps 5****OAT Adjustments**

OAT (°C)	REFERENCE OBSTACLE LIMIT WEIGHT (1000 KG)						
	36	40	44	48	52	56	60
30 & Below	0	0	0	0	0	0	0
32	-0.5	-0.6	-0.6	-0.7	-0.7	-0.8	-0.9
34	-1.0	-1.1	-1.2	-1.4	-1.5	-1.6	-1.7
36	-1.5	-1.7	-1.9	-2.0	-2.2	-2.4	-2.6
38	-2.0	-2.3	-2.5	-2.7	-3.0	-3.2	-3.4
40	-2.5	-2.8	-3.1	-3.4	-3.7	-4.0	-4.3
42	-3.1	-3.4	-3.8	-4.1	-4.5	-4.9	-5.2
44	-3.6	-4.0	-4.5	-4.9	-5.3	-5.7	-6.2
46	-4.1	-4.6	-5.1	-5.6	-6.1	-6.6	-7.1
48	-4.7	-5.2	-5.8	-6.4	-6.9	-7.5	-8.0
50	-5.2	-5.8	-6.5	-7.1	-7.7	-8.3	-9.0

Pressure Altitude Adjustments

ALT (FT)	OAT ADJUSTED OBSTACLE LIMIT WEIGHT (1000 KG)						
	36	40	44	48	52	56	60
S.L.&Below	0	0	0	0	0	0	0
1000	-1.1	-1.2	-1.3	-1.4	-1.5	-1.6	-1.7
2000	-2.1	-2.3	-2.5	-2.7	-2.9	-3.2	-3.4
3000	-2.7	-2.9	-3.1	-3.2	-3.4	-3.6	-3.7
4000	-3.3	-3.4	-3.6	-3.7	-3.8	-4.0	-4.1
5000	-4.5	-4.8	-5.1	-5.3	-5.6	-5.9	-6.2
6000	-5.6	-6.1	-6.5	-7.0	-7.5	-7.9	-8.4
7000	-7.0	-7.6	-8.3	-8.9	-9.6	-10.2	-10.9
8000	-8.3	-9.2	-10.0	-10.9	-11.7	-12.6	-13.4

Wind Adjustments

WIND (KTS)	OAT&ALTADJUSTEDOBSTACLELIMITWEIGHT(1000KG)						
	36	40	44	48	52	56	60
15TW	-7.4	-7.0	-6.7	-6.3	-5.9	-5.6	-5.2
10TW	-4.9	-4.7	-4.4	-4.2	-4.0	-3.7	-3.5
5TW	-2.5	-2.3	-2.2	-2.1	-2.0	-1.9	-1.7
0	0	0	0	0	0	0	0
10HW	0.7	0.6	0.5	0.5	0.4	0.3	0.2
20HW	1.4	1.2	1.1	0.9	0.8	0.6	0.4
30HW	2.1	1.9	1.6	1.4	1.2	0.9	0.7
40HW	2.8	2.5	2.2	1.9	1.6	1.3	1.0

With engine bleed for packs off, increase weight by 450 kg.

With engine anti-ice on, decrease weight by 900 kg.

With engine and wing anti-ice on, decrease weight by 1950 kg.

Performance Dispatch**Chapter PD****Enroute****Section 31****Long Range Cruise Maximum Operating Altitude****Max Cruise Thrust****ISA + 10°C and Below**

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	-10	33400*	33200	32300	30700	29200
62	31500	-11	34300*	33800	33000	31400	29900
60	32200	-13	35100*	34500	33700	32100	30600
58	32900	-14	36000*	35300	34400	32800	31400
56	33700	-16	36600*	36000	35200	33600	32100
54	34400	-18	37000	36700	35900	34400	32900
52	35200	-19	37000	37000	36700	35200	33700
50	36100	-21	37000	37000	37000	36000	34500
48	36900	-21	37000	37000	37000	36800	35400
46	37000	-21	37000	37000	37000	37000	36300
44	37000	-21	37000	37000	37000	37000	37000
42	37000	-21	37000	37000	37000	37000	37000

ISA + 15°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	-4	32500*	32500*	32300	30700	29200
62	31500	-6	33400*	33400*	33000	31400	29900
60	32200	-7	34300*	34300*	33700	32100	30600
58	32900	-9	35200*	35200*	34400	32800	31400
56	33700	-10	36100*	36000	35200	33600	32100
54	34400	-12	36700*	36700	35900	34400	32900
52	35200	-14	37000	37000	36700	35200	33700
50	36100	-16	37000	37000	37000	36000	34500
48	36900	-16	37000	37000	37000	36800	35400
46	37000	-16	37000	37000	37000	37000	36300
44	37000	-16	37000	37000	37000	37000	37000
42	37000	-16	37000	37000	37000	37000	37000

ISA + 20°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	1	31400*	31400*	31400*	30700	29200
62	31500	0	32300*	32300*	32300*	31400	29900
60	32200	-2	33300*	33300*	33300*	32100	30600
58	32900	-3	34200*	34200*	34200*	32800	31400
56	33700	-5	35200*	35200*	35200	33600	32100
54	34400	-7	36100*	36100*	35900	34400	32900
52	35200	-8	36800*	36800*	36700	35200	33700
50	36100	-10	37000	37000	37000	36000	34500
48	36900	-10	37000	37000	37000	36800	35400
46	37000	-10	37000	37000	37000	37000	36300
44	37000	-10	37000	37000	37000	37000	37000
42	37000	-10	37000	37000	37000	37000	37000

*Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.

737 Flight Crew Operations Manual

**Long Range Cruise Trip Fuel and Time
Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
274	255	239	224	211	200	190	181	173	166	159	
540	505	473	446	422	400	381	364	348	334	322	
806	755	708	668	632	600	573	548	525	503	484	
1071	1004	943	890	843	800	764	731	700	672	647	
1335	1252	1177	1112	1053	1000	955	914	875	840	809	
1598	1500	1411	1333	1264	1200	1146	1097	1051	1009	971	
1861	1748	1645	1555	1474	1400	1337	1280	1226	1178	1134	
2123	1995	1878	1775	1684	1600	1529	1463	1402	1346	1296	
2384	2241	2111	1996	1894	1800	1720	1646	1577	1515	1459	
2645	2487	2343	2217	2103	2000	1911	1829	1753	1684	1621	
2905	2732	2576	2437	2313	2200	2103	2012	1929	1853	1783	
3165	2978	2808	2657	2523	2400	2294	2196	2105	2022	1946	
3425	3223	3040	2878	2733	2600	2485	2379	2280	2190	2108	
3684	3469	3272	3098	2943	2800	2677	2562	2456	2359	2270	
3943	3713	3504	3319	3152	3000	2868	2745	2631	2528	2433	
4201	3957	3735	3538	3362	3200	3059	2928	2807	2696	2596	
4459	4201	3967	3759	3571	3400	3250	3111	2982	2865	2758	

737 Flight Crew Operations Manual

Long Range Cruise Trip Fuel and Time**Reference Fuel and Time Required**

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)							
	29		31		33		37	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	1.5	0:38	1.5	0:38	1.5	0:38	1.5	0:38
400	2.6	1:06	2.5	1:06	2.5	1:06	2.4	1:06
600	3.6	1:35	3.5	1:34	3.5	1:33	3.4	1:34
800	4.7	2:03	4.6	2:02	4.5	2:01	4.3	2:02
1000	5.8	2:31	5.7	2:30	5.5	2:29	5.3	2:30
1200	6.9	2:59	6.7	2:57	6.6	2:57	6.4	2:59
1400	8.0	3:27	7.8	3:25	7.6	3:25	7.4	3:27
1600	9.2	3:54	8.9	3:52	8.7	3:52	8.5	3:55
1800	10.3	4:22	10.0	4:20	9.8	4:20	9.5	4:23
2000	11.5	4:49	11.2	4:47	10.9	4:48	10.6	4:51
2200	12.7	5:17	12.3	5:15	12.0	5:16	11.8	5:19
2400	13.9	5:44	13.5	5:43	13.1	5:43	13.0	5:47
2600	15.1	6:11	14.7	6:10	14.3	6:11		
2800	16.3	6:39	15.9	6:38	15.5	6:39		
3000	17.6	7:06	17.0	7:05	16.6	7:07		
3200	18.8	7:33	18.3	7:33	17.9	7:35		
3400	20.1	8:01	19.5	8:00	19.1	8:02		

Fuel Required Adjustments (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	LANDING WEIGHT (1000 KG)				
	30	35	40	45	50
2	-0.3	-0.2	-0.1	0.0	0.1
4	-0.6	-0.4	-0.2	0.0	0.2
6	-0.9	-0.6	-0.3	0.0	0.4
8	-1.2	-0.8	-0.4	0.0	0.5
10	-1.5	-1.0	-0.5	0.0	0.7
12	-1.8	-1.2	-0.6	0.0	0.9
14	-2.1	-1.5	-0.7	0.0	1.1
16	-2.5	-1.7	-0.8	0.0	1.3
18	-2.8	-1.9	-1.0	0.0	1.6
20	-3.1	-2.1	-1.1	0.0	1.8
22	-3.4	-2.3	-1.2	0.0	2.1

Based on 280/.74 climb, Long Range Cruise speed and .74/250 descent.

Long Range Cruise Step Climb
Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
813	759	712	670	633	600	570	543	518	496	475	
1075	1006	945	891	843	800	761	726	694	664	637	
1336	1252	1178	1112	1053	1000	952	909	869	832	799	
1598	1498	1411	1333	1263	1200	1143	1091	1044	1001	961	
1859	1745	1643	1553	1473	1400	1334	1274	1219	1169	1123	
2120	1991	1876	1774	1683	1600	1525	1457	1395	1337	1285	
2381	2237	2109	1995	1892	1800	1716	1640	1570	1506	1447	
2642	2483	2341	2215	2102	2000	1907	1823	1745	1674	1609	
2903	2729	2574	2436	2312	2200	2098	2006	1921	1843	1771	
3164	2974	2807	2657	2522	2400	2289	2189	2096	2012	1933	
3424	3220	3039	2877	2732	2600	2481	2372	2272	2180	2096	
3685	3466	3271	3098	2941	2800	2672	2555	2447	2349	2258	
3945	3712	3504	3318	3151	3000	2863	2738	2623	2517	2420	
4206	3957	3736	3539	3361	3200	3054	2921	2798	2686	2582	
4466	4203	3968	3759	3570	3400	3245	3104	2974	2855	2745	

Trip Fuel and Time Required

AIR DIST (NM)	TRIP FUEL (1000 KG)					TIME (HRS:MIN)	
	LANDING WEIGHT (1000 KG)						
	30	35	40	45	50		
600	2.7	2.9	3.1	3.4	3.7	1:34	
800	3.5	3.7	4.0	4.3	4.8	2:03	
1000	4.3	4.6	4.9	5.3	5.8	2:31	
1200	5.1	5.4	5.9	6.3	7.0	2:59	
1400	5.8	6.3	6.8	7.4	8.1	3:27	
1600	6.7	7.2	7.7	8.4	9.2	3:56	
1800	7.5	8.1	8.7	9.5	10.4	4:24	
2000	8.3	9.0	9.7	10.6	11.6	4:52	
2200	9.1	9.9	10.7	11.7	12.8	5:20	
2400	10.0	10.8	11.7	12.9	14.1	5:48	
2600	10.8	11.7	12.7	14.0	15.4	6:16	
2800	11.7	12.7	13.8	15.2	16.7	6:43	
3000	12.6	13.6	14.9	16.4	18.0	7:11	
3200	13.5	14.6	16.0	17.6	19.3	7:39	
3400	14.4	15.6	17.1	18.8	20.7	8:07	

Based on .74 climb, Long Range Cruise speed and .74/.250 descent.

Valid for all pressure altitudes with 4000 ft step climb to 2000 ft above optimum altitude.

737 Flight Crew Operations Manual

Short Trip Fuel and Time**Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		(NM)	20	40	60	80	
91	78	69	61	55	50	46	42	39	37	34	
158	142	128	117	108	100	93	87	82	77	73	
225	204	187	173	161	150	141	132	125	118	113	
291	267	246	229	213	200	188	178	168	160	152	
356	328	304	284	266	250	236	223	212	202	193	
421	389	362	339	318	300	284	269	256	244	233	
485	450	420	394	371	350	332	315	300	286	274	
550	512	478	449	423	400	379	361	344	328	314	
615	573	537	504	476	450	427	406	388	370	355	
682	636	595	560	528	500	475	452	431	412	395	

Trip Fuel and Time Required

AIR DIST (NM)		LANDING WEIGHT (1000 KG)					TIME (HRS:MIN)
		30	35	40	45	50	
50	FUEL (1000 KG)	0.5	0.6	0.6	0.6	0.7	0:14
	ALT (FT)	13000	13000	11000	11000	11000	
100	FUEL (1000 KG)	0.8	0.8	0.9	0.9	1.0	0:22
	ALT (FT)	25000	23000	23000	21000	19000	
150	FUEL (1000 KG)	1.0	1.1	1.2	1.2	1.3	0:30
	ALT (FT)	35000	33000	31000	29000	27000	
200	FUEL (1000 KG)	1.2	1.3	1.4	1.5	1.6	0:37
	ALT (FT)	37000	37000	37000	35000	33000	
250	FUEL (1000 KG)	1.4	1.5	1.6	1.7	1.8	0:45
	ALT (FT)	37000	37000	37000	37000	35000	
300	FUEL (1000 KG)	1.6	1.7	1.8	1.9	2.1	0:52
	ALT (FT)	37000	37000	37000	37000	35000	
350	FUEL (1000 KG)	1.8	1.9	2.0	2.2	2.3	0:58
	ALT (FT)	37000	37000	37000	37000	35000	
400	FUEL (1000 KG)	2.0	2.1	2.2	2.4	2.6	1:05
	ALT (FT)	37000	37000	37000	37000	35000	
450	FUEL (1000 KG)	2.1	2.3	2.5	2.6	2.9	1:13
	ALT (FT)	37000	37000	37000	37000	35000	
500	FUEL (1000 KG)	2.3	2.5	2.7	2.9	3.1	1:20
	ALT (FT)	37000	37000	37000	37000	35000	

Based on 280/.74 climb, Long Range Cruise speed and .74/250 descent.

Holding Planning

Flaps Up

WEIGHT (1000 KG)	TOTAL FUEL FLOW (KG/HR)								
	PRESSURE ALTITUDE (FT)								
	1500	5000	10000	15000	20000	25000	30000	35000	37000
64	2870	2830	2780	2730	2700	2690	2680		
62	2800	2740	2700	2650	2610	2610	2590		
60	2720	2660	2620	2570	2530	2520	2500		
58	2640	2590	2540	2490	2450	2440	2420		
56	2570	2510	2460	2410	2370	2360	2330	2380	
54	2490	2430	2380	2330	2290	2280	2250	2270	
52	2420	2360	2310	2250	2210	2190	2170	2180	
50	2340	2280	2230	2170	2130	2110	2090	2080	2120
48	2270	2210	2150	2100	2050	2030	2000	2000	2020
46	2200	2130	2080	2020	1970	1960	1920	1920	1930
44	2130	2060	2010	1940	1900	1880	1840	1840	1850
42	2070	2010	1950	1890	1830	1800	1770	1760	1770
40	2010	1950	1900	1830	1780	1750	1700	1690	1700
38	1970	1910	1850	1780	1720	1690	1650	1630	1640
36	1920	1860	1800	1740	1680	1640	1600	1580	1590

This table includes 5% additional fuel for holding in a racetrack pattern.

737 Flight Crew Operations Manual

Crew Oxygen Requirements**Required Pressure (PSI) for 39 Cubic ft. Cylinder**

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	
50	122	1335		1950
45	113	1315		1915
40	104	1290		1885
35	95	1270		1855
30	86	1250		1825
25	77	1230		1795
20	68	1210		1765
15	59	1190		1735
10	50	1170		1705
5	41	1150		1675
0	32	1130		1645
-5	23	1110		1615
-10	14	1090		1585

Required Pressure (PSI) for 76 Cubic ft. Cylinder

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	4
50	122	735	1050	1370
45	113	725	1035	1345
40	104	715	1020	1325
35	95	700	1005	1300
30	86	690	990	1280
25	77	680	970	1260
20	68	670	955	1240
15	59	655	940	1220
10	50	645	920	1200
5	41	635	905	1175
0	32	620	890	1155
-5	23	610	875	1130
-10	14	600	860	1110

Required Pressure (PSI) for 114/115 Cubic ft. Cylinder

BOTTLE TEMPERATURE		NUMBER OF CREW USING OXYGEN		
°C	°F	2	3	4
50	122	530	735	945
45	113	520	725	930
40	104	510	715	915
35	95	505	700	900
30	86	495	690	885
25	77	485	680	870
20	68	480	670	860
15	59	470	655	840
10	50	460	645	830
5	41	455	635	815
0	32	445	620	800
-5	23	440	610	785
-10	14	430	600	770

ENGINE INOP**MAX CONTINUOUS THRUST****Net Level Off Weight**

PRESSURE ALTITUDE (1000 FT)	LEVEL OFF WEIGHT (1000 KG)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
28	35.0	34.0	33.0
26	37.4	36.3	35.3
24	39.9	38.7	37.5
22	42.5	41.2	39.9
20	45.2	43.7	42.2
18	49.7	48.2	46.5
16	53.8	51.9	50.0
14	57.0	55.0	52.8
12	60.4	58.0	55.7
10	63.6	61.2	58.6

Bleed Adjustments

BLEED CONFIGURATION	WEIGHT ADJUSTMENT (KG)
ENGINE A/I ON	-2000
ENGINE AND WING A/I ON	-6800
ENGINE BLEED TO PACKS OFF (BELOW 17000 FT)	+2050

ALL ENGINES**LRC Cruise Critical Fuel Reserves****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
288	265	245	228	213	200	189	178	169	161	153	
582	533	492	457	427	400	376	356	337	320	305	
876	802	740	687	640	600	564	533	505	479	456	
1170	1071	987	916	854	800	752	710	672	638	608	
1464	1340	1235	1145	1068	1000	940	887	840	798	759	
1759	1609	1483	1375	1281	1200	1128	1065	1008	957	911	
2053	1878	1730	1604	1495	1400	1316	1242	1176	1116	1062	
2347	2147	1978	1833	1709	1600	1504	1419	1343	1275	1214	
2641	2415	2225	2063	1922	1800	1692	1597	1511	1435	1365	

Critical Fuel (1000 KG)

AIR DIST (NM)	WEIGHT AT CRITICAL POINT (1000 KG)					
	35	40	45	50	55	60
200	1.8	1.9	2.0	2.0	2.1	2.2
300	2.6	2.6	2.7	2.8	3.0	3.1
400	3.3	3.4	3.5	3.6	3.8	3.9
500	4.0	4.1	4.3	4.4	4.6	4.8
600	4.7	4.9	5.0	5.2	5.4	5.6
700	5.4	5.6	5.8	6.0	6.2	6.5
800	6.1	6.3	6.5	6.8	7.0	7.3
900	6.8	7.0	7.3	7.5	7.8	8.1
1000	7.5	7.8	8.0	8.3	8.6	8.9
1100	8.2	8.5	8.8	9.1	9.4	9.8
1200	8.9	9.2	9.5	9.8	10.2	10.6
1300	9.5	9.9	10.2	10.6	11.0	11.4
1400	10.2	10.6	11.0	11.3	11.8	12.2
1500	10.9	11.3	11.7	12.1	12.5	13.0
1600	11.6	12.0	12.4	12.8	13.3	13.8
1700	12.3	12.7	13.1	13.6	14.1	14.6
1800	13.0	13.4	13.8	14.3	14.8	15.3

Based on: Emergency descent to 10000 ft, level cruise at 10000 ft, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included. Includes APU fuel burn.

Adjustments:

- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
- Increase fuel required 0.5% per 10°C above ISA.
- When icing conditions are forecast, use the greater of engine and wing anti-ice on (4%) for the total forecast time or engine and wing anti-ice on and ice drag (18%) for 10% of the forecast time.

Compare the critical fuel reserves required for all engines cruise, engine inoperative cruise, and engine inoperative driftdown and use the higher of the three.

ENGINE INOP**LRC Cruise Critical Fuel Reserves****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
292	268	247	229	213	200	188	178	168	160	152	
597	544	499	461	428	400	375	353	334	316	301	
903	820	751	693	643	600	562	529	499	473	449	
1208	1096	1003	925	858	800	749	705	665	630	598	
1514	1373	1256	1157	1073	1000	936	880	831	787	747	
1819	1649	1508	1389	1288	1200	1124	1056	997	943	895	
2124	1925	1760	1621	1502	1400	1311	1232	1162	1100	1044	
2430	2201	2012	1853	1717	1600	1498	1408	1328	1257	1193	
2735	2478	2265	2085	1932	1800	1685	1583	1494	1413	1341	

Critical Fuel (1000 KG)

AIR DIST (NM)	WEIGHT AT CRITICAL POINT (1000 KG)					
	35	40	45	50	55	60
200	1.6	1.7	1.8	1.9	2.0	2.1
300	2.3	2.4	2.5	2.6	2.8	2.9
400	2.9	3.0	3.2	3.3	3.5	3.7
500	3.5	3.7	3.9	4.1	4.3	4.5
600	4.2	4.4	4.6	4.8	5.0	5.3
700	4.8	5.0	5.3	5.5	5.8	6.1
800	5.4	5.7	5.9	6.2	6.5	6.8
900	6.0	6.3	6.6	6.9	7.3	7.6
1000	6.6	6.9	7.3	7.6	8.0	8.4
1100	7.2	7.6	7.9	8.3	8.7	9.1
1200	7.8	8.2	8.6	9.0	9.5	9.9
1300	8.4	8.8	9.3	9.7	10.2	10.6
1400	9.0	9.5	9.9	10.4	10.9	11.4
1500	9.6	10.1	10.6	11.1	11.6	12.1
1600	10.2	10.7	11.2	11.7	12.3	12.9
1700	10.8	11.3	11.9	12.4	13.0	13.6
1800	11.4	11.9	12.5	13.1	13.7	14.3

Based on: Emergency descent to 10000 ft, level cruise at 10000 ft, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included. Includes APU fuel burn.

Adjustments:

- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
- Increase fuel required 0.5% per 10°C above ISA.
- When icing conditions are forecast, use the greater of engine and wing anti-ice on (5%) for the total forecast time or engine and wing anti-ice on and ice drag (28%) for 10% of the forecast time.

Compare the critical fuel reserves required for all engines cruise, engine inoperative cruise, and engine inoperative driftdown and use the higher of the three.

ENGINE INOP**LRC Driftdown Critical Fuel Reserves****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
271	253	237	223	211	200	189	180	172	165	158	
546	508	476	447	422	400	379	361	344	329	315	
822	765	716	672	634	600	569	541	516	493	472	
1101	1024	957	898	846	800	758	721	687	656	628	
1381	1283	1198	1124	1058	1000	947	900	857	819	783	
1662	1543	1440	1350	1270	1200	1136	1079	1028	981	938	
1944	1804	1682	1576	1483	1400	1325	1258	1198	1143	1093	
2227	2065	1925	1803	1695	1600	1514	1437	1368	1305	1248	
2510	2326	2168	2029	1907	1800	1703	1616	1538	1467	1402	

Critical Fuel (1000 KG)

AIR DIST (NM)	WEIGHT AT CRITICAL POINT (1000 KG)					
	35	40	45	50	55	60
200	1.4	1.5	1.5	1.6	1.7	1.7
300	1.8	1.9	2.1	2.2	2.3	2.5
400	2.3	2.4	2.6	2.8	3.0	3.2
500	2.7	2.9	3.2	3.4	3.7	3.9
600	3.1	3.4	3.7	4.0	4.3	4.7
700	3.5	3.9	4.2	4.6	5.0	5.4
800	3.9	4.3	4.8	5.2	5.7	6.1
900	4.3	4.8	5.3	5.8	6.3	6.8
1000	4.7	5.2	5.8	6.4	6.9	7.5
1100	5.1	5.7	6.4	7.0	7.6	8.2
1200	5.5	6.2	6.9	7.6	8.2	8.9
1300	5.9	6.6	7.4	8.2	8.9	9.6
1400	6.3	7.1	7.9	8.7	9.5	10.3
1500	6.7	7.5	8.4	9.3	10.1	11.0
1600	7.1	7.9	8.9	9.9	10.7	11.7
1700	7.4	8.4	9.4	10.4	11.4	12.4
1800	7.8	8.8	9.9	11.0	12.0	13.0

Based on: Driftdown to and cruise at level off altitude, 250 KIAS descent to 1500 ft, 15 minutes hold at 1500 ft, approach and land. Allowance for performance deterioration not included. Includes APU fuel burn.

Adjustments:

- Increase forecast headwind or decrease forecast tailwind by 5% if an acceptable wind forecasting model is used; otherwise, increase diversion fuel by 5% to account for wind errors.
- Increase fuel required by 0.5% per 10°C above ISA.
- When icing conditions are forecast, use the greater of engine and wing anti-ice on (14%) for the total forecast time or engine and wing anti-ice on and ice drag (50%) for 10% of the forecast time.

Compare the critical fuel reserves required for all engines cruise, engine inoperative cruise, and engine inoperative driftdown and use the higher of the three.

Intentionally
Blank

Performance Dispatch

Landing

Chapter PD

Section 32

Landing Field Limit Weight - Dry Runway

Flaps 40

Anti-skid Operative and Automatic Speedbrakes

Category "A" Brakes

Wind Corrected Field Length (FT)

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
3000			2620	3000	3230	3440	3640	3810
3400		2700	3010	3400	3630	3850	4060	4270
3800	2810	3070	3400	3800	4030	4260	4490	4720
4200	3150	3440	3790	4200	4430	4670	4920	5170
4600	3490	3810	4180	4600	4840	5090	5350	5620
5000	3830	4180	4570	5000	5240	5500	5780	6080
5400	4170	4550	4960	5400	5640	5910	6200	6530
5800	4510	4920	5350	5800	6040	6320	6630	6980
6200	4850	5260	5710	6200	6440	6730	7060	7430
6600	5170	5580	6060	6600	6850	7140	7490	7890
7000	5460	5900	6410	7000	7250	7550	7920	8340
7400	5750	6220	6770	7400	7650	7960	8340	8790
7800	6030	6540	7130	7800	8050	8370	8770	9240
8200	6320	6860	7490	8200	8450	8790	9200	9700
8600	6610	7180	7850	8600	8850	9200	9630	10150
9000	6890	7500	8200	9000	9260	9610	10060	
9400	7180	7820	8560	9400	9660	10020		
9800	7470	8140	8920	9800	10060			
10200	7750	8460	9280	10200				
10600	8040	8780	9630	10600				

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
3400	35.3	33.2			
3800	40.8	38.4	36.2	34.0	
4200	46.4	43.7	41.2	38.7	36.3
4600	52.0	49.0	46.1	43.4	40.7
5000	55.8	53.7	51.1	48.0	45.2
5400	59.3	57.0	54.9	52.7	49.6
5800	62.6	60.3	58.0	55.7	53.5
6200		63.4	61.0	58.7	56.3
6600			63.9	61.4	59.1
7000				63.8	61.3
7400					63.3
7800					65.4

Decrease field limit weight by 7100 kg when using manual speedbrakes.

Landing Field Limit Weight - Dry Runway**Flaps 40****Anti-skid Inoperative and Manual Speedbrakes****Category "A" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5000				5000	5350	5750	6200	6710
5400			4810	5400	5760	6170	6630	7140
5800			5190	5800	6170	6590	7050	7570
6200		4940	5580	6200	6580	7010	7480	7990
6600	4640	5310	5960	6600	6990	7430	7910	8420
7000	5000	5680	6340	7000	7410	7850	8330	8850
7400	5370	6050	6720	7400	7820	8270	8760	9280
7800	5730	6410	7100	7800	8230	8690	9180	9710
8200	6100	6790	7490	8200	8640	9110	9610	10140
8600	6460	7160	7870	8600	9050	9530	10040	10570
9000	6830	7530	8250	9000	9460	9950	10460	11000
9400	7190	7900	8630	9400	9870	10370	10890	11430
9800	7550	8270	9010	9800	10290	10790	11310	11860
10200	7920	8640	9400	10200	10700	11210	11740	12290
10600	8280	9010	9780	10600	11110	11630	12170	12720
11000	8650	9380	10160	11000	11520	12050	12590	13150
11400	9010	9750	10540	11400	11930	12470	13020	13580
11800	9380	10120	10920	11800	12340	12890	13440	14010
12200	9740	10480	11310	12200	12750	13310	13870	
12600	10100	10860	11690	12600	13160	13730		

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
5400	32.0				
5800	35.3	33.3			
6200	38.6	36.4	34.3	32.3	
6600	41.9	39.5	37.3	35.1	33.0
7000	45.3	42.6	40.2	37.9	35.6
7400	48.7	45.8	43.1	40.6	38.2
7800	52.3	49.1	46.2	43.4	40.8
8200	55.8	52.4	49.2	46.2	43.4
8600	59.5	55.8	52.4	49.1	46.1
9000	63.2	59.2	55.6	52.1	48.8
9400		62.7	58.8	55.1	51.5
9800			62.1	58.1	54.3
10200			65.3	61.1	57.1
10600				64.2	60.0
11000					62.9

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Landing Field Limit Weight - Wet Runway**Flaps 40****Anti-skid Operative and Automatic Speedbrakes****Category "A" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
3000				3000	3260	3500	3700	3880
3400				3400	3660	3910	4130	4330
3800		3000	3350	3800	4070	4320	4560	4780
4200	3080	3370	3740	4200	4470	4730	4980	5230
4600	3420	3740	4130	4600	4870	5140	5410	5690
5000	3760	4110	4520	5000	5270	5550	5840	6140
5400	4100	4480	4910	5400	5670	5960	6270	6590
5800	4440	4850	5300	5800	6070	6370	6700	7040
6200	4780	5220	5690	6200	6480	6780	7120	7500
6600	5120	5590	6080	6600	6880	7200	7550	7950
7000	5460	5950	6460	7000	7280	7610	7980	8400
7400	5800	6270	6800	7400	7680	8020	8410	8850
7800	6100	6580	7150	7800	8080	8430	8840	9310
8200	6380	6900	7510	8200	8480	8840	9260	9760
8600	6670	7230	7870	8600	8890	9250	9690	10210
9000	6960	7550	8230	9000	9290	9660	10120	10660
9400	7240	7860	8580	9400	9690	10070	10550	11120
9800	7530	8190	8940	9800	10090	10480	10980	11570
10200	7820	8510	9300	10200	10490	10900	11400	
10600	8100	8830	9660	10600	10900	11310		

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
3800	33.9				
4200	38.8	36.5	34.4	32.3	
4600	43.6	41.1	38.7	36.4	34.1
5000	48.4	45.6	43.0	40.4	38.0
5400	52.9	50.2	47.3	44.5	41.8
5800	56.2	54.1	51.6	48.6	45.6
6200	59.2	57.0	54.8	52.6	49.5
6600	62.1	59.8	57.5	55.3	53.0
7000	64.9	62.5	60.2	57.9	55.5
7400		65.2	62.7	60.3	58.0
7800			65.3	62.5	60.1
8200				64.5	62.0
8600					63.7

Decrease field limit weight by 7100 kg when using manual speedbrakes.

Landing Field Limit Weight - Wet Runway**Flaps 40****Anti-skid Inoperative and Manual Speedbrakes****Category "A" Brakes****Wind Corrected Field Length (FT)**

FIELD LENGTH AVAILABLE (FT)	WIND COMPONENT (KTS)							
	-15	-10	-5	0	10	20	30	40
5000				5380	5820	6330	6910	
5400				5400	5790	6240	6760	7340
5800				5800	6200	6660	7190	7770
6200			5530	6200	6610	7090	7610	8200
6600			5910	6600	7030	7500	8040	8620
7000		5550	6290	7000	7440	7920	8460	9050
7400		5920	6670	7400	7850	8340	8890	9480
7800	5530	6300	7050	7800	8260	8770	9320	9910
8200	5890	6670	7430	8200	8670	9180	9740	10340
8600	6250	7040	7820	8600	9080	9600	10170	10770
9000	6620	7400	8200	9000	9490	10020	10590	11200
9400	6980	7780	8580	9400	9900	10440	11020	11630
9800	7350	8150	8960	9800	10320	10870	11450	12060
10200	7710	8510	9340	10200	10730	11290	11870	12490
10600	8080	8890	9730	10600	11140	11700	12300	12920
11000	8440	9260	10110	11000	11550	12130	12720	13350
11400	8810	9630	10490	11400	11960	12550	13150	13780
11800	9170	9990	10870	11800	12370	12960	13580	14210
12200	9530	10360	11250	12200	12780	13390	14000	14640
12600	9900	10730	11640	12600	13200	13800	14430	15070

Field Limit Weight (1000 KG)

WIND CORRECTED FIELD LENGTH (FT)	AIRPORT PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
6600	34.8	32.8			
7000	37.6	35.5	33.5		
7400	40.5	38.2	36.1	34.0	
7800	43.4	40.9	38.6	36.4	34.2
8200	46.4	43.7	41.2	38.8	36.5
8600	49.4	46.5	43.7	41.2	38.7
9000	52.5	49.3	46.4	43.6	41.0
9400	55.6	52.2	49.0	46.1	43.2
9800	58.8	55.1	51.8	48.6	45.5
10200	62.0	58.1	54.5	51.1	47.9
10600	65.2	61.1	57.3	53.7	50.3
11000		64.2	60.1	56.3	52.7
11400			63.0	58.9	55.1
11800				61.6	57.6
12200				64.3	60.1
12600					62.6
13000					65.1

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Landing Climb Limit Weight**Valid for approach with Flaps 15 and landing with Flaps 40****Based on engine bleed for packs on and anti-ice off**

AIRPORT OAT (°C)	LANDING CLIMB LIMIT WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
-1000	0	2000	4000	6000	8000	
54	49.4	48.5				
52	50.4	49.3				
50	51.3	50.1	48.2			
48	52.3	51.0	49.0			
46	53.3	51.9	49.8	49.2		
44	54.2	52.9	50.6	50.0		
42	55.2	53.8	51.4	50.7	47.1	
40	56.2	54.7	52.2	51.7	47.8	
38	57.0	55.7	53.0	52.6	48.6	43.9
36	57.8	56.5	53.8	53.6	49.5	44.3
34	58.6	57.4	54.5	54.6	50.3	44.6
32	59.4	58.2	55.2	55.6	51.2	45.5
30	59.5	59.0	56.0	56.6	52.1	46.3
28	59.5	59.1	56.6	57.0	52.9	47.1
26	59.6	59.1	57.3	57.0	53.8	48.0
24	59.6	59.2	57.4	57.1	54.1	48.8
22	59.7	59.2	57.4	57.1	54.2	49.6
20	59.7	59.3	57.5	57.2	54.2	50.0
18	59.8	59.3	57.5	57.2	54.2	50.2
16	59.8	59.4	57.6	57.3	54.3	50.4
14	59.9	59.4	57.6	57.3	54.3	50.5
12	59.9	59.5	57.7	57.4	54.4	50.6
10	59.9	59.5	57.7	57.4	54.4	50.6
-40	60.4	60.0	58.2	58.0	55.0	51.1

With engine bleed for packs off, increase weight by 1300 kg.

With engine anti-ice on, decrease weight by 450 kg.

With engine and wing anti-ice on, decrease weight by 4900 kg.

When operating in icing conditions during any part of the flight with forecast landing temperature below 8°C, decrease weight by 4670 kg.

For 42 inch tires or 40 inch tires with a 42 inch tire wheel well, decrease weight by 60 kg.

ENGINE INOP

ADVISORY INFORMATION

GO-AROUND THRUST

Go-Around Climb Gradient**Flaps 15****Based on engine bleed for packs on and anti-ice off****Reference Go-Around Gradient (%)**

OAT (°C)	PRESSURE ALTITUDE (FT)				
	0	2000	4000	6000	8000
50	2.37	1.86	1.39		
46	2.86	2.30	2.16	0.90	
42	3.34	2.72	2.55	1.57	0.24
38	3.81	3.13	3.05	1.99	0.73
34	4.23	3.52	3.56	2.46	0.91
30	4.64	3.88	4.06	2.92	1.38
26	4.66	4.24	4.17	3.35	1.83
22	4.69	4.26	4.19	3.44	2.28
18	4.71	4.29	4.21	3.46	2.43
14	4.74	4.31	4.23	3.48	2.53
10	4.75	4.33	4.26	3.50	2.55

Gradient Adjustment for Weight (%)

WEIGHT (1000 KG)	REFERENCE GO-AROUND GRADIENT (%)					
	0	1	2	3	4	5
60	-2.48	-2.74	-3.00	-3.25	-3.51	-3.78
56	-2.01	-2.21	-2.41	-2.61	-2.81	-3.02
52	-1.43	-1.56	-1.69	-1.83	-1.97	-2.10
48	-0.64	-0.69	-0.75	-0.81	-0.87	-0.93
45.4	0.00	0.00	0.00	0.00	0.00	0.00
44	0.34	0.38	0.41	0.45	0.49	0.52
40	1.49	1.63	1.78	1.94	2.10	2.26
36	2.89	3.18	3.47	3.79	4.12	4.46
32	4.71	5.18	5.67	6.20	6.77	7.39

Gradient Adjustment for Speed (%)

SPEED (KIAS)	WEIGHT ADJUSTED GO-AROUND GRADIENT (%)													
	0	1	2	3	4	5	6	7	8	9	10	11	12	13
VREF	-0.53	-0.55	-0.57	-0.58	-0.60	-0.62	-0.63	-0.63	-0.63	-0.63	-0.61	-0.59	-0.56	-0.51
VREF+5	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
VREF+10	0.32	0.33	0.34	0.35	0.35	0.35	0.35	0.35	0.34	0.33	0.32	0.30	0.28	0.25
VREF+20	0.68	0.71	0.73	0.76	0.78	0.79	0.80	0.79	0.77	0.74	0.69	0.62	0.53	0.42
VREF+30	0.87	0.89	0.90	0.90	0.88	0.86	0.83	0.79	0.74	0.69	0.64	0.58	0.53	0.48

With engine bleed for packs off, increase gradient by 0.3%.

With engine anti-ice on, decrease gradient by 0.1%.

With engine and wing anti-ice on, decrease gradient by 1.3%.

When operating in icing conditions during any part of the flight with forecast landing temperatures below 8°C, decrease gradient by 0.8%.

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Quick Turnaround Limit Weight**Flaps 40**

AIRPORT OAT (°C)	LIMIT WEIGHT (1000 KG)					
	AIRPORT PRESSURE ALTITUDE (FT)					
-1000	0	2000	4000	6000	8000	
54	56.9	55.7				
50	57.3	56.1	53.9			
45	57.8	56.6	54.4	52.3		
40	58.3	57.1	54.9	52.7	50.7	
35	58.8	57.7	55.4	53.2	51.1	49.1
30	59.4	58.2	55.9	53.7	51.5	49.5
25	59.9	58.7	56.4	54.2	52.0	50.0
20	60.5	59.3	56.9	54.6	52.5	50.4
15	61.0	59.8	57.5	55.2	52.9	50.8
10	61.6	60.4	58.0	55.7	53.4	51.3
5	62.2	61.0	58.6	56.2	53.9	51.7
0	62.8	61.6	59.1	56.7	54.4	52.2
-5	63.1	62.2	59.7	57.3	55.0	52.7
-10	63.5	62.8	60.3	57.9	55.5	53.2
-15	63.5	63.1	61.0	58.5	56.1	53.8
-20	63.5	63.5	61.6	59.1	56.7	54.3
-30	63.5	63.5	63.0	60.4	57.9	55.5
-40	63.5	63.5	63.5	61.8	59.2	56.7
-50	63.5	63.5	63.5	63.4	60.7	58.2
-54	63.5	63.5	63.5	63.5	61.4	58.8

Increase weight by 500 kg per 1% uphill slope. Decrease weight by 950 kg per 1% downhill slope.

Increase weight by 1500 kg per 10 knots headwind. Decrease weight by 6600 kg per 10 knots tailwind.

After landing at weights exceeding those shown above, adjusted for slope and wind, wait at least 53 minutes and check that wheel thermal plugs have not melted before executing a takeoff.

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Performance Dispatch

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Chapter PD

Section 33

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 the data presented in this chapter and that contained in the approved Airplane Flight Manual, the Flight Manual shall always take precedence.

Takeoff

The maximum allowable takeoff weight will be the least of the Field, Climb and Obstacle Limit Weights as determined from the tables shown. Tire and Brake Energy Limits 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 provide corrections to the field length available for the effects of runway slope and wind component along the runway. Enter the Slope Correction table with the available field length and runway slope to determine the slope corrected field length. Now enter the Wind Correction table 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 conditions and show both Field and Climb Limit Weights. Enter the appropriate table 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.

Obstacle Limit Weight

The Reference Obstacle Limit Weight table provides obstacle limit weights for reference airport conditions based on obstacle height above the runway surface and distance from brake release. Enter the adjustment tables to adjust the reference Obstacle Limit Weight for the effects of

OAT, pressure altitude and wind as indicated. In the case of multiple obstacles, enter the tables successively with each obstacle and determine the most limiting weight.

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 this table considers both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude.

The altitudes shown in the table are limited to the maximum certified altitude of 37000 ft.

Long Range Cruise Trip Fuel and Time

Long Range Cruise Trip Fuel and Time tables are provided to determine trip time and fuel required to destination. Data is based on economy climb and descent speeds, and Long Range Cruise with normal engine bleed for air conditioning. 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 to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time tables. Next, enter the Reference Fuel and Time table with air distance from the Ground to Air Miles Conversion table and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment table with the Reference Fuel and the planned landing weight to obtain the adjustment to the fuel required at the planned landing weight.

Long Range Cruise Step Climb Trip Fuel and Time

The Long Range Cruise Step Climb Trip Fuel and Time tables are provided to determine trip time and fuel required to destination when flying a step climb profile. Step climb profiles are based on 4000 ft step climbs to keep the flight within 2000 ft of the optimum altitude for the current cruise weight. To determine trip fuel and time, enter the Ground to Air Miles

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Conversion table and determine air distance as discussed above. Then enter the Trip Fuel and Time Required table 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. Obtain air distance from the upper table using the ground distance and wind component to the alternate. Enter the Trip Fuel and Time table with air distance and read trip fuel required for the expected landing weight, together with time to alternate at right. For distances greater than shown or other altitudes, use the Long Range Cruise Trip Fuel and Time tables.

Holding Planning

This table provides total fuel flow information necessary for planning flaps up holding and reserve fuel requirements. Data is based on the FMC holding speed schedule which is the higher of the maximum endurance and flaps up maneuver speeds. As noted, the fuel flow is based on flight in a racetrack holding pattern. For holding in straight and level flight, reduce table values by 5%.

Flight Crew Oxygen Requirements

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. The oxygen quantity associated with the above requirements is achieved with the minimum dispatch oxygen cylinder pressure.

To determine the minimum dispatch oxygen cylinder pressure, enter the appropriate flight crew oxygen table with the number of crew plus observers using oxygen and read the minimum cylinder pressure required for the appropriate cylinder temperature.

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 1000 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.

Extended Operations - LRC Critical Fuel Reserves

ETOPS regulations require that flights conducted over a route that contains a point further than one hour's time at "normal one-engine-inoperative speed" from an adequate airport comply with rules specific to extended operations for airplanes with more than two engines. This section provides reserve fuel planning information for the "Critical Fuel Diversion Scenario".

ETOPS regulations require reserve planning to include a "Critical Fuel Diversion Scenario" calculation. The information shown is the fuel required to satisfy the flight profile described below the tables. This information is shown for all engines operating and one engine inoperative at Long Range Cruise (LRC). There are two engine-inoperative scenarios, a decompression scenario and a driftdown scenario. The decompression scenario assumes an engine failure, loss of pressurization, emergency descent, and subsequent cruise at 10000 ft. The driftdown scenario assumes an engine failure without loss of pressurization, where the airplane "drifts down" to the thrust limited level-off altitude for the remainder of the diversion.

The ETOPS critical fuel required is the greater of the all-engine fuel or the engine-inoperative fuel. The ETOPS critical fuel required is compared to the amount of fuel that is predicted to be onboard the airplane at the critical point. If the fuel required by the ETOPS critical fuel reserves of the route exceeds the amount of fuel predicted, the fuel load must be adjusted accordingly. The data does not include an allowance for performance deterioration. However, regulations require a 5% allowance for performance deterioration, unless a value has been established by the operator for in-service deterioration.

To determine the ETOPS critical fuel required, enter the Ground to Air Mile Conversion table with the forecast wind (factored if applicable) and ground distance to diversion airport from critical point, to obtain air distance. Then enter the Critical Fuel table with air distance and expected weight at the critical point and read the required fuel. Apply the noted fuel adjustments for non-standard conditions, as necessary. When using a wind forecasting model acceptable to the FAA (such as the World Area Forecast System, WAFS), regulations allow the wind factor applied in this step to be 5% of the forecast wind (increase headwinds, decrease tailwinds), as

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indicated in the note below the chart. However, if an FAA-acceptable wind forecasting model is not used, the ETOPS critical fuel must be increased by 5%, instead of factoring the forecast winds.

Landing

Tables are provided for determining the maximum landing weight as limited by field length or climb requirements for a single landing flap.

Maximum landing weight is the lowest of the field length limit weight, climb limit weight, or maximum certified landing weight.

Landing Field Limit Weight

For expected runway condition and anti-skid system configuration, obtain wind corrected field length by entering the Wind Component table with field length available and wind component along the runway. Now enter the Landing Field Limit Weight table with wind corrected field length and pressure altitude to read field limit weight.

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.

Go-Around Climb Gradient

Enter the Reference Go-Around Gradient table with airport OAT and pressure altitude to determine the reference go-around gradient. Then adjust the reference gradient for airplane weight and speed using the tables provided to determine the weight and speed adjusted go-around gradient. Apply the necessary corrections for engine bleed configuration and icing conditions as noted.

Quick Turnaround Limit Weight

Enter the 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.

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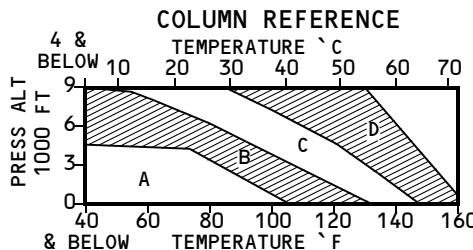
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Performance Inflight**General****Chapter PI****Section 10****Takeoff Speeds**

WEIGHT 1000 KG	SLOPE/WIND V1 ADJUSTMENT*			V1 NOT TO EXCEED VR	WIND KTS HEAD
	SLOPE DN	% UP	TAIL		
65	-2	0	3	-3	0
55	-2	0	2	-3	0
45	-2	0	1	-3	0
35	-2	0	1	-3	0

*V1 NOT TO EXCEED VR

FLAPS	WT 1000 KG	A			B			C			D		
		V1	VR	V2									
1	65	158	162	168	160	164	168	161	165	168			
	60	149	153	160	152	155	160	153	156	160			
	55	141	144	153	143	146	152	144	147	152	147	150	152
	50	132	134	145	134	137	145	136	138	144	139	140	144
	45	123	125	138	125	127	137	127	129	137	130	131	136
	40	114	116	131	116	118	130	118	120	129	121	122	128
	35	104	107	124	107	109	122	109	110	122	111	113	121
5	65	151	154	160	152	156	160	146	149	153			
	60	143	146	153	145	148	153	139	141	146			
	55	135	137	146	137	140	146	131	133	139	132	135	139
	50	127	129	139	129	131	139	123	124	132	125	126	131
	45	118	120	132	120	122	132	114	115	124	117	117	123
	40	109	112	126	112	114	125	105	106	117	107	108	116
	35	100	103	119	103	105	118						
15	65	144	146	152	145	148	152	133	134	138			
	60	136	138	145	138	140	145	125	126	132			
	55	129	130	139	131	132	139	117	118	125	118	119	125
	50	121	122	132	123	124	132	108	109	118	110	111	118
	45	113	114	126	115	116	125	100	101	112	102	103	111
	40	104	106	120	106	108	119						
	35	96	98	113	97	99	112						

CHECK V1(MCG).

V1(MCG)

ACTUAL OAT		PRESS ALT FT					
°C	°F	-1000	0	2000	4000	6000	8000
55	131	106	105	99			
50	122	108	107	103			
40	104	113	111	107	103	99	94
30	86	116	116	111	107	103	99
20	68	117	116	113	111	107	102
10	50	117	116	113	111	108	104
-50	-58	118	118	115	112	109	105

FOR A/C OFF INCREASE V₁(MCG) BY 2 KNOTS.**Maximum Allowable Clearway**

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
4000	450
6000	550
8000	650
10000	700
12000	750
14000	800

Clearway and Stopway V1 Adjustments

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)			
	100	120	140	160
800			-3	-2
600		-5	-3	-2
400	-6	-5	-3	-1
200	-3	-2	-1	0
0	0	0	0	0
-800	0	0	0	0

Stab Trim Setting**Max Takeoff Thrust**

FLAP POSITION	C.G. % MAC						
	6	10	14	18	22	26	30
STAB TRIM UNITS (NOSE UP)							
1 & 5	6 1/4	5 3/4	5 1/4	4 3/4	4 1/4	3 3/4	3
15	5 3/4	5	4 1/2	3 3/4	3	2 1/2	1 3/4

For weights at or below 45360 kg subtract 1/2 unit from above value

VREF

WEIGHT (1000 KG)	FLAPS		
	40	30	15
65	153	154	165
60	146	147	158
55	138	141	151
50	131	134	144
45	123	127	136
40	115	119	128
35	107	111	119

For approach speed add wind factor of 1/2 headwind component + gust (max 20 knots).

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Recommended Maneuvering Speeds

FLAP POSITION	MANEUVER SPEED (KIAS)		
	WEIGHT		
	AT OR BELOW 53070 KG	ABOVE 53070 KG AND AT OR BELOW 62823 KG	ABOVE 62823 KG
UP	210	220	230
1	190	200	210
5	170/ *180	180/ *190	190/ *200
10	160/ *170	170/ *180	180/ *190
15	150	160	170
25	140	150	160
30		VREF 30	
40		VREF 40	

*Maneuvering speeds for airplanes without the Rudder System Enhancement Program (RSEP) installed.

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ADVISORY INFORMATION**Slush/Standing Water Takeoff****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-7.1	-7.7	-7.5	-8.3	-9.1	-9.2	-12.5	-12.7	-13.2
64	-6.6	-7.2	-7.8	-7.9	-8.6	-9.4	-11.1	-12.8	-12.8
60	-6.1	-6.8	-7.5	-7.3	-8.2	-9.1	-9.8	-11.9	-12.7
56	-5.6	-6.4	-7.1	-6.6	-7.6	-8.5	-8.9	-10.5	-12.3
52	-5.0	-5.8	-6.5	-5.8	-6.8	-7.8	-7.7	-9.1	-11.3
48	-4.4	-5.0	-5.9	-5.1	-6.0	-6.9	-6.5	-7.8	-9.8
44	-3.7	-4.4	-5.1	-4.2	-5.1	-6.0	-5.3	-6.5	-8.1
40	-3.1	-3.7	-4.3	-3.2	-4.0	-4.8	-4.2	-5.2	-6.0
36	-2.5	-3.0	-3.5	-2.2	-3.0	-3.7	-3.1	-3.9	-3.9

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
4600							30.5		
5000	29.4			31.8			36.6	31.0	
5400	35.1	28.1		37.8	31.0		42.6	35.9	30.0
5800	40.7	33.2		44.0	36.0	29.8	48.4	40.8	34.3
6200	46.7	38.2	32.1	49.9	41.1	34.4	54.4	45.5	38.7
6600	52.9	43.3	36.2	56.3	46.7	38.9	60.7	50.5	42.9
7000	59.6	48.4	40.4	62.6	52.0	43.5	66.9	55.8	47.2
7400	66.9	53.9	44.8	68.8	57.6	48.2	73.2	61.5	51.4
7800	74.1	59.9	49.4	75.1	63.2	52.6		67.2	55.6
8200		66.1	54.0		68.9	57.4		72.9	60.1
8600		72.4			74.6	62.6			64.5
9000			64.2			67.8			68.9
9400			69.5			73.0			73.3
9800			74.8						

1. Enter Weight Adjustment table with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
2. Adjust field length available by -110ft/+110ft for every 5°C above/below 4°C
3. Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
4. Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

ADVISORY INFORMATION**Slush/Standing Water Takeoff****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH										
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-12	-11	-9	-6	-6	-8	0	-1	-6		
64	-14	-12	-11	-8	-7	-8	0	0	-4		
60	-16	-14	-12	-10	-8	-8	0	0	-1		
56	-18	-16	-13	-13	-10	-8	0	0	0		
52	-20	-18	-15	-16	-12	-9	-4	0	0		
48	-22	-19	-17	-19	-15	-11	-8	-1	0		
44	-23	-21	-18	-20	-17	-13	-12	-5	0		
40	-23	-21	-19	-21	-18	-15	-15	-9	-1		
36	-23	-22	-20	-21	-19	-17	-17	-13	-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 V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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ADVISORY INFORMATION**Slush/Standing Water Takeoff****No Reverse Thrust****Weight Adjustment (1000 KG)**

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-9.1	-10.0	-10.9	-10.9	-12.1	-12.7	-14.7	-16.6	-16.5
64	-8.4	-9.4	-10.2	-9.9	-11.2	-12.2	-13.2	-15.5	-16.3
60	-7.7	-8.6	-9.5	-9.0	-10.3	-11.5	-11.8	-14.0	-15.9
56	-7.0	-7.8	-8.8	-8.0	-9.3	-10.6	-10.3	-12.4	-15.0
52	-6.4	-7.2	-8.1	-7.2	-8.3	-9.6	-9.0	-10.8	-13.3
48	-5.6	-6.4	-7.3	-6.3	-7.3	-8.5	-7.7	-9.2	-11.3
44	-4.8	-5.4	-6.3	-5.3	-6.2	-7.3	-6.4	-7.7	-9.3
40	-3.8	-4.5	-5.3	-4.3	-5.1	-6.1	-5.1	-6.4	-7.9

V1 (MCG) Limit Weight (1000 KG)

AVAILABLE FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH							
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
6000							33.0	26.6
6500				31.2			40.2	33.3
7000	32.0			38.5	30.7		47.4	39.9
7500	39.4	30.3		46.1	36.9	30.3	54.9	46.2
8000	47.3	36.7	29.1	54.2	43.4	35.7	62.5	52.4
8500	55.9	43.3	34.6	62.9	50.1	41.3	70.3	58.3
9000	65.2	50.4	40.4	72.4	57.2	47.1		64.1
9500		57.8	46.4		64.7	53.0		64.2
10000		65.8	52.7			59.2		
10500			59.2			65.6		
11000			66.2					

1. Enter Weight Adjustment table with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
2. Adjust field length available by -185 ft/+125 ft for every 5°C above/below 4°C.
3. Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
4. Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
60	-25	-22	-20	-17	-14	-12	0	0	-2
56	-28	-24	-21	-20	-15	-12	-4	0	0
52	-29	-27	-23	-24	-19	-14	-8	0	0
48	-32	-29	-25	-27	-22	-16	-13	-4	0
44	-32	-30	-27	-29	-25	-19	-18	-10	0
40	-33	-31	-28	-30	-27	-22	-23	-15	-4
36	-33	-31	-29	-31	-28	-25	-27	-20	-10

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 V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff****Maximum Reverse Thrust****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.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	0.0	0.0	0.0	-4.0	-4.0	-4.0	-7.3	-7.3	-7.3
64	0.0	0.0	0.0	-3.8	-3.8	-3.8	-7.1	-7.1	-7.1
60	-0.7	-0.7	-0.7	-3.8	-3.8	-3.8	-6.8	-6.8	-6.8
56	-0.9	-0.9	-0.9	-3.8	-3.8	-3.8	-6.6	-6.6	-6.6
52	-1.0	-1.0	-1.0	-3.6	-3.6	-3.6	-6.2	-6.2	-6.2
48	-1.1	-1.1	-1.1	-3.2	-3.2	-3.2	-5.7	-5.7	-5.7
44	-0.8	-0.8	-0.8	-2.9	-2.9	-2.9	-5.1	-5.1	-5.1
40	-0.5	-0.5	-0.5	-2.5	-2.5	-2.5	-4.4	-4.4	-4.4
36	-0.2	-0.2	-0.2	-2.0	-2.0	-2.0	-3.5	-3.5	-3.5

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
3800	31.5								
4200	41.0								
4600	49.9	34.4							
5000	60.3	43.6		32.9					
5400	71.0	52.9	37.2	39.6	28.2				
5800		63.5	46.3	46.6	34.9				
6200		74.2	56.0	54.6	41.7	30.2	32.5		
6600			66.7	63.3	48.7	37.0	37.2		
7000				71.9	57.2	43.8	42.1	29.1	
7400					65.9	51.0	47.2	33.9	
7800					74.5	59.8	52.6	38.7	
8200						68.5	58.5	43.6	30.6
8600							64.6	48.8	35.3
9000							70.6	54.3	40.1
9400								60.3	45.1
9800								66.4	50.4
10200								72.4	56.1
10600									62.1
11000									68.2
11400									74.2

- Enter Weight Adjustment table with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -90ft /+90ft for every 5°C above/below 4°C
Adjust "Medium" field length available by -90ft /+90ft for every 5°C above/below 4°C
Adjust "Poor" field length available by -120ft /+110ft for every 5°C above/below 4°C
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slippery Runway Takeoff****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-4	-2	0	-13	-11	-9	-27	-24	-21
64	-6	-4	-2	-15	-13	-11	-30	-27	-24
60	-7	-5	-3	-17	-15	-13	-32	-29	-26
56	-9	-7	-5	-20	-18	-16	-34	-31	-28
52	-10	-8	-6	-22	-20	-18	-36	-33	-30
48	-12	-10	-8	-24	-22	-20	-38	-35	-32
44	-13	-11	-9	-26	-24	-22	-39	-36	-33
40	-14	-12	-10	-27	-25	-23	-40	-37	-34
36	-14	-12	-10	-28	-26	-24	-40	-37	-34

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 V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff****No Reverse Thrust****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.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-0.9	-0.9	-0.9	-5.8	-5.8	-5.8	-9.7	-9.7	-9.7
64	-1.3	-1.3	-1.3	-5.7	-5.7	-5.7	-9.2	-9.2	-9.2
60	-1.6	-1.6	-1.6	-5.7	-5.7	-5.7	-8.8	-8.8	-8.8
56	-1.8	-1.8	-1.8	-5.5	-5.5	-5.5	-8.4	-8.4	-8.4
52	-1.9	-1.9	-1.9	-5.3	-5.3	-5.3	-7.9	-7.9	-7.9
48	-1.8	-1.8	-1.8	-5.0	-5.0	-5.0	-7.2	-7.2	-7.2
44	-1.7	-1.7	-1.7	-4.5	-4.5	-4.5	-6.3	-6.3	-6.3
40	-1.4	-1.4	-1.4	-3.9	-3.9	-3.9	-5.2	-5.2	-5.2
36	-1.0	-1.0	-1.0	-3.1	-3.1	-3.1	-3.8	-3.8	-3.8

V1 (MCG) Limit Weight (1000 KG)

AVAILABLE FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
4500	36.6								
5000	51.7								
5500	66.5	42.7							
6000		57.6	33.5						
6500		72.3	48.7	35.7					
7000			63.5	47.2	29.2				
7500				59.4	40.1				
8000				71.8	52.0	33.5			
8500					64.4	44.8			
9000						56.9	28.1		
9500						69.3	34.7		
10000							41.6	30.7	
10500							49.2	37.4	
11000							57.4	44.6	33.4
11500							66.2	52.4	40.1
12000							75.0	60.9	47.6
12500								69.7	55.7
13000								30.7	64.4
13500									73.2

- Enter Weight Adjustment table with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -95 ft/+95 ft for every 5°C above/below 4°C.
Adjust "Medium" field length available by -95 ft/+95 ft for every 5°C above/below 4°C.
Adjust "Poor" field length available by -170 ft/+170 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slippery Runway Takeoff****No Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
64	-8	-6	-4	-21	-19	-17	-41	-39	-37
60	-9	-7	-5	-23	-21	-19	-44	-42	-40
56	-11	-9	-7	-26	-24	-22	-47	-45	-43
52	-13	-11	-9	-29	-27	-25	-50	-48	-46
48	-15	-13	-11	-31	-29	-27	-53	-51	-49
44	-16	-14	-12	-33	-31	-29	-55	-53	-51
40	-17	-15	-13	-35	-33	-31	-56	-54	-52
36	-18	-16	-14	-36	-34	-32	-56	-54	-52

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 V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

Takeoff %N1

Based on engine bleed to packs on (Auto) and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	93.2	93.8	93.8	93.8	93.9	93.6	94.7	94.4	94.2	
50	122	93.8	94.3	94.3	94.3	93.9	94.6	94.7	94.4	94.2	
45	113	94.2	94.7	94.7	94.6	94.6	94.6	94.7	94.4	94.2	
40	104	94.6	95.2	95.2	95.1	95.0	95.1	95.1	95.2	95.1	94.9
35	95	95.2	95.6	95.6	95.6	95.5	95.7	95.7	95.7	95.6	95.5
30	86	95.2	96.1	96.1	96.0	96.0	96.3	96.2	96.1	96.0	96.0
25	77	94.4	95.3	95.8	96.2	96.5	96.7	96.6	96.6	96.5	96.4
20	68	93.6	94.5	95.0	95.4	95.9	96.6	97.1	97.1	97.0	96.9
15	59	92.8	93.7	94.2	94.6	95.1	95.8	96.3	96.8	97.2	97.5
10	50	92.0	92.9	93.4	93.8	94.2	95.0	95.4	95.9	96.4	96.8
5	41	91.2	92.1	92.5	92.9	93.4	94.1	94.6	95.1	95.5	96.0
0	32	90.3	91.2	91.7	92.1	92.6	93.3	93.7	94.2	94.7	95.1
-10	14	88.7	89.6	90.0	90.4	90.8	91.5	92.0	92.5	92.9	93.4
-20	-4	87.0	87.8	88.3	88.7	89.1	89.8	90.2	90.7	91.1	91.6
-30	-22	85.2	86.0	86.5	86.9	87.3	88.0	88.4	88.9	89.3	89.7
-40	-40	83.5	84.3	84.7	85.1	85.5	86.2	86.6	87.1	87.4	87.9
-50	-58	81.7	82.5	82.9	83.2	83.7	84.3	84.7	85.2	85.6	86.0

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-2000	9000
ENGINE BLEED TO PACKS OFF	1.0	1.0

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Assumed Temperature Reduced Thrust**Maximum Assumed Temperature (Table 1)****Based on 25% Takeoff Thrust Reduction**

OAT (°C)	PRESS ALT (1000 FT)								OAT (°F)	PRESS ALT (1000 FT)									
	-1	0	1	2	3	4	5	6		-1	0	1	2	3	4	5	6	7	8
55	74	71	71						130	165	159	159							
50	71	69	68	68	69	70			120	160	155	154	154	155	157				
45	69	67	66	66	67	67	67	68	70	110	155	151	149	149	150	151	151	155	
40	67	65	64	64	64	64	64	64	68	100	151	148	145	145	145	147	145	149	151
35	65	63	62	62	62	61	61	62	63	90	146	143	141	141	140	140	140	143	144
30	63	61	60	60	59	59	59	59	60	80	146	142	139	138	136	135	135	137	138
25	63	61	59	58	57	56	56	56	57	70	146	142	138	136	135	131	129	129	132
20	63	61	59	58	57	55	53	54	54	60	146	142	138	136	135	131	127	127	126
15 & BELOW	63	61	59	58	57	55	53	53	52	50 & BELOW	146	142	138	136	135	131	127	127	126

Maximum Takeoff %N1 (Table 2)**Based on engine bleed to packs on (Auto) and engine anti-ice on or off**

ASSUMED TEMP		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
75	167	86.0	85.4	85.4							
70	158	87.8	87.6	87.4	87.4	87.6					
65	149	89.7	89.7	89.4	89.2	89.2	89.2	89.3	89.5	89.9	90.4
60	140	91.6	91.8	91.3	91.0	90.8	90.7	90.7	90.8	91.1	91.4
55	131	93.1	93.8	93.2	92.7	92.4	92.1	92.1	92.0	92.1	92.3
50	122	93.7	94.3	94.3	94.3	93.9	93.6	93.4	93.2	93.2	93.2
45	113	94.0	94.7	94.7	94.6	94.6	94.6	94.7	94.4	94.2	94.0
40	104	94.4	95.2	95.2	95.1	95.0	95.1	95.1	95.2	95.1	94.9
35	95	95.0	95.6	95.6	95.6	95.5	95.7	95.7	95.7	95.6	95.5
30	86	95.2	96.1	96.1	96.0	96.0	96.3	96.2	96.1	96.0	96.0
25	77	94.4		96.6	96.5	96.5	96.7	96.6	96.6	96.5	96.4
20	68	93.6					97.1	97.1	97.1	97.0	96.9
15	59	92.8						97.6	97.6	97.5	97.5
MINIMUM ASSUMED TEMP °C (°F)		32(90)	30(86)	28(82)	26(79)	24(75)	22(72)	20(68)	18(64)	16(61)	15(59)

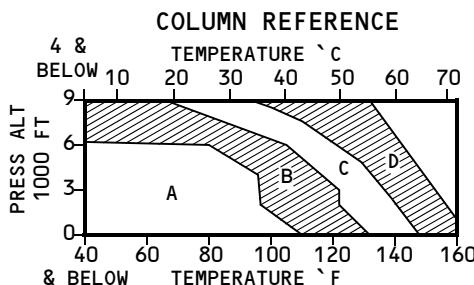
With engine bleed to packs off, increase %N1 by 1.0.

Assumed Temperature Reduced Thrust**%N1 Adjustment For Temperature Difference (Table 3)**

ASSUMED TEMP MINUS OAT		OUTSIDE AIR TEMPERATURE														
°C	°F	°C	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
°F		°F	-40	-4	32	41	50	59	68	77	86	95	104	113	122	131
10	18							1.6	1.6	1.6	1.5	1.5	1.5	1.4	1.4	
20	36				3.3	3.2	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.5	2.3	
30	54				4.8	4.8	4.6	4.5	4.4	4.3	4.0	3.8	3.6	3.6	3.6	
40	72			6.0	6.2	6.1	6.0	5.8	5.7	5.2	5.0	5.0				
50	90			8.2	7.5	7.3	7.2	6.6	6.5							
60	108		10.4	9.5	8.7	8.1	7.9									
70	126		11.8	10.7	9.3											
80	144		13.0	11.8	10.1											
90	162		14.0	12.4												
100	180		15.0	12.8												
110	198		15.4													

1. Determine Maximum Assumed Temperature allowed from Table 1.
2. Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).
3. Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.
4. Subtract %N1 adjustment from Maximum %N1 in Table 2.

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Takeoff Speeds (20K Derate)

WEIGHT 1000 KG	SLOPE/WIND V1 ADJUSTMENT*				
	SLOPE % DN	UP	WIND KTS TAIL	HEAD	
65	-2	0	3	-2	0 1
55	-2	0	1	-3	0 1
45	-2	0	0	-3	0 0
35	-2	0	1	-3	0 0

*V1 NOT TO EXCEED V_R

FLAPS	WT 1000 KG	A			B			C			D		
		V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
1	65	161	163	166	161	164	167	147 149 152			132 133 136		
	60	153	155	160	153	156	160						
	55	144	146	152	145	148	152						
	50	136	137	145	137	139	145						
	45	127	128	137	128	130	137						
	40	118	118	130	119	120	129						
	35	109	109	122	110	111	122						
5	65	153	156	159	154	157	159	133 134 139			127 127 131		
	60	146	148	153	147	149	152						
	55	138	139	146	139	141	145						
	50	130	131	139	131	133	138						
	45	121	122	132	123	124	132						
	40	113	113	125	114	115	125						
	35	104	104	118	105	106	118						
15	65	146	147	152	148	148	151	119 120 125			121 121 125		
	60	139	140	145	141	141	145						
	55	131	132	139	133	134	138						
	50	124	124	132	126	126	132						
	45	115	116	126	118	118	125						
	40	107	108	119	109	110	119						
	35	98	100	113	100	101	112						

CHECK V₁(MCG).

V1(MCG) (20K Derate)

ACTUAL OAT		PRESS ALT FT					
°C	°F	-1000	0	2000	4000	6000	8000
55	131	101	100	97			
50	122	103	102	100	98	93	
40	104	108	107	104	103	99	94
30	86	111	110	108	108	103	97
20	68	111	111	109	108	106	101
10	50	112	111	109	109	106	102
-50	-58	113	112	110	110	107	103

FOR A/C OFF INCREASE V1(MCG) BY 2 KNOTS.

Maximum Allowable Clearway (20K Derate)

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
4000	450
6000	550
8000	650
10000	700
12000	750
14000	800

Clearway and Stopway V1 Adjustments (20K Derate)

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)			
	100	120	140	160
800			-3	-2
600		-5	-3	-2
400	-6	-5	-3	-1
200	-3	-2	-1	0
0	0	0	0	0
-800	0	0	0	0

Stab Trim Setting (20K Derate)**Max Takeoff Thrust**

FLAP POSITION	C.G. % MAC						
	6	10	14	18	22	26	30
STAB TRIM UNITS (NOSE UP)							
1 & 5	6 1/4	5 3/4	5 1/4	4 3/4	4 1/4	3 3/4	3
15	5 3/4	5	4 1/2	3 3/4	3	2 1/2	1 3/4

For weights at or below 45360 kg subtract 1/2 unit from above value

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ADVISORY INFORMATION**Slush/Standing Water Takeoff (20K Derate)****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-7.6	-7.8	-8.2	-9.4	-9.4	-9.4	-12.4	-12.8	-13.5
64	-7.3	-7.6	-8.2	-8.9	-9.4	-9.8	-12.1	-12.9	-12.9
60	-6.6	-7.2	-7.8	-7.9	-8.8	-9.5	-10.9	-12.1	-12.4
56	-5.9	-6.6	-7.3	-6.8	-7.8	-9.0	-9.4	-11.0	-12.0
52	-5.2	-6.0	-6.6	-6.0	-7.0	-8.2	-8.2	-9.6	-11.3
48	-4.6	-5.2	-6.0	-5.2	-6.2	-7.3	-7.0	-8.2	-10.2
44	-3.9	-4.5	-5.2	-4.5	-5.1	-6.4	-5.9	-6.7	-8.3
40	-3.2	-3.5	-4.4	-3.8	-4.3	-5.0	-4.4	-4.7	-6.3
36	-2.6	-2.4	-3.5	-3.2	-3.5	-3.7	-2.9	-2.5	-4.3

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
4600				30.1			34.0		
5000	33.9			36.6			40.5	30.8	
5400	40.6	29.5		43.1	32.4		46.9	36.3	30.2
5800	47.2	35.0	29.2	49.6	37.9	31.5	53.3	41.8	35.3
6200	53.9	40.5	33.9	56.1	43.4	36.3	60.0	47.3	40.3
6600	60.5	46.1	38.6	62.5	48.9	41.1	66.7	52.6	45.5
7000	67.2	51.6	43.3	69.0	54.4	46.0	73.4	58.1	50.5
7400	73.8	57.2	48.0	75.5	59.9	50.8		63.6	55.7
7800		62.9	52.7		65.4	55.7		69.1	60.9
8200		68.5	57.4		70.9	60.6		74.6	66.1
8600		74.1	62.1			65.5			71.3
9000			66.9			70.4			
9400			71.6			75.3			

- Enter Weight Adjustment table with slush/standing water depth and 20K derate dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
- Adjust field length available by -110ft/+100ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slush/Standing Water Takeoff (20K Derate)****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH										
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-9	-9	-8	-3	-5	-6	0	0	-4		
64	-11	-11	-9	-5	-6	-6	0	0	-2		
60	-13	-13	-11	-6	-7	-6	0	0	0		
56	-15	-14	-12	-9	-8	-7	0	0	0		
52	-17	-16	-14	-12	-11	-7	0	0	0		
48	-19	-18	-15	-15	-13	-9	-3	0	0		
44	-21	-20	-16	-17	-15	-11	-7	-3	0		
40	-21	-21	-18	-19	-17	-13	-11	-8	0		
36	-21	-21	-19	-19	-18	-15	-15	-11	-3		

1. Obtain V1, VR and V2 for the actual weight using the 20K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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ADVISORY INFORMATION**Slush/Standing Water Takeoff (20K Derate)****No Reverse Thrust****Weight Adjustment (1000 KG)**

FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-9.9	-10.4	-11.3	-11.9	-12.5	-13.3	-16.0	-16.8	-16.2
64	-9.0	-9.6	-10.6	-10.8	-11.6	-12.7	-14.6	-15.9	-15.9
60	-8.1	-8.8	-9.8	-9.6	-10.5	-11.8	-12.9	-14.5	-15.6
56	-7.4	-8.0	-9.0	-8.6	-9.5	-10.9	-11.2	-12.9	-14.9
52	-6.7	-7.3	-8.2	-7.6	-8.4	-9.8	-9.7	-11.2	-13.6
48	-5.9	-6.5	-7.4	-6.7	-7.4	-8.7	-8.4	-9.5	-11.8
44	-5.1	-5.5	-6.4	-5.6	-6.3	-7.5	-7.0	-7.9	-9.7
40	-3.9	-4.4	-5.2	-4.4	-5.0	-6.0	-5.4	-6.3	-7.4

V1 (MCG) Limit Weight (1000 KG)

AVAILABLE FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
6000			30.8			39.2			
6500	32.6		38.7			47.2	35.9		
7000	40.9		47.1	33.8		55.2	42.3	36.2	
7500	49.8	33.8		56.1	40.3	33.8	63.2	48.8	41.8
8000	59.2	40.6	33.0	65.3	47.3	39.6		55.2	47.4
8500	68.8	47.7	39.0		54.6	45.6		61.7	53.0
9000		55.3	45.2		62.1	51.9			58.6
9500		63.1	51.6			58.3			64.2
10000			58.4			64.8			
10500			65.3						

- Enter Weight Adjustment table with slush/standing water depth and 20K Derate dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
- Adjust field length available by -160 ft/+105 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
60	-20	-20	-16	-11	-11	-10	0	-7	0
56	-22	-22	-18	-14	-12	-9	0	0	0
52	-26	-24	-20	-19	-16	-11	-2	0	0
48	-27	-27	-22	-22	-20	-13	-7	-1	0
44	-29	-28	-24	-25	-23	-16	-12	-6	0
40	-30	-29	-26	-27	-25	-19	-17	-12	-1
36	-31	-30	-28	-28	-27	-23	-22	-18	-7

- Obtain V1, VR and V2 for the actual weight using the 20K Derate Dry Runway Takeoff Speeds table.
- If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff (20K Derate)****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

20K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	0.0	0.0	0.0	-3.6	-3.6	-3.6	-7.5	-7.5	-7.5
64	-0.2	-0.2	-0.2	-3.9	-3.9	-3.9	-7.3	-7.3	-7.3
60	-0.6	-0.6	-0.6	-4.0	-4.0	-4.0	-6.9	-6.9	-6.9
56	-0.8	-0.8	-0.8	-3.9	-3.9	-3.9	-6.6	-6.6	-6.6
52	-1.1	-1.1	-1.1	-3.8	-3.8	-3.8	-6.3	-6.3	-6.3
48	-1.1	-1.1	-1.1	-3.7	-3.7	-3.7	-5.9	-5.9	-5.9
44	-0.8	-0.8	-0.8	-3.1	-3.1	-3.1	-5.3	-5.3	-5.3
40	-0.3	-0.3	-0.3	-2.6	-2.6	-2.6	-4.5	-4.5	-4.5
36	0.0	0.0	0.0	-2.0	-2.0	-2.0	-3.6	-3.6	-3.6

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
3800	36.3								
4200	46.4	29.2							
4600	56.6	39.3		28.5					
5000	66.1	49.6	32.3	36.7					
5400	75.7	59.4	42.3	44.8	30.9				
5800		69.0	52.7	52.8	39.2		30.5		
6200			62.3	59.1	47.1	33.4	35.6		
6600				71.9	65.0	55.0	41.6	40.8	
7000					70.8	60.9	49.5	46.2	32.0
7400						66.7	56.8	51.9	37.2
7800						72.6	62.6	57.8	42.4
8200							68.5	63.6	28.4
8600							74.3	69.5	53.7
9000								75.4	59.6
9400									44.0
9800									65.4
10200									49.6
10600									55.5
11000									61.3
									67.2
									73.0

- Enter Weight Adjustment table with reported braking action and 20K derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -90ft/+90ft for every 5°C above/below 4°C
Adjust "Medium" field length available by -90ft/+90ft for every 5°C above/below 4°C
Adjust "Poor" field length available by -120ft/+110ft for every 5°C above/below 4°C
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slippery Runway Takeoff (20K Derate)****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-2	0	0	-9	-7	-5	-23	-20	-17
64	-4	-2	0	-12	-10	-8	-25	-22	-19
60	-6	-4	-2	-15	-13	-11	-28	-25	-22
56	-8	-6	-4	-17	-15	-13	-31	-28	-25
52	-9	-7	-5	-19	-17	-15	-33	-30	-27
48	-11	-9	-7	-21	-19	-17	-35	-32	-29
44	-12	-10	-8	-23	-21	-19	-36	-33	-30
40	-12	-10	-8	-24	-22	-20	-37	-34	-31
36	-13	-11	-9	-25	-23	-21	-38	-35	-32

1. Obtain V1, VR and V2 for the actual weight using the 20K Derate Dry Runway Takeoff Speds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff (20K Derate)****No Reverse Thrust****Weight Adjustment (1000 KG)**

20K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-1.1	-1.1	-1.1	-5.5	-5.5	-5.5	-9.6	-9.6	-9.6
64	-1.5	-1.5	-1.5	-5.6	-5.6	-5.6	-9.3	-9.3	-9.3
60	-1.8	-1.8	-1.8	-5.6	-5.6	-5.6	-8.9	-8.9	-8.9
56	-2.0	-2.0	-2.0	-5.4	-5.4	-5.4	-8.5	-8.5	-8.5
52	-2.1	-2.1	-2.1	-5.2	-5.2	-5.2	-7.9	-7.9	-7.9
48	-2.0	-2.0	-2.0	-4.9	-4.9	-4.9	-7.2	-7.2	-7.2
44	-1.8	-1.8	-1.8	-4.5	-4.5	-4.5	-6.4	-6.4	-6.4
40	-1.6	-1.6	-1.6	-4.0	-4.0	-4.0	-5.5	-5.5	-5.5
36	-1.2	-1.2	-1.2	-3.4	-3.4	-3.4	-4.5	-4.5	-4.5

V1 (MCG) Limit Weight (1000 KG)

AVAILABLE FIELD LENGTH (FT)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
4000	29.8							
4500	44.8							
5000	59.9	23.7						
5500	74.9	38.8		20.4				
6000		53.8	17.7	32.8				
6500		68.9	32.8	45.3				
7000			47.8	57.8	27.8			
7500			62.9	70.3	40.3			
8000			77.9		52.8	22.8		
8500					65.3	35.3	25.8	
9000					77.8	47.8	34.3	
9500						60.3	42.7	22.4
10000						72.8	51.2	30.9
10500							59.7	39.4
11000							68.2	47.8
11500								56.3
12000								64.8
12500								73.3
13000								61.4
13500								69.9

- Enter Weight Adjustment table with reported braking action and 20K Derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -90 ft/+90 ft for every 5°C above/below 4°C.
Adjust "Medium" field length available by -90 ft/+90 ft for every 5°C above/below 4°C.
Adjust "Poor" field length available by -150 ft/+150 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slippery Runway Takeoff (20K Derate)**

No Reverse Thrust
V1 Adjustment (KIAS)

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
64	-6	-4	-2	-16	-14	-12	-34	-32	-30
60	-8	-6	-4	-19	-17	-15	-38	-36	-34
56	-10	-8	-6	-22	-20	-18	-42	-40	-38
52	-12	-10	-8	-25	-23	-21	-45	-43	-41
48	-14	-12	-10	-28	-26	-24	-48	-46	-44
44	-15	-13	-11	-30	-28	-26	-51	-49	-47
40	-16	-14	-12	-32	-30	-28	-53	-51	-49
36	-17	-15	-13	-34	-32	-30	-54	-52	-50

1. Obtain V1, VR and V2 for the actual weight using the 20K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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Takeoff %N1 (20K Derate)**Based on engine bleed to packs on (Auto) and anti-ice on or off**

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	89.9	90.5								
50	122	90.6	91.1	91.6	92.3	93.1					
45	113	91.2	91.6	92.1	92.6	93.9	94.9	94.7	94.2		
40	104	91.7	92.1	92.6	93.0	94.3	95.3	95.3	95.3	95.0	94.3
35	95	92.0	92.5	93.0	93.4	94.7	95.9	95.8	95.8	95.1	94.5
30	86	91.8	92.8	93.2	93.6	95.0	96.5	96.4	96.4	95.7	95.0
25	77	91.0	92.1	92.9	93.6	94.5	95.9	96.3	96.7	96.2	95.6
20	68	90.3	91.3	92.1	92.8	93.8	95.1	95.5	95.9	95.9	95.9
15	59	89.5	90.5	91.3	92.0	93.0	94.3	94.7	95.1	95.3	95.3
10	50	88.7	89.7	90.5	91.2	92.1	93.4	93.9	94.3	94.4	94.6
5	41	87.9	88.9	89.7	90.4	91.3	92.6	93.0	93.4	93.6	93.7
0	32	87.1	88.1	88.9	89.6	90.5	91.8	92.2	92.6	92.7	92.9
-10	14	85.5	86.5	87.2	87.9	88.8	90.1	90.5	90.9	91.0	91.2
-20	-4	83.9	84.8	85.6	86.2	87.1	88.3	88.7	89.1	89.2	89.4
-30	-22	82.2	83.1	83.9	84.5	85.4	86.6	87.0	87.4	87.5	87.6
-40	-40	80.5	81.4	82.1	82.7	83.6	84.8	85.1	85.5	85.7	85.8
-50	-58	78.8	79.6	80.3	81.0	81.8	82.9	83.3	83.7	83.8	84.0

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-1000	8000
ENGINE BLEED TO PACKS OFF	1.0	1.0

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Assumed Temperature Reduced Thrust (20K Derate)**Maximum Assumed Temperature (Table 1)****Based on 25% Takeoff Thrust Reduction**

OAT (°C)	PRESS ALT (1000 FT)								OAT (°F)	PRESS ALT (1000 FT)											
	-1	0	1	2	3	4	5	6		-1	0	1	2	3	4	5	6	7	8		
55	74	73	73						130	164	162	162									
50	71	71	69	68	66	65			120	159	158	155	153	149	147						
45	69	68	67	66	63	62	62	63	65	110	154	153	151	149	144	142	142	143	145		
40	66	66	65	64	61	60	60	60	62	100	150	148	146	145	140	138	138	137	139	141	
35	64	63	62	62	59	58	58	57	59	60	90	146	143	142	141	137	134	133	132	136	137
30	63	61	61	60	58	56	55	55	56	58	80	146	141	140	137	135	131	129	128	131	132
25	63	61	60	58	57	55	54	53	54	55	70	146	141	140	136	134	131	129	127	127	126
20 & BELOW	63	61	60	58	57	55	54	53	53	52	60 & BELOW	146	141	140	136	134	131	129	127	127	126

Maximum Takeoff %N1 (Table 2)**Based on engine bleed to packs on (Auto) and engine anti-ice on or off**

ASSUMED TEMP		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
75	167	83.0	83.9	83.8	83.5						
70	158	84.7	85.6	85.6	85.4	84.9	84.7				
65	149	86.6	87.3	87.3	87.2	87.0	87.0	87.1	87.2	87.6	87.9
60	140	88.3	88.9	89.0	89.0	89.1	89.1	89.1	89.0	89.1	89.3
55	131	89.7	90.5	90.6	90.7	91.1	91.3	91.0	90.8	90.7	90.6
50	122	90.4	91.1	91.6	92.3	93.1	93.4	92.9	92.5	92.2	91.9
45	113	91.0	91.6	92.1	92.7	93.9	94.9	94.8	94.2	93.7	93.1
40	104	91.6	92.1	92.6	93.0	94.3	95.3	95.3	95.3	95.0	94.3
35	95	92.0	92.5	93.0	93.4	94.8	95.9	95.9	95.8	95.1	94.5
30	86	91.7	92.8	93.2	93.6	95.0	96.5	96.4	96.4	95.7	95.0
25	77	90.9		92.9	93.7	94.5	95.9	96.5	96.7	96.2	95.6
20	68	90.2				93.8				95.9	95.9
15	59	89.4									95.4
MINIMUM ASSUMED TEMP °C (°F)		32(90)	30(86)	28(82)	26(79)	24(75)	29(85)	27(81)	25(77)	20(68)	15(59)

With engine bleed to packs off, increase %N1 by 1.0.

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**Assumed Temperature Reduced Thrust (20K Derate)
%N1 Adjustment For Temperature Difference (Table 3)**

ASSUMED TEMP MINUS OAT		OUTSIDE AIR TEMPERATURE														
°C	°F	°C	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
		°F	-40	-4	32	41	50	59	68	77	86	95	104	113	122	131
10	18				1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3			
20	36			3.3	3.3	3.1	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.3		
30	54			4.8	4.7	4.6	4.5	4.4	4.3	4.1	3.9	3.7	3.5	3.4	3.3	
40	72		6.8	6.1	6.0	5.9	5.7	5.5	5.3	5.1	4.9					
50	90		8.1	7.4	7.2	6.9	6.7	6.3								
60	108	10.4	9.3	8.4	8.1	7.7										
70	126	11.5	10.5	9.0												
80	144	12.7	11.4	9.8												
90	162	13.8	11.9													
100	180	14.5	12.6													
110	198	14.9														

1. Determine Maximum Assumed Temperature allowed from Table 1.
2. Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).
3. Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.
4. Subtract %N1 adjustment from Maximum %N1 in Table 2.

737 Flight Crew Operations Manual

Max Climb %N1

Based on engine bleed to packs on (Auto) and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)								
	0	5	10	15	20	25	30	35	37
250	250	250	280	280	280	.74	.74	.74	
50	90.9	91.1	92.5						
40	92.0	92.2	93.6	93.3	93.6				
30	92.2	93.2	93.5	94.2	94.6	94.7			
20	90.6	92.8	94.3	95.0	95.4	95.6	95.7		
10	89.1	91.2	93.1	95.1	96.1	96.4	96.6	96.6	96.6
0	87.5	89.6	91.5	93.4	95.5	97.2	97.5	97.5	97.5
-10	85.9	87.9	89.8	91.7	93.7	95.9	97.9	98.4	98.4
-20	84.2	86.3	88.1	90.0	91.9	94.0	96.0	99.0	99.3
-30	82.5	84.5	86.3	88.2	90.1	92.1	94.1	97.0	97.6
-40	80.8	82.8	84.5	86.3	88.2	90.2	92.2	95.0	95.6
-50	79.1	81.0	82.7	84.5	86.3	88.3	90.2	92.9	93.5

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	0	5	10	15	20	25	30	35	37
ENGINE BLEED TO PACKS OFF	0.5	0.5	0.6	0.7	0.8	0.8	0.9	0.9	0.9
PACKS HIGH	-0.3	-0.3	-0.4	-0.4	-0.4	-0.4	-0.5	-0.6	-0.6
ENGINE ANTI-ICE ON	-0.7	-0.8	-0.9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
ENGINE & WING ANTI-ICE ON	-1.9	-2.0	-2.2	-2.4	-2.6	-2.7	-2.8	-3.0	-3.0

Go-around %N1

Based on engine bleed to packs on (Auto), engine anti-ice on or off, and wing anti-ice off

REPORTED OAT		TAT	PRESSURE ALTITUDE (FT)									
°C	°F		-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	58	93.1	93.9	93.9	93.9						
50	122	53	93.7	94.2	94.2	94.2	94.2					
45	113	48	94.1	94.7	94.6	94.6	94.6	94.6	94.7	94.8	94.6	
40	104	43	94.5	95.1	95.1	95.1	95.0	95.1	95.1	95.2	95.1	95.0
35	95	38	95.1	95.5	95.6	95.5	95.5	95.7	95.7	95.7	95.6	95.6
30	86	33	95.1	96.1	96.1	96.0	96.0	96.3	96.2	96.2	96.1	96.0
25	77	28	94.3	95.3	95.8	96.2	96.5	96.7	96.7	96.6	96.5	96.5
20	68	23	93.5	94.5	95.0	95.4	95.9	96.6	97.1	97.2	97.0	96.9
15	59	18	92.7	93.7	94.1	94.6	95.1	95.8	96.3	96.8	97.3	97.5
10	50	13	91.9	92.8	93.3	93.7	94.2	95.0	95.4	96.0	96.4	96.9
5	41	8	91.1	92.0	92.5	92.9	93.4	94.1	94.6	95.1	95.6	96.1
0	32	3	90.3	91.2	91.7	92.1	92.6	93.3	93.7	94.3	94.7	95.2
-10	14	-8	88.5	89.5	90.0	90.4	90.8	91.5	92.0	92.5	93.0	93.4
-20	-4	-18	86.8	87.8	88.2	88.6	89.1	89.8	90.3	90.8	91.2	91.6
-30	-22	-28	85.1	86.0	86.5	86.9	87.3	88.0	88.5	89.0	89.4	89.8
-40	-40	-38	83.3	84.2	84.7	85.1	85.5	86.2	86.6	87.1	87.5	87.9
-50	-58	-48	81.5	82.4	82.8	83.2	83.7	84.3	84.7	85.2	85.6	86.0

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	TAT (°C)	
	- 60	60
ENGINE BLEED TO PACKS OFF	0.8	1.0
PACKS HIGH	- 0.3	- 0.3
WING A/I ALL ENGINES	- 1.3	- 1.6
WING A/I 1 ENGINE INOP	- 2.2	- 2.7

737 Flight Crew Operations Manual

Flight With Unreliable Airspeed / Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

Climb**Flaps Up, Set Max Climb Thrust**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		32	34	44	54	64
35000 (.73M)	PITCH ATT V/S (FT/MIN)	6.5 3100	6.5 2800	6.0 1800	5.5 1000	5.5 300
30000 (.73M)	PITCH ATT V/S (FT/MIN)	7.0 3900	6.5 3600	6.0 2500	5.5 1700	5.5 1100
25000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	7.0 3700	6.5 3500	6.0 2500	6.0 1800	6.0 1300
20000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	8.5 4600	8.5 4300	7.5 3100	7.0 2300	7.0 1800
15000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	10.5 5400	10.0 5100	9.0 3800	8.0 2900	8.0 2200
10000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	13.0 6300	12.0 5900	10.5 4400	9.5 3400	9.0 2700
5000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	15.0 7100	14.5 6700	12.0 5000	11.0 3900	10.0 3100
SEA LEVEL (280 KIAS)	PITCH ATT V/S (FT/MIN)	17.5 7900	17.0 7400	14.0 5600	12.5 4400	11.5 3500

Cruise**Flaps Up, Adjust %N1 for Level Flight**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		34	38	42	46	50
30000 (.73M)	PITCH ATT %N1	2.0 79	2.0 79	2.5 80	3.0 81	3.0 82
10000 (280 KIAS)	PITCH ATT %N1	2.0 65	2.0 65	2.5 66	3.0 66	3.0 67

Descent**Flaps Up, Set Idle Thrust**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		34	38	42	46	50
30000 (.73M)	PITCH ATT V/S (FT/MIN)	-3.5 -4200	-3.0 -3800	-2.5 -3600	-2.0 -3400	-1.5 -3300
20000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	-2.5 -2900	-2.0 -2600	-1.0 -2500	-0.5 -2300	0.0 -2200
10000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	-2.5 -2500	-2.0 -2300	-1.5 -2200	-1.0 -2100	-0.5 -2000

Holding**Flaps Up, Adjust %N1 for Level Flight**

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)				
		34	38	42	46	50
10000	PITCH ATT %N1 KIAS	4.0 56 210	4.5 57 210	5.5 59 210	5.5 61 215	5.5 63 225

737 Flight Crew Operations Manual

Flight With Unreliable Airspeed / Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

Terminal Area**Adjust %N1 for Level Flight**

FLAP POSITION (SPEED)		WEIGHT (1000 KG)				
		32	40	48	56	64
FLAPS UP (GEAR UP)	PITCH ATT	3.5	5.0	6.0	6.5	7.0
	%N1	52	55	58	62	65
	KIAS	210	210	210	220	230
FLAPS 1 (GEAR UP)	PITCH ATT	4.0	5.5	6.5	7.0	7.5
	%N1	55	57	60	64	67
	KIAS	190	190	190	200	210
FLAPS 5 (GEAR UP)	PITCH ATT	3.5	4.5	6.0	6.5	6.5
	%N1	55	58	61	65	68
	KIAS	180	180	180	190	200
FLAPS 15 (GEAR DOWN)	PITCH ATT	3.5	5.5	7.5	8.0	8.0
	%N1	61	64	68	72	75
	KIAS	150	150	150	160	170

Final Approach**Gear Down, Adjust %N1 for 3° Glideslope**

FLAP POSITION		WEIGHT (1000 KG)				
		32	40	48	56	64
FLAPS 15 (VREF 15+10)	PITCH ATT	4.5	4.5	4.5	4.5	4.5
	%N1	43	48	52	56	60
	KIAS	123	138	151	163	173
FLAPS 30 (VREF 30+10)	PITCH ATT	2.0	2.0	2.0	2.5	2.5
	%N1	48	53	58	62	65
	KIAS	116	129	141	152	162
FLAPS 40 (VREF 40+10)	PITCH ATT	0.5	0.5	0.5	0.5	0.0
	%N1	54	60	65	69	73
	KIAS	113	125	137	150	161

Performance Inflight**All Engines****Chapter PI****Section 11****Long Range Cruise Maximum Operating Altitude****Max Cruise Thrust****ISA + 10°C and Below**

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	-10	34100	33200	32300	30700	29200
62	31500	-11	34700	33800	33000	31400	29900
60	32200	-13	35400	34500	33700	32100	30600
58	32900	-14	36100	35300	34400	32800	31400
56	33700	-16	36900	36000	35200	33600	32100
54	34400	-18	37000	36700	35900	34400	32900
52	35200	-19	37000	37000	36700	35200	33700
50	36100	-21	37000	37000	37000	36000	34500
48	36900	-21	37000	37000	37000	36800	35400
46	37000	-21	37000	37000	37000	37000	36300
44	37000	-21	37000	37000	37000	37000	37000

ISA + 15°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	-4	34100	33200	32300	30700	29200
62	31500	-6	34700	33800	33000	31400	29900
60	32200	-7	35400	34500	33700	32100	30600
58	32900	-9	36100	35300	34400	32800	31400
56	33700	-10	36900	36000	35200	33600	32100
54	34400	-12	37000	36700	35900	34400	32900
52	35200	-14	37000	37000	36700	35200	33700
50	36100	-16	37000	37000	37000	36000	34500
48	36900	-16	37000	37000	37000	36800	35400
46	37000	-16	37000	37000	37000	37000	36300
44	37000	-16	37000	37000	37000	37000	37000

ISA + 20°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	1	33600*	33200	32300	30700	29200
62	31500	0	34400*	33800	33000	31400	29900
60	32200	-2	35300*	34500	33700	32100	30600
58	32900	-3	36100	35300	34400	32800	31400
56	33700	-5	36800*	36000	35200	33600	32100
54	34400	-7	37000	36700	35900	34400	32900
52	35200	-8	37000	37000	36700	35200	33700
50	36100	-10	37000	37000	37000	36000	34500
48	36900	-10	37000	37000	37000	36800	35400
46	37000	-10	37000	37000	37000	37000	36300
44	37000	-10	37000	37000	37000	37000	37000

*Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.

Long Range Cruise Control

WEIGHT (1000 KG)	%N1	PRESSURE ALTITUDE (1000 FT)							
		21	23	25	27	29	31	33	35
62	%N1	81.1	82.2	83.3	84.3	85.2	86.4	88.2	91.0
	MACH	.698	.718	.734	.744	.745	.745	.745	.744
	KIAS	317	313	308	299	287	275	263	251
	FF/ENG	1499	1479	1452	1419	1372	1337	1329	1356
58	%N1	79.7	81.0	82.1	83.1	84.1	85.1	86.3	88.4
	MACH	.682	.703	.722	.737	.744	.745	.745	.742
	KIAS	309	306	302	296	287	275	263	251
	FF/ENG	1413	1396	1376	1348	1313	1271	1244	1244
54	%N1	78.1	79.5	80.7	81.8	82.8	83.8	84.8	86.3
	MACH	.665	.685	.707	.725	.740	.745	.745	.745
	KIAS	301	298	295	291	285	275	263	251
	FF/ENG	1328	1311	1295	1274	1248	1211	1174	1154
50	%N1	76.5	77.8	79.1	80.4	81.5	82.5	83.4	84.5
	MACH	.646	.667	.688	.709	.728	.741	.745	.745
	KIAS	292	289	287	284	280	274	263	251
	FF/ENG	1244	1227	1210	1195	1175	1150	1114	1081
46	%N1	74.9	76.1	77.4	78.7	79.9	81.0	82.1	83.0
	MACH	.625	.647	.668	.689	.710	.729	.742	.745
	KIAS	282	280	278	276	273	269	262	251
	FF/ENG	1160	1144	1128	1112	1098	1079	1055	1021
42	%N1	72.9	74.2	75.5	76.8	78.1	79.3	80.5	81.5
	MACH	.603	.624	.646	.667	.688	.710	.729	.743
	KIAS	271	270	268	266	264	261	257	250
	FF/ENG	1077	1062	1046	1029	1015	1003	985	963
38	%N1	70.8	72.2	73.5	74.7	76.0	77.4	78.6	79.8
	MACH	.579	.599	.621	.643	.664	.686	.709	.728
	KIAS	260	259	257	256	254	252	249	245
	FF/ENG	994	981	964	948	934	921	910	894
34	%N1	68.4	69.8	71.2	72.5	73.8	75.1	76.5	77.7
	MACH	.553	.573	.593	.615	.637	.659	.682	.705
	KIAS	248	247	246	244	243	241	239	237
	FF/ENG	912	898	884	866	852	840	829	818

Shaded area approximates optimum altitude.

737 Flight Crew Operations Manual

Long Range Cruise Enroute Fuel and Time - Low Altitudes
Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
284	262	243	226	213	200	191	182	174	167	160	
428	395	366	341	319	300	286	273	261	250	241	
573	528	489	455	426	400	381	364	348	334	321	
719	662	612	570	533	500	477	455	435	418	402	
865	796	735	684	640	600	572	546	522	501	482	
1011	931	859	799	747	700	667	637	610	584	562	
1158	1065	983	914	854	800	763	728	697	668	642	
1305	1200	1107	1028	961	900	858	819	784	751	722	
1453	1335	1231	1143	1068	1000	953	910	871	835	802	
1601	1471	1355	1258	1175	1100	1048	1001	957	917	881	
1750	1607	1480	1374	1282	1200	1144	1091	1044	1000	961	
1900	1743	1605	1489	1389	1300	1239	1183	1131	1084	1041	
2050	1880	1730	1605	1497	1400	1334	1274	1218	1167	1121	
2201	2018	1856	1721	1604	1500	1429	1364	1304	1250	1201	
2352	2156	1982	1836	1712	1600	1524	1455	1391	1332	1280	
2504	2293	2108	1952	1819	1700	1620	1545	1477	1415	1359	
2656	2432	2234	2068	1926	1800	1715	1636	1564	1498	1438	
2809	2571	2360	2185	2034	1900	1810	1727	1650	1580	1517	
2963	2710	2487	2301	2142	2000	1905	1817	1737	1663	1597	

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	1.4	0:39	1.3	0:38	1.1	0:37	1.0	0:36	0.9	0:35
300	2.2	0:58	2.0	0:56	1.7	0:53	1.5	0:51	1.4	0:50
400	2.9	1:17	2.7	1:14	2.3	1:09	2.1	1:07	1.9	1:04
500	3.7	1:35	3.3	1:31	2.9	1:26	2.6	1:22	2.4	1:19
600	4.4	1:54	4.0	1:49	3.5	1:42	3.2	1:38	2.9	1:34
700	5.2	2:13	4.7	2:07	4.1	1:59	3.7	1:53	3.4	1:49
800	5.9	2:32	5.4	2:25	4.7	2:15	4.3	2:09	4.0	2:04
900	6.6	2:52	6.0	2:44	5.3	2:32	4.8	2:25	4.5	2:19
1000	7.3	3:11	6.7	3:02	5.8	2:49	5.4	2:41	5.0	2:34
1100	8.1	3:31	7.4	3:21	6.4	3:06	5.9	2:57	5.5	2:49
1200	8.8	3:50	8.0	3:39	7.0	3:23	6.4	3:13	5.9	3:04
1300	9.5	4:10	8.7	3:58	7.6	3:40	7.0	3:29	6.4	3:20
1400	10.2	4:30	9.3	4:17	8.1	3:57	7.5	3:45	6.9	3:35
1500	10.9	4:51	10.0	4:36	8.7	4:15	8.0	4:02	7.4	3:50
1600	11.6	5:11	10.6	4:55	9.3	4:32	8.6	4:18	7.9	4:06
1700	12.3	5:31	11.2	5:14	9.8	4:50	9.1	4:35	8.4	4:21
1800	13.0	5:52	11.9	5:34	10.4	5:08	9.6	4:51	8.9	4:37
1900	13.6	6:13	12.5	5:54	10.9	5:25	10.1	5:08	9.3	4:53
2000	14.3	6:34	13.1	6:13	11.5	5:43	10.6	5:25	9.8	5:09

737 Flight Crew Operations Manual

Long Range Cruise Enroute Fuel and Time - Low Altitudes
Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)						
	30	35	40	45	50	55	60
4	-0.4	-0.3	-0.1	0.0	0.2	0.4	0.6
6	-0.6	-0.4	-0.2	0.0	0.3	0.6	1.0
8	-0.9	-0.6	-0.3	0.0	0.4	0.9	1.3
10	-1.1	-0.7	-0.4	0.0	0.5	1.1	1.6
12	-1.3	-0.9	-0.4	0.0	0.6	1.3	1.9
14	-1.6	-1.0	-0.5	0.0	0.7	1.5	2.3
16	-1.8	-1.2	-0.6	0.0	0.9	1.7	2.6

737 Flight Crew Operations Manual

Long Range Cruise Enroute Fuel and Time - High Altitudes
Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
534	503	475	448	423	400	381	363	346	331	317	
797	751	708	669	633	600	572	545	521	499	479	
1062	999	942	890	843	800	763	728	696	667	642	
1328	1248	1176	1111	1053	1000	954	911	872	837	806	
1595	1498	1410	1333	1263	1200	1146	1095	1049	1007	970	
1862	1748	1646	1555	1474	1400	1337	1279	1226	1177	1133	
2130	2000	1881	1777	1685	1600	1529	1463	1402	1346	1296	
2399	2251	2118	2000	1896	1800	1720	1646	1578	1515	1458	
2668	2504	2355	2224	2107	2000	1911	1828	1752	1683	1620	
2939	2757	2592	2447	2318	2200	2102	2011	1927	1850	1781	
3211	3011	2830	2671	2529	2400	2293	2194	2102	2019	1943	
3484	3266	3068	2895	2741	2600	2484	2377	2277	2187	2104	
3757	3521	3307	3119	2952	2800	2675	2559	2452	2355	2266	
4032	3777	3546	3344	3164	3000	2866	2742	2627	2522	2427	
4309	4034	3786	3569	3376	3200	3057	2924	2801	2689	2588	
4586	4292	4026	3794	3588	3400	3247	3106	2975	2856	2748	
4864	4551	4268	4020	3800	3600	3438	3288	3149	3023	2909	
5144	4811	4509	4246	4012	3800	3629	3470	3323	3190	3069	
5425	5071	4751	4472	4225	4000	3819	3652	3498	3357	3229	

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		37	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
400	2.1	0:59	2.0	0:59	1.9	0:59	1.8	1:01	1.8	1:03
600	3.0	1:30	2.9	1:29	2.8	1:28	2.7	1:29	2.6	1:31
800	4.0	2:01	3.8	1:59	3.7	1:57	3.6	1:58	3.5	1:59
1000	4.9	2:31	4.7	2:28	4.6	2:26	4.4	2:26	4.3	2:27
1200	5.9	3:02	5.6	2:58	5.4	2:56	5.3	2:55	5.1	2:55
1400	6.8	3:32	6.6	3:28	6.3	3:25	6.1	3:23	6.0	3:23
1600	7.7	4:03	7.5	3:58	7.2	3:54	7.0	3:52	6.8	3:51
1800	8.7	4:34	8.4	4:28	8.1	4:23	7.8	4:20	7.6	4:19
2000	9.6	5:05	9.3	4:58	9.0	4:52	8.7	4:49	8.4	4:48
2200	10.5	5:36	10.2	5:28	9.8	5:22	9.5	5:18	9.3	5:16
2400	11.5	6:08	11.1	5:59	10.7	5:52	10.3	5:47	10.1	5:44
2600	12.4	6:40	11.9	6:30	11.5	6:22	11.2	6:16	10.8	6:13
2800	13.2	7:12	12.8	7:02	12.4	6:52	12.0	6:46	11.6	6:42
3000	14.1	7:45	13.6	7:33	13.2	7:23	12.8	7:16	12.4	7:11
3200	15.0	8:18	14.5	8:05	14.0	7:54	13.5	7:46	13.2	7:40
3400	15.9	8:52	15.3	8:38	14.8	8:25	14.3	8:16	13.9	8:09
3600	16.7	9:26	16.1	9:10	15.6	8:57	15.1	8:47	14.7	8:39
3800	17.5	10:00	16.9	9:43	16.4	9:29	15.9	9:18	15.4	9:09
4000	18.4	10:35	17.7	10:17	17.1	10:01	16.6	9:49	16.1	9:39

737 Flight Crew Operations Manual

Long Range Cruise Enroute Fuel and Time - High Altitudes
Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)						
	30	35	40	45	50	55	60
4	-0.5	-0.4	-0.2	0.0	0.3	0.7	1.3
6	-0.9	-0.6	-0.3	0.0	0.4	1.0	1.8
8	-1.2	-0.8	-0.4	0.0	0.6	1.3	2.3
10	-1.5	-1.0	-0.5	0.0	0.7	1.6	2.7
12	-1.8	-1.3	-0.6	0.0	0.8	1.9	3.1
14	-2.1	-1.5	-0.7	0.0	1.0	2.1	3.5
16	-2.4	-1.6	-0.9	0.0	1.1	2.4	3.9
18	-2.6	-1.8	-1.0	0.0	1.2	2.6	4.2
20	-2.8	-2.0	-1.1	0.0	1.3	2.8	4.5
22	-3.0	-2.1	-1.2	0.0	1.4	3.0	4.8

737 Flight Crew Operations Manual

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 KG)													
	62	60	58	56	54	52	50	48	46	44	42	40	38	36
37					14	8	1	0	0	0	0	0	0	0
35		9	5	2	0	0	2	6	8	10	12	13	14	14
33	2	1	0	1	3	7	12	17	20	23	26	27	29	30
31	1	3	4	9	14	19	25	31	35	38	41	43	44	45
29	8	12	17	22	28	33	39	45	50	54	57	59	60	61
27	17	25	30	35	41	48	55	61	66	69	71	74	75	77
25	34	39	44	51	57	63	70	78	82	86	89	92	94	96
23	48	53	59	65	72	79	86	94	99	103	106	109	112	113

The above wind factor tables are 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**Based on .74/250 descent speed**

PRESSURE ALT (1000 FT)	25	27	29	31	33	35	37
DISTANCE (NM)	79	86	92	98	105	111	116
TIME (MINUTES)	18	19	20	21	22	23	23

Holding**Flaps Up**

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)								
	1500	5000	10000	15000	20000	25000	30000	35000	37000
62	%N1	61.7	64.3	68.3	72.4	76.3	80.4	84.5	90.6
	KIAS	247	248	250	253	255	257	256	249
	FF/ENG	1430	1400	1360	1330	1310	1310	1310	1400
58	%N1	60.1	62.6	66.5	70.7	74.7	78.7	82.8	87.6
	KIAS	239	240	241	244	246	248	248	239
	FF/ENG	1360	1320	1280	1250	1230	1230	1220	1250
54	%N1	58.4	60.8	64.7	68.7	73.0	77.0	81.0	85.4
	KIAS	231	231	232	235	237	239	241	238
	FF/ENG	1280	1240	1200	1170	1150	1150	1140	1150
50	%N1	56.6	59.1	62.7	66.8	71.0	75.0	79.1	83.3
	KIAS	224	223	223	225	227	230	232	228
	FF/ENG	1210	1170	1130	1090	1070	1060	1050	1070
46	%N1	54.8	57.1	60.6	64.6	68.8	73.0	77.1	81.2
	KIAS	216	214	214	215	218	220	222	221
	FF/ENG	1130	1100	1050	1020	990	980	970	980
42	%N1	53.1	55.3	58.8	62.6	66.6	70.8	74.9	79.0
	KIAS	210	210	210	210	210	210	212	212
	FF/ENG	1070	1030	990	950	920	900	890	890
38	%N1	51.5	53.8	57.2	60.8	64.8	69.0	72.9	76.9
	KIAS	210	210	210	210	210	210	210	210
	FF/ENG	1010	980	940	900	870	840	830	820
34	%N1	50.0	52.4	55.7	59.3	63.1	67.2	71.2	75.1
	KIAS	210	210	210	210	210	210	210	210
	FF/ENG	970	940	900	860	820	800	770	770

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

Performance Inflight

Advisory Information

Chapter PI

Section 12

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 15

Dry Runway

	LANDING DISTANCE AND ADJUSTMENT (FT)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	VREF ADJ	REVERSE THRUST ADJ	PER 10 KTS ABOVE VREF15	ONE REV	NO REV	
BRAKING CONFIGURATION	48000 KG LANDING WEIGHT	PER 5000 KG ABOVE/BELOW 48000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA			
MAX MANUAL	2740	390/-180	50	-100	340	30	-30	50	-50	210	40	150
MAX AUTO	3650	300/-270	80	-130	440	0	0	80	-80	350	0	10
AUTOBRAKES 3	5180	420/-440	130	-220	740	20	-30	140	-140	540	50	60
AUTOBRAKES 2	6160	580/-600	180	-290	970	100	-140	170	-170	470	320	320
AUTOBRAKES 1	6620	680/-670	210	-330	1130	210	-210	180	-180	470	820	1220

Good Reported Braking Action

MAX MANUAL	3790	290/-290	90	-160	580	80	-70	90	-90	270	200	690
MAX AUTO	4060	320/-320	100	-170	600	70	-60	90	-90	330	220	760
AUTOBRAKE 3	5190	430/-450	130	-220	750	30	-30	140	-140	540	50	200
AUTOBRAKE 2	6160	580/-600	180	-290	970	100	-140	170	-170	470	320	320
AUTOBRAKE 1	6620	680/-670	210	-330	1130	210	-210	180	-180	470	820	1220

Medium Reported Braking Action

MAX MANUAL	5060	460/-440	140	-260	940	200	-160	130	-130	350	540	2240
MAX AUTO	5110	470/-460	140	-260	940	170	-140	130	-130	410	540	2240
AUTOBRAKE 3	5570	490/-490	150	-280	990	140	-100	140	-140	540	370	2060
AUTOBRAKE 2	6300	590/-610	190	-310	1100	170	-180	170	-170	470	400	1460
AUTOBRAKE 1	6640	690/-670	210	-330	1170	250	-220	180	-190	470	840	1850

Poor Reported Braking Action

MAX MANUAL	6410	640/-610	200	-380	1440	450	-310	160	-160	420	1090	6360
MAX AUTO	6410	640/-610	200	-370	1430	440	-300	160	-160	430	1080	6380
AUTOBRAKE 3	6470	650/-620	200	-380	1450	410	-270	170	-170	520	1090	6380
AUTOBRAKE 2	6870	680/-670	210	-390	1500	400	-300	180	-180	470	900	5980
AUTOBRAKE 1	7080	730/-720	230	-410	1530	460	-340	190	-190	470	1130	5930

Reference distance is for sea level, standard day, no wind or slope, VREF15 approach speed and two engine detent reverse thrust.

Max manual braking data valid for auto speedbrakes. Autobrake data valid for both auto and manual speedbrakes.

For max manual braking and manual speedbrakes, increase reference landing distance by 310 ft.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Normal Configuration Landing Distance****Flaps 30****Dry Runway**

	LANDING DISTANCE AND ADJUSTMENTS (FT)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		TEMP ADJ PER 10°C		VREF ADJ	REVERSE THRUST ADJ	
BRAKING CONFIGURATION	48000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 48000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF30	ONE REV NO REV	
MAX MANUAL	2570	300/-160	50	-90	320	30	-30	50	-50	190	40	120
MAX AUTO	3320	240/-230	70	-120	420	0	0	70	-70	330	0	10
AUTOBRAKES 3	4640	360/-380	120	-210	700	20	-30	120	-120	490	40	50
AUTOBRAKES 2	5540	490/-520	160	-270	920	80	-120	150	-150	450	200	200
AUTOBRAKES 1	5960	590/-580	190	-310	1070	180	-180	160	-160	440	640	950

Good Reported Braking Action

MAX MANUAL	3540	260/-260	80	-160	560	80	-70	80	-80	280	170	610
MAX AUTO	3760	280/-290	90	-170	580	60	-60	80	-80	320	190	660
AUTOBRAKE 3	4650	360/-390	120	-210	710	30	-30	120	-120	490	50	190
AUTOBRAKE 2	5540	490/-520	160	-270	920	80	-120	150	-150	450	200	200
AUTOBRAKE 1	5960	590/-580	190	-310	1070	180	-180	160	-160	440	640	950

Medium Reported Braking Action

MAX MANUAL	4670	400/-400	130	-250	910	190	-150	110	-110	350	460	1940
MAX AUTO	4690	410/-410	130	-250	910	160	-130	110	-110	400	450	1930
AUTOBRAKE 3	5030	430/-430	130	-260	950	130	-100	130	-130	490	340	1870
AUTOBRAKE 2	5670	510/-530	160	-290	1040	150	-170	150	-150	450	280	1270
AUTOBRAKE 1	5990	590/-580	190	-310	1110	230	-200	160	-160	440	670	1540

Poor Reported Braking Action

MAX MANUAL	5870	560/-540	180	-360	1390	420	-290	150	-150	400	910	5470
MAX AUTO	5870	560/-540	180	-360	1380	420	-280	150	-150	420	910	5500
AUTOBRAKE 3	5910	580/-550	180	-360	1390	400	-260	150	-150	470	940	5500
AUTOBRAKE 2	6240	590/-590	180	-370	1440	380	-280	160	-160	440	720	5180
AUTOBRAKE 1	6420	640/-630	200	-390	1470	430	-310	170	-170	440	930	5110

Reference distance is for sea level, standard day, no wind or slope, VREF30 approach speed and two engine detent reverse thrust.

Max manual braking data valid for auto speedbrakes. Autobrake data valid for both auto and manual speedbrakes.

For max manual braking and manual speedbrakes, increase reference landing distance by 280 ft.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Normal Configuration Landing Distance****Flaps 40****Dry Runway**

	LANDING DISTANCE AND ADJUSTMENTS (FT)										
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	VREF ADJ	REVERSE THRUST ADJ	PER 10 KTS ABOVE VREF40	ONE REV	NO REV
BRAKING CONFIGURATION	48000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 48000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF40	ONE REV
MAX MANUAL	2520	290/-160	50	-90	320	30	-30	50	-50	200	30
MAX AUTO	3200	260/-220	70	-120	410	0	0	70	-70	320	0
AUTOBRAKE 3	4430	400/-370	110	-200	680	20	-40	110	-110	450	40
AUTOBRAKE 2	5250	520/-480	150	-260	890	90	-110	140	-140	420	200
AUTOBRAKE 1	5650	600/-540	170	-300	1040	170	-170	150	-150	420	560
											890

Good Reported Braking Action

MAX MANUAL	3440	290/-250	80	-160	550	80	-70	80	-80	280	150	560
MAX AUTO	3650	310/-280	90	-160	570	60	-50	80	-80	320	170	620
AUTOBRAKE 3	4440	400/-370	110	-200	690	30	-40	110	-110	450	40	200
AUTOBRAKE 2	5250	520/-480	150	-260	890	90	-110	140	-140	420	200	200
AUTOBRAKE 1	5650	600/-540	170	-300	1040	170	-170	150	-150	420	560	890

Medium Reported Braking Action

MAX MANUAL	4500	430/-380	120	-240	890	180	-150	110	-110	340	410	1770
MAX AUTO	4520	440/-390	120	-240	890	160	-120	110	-110	400	410	1750
AUTOBRAKE 3	4820	460/-410	130	-250	930	130	-110	120	-120	450	320	1730
AUTOBRAKE 2	5380	530/-500	150	-280	1010	160	-160	140	-140	420	270	1180
AUTOBRAKE 1	5680	600/-550	170	-300	1080	210	-180	150	-150	420	580	1440

Poor Reported Braking Action

MAX MANUAL	5620	580/-510	170	-350	1360	400	-270	140	-140	390	810	4890
MAX AUTO	5620	580/-510	170	-350	1360	400	-260	140	-140	410	800	4910
AUTOBRAKE 3	5660	590/-520	170	-350	1370	390	-260	140	-140	420	840	4950
AUTOBRAKE 2	5930	610/-560	170	-360	1400	380	-270	150	-150	420	670	4630
AUTOBRAKE 1	6100	650/-590	190	-370	1430	410	-300	160	-160	420	820	4610

Reference distance is for sea level, standard day, no wind or slope, VREF40 approach speed and two engine detent reverse thrust.

Max manual braking data valid for auto speedbrakes. Autobrake data valid for both auto and manual speedbrakes.

For max manual braking and manual speedbrakes, increase reference landing distance by 250 ft.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Dry Runway**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 48000 KG LANDING WEIGHT	WT ADJ PER 2000 KG ABV/BLW 48000 KG	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED
					HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF
ALL FLAPS UP	VREF40+55	4040	360/-140	230	-160	590	50	-50	380
ANTI-SKID INOPERATIVE	VREF40	3940	120/-110	80	-175	610	80	-70	300
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	3180	100/-90	130	-120	400	70	-50	440
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	3280	90/-100	130	-120	410	70	-50	440
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	3310	110/-90	150	-120	390	50	-50	340
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	3150	170/-90	150	-120	420	50	-50	250
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH SYSTEM A & B)	VREF15	4900	170/-160	230	-210	700	150	-130	520
STABILIZER TRIM INOPERATIVE	VREF15	2790	150/-70	130	-100	350	30	-30	210
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	2790	150/-70	130	-100	350	30	-30	210
LEADING EDGE FLAPS TRANSIT	VREF15+5	2920	170/-70	150	-110	360	30	-30	230
ONE ENGINE INOPERATIVE	VREF15	2820	160/-80	140	-110	360	30	-30	230

Reference distance assumes sea level, standard day, with no wind or slope.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above runway threshold (1000 ft of air distance).

Assumes maximum manual braking and maximum reverse thrust when available on operating engine(s).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance**
Dry Runway

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 48000 KG LANDING WEIGHT	WT ADJ PER 2000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED PER 10 KTS ABOVE VREF
HEAD WIND	TAIL WIND	DOWN HILL	UP HILL						
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	2590	130/-60	50	-90	330	30	-30	200
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	2790	160/-70	130	-90	340	30	-30	210
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	3250	210/-100	180	-120	430	30	-30	260
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	2590	130/-60	50	-90	330	30	-30	200
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	2790	160/-70	130	-90	340	30	-30	210
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	3250	210/-100	180	-120	430	30	-30	260
TRAILING EDGE FLAPS UP (FLAPS < 1)	VREF40+40	3510	250/-110	190	-130	510	50	-50	330

Reference distance assumes sea level, standard day, with no wind or slope.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above runway threshold (1000 ft of air distance).

Assumes maximum manual braking and maximum reverse thrust when available on operating engine(s).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance****Good Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 48000 KG LANDING WEIGHT	WT ADJ PER 2000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED
					HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF
ALL FLAPS UP	VREF40+55	5100	160/-140	240	-200	670	100	-100	300
ANTI-SKID INOPERATIVE	VREF40	4810	170/-150	110	-245	900	160	-130	340
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	4260	160/-150	180	-190	660	130	-110	490
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	4460	150/-150	180	-200	670	150	-130	520
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	4650	160/-140	210	-200	670	130	-110	460
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	3940	120/-120	170	-170	590	80	-80	300
HYDRAULICS-MANUAL REVERSION (LOSS OF SYSTEM A & B)	VREF15	4990	170/-160	230	-210	710	150	-150	540
STABILIZER TRIM INOPERATIVE	VREF15	3750	120/-110	150	-170	570	80	-80	280
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	3750	120/-110	150	-170	570	80	-80	280
LEADING EDGE FLAPS TRANSIT	VREF15+5	4070	130/-120	190	-180	610	100	-80	310
ONE ENGINE INOPERATIVE	VREF15	3950	130/-120	170	-180	610	100	-80	310

Reference distance assumes sea level, standard day, with no wind or slope.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above runway threshold (1000 ft of air distance).

Assumes maximum manual braking and maximum reverse thrust when available on operating engine(s).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Good Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 48000 KG LANDING WEIGHT	WT ADJ PER 2000 KG ABV/BLW 48000 KG	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED
					HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	3510	100/-100	90	-150	570	80	-70	280
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	3740	130/-110	150	-160	570	80	-80	280
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	4230	140/-120	190	-180	600	80	-80	260
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	3510	100/-100	90	-150	570	80	-70	280
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	3740	130/-110	150	-160	570	80	-80	280
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	4230	140/-120	190	-180	600	80	-80	260
TRAILING EDGE FLAPS UP (FLAPS < 1)	VREF40+40	4530	140/-130	210	-180	630	100	-80	280

Reference distance assumes sea level, standard day, with no wind or slope.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above runway threshold (1000 ft of air distance).

Assumes maximum manual braking and maximum reverse thrust when available on operating engine(s).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance****Medium Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 48000 KG LANDING WEIGHT	WT ADJ PER 2000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED
					HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF
ALL FLAPS UP	VREF40+55	6850	250/-230	330	-310	1060	250	-210	390
ANTI-SKID INOPERATIVE	VREF40	5890	220/-200	145	-350	1350	390	-250	390
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	5370	220/-200	230	-290	1000	260	-210	520
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	5690	210/-220	240	-300	1030	280	-230	560
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	6070	230/-220	280	-300	1040	280	-250	540
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	5250	190/-180	230	-270	960	200	-180	380
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH SYSTEM A & B)	VREF15	6500	250/-230	310	-320	1100	310	-260	610
STABILIZER TRIM INOPERATIVE	VREF15	4990	180/-170	210	-260	920	200	-160	340
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	4990	180/-170	210	-260	920	200	-160	340
LEADING EDGE FLAPS TRANSIT	VREF15+5	5420	200/-190	260	-270	970	210	-180	390
ONE ENGINE INOPERATIVE	VREF15	5510	200/-190	250	-290	1030	260	-210	410

Reference distance assumes sea level, standard day, with no wind or slope.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above runway threshold (1000 ft of air distance).

Assumes maximum manual braking and maximum reverse thrust when available on operating engine(s).

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ADVISORY INFORMATION**Non-Normal Configuration Landing Distance**
Medium Reported Braking Action

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 48000 KG LANDING WEIGHT	WT ADJ PER 2000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED PER 10 KTS ABOVE VREF
HEAD WIND	TAIL WIND	DOWN HILL	UP HILL						
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	4610	170/-160	130	-240	890	180	-150	340
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	4990	180/-160	210	-250	920	200	-160	340
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	5660	210/-190	260	-280	980	200	-180	360
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	4610	170/-160	130	-240	890	180	-150	340
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	4990	180/-160	210	-250	920	200	-160	340
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	5660	210/-190	260	-280	980	200	-180	360
TRAILING EDGE FLAPS UP (FLAPS < 1)	VREF40+40	6070	220/-200	280	-290	1000	210	-180	360

Reference distance assumes sea level, standard day, with no wind or slope.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above runway threshold (1000 ft of air distance).

Assumes maximum manual braking and maximum reverse thrust when available on operating engine(s).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Poor Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 48000 KG LANDING WEIGHT	WT ADJ PER 2000 KG ABV/BLW 48000 KG	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED
					HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF
ALL FLAPS UP	VREF40+55	8610	340/-310	420	-440	1580	490	-380	460
ANTI-SKID INOPERATIVE	VREF40	7430	310/-280	200	-550	2345	2300	-520	430
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	6490	280/-260	280	-400	1470	480	-360	520
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	6900	270/-280	290	-420	1520	510	-390	570
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	7500	310/-280	360	-430	1550	520	-410	590
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	6630	270/-240	300	-390	1450	430	-330	440
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH SYSTEM A & B)	VREF15	7970	330/-300	380	-450	1610	570	-440	640
STABILIZER TRIM INOPERATIVE	VREF15	6240	250/-230	270	-380	1400	390	-310	410
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	6240	250/-230	270	-380	1400	390	-310	410
LEADING EDGE FLAPS TRANSIT	VREF15+5	6820	280/-260	330	-400	1460	440	-340	460
ONE ENGINE INOPERATIVE	VREF15	7330	300/-280	330	-450	1640	610	-440	510

Reference distance assumes sea level, standard day, with no wind or slope.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above runway threshold (1000 ft of air distance).

Assumes maximum manual braking and maximum reverse thrust when available on operating engine(s).

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ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Poor Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 48000 KG LANDING WEIGHT	WT ADJ PER 2000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS HEAD WIND	SLOPE ADJ PER 1% DOWN HILL	APPROACH SPEED PER 10 KTS ABOVE VREF		
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	5760	210/-220	200	-350	1360	380	-280	390
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	6250	270/-240	260	-370	1390	390	-310	410
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	7120	290/-260	340	-400	1460	430	-330	430
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	5760	210/-220	200	-350	1360	380	-280	390
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	6250	270/-240	260	-370	1390	390	-310	410
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	7120	290/-260	340	-400	1460	430	-330	430
TRAILING EDGE FLAPS UP (FLAPS < 1)	VREF40+40	7640	310/-270	360	-410	1500	440	-340	430

Reference distance assumes sea level, standard day, with no wind or slope.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above runway threshold (1000 ft of air distance).

Assumes maximum manual braking and maximum reverse thrust when available on operating engine(s).

ADVISORY INFORMATION**Recommended Brake Cooling Schedule****Reference Brake Energy Per Brake (Millions of Foot Pounds)**

WEIGHT (1000 KG)	OAT (°C)	WIND CORRECTED BRAKES ON SPEED (KIAS)*											
		60			80			100			120		
		PRESS	ALT	PRESS	ALT	PRESS	ALT	PRESS	ALT	PRESS	ALT	PRESS	ALT
70	-20	6.6	7.4	8.3	11.1	12.5	14.1	16.5	18.7	21.4	22.9	26.0	29.7
	0	7.1	7.9	8.8	11.9	13.4	15.1	17.7	20.1	22.9	24.5	27.9	31.9
	15	7.4	8.3	9.3	12.5	14.1	15.9	18.7	21.2	24.2	25.9	29.4	33.6
	20	7.5	8.4	9.4	12.7	14.3	16.2	19.0	21.5	24.6	26.3	29.9	34.1
	40	7.9	8.8	9.8	13.3	15.0	17.0	20.0	22.7	25.9	27.8	31.6	36.1
65	-20	6.2	6.9	7.8	10.4	11.7	13.2	15.5	17.5	20.0	21.4	24.3	27.8
	0	6.7	7.4	8.3	11.1	12.5	14.1	16.6	18.8	21.4	22.9	26.0	29.7
	15	7.0	7.8	8.7	11.7	13.2	14.9	17.5	19.8	22.6	24.2	27.4	31.4
	20	7.1	7.9	8.8	11.9	13.4	15.2	17.8	20.1	23.0	24.6	27.9	31.9
	40	7.4	8.2	9.2	12.5	14.0	15.9	18.7	21.2	24.2	25.9	29.5	33.7
60	-20	5.8	6.5	7.2	9.7	10.9	12.3	14.4	16.3	18.6	19.9	22.6	25.8
	0	6.3	7.0	7.8	10.4	11.7	13.2	15.4	17.5	19.9	21.3	24.2	27.6
	15	6.6	7.3	8.1	10.9	12.3	13.9	16.3	18.4	21.0	22.5	25.5	29.1
	20	6.7	7.4	8.3	11.1	12.5	14.1	16.5	18.7	21.3	22.8	25.9	29.6
	40	6.9	7.7	8.6	11.6	13.1	14.8	17.4	19.7	22.5	24.1	27.4	31.3
55	-20	5.5	6.1	6.8	9.0	10.1	11.4	13.4	15.1	17.2	18.4	20.8	23.8
	0	5.9	6.5	7.2	9.7	10.8	12.2	14.3	16.2	18.4	19.7	22.3	25.5
	15	6.1	6.8	7.6	10.2	11.4	12.8	15.1	17.0	19.4	20.7	23.5	26.9
	20	6.2	6.9	7.7	10.3	11.6	13.0	15.3	17.3	19.7	21.1	23.9	27.3
	40	6.5	7.2	8.0	10.8	12.1	13.7	16.1	18.2	20.8	22.2	25.2	28.8
50	-20	5.1	5.6	6.3	8.3	9.3	10.5	12.3	13.9	15.7	16.8	19.1	21.8
	0	5.4	6.0	6.7	8.9	10.0	11.2	13.2	14.8	16.9	18.0	20.4	23.3
	15	5.7	6.3	7.0	9.4	10.5	11.8	13.8	15.6	17.8	19.0	21.5	24.6
	20	5.8	6.4	7.1	9.5	10.7	12.0	14.1	15.9	18.1	19.3	21.9	25.0
	40	6.0	6.7	7.4	10.0	11.2	12.6	14.8	16.7	19.0	20.3	23.1	26.4
45	-20	4.7	5.2	5.8	7.7	8.6	9.6	11.2	12.6	14.3	15.3	17.3	19.7
	0	5.0	5.6	6.2	8.2	9.2	10.3	12.0	13.5	15.3	16.4	18.5	21.1
	15	5.3	5.8	6.5	8.6	9.6	10.8	12.6	14.2	16.1	17.3	19.5	22.3
	20	5.3	5.9	6.6	8.7	9.8	11.0	12.8	14.5	16.4	17.5	19.9	22.7
	40	5.5	6.2	6.8	9.1	10.2	11.5	13.5	15.2	17.3	18.5	20.9	23.9
40	-20	4.3	4.8	5.3	7.0	7.8	8.7	10.1	11.4	12.9	13.7	15.5	17.7
	0	4.6	5.1	5.7	7.5	8.3	9.3	10.9	12.2	13.8	14.7	16.6	18.9
	15	4.9	5.4	5.9	7.8	8.8	9.8	11.4	12.8	14.5	15.5	17.5	20.0
	20	4.9	5.4	6.0	8.0	8.9	10.0	11.6	13.0	14.8	15.8	17.8	20.3
	40	5.1	5.6	6.3	8.3	9.3	10.4	12.1	13.7	15.5	16.6	18.8	21.4

*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°C.

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Recommended Brake Cooling Schedule****Adjusted Brake Energy Per Brake (Millions of Foot Pounds)****No Reverse Thrust**

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)						
EVENT		10	15	20	25	30	35	40
LANDING	RTO MAX MAN	10	15	20	25	30	35	40
	MAX MAN	8.6	13.3	18.1	22.8	27.5	32.3	37.0
	MAX AUTO	8.1	12.3	16.6	21.0	25.4	29.9	34.4
	AUTOBRAKE 3	8.0	11.6	15.3	19.2	23.1	27.1	31.2
	AUTOBRAKE 2	7.8	11.0	14.3	17.6	21.1	24.6	28.3
	AUTOBRAKE 1	7.5	10.4	13.4	16.3	19.4	22.5	25.6

Two Engine Detent Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)						
EVENT		10	15	20	25	30	35	40
LANDING	RTO MAX MAN	10	15	20	25	30	35	40
	MAX MAN	8.2	12.5	16.7	20.9	25.0	29.0	33.0
	MAX AUTO	6.0	9.4	12.8	16.4	20.1	23.8	27.7
	AUTOBRAKE 3	3.2	5.2	7.4	9.7	12.2	14.8	17.5
	AUTOBRAKE 2	1.4	2.5	3.8	5.2	6.8	8.5	10.3
	AUTOBRAKE 1	0.6	1.3	2.1	3.0	3.9	5.0	6.2

Cooling Time (Minutes) - Category A Brakes

		ADJUSTED BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)						
8 & BELOW		10	12	14	16	18	18.5 TO 23.7	23.8 & ABOVE
		BRAKE TEMPERATURE INDICATOR READING						
UP TO 2.1		2.8	3.2	3.6	4.2	4.8	4.9 TO 6.3	6.3 & ABOVE
INFLIGHT GEAR DOWN	NO SPECIAL PROCEDURE	2	3	4	5	6	CAUTION	FUSE PLUG MELT ZONE
	REQUIRED	19	32	43	53	61		

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.

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 7 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not approach gear or attempt to taxi for one hour. Tire, wheel and brake replacement may be required. If overheat occurs after takeoff, extend gear soon for at least 12 minutes.

Brake Temperature Indicator (if installed) on First Officer's Instrument Panel may be used 10 to 15 minutes after brake application, to determine recommended cooling time.

Intentionally
Blank

**Performance Inflight
Engine Inoperative**
**Chapter PI
Section 13**
ENGINE INOP
Initial Max Continuous %N1
Based on .74M, engine bleed for packs auto and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)					
	27	29	31	33	35	37
20	95.2	95.2	95.2	95.2	95.1	95.1
15	95.8	95.8	95.8	95.8	95.7	95.7
10	96.1	96.1	96.1	96.1	96.0	96.0
5	96.6	96.6	96.6	96.6	96.5	96.5
0	97.1	97.1	97.1	97.1	97.0	97.0
-5	96.6	97.7	97.7	97.7	97.6	97.6
-10	95.7	96.9	98.1	98.7	98.0	98.0
-15	94.8	96.0	97.1	98.4	98.3	98.3
-20	93.9	95.1	96.2	97.4	98.4	98.7
-25	92.9	94.1	95.3	96.5	97.5	98.0
-30	92.0	93.2	94.3	95.5	96.5	97.0
-40	90.1	91.3	92.1	93.5	94.5	95.0
-50	88.1	89.3	90.3	91.5	92.4	93.0

%N1 Adjustment for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)						
	25	27	29	31	33	35	37
ENGINE A/I ON	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9	-1.0
ENGINE AND WING A/I ON	-2.9	-2.9	-2.9	-2.8	-2.8	-2.8	-2.9

ENGINE INOP**Max Continuous %N1****33000 FT to 23000 FT Pressure Altitudes****Based on engine bleed for packs auto and anti-ice off**

33000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.58	92.3	94.4	96.4	97.1	96.5	96.0	95.7					
220	.63	92.2	94.3	96.3	97.8	97.1	96.4	96.1	95.7	95.3			
240	.68	92.1	94.2	96.2	98.1	97.8	96.9	96.4	96.0				
260	.74	91.4	93.5	95.5	97.4	98.0	97.0	96.6	96.1	95.6			
31000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.55	91.5	93.5	95.5	97.0	96.4	95.8	95.5					
220	.61	91.3	93.3	95.3	97.2	96.8	96.2	95.9	95.6	95.3			
240	.66	91.1	93.1	95.1	97.1	97.4	96.7	96.3	95.9	95.5			
260	.71	90.9	92.9	94.9	96.8	98.0	97.0	96.5	96.1	95.6			
29000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.53	90.6	92.6	94.6	96.5	96.2	95.6	95.4	95.1				
220	.58	90.4	92.4	94.4	96.3	96.6	96.1	95.8	95.5	95.1			
240	.63	90.2	92.2	94.1	96.1	97.1	96.5	96.1	95.8	95.4			
260	.68	90.0	92.0	93.9	95.9	97.7	96.9	96.4	96.0	95.6	95.1		
27000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.51	89.8	91.8	93.8	95.7	96.0	95.5	95.2	94.9				
220	.56	89.6	91.6	93.5	95.4	96.4	95.9	95.6	95.3	95.0	94.6		
240	.60	89.3	91.3	93.2	95.1	96.9	96.3	96.0	97.7	95.3	95.0		
260	.65	89.1	91.0	93.0	94.9	96.7	96.7	96.3	95.9	95.5	95.1		
25000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.49	89.0	91.0	92.9	94.8	95.9	95.4	95.1	94.8	94.5			
220	.53	88.8	90.7	92.7	94.6	96.3	95.7	95.4	95.1	94.8	94.5		
240	.58	88.5	90.5	92.4	94.3	96.1	96.1	95.8	95.5	95.2	94.8		
260	.63	88.2	90.2	92.1	94.0	95.8	96.5	96.1	95.8	95.4	95.0	94.6	
23000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.47	88.2	90.1	92.0	93.9	95.7	95.3	95.0	94.4	94.0			
220	.51	88.0	89.9	91.8	93.7	95.5	95.6	95.3	95.0	94.7	94.4		
240	.56	87.7	89.7	91.6	93.4	95.3	95.9	95.7	95.4	95.0	94.7	94.3	
260	.60	87.5	89.4	91.3	93.2	95.0	96.3	96.0	95.7	95.4	95.0	94.6	

Anti-Ice Adjustments

BLEED CONFIGURATION			PRESS ALT (1000 FT)					
			23	25	27	29	31	33
ENGINE ANTI-ICE ON			-0.9	-0.9	-0.9	-0.9	-0.9	-0.9
ENGINE AND WING ANTI-ICE ON			-2.9	-2.9	-2.9	-2.9	-2.8	-2.8

ENGINE INOP**Max Continuous %N1****21000 FT to 14000 FT Pressure Altitudes****Based on engine bleed for packs auto and anti-ice off**

21000 FT PRESS ALT.			TAT (°C)									
KIAS	M	-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.45	87.3	89.3	91.2	93.0	94.8	95.1	94.9	94.6	94.3	93.9	
220	.49	87.2	89.1	91.0	92.9	94.7	95.4	95.1	94.9	94.6	94.2	93.9
240	.54	86.9	88.9	90.8	92.6	94.4	95.8	95.5	95.2	94.9	94.5	94.2
260	.60	86.7	88.6	90.5	92.3	94.1	95.9	95.8	95.5	95.2	94.8	94.5
20000 FT PRESS ALT.			TAT (°C)									
KIAS	M	-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.44	86.9	88.9	90.7	92.6	94.4	95.1	94.8	94.5	94.2	93.9	93.5
220	.48	86.8	88.7	90.6	92.4	94.2	95.4	95.1	94.8	94.5	94.2	93.8
240	.53	86.6	88.5	90.4	92.2	94.0	95.7	95.4	95.1	94.8	94.5	94.1
260	.57	86.3	88.2	90.1	91.9	93.7	95.5	95.8	95.5	95.1	94.8	94.4
18000 FT PRESS ALT.			TAT (°C)									
KIAS	M	-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.42	86.1	88.0	89.9	91.7	93.5	95.0	94.7	94.4	94.1	93.8	93.4
220	.46	86.0	87.9	89.7	91.6	93.4	95.1	95.0	94.7	94.4	94.1	93.7
240	.51	85.8	87.7	89.6	91.4	93.2	94.9	95.3	95.0	94.7	94.3	94.0
260	.55	85.6	87.4	89.3	91.1	92.9	94.7	95.5	95.3	95.0	94.6	94.3
17000 FT PRESS ALT.			TAT (°C)									
KIAS	M	-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.42	85.7	87.6	89.5	91.3	93.1	94.9	94.7	94.4	94.1	93.7	93.3
220	.46	85.6	87.5	89.3	91.1	92.9	94.7	94.9	94.6	94.3	94.0	93.6
240	.50	85.4	87.3	89.2	91.0	92.8	94.5	95.2	94.9	94.6	94.3	93.9
260	.54	85.2	87.1	88.9	90.7	92.5	94.2	95.1	95.2	94.9	94.6	94.2
16000 FT PRESS ALT.			TAT (°C)									
KIAS	M	-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.41	85.4	87.2	89.1	90.9	92.7	94.4	94.6	94.3	94.0	93.6	93.3
220	.45	85.2	87.1	88.9	90.7	92.5	94.3	94.9	94.6	94.3	93.9	93.6
240	.49	85.0	86.9	88.8	90.6	92.3	94.1	94.9	94.8	94.5	94.2	93.8
260	.53	84.8	86.7	88.5	90.3	92.1	93.8	94.7	95.1	94.8	94.5	94.1
14000 FT PRESS ALT.			TAT (°C)									
KIAS	M	-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.39	84.6	86.5	88.3	90.1	91.9	93.6	94.4	94.3	93.9	93.6	93.2
220	.43	84.4	86.3	88.1	89.9	91.7	93.4	94.2	94.5	94.2	93.8	93.4
240	.47	84.3	86.1	87.9	89.7	91.5	93.2	94.1	94.7	94.4	94.1	93.7
260	.51	84.1	85.9	87.8	89.6	91.3	93.0	93.9	94.7	94.7	94.4	94.0

Anti-Ice Adjustments

BLEED CONFIGURATION	PRESS ALT (1000 FT)					
	14	16	17	18	20	21
ENGINE ANTI-ICE ON	-0.9	-0.9	-0.9	-0.9	-0.9	-0.9
ENGINE AND WING ANTI-ICE ON	-3.1	-3.1	-3.1	-3.0	-3.0	-3.0

ENGINE INOP**Max Continuous %N1****12000 FT to 1000 FT Pressure Altitudes****Based on engine bleed for packs auto and anti-ice off**

12000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.38	83.8	85.7	87.5	89.3	91.0	92.7	93.6	94.2	93.9	93.5	93.1	92.7	
220	.41	83.6	85.5	87.3	89.1	90.8	92.5	93.4	94.2	94.1	93.7	93.3	92.9	
240	.45	83.5	85.3	87.1	88.9	90.7	92.4	93.2	94.0	94.3	94.0	93.6	93.2	
260	.49	83.3	85.2	87.0	88.8	90.5	92.2	93.0	93.9	94.6	94.2	93.9	93.5	
10000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.36	83.1	84.9	86.7	88.5	90.2	91.9	92.7	93.6	93.8	93.5	93.1	92.6	
220	.40	82.9	84.7	86.5	88.3	90.0	91.7	92.5	93.3	94.0	93.6	93.2	92.8	
240	.43	82.7	84.6	86.4	88.1	89.8	91.5	92.4	93.2	94.0	93.9	93.5	93.1	
260	.47	82.6	84.4	86.2	88.0	89.7	91.4	92.2	93.0	93.8	94.1	93.8	93.4	
7000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.34	81.9	83.7	85.5	87.2	88.9	90.6	91.4	92.3	93.1	93.4	93.0	92.6	
220	.38	81.7	83.5	85.3	87.1	88.8	90.4	91.3	92.1	92.9	93.5	93.2	92.7	
240	.41	81.6	83.4	85.2	86.9	88.6	90.3	91.1	91.9	92.7	93.5	93.3	92.9	
260	.45	81.4	83.3	85.0	86.7	88.4	90.1	90.9	91.7	92.6	93.4	93.6	93.2	
5000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.33	81.1	82.9	84.7	86.4	88.1	89.8	90.6	91.4	92.2	93.0	93.0	92.5	
220	.36	81.0	82.8	84.5	86.2	87.9	89.6	90.4	91.2	92.0	92.8	93.1	92.7	
240	.40	80.8	82.6	84.4	86.1	87.8	89.4	90.2	91.0	91.8	92.6	93.3	92.8	
260	.43	80.7	82.5	84.2	85.9	87.6	89.3	90.1	90.9	91.7	92.5	93.3	93.1	
3000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.32	80.4	82.2	83.9	85.6	87.3	88.9	89.7	90.5	91.3	92.1	92.9	92.5	
220	.35	80.2	82.0	83.7	85.4	87.1	88.8	89.6	90.4	91.2	91.9	92.7	92.6	
240	.40	80.1	81.8	83.6	85.3	86.9	88.6	89.4	90.2	91.0	91.8	92.5	92.8	
260	.43	79.9	81.7	83.4	85.1	86.8	88.4	89.2	90.0	90.8	91.6	92.4	93.0	
1000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.31	79.6	81.4	83.1	84.8	86.4	88.1	88.9	89.7	90.5	91.2	92.0	92.5	
220	.34	79.5	81.2	82.9	84.6	86.3	87.9	88.7	89.5	90.3	91.1	91.8	92.6	
240	.37	79.3	81.1	82.8	84.5	86.1	87.7	88.5	89.3	90.1	90.9	91.7	92.4	
260	.40	79.2	80.9	82.6	84.3	86.0	87.6	88.4	89.2	90.0	90.7	91.5	92.3	

Anti-Ice Adjustments

BLEED CONFIGURATION	PRESS ALT (1000 FT)					
	1	3	5	7	10	12
ENGINE ANTI-ICE ON	-0.6	-0.7	-0.8	-0.8	-0.8	-0.8
ENGINE AND WING ANTI-ICE ON	-2.4	-2.6	-2.8	-2.8	-2.9	-2.9

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°C & BELOW	ISA + 15°C	ISA + 20 °C
64	61	235	16200	15000	13600
60	57	228	18200	17200	15900
56	53	220	20400	19300	18200
52	49	212	22700	21700	20600
48	46	204	25100	24100	23100
44	42	196	27400	26600	25700
40	38	187	29900	29200	28400

Includes APU fuel burn.

ENGINE INOP**MAX CONTINUOUS THRUST****Driftdown/LRC Cruise Range Capability****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20	20	40	60	80	100	
140	130	121	113	106	100	95	90	85	81	78
288	265	245	228	213	200	188	178	169	161	153
433	398	368	342	320	300	283	267	253	241	229
576	530	490	456	426	400	377	356	338	321	306
718	660	611	569	532	500	471	446	423	402	384
858	790	732	682	638	600	566	536	508	484	461
997	919	852	795	744	700	661	626	594	565	539
1134	1047	972	907	850	800	755	716	680	647	618
1272	1175	1091	1019	956	900	850	806	766	729	696
1408	1302	1211	1131	1062	1000	945	896	852	812	775
1545	1429	1330	1243	1167	1100	1040	986	938	894	854
1682	1557	1449	1355	1273	1200	1135	1077	1024	976	933
1819	1684	1568	1467	1379	1300	1230	1167	1110	1059	1012
1956	1812	1688	1580	1484	1400	1325	1257	1196	1141	1090
2095	1941	1808	1692	1590	1500	1419	1347	1282	1222	1168
2234	2070	1929	1805	1696	1600	1514	1437	1367	1304	1246

Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG)								TIME (HRS:MIN)	
	WEIGHT AT START OF DRIFTDOWN (1000 KG)									
	35	40	45	50	55	60	65	70		
100	0.4	0.4	0.4	0.5	0.5	0.5	0.6	0.6	0:17	
200	0.8	0.9	1.0	1.1	1.1	1.2	1.3	1.4	0:37	
300	1.3	1.4	1.6	1.7	1.9	2.0	2.2	2.3	0:55	
400	1.7	1.9	2.1	2.4	2.6	2.8	3.1	3.2	1:13	
500	2.1	2.4	2.6	3.0	3.2	3.5	3.8	4.1	1:31	
600	2.5	2.8	3.2	3.5	3.9	4.2	4.6	4.9	1:48	
700	2.9	3.3	3.7	4.1	4.5	4.9	5.4	5.8	2:05	
800	3.3	3.8	4.2	4.7	5.2	5.6	6.1	6.6	2:22	
900	3.7	4.2	4.7	5.3	5.8	6.3	6.9	7.4	2:38	
1000	4.1	4.7	5.2	5.8	6.4	7.0	7.6	8.2	2:54	
1100	4.5	5.1	5.7	6.4	7.0	7.7	8.3	9.0	3:10	
1200	4.9	5.5	6.2	6.9	7.6	8.3	9.1	9.8	3:26	
1300	5.3	6.0	6.7	7.5	8.2	9.0	9.8	10.6	3:42	
1400	5.7	6.4	7.2	8.0	8.8	9.6	10.5	11.4	3:59	
1500	6.1	6.9	7.7	8.6	9.4	10.3	11.2	12.2	4:16	
1600	6.5	7.3	8.2	9.1	10.0	11.0	11.9	12.9	4:33	

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°C & BELOW	ISA + 15°C	ISA + 20°C
64	9500	7200	4900
60	12300	10200	7900
56	15200	13200	11000
52	18000	16200	14100
48	20900	19200	17400
44	24000	22300	20600
40	27000	25600	24000
36	30000	28800	27500
32	33200	32200	31000

With engine anti-ice on, decrease altitude capability by 1400 ft.

With engine and wing anti-ice on, decrease altitude capability by 5300 ft.

Long Range Cruise Control

WEIGHT (1000 KG)	PRESSURE ALTITUDE (1000 FT)									
	10	12	14	16	18	20	22	24	26	28
64	%N1	90.9	92.4							
	MACH	.561	.577							
	KIAS	311	309							
	FF/ENG	2974	2952							
60	%N1	89.2	90.7	92.2						
	MACH	.547	.564	.580						
	KIAS	303	302	299						
	FF/ENG	2796	2780	2755						
56	%N1	87.5	88.9	90.4	91.9					
	MACH	.531	.549	.566	.582					
	KIAS	294	293	292	289					
	FF/ENG	2613	2603	2584	2553					
52	%N1	85.7	87.0	88.5	90.0	91.6	93.2			
	MACH	.513	.532	.550	.567	.584	.600			
	KIAS	284	284	283	281	278	275			
	FF/ENG	2428	2419	2409	2383	2353	2333			
48	%N1	83.6	85.1	86.5	88.0	89.5	91.1	92.8		
	MACH	.495	.513	.532	.550	.568	.584	.600		
	KIAS	274	274	273	272	271	268	265		
	FF/ENG	2243	2233	2225	2210	2185	2161	2153		
44	%N1	81.5	82.9	84.4	85.8	87.3	88.8	90.4	92.1	
	MACH	.475	.493	.511	.530	.549	.567	.584	.600	
	KIAS	263	263	263	262	261	260	257	254	
	FF/ENG	2059	2049	2040	2030	2014	1994	1981	1970	
40	%N1	79.0	80.5	82.0	83.5	84.9	86.4	88.0	89.6	91.3
	MACH	.454	.471	.489	.508	.527	.546	.565	.582	.599
	KIAS	251	251	251	251	250	250	248	246	.616
	FF/ENG	1878	1866	1857	1849	1838	1825	1816	1799	.239
36	%N1	76.4	77.8	79.4	80.9	82.4	83.8	85.3	86.9	88.5
	MACH	.434	.449	.465	.484	.502	.522	.541	.561	.578
	KIAS	240	239	239	239	238	238	238	236	.595
	FF/ENG	1707	1689	1677	1668	1660	1650	1646	1635	.231

ENGINE INOP**MAX CONTINUOUS THRUST****Long Range Cruise Diversion Fuel and Time****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)				20	40	TAILWIND COMPONENT (KTS)				100
100	80	60	40	20		20	40	60	80	
299	272	249	230	214	200	190	181	173	166	159
608	552	504	464	430	400	380	362	345	330	316
920	834	759	697	646	600	570	542	517	494	473
1235	1118	1015	932	862	800	760	722	688	658	630
1553	1403	1273	1167	1078	1000	949	903	860	821	787
1873	1691	1532	1403	1295	1200	1139	1082	1031	984	943
2196	1980	1792	1640	1512	1400	1328	1262	1202	1147	1099
2524	2273	2055	1877	1730	1600	1517	1441	1372	1310	1255

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	1.4	0:42	1.2	0:40	1.1	0:39	1.0	0:38	0.9	0:37
400	2.8	1:22	2.6	1:18	2.3	1:14	2.1	1:11	2.0	1:09
600	4.2	2:03	3.9	1:56	3.5	1:50	3.3	1:46	3.1	1:42
800	5.6	2:44	5.2	2:35	4.7	2:26	4.4	2:20	4.1	2:15
1000	7.0	3:26	6.4	3:14	5.9	3:03	5.5	2:55	5.2	2:48
1200	8.3	4:08	7.7	3:54	7.1	3:40	6.6	3:30	6.2	3:22
1400	9.6	4:51	8.9	4:34	8.2	4:18	7.7	4:05	7.2	3:56
1600	11.0	5:35	10.1	5:15	9.4	4:57	8.7	4:41	8.2	4:30

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)					
	35	40	45	50	55	60
2	-0.2	-0.1	0.0	0.1	0.3	0.5
4	-0.3	-0.2	0.0	0.3	0.7	1.0
6	-0.5	-0.3	0.0	0.5	1.0	1.5
8	-0.7	-0.4	0.0	0.6	1.3	2.0
10	-0.9	-0.4	0.0	0.7	1.6	2.5
12	-1.0	-0.5	0.0	0.9	1.8	2.9
14	-1.2	-0.6	0.0	1.0	2.1	3.3

ENGINE INOP

MAX CONTINUOUS THRUST

Holding Flaps Up

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)				
		1500	5000	10000	15000	20000
62	%N1	78.9	81.8	85.5	89.8	
	KIAS	242	243	243	245	
	FF/ENG	2530	2510	2500	2520	
58	%N1	77.0	79.9	83.8	87.8	
	KIAS	234	235	236	236	
	FF/ENG	2360	2340	2330	2330	
54	%N1	75.1	77.8	81.8	85.8	90.5
	KIAS	225	227	228	228	230
	FF/ENG	2200	2180	2160	2160	2190
50	%N1	72.9	75.7	79.8	83.7	88.0
	KIAS	216	218	219	219	221
	FF/ENG	2050	2020	2000	1990	2000
46	%N1	70.8	73.5	77.5	81.5	85.6
	KIAS	210	210	210	211	213
	FF/ENG	1900	1870	1840	1830	1860
42	%N1	68.9	71.6	75.6	79.6	83.5
	KIAS	210	210	210	210	210
	FF/ENG	1790	1760	1720	1700	1690
38	%N1	67.1	69.8	73.8	77.8	81.7
	KIAS	210	210	210	210	210
	FF/ENG	1690	1660	1620	1590	1580
34	%N1	65.4	68.1	72.1	76.0	79.9
	KIAS	210	210	210	210	210
	FF/ENG	1600	1570	1520	1500	1480

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

Performance Inflight**PMC Off****Chapter PI****Section 14****PMC OFF****Takeoff Weight Adjustments**

AIRPORT PRESSURE ALTITUDE (FT)	TEMPERATURE	PMC OFF TAKEOFF LIMIT WEIGHT ADJUSTMENT (1000 KG)				
		FIELD LIMIT	CLIMB LIMIT	TIRE SPEED LIMIT	BRAKE ENERGY LIMIT (NORMAL TAKEOFF)	BRAKE ENERGY LIMIT (IMPROVED CLIMB TAKEOFF)
BELOW 5000	ABOVE 21°C (70°F)	0	0	-0.25	-0.68	-0.32
	21°C (70°F) & BELOW	0	0	-0.04	-0.68	-0.32
5000 & ABOVE	ABOVE 21°C (70°F)	0	0	-0.22	-0.68	-0.32
	21°C (70°F) & BELOW	-1.66	-1.99	-0.14	-0.34	-0.16

Valid for all Flaps.

Obstacle Limit Weight Adjustments

NORMAL OBSTACLE LIMIT WEIGHT (1000 KG)	PMC OFF OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)
30	-2.30
40	-3.00
50	-3.70
60	-4.40
70	-5.20

Valid for all Flaps.

Takeoff Speeds Adjustments

SPEED (KIAS)	PRESSURE ALTITUDE (FT)			
	BELOW 5000		5000 & ABOVE	
	ABOVE 21°C (70°F)	21°C (70°F) & BELOW	ABOVE 21°C (70°F)	21°C (70°F) & BELOW
V1(MCG)	6	4	6	4
V1	0	0	0	0
VR	0	0	0	1

PMC OFF**Takeoff %N1**

Based on engine bleed to packs on (Auto) and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	-0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	94.7	94.9	94.9	94.9						
50	122	95.1	95.4	95.4	95.4	95.4					
45	113	95.6	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	
40	104	96.0	96.3	96.3	96.3	96.3	96.3	96.3	96.4	96.4	96.4
35	95	96.3	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8
30	86	95.5	96.6	96.8	97.2	97.2	97.2	97.2	97.1	97.1	97.1
25	77	94.8	95.8	96.0	96.5	97.0	97.4	97.6	97.5	97.5	97.4
20	68	94.0	95.0	95.2	95.7	96.2	96.5	96.9	97.1	97.1	97.1
15	59	93.2	94.1	94.4	94.8	95.4	95.7	96.3	96.3	96.3	96.3
10	50	92.4	93.3	93.5	94.0	94.6	94.9	95.2	95.5	95.6	95.7
5	41	91.5	92.5	92.7	93.2	93.7	94.0	94.4	94.7	94.8	94.9
0	32	90.7	91.7	91.9	92.3	92.9	93.2	93.5	93.8	93.9	94.0
-10	14	89.0	90.0	90.2	90.6	91.2	91.5	91.8	92.1	92.2	92.3
-20	-4	87.3	88.2	88.4	88.9	89.4	89.7	90.0	90.3	90.4	90.5
-30	-22	85.6	86.5	86.7	87.1	87.6	87.9	88.2	88.5	88.6	88.7
-40	-40	83.8	84.7	84.9	85.3	85.8	86.1	86.4	86.7	86.8	86.9
-50	-58	82.0	82.8	83.0	83.5	83.9	84.2	84.5	84.8	84.9	85.0

Based on engine bleed to packs off and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	95.7	95.9	95.9	95.9						
50	122	96.1	96.4	96.4	96.4	96.4					
45	113	96.6	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.9	
40	104	97.0	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3
35	95	97.3	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7
30	86	96.5	97.5	97.7	98.1	98.1	98.1	98.1	98.1	98.1	98.0
25	77	95.7	96.7	96.9	97.4	97.9	97.9	97.9	97.9	97.9	97.9
20	68	94.9	95.9	96.1	96.6	97.1	97.1	97.1	97.1	97.1	97.1
15	59	94.1	95.0	95.3	95.7	96.3	96.3	96.3	96.3	96.3	96.3
10	50	93.3	94.2	94.4	94.9	95.6	95.8	96.1	96.3	96.3	96.3
5	41	92.4	93.4	93.6	94.1	94.6	94.9	95.2	95.4	95.4	95.4
0	32	91.6	92.5	92.7	93.2	93.8	94.1	94.4	94.5	94.5	94.5
-10	14	89.8	90.8	91.0	91.5	92.0	92.3	92.6	92.8	92.8	92.8
-20	-4	88.1	89.1	89.3	89.7	90.3	90.6	90.9	91.0	91.0	91.0
-30	-22	86.4	87.3	87.5	88.0	88.5	88.8	89.1	89.2	89.2	89.2
-40	-40	84.6	85.5	85.7	86.1	86.6	86.9	87.2	87.3	87.4	87.4
-50	-58	82.8	83.6	83.8	84.3	84.7	85.0	85.3	85.5	85.5	85.5

PMC OFF**Takeoff Weight Adjustments (20K Derate)**

AIRPORT PRESSURE ALTITUDE (FT)	TEMPERATURE °C (°F)	PMC OFF TAKEOFF LIMIT WEIGHT ADJUSTMENT (1000 KG)				
		FIELD LIMIT	CLIMB LIMIT	TIRE SPEED LIMIT	BRAKE ENERGY LIMIT (NORMAL TAKEOFF)	BRAKE ENERGY LIMIT (IMPROVED CLIMB TAKEOFF)
BELOW 5000	ABOVE 21°C (70°F)	-1.45	-2.55	-0.15	-0.68	-0.32
	21°C (70°F) & BELOW	-0.50	-0.65	-0.07	-0.68	-0.32
5000 & ABOVE	ABOVE 21°C (70°F)	-1.51	-2.56	-0.15	-0.34	-0.16
	21°C (70°F) & BELOW	-0.78	-0.93	-0.07	-0.34	-0.16

Valid for all Flaps.

Obstacle Limit Weight Adjustments (20K Derate)

NORMAL OBSTACLE LIMIT WEIGHT (1000 KG)	PMC OFF OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)
30	-2.20
40	-3.30
50	-4.40
60	-5.50
70	-6.60

Valid for all Flaps.

Takeoff Speeds Adjustment (20K Derate)

SPEED (KIAS)	PRESSURE ALTITUDE (FT)	
	BELOW 5000	5000 & ABOVE
V1 (MCG)	6	4
V1	0	0
VR	0	0

PMC OFF**PMC Off Takeoff %N1 (20K Derate)****Based on engine bleed to packs on (Auto) and anti-ice on or off**

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	91.5	92.3	92.2	91.7						
50	122	92.0	92.8	93.4	93.7	93.0	93.0				
45	113	92.6	93.1	93.6	93.9	93.9	94.5	94.3	93.7		
40	104	93.1	93.6	94.0	94.2	94.3	95.1	95.0	94.9	94.8	94.5
35	95	93.2	94.1	94.6	94.8	94.8	95.5	95.7	95.6	95.8	95.7
30	86	93.0	94.5	94.3	94.5	95.0	95.4	95.6	95.8	95.8	95.8
25	77	92.2	93.7	93.7	93.7	94.4	95.5	95.3	95.1	95.4	95.8
20	68	91.5	92.9	92.9	92.9	93.6	95.5	95.7	95.8	95.8	95.7
15	59	90.7	92.1	92.1	92.1	92.8	94.9	95.1	95.1	95.1	95.1
10	50	89.9	91.3	91.3	91.3	92.0	94.1	94.3	94.3	94.3	94.3
5	41	89.1	90.5	90.5	90.5	91.2	93.2	93.4	93.4	93.4	93.4
0	32	88.3	89.7	89.7	89.7	90.4	92.4	92.6	92.6	92.6	92.6
-10	14	86.6	88.0	88.0	88.0	88.7	90.7	90.9	90.9	90.9	90.9
-20	-4	85.0	86.3	86.3	86.4	87.0	89.0	89.1	89.1	89.1	89.1
-30	-22	83.3	84.6	84.6	84.6	85.3	87.2	87.4	87.4	87.4	87.4
-40	-40	81.6	82.9	82.9	82.9	83.5	85.4	85.5	85.5	85.6	85.6
-50	-58	79.8	81.1	81.1	81.1	81.7	83.5	83.7	83.7	83.7	83.7

Based on engine bleed to packs off and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	92.4	93.3	93.2	92.7						
50	122	93.0	93.8	94.4	94.6	94.0	94.0				
45	113	93.5	94.0	94.6	94.9	94.8	95.5	95.3	94.7		
40	104	94.0	94.5	94.9	95.1	95.2	96.1	95.9	95.8	95.8	95.4
35	95	94.2	95.0	95.6	95.7	95.7	96.5	96.6	96.6	96.7	96.6
30	86	93.9	95.4	95.2	95.4	96.0	96.3	96.5	96.7	96.7	96.8
25	77	93.1	94.6	94.6	94.6	95.3	96.4	96.2	96.0	96.3	96.7
20	68	92.4	93.8	93.8	93.8	94.6	95.9	95.9	95.9	95.9	95.9
15	59	91.6	93.0	93.0	93.0	93.7	95.1	95.1	95.1	95.1	95.1
10	50	90.8	92.2	92.2	92.2	92.9	94.3	94.3	94.3	94.3	94.3
5	41	90.0	91.4	91.4	91.4	92.1	93.4	93.4	93.4	93.4	93.4
0	32	89.2	90.6	90.6	90.6	91.3	92.6	92.6	92.6	92.6	92.6
-10	14	87.5	88.9	88.9	88.9	89.6	90.9	90.9	90.9	90.9	90.9
-20	-4	85.8	87.2	87.2	87.2	87.9	89.1	89.1	89.1	89.1	89.1
-30	-22	84.1	85.5	85.5	85.5	86.1	87.4	87.4	87.4	87.4	87.4
-40	-40	82.4	83.7	83.7	83.7	84.3	85.5	85.5	85.5	85.6	85.6
-50	-58	80.6	81.9	81.9	81.9	82.5	83.7	83.7	83.7	83.7	83.7

Performance Inflight**Gear Down****Chapter PI****Section 15****GEAR DOWN****220 KIAS Cruise Altitude Capability****Max Cruise Thrust, 100 ft/min residual rate of climb**

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
64	22700	21400	20100
62	24100	23000	21800
60	25000	23800	22600
58	25700	24600	23500
56	26400	25400	24200
54	27100	26100	25000
52	27700	26800	25700
50	28300	27400	26300
48	28900	28000	26900
46	29500	28600	27500
44	30000	29100	28100
42	30500	29600	28700
40	31000	30100	29200
38	31400	30600	29700
36	31800	31000	30100
34	32200	31400	30500
32	32600	31800	30900

Based on 230 KIAS for weights above 62823 kg.

GEAR DOWN**220 KIAS Cruise Control**

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)								
		13	15	17	19	21	23	25	27	31
64	%N1	82.0	83.7	85.3	87.2	89.1	91.5			
	MACH	.441	.458	.476	.495	.515	.536			
	KIAS	230	230	230	230	230	230			
	FF/ENG	1887	1888	1892	1900	1915	1947			
60	%N1	79.9	81.6	83.2	84.9	86.8	88.9	91.4		
	MACH	.422	.438	.456	.474	.493	.513	.534		
	KIAS	220	220	220	220	220	220	220		
	FF/ENG	1739	1739	1741	1746	1753	1771	1807		
56	%N1	78.9	80.5	82.1	83.8	85.5	87.4	89.7	92.3	
	MACH	.422	.438	.456	.474	.493	.513	.534	.557	
	KIAS	220	220	220	220	220	220	220	220	
	FF/ENG	1672	1670	1670	1671	1675	1685	1707	1742	
52	%N1	77.9	79.5	81.1	82.7	84.4	86.2	88.3		
	MACH	.422	.438	.456	.474	.493	.513	.534	.557	
	KIAS	220	220	220	220	220	220	220	220	
	FF/ENG	1613	1609	1607	1606	1608	1614	1629	1651	
48	%N1	76.9	78.6	80.2	81.8	83.5	85.2	87.1	89.4	92.0
	MACH	.422	.438	.456	.474	.493	.513	.534	.557	.580
	KIAS	220	220	220	220	220	220	220	220	
	FF/ENG	1561	1556	1553	1551	1551	1555	1565	1578	1612
44	%N1	76.0	77.7	79.3	80.9	82.6	84.3	86.1	88.2	90.6
	MACH	.422	.438	.456	.474	.493	.513	.534	.557	.580
	KIAS	220	220	220	220	220	220	220	220	
	FF/ENG	1513	1507	1503	1501	1500	1502	1509	1517	1542
40	%N1	75.3	76.9	78.6	80.1	81.8	83.4	85.2	87.2	89.5
	MACH	.422	.438	.456	.474	.493	.513	.534	.557	.580
	KIAS	220	220	220	220	220	220	220	220	
	FF/ENG	1472	1466	1461	1458	1456	1456	1461	1466	1483
36	%N1	74.6	76.2	77.9	79.5	81.1	82.7	84.4	86.4	88.6
	MACH	.422	.438	.456	.474	.493	.513	.534	.557	.580
	KIAS	220	220	220	220	220	220	220	220	
	FF/ENG	1437	1430	1425	1421	1419	1418	1422	1424	1436

Based on 230 KIAS for weights above 62823 kg.

GEAR DOWN**220 KIAS Enroute Fuel and Time****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
321	288	259	236	217		189	180	171	163	156
650	580	520	473	434		378	358	340	324	310
980	874	783	711	652		568	538	511	487	465
1309	1167	1045	949	869		756	717	680	648	619
1639	1461	1308	1186	1087		945	895	850	810	774
1968	1754	1571	1424	1305		1134	1074	1020	971	928
2298	2048	1833	1662	1522		1323	1253	1189	1132	1082
2627	2341	2096	1900	1740		1512	1432	1360	1295	1237
2956	2635	2358	2138	1958		1701	1611	1529	1456	1391

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	2.3	0:49	2.1	0:46	1.8	0:43	1.7	0:41	1.5	0:39
400	4.6	1:36	4.3	1:31	3.8	1:24	3.6	1:19	3.3	1:15
600	7.0	2:23	6.4	2:15	5.8	2:04	5.4	1:57	5.1	1:50
800	9.3	3:10	8.6	3:00	7.7	2:44	7.2	2:35	6.8	2:26
1000	11.5	3:57	10.7	3:44	9.7	3:25	9.1	3:13	8.6	3:01
1200	13.8	4:45	12.8	4:28	11.6	4:05	10.9	3:51	10.3	3:37
1400	16.0	5:32	14.9	5:13	13.5	4:46	12.6	4:29	11.9	4:12
1600	18.2	6:19	16.9	5:57	15.3	5:26	14.4	5:06	13.6	4:48
1800	20.4	7:06	19.0	6:41	17.2	6:06	16.1	5:44	15.2	5:23

Fuel Required Adjustments (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)						
	30	35	40	45	50	55	60
5	-0.3	-0.3	-0.1	0.0	0.2	0.5	0.9
10	-0.7	-0.5	-0.3	0.0	0.4	1.0	1.6
15	-0.9	-0.7	-0.4	0.0	0.6	1.3	2.2
20	-1.0	-0.8	-0.4	0.0	0.7	1.5	2.5
25	-1.1	-0.9	-0.5	0.0	0.7	1.6	2.6

Based on 220 KIAS cruise and descent.

Descent at 220 KIAS

PRESSURE ALT (1000 FT)	5	10	15	17	19	21	23	25	27	29	31	33
DISTANCE (NM)	17	26	35	39	43	46	50	54	57	61	65	69
TIME (MINUTES)	6	8	10	11	12	13	13	14	15	16	16	17

GEAR DOWN**Holding
Flaps Up**

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)						
	1500	5000	10000	15000	20000	25000	30000
62	%N1	71.2	74.0	78.1	82.2	86.6	92.4
	KIAS	220	220	220	220	220	220
	FF/ENG	1930	1890	1870	1870	1880	1960
58	%N1	70.2	72.9	77.0	81.0	85.2	90.5
	KIAS	220	220	220	220	220	220
	FF/ENG	1860	1830	1800	1790	1800	1840
54	%N1	69.2	71.9	75.9	80.0	84.1	88.9
	KIAS	220	220	220	220	220	220
	FF/ENG	1800	1770	1730	1720	1720	1750
50	%N1	67.0	69.6	73.6	77.7	81.8	86.2
	KIAS	210	210	210	210	210	210
	FF/ENG	1670	1630	1590	1570	1570	1650
46	%N1	65.9	68.5	72.6	76.6	80.7	85.0
	KIAS	210	210	210	210	210	210
	FF/ENG	1620	1580	1540	1510	1510	1550
42	%N1	65.0	67.6	71.6	75.6	79.7	83.9
	KIAS	210	210	210	210	210	210
	FF/ENG	1570	1530	1490	1460	1450	1480
38	%N1	64.2	66.7	70.7	74.7	78.8	82.9
	KIAS	210	210	210	210	210	210
	FF/ENG	1530	1490	1440	1420	1400	1420
34	%N1	63.5	65.9	69.9	73.9	78.0	82.1
	KIAS	210	210	210	210	210	210
	FF/ENG	1490	1450	1410	1380	1360	1370

This table includes 5% additional fuel for holding in a racetrack pattern.

Performance Inflight

Text

Chapter PI**Section 16**

Introduction

This chapter contains information to supplement performance data from the Flight Management Computer (FMC). In addition, sufficient inflight data is provided to complete a flight with the FMC inoperative. In the event of conflict between data presented in this chapter and that contained in the Approved Flight Manual, the Flight Manual shall always take precedence.

General**Takeoff Speeds**

The speeds presented in the Takeoff Speeds table, as well as FMC computed takeoff speeds, can be used for all performance conditions provided adjustments are made to V1 for clearway, stopway, brake deactivation, improved climb, contaminated runway situations, brake energy limits or obstacle clearance with unbalanced V1. These speeds may be used for weights less than or equal to the performance limited weight.

Normal takeoff speeds, V1, VR, and V2, with anti-skid on, are read from the table by entering with takeoff flap setting, brake release weight, and appropriate column. The appropriate column is obtained by entering the Column Reference chart with the airport pressure altitude and the actual temperature. If an Altitude Adjustment chart is provided, adjust the takeoff speeds appropriately. Slope and wind adjustments to V1 are obtained by entering the Slope and Wind V1 Adjustment table.

V1(MCG)

Regulations prohibit scheduling takeoff with a V1 less than minimum V1 for control on the ground, V1(MCG). Therefore compare the adjusted V1 to the V1(MCG). To find V1(MCG) enter the V1(MCG) table with the airport pressure altitude and actual OAT. If applicable, add the adjustments shown below the table. If the adjusted V1 is less than V1(MCG), set V1 equal to V1(MCG). If VR is less than V1(MCG), set VR equal to V1(MCG), and determine a new V2 by adding the difference between the normal VR and V1(MCG) to the normal V2.

If it is necessary to increase V1 to V1(MCG), then provided the actual field length exceeds the minimum field length of 4500 ft no takeoff weight adjustment is necessary.

Clearway and Stopway V1 Adjustments

Takeoff speed corrections are to be applied to V1 speed when using takeoff weights based on the use of clearway and stopway.

Adjust V1 speed by the amount shown in the appropriate column. The adjusted V1 speed must not exceed VR. If the adjusted V1 speed is greater than VR, reduce V1 to equal VR.

Maximum allowable clearway limits are provided for guidance when more precise data is not available.

Assumed Temperature Takeoff

For reduced thrust takeoffs based on assumed temperature, determine V1, VR, V2 from the appropriate column for airport pressure altitude and assumed temperature. Adjust V1 for slope, wind, clearway and stopway as required. Compare adjusted V1 with V1(MCG) from table using airport altitude and actual temperature. This is a regulatory requirement to cover the case where the pilot elects to advance thrust levers to maximum takeoff thrust following the engine failure. If adjusted V1 is less than V1(MCG) set V1 equal to V1(MCG).

Stab Trim

To find takeoff stabilizer trim setting, enter the Stab Trim Setting table with takeoff flap setting and center of gravity (C.G. % MAC) and read required stabilizer trim units. For weights that meet the conditions listed, apply the adjustments shown below the table.

VREF

The Reference Speed table contains flaps 40, 30, and 15 landing speeds for a given weight. Apply wind correction shown as required.

Recommended Maneuvering Speeds

This table provides the flap speed schedule for recommended maneuvering speed. The speed schedule is a function of weight and will provide adequate maneuver margin above stall at all weights.

During flap retraction/extension, movement of the flap to the next position should be initiated when reaching the maneuver speed for the existing flap.

Slush/Standing Water Takeoff

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water, or ice. Therefore a reduction in field length/obstacle limited takeoff weight and revised takeoff speeds is necessary. The information provided is intended for guidance in accordance with advisory material. The performance is

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based on an engine failure at the critical point during takeoff and a 15 ft. screen height at the end of the runway. Tables are provided for dispatch with all thrust reversers operative and dispatch with one or two thrust reversers inoperative.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore this information is conservative when operating under typical colder weather conditions where patches of slush exist and some degree of sanding is common.

Takeoffs in slush depths greater than 0.5 inches (13mm) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature method for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Instructions for Using Tables:

Takeoff weight is determined as follows:

1. Determine the dry field length and obstacle limit weight for the takeoff flap setting.
2. Enter the Weight Adjustment table with the more limiting of the dry field length or obstacle limit weights, to obtain the weight reduction for the slush/standing water depth and airport pressure altitude.
3. When indicated, adjust field length available for temperature by the amount provided in the notes below the V1(MCG) limit weight table.
4. Enter V1(MCG) Limit Weight table 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.

The maximum allowable takeoff weight in slush/standing water is the lesser of the limit weights found in steps 2 and 4.

Takeoff speeds determination:

1. Determine takeoff speeds V1, VR and V2 for actual brake release weight using the Takeoff Speeds table in this section.
2. If V1(MCG) limited, set V1 = V1(MCG). If not limited by V1(MCG) considerations, enter V1 Adjustment table with actual brake release weight to determine the V1 reduction to apply to V1 speed. If the adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

Slippery Runway

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 used to calculate the "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate the "poor" data reflects a runway covered with wet ice. Performance is based on an engine failure at the critical point during takeoff and a 15 ft. screen height at the end of the runway. Tables are provided for dispatch with all thrust reversers operative and dispatch with one or two thrust reversers inoperative, and are used in the same manner as the Slush/Standing Water Takeoff tables.

Anti-skid Inoperative

When operating with anti-skid inoperative, the field limit weight and V1 must be reduced to account for the effect on accelerate-stop performance. A simplified method which conservatively accounts for the effects of anti-skid inoperative on a dry runway is to reduce the normal field length/obstacle limited weight by 7800 kg and the V1 associated with the reduced weight by the amount shown in the table below.

ANTI-SKID INOPERATIVE V1 ADJUSTMENT	
FIELD LENGTH (FT)	V1 ADJUSTMENT (KIAS)
6000	-27
8000	-22
10000	-18
12000	-15
14000	-12

If the resulting V1 is less than minimum V1, takeoff is permitted with V1 set equal to V1(MCG) provided the dry accelerate stop distance adjusted for wind and slope exceeds approximately 7900 ft.

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Takeoff %N1

To find Max Takeoff %N1 based on normal engine bleed for air conditioning packs on (Auto), enter Takeoff %N1 Table with airport pressure altitude and airport OAT and read %N1. For packs off operation, apply the %N1 adjustment shown below the table. No takeoff %N1 adjustment is required for engine and wing anti-ice.

Assumed Temperature Reduced Thrust

Regulations permit the use of up to 25% takeoff thrust reduction for operation with assumed temperature reduced thrust. To find the maximum allowable assumed temperature enter the top chart with airport pressure altitude and OAT. Compare this temperature to that at which the airplane is performance limited as determined from available takeoff performance data. Next, enter the center table with airport pressure altitude and the lower of the two temperatures previously determined to obtain a maximum takeoff %N1. Do not use an assumed temperature less than the minimum assumed temperature shown. Enter the %N1 Adjustment table with OAT and the difference between the assumed and actual OAT to obtain a %N1 adjustment. Subtract the %N1 adjustment from the maximum takeoff %N1 found previously to determine the assumed temperature reduced thrust %N1.

Takeoff with assumed temperature reduced thrust is not permitted when: runway is contaminated with ice, slush, snow, or standing water; anti-skid is inoperative; or PMC is off. Use of this procedure is not recommended if potential windshear conditions exist.

Max Climb %N1

This table shows Max Climb %N1 for a 250 KIAS/280 KIAS/.74M climb speed schedule, normal engine bleed for packs on (Auto) and anti-ice off. Enter the table with airport pressure altitude and TAT and read %N1. Apply the appropriate bleed setting %N1 adjustment shown below the table. %N1 adjustments are shown for engine bleed to packs off operation, packs high operation, and wing anti-ice on.

Go-around %N1

To find Max Go-around %N1 based on normal engine bleed for packs on (Auto) and anti-ice off, enter the Go-around %N1 table with airport pressure altitude and reported OAT or TAT and read %N1. Apply the appropriate bleed setting %N1 adjustment shown below the table. %N1 adjustments are shown for engine bleed to packs off operation, packs high operation, and wing anti-ice on.

Flight with Unreliable Airspeed / Turbulent Air Penetration

Pitch attitude and average %N1 information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking or freezing of the pitot system. Loss of radome or turbulent air may also cause unreliable airspeed/Mach indications. The cruise table in this section may also be used for turbulent air penetration.

Pitch attitude is shown in bold type for emphasis since altitude and/or vertical speed indications may also be unreliable.

All Engines

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. This table considers both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude.

Note that the altitudes shown in the table are limited to the maximum certified altitude of 37000 ft.

Long Range Cruise Control

These tables provide target %N1, 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 .74M 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 .74M/250 KIAS descent. Tables are presented for low altitudes and high altitudes.

To determine remaining fuel and time required, first enter the Ground to Air Miles Conversion table to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time tables. Next, enter the Reference Fuel and Time Table with air distance from the Ground to Air Miles Conversion Table and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment Table with the Reference Fuel and the actual weight at checkpoint to obtain fuel required to destination.

Long Range Cruise Wind-Altitude Trade

Wind is a factor which may justify operations considerably below optimum altitude. For example, a favorable wind component may have an effect on ground speed which more than compensates for the loss in air range.

Using this table, it is possible to determine the break-even wind (advantage necessary or disadvantage that can be tolerated) to maintain the same range at another altitude and long range cruise speed. The tables make no allowance for climb or descent time, fuel or distance, and are based on comparing ground fuel mileage.

Descent

Distance and time for descent are shown for a .74M/250 KIAS descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach with gear down and landing flaps at the outer marker.

Holding

Target %N1, indicated airspeed and fuel flow per engine information is tabulated for holding with flaps up based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read %N1, IAS and fuel flow per engine.

Advisory Information

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distance on dry runways and slippery runways with good, medium, and poor reported braking action. These values are actual landing distances and do not include the 1.67 regulatory factor. Therefore, they cannot be used to determine the dispatch required landing field length.

To use these tables, enter the appropriate table for selected landing flaps and determine the reference landing distance for the selected braking configuration. Then read across the table to adjust the reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers, using the values provided, to obtain the actual landing distance.

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. If the surface is affected by water, snow, or ice and the braking action is reported as "good", conditions should not be expected to be as good as on clean, dry runways. The value "good" is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when landing. The performance level used to calculate the "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate "poor" data reflects runways covered with wet ice.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" braking action, the airplane may not be able to achieve these deceleration rates. In these cases, runway slope and inoperative reversers influence the stopping distance. Since it cannot be easily determined when this becomes a factor, it is conservative to add the effects of slope and inoperative reversers when using the autobrake system.

Non-Normal Configuration Landing Distance

Advisory information is provided to support non-normal configurations that affect landing performance of the airplane. Landing distances are shown for dry runway and good, medium, and poor reported braking action. Each non-normal configuration is listed with its recommended approach speed. Landing distance can be determined for the reference landing weight and then adjusted for actual weight and pressure altitude.

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 quick turnaround limit weight. Application of the recommended cooling procedures shown will avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Engine Inoperative

Initial Max Continuous %N1

The Initial Max Continuous %N1 setting for use following an engine failure is shown. The table is based on the typical all engine cruise speed of .74M 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

Power setting is based on one engine operating with one A/C pack operating and all anti-ice bleeds off. Enter the table with pressure altitude and IAS or Mach to read %N1.

It is desirable to maintain engine thrust within the limits of the Max Cruise thrust rating. However, where thrust 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/LRC Cruise Range Capability

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to Long Range Cruise speed. Cruise is continued at level off altitude and Long Range Cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion table with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time table with air distance and weight at start of driftdown to determine fuel and time required. 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 Enroute 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 Long Range Cruise speed, Max Continuous thrust, and 100 ft/min residual rate of climb.

Long Range Cruise Control

The table provides target %N1, 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. To conservatively account for APU fuel burn, add 90 kg/hr to fuel flow values.

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 (KG/HR)
37	35
35	35
31	45
25	60
20	75
15	90
10	115
5	140

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 .74M/250 KIAS descent. Enter with Air Distance as determined from the Ground to Air Miles Conversion Table and read Fuel and Time required at the cruise pressure altitude. Adjust the fuel obtained for deviation from the reference weight at checkpoint as required by entering the off reference fuel corrections table with the fuel required for the reference weight and the actual weight at checkpoint. Read fuel required and time for the actual weight.

Holding

Single engine holding data is provided in the same format as the all engine holding data and is based on the same assumptions.

PMC Off

Introduction

This section contains performance data for airplane operation with the Power Management Control (PMC) OFF (PMC switch - amber INOP light illuminated) for applicable thrust ratings. Do not use assumed temperature reduced thrust with PMC Off.

Takeoff Weight Adjustment

When operating with PMC off, the normal takeoff performance limit weights should be adjusted by the amount shown in the Takeoff Weights Adjustment and Obstacle Limit Weight Adjustment tables. To determine the limit weights for PMC Off operations, enter the Takeoff Weight Adjustments table with the airport pressure altitude and OAT, then apply the adjustments to the normal PMC On limit weights for field length, climb, tire speed, and brake energy.

Takeoff Speed Adjustment

When operating with PMC Off, the normal takeoff speeds should be adjusted by the amount shown in the Takeoff Speeds Adjustment table. To determine the PMC Off takeoff speeds, determine the normal PMC On takeoff speeds associated with the actual takeoff weight after any adjustment necessitated by PMC Off operations, then apply the appropriate adjustments to the takeoff speeds, determined by entering the table with the airport pressure altitude and OAT. The adjusted V1 should not exceed the adjusted VR.

NOTE: The FMC does not incorporate PMC OFF performance in its takeoff speeds calculations.

Power Settings

Tables are provided to account for engine bleed effects of normal air conditioning packs operation and for engine bleed to packs off operation.

To find Max Takeoff %N1 with both PMC's Off, enter Max Takeoff %N1 table (PMC Off) for the appropriate bleed configuration with airport pressure altitude and airport OAT and read %N1. No takeoff %N1 correction is required for engine anti-ice operation up to 10°C (50°F) which is the highest temperature recommended for engine anti-ice operation.

For Maximum Climb and Go-Around thrust setting with both PMC's Off, use PMC On %N1.

Gear Down

This section contains performance for airplane operation with the landing gear extended for all phases of flight. The data is based on engine bleeds for normal air conditioning.

Note: The Flight Management Computer System (FMCS) does not contain special provisions for operation with landing gear extended. As a result, the FMCS will generate inappropriate 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 (ETA) is available if current speed or Mach is entered into the VNAV cruise page.

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.

DO NOT USE FOR FLIGHT

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Performance Inflight

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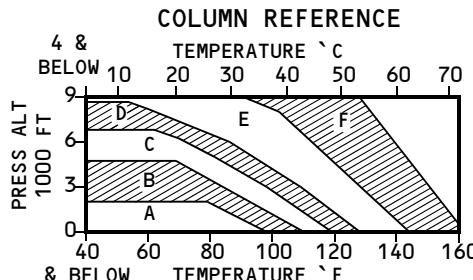
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Performance Inflight**General****Chapter PI****Section 20****Takeoff Speeds****Flaps 5**

WEIGHT 1000 KG	SLOPE/WIND V ₁ ADJUSTMENT*		
	SLOPE DN	% UP	WIND KTS TAIL HEAD
70	-3	0	4 -3 0 1
60	-2	0	3 -3 0 1
50	-2	0	2 -3 0 2
40	-2	0	2 -3 0 2

*V₁ NOT TO EXCEED V_R

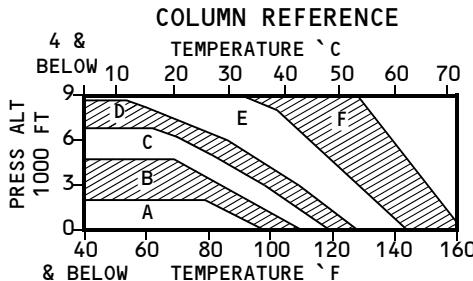
WT 1000 KG	A			B			C		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
70	157	162	168	157	163	168			
65	150	154	162	151	156	161	152	157	161
60	143	147	155	144	148	155	145	149	155
55	136	139	149	136	140	149	138	141	148
50	128	131	143	129	132	142	130	133	142
45	120	123	136	120	123	136	122	125	135
40	112	115	130	112	115	129	113	116	129

WT 1000 KG	D			E			F		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
70									
65									
60	145	149	155						
55	138	142	148	140	143	148			
50	130	133	142	132	135	141			
45	122	125	135	124	126	134	128	128	134
40	113	116	128	116	118	128	119	120	127

IN BOXED AREA CHECK MINIMUM V₁ (MCG) FOR ACTUAL TEMP.

Takeoff Speeds

Flaps 15



WEIGHT 1000 KG	SLOPE/WIND V1 ADJUSTMENT*			
	SLOPE % DN	% UP	WIND KTS TAIL	KTS HEAD
1000	-2	0	2	-15
70	-3	0	4	-3
60	-2	0	3	-3
50	-2	0	2	-3
40	-2	0	2	-3

*V1 NOT TO EXCEED VR

WT 1000 KG	A			B			C		
	V1	VR	V2	V1	VR	V2	V1	VR	V2
70	148	151	157				145	147	152
65	142	145	152	143	146	151	138	140	146
60	135	138	146	136	139	146	131	133	140
55	128	131	141	129	132	140	123	125	134
50	121	123	135	122	124	134			
45	113	116	129	113	116	128	115	118	128
40	105	107	122	105	108	122	107	110	122

WT 1000 KG	D			E			F		
	V1	VR	V2	V1	VR	V2	V1	VR	V2
70									
65									
60	139	140	146						
55	132	133	140	134	134	139			
50	124	126	134	126	127	133			
45	116	118	128	118	119	127	120	120	127
40	107	110	121	109	111	120	112	113	120

IN BOXED AREA CHECK MINIMUM V1 (MCG) FOR ACTUAL TEMP.

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V1(MCG)

ACTUAL OAT		PRESS ALT FT					
°C	°F	-1000	0	2000	4000	6000	8000
55	131	107	105				
50	122	111	109	104			
40	104	116	114	110	105	100	96
30	86	120	120	115	110	106	102
20	68	120	120	117	114	110	106
10	50	120	120	117	114	111	108
-50	-58	121	121	118	115	112	109

FOR A/C OFF INCREASE V₁ (MCG) BY 3 KNOTS.**Maximum Allowable Clearway**

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
4000	450
6000	550
8000	600
10000	650
12000	700
14000	750

Clearway and Stopway V1 Adjustments

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)			
	100	120	140	160
800			-3	-2
600		-3	-3	-2
400	-4	-3	-2	-1
200	-2	-2	-1	0
0	0	0	0	0
-400	2	2	2	1
-800	2	2	2	1

Stab Trim Setting**Max Takeoff Thrust****Flaps 5**

C.G. % MAC	6	10	14	18	22	26	30
STAB TRIM	5 1/2	5	4 1/2	3 3/4	3 1/4	2 3/4	2 1/4

For weights at or below 45360 kg subtract 1/2 unit from above value.

For weights at or above 61235 kg add 1/2 unit from above value.

Flaps 15

C.G. % MAC	6	10	14	18	22	26	30
STAB TRIM	5	4 1/4	3 3/4	3	2 1/2	1 3/4	1

For weights at or below 45360 kg subtract 1/2 unit from above value.

For weights at or above 61235 kg add 1/2 unit from above value.

VREF

WEIGHT (1000 KG)	FLAPS		
	40	30	15
70	155	159	177
65	149	154	171
60	143	147	164
55	137	141	156
50	130	134	149
45	124	127	141
40	116	119	132
35	109	111	123

For approach speed add wind factor of 1/2 headwind component + gust (max 20 knots).

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Recommended Maneuvering Speeds

FLAP POSITION	MANEUVER SPEED (KIAS)		
	WEIGHT		
	AT OR BELOW 53070 KG	ABOVE 53070 KG AND AT OR BELOW 62823 KG	ABOVE 62823 KG
UP	210	220	230
1	190	200	210
5	170/ *180	180/ *190	190/ *200
10	160/ *170	170/ *180	180/ *190
15	150	160	170
25	140	150	160
30		VREF 30	
40		VREF 40	

*Maneuvering speeds for airplanes without the Rudder System Enhancement Program (RSEP) installed.

ADVISORY INFORMATION**Slush/Standing Water Takeoff****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH										
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-7.3	-7.8	-8.1	-9.0	-9.4	-9.3	-12.7	-13.2	-12.3		
64	-6.9	-7.5	-7.7	-8.4	-9.1	-9.1	-11.9	-13.0	-12.8		
60	-6.5	-7.2	-7.5	-7.8	-8.8	-9.1	-10.8	-12.4	-13.0		
56	-5.9	-6.7	-7.5	-7.0	-8.1	-9.0	-9.4	-11.4	-12.7		
52	-5.2	-6.1	-7.0	-6.1	-7.2	-8.5	-8.0	-9.9	-11.7		
48	-4.5	-5.3	-6.1	-5.2	-6.1	-7.4	-6.7	-8.3	-10.2		
44	-3.8	-4.5	-5.2	-4.3	-5.1	-6.2	-5.4	-6.8	-8.5		
40	-3.0	-3.6	-4.2	-3.4	-4.1	-4.9	-4.2	-5.0	-6.8		
36	-2.0	-2.5	-3.0	-2.2	-3.0	-3.5	-2.9	-3.3	-5.1		

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH										
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
4600							30.5				
5000	28.5			31.6			36.4	29.8			
5400	34.3			37.5	29.9		42.4	35.1	29.9		
5800	40.2	32.1		43.3	35.2	28.3	48.4	40.4	34.0		
6200	46.1	37.2	30.0	49.4	40.6	32.9	54.4	45.4	38.1		
6600	52.4	42.3	34.3	55.9	45.6	37.6	60.6	50.2	42.4		
7000	58.9	47.4	38.6	62.1	51.0	42.2	66.8	55.6	46.7		
7400	65.4	52.9	43.0	68.5	56.4	46.7	72.9	60.8	50.9		
7800	72.4	58.6	47.7	75.0	62.1	51.2		66.3	55.2		
8200		64.2	52.3		67.9	55.9		71.8	59.3		
8600		70.3	57.1		73.6	60.7			63.7		
9000			62.3			65.7			67.8		
9400				67.3			70.6			71.9	
9800				72.2			75.5				

- Enter Weight Adjustment table with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
- Adjust field length available by -130 ft/+120 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slush/Standing Water Takeoff****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH										
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-13	-11	-10	-7	-7	-7	0	0	-2		
64	-14	-13	-11	-8	-8	-7	0	0	-2		
60	-16	-15	-13	-10	-9	-8	0	0	-1		
56	-18	-16	-15	-13	-11	-9	0	0	0		
52	-20	-18	-16	-15	-13	-10	-4	0	0		
48	-21	-20	-18	-17	-16	-12	-8	-2	0		
44	-22	-21	-19	-19	-17	-13	-12	-5	0		
40	-22	-22	-20	-20	-19	-15	-14	-9	-1		
36	-22	-22	-21	-20	-20	-17	-16	-12	-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 V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slush/Standing Water Takeoff****No Reverse Thrust****Weight Adjustment (1000 KG)**

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
72	-9.3	-10.4	-11.2	-11.1	-12.8	-13.6	-16.0	-17.5	-17.0
68	-8.6	-9.7	-10.6	-10.1	-11.7	-12.9	-14.4	-16.7	-17.0
64	-8.0	-9.0	-10.0	-9.1	-10.7	-12.1	-12.8	-15.4	-16.8
60	-7.3	-8.2	-9.3	-8.2	-9.6	-11.2	-11.1	-13.7	-16.4
56	-6.6	-7.4	-8.5	-7.3	-8.5	-10.1	-9.4	-11.8	-15.6
52	-5.9	-6.6	-7.6	-6.4	-7.4	-8.9	-7.9	-9.9	-14.5
48	-5.1	-5.8	-6.7	-5.5	-6.3	-7.5	-6.5	-8.1	-13.0
44	-4.3	-4.9	-5.6	-4.5	-5.2	-6.2	-5.4	-6.7	-10.9
40	-3.3	-3.9	-4.5	-3.5	-4.1	-4.8	-4.5	-5.6	-8.2

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
6000							32.7		
6500							39.3	32.6	
7000	30.1			30.1			46.5	38.7	32.9
7500	37.2			37.0			53.9	44.8	37.6
8000	44.5	34.5		44.2	35.6		61.3	50.8	42.4
8500	52.5	40.7	32.0	51.9	41.7	34.1	68.3	56.9	47.4
9000	60.9	47.3	37.3	60.1	48.2	39.4			
9500	69.5	54.3	42.8	62.2			70.1	58.1	
10000	78.3	61.7	48.7	69.6					63.9
10500				69.2	54.8		62.8		
11000				76.7	61.2		69.1		
11500					67.7				
12000					74.1				

- Enter Weight Adjustment table with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
- Adjust field length available by -160 ft/+150 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slush/Standing Water Takeoff****No Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH										
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-22	-17	-14	-14	-6	-5					
64	-25	-21	-17	-17	-10	-7					
60	-27	-23	-20	-20	-14	-10					
56	-29	-26	-22	-23	-18	-12	-5	0	0	0	
52	-31	-28	-24	-26	-21	-15	-12	0	0	0	
48	-32	-30	-26	-29	-25	-18	-18	-6	0	0	
44	-33	-31	-28	-31	-27	-22	-23	-14	0	0	
40	-33	-32	-30	-31	-29	-25	-26	-21	-4		
36	-33	-31	-30	-31	-29	-26	-27	-23	-10		

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 V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff****Maximum Reverse Thrust****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.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	0.0	0.0	-3.6	-3.6	-3.6	-7.0	-7.0	-7.0
64	-0.3	-0.3	-3.9	-3.9	-3.9	-6.9	-6.9	-6.9
60	-0.7	-0.7	-3.9	-3.9	-3.9	-6.6	-6.6	-6.6
56	-0.9	-0.9	-4.0	-4.0	-4.0	-6.3	-6.3	-6.3
52	-1.1	-1.1	-3.8	-3.8	-3.8	-5.8	-5.8	-5.8
48	-1.1	-1.1	-3.5	-3.5	-3.5	-5.3	-5.3	-5.3
44	-0.9	-0.9	-3.1	-3.1	-3.1	-4.6	-4.6	-4.6
40	-0.6	-0.6	-2.5	-2.5	-2.5	-3.7	-3.7	-3.7
36	-0.2	-0.2	-1.8	-1.8	-1.8	-2.7	-2.7	-2.7

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
3800	29.3							
4200	39.7							
4600	50.0	34.5						
5000	60.6	44.8	29.3	30.7				
5400	70.4	55.2	39.7	38.2				
5800		65.7	50.0	45.6	34.4			
6200			75.2	60.6	53.1	41.9	30.7	29.7
6600				70.4	61.2	49.4	38.2	34.3
7000					70.1	57.1	45.6	38.9
7400						65.5	53.1	43.6
7800						74.6	61.2	48.6
8200							70.1	53.9
8600								41.2
9000								29.7
9400								
9800							59.4	46.1
10200							65.0	51.2
10600							70.9	56.6
11000								43.6
11400								48.6
							62.2	68.0
							68.0	53.9
							73.9	59.4
								65.0
								70.9

- Enter Weight Adjustment table with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -100 ft/+100 ft for every 5°C above/below 4°C
Adjust "Medium" field length available by -100 ft/+100 ft for every 5°C above/below 4°C
Adjust "Poor" field length available by -140 ft/+130 ft for every 5°C above/below 4°C
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slippery Runway Takeoff****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-4	-2	0	-14	-12	-10	-31	-27	-23
64	-6	-4	-2	-16	-14	-12	-34	-30	-26
60	-7	-5	-3	-18	-16	-14	-36	-32	-28
56	-9	-7	-5	-20	-18	-16	-38	-34	-30
52	-11	-9	-7	-22	-20	-18	-40	-36	-32
48	-12	-10	-8	-24	-22	-20	-41	-37	-33
44	-13	-11	-9	-25	-23	-21	-42	-38	-34
40	-14	-12	-10	-26	-24	-22	-43	-39	-35
36	-15	-13	-11	-27	-25	-23	-43	-39	-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 V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff****No Reverse Thrust****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)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
72	-0.9	-0.9	-0.9	-5.7	-5.7	-5.7	-9.2	-9.2	-9.2	-9.2	
68	-1.3	-1.3	-1.3	-5.7	-5.7	-5.7	-8.8	-8.8	-8.8	-8.8	
64	-1.5	-1.5	-1.5	-5.6	-5.6	-5.6	-8.4	-8.4	-8.4	-8.4	
60	-1.7	-1.7	-1.7	-5.5	-5.5	-5.5	-7.9	-7.9	-7.9	-7.9	
56	-1.8	-1.8	-1.8	-5.2	-5.2	-5.2	-7.3	-7.3	-7.3	-7.3	
52	-1.8	-1.8	-1.8	-4.8	-4.8	-4.8	-6.6	-6.6	-6.6	-6.6	
48	-1.6	-1.6	-1.6	-4.3	-4.3	-4.3	-5.8	-5.8	-5.8	-5.8	
44	-1.4	-1.4	-1.4	-3.7	-3.7	-3.7	-5.0	-5.0	-5.0	-5.0	
40	-1.0	-1.0	-1.0	-3.0	-3.0	-3.0	-4.0	-4.0	-4.0	-4.0	
36	-0.6	-0.6	-0.6	-2.2	-2.2	-2.2	-2.8	-2.8	-2.8	-2.8	

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION										
	GOOD			MEDIUM			POOR				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
4800	40.3										
5200	52.2	34.3									
5600	63.8	46.2	28.3								
6000	75.3	58.0	40.3								
6400		69.6	52.2	29.3							
6800			63.8	37.8							
7200				75.3	46.7	33.6					
7600					56.1	42.2	29.3				
8000					65.8	51.3	37.8				
8400					75.7	60.9	46.7				
8800						70.8	56.1				
9200							65.8				
9600							75.7	33.7			
10000								38.9			
10400								44.4	31.6		
10800								50.2	36.8		
11200								56.5	42.1		
11600								63.2	47.8	34.7	
12000								70.2	53.9	39.9	
12400									60.5	45.5	
12800									67.4	51.5	
13200									74.6	57.8	
13600										64.6	
14000										71.7	

- Enter Weight Adjustment table with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -100 ft/+100 ft for every 5°C above/below 4°C
Adjust "Medium" field length available by -100 ft/+100 ft for every 5°C above/below 4°C
Adjust "Poor" field length available by -180 ft/+180 ft for every 5°C above/below 4°C
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slippery Runway Takeoff****No Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-7	-4	-1	-21	-18	-15	-42	-36	-30
64	-9	-6	-3	-23	-20	-17	-45	-39	-33
60	-11	-8	-5	-26	-23	-20	-48	-42	-36
56	-13	-10	-7	-29	-26	-23	-51	-45	-39
52	-15	-12	-9	-32	-29	-26	-54	-48	-42
48	-16	-13	-10	-34	-31	-28	-56	-50	-44
44	-18	-15	-12	-36	-33	-30	-58	-52	-46
40	-19	-16	-13	-37	-34	-31	-59	-53	-47
36	-20	-17	-14	-38	-35	-32	-59	-53	-47

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 V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

Takeoff %N1**Based on engine bleed to packs on (Auto) and anti-ice on or off**

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	93.6	93.5	93.0	92.5						
50	122	94.8	95.1	94.9	94.8	94.4	93.3				
45	113	95.4	95.9	95.9	96.0	95.8	95.4	95.3	94.7	94.1	
40	104	96.1	96.6	96.6	96.6	96.5	96.4	96.4	96.4	96.4	95.9
35	95	96.6	97.3	97.2	97.2	97.1	97.1	97.2	97.1	97.1	97.1
30	86	96.5	97.8	97.8	97.9	97.8	97.8	97.9	97.9	98.0	97.9
25	77	95.7	97.0	97.6	98.3	98.6	98.6	98.7	98.7	98.8	98.7
20	68	94.9	96.2	96.7	97.5	98.1	98.7	99.3	99.4	99.5	99.4
15	59	94.1	95.4	95.9	96.6	97.2	97.8	98.4	99.1	99.7	99.9
10	50	93.3	94.6	95.1	95.8	96.4	97.0	97.6	98.2	98.8	99.3
5	41	92.5	93.7	94.2	94.9	95.5	96.1	96.7	97.3	97.9	98.4
0	32	91.6	92.9	93.4	94.1	94.7	95.2	95.8	96.5	97.0	97.5
-10	14	89.9	91.1	91.6	92.3	92.9	93.5	94.1	94.7	95.3	95.7
-20	-4	88.2	89.4	89.9	90.6	91.1	91.7	92.3	92.9	93.4	93.9
-30	-22	86.4	87.6	88.1	88.8	89.3	89.9	90.4	91.0	91.6	92.0
-40	-40	84.7	85.8	86.3	86.9	87.4	88.0	88.5	89.1	89.7	90.1
-50	-58	82.8	83.9	84.4	85.0	85.6	86.1	86.6	87.2	87.7	88.1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-1000	8000
ENGINE BLEED TO PACKS OFF	1.0	1.0

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Assumed Temperature Reduced Thrust**Maximum Assumed Temperature (Table 1)****Based on 25% Takeoff Thrust Reduction**

OAT (°C)	PRESS ALT (1000 FT)								OAT (°F)	PRESS ALT (1000 FT)											
	-1	0	1	2	3	4	5	6		-1	0	1	2	3	4	5	6	7	8		
55	70	71	69						130	158	158	156									
50	67	67	67	67	65	63			120	152	152	151	151	148	146						
45	65	65	64	64	62	61	60	59	57	110	149	148	147	145	143	140	139	137	135		
40	64	63	62	62	60	59	58	57	56	55	100	145	144	143	142	139	136	134	133	131	129
35	62	61	61	60	58	57	56	55	54	53	90	142	140	139	138	136	132	130	129	127	126
30	61	59	59	58	57	55	54	53	52	51	80	142	139	136	134	132	129	127	125	123	122
25	61	59	58	56	55	53	52	51	50	49	70	142	139	136	133	130	126	124	122	120	118
20	61	59	58	56	55	52	51	50	49	48	60	142	139	136	133	130	126	123	121	118	116
15 & BELOW	61	59	58	56	55	52	51	49	48	46	50 & BELOW	142	139	136	133	130	126	123	121	118	116

Maximum Takeoff %N1 (Table 2)**Based on engine bleed to packs on (Auto) and engine anti-ice on or off**

ASSUMED TEMP		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
75	167	83.0	86.2	87.2							
70	158	85.7	86.3	86.5	87.3	87.3					
65	149	88.5	88.8	88.4	88.0	86.8	86.8	87.4	88.2	88.9	89.5
60	140	91.2	91.2	90.8	90.3	89.4	88.2	87.6	87.5	88.2	88.8
55	131	93.5	93.6	93.1	92.6	91.9	90.8	90.2	89.6	89.0	88.3
50	122	94.7	95.1	94.9	94.8	94.4	93.3	92.8	92.2	91.6	90.9
45	113	95.3	95.9	95.9	96.0	95.8	95.4	95.3	94.8	94.1	93.4
40	104	96.0	96.7	96.6	96.6	96.5	96.4	96.4	96.4	96.4	95.9
35	95	96.5	97.3	97.3	97.2	97.2	97.1	97.2	97.2	97.1	97.1
30	86	96.4	97.8	97.8	97.9	97.8	97.8	98.0	97.9	98.0	97.9
25	77	95.6	97.0	97.6	98.3	98.6	98.6	98.7	98.7	98.8	98.7
20	68	94.8	96.2	96.8	97.5	98.1	98.7	99.3	99.4	99.5	99.4
15	59	94.0	95.4	95.9	96.6	97.2	97.8	98.4	99.1	99.7	99.9
MINIMUM ASSUMED TEMP °C (°F)		32(90)	30(86)	28(82)	26(79)	24(75)	22(72)	20(68)	18(64)	16(61)	14(57)

With engine bleed to packs off, increase %N1 by 1.0.

Assumed Temperature Reduced Thrust**%N1 Adjustment For Temperature Difference (Table 3)**

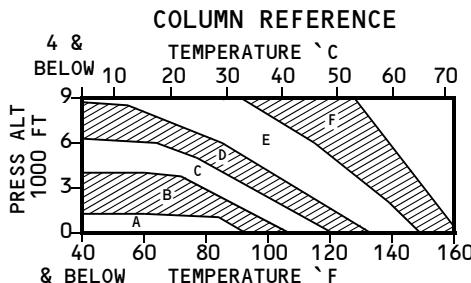
ASSUMED TEMP MINUS OAT		OUTSIDE AIR TEMPERATURE														
°C	°F	°C	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
°F		°F	-40	-4	32	41	50	59	68	77	86	95	104	113	122	131
10	18					1.6	1.6	1.6	1.5	1.5	1.5	1.5	1.4	1.4	1.3	
20	36				3.3	3.2	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.5	2.3	
30	54				4.8	4.8	4.6	4.5	4.4	4.3	4.0	3.8	3.6	3.6	3.6	
40	72			6.0	6.2	6.1	6.0	5.8	5.7	5.2	5.0	5.0				
50	90			8.2	7.5	7.3	7.2	6.6								
60	108		10.4	9.5	8.7	8.1	7.9									
70	126		11.8	10.7	9.3											
80	144		13.0	11.8	10.1											
90	162		14.0	12.4												
100	180		15.0	12.8												
110	198		15.4													

1. Determine Maximum Assumed Temperature allowed from Table 1.
2. Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).
3. Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.
4. Subtract %N1 adjustment from Maximum %N1 in Table 2.

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Takeoff Speeds (22K Derate)

Flaps 5



WEIGHT 1000 KG	SLOPE/WIND V1 ADJUSTMENT*		
	SLOPE DN	% UP	WIND KTS TAIL HEAD
1000	-2	0	-15 0 40
70	-3	0	-3 0 1
60	-2	0	-3 0 1
50	-2	0	-4 0 1
40	-2	0	-4 0 1

*V1 NOT TO EXCEED VR

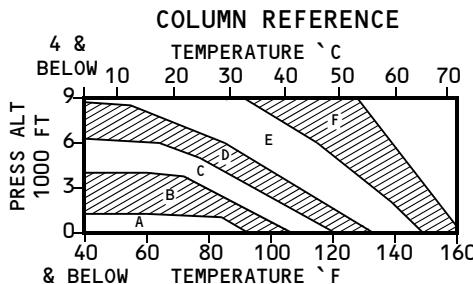
WT 1000 KG	A			B			C		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
70	158	163	168	158	164	169			
65	151	155	161	152	156	162	153	157	162
60	144	148	155	145	148	155	146	149	155
55	137	139	149	138	140	149	138	141	148
50	129	131	142	130	132	142	131	133	142
45	121	123	136	122	124	135	122	125	135
40	113	114	130	113	116	129	113	116	128

WT 1000 KG	D			E			F		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
70									
65									
60									
55	140	143	148						
50	132	134	141	133	135	141			
45	124	126	135	125	127	134	128	128	134
40	115	117	128	116	118	127	119	120	126

IN BOXED AREA CHECK MINIMUM V₁ (MCG) FOR ACTUAL TEMP.

Takeoff Speeds (22K Derate)

Flaps 15



WEIGHT 1000 KG	SLOPE/WIND V ₁ ADJUSTMENT*			V ₁	
	SLOPE % DN	% UP	WIND KTS TAIL	HEAD	
70	-2	0	2	-15	0 40
60	-3	0	4	-3	0 1
50	-2	0	2	-4	0 1
40	-2	0	1	-4	0 1

*V₁ NOT TO EXCEED V_R

WT 1000 KG	A			B			C		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
70	150	152	158						
65	143	145	152	145	146	151			
60	137	139	146	138	140	146	139	140	146
55	130	131	141	131	132	140	131	133	140
50	122	124	135	123	125	134	124	125	134
45	114	116	128	116	117	128	116	118	128
40	106	107	122	108	109	122	108	110	122

WT 1000 KG	D			E			F		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
70									
65									
60									
55	134	134	140						
50	126	126	134	127	128	133			
45	118	119	127	120	120	126	120	121	127
40	109	111	121	111	112	120	112	113	120

IN BOXED AREA CHECK MINIMUM V₁ (MCG) FOR ACTUAL TEMP.

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V1(MCG) (22K Derate)

ACTUAL OAT		PRESS ALT FT					
°C	°F	-1000	0	2000	4000	6000	8000
55	131	106	104				
50	122	109	107	103			
40	104	113	111	107	103	99	94
30	86	117	116	111	107	104	98
20	68	117	116	113	111	107	102
10	50	118	116	113	111	108	104
-50	-58	119	118	115	112	109	105

FOR A/C OFF INCREASE V₁ (MCG)
BY 2 KNOTS.

Maximum Allowable Clearway (22K Derate)

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
4000	400
6000	500
8000	550
10000	600
12000	700
14000	750

Clearway and Stopway V1 Adjustments (22K Derate)

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)			
	100	120	140	160
800			-3	-2
600		-3	-2	-1
400	-4	-3	-2	-1
200	-2	-1	-1	0
0	0	0	0	0
-400	1	1	1	1
-800	1	1	1	1

Stab Trim Setting (22K Derate)**Flaps 5**

C.G. % MAC	6	10	14	18	22	26	30
STAB TRIM	5 1/2	5	4 1/2	3 3/4	3 1/4	2 3/4	2 1/4

For weights at or below 45360 kg subtract 1/2 unit from above value.

For weights at or above 61235 kg add 1/2 unit from above value.

Flaps 15

C.G. % MAC	6	10	14	18	22	26	30
STAB TRIM	5	4 1/4	3 3/4	3	2 1/2	1 3/4	1

For weights at or below 45360 kg subtract 1/2 unit from above value.

For weights at or above 61235 kg add 1/2 unit from above value.

ADVISORY INFORMATION**Slush/Standing Water Takeoff (22K Derate)****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

22K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH										
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-7.6	-8.1	-8.6	-9.5	-9.9	-9.7	-13.8	-13.7	-12.3		
64	-7.2	-7.8	-8.1	-8.7	-9.5	-9.7	-12.3	-13.2	-13.1		
60	-6.6	-7.4	-7.9	-7.9	-8.8	-9.5	-10.9	-12.5	-13.1		
56	-6.0	-6.8	-7.5	-7.1	-8.1	-9.0	-9.5	-11.4	-12.7		
52	-5.3	-6.2	-7.0	-6.2	-7.3	-8.5	-8.1	-10.1	-11.8		
48	-4.6	-5.4	-6.3	-5.3	-6.4	-7.5	-6.8	-8.6	-10.4		
44	-3.8	-4.5	-5.2	-4.3	-5.2	-6.3	-5.4	-6.8	-8.6		
40	-3.0	-3.6	-4.2	-3.4	-4.1	-4.8	-4.2	-5.0	-6.8		
36	-2.0	-2.4	-2.7	-2.2	-2.6	-3.1	-3.0	-3.2	-5.0		

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH										
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
4600							32.1				
5000	30.2			33.0			38.3				
5400	37.0	29.2		40.0	32.4		44.7	37.2		31.5	
5800	43.6	34.8	28.7	46.7	37.9	31.5	50.9	42.3		35.8	
6200	49.9	40.4	33.2	52.9	43.3	36.2	56.4	47.4		40.0	
6600	56.7	45.8	37.7	59.3	48.7	40.8	62.0	52.3		44.4	
7000	63.2	51.4	42.1	66.3	54.3	45.2	67.6	57.3		48.9	
7400	70.2	56.9	46.8	73.3	59.9	49.9	73.1	62.1		53.3	
7800		62.5	51.8		65.3	54.7		66.9		57.9	
8200			68.7	56.6		71.4	59.5		71.8		62.5
8600			75.0	61.6			64.6				67.0
9000				66.7			69.4				71.6
9400				71.7			74.1				

1. Enter Weight Adjustment table with reported braking action and 22K derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
2. Adjust field length available by -130 ft/+120 ft for every 5°C above/below 4°C
3. Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
4. Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slush/Standing Water Takeoff (22K Derate)****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-11	-10	-8	-6	-5	-5	0	0	-2
64	-13	-11	-9	-7	-6	-6	0	0	-1
60	-15	-13	-11	-9	-7	-6	0	0	-1
56	-17	-15	-12	-11	-9	-7	0	0	0
52	-18	-16	-14	-14	-11	-8	-1	0	0
48	-20	-18	-15	-16	-13	-9	-5	0	0
44	-21	-20	-17	-18	-15	-11	-10	-3	0
40	-22	-20	-18	-19	-17	-13	-14	-7	0
36	-22	-21	-19	-20	-18	-15	-15	-11	-3

1. Obtain V1, VR and V2 for the actual weight using 22K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slush/Standing Water Takeoff (22K Derate)****No Reverse Thrust****Weight Adjustment (1000 KG)**

22K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
72	-9.7	-10.7	-11.5	-11.8	-13.1	-13.4	-16.8	-17.7	-16.3
68	-9.0	-10.0	-11.0	-10.6	-12.2	-13.1	-15.0	-16.9	-16.6
64	-8.3	-9.3	-10.3	-9.6	-11.2	-12.5	-13.3	-15.7	-16.5
60	-7.6	-8.6	-9.6	-8.6	-10.1	-11.7	-11.5	-14.2	-16.2
56	-6.8	-7.8	-8.8	-7.6	-8.9	-10.6	-9.8	-12.4	-15.4
52	-6.1	-6.9	-7.9	-6.7	-7.8	-9.4	-8.2	-10.6	-14.4
48	-5.2	-6.0	-6.9	-5.7	-6.6	-8.0	-6.7	-8.6	-12.9
44	-4.4	-5.0	-5.8	-4.8	-5.4	-6.5	-5.4	-6.6	-11.0
40	-3.5	-4.0	-4.6	-3.7	-4.3	-5.0	-4.2	-4.8	-8.7

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
6000							34.8		
6500				33.2			42.1		
7000	33.9			40.4	32.6		49.4	41.4	35.1
7500	41.3	32.0		48.2	38.9	32.1	56.9	47.3	39.8
8000	49.4	38.6	30.6	56.4	45.5	37.6	64.5	53.2	44.9
8500	58.0	45.3	36.3	65.1	52.4	43.3	72.5	59.4	50.4
9000	67.0	52.5	42.1	74.1	59.7	49.2		66.6	56.1
9500	76.1	60.0	48.2		67.2	55.3		75.1	62.0
10000		67.8	54.5		74.9	61.7			67.8
10500			75.8	61.2			68.1		
11000				67.9					
11500				74.7					73.5

- Enter Weight Adjustment table with slush/standing water depth and 22K Derate dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
- Adjust field length available by -160 ft/+150 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Slush/Standing Water Takeoff (22K Derate)****No Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH							
	3mm (0.12 INCHES)			6mm (0.25 INCHES)			13mm (0.50 INCHES)	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-20	-14	-12	-10	-3	-3	0	0
64	-22	-18	-14	-14	-7	-5	0	0
60	-25	-21	-17	-17	-11	-7	0	0
56	-27	-24	-20	-21	-15	-10	-2	0
52	-29	-27	-22	-24	-19	-12	-7	0
48	-31	-28	-24	-27	-22	-15	-14	-3
44	-32	-30	-27	-29	-25	-19	-21	-10
40	-32	-31	-28	-30	-27	-23	-25	-17
36	-32	-30	-28	-30	-28	-25	-26	-22

1. Obtain V1, VR and V2 for the actual weight using 22K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff (22K Derate)****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

22K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-0.5	-0.5	-0.5	-4.4	-4.4	-4.4	-7.1	-7.1
64	-0.7	-0.7	-0.7	-4.2	-4.2	-4.2	-7.0	-7.0
60	-1.0	-1.0	-1.0	-4.1	-4.1	-4.1	-6.7	-6.7
56	-1.1	-1.1	-1.1	-4.1	-4.1	-4.1	-6.4	-6.4
52	-1.3	-1.3	-1.3	-4.1	-4.1	-4.1	-6.0	-6.0
48	-1.3	-1.3	-1.3	-3.9	-3.9	-3.9	-5.4	-5.4
44	-1.1	-1.1	-1.1	-3.5	-3.5	-3.5	-4.7	-4.7
40	-0.8	-0.8	-0.8	-2.9	-2.9	-2.9	-3.9	-3.9
36	-0.5	-0.5	-0.5	-1.9	-1.9	-1.9	-2.8	-2.8

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
3800	31.6							
4200	42.1							
4600	52.6	36.8						
5000	62.9	47.3	31.6	33.2				
5400	73.2	57.8	42.1	40.9	29.4			
5800		68.0	52.6	48.5	37.1			
6200			62.9	56.3	44.7	33.2	31.4	
6600				73.2	64.4	52.3	40.9	36.1
7000					72.5	60.3	48.5	40.9
7400						68.4	56.3	45.9
7800							64.4	51.1
8200							72.5	56.6
8600								62.3
9000								43.3
9400								31.4
9800								
10200								
10600								
11000								
11400								

- Enter Weight Adjustment table with reported braking action and 22K derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -100 ft/+90 ft for every 5°C above/below 4°C
Adjust "Medium" field length available by -100 ft/+90 ft for every 5°C above/below 4°C
Adjust "Poor" field length available by -140 ft/+130 ft for every 5°C above/below 4°C
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slippery Runway Takeoff (22K Derate)****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION										
	GOOD			MEDIUM			POOR				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-4	-2	0	-12	-10	-8	-29	-25	-21		
64	-5	-3	-1	-15	-13	-11	-32	-28	-24		
60	-7	-5	-3	-17	-15	-13	-34	-30	-26		
56	-8	-6	-4	-19	-17	-15	-37	-33	-29		
52	-10	-8	-6	-21	-19	-17	-38	-34	-30		
48	-11	-9	-7	-23	-21	-19	-40	-36	-32		
44	-12	-10	-8	-24	-22	-20	-41	-37	-33		
40	-13	-11	-9	-25	-23	-21	-42	-38	-34		
36	-14	-12	-10	-27	-25	-23	-42	-38	-34		

1. Obtain V1, VR and V2 for the actual weight using 22K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff (22K Derate)****No Reverse Thrust****Weight Adjustment (1000 KG)**

22K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
72	-0.9	-0.9	-0.9	-5.8	-5.8	-5.8	-9.4	-9.4	-9.4
68	-1.3	-1.3	-1.3	-5.8	-5.8	-5.8	-9.0	-9.0	-9.0
64	-1.6	-1.6	-1.6	-5.7	-5.7	-5.7	-8.6	-8.6	-8.6
60	-1.8	-1.8	-1.8	-5.6	-5.6	-5.6	-8.1	-8.1	-8.1
56	-1.8	-1.8	-1.8	-5.3	-5.3	-5.3	-7.5	-7.5	-7.5
52	-1.8	-1.8	-1.8	-4.9	-4.9	-4.9	-6.8	-6.8	-6.8
48	-1.7	-1.7	-1.7	-4.4	-4.4	-4.4	-6.0	-6.0	-6.0
44	-1.5	-1.5	-1.5	-3.9	-3.9	-3.9	-5.2	-5.2	-5.2
40	-1.1	-1.1	-1.1	-3.1	-3.1	-3.1	-4.1	-4.1	-4.1
36	-0.7	-0.7	-0.7	-2.3	-2.3	-2.3	-3.0	-3.0	-3.0

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
4400	32.2								
4800	44.2	27.3							
5200	56.1	39.4							
5600	67.7	51.4	34.6						
6000	79.1	63.1	46.6						
6400		74.5	58.5	33.2					
6800			70.0	42.1	29.6				
7200				51.5	38.4				
7600				61.3	47.6	35.0			
8000				71.2	57.2	43.9			
8400					67.1	53.4			
8800					77.1	63.2			
9200						73.2	31.6		
9600							37.0		
10000							42.5		
10400							48.5	35.9	
10800							54.9	41.4	
11200							61.7	47.3	34.8
11600							68.9	53.6	40.3
12000								60.3	46.1
12400								67.4	52.3
12800								74.8	58.9
13200									66.0
13600									73.3

- Enter Weight Adjustment table with reported braking action and 22K Derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -100 ft/+100 ft for every 5°C above/below 4°C
Adjust "Medium" field length available by -100 ft/+100 ft for every 5°C above/below 4°C
Adjust "Poor" field length available by -180 ft/+130 ft for every 5°C above/below 4°C
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slippery Runway Takeoff (22K Derate)****No Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-6	-3	0	-19	-16	-13	-38	-31	-24
64	-8	-5	-2	-21	-18	-15	-42	-35	-28
60	-10	-7	-4	-24	-21	-18	-45	-38	-31
56	-12	-9	-6	-27	-24	-21	-49	-42	-35
52	-14	-11	-8	-30	-27	-24	-52	-45	-38
48	-15	-12	-9	-32	-29	-26	-54	-47	-40
44	-17	-14	-11	-34	-31	-28	-56	-49	-42
40	-18	-15	-12	-36	-33	-30	-57	-50	-43
36	-19	-16	-13	-37	-34	-31	-58	-51	-44

1. Obtain V1, VR and V2 for the actual weight using 22K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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Takeoff %N1 (22K Derate)**Based on engine bleed to packs on (Auto) and anti-ice on or off**

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	93.2	93.8	93.8	93.8	93.9	93.6	94.7	94.4	94.2	
50	122	93.8	94.3	94.3	94.3	94.7	94.6	94.6			
45	113	94.2	94.7	94.7	94.6	94.6	94.6	94.7	94.4	94.2	
40	104	94.6	95.2	95.2	95.1	95.0	95.1	95.1	95.2	95.1	94.9
35	95	95.2	95.6	95.6	95.6	95.5	95.7	95.7	95.7	95.6	95.5
30	86	95.2	96.1	96.1	96.0	96.0	96.3	96.2	96.1	96.0	96.0
25	77	94.4	95.3	95.8	96.2	96.5	96.7	96.6	96.6	96.5	96.4
20	68	93.6	94.5	95.0	95.4	95.9	96.6	97.1	97.1	97.0	96.9
15	59	92.8	93.7	94.2	94.6	95.1	95.8	96.3	96.8	97.2	97.5
10	50	92.0	92.9	93.4	93.8	94.2	95.0	95.4	95.9	96.4	96.8
5	41	91.2	92.1	92.5	92.9	93.4	94.1	94.6	95.1	95.5	96.0
0	32	90.3	91.2	91.7	92.1	92.6	93.3	93.7	94.2	94.7	95.1
-10	14	88.7	89.6	90.0	90.4	90.8	91.5	92.0	92.5	92.9	93.4
-20	-4	87.0	87.8	88.3	88.7	89.1	89.8	90.2	90.7	91.1	91.6
-30	-22	85.2	86.0	86.5	86.9	87.3	88.0	88.4	88.9	89.3	89.7
-40	-40	83.5	84.3	84.7	85.1	85.5	86.2	86.6	87.1	87.4	87.9
-50	-58	81.7	82.5	82.9	83.2	83.7	84.3	84.7	85.2	85.6	86.0

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-2000	9000
ENGINE BLEED TO PACKS OFF	1.0	1.0

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Assumed Temperature Reduced Thrust (22K Derate)**Maximum Assumed Temperature (Table 1)****Based on 25% Takeoff Thrust Reduction**

OAT (°C)	PRESS ALT (1000 FT)								OAT (°F)	PRESS ALT (1000 FT)									
	-1	0	1	2	3	4	5	6		-1	0	1	2	3	4	5	6	7	8
55	74	71	71						130	165	159	159							
50	71	69	68	68	69	70			120	160	155	154	154	155	157				
45	69	67	66	66	67	67	67	68	70	110	155	151	149	149	150	151	151	155	
40	67	65	64	64	64	64	64	64	68	100	151	148	145	145	145	147	145	149	
35	65	63	62	62	62	61	61	62	63	64	90	146	143	141	141	140	140	140	
30	63	61	60	60	59	59	59	59	60	61	80	146	142	139	138	136	135	135	
25	63	61	59	58	57	56	56	56	57	58	70	146	142	138	136	135	131	129	
20	63	61	59	58	57	55	53	54	54	55	60	146	142	138	136	135	131	127	
15 & BELOW	63	61	59	58	57	55	53	53	52	52	50 & BELOW	146	142	138	136	135	131	127	126

Maximum Takeoff %N1 (Table 2)**Based on engine bleed to packs on (Auto) and engine anti-ice on or off**

ASSUMED TEMP		AIRPORT PRESSURE ALTITUDE (FT)															
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000						
75	167	86.0	85.4	85.4													
70	158	87.8	87.6	87.4	87.4	87.6											
65	149	89.7	89.7	89.4	89.2	89.2	89.2	89.2	89.3	89.3	89.5	89.9	90.4				
60	140	91.6	91.8	91.3	91.0	90.8	90.7	90.7	90.7	90.8	91.1	91.4					
55	131	93.1	93.8	93.2	92.7	92.4	92.1	92.1	92.1	92.0	92.1	92.3					
50	122	93.7	94.3	94.3	94.3	93.9	93.6	93.6	93.4	93.2	93.2	93.2	93.2				
45	113	94.0	94.7	94.7	94.6	94.6	94.6	94.6	94.7	94.4	94.2	94.0					
40	104	94.4	95.2	95.2	95.1	95.0	95.1	95.1	95.1	95.2	95.1	94.9					
35	95	95.0	95.6	95.6	95.6	95.5	95.5	95.7	95.7	95.7	95.6	95.5					
30	86	95.2	96.1	96.1	96.0	96.0	96.3	96.2	96.1	96.0	96.0	96.0					
25	77	94.4		96.6	96.6	96.5	96.7	96.6	96.5	96.6	96.5	96.4					
20	68	93.6					97.1	97.1	97.1	97.0	97.0	96.9					
15	59	92.8						97.6	97.6	97.5	97.5	97.5					
MINIMUM ASSUMED TEMP °C (°F)		32(90)	30(86)	28(82)	26(79)	24(75)	22(72)	20(68)	18(64)	16(61)	15(59)						

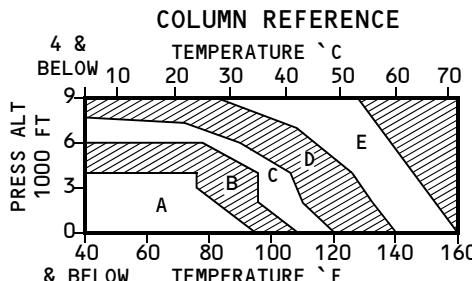
With engine bleed to packs off, increase %N1 by 1.0.

**Assumed Temperature Reduced Thrust (22K Derate)
%N1 Adjustment For Temperature Difference (Table 3)**

ASSUMED TEMP MINUS OAT		OUTSIDE AIR TEMPERATURE														
°C	°F	°C	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
°F		°F	-40	-4	32	41	50	59	68	77	86	95	104	113	122	131
10	18							1.6	1.6	1.6	1.5	1.5	1.5	1.4	1.4	
20	36				3.3	3.2	3.2	3.1	3.0	2.9	2.8	2.8	2.7	2.5	2.3	
30	54				4.8	4.8	4.6	4.5	4.4	4.3	4.0	3.8	3.6	3.6	3.6	
40	72			6.0	6.2	6.1	6.0	5.8	5.7	5.2	5.0	5.0				
50	90			8.2	7.5	7.3	7.2	6.6	6.5							
60	108		10.4	9.5	8.7	8.1	7.9									
70	126		11.8	10.7	9.3											
80	144		13.0	11.8	10.1											
90	162		14.0	12.4												
100	180		15.0	12.8												
110	198		15.4													

1. Determine Maximum Assumed Temperature allowed from Table 1.
2. Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).
3. Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.
4. Subtract %N1 adjustment from Maximum %N1 in Table 2.

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Takeoff Speeds (20K Derate)

WEIGHT 1000 KG	SLOPE/WIND V1 ADJUSTMENT*			
	SLOPE % DN	% UP	WIND KTS TAIL	HEAD
1000	-2	0	2	-15 0 40
70	-2	0	3	-3 0 2
60	-2	0	1	-3 0 1
50	-2	0	1	-4 0 1
40	-2	0	1	-4 0 1

*V1 NOT TO EXCEED VR

FLAPS	WT 1000 KG	A			B			C			D			E		
		V1	VR	V2												
5	70	161	165	168	161	165	168									
	65	154	157	162	154	158	161									
	60	147	149	155	147	150	155									
	55	139	141	149	140	142	148									
	50	132	133	142	132	134	141									
	45	123	125	135	124	125	135									
15	40	115	116	128	115	117	128									
	70	152	154	159												
	65	146	147	152												
	60	139	140	146												
	55	132	133	140												
	50	124	125	134												
	45	116	118	128	118	118	128									
	40	107	110	122	109	110	121	110	111	121	111	112	120	112	113	120

IN BOXED AREA CHECK MINIMUM V1 (MCG) FOR ACTUAL TEMP.

V1(MCG) (20K Derate)

ACTUAL OAT	PRESS ALT FT							
	°C	°F	-1000	0	2000	4000	6000	8000
54	130	101	99					
50	122	103	101	99	97			
40	104	107	106	103	103	98	93	
30	86	110	110	107	107	103	96	
20	68	111	110	108	108	105	101	
10	50	111	110	109	108	105	101	
-50	-58	112	111	110	109	106	102	

FOR A/C OFF INCREASE V1 (MCG)
BY 3 KNOTS.

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Maximum Allowable Clearway (20K Derate)

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
4000	400
6000	500
8000	550
10000	600
12000	700
14000	750

Clearway and Stopway V1 Adjustments (20K Derate)

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)			
	100	120	140	160
800			-3	-2
600		-3	-2	-1
400	-4	-3	-2	-1
200	-2	-1	-1	0
0	0	0	0	0
-400	1	1	1	1
-800	1	1	1	1

Stab Trim Setting (20K Derate)**Flaps 5**

C.G. % MAC	6	10	14	18	22	26	30
STAB TRIM	5 1/2	5	4 1/2	3 3/4	3 1/4	2 3/4	2 1/4

For weights at or below 45360 kg subtract 1/2 unit from above value.

For weights at or above 61235 kg add 1/2 unit from above value.

Flaps 15

C.G. % MAC	6	10	14	18	22	26	30
STAB TRIM	5	4 1/4	3 3/4	3	2 1/2	1 3/4	1

For weights at or below 45360 kg subtract 1/2 unit from above value.

For weights at or above 61235 kg add 1/2 unit from above value.

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ADVISORY INFORMATION**Slush/Standing Water Takeoff (20K Derate)****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

20K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-7.4	-7.8	-8.2	-9.3	-9.7	-10.0	-13.8	-15.5	-17.1
64	-7.0	-7.4	-7.7	-8.6	-9.0	-9.4	-12.5	-14.1	-15.8
60	-6.5	-6.9	-7.2	-7.9	-8.3	-8.6	-11.1	-12.8	-14.4
56	-5.9	-6.3	-6.6	-7.1	-7.5	-7.8	-9.8	-11.4	-13.1
52	-5.2	-5.6	-6.0	-6.2	-6.6	-6.9	-8.4	-10.1	-11.7
48	-4.5	-4.8	-5.2	-5.3	-5.6	-6.0	-7.0	-8.7	-10.3
44	-3.6	-4.0	-4.4	-4.2	-4.6	-5.0	-5.6	-7.3	-9.0
40	-2.7	-3.1	-3.5	-3.1	-3.5	-3.9	-4.2	-5.9	-7.5
36	-1.7	-2.1	-2.5	-2.0	-2.4	-2.7	-2.8	-4.5	-6.1

V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
4200							28.5		
4600	28.5			30.4			34.0		
5000	34.5			36.3			39.7		
5400	40.7			42.4	29.9		46.1	33.5	
5800	47.2	33.9		49.1	35.7		53.0	39.1	
6200	54.0	40.0		56.0	41.8	29.3	60.1	45.4	32.9
6600	60.8	46.5	33.3	62.8	48.4	35.1	66.8	52.3	38.5
7000	67.3	53.3	39.4	69.3	55.3	41.2	73.1	59.4	44.7
7400	73.7	60.1	45.9	75.6	62.1	47.7		66.2	51.6
7800			66.7	52.6		68.6	54.6		72.4
8200			73.0	59.4		74.9	61.5		65.5
8600				66.0			68.0		71.8
9000				72.4			74.3		

- Enter Weight Adjustment table with slush/standing water depth and 20K Derate dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
- Adjust field length available by -110 ft/+100 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

ADVISORY INFORMATION**Slush/Standing Water Takeoff (20K Derate)****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.
64	-10	-6	-2	-4	0	0	0	0	0
60	-13	-9	-5	-7	-3	0	0	0	0
56	-15	-11	-7	-9	-5	-1	0	0	0
52	-16	-12	-8	-11	-7	-3	0	0	0
48	-18	-14	-10	-13	-9	-5	-3	0	0
44	-19	-15	-11	-14	-10	-6	-6	-2	0
40	-20	-16	-12	-16	-12	-8	-9	-5	-1
36	-20	-16	-12	-18	-14	-10	-12	-8	-4

1. Obtain V1, VR and V2 for the actual weight using the 20K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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ADVISORY INFORMATION**Slush/Standing Water Takeoff (20K Derate)****No Reverse Thrust****Weight Adjustment (1000 KG)**

20K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-10.7	-11.4	-12.0	-13.0	-13.6	-14.3	-18.3	-19.8	-21.3
64	-10.0	-10.7	-11.3	-11.9	-12.6	-13.2	-16.3	-17.8	-19.2
60	-9.3	-9.9	-10.6	-10.8	-11.5	-12.2	-14.4	-15.9	-17.3
56	-8.5	-9.1	-9.8	-9.7	-10.4	-11.0	-12.6	-14.0	-15.5
52	-7.6	-8.3	-8.9	-8.6	-9.3	-9.9	-10.8	-12.3	-13.8
48	-6.7	-7.3	-8.0	-7.4	-8.1	-8.8	-9.2	-10.7	-12.2
44	-5.7	-6.3	-7.0	-6.3	-6.9	-7.6	-7.7	-9.2	-10.7
40	-4.6	-5.3	-5.9	-5.1	-5.7	-6.4	-6.3	-7.8	-9.2
36	-3.5	-4.1	-4.8	-3.8	-4.5	-5.1	-4.9	-6.4	-7.9

V1(MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH							
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
5800							30.5	
6200							35.6	
6600			29.6				41.5	
7000	28.9			35.5			50.0	30.5
7400	35.5			42.2			59.2	35.6
7800	42.7			50.7	29.6		65.9	41.5
8200	50.9	28.9		58.9	35.5		70.9	50.0
8600	58.5	35.5		65.1	42.2		75.7	59.2
9000	64.5	42.7		69.8	50.7	29.6	65.9	41.5
9400	69.4	50.9	28.9	74.4	58.9	35.5		70.9
9800	73.9	58.5	35.5		65.1	42.2		75.7
10200		64.5	42.7		69.8	50.7		65.9
10600		69.4	50.9		74.4	58.9		70.9
11000		73.9	58.5			65.1		75.7
11400			64.5			69.8		
11800			69.4			74.4		
12200			73.9					

- Enter Weight Adjustment table with slush/standing water depth and 20K Derate dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
- Adjust field length available by -170 ft/+140 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for available field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slush/Standing Water Takeoff (20K Derate)****No Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3 mm)			0.25 INCHES (6 mm)			0.50 INCHES (13 mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.
60	-22	-18	-14	-12	-8	-4	0	0	0
56	-25	-21	-17	-15	-11	-7	0	0	0
52	-27	-23	-19	-19	-15	-11	-1	0	0
48	-30	-26	-22	-22	-18	-14	-6	-2	0
44	-32	-28	-24	-25	-21	-17	-12	-8	-4
40	-34	-30	-26	-29	-25	-21	-18	-14	-10
36	-36	-32	-28	-32	-28	-24	-25	-21	-17

1. Obtain V1, VR and V2 for the actual weight using 20K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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ADVISORY INFORMATION**Slippery Runway Takeoff (20K Derate)****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

20K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	0.0	0.0	-3.7	-3.7	-3.7	-6.8	-6.8	-6.8
64	-0.3	-0.3	-0.3	-4.0	-4.0	-4.0	-7.0	-7.0
60	-0.7	-0.7	-0.7	-4.2	-4.2	-4.2	-6.9	-6.9
56	-0.9	-0.9	-0.9	-4.1	-4.1	-4.1	-6.6	-6.6
52	-0.9	-0.9	-0.9	-3.9	-3.9	-3.9	-6.1	-6.1
48	-0.8	-0.8	-0.8	-3.5	-3.5	-3.5	-5.5	-5.5
44	-0.6	-0.6	-0.6	-3.0	-3.0	-3.0	-4.8	-4.8
40	-0.3	-0.3	-0.3	-2.5	-2.5	-2.5	-4.0	-4.0
36	0.0	0.0	0.0	-1.8	-1.8	-1.8	-3.1	-3.1

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
3800	34.7							
4200	45.2	31.6						
4600	55.7	42.1	28.4	28.5				
5000	66.3	52.6	38.9	36.5				
5400		63.1	49.4	44.4	30.9			
5800		73.6	59.9	52.3	38.9	29.4		
6200			70.5	60.3	46.8	33.3	34.9	
6600					68.2	54.7	41.2	40.4
7000						62.6	49.2	45.9
7400						70.6	57.1	51.3
7800							65.0	56.8
8200							72.9	62.3
8600								67.7
9000								54.1
9400								73.2
9800								59.5
10200								65.0
10600								51.3
11000								40.4

- Enter Weight Adjustment table with reported braking action and 20K Derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Find V1(MCG) limit weight for available field length and pressure altitude.
Adjust "Good" field length available by -90 ft/+90 ft for every 5°C above/below 4°C.
Adjust "Medium" field length available by -90 ft/+90 ft for every 5°C above/below 4°C.
Adjust "Poor" field length available by -120 ft/+110 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for available field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

ADVISORY INFORMATION**Slippery Runway Takeoff (20K Derate)****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION									
	GOOD			MEDIUM			POOR			
	PRESS ALT (FT)		S.L.	4000	8000	S.L.	4000	8000	S.L.	4000
68	-2	-1	0	-10	-9	-8	-19	-17	-16	
64	-4	-3	-2	-12	-11	-10	-21	-20	-18	
60	-6	-4	-3	-14	-13	-12	-23	-22	-21	
56	-7	-6	-5	-16	-15	-14	-26	-25	-24	
52	-9	-7	-6	-18	-17	-16	-29	-28	-26	
48	-10	-8	-7	-20	-19	-18	-31	-30	-29	
44	-11	-9	-8	-22	-20	-19	-33	-32	-31	
40	-11	-10	-9	-23	-21	-20	-35	-33	-32	
36	-11	-10	-9	-23	-22	-21	-35	-34	-33	

1. Obtain V1, VR and V2 for the actual weight using 20K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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ADVISORY INFORMATION**Slippery Runway Takeoff (20K Derate)****No Reverse Thrust****Weight Adjustment (1000 KG)**

20K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-1.2	-1.2	-1.2	-6.3	-6.3	-6.3	-10.4	-10.4
64	-1.7	-1.7	-1.7	-6.6	-6.6	-6.6	-10.4	-10.4
60	-2.1	-2.1	-2.1	-6.7	-6.7	-6.7	-10.1	-10.1
56	-2.3	-2.3	-2.3	-6.5	-6.5	-6.5	-9.5	-9.5
52	-2.4	-2.4	-2.4	-6.2	-6.2	-6.2	-8.8	-8.8
48	-2.3	-2.3	-2.3	-5.7	-5.7	-5.7	-7.9	-7.9
44	-2.1	-2.1	-2.1	-5.1	-5.1	-5.1	-7.0	-7.0
40	-1.8	-1.8	-1.8	-4.4	-4.4	-4.4	-6.2	-6.2
36	-1.3	-1.3	-1.3	-3.6	-3.6	-3.6	-5.5	-5.5

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
4600	36.7							
5000	50.7	33.8						
5400	64.7	47.9	31.0					
5800		61.9	45.1					
6200		76.0	59.1					
6600			73.2	29.7				
7000				41.7				
7400				53.7	30.9			
7800				65.7	42.9			
8200					54.9	32.1		
8600					66.9	44.1		
9000						56.1		
9400						68.1		
10200							31.2	
10600							39.3	
11000							47.5	
11400							55.7	
11800							63.8	
12200							72.0	45.9
12600								54.0
13000								62.2
13400								36.1
13800							70.4	44.2
14200								52.4
14600								60.6
								68.7

- Enter Weight Adjustment table with reported braking action and 20K Derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Find V1(MCG) limit weight for available field length and pressure altitude.
Adjust "Good" field length available by -110 ft/+100 ft for every 5°C above/below 4°C.
Adjust "Medium" field length available by -110 ft/+100 ft for every 5°C above/below 4°C.
Adjust "Poor" field length available by -180 ft/+180 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

ADVISORY INFORMATION**Slippery Runway Takeoff (20K Derate)****No Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION									
	GOOD			MEDIUM			POOR			
	PRESS ALT (FT)		S.L.	4000	8000	S.L.	4000	8000	S.L.	4000
68	-4	-1	0	-15	-12	-9	-34	-31	-28	
64	-6	-3	-1	-18	-15	-12	-38	-35	-32	
60	-8	-6	-3	-22	-19	-16	-42	-40	-37	
56	-10	-8	-5	-25	-22	-19	-47	-44	-41	
52	-12	-10	-7	-28	-25	-23	-51	-49	-46	
48	-14	-12	-9	-31	-28	-26	-56	-53	-50	
44	-16	-13	-10	-34	-31	-29	-61	-58	-55	
40	-18	-15	-12	-37	-34	-32	-65	-62	-60	
36	-19	-16	-14	-40	-37	-34	-70	-67	-64	

1. Obtain V1, VR and V2 for the actual weight using the 20K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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Takeoff %N1 (20K Derate)**Based on engine bleed to packs on (Auto) and anti-ice on or off**

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	89.9	90.5								
50	122	90.6	91.1	91.6	92.3	93.1					
45	113	91.2	91.6	92.1	92.6	93.9	94.9	94.7	94.2		
40	104	91.7	92.1	92.6	93.0	94.3	95.3	95.3	95.3	95.0	94.3
35	95	92.0	92.5	93.0	93.4	94.7	95.9	95.8	95.8	95.1	94.5
30	86	91.8	92.8	93.2	93.6	95.0	96.5	96.4	96.4	95.7	95.0
25	77	91.0	92.1	92.9	93.6	94.5	95.9	96.3	96.7	96.2	95.6
20	68	90.3	91.3	92.1	92.8	93.8	95.1	95.5	95.9	95.9	95.9
15	59	89.5	90.5	91.3	92.0	93.0	94.3	94.7	95.1	95.3	95.3
10	50	88.7	89.7	90.5	91.2	92.1	93.4	93.9	94.3	94.4	94.6
5	41	87.9	88.9	89.7	90.4	91.3	92.6	93.0	93.4	93.6	93.7
0	32	87.1	88.1	88.9	89.6	90.5	91.8	92.2	92.6	92.7	92.9
-10	14	85.5	86.5	87.2	87.9	88.8	90.1	90.5	90.9	91.0	91.2
-20	-4	83.9	84.8	85.6	86.2	87.1	88.3	88.7	89.1	89.2	89.4
-30	-22	82.2	83.1	83.9	84.5	85.4	86.6	87.0	87.4	87.5	87.6
-40	-40	80.5	81.4	82.1	82.7	83.6	84.8	85.1	85.5	85.7	85.8
-50	-58	78.8	79.6	80.3	81.0	81.8	82.9	83.3	83.7	83.8	84.0

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-1000	8000
ENGINE BLEED TO PACKS OFF	1.0	1.0

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Assumed Temperature Reduced Thrust (20K Derate)**Maximum Assumed Temperature (Table 1)****Based on 25% Takeoff Thrust Reduction**

OAT (°C)	PRESS ALT (1000 FT)								OAT (°F)	PRESS ALT (1000 FT)											
	-1	0	1	2	3	4	5	6		-1	0	1	2	3	4	5	6	7	8		
55	74	73	73						130	164	162	162									
50	71	71	69	68	66	65			120	159	158	155	153	149	147						
45	69	68	67	66	63	62	62	63	65	110	154	153	151	149	144	142	142	143	145		
40	66	66	65	64	61	60	60	60	62	100	150	148	146	145	140	138	138	137	139	141	
35	64	63	62	62	59	58	58	57	59	60	90	146	143	142	141	137	134	133	132	136	137
30	63	61	61	60	58	56	55	55	56	58	80	146	141	140	137	135	131	129	128	131	132
25	63	61	60	58	57	55	54	53	54	55	70	146	141	140	136	134	131	129	127	127	126
20 & BELOW	63	61	60	58	57	55	54	53	53	52	60 & BELOW	146	141	140	136	134	131	129	127	127	126

Maximum Takeoff %N1 (Table 2)**Based on engine bleed to packs on (Auto) and engine anti-ice on or off**

ASSUMED TEMP		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
75	167	83.0	83.9	83.8	83.5						
70	158	84.7	85.6	85.6	85.4	84.9	84.7				
65	149	86.6	87.3	87.3	87.2	87.0	87.0	87.1	87.2	87.6	87.9
60	140	88.3	88.9	89.0	89.0	89.1	89.1	89.1	89.0	89.1	89.3
55	131	89.7	90.5	90.6	90.7	91.1	91.3	91.0	90.8	90.7	90.6
50	122	90.4	91.1	91.6	92.3	93.1	93.4	92.9	92.5	92.2	91.9
45	113	91.0	91.6	92.1	92.7	93.9	94.9	94.8	94.2	93.7	93.1
40	104	91.6	92.1	92.6	93.0	94.3	95.3	95.3	95.3	95.0	94.3
35	95	92.0	92.5	93.0	93.4	94.8	95.9	95.9	95.8	95.1	94.5
30	86	91.7	92.8	93.2	93.6	95.0	96.5	96.4	96.4	95.7	95.0
25	77	90.9		92.9	93.7	94.5	95.9	96.5	96.7	96.2	95.6
20	68	90.2				93.8				95.9	95.9
15	59	89.4									95.4
MINIMUM ASSUMED TEMP °C (°F)		32(90)	30(86)	28(82)	26(79)	24(75)	29(85)	27(81)	25(77)	20(68)	15(59)

With engine bleed to packs off, increase %N1 by 1.0.

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Assumed Temperature Reduced Thrust (20K Derate)**%N1 Adjustment For Temperature Difference (Table 3)**

ASSUMED TEMP MINUS OAT		OUTSIDE AIR TEMPERATURE														
°C	°F	°C	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
		°F	-40	-4	32	41	50	59	68	77	86	95	104	113	122	131
10	18				1.6	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3		
20	36			3.3	3.3	3.1	3.1	3.0	3.0	2.9	2.8	2.7	2.6	2.5	2.3	
30	54			4.8	4.7	4.6	4.5	4.4	4.3	4.1	3.9	3.7	3.5	3.4	3.3	
40	72			6.8	6.1	6.0	5.9	5.7	5.5	5.3	5.1	4.9				
50	90			8.1	7.4	7.2	6.9	6.7	6.3							
60	108		10.4	9.3	8.4	8.1	7.7									
70	126		11.5	10.5	9.0											
80	144		12.7	11.4	9.8											
90	162		13.8	11.9												
100	180		14.5	12.6												
110	198		14.9													

1. Determine Maximum Assumed Temperature allowed from Table 1.
2. Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).
3. Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.
4. Subtract %N1 adjustment from Maximum %N1 in Table 2.

Max Climb %N1

Based on engine bleed to packs on (Auto) and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)								
	0	5	10	15	20	25	30	35	37
250	250	250	280	280	280	.74	.74	.74	.74
50	93.7	93.9	94.1						
40	93.9	94.0	94.3	95.0	95.2				
30	93.8	94.8	95.1	95.8	96.0	96.0			
20	92.2	94.4	96.1	96.8	97.1	97.1	97.1		
10	90.6	92.8	95.2	97.3	98.3	98.5	98.6	98.6	98.6
0	89.0	91.1	93.5	95.5	98.2	100.1	100.3	100.3	100.3
-10	87.4	89.4	91.8	93.8	96.4	98.8	101.4	102.1	102.1
-20	85.7	87.7	90.0	92.0	94.5	96.9	99.4	102.3	102.5
-30	84.0	86.0	88.3	90.1	92.6	95.0	97.4	100.3	100.5
-40	82.3	84.2	86.4	88.3	90.7	93.0	95.4	98.2	98.4
-50	80.5	82.3	84.5	86.4	88.8	91.0	93.4	96.1	96.3

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	0	5	10	15	20	25	30	35	37
ENGINE BLEED TO PACKS OFF	1.0	0.9	0.9	1.0	1.0	1.0	1.1	1.1	1.1
PACKS HIGH	-0.2	-0.2	-0.3	-0.3	-0.4	-0.4	-0.4	-0.4	-0.4
ENGINE ANTI-ICE ON	-0.6	-0.7	-0.7	-0.8	-0.9	-0.9	-0.9	-0.9	-0.9
ENGINE & WING ANTI-ICE ON	-1.5	-1.6	-1.7	-2.0	-2.3	-2.6	-2.8	-3.1	-3.1

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Go-around %N1

Based on engine bleed to packs on (Auto), engine anti-ice on or off, and wing anti-ice off

REPORTED OAT		TAT	AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	(°C)	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	58	93.6	93.7	93.6	93.4						
50	122	53	94.9	95.1	95.0	94.9	94.9	94.4				
45	113	48	95.5	95.9	95.9	96.0	95.9	95.5	95.5	95.7	95.8	
40	104	43	96.0	96.7	96.6	96.6	96.5	96.5	96.5	96.5	96.5	96.5
35	95	38	96.5	97.3	97.3	97.2	97.2	97.2	97.3	97.3	97.3	97.2
30	86	33	96.5	97.7	97.9	97.9	97.9	97.9	98.0	98.0	98.1	98.0
25	77	28	95.7	96.9	97.4	98.2	98.7	98.7	98.8	98.8	99.0	98.8
20	68	23	94.9	96.1	96.6	97.4	98.0	98.6	99.2	99.5	99.6	99.5
15	59	18	94.1	95.2	95.8	96.5	97.1	97.8	98.4	99.0	99.7	100.1
10	50	13	93.2	94.4	95.0	95.7	96.3	96.9	97.5	98.2	98.8	99.3
5	41	8	92.4	93.6	94.1	94.8	95.5	96.1	96.7	97.3	97.9	98.4
0	32	3	91.6	92.7	93.3	94.0	94.6	95.2	95.8	96.4	97.0	97.5
-10	14	-8	89.8	91.0	91.5	92.3	92.8	93.4	94.0	94.6	95.2	95.7
-20	-4	-18	88.1	89.3	89.8	90.5	91.1	91.6	92.2	92.8	93.4	93.9
-30	-22	-28	86.3	87.5	88.0	88.7	89.2	89.8	90.4	91.0	91.5	92.0
-40	-40	-38	84.5	85.7	86.2	86.8	87.4	87.9	88.5	89.1	89.6	90.1
-50	-58	-48	82.7	83.8	84.3	85.0	85.5	86.0	86.6	87.2	87.7	88.1

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	TAT (°C)	
	-50	+60
ENGINE BLEED TO PACKS OFF	1.0	1.2
PACKS HIGH	-0.2	-0.3
WING A/I ALL ENGINES	-1.3	-1.7
WING A/I 1 ENGINE INOP	-2.1	-2.6

Flight With Unreliable Airspeed / Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.
Climb**Flaps Up, Set Max Climb Thrust**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		36	44	52	60	68
35000 (.73M)	PITCH ATT V/S (FT/MIN)	6.5 2800	6.0 2000	5.5 1300	5.5 700	5.5 100
30000 (.73M)	PITCH ATT V/S (FT/MIN)	7.0 3700	6.0 2800	6.0 2100	5.5 1500	5.5 1000
25000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	7.0 3600	6.5 2800	6.0 2200	6.0 1700	6.0 1300
20000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	9.0 4400	8.0 3500	7.5 2800	7.0 2200	7.0 1800
15000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	10.5 5200	9.5 4100	9.0 3300	8.5 2700	8.0 2200
10000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	12.5 5900	11.0 4700	10.0 3900	9.5 3200	9.5 2700
5000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	14.5 6700	13.0 5400	11.5 4400	11.0 3700	10.5 3100
SEA LEVEL (280 KIAS)	PITCH ATT V/S (FT/MIN)	17.0 7400	15.0 6000	13.5 4900	12.5 4200	11.5 3500

Cruise**Flaps Up, Adjust %N1 for Level Flight**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		36	44	52	60	68
30000 (.73M)	PITCH ATT %N1	2.0 79	2.5 81	3.0 83	3.5 85	4.0 87
10000 (280 KIAS)	PITCH ATT %N1	2.0 66	2.5 67	3.5 69	4.0 70	4.5 72

Descent**Flaps Up, Set Idle Thrust**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		36	44	52	60	68
30000 (.73M)	PITCH ATT V/S (FT/MIN)	-3.5 -4100	-2.0 -3600	-1.5 -3300	-0.5 -3100	0.0 -3100
20000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	-2.0 -2800	-1.0 -2400	0.0 -2200	0.5 -2100	1.5 -2000
10000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	-2.5 -2500	-1.0 -2100	0.0 -2000	0.5 -1800	1.5 -1800

Holding**Flaps Up, Adjust %N1 for Level Flight**

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)				
		36	44	52	60	68
10000	PITCH ATT %N1 KIAS	4.5 57 210	5.5 60 210	5.5 64 230	5.5 68 245	5.5 72 265

737 Flight Crew Operations Manual

Flight With Unreliable Airspeed / Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

Terminal Area**Adjust %N1 for Level Flight**

FLAP POSITION (SPEED)		WEIGHT (1000 KG)				
		36	44	52	60	68
FLAPS UP (GEAR UP)	PITCH ATT	4.5	5.5	6.5	7.0	7.5
	%N1	54.7	57.4	60.5	64.0	67.5
	KIAS	210	210	210	220	230
FLAPS 1 (GEAR UP)	PITCH ATT	4.5	6.0	7.5	7.5	8.0
	%N1	56.1	58.8	62.1	65.9	69.4
	KIAS	190	190	190	200	210
FLAPS 5 (GEAR UP)	PITCH ATT	4.0	5.5	7.0	7.0	7.5
	%N1	56.3	59.4	63.1	67.0	70.5
	KIAS	180	180	180	190	200
FLAPS 15 (GEAR DOWN)	PITCH ATT	5.0	6.5	8.5	8.5	8.5
	%N1	62.0	66.3	70.5	74.6	78.2
	KIAS	150	150	150	160	170

Final Approach**Gear Down, Adjust %N1 for 3° Glideslope**

FLAP POSITION		WEIGHT (1000 KG)				
		36	44	52	60	68
FLAPS 15 (VREF15+10)	PITCH ATT	4.0	4.0	4.0	4.0	4.0
	%N1	45	50	54	58	61
	KIAS	135	149	162	174	185
FLAPS 30 (VREF30+10)	PITCH ATT	2.0	2.0	2.0	2.0	2.5
	%N1	50	55	60	64	67
	KIAS	123	135	147	158	167
FLAPS 40 (VREF40+10)	PITCH ATT	0.5	0.5	0.5	0.5	0.5
	%N1	57	62	67	71	74
	KIAS	120	132	143	154	163

Intentionally
Blank

Performance Inflight**All Engines****Chapter PI****Section 21****Long Range Cruise Maximum Operating Altitude****Max Cruise Thrust****ISA + 10°C and Below**

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
68	29500	-7	32800	31900	31000	29400	27900
66	30100	-8	33400	32500	31700	30000	28500
64	30800	-10	34100	33200	32300	30700	29200
62	31500	-11	34700	33800	33000	31400	29900
60	32200	-13	35400	34500	33700	32100	30600
58	32900	-14	36100	35300	34400	32800	31400
56	33700	-16	36900	36000	35200	33600	32100
54	34400	-18	37000	36700	35900	34400	32900
52	35200	-19	37000	37000	36700	35200	33700
50	36100	-21	37000	37000	37000	36000	34500
48	36900	-21	37000	37000	37000	36800	35400
46	37000	-21	37000	37000	37000	37000	36300
44	37000	-21	37000	37000	37000	37000	37000

ISA + 15°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
68	29500	-1	32400*	31900	31000	29400	27900
66	30100	-3	33200*	32500	31700	30000	28500
64	30800	-4	34000*	33200	32300	30700	29200
62	31500	-6	34700	33800	33000	31400	29900
60	32200	-7	35400	34500	33700	32100	30600
58	32900	-9	36100	35300	34400	32800	31400
56	33700	-10	36900	36000	35200	33600	32100
54	34400	-12	37000	36700	35900	34400	32900
52	35200	-14	37000	37000	36700	35200	33700
50	36100	-16	37000	37000	37000	36000	34500
48	36900	-16	37000	37000	37000	36800	35400
46	37000	-16	37000	37000	37000	37000	36300
44	37000	-16	37000	37000	37000	37000	37000

ISA + 20°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
68	29500	4	31500*	31500*	31000	29400	27900
66	30100	3	32400*	32400*	31700	30000	28500
64	30800	1	33300*	33200	32300	30700	29200
62	31500	0	34100*	33800	33000	31400	29900
60	32200	-2	35000*	34500	33700	32100	30600
58	32900	-3	35900*	35300	34400	32800	31400
56	33700	-5	36600*	36000	35200	33600	32100
54	34400	-7	37000	36700	35900	34400	32900
52	35200	-8	37000	37000	36700	35200	33700
50	36100	-10	37000	37000	37000	36000	34500
48	36900	-10	37000	37000	37000	36800	35400
46	37000	-10	37000	37000	37000	37000	36300
44	37000	-10	37000	37000	37000	37000	37000

*Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.

Long Range Cruise Control

WEIGHT (1000 KG)	%N1	PRESSURE ALTITUDE (1000 FT)							
		21	23	25	27	29	31	33	35
66	%N1	82.7	83.8	84.7	85.6	86.6	88.0	90.2	
	MACH	.713	.730	.742	.745	.745	.745	.745	
	KIAS	324	319	311	300	287	275	263	
	FF/ENG	1610	1581	1547	1498	1457	1433	1437	
62	%N1	81.5	82.6	83.6	84.6	85.4	86.5	88.2	90.9
	MACH	.698	.718	.734	.744	.745	.745	.745	.744
	KIAS	317	313	308	299	287	275	263	251
	FF/ENG	1525	1502	1473	1439	1391	1357	1341	1363
58	%N1	80.2	81.3	82.4	83.4	84.3	85.2	86.4	88.3
	MACH	.682	.703	.722	.737	.744	.745	.745	.742
	KIAS	309	306	302	296	287	275	263	251
	FF/ENG	1440	1420	1397	1369	1331	1289	1261	1253
54	%N1	78.8	79.9	81.1	82.1	83.2	84.0	85.0	86.3
	MACH	.665	.685	.707	.725	.740	.745	.745	.745
	KIAS	301	298	295	291	285	275	263	251
	FF/ENG	1356	1336	1317	1294	1267	1228	1191	1168
50	%N1	77.2	78.4	79.6	80.7	81.8	82.8	83.6	84.6
	MACH	.646	.667	.688	.709	.728	.741	.745	.745
	KIAS	292	289	287	284	280	274	263	251
	FF/ENG	1270	1253	1233	1216	1194	1167	1130	1098
46	%N1	75.5	76.7	77.9	79.1	80.3	81.3	82.3	83.2
	MACH	.625	.647	.668	.689	.710	.729	.742	.745
	KIAS	282	280	278	276	273	269	262	251
	FF/ENG	1184	1168	1151	1132	1117	1096	1071	1035
42	%N1	73.6	74.9	76.1	77.4	78.5	79.7	80.8	81.8
	MACH	.603	.624	.646	.667	.688	.710	.729	.743
	KIAS	271	270	268	266	264	261	257	250
	FF/ENG	1098	1084	1068	1050	1034	1020	1000	978
38	%N1	71.6	72.8	74.1	75.4	76.6	77.8	79.0	80.1
	MACH	.579	.599	.621	.643	.664	.686	.709	.728
	KIAS	260	259	257	256	254	252	249	245
	FF/ENG	1012	1000	984	967	953	939	925	908

Shaded area approximates optimum altitude.

737 Flight Crew Operations Manual

Long Range Cruise Enroute Fuel and Time - Low Altitudes
Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
279	259	241	226	212	200	191	182	174	167	161	
421	390	362	339	318	300	286	273	262	251	242	
563	521	484	452	425	400	382	365	349	336	323	
706	653	606	566	531	500	477	456	437	420	404	
849	785	729	680	638	600	573	548	525	504	485	
992	917	851	794	744	700	669	639	612	588	566	
1136	1050	973	908	851	800	764	731	700	672	646	
1280	1183	1096	1022	958	900	859	822	787	755	727	
1425	1316	1219	1136	1064	1000	955	913	874	839	807	
1570	1449	1342	1251	1171	1100	1050	1004	961	922	888	
1716	1583	1465	1365	1278	1200	1145	1095	1048	1006	968	
1862	1718	1589	1480	1385	1300	1241	1186	1135	1090	1049	
2009	1852	1713	1595	1492	1400	1336	1277	1223	1173	1129	
2156	1987	1837	1709	1599	1500	1431	1368	1310	1257	1209	
2304	2122	1961	1824	1706	1600	1527	1459	1397	1340	1289	
2452	2258	2085	1939	1813	1700	1622	1550	1484	1423	1369	
2601	2394	2210	2055	1920	1800	1717	1641	1571	1507	1449	
2750	2530	2335	2170	2028	1900	1813	1732	1658	1590	1529	
2900	2667	2460	2286	2135	2000	1908	1823	1745	1673	1609	

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	1.5	0:38	1.4	0:37	1.1	0:36	1.0	0:35	0.9	0:35
300	2.3	0:56	2.1	0:54	1.8	0:51	1.6	0:50	1.5	0:49
400	3.1	1:14	2.8	1:11	2.4	1:07	2.2	1:05	2.0	1:03
500	3.9	1:32	3.5	1:28	3.1	1:23	2.8	1:20	2.6	1:17
600	4.6	1:50	4.2	1:45	3.7	1:38	3.4	1:35	3.1	1:31
700	5.4	2:08	5.0	2:02	4.3	1:54	4.0	1:50	3.7	1:46
800	6.2	2:26	5.7	2:19	5.0	2:10	4.6	2:05	4.2	2:00
900	6.9	2:45	6.4	2:37	5.6	2:26	5.2	2:20	4.8	2:15
1000	7.7	3:03	7.1	2:54	6.2	2:42	5.7	2:35	5.3	2:29
1100	8.4	3:22	7.8	3:12	6.8	2:58	6.3	2:51	5.8	2:44
1200	9.2	3:41	8.5	3:30	7.4	3:15	6.9	3:06	6.4	2:58
1300	9.9	4:00	9.1	3:48	8.0	3:31	7.5	3:21	6.9	3:13
1400	10.7	4:19	9.8	4:06	8.7	3:48	8.0	3:37	7.4	3:28
1500	11.4	4:38	10.5	4:24	9.3	4:04	8.6	3:53	7.9	3:42
1600	12.1	4:57	11.2	4:42	9.9	4:21	9.1	4:08	8.5	3:57
1700	12.8	5:17	11.8	5:01	10.5	4:38	9.7	4:24	9.0	4:12
1800	13.6	5:36	12.5	5:19	11.0	4:55	10.2	4:40	9.5	4:27
1900	14.3	5:56	13.2	5:38	11.6	5:12	10.8	4:56	10.0	4:42
2000	15.0	6:16	13.8	5:57	12.2	5:29	11.3	5:12	10.5	4:57

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	35	45	50	55	65
5	-0.6	-0.2	0.0	0.2	0.8
10	-1.1	-0.4	0.0	0.5	1.5
15	-1.7	-0.6	0.0	0.7	2.3

737 Flight Crew Operations Manual

**Long Range Cruise Enroute Fuel and Time - High Altitudes
Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
269	252	236	223	211	200	191	182	174	167	161	
530	498	468	443	421	400	382	365	349	336	323	
791	744	702	664	631	600	573	548	525	504	485	
1052	991	935	885	841	800	764	731	700	672	647	
1315	1238	1168	1106	1051	1000	955	914	875	840	809	
1578	1486	1402	1328	1261	1200	1146	1096	1051	1009	971	
1842	1734	1635	1549	1471	1400	1337	1279	1226	1177	1133	
2107	1983	1870	1771	1682	1600	1529	1463	1402	1347	1296	
2372	2232	2105	1993	1892	1800	1720	1646	1578	1515	1458	
2638	2482	2341	2215	2103	2000	1911	1829	1753	1683	1620	
2905	2732	2575	2437	2313	2200	2102	2012	1928	1852	1782	
3172	2983	2811	2660	2524	2400	2293	2195	2103	2020	1944	
3441	3235	3047	2882	2735	2600	2485	2377	2279	2188	2106	
3710	3487	3285	3106	2946	2800	2676	2560	2454	2356	2268	
3981	3740	3522	3329	3157	3000	2867	2743	2629	2525	2430	

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		37	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	0.9	0:35	0.8	0:34	0.8	0:35	0.8	0:35	0.7	0:35
400	2.0	1:03	1.9	1:02	1.8	1:02	1.8	1:03	1.7	1:03
600	3.1	1:31	2.9	1:30	2.8	1:30	2.8	1:31	2.7	1:31
800	4.1	1:59	4.0	1:58	3.9	1:58	3.7	1:59	3.7	1:59
1000	5.2	2:28	5.0	2:26	4.8	2:25	4.7	2:26	4.6	2:27
1200	6.2	2:57	6.0	2:54	5.8	2:53	5.7	2:54	5.6	2:55
1400	7.3	3:26	7.0	3:23	6.8	3:21	6.6	3:22	6.5	3:23
1600	8.3	3:55	8.0	3:51	7.8	3:49	7.5	3:50	7.4	3:51
1800	9.3	4:24	9.0	4:20	8.7	4:18	8.5	4:18	8.3	4:19
2000	10.3	4:54	10.0	4:49	9.6	4:46	9.4	4:46	9.2	4:47
2200	11.3	5:24	10.9	5:18	10.6	5:15	10.3	5:14	10.1	5:15
2400	12.3	5:55	11.9	5:48	11.5	5:43	11.2	5:43	10.9	5:43
2600	13.2	6:25	12.8	6:18	12.4	6:12	12.0	6:11	11.8	6:12
2800	14.2	6:56	13.7	6:48	13.3	6:42	12.9	6:40	12.6	6:40
3000	15.1	7:27	14.6	7:18	14.2	7:11	13.8	7:08	13.5	7:08

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	35	45	50	55	65
4	-0.6	-0.2	0.0	0.5	2.5
8	-1.2	-0.4	0.0	0.9	4.3
12	-1.8	-0.6	0.0	1.2	5.2
16	-2.4	-0.8	0.0	1.4	5.3

737 Flight Crew Operations Manual

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 KG)																	
	68	66	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36	
37					9	5	2	14	8	1	0	0	0	0	0	0	0	
35						0	0	2	6	8	10	12	13	14	14	14	14	
33	9	5	2	1	0	1	3	7	12	17	20	23	26	27	29	30	30	
31	2	1	0	1	3	4	9	14	19	25	31	35	38	41	43	44	45	
29	1	2	5	8	12	17	22	28	33	39	45	50	54	57	59	60	61	
27	8	12	15	17	25	30	35	41	48	55	61	66	69	71	74	75	77	
25	19	24	28	34	39	44	51	57	63	70	78	82	86	89	92	94	96	
23	32	37	42	48	53	59	65	72	79	86	94	99	103	106	109	112	113	

The above wind factor tables are 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**Based on .74/250 descent speed**

PRESSURE ALT (1000 FT)	21	23	25	27	29	31	33	35	37
DISTANCE (NM)	66	72	78	85	91	97	103	109	114
TIME (MINUTES)	15	16	18	18	19	20	21	22	23

Holding**Flaps Up**

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)								
	1500	5000	10000	15000	20000	25000	30000	35000	37000
66	%N1	63.7	66.7	70.8	74.7	78.5	82.3	86.1	
	KIAS	255	256	259	261	263	265	263	
	FF/ENG	1500	1480	1460	1440	1420	1420	1420	
62	%N1	62.1	64.9	69.2	73.2	77.0	80.8	84.6	90.6
	KIAS	247	248	250	253	255	257	256	249
	FF/ENG	1410	1390	1370	1350	1340	1330	1330	1410
58	%N1	60.5	63.1	67.4	71.4	75.4	79.2	83.0	87.5
	KIAS	239	240	241	244	246	248	248	239
	FF/ENG	1330	1310	1290	1270	1250	1250	1240	1370
54	%N1	58.9	61.3	65.4	69.6	73.6	77.5	81.3	85.3
	KIAS	231	231	232	235	237	239	241	238
	FF/ENG	1260	1230	1210	1190	1170	1160	1150	1200
50	%N1	57.2	59.5	63.3	67.6	71.7	75.6	79.5	83.3
	KIAS	224	223	223	225	227	230	232	228
	FF/ENG	1180	1150	1130	1110	1090	1080	1070	1080
46	%N1	55.5	57.7	61.1	65.4	69.6	73.6	77.5	81.4
	KIAS	216	214	214	215	218	220	222	221
	FF/ENG	1110	1070	1050	1030	1010	1000	980	990
42	%N1	53.7	56.0	59.3	63.3	67.5	71.5	75.4	79.3
	KIAS	210	210	210	210	210	210	212	212
	FF/ENG	1040	1010	990	960	930	920	900	900
38	%N1	52.4	54.7	57.9	61.5	65.7	69.7	73.5	77.4
	KIAS	210	210	210	210	210	210	210	210
	FF/ENG	990	960	940	900	880	860	840	840

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

Performance Inflight

Advisory Information

Chapter PI

Section 22

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 15

Dry Runway

	LANDING DISTANCE AND ADJUSTMENTS (FT)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	VREF ADJ	REVERSE THRUST ADJ	PER 10 KTS ABOVE VREF15	ONE REV	NO REV	
BRAKING CONFIGURATION	52000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 52000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA			
MAX MANUAL	3110	470/-220	70	-110	390	40	-40	70	-70	230	70	210
MAX AUTO	4030	350/-290	90	-140	480	0	0	100	-100	380	0	50
AUTOBRAKE 3	5800	460/-480	160	-240	800	20	-40	160	-160	540	50	80
AUTOBRAKE 2	6870	620/-630	210	-310	1040	140	-160	190	-190	500	420	440
AUTOBRAKE 1	7410	720/-710	240	-360	1210	230	-250	210	-210	490	900	1490

Good Reported Braking Action

MAX MANUAL	4160	320/-310	110	-180	620	100	-80	100	-100	290	230	750
MAX AUTO	4480	340/-340	110	-190	640	80	-70	110	-110	340	260	840
AUTOBRAKE 3	5810	470/-480	160	-240	810	40	-50	160	-160	540	60	210
AUTOBRAKE 2	6870	620/-630	210	-310	1040	140	-160	190	-190	500	420	440
AUTOBRAKE 1	7410	720/-710	240	-360	1210	230	-250	210	-210	490	900	1490

Medium Reported Braking Action

MAX MANUAL	5600	490/-470	160	-280	1000	230	-180	150	-150	370	610	2370
MAX AUTO	5690	500/-490	170	-280	1010	200	-160	150	-150	430	620	2390
AUTOBRAKE 3	6230	530/-520	180	-300	1060	160	-130	170	-170	540	410	2150
AUTOBRAKE 2	7020	640/-640	210	-330	1170	220	-210	200	-200	500	510	1570
AUTOBRAKE 1	7440	730/-710	250	-360	1250	290	-260	210	-210	490	930	2080

Poor Reported Braking Action

MAX MANUAL	7120	680/-640	230	-400	1530	510	-350	190	-190	440	1230	6390
MAX AUTO	7120	680/-640	230	-400	1530	500	-330	190	-190	470	1210	6400
AUTOBRAKE 3	7240	690/-650	230	-410	1540	470	-310	200	-200	530	1220	6440
AUTOBRAKE 2	7650	730/-700	240	-420	1590	480	-340	210	-210	500	1090	5940
AUTOBRAKE 1	7910	770/-760	260	-440	1630	510	-390	220	-220	490	1260	5990

Reference distance is for sea level, standard day, no wind or slope, VREF15 approach speed and two engine detent reverse thrust.

Max manual braking data valid for auto speedbrakes. Autobrakes data valid for both auto and manual speedbrakes.

For max manual braking and manual speedbrakes, increase reference landing distance by 330 ft.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Normal Configuration Landing Distance****Flaps 30****Dry Runway**

	LANDING DISTANCE AND ADJUSTMENTS (FT)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	VREF ADJ	REVERSE THRUST ADJ				
BRAKING CONFIGURATION	52000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 52000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF30		
MAX MANUAL	2740	330/-160	60	-100	340	30	-30	60	-60	210	40	140
MAX AUTO	3510	260/-230	80	-130	430	0	0	80	-80	340	0	20
AUTOBRAKE 3	4950	380/-380	130	-220	730	20	-30	130	-130	510	40	50
AUTOBRAKE 2	5950	510/-520	170	-280	960	90	-130	160	-160	480	200	200
AUTOBRAKE 1	6450	600/-580	200	-330	1130	190	-210	180	-180	470	660	990

Good Reported Braking Action

MAX MANUAL	3750	270/-270	90	-170	590	90	-80	90	-90	290	180	630
MAX AUTO	4000	290/-290	100	-170	610	70	-60	90	-90	340	210	690
AUTOBRAKE 3	4960	380/-380	130	-220	740	30	-40	130	-130	510	50	190
AUTOBRAKE 2	5950	510/-520	170	-280	960	90	-130	160	-160	480	200	200
AUTOBRAKE 1	6450	600/-580	200	-330	1130	190	-210	180	-180	470	660	990

Medium Reported Braking Action

MAX MANUAL	5000	420/-400	140	-260	950	210	-170	130	-130	370	490	1980
MAX AUTO	5030	430/-410	140	-260	950	180	-140	130	-130	420	490	1970
AUTOBRAKE 3	5380	440/-430	150	-270	990	150	-120	140	-140	510	380	1910
AUTOBRAKE 2	6100	520/-530	180	-310	1090	170	-180	170	-170	480	290	1250
AUTOBRAKE 1	6480	600/-590	210	-330	1170	250	-220	180	-180	470	680	1540

Poor Reported Braking Action

MAX MANUAL	6330	580/-550	200	-380	1460	470	-320	160	-160	420	990	5350
MAX AUTO	6330	580/-550	200	-380	1460	470	-310	160	-160	450	990	5380
AUTOBRAKE 3	6370	590/-560	200	-380	1470	450	-300	170	-170	480	1020	5400
AUTOBRAKE 2	6710	610/-590	210	-400	1510	430	-310	180	-180	470	790	5030
AUTOBRAKE 1	6940	650/-640	220	-410	1550	470	-350	190	-190	470	980	4960

Reference distance is for sea level, standard day, no wind or slope, VREF30 approach speed and two engine detent reverse thrust.

Max manual braking data valid for auto speedbrakes. Autobrakes data valid for both auto and manual speedbrakes.

For max manual braking and manual speedbrakes, increase reference landing distance by 300 ft.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Normal Configuration Landing Distance****Flaps 40****Dry Runway**

	LANDING DISTANCE AND ADJUSTMENTS (FT)										
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	VREF ADJ	REVERSE THRUST ADJ	PER 10 KTS ABOVE VREF40	ONE REV	NO REV
BRAKING CONFIGURATION	52000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 52000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND TAIL WIND DOWN HILL UP HILL	ABV ISA BLW ISA	PER 10 KTS ABOVE VREF40	ONE REV	NO REV			
MAX MANUAL	2650	290/-150	50	-100 330 30	-30	50	-50	200	40	130	
MAX AUTO	3390	230/-220	70	-130 420 0	0	70	-70	330	0	10	
AUTOBRAKE 3	4730	350/-360	120	-210 710 20	-40	120	-120	510	40	60	
AUTOBRAKE 2	5640	470/-480	160	-270 930 100	-120	150	-150	500	210	210	
AUTOBRAKE 1	6110	550/-540	190	-320 1100 180	-190	170	-170	490	570	940	

Good Reported Braking Action

MAX MANUAL	3650	260/-250	90	-160	580	90	-80	80	-80	290	170	590
MAX AUTO	3880	280/-270	100	-170	600	70	-60	90	-90	340	190	640
AUTOBRAKE 3	4740	350/-360	120	-210	720	40	-40	120	-120	510	40	200
AUTOBRAKE 2	5640	470/-480	160	-270	930	100	-120	150	-150	500	210	210
AUTOBRAKE 1	6110	550/-540	190	-320	1100	180	-190	170	-170	490	570	940

Medium Reported Braking Action

MAX MANUAL	4820	390/-380	130	-260	930	200	-160	120	-120	380	450	1800
MAX AUTO	4860	400/-390	140	-260	940	180	-140	120	-120	440	440	1800
AUTOBRAKE 3	5160	410/-400	140	-270	970	150	-120	130	-130	510	350	1770
AUTOBRAKE 2	5790	480/-490	170	-300	1060	170	-170	160	-160	500	290	1180
AUTOBRAKE 1	6140	560/-540	190	-320	1140	230	-210	170	-170	490	600	1460

Poor Reported Braking Action

MAX MANUAL	6050	540/-510	180	-370	1430	450	-310	150	-160	440	880	4780
MAX AUTO	6050	540/-510	180	-370	1430	450	-290	160	-160	460	880	4800
AUTOBRAKE 3	6100	550/-520	190	-370	1440	440	-300	160	-160	480	910	4850
AUTOBRAKE 2	6390	570/-550	190	-390	1470	420	-290	170	-170	500	740	4500
AUTOBRAKE 1	6600	600/-590	210	-400	1510	450	-330	180	-180	490	870	4480

Reference distance is for sea level, standard day, no wind or slope, VREF40 approach speed and two engine detent reverse thrust.

Max manual braking data valid for auto speedbrakes. Autobrakes data valid for both auto and manual speedbrakes.

For max manual braking and manual speedbrakes, increase reference landing distance by 260 ft.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Dry Runway**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 52000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	APPROACH SPEED		
HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF					
ALL FLAPS UP	VREF40+55	4430	820/-390	150	-180	650	70	-60	410
ANTI SKID INOPERATIVE	VREF40	4150	280/-280	100	-180	630	90	-80	320
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	3360	220/-220	80	-120	410	60	-60	450
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	3470	250/-230	80	-130	420	70	-60	450
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	3650	440/-250	80	-130	420	60	-60	370
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	3090	490/-220	70	-110	380	40	-40	230
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH-SYSTEM A & B)	VREF15	5470	610/-430	150	-220	730	40	-40	560
STABILIZER TRIM INOPERATIVE	VREF15	3090	490/-220	70	-110	380	40	-40	230
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	3090	490/-220	70	-110	380	40	-40	230
LEADING EDGE FLAPS TRANSIT	VREF15+5	3260	550/-220	80	-110	390	40	-40	240
ONE ENGINE INOPERATIVE	VREF15	3150	530/-230	70	-120	390	40	-40	240

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

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ADVISORY INFORMATION**Non-Normal Configuration Landing Distance**
Dry Runway

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)								
		REF DIST FOR 52000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 52000 KG	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED	
HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF						
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	2730	350/-160	60	-100	340	30	-30	210	
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	3090	490/-220	70	-110	380	40	-40	230	
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	3510	570/-270	100	-130	500	50	-40	310	
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	2730	350/-160	60	-100	340	30	-30	210	
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	3090	490/-220	70	-110	380	40	-40	230	
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	3510	570/-270	100	-130	500	50	-40	310	
TRAILING EDGE FLAPS UP (FLAPS <1)	VREF40+40	3830	660/-310	120	-150	560	50	-50	350	

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Good Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 52000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS HEAD WIND	SLOPE ADJ PER 1% DOWN HILL	APPROACH SPEED PER 10 KTS UP HILL	PER 10 KTS ABOVE VREF	
ALL FLAPS UP	VREF40+55	5400	350/-360	150	-200	680	110	-100	300
ANTI SKID INOPERATIVE	VREF40	5130	390/-380	140	-260	930	180	-150	380
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	4550	350/-340	120	-200	670	140	-130	520
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	4760	370/-360	130	-210	690	150	-130	540
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	5160	420/-410	140	-210	710	150	-130	490
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	4120	310/-310	110	-170	600	90	-80	280
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH-SYSTEM A & B)	VREF15	5540	450/-440	150	-220	750	110	-100	570
STABILIZER TRIM INOPERATIVE	VREF15	4120	310/-310	110	-170	600	90	-80	280
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	4120	310/-310	110	-170	600	90	-80	280
LEADING EDGE FLAPS TRANSIT	VREF15+5	4480	350/-340	120	-190	630	100	-90	320
ONE ENGINE INOPERATIVE	VREF15	4350	330/-330	110	-190	640	110	-100	320

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

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ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Good Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)								APPROACH SPEED
		REF DIST FOR 52000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	APPROACH SPEED	HEAD WIND	TAIL WIND	
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	3720	270/-260	90	-160	570	80	-70		290
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	4120	310/-310	110	-170	600	90	-80		280
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	4460	300/-300	120	-180	620	90	-80		280
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	3720	270/-260	90	-160	570	80	-70		290
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	4120	310/-310	110	-170	600	90	-80		280
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	4460	300/-300	120	-180	620	90	-80		280
TRAILING EDGE FLAPS UP (FLAPS <1)	VREF40+40	4800	320/-320	130	-190	640	100	-90		280

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance****Medium Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 52000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS HEAD WIND	SLOPE ADJ PER 1% DOWN HILL	APPROACH SPEED PER 10 KTS UP HILL	PER 10 KTS ABOVE VREF	
ALL FLAPS UP	VREF40+55	7320	560/-560	240	-310	1080	250	-220	400
ANTI-SKID INOPERATIVE	VREF40	6290	530/-510	190	-380	1400	380	-290	430
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	5770	490/-470	180	-290	1030	270	-230	540
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	6110	540/-510	190	-300	1060	290	-250	580
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	6780	630/-590	220	-320	1100	300	-260	570
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	5500	480/-460	170	-270	960	200	-180	360
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH SYSTEM A & B)	VREF15	7250	670/-630	230	-330	1150	280	-230	640
STABILIZER TRIM INOPERATIVE	VREF15	5500	480/-460	170	-270	960	200	-180	360
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	5500	480/-460	170	-270	960	200	-180	360
LEADING EDGE FLAPS TRANSIT	VREF15+5	6010	530/-510	190	-290	1010	230	-200	410
ONE ENGINE INOPERATIVE	VREF15	6110	530/-520	180	-310	1070	280	-230	430

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

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ADVISORY INFORMATION**Non-Normal Configuration Landing Distance**
Medium Reported Braking Action

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)								
		REF DIST FOR 52000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED	
HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF						
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	4920	410/-390	140	-260	910	190	-160	360	
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	5500	480/-460	170	-270	960	200	-180	360	
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	6030	470/-460	190	-280	990	210	-180	370	
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	4920	410/-390	140	-260	910	190	-160	360	
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	5500	480/-460	170	-270	960	200	-180	360	
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	6030	470/-460	190	-280	990	210	-180	370	
TRAILING EDGE FLAPS UP (FLAPS <1)	VREF40+40	6480	500/-490	200	-290	1020	230	-200	370	

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Poor Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 52000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS HEAD WIND	SLOPE ADJ PER 1% DOWN HILL	APPROACH SPEED PER 10 KTS UP HILL		
ALL FLAPS UP	VREF40+55	9260	800/-770	330	-450	1620	520	-410	480
ANTI SKID INOPERATIVE	VREF40	8030	750/-710	260	-600	2430	1170	-620	470
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	7000	650/-610	230	-410	1510	500	-380	550
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	7450	720/-660	250	-430	1550	540	-410	600
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	8380	850/-780	290	-450	1620	570	-440	610
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	6930	660/-620	230	-390	1450	420	-330	420
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH SYSTEM A & B)	VREF15	8890	900/-820	310	-470	1680	640	-480	680
STABILIZER TRIM INOPERATIVE	VREF15	6930	660/-620	230	-390	1450	420	-330	420
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	6930	660/-620	230	-390	1450	420	-330	420
LEADING EDGE FLAPS TRANSIT	VREF15+5	7580	740/-690	260	-420	1520	470	-370	480
ONE ENGINE INOPERATIVE	VREF15	8160	780/-750	270	-470	1700	640	-480	520

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Poor Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)								APPROACH SPEED
		REF DIST FOR 52000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	APPROACH SPEED	HEAD WIND	TAIL WIND	
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	6180	570/-530	200	-370	1390	400	-300		410
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	6930	660/-620	230	-390	1450	420	-330		420
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	7650	670/-640	260	-410	1500	450	-350		440
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	6180	570/-530	200	-370	1390	400	-300		410
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	6930	660/-620	230	-390	1450	420	-330		420
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	7650	670/-640	260	-410	1500	450	-350		440
TRAILING EDGE FLAPS UP (FLAPS <1)	VREF40+40	8200	720/-680	280	-420	1540	470	-370		450

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Recommended Brake Cooling Schedule****Reference Brake Energy Per Brake (Millions of Foot Pounds)**

WEIGHT (1000 KG)	OAT (°C)	WIND CORRECTED BRAKES ON SPEED (KIAS)*											
		60			80			100			120		
		PRESS	ALT	PRESS	ALT	PRESS	ALT	PRESS	ALT	PRESS	ALT	PRESS	ALT
70	-20	6.6	7.4	8.3	11.1	12.5	14.1	16.5	18.7	21.4	22.9	26.0	29.7
	0	7.1	7.9	8.8	11.9	13.4	15.1	17.7	20.1	22.9	24.5	27.9	31.9
	15	7.4	8.3	9.3	12.5	14.1	15.9	18.7	21.2	24.2	25.9	29.4	33.6
	20	7.5	8.4	9.4	12.7	14.3	16.2	19.0	21.5	24.6	26.3	29.9	34.1
	40	7.9	8.8	9.8	13.3	15.0	17.0	20.0	22.7	25.9	27.8	31.6	36.1
65	-20	6.2	6.9	7.8	10.4	11.7	13.2	15.5	17.5	20.0	21.4	24.3	27.8
	0	6.7	7.4	8.3	11.1	12.5	14.1	16.6	18.8	21.4	22.9	26.0	29.7
	15	7.0	7.8	8.7	11.7	13.2	14.9	17.5	19.8	22.6	24.2	27.4	31.4
	20	7.1	7.9	8.8	11.9	13.4	15.2	17.8	20.1	23.0	24.6	27.9	31.9
	40	7.4	8.2	9.2	12.5	14.0	15.9	18.7	21.2	24.2	25.9	29.5	33.7
60	-20	5.8	6.5	7.2	9.7	10.9	12.3	14.4	16.3	18.6	19.9	22.6	25.8
	0	6.3	7.0	7.8	10.4	11.7	13.2	15.4	17.5	19.9	21.3	24.2	27.6
	15	6.6	7.3	8.1	10.9	12.3	13.9	16.3	18.4	21.0	22.5	25.5	29.1
	20	6.7	7.4	8.3	11.1	12.5	14.1	16.5	18.7	21.3	22.8	25.9	29.6
	40	6.9	7.7	8.6	11.6	13.1	14.8	17.4	19.7	22.5	24.1	27.4	31.3
55	-20	5.5	6.1	6.8	9.0	10.1	11.4	13.4	15.1	17.2	18.4	20.8	23.8
	0	5.9	6.5	7.2	9.7	10.8	12.2	14.3	16.2	18.4	19.7	22.3	25.5
	15	6.1	6.8	7.6	10.2	11.4	12.8	15.1	17.0	19.4	20.7	23.5	26.9
	20	6.2	6.9	7.7	10.3	11.6	13.0	15.3	17.3	19.7	21.1	23.9	27.3
	40	6.5	7.2	8.0	10.8	12.1	13.7	16.1	18.2	20.8	22.2	25.2	28.8
50	-20	5.1	5.6	6.3	8.3	9.3	10.5	12.3	13.9	15.7	16.8	19.1	21.8
	0	5.4	6.0	6.7	8.9	10.0	11.2	13.2	14.8	16.9	18.0	20.4	23.3
	15	5.7	6.3	7.0	9.4	10.5	11.8	13.8	15.6	17.8	19.0	21.5	24.6
	20	5.8	6.4	7.1	9.5	10.7	12.0	14.1	15.9	18.1	19.3	21.9	25.0
	40	6.0	6.7	7.4	10.0	11.2	12.6	14.8	16.7	19.0	20.3	23.1	26.4
45	-20	4.7	5.2	5.8	7.7	8.6	9.6	11.2	12.6	14.3	15.3	17.3	19.7
	0	5.0	5.6	6.2	8.2	9.2	10.3	12.0	13.5	15.3	16.4	18.5	21.1
	15	5.3	5.8	6.5	8.6	9.6	10.8	12.6	14.2	16.1	17.3	19.5	22.3
	20	5.3	5.9	6.6	8.7	9.8	11.0	12.8	14.5	16.4	17.5	19.9	22.7
	40	5.5	6.2	6.8	9.1	10.2	11.5	13.5	15.2	17.3	18.5	20.9	23.9
40	-20	4.3	4.8	5.3	7.0	7.8	8.7	10.1	11.4	12.9	13.7	15.5	17.7
	0	4.6	5.1	5.7	7.5	8.3	9.3	10.9	12.2	13.8	14.7	16.6	18.9
	15	4.9	5.4	5.9	7.8	8.8	9.8	11.4	12.8	14.5	15.5	17.5	20.0
	20	4.9	5.4	6.0	8.0	8.9	10.0	11.6	13.0	14.8	15.8	17.8	20.3
	40	5.1	5.6	6.3	8.3	9.3	10.4	12.1	13.7	15.5	16.6	18.8	21.4

*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°C.

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Recommended Brake Cooling Schedule****Adjusted Brake Energy Per Brake (Millions of Foot Pounds)****No Reverse Thrust**

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)						
EVENT		10	15	20	25	30	35	40
LANDING	RTO MAX MAN	10	15	20	25	30	35	40
	MAX MAN	8.6	13.3	18.1	22.8	27.5	32.3	37.0
	MAX AUTO	8.1	12.3	16.6	21.0	25.4	29.9	34.4
	AUTOBRAKE 3	8.0	11.6	15.3	19.2	23.1	27.1	31.2
	AUTOBRAKE 2	7.8	11.0	14.3	17.6	21.1	24.6	28.3
	AUTOBRAKE 1	7.5	10.4	13.4	16.3	19.4	22.5	25.6

Two Engine Detent Reverse Thrust

		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)						
EVENT		10	15	20	25	30	35	40
LANDING	RTO MAX MAN	10	15	20	25	30	35	40
	MAX MAN	8.2	12.5	16.7	20.9	25.0	29.0	33.0
	MAX AUTO	6.0	9.4	12.8	16.4	20.1	23.8	27.7
	AUTOBRAKE 3	3.2	5.2	7.4	9.7	12.2	14.8	17.5
	AUTOBRAKE 2	1.4	2.5	3.8	5.2	6.8	8.5	10.3
	AUTOBRAKE 1	0.6	1.3	2.1	3.0	3.9	5.0	6.2

Cooling Time (Minutes) - Category A Brakes

		ADJUSTED BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)						
8 & BELOW		10	12	14	16	18	18.5 TO 23.7	23.8 & ABOVE
		BRAKE TEMPERATURE INDICATOR READING						
UP TO 2.1		2.8	3.2	3.6	4.2	4.8	4.9 to 6.3	6.3 & ABOVE
INFLIGHT GEAR DOWN	NO SPECIAL PROCEDURE	2	3	4	5	6	CAUTION	FUSE PLUG MELT ZONE
	REQUIRED	19	32	43	53	61		

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.

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 7 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not approach gear or attempt to taxi for one hour. Tire, wheel and brake replacement may be required. If overheat occurs after takeoff, extend gear soon for at least 12 minutes.

Brake Temperature Indicator (if installed) on First Officer's Instrument Panel may be used 10 to 15 minutes after brake application, to determine recommended cooling time.

ADVISORY INFORMATION**Recommended Brake Cooling Schedule****Cooling Time (Minutes) - Category B Brakes**

ADJUSTED BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)								
8 & BELOW		10	12	14	16	18	20	21.0 TO 28.7 28.8 & ABOVE
BRAKE TEMPERATURE INDICATOR READING								
INFLIGHT GEAR DOWN	NO SPECIAL PROCEDURE	UP TO 2.1	2.8	3.2	3.6	4.2	4.8	5.4
GROUND	REQUIRED	19	32	43	53	61	67	CAUTION FUSE PLUG MELT ZONE

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.

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 7 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not approach gear or attempt to taxi for one hour. Tire, wheel and brake replacement may be required. If overheat occurs after takeoff, extend gear soon for at least 12 minutes.

Brake Temperature Indicator (if installed) on First Officer's Instrument Panel may be used 10 to 15 minutes after brake application, to determine recommended cooling time.

**Performance Inflight
Engine Inoperative**
**Chapter PI
Section 23**
ENGINE INOP
Initial Max Continuous %N1
Based on .74M, engine bleed to packs auto and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)					
	27	29	31	33	35	37
20	96.6	96.6	96.6	96.6	96.6	96.6
15	97.3	97.3	97.3	97.3	97.3	97.3
10	98.1	98.1	98.1	98.1	98.1	98.1
5	98.9	98.9	98.9	98.9	98.9	98.9
0	99.8	99.8	99.8	99.8	99.8	99.8
-5	99.5	100.7	100.7	100.7	100.7	100.7
-10	98.5	100.1	101.6	101.6	101.6	101.6
-15	97.6	99.2	100.8	102.5	102.5	102.5
-20	96.7	98.2	99.8	101.5	102.1	102.1
-25	95.7	97.2	98.8	100.4	101.0	101.1
-30	94.7	96.3	97.8	99.4	100.0	100.0
-40	92.8	94.3	95.8	97.4	97.9	98.0
-50	90.7	92.2	93.7	95.3	95.8	95.8

%N1 Adjustment for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	27	29	31	33	35	37
ENGINE ANTI-ICE ON	-1.1	-1.1	-1.1	-1.1	-1.1	-1.1
ENGINE AND WING ANTI-ICE ON	-3.4	-3.5	-3.5	-3.7	-3.7	-3.8

ENGINE INOP**Max Continuous %N1****33000 FT to 23000 FT Pressure Altitudes****Based on engine bleed to packs auto and anti-ice off**

33000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.58	95.2	97.3	99.4	101.1	100.0	98.9	98.2					
220	.63	95.1	97.3	99.3	101.3	100.7	99.3	98.5	97.9	97.2			
240	.68	95.1	97.2	99.2	101.2	101.4	99.6	98.8	98.0				
260	.74	94.5	96.6	98.7	100.7	101.6	99.8	98.9	98.1	97.3			
31000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.55	94.7	96.8	98.9	100.8	99.8	98.7	98.1					
220	.61	94.6	96.7	98.7	100.7	100.3	99.1	98.4	97.8	97.1			
240	.66	94.4	96.5	98.5	100.5	101.0	99.4	98.7	97.9	97.2			
260	.71	94.1	96.2	98.2	100.2	101.6	99.8	98.9	98.1	97.3			
29000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.53	94.0	96.1	98.1	100.1	99.6	98.5	97.9	97.3				
220	.58	93.8	95.9	97.9	99.9	100.1	98.9	98.3	97.6	97.0			
240	.63	93.6	95.6	97.7	99.6	100.7	99.3	98.6	97.9	97.2			
260	.68	93.3	95.3	97.4	99.3	101.3	99.6	98.8	98.0	97.3	96.6		
27000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.51	93.1	95.2	97.2	99.2	99.4	98.3	97.8	97.2				
220	.56	92.9	94.9	96.9	98.9	99.8	98.7	98.1	97.5	96.9	96.3		
240	.60	92.6	94.6	96.7	98.6	100.3	99.1	98.4	97.8	97.2	96.6		
260	.65	92.1	94.2	96.2	98.1	100.1	99.4	98.7	97.9	97.2	96.6		
25000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.49	92.3	94.3	96.3	98.3	99.3	98.2	97.6	97.1	96.5			
220	.53	92.0	94.0	96.0	97.9	99.6	98.5	98.0	97.4	96.8	96.2		
240	.58	91.7	93.7	95.7	97.6	99.6	98.9	98.3	97.7	97.0	96.5		
260	.63	91.2	93.2	95.2	97.1	99.0	99.3	98.6	97.9	97.2	96.6	96.0	
23000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.47	91.3	93.4	95.3	97.3	99.2	98.1	97.6	97.0	96.4	95.8		
220	.51	90.9	93.0	94.9	96.9	98.8	98.4	97.8	97.2	96.7	96.1		
240	.56	90.6	92.6	94.6	96.5	98.4	98.7	98.1	97.5	96.9	96.3	95.8	
260	.60	90.3	92.3	94.3	96.2	98.1	99.1	98.4	97.8	97.2	96.6	96.0	

Anti-Ice Adjustments

BLEED CONFIGURATION			PRESS ALT (1000 FT)					
			23	25	27	29	31	33
ENGINE ANTI-ICE ON			-1.1	-1.1	-1.1	-1.1	-1.1	-1.2
ENGINE AND WING ANTI-ICE ON			-3.3	-3.4	-3.4	-3.5	-3.5	-3.7

ENGINE INOP**Max Continuous %N1****21000 FT to 14000 FT Pressure Altitudes****Based on engine bleed to packs auto and anti-ice off**

21000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.45		90.4	92.4	94.4	96.3	98.2	98.1	97.5	96.9	96.3	95.7		
220	.49		90.0	92.0	93.9	95.8	97.7	98.3	97.7	97.1	96.5	96.0	95.4	94.9
240	.54		89.6	91.6	93.6	95.5	97.3	98.6	98.0	97.4	96.8	96.2	95.7	
260	.60		89.3	91.3	93.2	95.1	97.0	98.8	98.3	97.7	97.1	96.5	95.9	95.4
20000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.44		89.9	91.9	93.9	95.8	97.7	98.0	97.5	96.8	96.2	95.6	95.1	
220	.48		89.5	91.5	93.4	95.3	97.2	98.2	97.7	97.1	96.5	95.9	95.4	94.9
240	.53		89.1	91.1	93.0	94.9	96.8	98.5	97.9	97.3	96.8	96.2	95.6	95.1
260	.57		88.8	90.8	92.7	94.6	96.4	98.2	98.2	97.6	97.0	96.4	95.9	95.4
18000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-40	-30	-20	-10	0	5	10	15	20	25	30	35
200	.42		90.9	92.8	94.7	96.6	98.0	97.4	96.8	96.1	95.5	95.0		
220	.46		90.5	92.4	94.3	96.2	98.0	97.6	97.0	96.4	95.8	95.3	94.8	
240	.51		90.1	92.0	93.9	95.8	97.6	97.8	97.2	96.7	96.1	95.5	95.0	
260	.55		89.8	91.7	93.5	95.4	97.2	98.0	97.5	96.9	96.3	95.8	95.3	94.9
17000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-40	-30	-20	-10	0	5	10	15	20	25	30	35
200	.42		90.4	92.3	94.2	96.0	97.8	97.4	96.7	96.1	95.5	95.0		
220	.46		90.0	91.9	93.8	95.6	97.4	97.6	97.0	96.4	95.8	95.2	94.7	
240	.50		89.6	91.5	93.4	95.2	97.0	97.8	97.2	96.6	96.0	95.5	95.0	94.6
260	.54		89.3	91.2	93.0	94.8	96.6	97.5	97.4	96.9	96.3	95.7	95.2	94.8
16000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-40	-30	-20	-10	0	5	10	15	20	25	30	35
200	.41		89.9	91.8	93.6	95.5	97.3	97.3	96.7	96.1	95.5	94.9	94.4	
220	.45		89.5	91.4	93.3	95.1	96.9	97.5	96.9	96.3	95.7	95.2	94.7	
240	.49		89.1	91.0	92.9	94.7	96.5	97.4	97.1	96.6	96.0	95.4	94.9	94.5
260	.53		88.8	90.7	92.5	94.3	96.1	97.0	97.4	96.8	96.2	95.7	95.2	94.8
14000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-30	-20	-10	0	5	10	15	20	25	30	35	40
200	.39		90.7	92.6	94.4	96.2	97.0	96.7	96.0	95.4	94.8	94.3	93.9	
220	.43		90.4	92.2	94.0	95.8	96.7	96.8	96.2	95.6	95.1	94.6	94.1	
240	.47		90.1	91.9	93.7	95.4	96.3	97.1	96.5	95.9	95.3	94.8	94.4	
260	.51		89.7	91.5	93.3	95.1	96.0	96.8	96.7	96.1	95.6	95.1	94.7	94.3

Anti-Ice Adjustments

BLEED CONFIGURATION		PRESS ALT (1000 FT)					
		14	16	17	18	20	21
ENGINE ANTI-ICE ON		-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
ENGINE AND WING ANTI-ICE ON		-2.9	-3.0	-3.0	-3.1	-3.1	-3.2

ENGINE INOP**Max Continuous %N1****12000 FT to 1000 FT Pressure Altitudes****Based on engine bleed to packs auto and anti-ice off**

12000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-20	-10	0	5	10	15	20	25	30	35	40	45
200	.38	91.5	93.3	95.0	95.9	96.6	96.0	95.4	94.8	94.3	93.9			
220	.41	91.2	93.0	94.7	95.6	96.4	96.1	95.5	95.0	94.5	94.0	93.8		
240	.45	90.9	92.7	94.4	95.3	96.1	96.4	95.8	95.2	94.7	94.3	94.0		
260	.49	90.6	92.4	94.1	95.0	95.8	96.6	96.0	95.5	95.0	94.6	94.2	94.0	
10000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-20	-10	0	5	10	15	20	25	30	35	40	45
200	.36	90.4	92.2	93.9	94.8	95.6	96.0	95.3	94.8	94.3	93.8	93.6		
220	.40	90.1	91.9	93.6	94.5	95.3	96.1	95.5	94.9	94.4	93.9	93.7		
240	.43	89.9	91.6	93.3	94.2	95.0	95.9	95.7	95.1	94.6	94.2	93.9	93.7	
260	.47	89.6	91.3	93.1	93.9	94.8	95.6	95.9	95.4	94.9	94.5	94.1	93.9	
7000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-10	0	5	10	15	20	25	30	35	40	45	50
200	.34	90.7	92.4	93.2	94.1	94.9	95.3	94.7	94.2	93.8	93.5	93.3		
220	.38	90.4	92.1	93.0	93.8	94.6	95.4	94.8	94.3	93.9	93.6	93.5	93.4	
240	.41	90.2	91.9	92.7	93.6	94.4	95.2	95.0	94.5	94.0	93.8	93.6	93.5	
260	.45	90.0	91.7	92.5	93.4	94.2	95.0	95.2	94.7	94.3	94.0	93.8	93.7	
5000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-10	0	5	10	15	20	25	30	35	40	45	50
200	.33	89.7	91.4	92.2	93.0	93.8	94.6	94.7	94.2	93.8	93.5	93.3		
220	.36	89.4	91.1	92.0	92.8	93.6	94.4	94.8	94.3	93.9	93.6	93.4		
240	.40	89.2	90.9	91.7	92.5	93.4	94.2	94.9	94.4	94.0	93.7	93.5		
260	.43	89.0	90.7	91.5	92.4	93.2	94.0	94.8	94.6	94.2	93.9	93.7		
3000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-10	0	5	10	15	20	25	30	35	40	45	50
200	.32	88.8	90.5	91.3	92.1	93.0	93.8	94.6	94.2	93.8	93.5	93.3	93.2	
220	.35	88.6	90.3	91.1	91.9	92.7	93.5	94.3	94.3	93.9	93.6	93.4	93.3	
240	.40	88.4	90.1	90.9	91.7	92.5	93.3	94.1	94.4	93.9	93.7	93.5	93.4	
260	.43	88.3	89.9	90.7	91.5	92.3	93.1	93.9	94.5	94.1	93.8	93.6	93.6	
1000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-10	0	5	10	15	20	25	30	35	40	45	50
200	.31	88.0	89.6	90.4	91.3	92.1	92.9	93.6	94.1	93.8	93.5	93.3	93.2	
220	.34	87.8	89.4	90.3	91.1	91.9	92.7	93.4	94.2	93.8	93.6	93.4	93.3	
240	.37	87.6	89.3	90.1	90.9	91.7	92.5	93.3	94.0	93.9	93.6	93.5	93.4	
260	.40	87.4	89.1	89.9	90.7	91.5	92.3	93.1	93.8	94.0	93.7	93.6	93.5	

Anti-Ice Adjustments

BLEED CONFIGURATION	PRESS ALT (1000 FT)					
	1	3	5	7	10	12
ENGINE ANTI-ICE ON	-0.7	-0.7	-0.7	-0.8	-0.9	-0.9
ENGINE AND WING ANTI-ICE ON	-2.2	-2.3	-2.4	-2.5	-2.7	-2.8

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°C & BELOW	ISA + 15°C	ISA + 20°C
68	65	242	15900	14500	13000
64	61	235	17900	16700	15300
60	57	228	19900	18900	17600
56	53	220	22000	21100	19900
52	50	213	24100	23300	22300
48	46	205	26300	25600	24700
44	42	196	28500	27900	27200
40	38	187	30700	30300	29700

Includes APU fuel burn.

ENGINE INOP**MAX CONTINUOUS THRUST****Driftdown/LRC Cruise Range Capability****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)				20		TAILWIND COMPONENT (KTS)				
100	80	60	40	20	20	40	60	80	100	
140	130	121	113	106	100	95	90	85	81	78
286	263	244	227	213	200	189	179	169	161	154
430	395	366	341	319	300	283	268	254	242	230
571	526	488	454	426	400	377	357	339	323	308
711	656	608	567	532	500	472	447	424	404	386
850	784	728	680	637	600	567	537	510	486	464
987	912	848	792	743	700	662	627	596	568	542
1124	1040	967	904	849	800	756	717	682	650	621
1260	1166	1086	1016	955	900	851	808	768	733	700
1395	1293	1205	1128	1060	1000	946	898	855	815	779
1531	1420	1324	1240	1166	1100	1041	989	941	898	858
1667	1547	1442	1351	1271	1200	1136	1079	1027	980	937
1803	1674	1562	1463	1377	1300	1231	1169	1114	1063	1016
1940	1801	1681	1576	1483	1400	1326	1260	1200	1145	1095
2079	1930	1801	1688	1588	1500	1421	1350	1285	1227	1173
2218	2059	1921	1801	1694	1600	1516	1440	1371	1308	1251

Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG)								TIME (HR:MIN)	
	WEIGHT AT START OF DRIFTDOWN (1000 KG)									
	35	40	45	50	55	60	65	70		
100	0.4	0.4	0.4	0.5	0.5	0.6	0.6	0.6	0:17	
200	0.8	0.9	1.0	1.1	1.2	1.3	1.4	1.5	0:36	
300	1.3	1.4	1.6	1.8	1.9	2.1	2.2	2.4	0:54	
400	1.7	1.9	2.2	2.4	2.7	2.9	3.1	3.3	1:12	
500	2.1	2.4	2.7	3.0	3.3	3.6	3.9	4.2	1:29	
600	2.6	2.9	3.2	3.6	3.9	4.3	4.6	5.0	1:46	
700	3.0	3.3	3.7	4.2	4.6	5.0	5.4	5.8	2:02	
800	3.4	3.8	4.2	4.7	5.2	5.7	6.1	6.6	2:18	
900	3.8	4.3	4.8	5.3	5.8	6.3	6.9	7.4	2:34	
1000	4.2	4.7	5.3	5.9	6.4	7.0	7.6	8.2	2:50	
1100	4.6	5.2	5.8	6.4	7.1	7.7	8.3	9.0	3:06	
1200	5.0	5.6	6.3	7.0	7.7	8.3	9.0	9.8	3:22	
1300	5.4	6.0	6.7	7.5	8.3	9.0	9.8	10.6	3:38	
1400	5.8	6.5	7.2	8.0	8.9	9.6	10.5	11.4	3:54	
1500	6.1	6.9	7.7	8.6	9.4	10.3	11.2	12.1	4:10	
1600	6.5	7.3	8.2	9.1	10.0	10.9	11.9	12.9	4:27	

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°C & BELOW	ISA + 15°C	ISA + 20°C
68	9000	6800	4700
66	10400	8100	6000
64	11900	9500	7300
62	13300	11000	8700
60	14800	12500	10100
58	16300	13900	11600
56	17800	15500	13100
54	19200	17000	14600
52	20600	18600	16300
50	21900	20100	17900
48	23300	21600	19500
46	24700	23100	21200
44	26100	24700	22900
42	27400	26200	24700
40	28800	27700	26300
38	30200	29300	27900

With engine anti-ice on, decrease altitude capability by 1400ft.

With engine and wing anti-ice on, decrease altitude capability by 4800ft.

ENGINE INOP**MAX CONTINUOUS THRUST****Long Range Cruise Control**

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)								
		9	11	13	15	17	19	21	23	25
66	%N1	91.2	92.5	93.9						
	MACH	.559	.575	.591						
	KIAS	316	314	310						
	FF/ENG	3123	3104	3082						
62	%N1	89.7	91.0	92.3	93.8					
	MACH	.545	.563	.578	.594					
	KIAS	308	306	304	300					
	FF/ENG	2940	2926	2905	2880					
58	%N1	88.0	89.4	90.8	92.1	93.6				
	MACH	.530	.548	.565	.581	.597				
	KIAS	299	298	297	294	290				
	FF/ENG	2753	2744	2728	2703	2667				
54	%N1	86.3	87.7	89.1	90.4	91.8	93.4	95.4		
	MACH	.513	.531	.550	.567	.583	.599	.615		
	KIAS	290	289	288	286	284	280	277		
	FF/ENG	2565	2556	2546	2528	2492	2463	2461		
50	%N1	84.4	85.8	87.2	88.6	89.9	91.4	93.0	95.1	
	MACH	.495	.513	.532	.550	.568	.584	.600	.617	
	KIAS	279	279	279	278	276	273	270	267	
	FF/ENG	2376	2367	2359	2348	2321	2290	2273	2273	
46	%N1	82.3	83.7	85.1	86.6	88.0	89.4	90.8	92.4	94.7
	MACH	.476	.494	.512	.531	.550	.568	.584	.601	.617
	KIAS	268	268	268	268	267	265	262	259	256
	FF/ENG	2187	2178	2170	2163	2144	2122	2100	2086	2084
42	%N1	80.0	81.5	82.9	84.4	85.8	87.2	88.6	90.1	91.7
	MACH	.456	.473	.491	.510	.529	.548	.566	.583	.600
	KIAS	257	257	257	257	256	256	254	251	248
	FF/ENG	2000	1991	1982	1974	1963	1948	1934	1914	1898
38	%N1	77.6	79.0	80.5	81.9	83.4	84.8	86.3	87.7	89.1
	MACH	.437	.452	.469	.487	.505	.525	.544	.563	.580
	KIAS	246	245	245	245	245	244	244	242	240
	FF/ENG	1825	1807	1796	1788	1780	1769	1760	1749	1728

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
286	264	244	227	213	200	190	181	173	166	159
579	533	492	457	427	400	380	362	346	331	318
874	803	740	686	641	600	571	544	519	497	477
1171	1074	989	917	855	800	761	725	692	662	635
1470	1347	1238	1147	1069	1000	951	906	864	827	793
1771	1621	1489	1379	1284	1200	1141	1086	1037	992	951
2075	1898	1742	1611	1500	1400	1331	1267	1209	1156	1109
2382	2176	1995	1844	1715	1600	1521	1448	1381	1321	1267
2691	2456	2250	2077	1931	1800	1711	1628	1553	1485	1424

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		16		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	1.5	0:40	1.2	0:38	1.1	0:37	1.0	0:37	0.9	0:36
400	3.0	1:18	2.6	1:13	2.4	1:11	2.2	1:09	2.1	1:07
600	4.5	1:57	3.9	1:49	3.6	1:44	3.4	1:41	3.3	1:39
800	5.9	2:36	5.3	2:24	4.9	2:18	4.6	2:13	4.5	2:10
1000	7.4	3:16	6.6	3:00	6.1	2:53	5.7	2:46	5.6	2:42
1200	8.8	3:56	7.9	3:37	7.3	3:27	6.9	3:19	6.7	3:14
1400	10.2	4:37	9.1	4:14	8.5	4:02	8.0	3:53	7.8	3:46
1600	11.6	5:19	10.4	4:52	9.6	4:37	9.1	4:26	8.8	4:18
1800	13.0	6:02	11.6	5:30	10.8	5:13	10.2	5:00	9.8	4:51

Fuel Required Adjustments (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	35	45	50	55	65
5	-0.7	-0.2	0.0	0.4	1.3
10	-1.4	-0.5	0.0	0.9	2.6
15	-2.1	-0.7	0.0	1.3	3.9

ENGINE INOP**MAX CONTINUOUS THRUST****Holding
Flaps Up**

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)						
		1500	5000	10000	15000	20000	25000	30000
66	%N1	5000	83.8	87.7	92.3			
	KIAS	251	251	251	253			
	FF/ENG	2720	2710	2710	2760			
64	%N1	80.2	83.0	86.8	91.3			
	KIAS	247	247	247	249			
	FF/ENG	2630	2630	2620	2660			
62	%N1	79.3	82.1	85.9	90.3			
	KIAS	242	243	243	245			
	FF/ENG	2550	2540	2530	2560			
60	%N1	78.3	81.2	85.1	89.3	94.7		
	KIAS	238	239	239	241	242		
	FF/ENG	2460	2450	2450	2470	2520		
58	%N1	77.4	80.3	84.1	88.3	93.4		
	KIAS	234	235	236	236	238		
	FF/ENG	2380	2370	2360	2380	2420		
56	%N1	76.4	79.3	83.2	87.2	92.2		
	KIAS	230	231	232	232	234		
	FF/ENG	2290	2290	2280	2280	2320		
54	%N1	75.3	78.2	82.2	86.2	91.0		
	KIAS	225	227	228	228	230		
	FF/ENG	2210	2200	2190	2190	2220		
52	%N1	74.3	77.1	81.2	85.1	89.8	96.5	
	KIAS	221	222	224	223	225	225	
	FF/ENG	2130	2120	2110	2110	2120	2220	
50	%N1	73.2	76.0	80.2	84.1	88.5	94.5	
	KIAS	216	218	219	219	221	221	
	FF/ENG	2050	2030	2030	2020	2030	2100	
48	%N1	72.1	74.9	79.1	83.0	87.3	92.8	
	KIAS	211	213	215	215	216	217	
	FF/ENG	1970	1950	1940	1930	1940	1990	
46	%N1	71.1	73.8	77.9	81.9	86.0	91.2	
	KIAS	210	210	210	211	211	213	
	FF/ENG	1900	1880	1860	1850	1850	1880	
44	%N1	70.1	72.9	76.9	80.9	84.9	89.8	
	KIAS	210	210	210	210	210	210	
	FF/ENG	1840	1820	1800	1780	1780	1790	
42	%N1	69.1	72.0	75.9	80.0	83.9	88.5	95.8
	KIAS	210	210	210	210	210	210	210
	FF/ENG	1780	1760	1740	1720	1710	1720	1810
40	%N1	68.2	71.1	75.0	79.1	83.0	87.3	93.4
	KIAS	210	210	210	210	210	210	210
	FF/ENG	1730	1700	1680	1660	1650	1650	1710
38	%N1	67.3	70.2	74.1	78.2	82.1	86.2	91.7
	KIAS	210	210	210	210	210	210	210
	FF/ENG	1670	1650	1630	1610	1600	1590	1620

This table includes 5% additional fuel for holding in a racetrack pattern.

Performance Inflight**PMC Off****Chapter PI****Section 24****PMC OFF****Takeoff Weight Adjustments**

AIRPORT PRESSURE ALTITUDE (FT)	TEMPERATURE °C (°F)	PMC OFF TAKEOFF LIMIT WEIGHT ADJUSTMENT (1000 KG)				
		FIELD LIMIT	CLIMB LIMIT	TIRE SPEED LIMIT	BRAKE ENERGY LIMIT (NORMAL TAKEOFF)	BRAKE ENERGY LIMIT (IMPROVED CLIMB TAKEOFF)
7000 & BELOW	ABOVE 27°C (80°F)	-0.75	-1.70	-0.30	0	0
	27°C (80°F) & BELOW	-3.60	-5.65	-0.85	0	0
ABOVE 7000	ABOVE 27°C (80°F)	-0.85	-1.90	-0.35	0	0
	27°C (80°F) & BELOW	-3.85	-6.05	-0.95	0	0

Valid for Flaps 5 or Flaps 15 takeoff.

Obstacle Limit Weight Adjustments

NORMAL OBSTACLE LIMIT WEIGHT (1000 KG)	PMC OFF OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)		
	AIRPORT PRESSURE ALTITUDE (FT)		
	7000 & BELOW	ABOVE 7000	
30	-4.50		-5.20
40	-4.90		-5.80
50	-5.40		-6.50
60	-5.80		-7.20
70	-6.20		-7.80

Valid for all Flaps.

Takeoff Speeds Adjustments

SPEED (KIAS)	PRESSURE ALTITUDE (FT)			
	7000 & BELOW		ABOVE 7000	
	ABOVE 27°C	27°C & BELOW	ABOVE 27°C	27°C & BELOW
V1(MCG)	2	2	2	1
V1	0	1	0	1
VR	1	2	1	2

PMC OFF**Takeoff %N1**

Based on engine bleed to packs on (Auto) and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	-0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	92.8	92.6	92.4	92.4						
50	122	94.1	94.3	94.1	94.0	94.0	94.3				
45	113	94.7	94.9	95.1	95.3	95.5	95.3	94.5	94.8	95.5	
40	104	95.4	95.5	95.6	95.7	96.0	96.0	95.7	95.7	96.0	95.8
35	95	95.6	95.7	96.1	96.2	96.4	96.6	96.6	96.6	96.6	96.8
30	86	95.4	95.7	96.0	96.5	96.8	97.1	97.4	97.5	97.4	97.4
25	77	94.6	94.9	95.5	96.4	97.1	97.5	97.9	98.4	98.2	97.8
20	68	93.8	94.1	94.7	95.6	96.5	97.3	97.9	97.8	97.9	97.9
15	59	93.0	93.3	93.9	94.8	95.7	96.5	97.1	97.1	97.1	97.1
10	50	92.2	92.5	93.1	94.0	94.8	95.7	96.3	96.3	96.3	96.3
5	41	91.4	91.6	92.3	93.1	94.0	94.8	95.4	95.4	95.4	95.4
0	32	90.5	90.8	91.4	92.3	93.1	93.9	94.5	94.5	94.5	94.5
-10	14	88.8	89.1	89.7	90.6	91.4	92.2	92.8	92.8	92.8	92.8
-20	-4	87.2	87.4	88.0	88.9	89.7	90.5	91.0	91.0	91.0	91.0
-30	-22	85.4	85.7	86.3	87.1	87.9	88.6	89.2	89.2	89.2	89.2
-40	-40	83.7	83.9	84.5	85.3	86.0	86.8	87.3	87.3	87.3	87.3
-50	-58	81.8	82.1	82.7	83.4	84.2	84.9	85.5	85.5	85.5	85.5

Based on engine bleed to packs off and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	93.8	93.6	93.3	93.4						
50	122	95.1	95.2	95.0	94.9	95.0	95.2				
45	113	95.7	95.8	96.0	96.2	96.4	96.2	95.5	95.7	96.4	
40	104	96.4	96.4	96.5	96.7	97.0	97.0	96.6	96.6	97.0	96.7
35	95	96.6	96.7	97.0	97.1	97.3	97.5	97.5	97.5	97.6	97.7
30	86	96.4	96.6	97.0	97.4	97.7	98.0	98.4	98.5	98.4	98.3
25	77	95.5	95.8	96.4	97.3	98.0	98.4	98.8	98.8	98.8	98.7
20	68	94.7	95.0	95.6	96.5	97.4	97.9	97.9	97.9	97.9	97.9
15	59	93.9	94.1	94.8	95.7	96.6	97.1	97.1	97.1	97.1	97.1
10	50	93.1	93.3	94.0	94.9	95.7	96.3	96.3	96.3	96.3	96.3
5	41	92.3	92.5	93.1	94.0	94.9	95.4	95.4	95.4	95.4	95.4
0	32	91.4	91.7	92.3	93.2	94.0	94.5	94.5	94.5	94.5	94.5
-10	14	89.6	90.0	90.6	91.4	92.3	92.8	92.8	92.8	92.8	92.8
-20	-4	88.0	88.3	88.9	89.7	90.5	91.0	91.0	91.0	91.0	91.0
-30	-22	86.2	86.5	87.1	87.9	88.7	89.2	89.2	89.2	89.2	89.2
-40	-40	84.5	84.7	85.3	86.1	86.8	87.3	87.3	87.3	87.3	87.3
-50	-58	82.6	82.9	83.4	84.2	85.0	85.5	85.5	85.5	85.5	85.5

PMC OFF**Takeoff Weight Adjustments (22K Derate)**

AIRPORT PRESSURE ALTITUDE (FT)	TEMPERATURE °C (°F)	PMC OFF TAKEOFF LIMIT WEIGHT ADJUSTMENT (1000 KG)				
		FIELD LIMIT	CLIMB LIMIT	TIRE SPEED LIMIT	BRAKE ENERGY LIMIT (NORMAL TAKEOFF)	BRAKE ENERGY LIMIT (IMPROVED CLIMB TAKEOFF)
BELOW 5000	ABOVE 21°C (70°F)	0	0	-0.25	-0.40	-0.16
	21°C (70°F) & BELOW	0	0	-0.21	-0.40	-0.16
5000 & ABOVE	ABOVE 21°C (70°F)	0	0	-0.20	-0.40	-0.16
	21°C (70°F) & BELOW	-1.66	-1.86	-0.27	-0.40	-0.16

Valid for Flaps 5 or Flaps 15 takeoff.

Obstacle Limit Weight Adjustments (22K Derate)

NORMAL OBSTACLE LIMIT WEIGHT (1000 KG)	PMC OFF OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)		
	AIRPORT PRESSURE ALTITUDE (FT)		
	5000 & BELOW	ABOVE 5000	
30	0	-2.40	
40	0	-2.50	
50	0	-2.70	
60	0	-2.90	
70	0	-3.00	

Valid for Flaps 5 or Flaps 15 takeoff.

Takeoff Speeds Adjustments (22K Derate)

SPEED (KIAS)	PRESSURE ALTITUDE (FT)			
	BELOW 5000		5000 & ABOVE	
	ABOVE 21°C	21°C & BELOW	ABOVE 21°C	21°C & BELOW
V1(MCG)	6	4	6	4
V1	0	0	0	0
VR	0	0	0	1

PMC OFF**Takeoff %N1 (22K Derate)****Based on engine bleed to packs on (Auto) and anti-ice on or off**

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	94.7	94.9	94.9	94.9						
50	122	95.1	95.4	95.4	95.4	95.4					
45	113	95.6	95.9	95.9	95.9	95.9	95.9	95.9	95.9	95.9	
40	104	96.0	96.3	96.3	96.3	96.3	96.3	96.3	96.4	96.4	96.4
35	95	96.3	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.8
30	86	95.5	96.6	96.8	97.2	97.2	97.2	97.2	97.1	97.1	97.1
25	77	94.8	95.8	96.0	96.5	97.0	97.4	97.6	97.5	97.5	97.4
20	68	94.0	95.0	95.2	95.7	96.2	96.5	96.9	97.1	97.1	97.1
15	59	93.2	94.1	94.4	94.8	95.4	95.7	96.3	96.3	96.3	96.3
10	50	92.4	93.3	93.5	94.0	94.6	94.9	95.2	95.5	95.6	95.7
5	41	91.5	92.5	92.7	93.2	93.7	94.0	94.4	94.7	94.8	94.9
0	32	90.7	91.7	91.9	92.3	92.9	93.2	93.5	93.8	93.9	94.0
-10	14	89.0	90.0	90.2	90.6	91.2	91.5	91.8	92.1	92.2	92.3
-20	-4	87.3	88.2	88.4	88.9	89.4	89.7	90.0	90.3	90.4	90.5
-30	-22	85.6	86.5	86.7	87.1	87.6	87.9	88.2	88.5	88.6	88.7
-40	-40	83.8	84.7	84.9	85.3	85.8	86.1	86.4	86.7	86.8	86.9
-50	-58	82.0	82.8	83.0	83.5	83.9	84.2	84.5	84.8	84.9	85.0

Based on engine bleed to packs off and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	95.7	95.9	95.9	95.9						
50	122	96.1	96.4	96.4	96.4	96.4					
45	113	96.6	96.8	96.8	96.8	96.8	96.8	96.8	96.8	96.9	
40	104	97.0	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3	97.3
35	95	97.3	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7	97.7
30	86	96.5	97.5	97.7	98.1	98.1	98.1	98.1	98.1	98.1	98.0
25	77	95.7	96.7	96.9	97.4	97.9	97.9	97.9	97.9	97.9	97.9
20	68	94.9	95.9	96.1	96.6	97.1	97.1	97.1	97.1	97.1	97.1
15	59	94.1	95.0	95.3	95.7	96.3	96.3	96.3	96.3	96.3	96.3
10	50	93.3	94.2	94.4	94.9	95.6	95.8	96.1	96.3	96.3	96.3
5	41	92.4	93.4	93.6	94.1	94.6	94.9	95.2	95.4	95.4	95.4
0	32	91.6	92.5	92.7	93.2	93.8	94.1	94.4	94.5	94.5	94.5
-10	14	89.8	90.8	91.0	91.5	92.0	92.3	92.6	92.8	92.8	92.8
-20	-4	88.1	89.1	89.3	89.7	90.3	90.6	90.9	91.0	91.0	91.0
-30	-22	86.4	87.3	87.5	88.0	88.5	88.8	89.1	89.2	89.2	89.2
-40	-40	84.6	85.5	85.7	86.1	86.6	86.9	87.2	87.3	87.4	87.4
-50	-58	82.8	83.6	83.8	84.3	84.7	85.0	85.3	85.5	85.5	85.5

PMC OFF**Takeoff Weight Adjustments (20K Derate)**

AIRPORT PRESSURE ALTITUDE (FT)	TEMPERATURE °C (°F)	PMC OFF TAKEOFF LIMIT WEIGHT ADJUSTMENT (1000 KG)				
		FIELD LIMIT	CLIMB LIMIT	TIRE SPEED LIMIT	BRAKE ENERGY LIMIT (NORMAL TAKEOFF)	BRAKE ENERGY LIMIT (IMPROVED CLIMB TAKEOFF)
BELOW 5000	ABOVE 21°C (70°F)	-1.43	-1.43	-0.15	-0.80	-0.32
	21°C (70°F) & BELOW	-0.46	-0.24	-0.09	-0.80	-0.32
5000 & ABOVE	ABOVE 21°C (70°F)	-1.54	-1.79	-0.15	-0.40	-0.16
	21°C (70°F) & BELOW	-1.18	-1.26	-0.09	-0.40	-0.16

Valid for Flaps 5 or Flaps 15 takeoff.

Obstacle Limit Weight Adjustments (20K Derate)

NORMAL OBSTACLE LIMIT WEIGHT (1000 KG)	PMC OFF OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)	
	AIRPORT PRESSURE ALTITUDE (FT)	
	3000 & BELOW	ABOVE 3000
30	0	-2.35
40	0	-2.85
50	0	-3.35
60	0	-3.85
70	0	-4.35

Valid for Flaps 5 or Flaps 15 takeoff.

Takeoff Speeds Adjustments (20K Derate)

SPEED (KIAS)	PRESSURE ALTITUDE (FT)	
	BELOW 5000	5000 & ABOVE
V1(MCG)	6	4
V1	0	0
VR	1	1

PMC OFF**Takeoff %N1 (20K Derate)****Based on engine bleed to packs on (Auto) and anti-ice on or off**

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	91.5	92.3	92.2	91.7						
50	122	92.0	92.8	93.4	93.7	93.0	93.0				
45	113	92.6	93.1	93.6	93.9	93.9	94.5	94.3	93.7		
40	104	93.1	93.6	94.0	94.2	94.3	95.1	95.0	94.9	94.8	94.5
35	95	93.2	94.1	94.6	94.8	94.8	95.5	95.7	95.6	95.8	95.7
30	86	93.0	94.5	94.3	94.5	95.0	95.4	95.6	95.8	95.8	95.8
25	77	92.2	93.7	93.7	93.7	94.4	95.5	95.3	95.1	95.4	95.8
20	68	91.5	92.9	92.9	92.9	93.6	95.5	95.7	95.8	95.8	95.7
15	59	90.7	92.1	92.1	92.1	92.8	94.9	95.1	95.1	95.1	95.1
10	50	89.9	91.3	91.3	91.3	92.0	94.1	94.3	94.3	94.3	94.3
5	41	89.1	90.5	90.5	90.5	91.2	93.2	93.4	93.4	93.4	93.4
0	32	88.3	89.7	89.7	89.7	90.4	92.4	92.6	92.6	92.6	92.6
-10	14	86.6	88.0	88.0	88.0	88.7	90.7	90.9	90.9	90.9	90.9
-20	-4	85.0	86.3	86.3	86.4	87.0	89.0	89.1	89.1	89.1	89.1
-30	-22	83.3	84.6	84.6	84.6	85.3	87.2	87.4	87.4	87.4	87.4
-40	-40	81.6	82.9	82.9	82.9	83.5	85.4	85.5	85.5	85.6	85.6
-50	-58	79.8	81.1	81.1	81.1	81.7	83.5	83.7	83.7	83.7	83.7

Based on engine bleed to packs off and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	92.4	93.3	93.2	92.7						
50	122	93.0	93.8	94.4	94.6	94.0	94.0				
45	113	93.5	94.0	94.6	94.9	94.8	95.5	95.3	94.7		
40	104	94.0	94.5	94.9	95.1	95.2	96.1	95.9	95.8	95.8	95.4
35	95	94.2	95.0	95.6	95.7	95.7	96.5	96.6	96.6	96.7	96.6
30	86	93.9	95.4	95.2	95.4	96.0	96.3	96.5	96.7	96.7	96.8
25	77	93.1	94.6	94.6	94.6	95.3	96.4	96.2	96.0	96.3	96.7
20	68	92.4	93.8	93.8	93.8	94.6	95.9	95.9	95.9	95.9	95.9
15	59	91.6	93.0	93.0	93.0	93.7	95.1	95.1	95.1	95.1	95.1
10	50	90.8	92.2	92.2	92.2	92.9	94.3	94.3	94.3	94.3	94.3
5	41	90.0	91.4	91.4	91.4	92.1	93.4	93.4	93.4	93.4	93.4
0	32	89.2	90.6	90.6	90.6	91.3	92.6	92.6	92.6	92.6	92.6
-10	14	87.5	88.9	88.9	88.9	89.6	90.9	90.9	90.9	90.9	90.9
-20	-4	85.8	87.2	87.2	87.2	87.9	89.1	89.1	89.1	89.1	89.1
-30	-22	84.1	85.5	85.5	85.5	86.1	87.4	87.4	87.4	87.4	87.4
-40	-40	82.4	83.7	83.7	83.7	84.3	85.5	85.5	85.5	85.6	85.6
-50	-58	80.6	81.9	81.9	81.9	82.5	83.7	83.7	83.7	83.7	83.7

Performance Inflight**Gear Down****Chapter PI****Section 25****GEAR DOWN****220 KIAS Cruise Altitude Capability****Max Cruise Thrust, 100 ft/min residual rate of climb**

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
66	21500	20200	18900
64	22200	21000	19700
62	23700	22600	21400
60	24500	23400	22200
58	25300	24200	23000
56	26000	25000	23800
54	26700	25700	24500
52	27400	26400	25200
50	28000	27000	25900
48	28600	27600	26600
46	29200	28200	27200
44	29700	28800	27800
42	30200	29300	28300
40	30700	29800	28800
38	31100	30300	29300

Based on 230 KIAS for weights above 62823 kg.

GEAR DOWN**220 KIAS Cruise Control**

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)									
		11	13	15	17	19	21	23	25	27	29
66	%N1	81.3	82.9	84.6	86.3	88.1	90.2				
	MACH	.424	.441	.458	.476	.495	.515				
	KIAS	230	230	230	230	230	230				
	FF/ENG	1948	1949	1951	1957	1966	1981				
62	%N1	79.3	80.9	82.6	84.2	86.0	87.9	90.1			
	MACH	.406	.422	.438	.456	.474	.493	.513			
	KIAS	220	220	220	220	220	220	220			
	FF/ENG	1800	1799	1801	1804	1809	1818	1835			
58	%N1	78.2	79.8	81.4	83.0	84.7	86.5	88.5	90.8		
	MACH	.406	.422	.438	.456	.474	.493	.513	.534		
	KIAS	220	220	220	220	220	220	220	220		
	FF/ENG	1729	1726	1725	1727	1727	1731	1744	1767		
54	%N1	77.1	78.8	80.4	82.0	83.6	85.3	87.1	89.2	91.7	
	MACH	.406	.422	.438	.456	.474	.493	.513	.534	.557	
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1665	1660	1657	1656	1655	1657	1664	1679	1705	
50	%N1	76.1	77.8	79.4	81.0	82.6	84.2	86.0	87.9	90.1	
	MACH	.406	.422	.438	.456	.474	.493	.513	.534	.557	
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1608	1602	1598	1595	1593	1592	1597	1608	1621	
46	%N1	75.2	76.9	78.5	80.1	81.7	83.3	85.0	86.8	88.8	91.3
	MACH	.406	.422	.438	.456	.474	.493	.513	.534	.557	.580
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1558	1551	1545	1542	1540	1537	1541	1548	1555	1579
42	%N1	74.3	76.0	77.7	79.3	80.8	82.4	84.1	85.9	87.8	90.0
	MACH	.406	.422	.438	.456	.474	.493	.513	.534	.557	.580
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1513	1505	1499	1495	1492	1489	1490	1496	1500	1516
38	%N1	73.6	75.3	76.9	78.6	80.1	81.7	83.3	85.1	86.9	88.9
	MACH	.406	.422	.438	.456	.474	.493	.513	.534	.557	.580
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1475	1466	1460	1455	1451	1448	1448	1453	1455	1464

Based on 230 KIAS for weights above 62823 kg.

GEAR DOWN**220 KIAS Enroute Fuel and Time****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
321	288	259	236	217		200	189	180	171	163
650	580	520	473	434		400	378	358	340	324
980	874	783	711	652		600	567	537	510	486
1309	1167	1045	949	869		800	756	717	680	648
1639	1461	1308	1186	1087		1000	945	895	850	809
1968	1754	1571	1424	1305		1200	1134	1074	1020	971
2298	2048	1833	1662	1522		1400	1323	1253	1189	1132
2627	2341	2096	1900	1740		1600	1512	1432	1360	1294
2956	2635	2358	2138	1958		1800	1701	1611	1529	1456
										1391

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	2.4	0:49	2.2	0:46	1.9	0:43	1.7	0:41	1.6	0:40
400	4.8	1:36	4.5	1:31	4.0	1:24	3.7	1:19	3.5	1:15
600	7.3	2:23	6.7	2:15	6.0	2:04	5.7	1:57	5.4	1:51
800	9.6	3:10	9.0	3:00	8.1	2:44	7.6	2:35	7.2	2:26
1000	12.0	3:57	11.2	3:44	10.1	3:25	9.5	3:13	9.0	3:02
1200	14.3	4:45	13.3	4:28	12.1	4:05	11.3	3:51	10.7	3:37
1400	16.6	5:32	15.5	5:13	14.0	4:46	13.2	4:29	12.5	4:12
1600	18.9	6:19	17.6	5:57	15.9	5:26	15.0	5:07	14.2	4:48
1800	21.1	7:06	19.7	6:41	17.8	6:06	16.8	5:44	15.9	5:23

Fuel Required Adjustments (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)			
	40	50	60	70
5	-0.3	0.0	0.7	1.7
10	-0.6	0.0	1.2	3.1
15	-0.8	0.0	1.6	4.0
20	-1.0	0.0	1.8	4.5
25	-1.1	0.0	1.9	4.6

Based on 220 KIAS cruise and descent.

Descent at 220 KIAS

PRESSURE ALT (1000 FT)	5	10	15	17	19	21	23	25	27	29	31	33
DISTANCE (NM)	17	26	35	38	42	46	49	53	56	60	64	67
TIME (MINUTES)	6	8	10	11	11	12	13	14	14	15	15	16

GEAR DOWN**Holding
Flaps Up**

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)						
	1500	5000	10000	15000	20000	25000	30000
66	%N1	73.7	76.4	80.5	84.6	89.1	
	KIAS	230	230	230	230	230	
	FF/ENG	2070	2060	2050	2050	2070	
62	%N1	71.7	74.3	78.4	82.6	86.9	
	KIAS	220	220	220	220	220	
	FF/ENG	1930	1910	1890	1890	1900	
58	%N1	70.6	73.3	77.3	81.4	85.6	90.8
	KIAS	220	220	220	220	220	
	FF/ENG	1860	1840	1820	1810	1820	1860
54	%N1	69.6	72.3	76.2	80.4	84.4	89.2
	KIAS	220	220	220	220	220	
	FF/ENG	1800	1770	1750	1740	1740	1760
50	%N1	67.1	70.0	73.9	78.0	82.1	86.5
	KIAS	210	210	210	210	210	210
	FF/ENG	1660	1630	1610	1590	1590	1660
46	%N1	66.1	68.9	72.8	77.0	81.0	85.2
	KIAS	210	210	210	210	210	210
	FF/ENG	1600	1570	1550	1530	1520	1560
42	%N1	65.1	67.9	71.9	75.9	80.0	84.1
	KIAS	210	210	210	210	210	210
	FF/ENG	1550	1520	1500	1480	1470	1460
38	%N1	64.2	67.0	71.1	75.0	79.1	83.2
	KIAS	210	210	210	210	210	210
	FF/ENG	1510	1480	1460	1430	1420	1410

This table includes 5% additional fuel for holding in a racetrack pattern.

Performance Inflight

Text

Chapter PI**Section 26**

Introduction

This chapter contains information to supplement performance data from the Flight Management Computer (FMC). In addition, sufficient inflight data is provided to complete a flight with the FMC inoperative. In the event of conflict between data presented in this chapter and that contained in the Approved Flight Manual, the Flight Manual shall always take precedence.

General**Takeoff Speeds**

The speeds presented in the Takeoff Speeds table, as well as FMC computed takeoff speeds, can be used for all performance conditions provided adjustments are made to V1 for clearway, stopway, brake deactivation, improved climb, contaminated runway situations, brake energy limits or obstacle clearance with unbalanced V1. These speeds may be used for weights less than or equal to the performance limited weight.

Normal takeoff speeds, V1, VR, and V2, with anti-skid on, are read from the table by entering with takeoff flap setting, brake release weight, and appropriate column. The appropriate column is obtained by entering the Column Reference chart with the airport pressure altitude and the actual temperature. If an Altitude Adjustment chart is provided, adjust the takeoff speeds appropriately. Slope and wind adjustments to V1 are obtained by entering the Slope and Wind V1 Adjustment table.

V1(MCG)

Regulations prohibit scheduling takeoff with a V1 less than minimum V1 for control on the ground, V1(MCG). Therefore compare the adjusted V1 to the V1(MCG). To find V1(MCG) enter the V1(MCG) table with the airport pressure altitude and actual OAT. If applicable, add the adjustments shown below the table. If the adjusted V1 is less than V1(MCG), set V1 equal to V1(MCG). If VR is less than V1(MCG), set VR equal to V1(MCG), and determine a new V2 by adding the difference between the normal VR and V1(MCG) to the normal V2.

If it is necessary to increase V1 to V1(MCG), then provided the actual field length exceeds the minimum field length of 4500 ft no takeoff weight adjustment is necessary.

Clearway and Stopway V1 Adjustments

Takeoff speed corrections are to be applied to V1 speed when using takeoff weights based on the use of clearway and stopway.

Adjust V1 speed by the amount shown in the appropriate column. The adjusted V1 speed must not exceed VR. If the adjusted V1 speed is greater than VR, reduce V1 to equal VR.

Maximum allowable clearway limits are provided for guidance when more precise data is not available.

Assumed Temperature Takeoff

For reduced thrust takeoffs based on assumed temperature, determine V1, VR, V2 from the appropriate column for airport pressure altitude and assumed temperature. Adjust V1 for slope, wind, clearway and stopway as required. Compare adjusted V1 with V1(MCG) from table using airport altitude and actual temperature. This is a regulatory requirement to cover the case where the pilot elects to advance thrust levers to maximum takeoff thrust following the engine failure. If adjusted V1 is less than V1(MCG) set V1 equal to V1(MCG).

Stab Trim

To find takeoff stabilizer trim setting, enter the appropriate Stab Trim Setting table with center of gravity (C.G. % MAC) and read required stabilizer trim units. For weights that meet the conditions listed, apply the adjustments shown below the table.

VREF

The Reference Speed table contains flaps 40, 30, and 15 landing speeds for a given weight. Apply wind correction shown as required.

Recommended Maneuvering Speeds

This table provides the flap speed schedule for recommended maneuvering speed. The speed schedule is a function of weight and will provide adequate maneuver margin above stall at all weights.

During flap retraction/extension, movement of the flap to the next position should be initiated when reaching the maneuver speed for the existing flap.

Slush/Standing Water Takeoff

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water, or ice. Therefore a reduction in field length/obstacle limited takeoff weight and revised takeoff speeds is necessary. The information provided is intended for guidance in accordance with advisory material. The performance is

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based on an engine failure at the critical point during takeoff and a 15 ft. screen height at the end of the runway. Tables are provided for dispatch with all thrust reversers operative and dispatch with one or two thrust reversers inoperative.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore this information is conservative when operating under typical colder weather conditions where patches of slush exist and some degree of sanding is common.

Takeoffs in slush depths greater than 0.5 inches (13mm) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature method for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Instructions for Using Tables:

Takeoff weight is determined as follows:

1. Determine the dry field length and obstacle limit weight for the takeoff flap setting.
2. Enter the Weight Adjustment table with the more limiting of the dry field length or obstacle limit weights, to obtain the weight reduction for the slush/standing water depth and airport pressure altitude.
3. When indicated, adjust field length available for temperature by the amount provided in the notes below the V1(MCG) limit weight table.
4. Enter V1(MCG) Limit Weight table 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.

The maximum allowable takeoff weight in slush/standing water is the lesser of the limit weights found in steps 2 and 4.

Takeoff speeds determination:

1. Determine takeoff speeds V1, VR and V2 for actual brake release weight using the Takeoff Speeds table in this section.
2. If V1(MCG) limited, set V1 = V1(MCG). If not limited by V1(MCG) considerations, enter V1 Adjustment table with actual brake release weight to determine the V1 reduction to apply to V1 speed. If the adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

Slippery Runway

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 used to calculate the "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate the "poor" data reflects a runway covered with wet ice. Performance is based on an engine failure at the critical point during takeoff and a 15 ft. screen height at the end of the runway. Tables are provided for dispatch with all thrust reversers operative and dispatch with one or two thrust reversers inoperative, and are used in the same manner as the Slush/Standing Water Takeoff tables.

Anti-skid Inoperative

When operating with anti-skid inoperative, the field limit weight and V1 must be reduced to account for the effect on accelerate-stop performance. A simplified method which conservatively accounts for the effects of anti-skid inoperative on a dry runway is to reduce the normal field length/obstacle limited weight by 7500 kg and the V1 associated with the reduced weight by the amount shown in the table below.

ANTI-SKID INOPERATIVE V1 ADJUSTMENT	
FIELD LENGTH (FT)	V1 ADJUSTMENT (KIAS)
6000	-28
8000	-22
10000	-18
12000	-14
14000	-13

If the resulting V1 is less than minimum V1, takeoff is permitted with V1 set equal to V1(MCG) provided the dry accelerate stop distance adjusted for wind and slope exceeds approximately 9000 ft.

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Takeoff %N1

To find Max Takeoff %N1 based on normal engine bleed for air conditioning packs on (Auto), enter Takeoff %N1 Table with airport pressure altitude and airport OAT and read %N1. For packs off operation, apply the %N1 adjustment shown below the table. No takeoff %N1 adjustment is required for engine and wing anti-ice.

Assumed Temperature Reduced Thrust

Regulations permit the use of up to 25% takeoff thrust reduction for operation with assumed temperature reduced thrust. To find the maximum allowable assumed temperature enter the top chart with airport pressure altitude and OAT. Compare this temperature to that at which the airplane is performance limited as determined from available takeoff performance data. Next, enter the center table with airport pressure altitude and the lower of the two temperatures previously determined to obtain a maximum takeoff %N1. Do not use an assumed temperature less than the minimum assumed temperature shown. Enter the %N1 Adjustment table with OAT and the difference between the assumed and actual OAT to obtain a %N1 adjustment. Subtract the %N1 adjustment from the maximum takeoff %N1 found previously to determine the assumed temperature reduced thrust %N1.

Takeoff with assumed temperature reduced thrust is not permitted when: runway is contaminated with ice, slush, snow, or standing water; anti-skid is inoperative; or PMC is off. Use of this procedure is not recommended if potential windshear conditions exist.

Max Climb %N1

This table shows Max Climb %N1 for a 250 KIAS/280 KIAS/.74M climb speed schedule, normal engine bleed for packs on (Auto) and anti-ice off. Enter the table with airport pressure altitude and TAT and read %N1. Apply the appropriate bleed setting %N1 adjustment shown below the table. %N1 adjustments are shown for engine bleed to packs off operation, packs high operation, and wing anti-ice on.

Go-around %N1

To find Max Go-around %N1 based on normal engine bleed for packs on (Auto) and anti-ice off, enter the Go-around %N1 table with airport pressure altitude and reported OAT or TAT and read %N1. Apply the appropriate bleed setting %N1 adjustment shown below the table. %N1 adjustments are shown for engine bleed to packs off operation, packs high operation, and wing anti-ice on.

Flight with Unreliable Airspeed / Turbulent Air Penetration

Pitch attitude and average %N1 information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking or freezing of the pitot system. Loss of radome or turbulent air may also cause unreliable airspeed/Mach indications. The cruise table in this section may also be used for turbulent air penetration.

Pitch attitude is shown in bold type for emphasis since altitude and/or vertical speed indications may also be unreliable.

All Engines

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. This table considers both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude.

Note that the altitudes shown in the table are limited to the maximum certified altitude of 37000 ft.

Long Range Cruise Control

These tables provide target %N1, 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 .74M 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 .74M/250 KIAS descent. Tables are presented for low altitudes and high altitudes.

To determine remaining fuel and time required, first enter the Ground to Air Miles Conversion table to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time tables. Next, enter the Reference Fuel and Time Table with air distance from the Ground to Air Miles Conversion Table and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment Table with the Reference Fuel and the actual weight at checkpoint to obtain fuel required to destination.

Long Range Cruise Wind-Altitude Trade

Wind is a factor which may justify operations considerably below optimum altitude. For example, a favorable wind component may have an effect on ground speed which more than compensates for the loss in air range.

Using this table, it is possible to determine the break-even wind (advantage necessary or disadvantage that can be tolerated) to maintain the same range at another altitude and long range cruise speed. The tables make no allowance for climb or descent time, fuel or distance, and are based on comparing ground fuel mileage.

Descent

Distance and time for descent are shown for a .74M/250 KIAS descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach with gear down and landing flaps at the outer marker.

Holding

Target %N1, indicated airspeed and fuel flow per engine information is tabulated for holding with flaps up based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read %N1, IAS and fuel flow per engine.

Advisory Information

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distance on dry runways and slippery runways with good, medium, and poor reported braking action. These values are actual landing distances and do not include the 1.67 regulatory factor. Therefore, they cannot be used to determine the dispatch required landing field length.

To use these tables, enter the appropriate table for selected landing flaps and determine the reference landing distance for the selected braking configuration. Then read across the table to adjust the reference distance for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers, using the values provided, to obtain the actual landing distance.

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. If the surface is affected by water, snow, or ice and the braking action is reported as "good", conditions should not be expected to be as good as on clean, dry runways. The value "good" is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when landing. The performance level used to calculate the "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate "poor" data reflects runways covered with wet ice.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" braking action, the airplane may not be able to achieve these deceleration rates. In these cases, runway slope and inoperative reversers influence the stopping distance. Since it cannot be easily determined when this becomes a factor, it is conservative to add the effects of slope and inoperative reversers when using the autobrake system.

Non-Normal Configuration Landing Distance

Advisory information is provided to support non-normal configurations that affect landing performance of the airplane. Landing distances are shown for dry runway and good, medium, and poor reported braking action. Each non-normal configuration is listed with its recommended approach speed. Landing distance can be determined for the reference landing weight and then adjusted for actual weight and pressure altitude.

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 quick turnaround limit weight. Application of the recommended cooling procedures shown will avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Engine Inoperative

Initial Max Continuous %N1

The Initial Max Continuous %N1 setting for use following an engine failure is shown. The table is based on the typical all engine cruise speed of .74M 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

Power setting is based on one engine operating with one A/C pack operating and all anti-ice bleeds off. Enter the table with pressure altitude and IAS or Mach to read %N1.

It is desirable to maintain engine thrust within the limits of the Max Cruise thrust rating. However, where thrust 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/LRC Cruise Range Capability

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to Long Range Cruise speed. Cruise is continued at level off altitude and Long Range Cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion table with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time table with air distance and weight at start of driftdown to determine fuel and time required. 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 Enroute 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 Long Range Cruise speed, Max Continuous thrust, and 100 ft/min residual rate of climb.

Long Range Cruise Control

The table provides target %N1, 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. To conservatively account for APU fuel burn, add 90 kg/hr to fuel flow values.

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 (KG/HR)
37	35
35	35
31	45
25	60
20	75
15	90
10	115
5	140

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 .74M/250 KIAS descent. Enter with Air Distance as determined from the Ground to Air Miles Conversion Table and read Fuel and Time required at the cruise pressure altitude. Adjust the fuel obtained for deviation from the reference weight at checkpoint as required by entering the off reference fuel corrections table with the fuel required for the reference weight and the actual weight at checkpoint. Read fuel required and time for the actual weight.

Holding

Single engine holding data is provided in the same format as the all engine holding data and is based on the same assumptions.

PMC Off

Introduction

This section contains performance data for airplane operation with the Power Management Control (PMC) OFF (PMC switch - amber INOP light illuminated) for applicable thrust ratings. Do not use assumed temperature reduced thrust with PMC Off.

Takeoff Weight Adjustment

When operating with PMC off, the normal takeoff performance limit weights should be adjusted by the amount shown in the Takeoff Weights Adjustment and Obstacle Limit Weight Adjustment tables. To determine the limit weights for PMC Off operations, enter the Takeoff Weight Adjustments table with the airport pressure altitude and OAT, then apply the adjustments to the normal PMC On limit weights for field length, climb, tire speed, and brake energy. For adjustments to takeoff obstacle limit, enter the Obstacle Limit Weight Adjustments table with the airport pressure altitude and the normal PMC On obstacle limit weight, then read the associated adjustment.

Takeoff Speed Adjustment

When operating with PMC Off, the normal takeoff speeds should be adjusted by the amount shown in the Takeoff Speeds Adjustment table. To determine the PMC Off takeoff speeds, determine the normal PMC On takeoff speeds associated with the actual takeoff weight after any adjustment necessitated by PMC Off operations, then apply the appropriate adjustments to the takeoff speeds, determined by entering the table with the airport pressure altitude and OAT. The adjusted V1 should not exceed the adjusted VR.

NOTE: The FMC does not incorporate PMC OFF performance in its takeoff speeds calculations.

Power Settings

Tables are provided to account for engine bleed effects of normal air conditioning packs operation and for engine bleed to packs off operation.

To find Max Takeoff %N1 with both PMC's Off, enter Max Takeoff %N1 table (PMC Off) for the appropriate bleed configuration with airport pressure altitude and airport OAT and read %N1. No takeoff %N1 correction is required for engine anti-ice operation up to 10°C (50°F) which is the highest temperature recommended for engine anti-ice operation.

For Maximum Climb and Go-Around thrust setting with both PMC's Off,
use PMC On %N1.

Gear Down

This section contains performance for airplane operation with the landing gear extended for all phases of flight. The data is based on engine bleeds for normal air conditioning.

Note: The Flight Management Computer System (FMCS) does not contain special provisions for operation with landing gear extended. As a result, the FMCS will generate inappropriate 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 (ETA) is available if current speed or Mach is entered into the VNAV cruise page.

Tables for gear down performance in this section are identical in format and used in the same manner as tables for the gear up configuration previously described.

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737-500 CFM56-3_20K KG FAA

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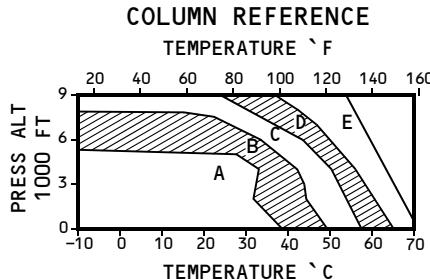
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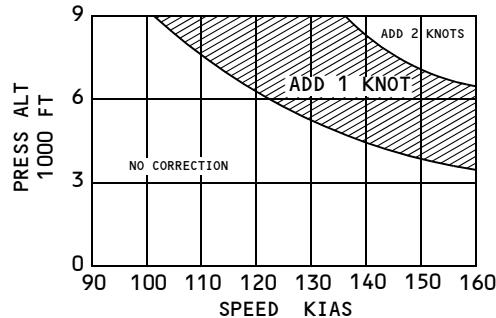
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Performance Inflight**General****Chapter PI****Section 30****Takeoff Speeds****Flaps 5**

WEIGHT KG	SLOPE/WIND V ₁ ADJUSTMENT*		
	SLOPE % DN	WIND KTS UP	TAIL HEAD
1000	-2	0	-15 0 40
65	-2	0	2 -2 0 2
55	-2	0	1 -3 0 1
45	-2	0	1 -3 0 1
35	-2	0	2 -3 0 2

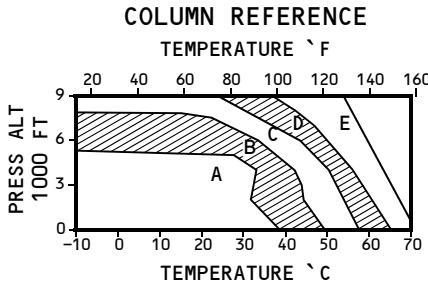
*V₁ NOT TO EXCEED V_R

WT 1000 KG	A			B			C			D			E		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
65	150	154	158	152	155	158	153	156	158	155	157	158	159	160	163
60	144	147	152	146	148	152	147	149	152	149	151	152	152	153	155
55	137	139	146	139	141	146	140	142	146	143	143	146	145	145	146
50	129	131	139	131	132	139	132	134	139	135	135	139	137	137	139
45	121	122	132	122	124	132	123	125	132	126	127	132	129	129	132
40	111	114	125	113	115	125	114	116	124	117	117	124	119	119	124
35	101	104	118	103	106	118	104	107	117	106	108	117	109	110	116
30	89	95	110	91	97	110	93	97	109	95	99	109	98	100	108

CHECK V₁(MCG) AND MINIMUM V_R.ALTITUDE V₁, V_R, V₂ ADJUSTMENT

Takeoff Speeds

Flaps 15



WEIGHT 1000 KG	SLOPE/WIND V ₁ ADJUSTMENT*		
	SLOPE % DN	% UP	WIND KTS TAIL HEAD
1000	-2	0	-15 0 40
65	-2	0	-2 0 2
55	-2	0	-3 0 1
45	-2	0	-3 0 1
35	-2	0	-3 0 2

*V₁ NOT TO EXCEED V_R

WT 1000 KG	A			B			C			D			E		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
60	137	138	143	139	140	144	141	141	144	142	143	145	145	145	146
55	131	131	138	132	132	138	134	134	138	135	135	138	137	137	139
50	123	124	132	125	125	131	126	126	131	127	127	131	129	129	132
45	115	116	126	117	117	125	118	118	125	119	119	124	121	121	125
40	106	108	119	107	109	119	109	110	118	111	111	118	113	113	117
35	96	99	112	97	101	112	99	102	112	102	103	111	104	104	110
30	84	90	106	86	92	106	88	93	105	90	94	103	92	95	102

CHECK V₁(MCG) AND MINIMUM VR.

V₁(MCG), Minimum VR

ACTUAL OAT	PRESSURE ALTITUDE FT												
	-1000		0		2000		4000		6000		8000		
°C	°F	V ₁ (MCG)	MIN VR										
55	131	99	102	98	101								
50	122	102	104	100	103	98	101	97	100	93	97	89	93
40	104	106	108	105	107	103	105	102	104	97	100	92	96
30	86	109	111	109	110	106	109	106	109	101	104	96	99
20	68	110	111	109	111	107	110	106	109	104	106	100	102
10	50	110	111	109	111	108	110	107	109	104	106	100	103
-50	-58	111	112	110	111	109	110	108	109	105	106	101	103

FOR A/C OFF INCREASE V₁(MCG) BY 2 KNOTS

FOR PMC OFF INCREASE V₁(MCG) BY 6 KNOTS

FOR PMC OFF INCREASE MIN VR BY 5 KNOTS

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Maximum Allowable Clearway

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
4000	450
6000	500
8000	550
10000	600
12000	650
14000	700

Clearway and Stopway V1 Adjustments

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)			
	100	120	140	160
800			-2	-1
600		-3	-2	-1
400	-4	-3	-2	0
200	-2	-1	-1	0
0	0	0	0	0
-400	1	1	1	1
-800	1	1	1	1

Stab Trim Setting**Max Takeoff Thrust****Flaps 5 and 15**

C.G. % MAC	6	10	14	18	22	26	30
STAB TRIM	6 1/4	5 1/2	5	4 1/4	3 3/4	3	2 1/2

For weights at or below 45360 kg subtract 1/2 unit from above value.

For weights at or above 54430 kg add 1/2 unit from above value.

VREF

WEIGHT (1000 KG)	FLAPS		
	40	30	15
64	145	149	159
60	140	144	154
56	135	140	149
52	130	135	143
48	125	129	138
44	120	123	132
40	114	117	125
36	108	111	118
32	101	105	111

Increase VREF by 1 knot per 4000 ft above sea level.

For approach speed add wind factor of 1/2 headwind component + gust (max 20 knots).

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Recommended Maneuvering Speeds

FLAP POSITION	MANEUVER SPEED (KIAS)		
	WEIGHT		
	AT OR BELOW 53070 KG	ABOVE 53070 KG AND AT OR BELOW 62823 KG	ABOVE 62823 KG
UP	210	220	230
1	190	200	210
5	170/ *180	180/ *190	190/ *200
10	160/ *170	170/ *180	180/ *190
15	150	160	170
25	140	150	160
30		VREF 30	
40		VREF 40	

*Maneuvering speeds for airplanes without the Rudder System Enhancement Program (RSEP) installed.

ADVISORY INFORMATION**Slush/Standing Water Takeoff****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.
68	-7.6	-7.8	-8.5	-9.4	-10.1	-10.8	-13.1	-13.7	-13.6
64	-7.2	-7.4	-8.3	-8.8	-9.6	-10.4	-12.3	-13.5	-13.4
60	-6.6	-6.8	-7.9	-7.9	-8.8	-9.8	-11.2	-12.5	-12.9
56	-5.9	-6.2	-7.3	-7.1	-8.0	-9.0	-9.8	-11.1	-12.3
52	-5.2	-5.4	-6.7	-6.2	-7.0	-8.1	-8.4	-9.7	-11.4
48	-4.6	-4.8	-5.9	-5.5	-6.1	-7.2	-7.1	-8.4	-10.3
44	-4.2	-4.3	-5.1	-4.8	-5.3	-6.1	-6.0	-7.3	-8.9
40	-3.8	-3.9	-4.4	-4.5	-4.9	-5.3	-5.5	-6.9	-7.2
36	-3.7	-3.9	-3.9	-4.3	-4.8	-4.6	-5.6	-7.5	-5.2

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.
4200							28.9		
4600				30.7			35.5		
5000	34.6			37.6	28.1		42.1	33.1	28.4
5400	41.5	30.6		44.5	33.7	28.1	48.6	38.6	32.9
5800	48.7	36.3	30.0	51.8	39.3	33.1	55.2	44.0	37.3
6200	56.3	42.0	35.0	59.1	44.9	38.1	61.7	49.3	41.8
6600	63.8	47.9	40.0	66.5	51.0	43.1	68.2	54.5	46.2
7000	71.3	54.1	45.0	73.8	57.1	48.3	74.8	59.7	50.5
7400		60.4	50.4		63.2	53.5		65.0	54.8
7800			66.6	55.8		69.3	58.8		70.2
8200			72.8	61.3		75.4	64.1		75.4
8600				66.8			69.3		67.6
9000				72.2			74.6		71.8

- Enter Weight Adjustment table with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
- Adjust field length available by -100 ft/+90 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Slush/Standing Water Takeoff****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-10	-10	-7	-3	-4	-4	0	0	0
64	-12	-11	-9	-5	-5	-4	0	0	0
60	-14	-13	-10	-7	-6	-5	0	0	0
56	-16	-15	-12	-10	-8	-6	0	0	0
52	-18	-17	-14	-13	-11	-7	-1	0	0
48	-20	-19	-15	-16	-13	-8	-5	0	0
44	-21	-20	-17	-18	-16	-11	-8	-4	0
40	-22	-21	-18	-19	-17	-13	-11	-8	-1
36	-22	-21	-19	-19	-18	-15	-13	-10	-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 V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Slush/Standing Water Takeoff****No Reverse Thrust****Weight Adjustment (1000 KG)**

DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
72	-10.1	-10.5	-11.1	-11.9	-12.2	-12.2	-16.7	-16.5	-15.6
68	-9.4	-10.0	-10.7	-10.9	-11.5	-12.1	-15.2	-16.1	-15.5
64	-8.7	-8.3	-10.1	-9.8	-10.6	-11.7	-13.7	-15.1	-15.2
60	-7.9	-8.6	-9.4	-8.7	-9.6	-10.9	-12.0	-13.6	-14.6
56	-7.1	-7.7	-8.7	-7.7	-8.5	-9.9	-10.3	-11.8	-13.7
52	-6.3	-6.8	-7.8	-6.6	-7.3	-8.7	-8.7	-10.0	-12.4
48	-5.4	-5.8	-6.8	-5.6	-6.2	-7.5	-7.2	-8.2	-10.8
44	-4.6	-5.0	-5.8	-4.6	-5.2	-6.2	-5.9	-6.8	-8.8
40	-3.7	-4.2	-4.7	-3.7	-4.3	-5.1	-4.9	-5.8	-6.4

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
5500				25.3			33.8		
6000	27.3			33.4			41.9	32.0	27.7
6500	35.7			42.0	29.9		50.4	38.5	33.3
7000	44.9	30.2		51.3	36.7	31.0	59.1	45.4	39.0
7500	54.7	37.1	30.4	61.0	43.9	37.0	67.8	52.5	44.9
8000	65.2	44.6	36.7		51.6	43.4		59.6	50.7
8500		52.6	43.3		59.6	50.0		66.7	56.6
9000		61.0	50.2		67.7	56.9			62.5
9500		69.5	57.5			64.0			
10000			65.0						

- Enter Weight Adjustment table with slush/standing water depth and dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
- Adjust field length available by -180 ft/+100 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
64	-20	-20	-16	-14	-14	-12			
60	-22	-22	-18	-17	-16	-12	-5	-12	-6
56	-25	-24	-20	-20	-17	-13	-5	-6	-5
52	-27	-26	-22	-23	-20	-15	-6	-2	-3
48	-28	-27	-24	-26	-23	-17	-11	-5	-2
44	-30	-29	-25	-28	-26	-20	-18	-11	-3
40	-31	-30	-27	-30	-28	-23	-22	-18	-5
36	-31	-31	-28	-29	-29	-24	-23	-22	-10

- Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.
- If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Slippery Runway Takeoff****Maximum Reverse Thrust****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.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-0.1	-0.1	-0.1	-4.1	-4.1	-4.1	-6.6	-6.6	-6.6
64	-0.5	-0.5	-0.5	-4.2	-4.2	-4.2	-6.5	-6.5	-6.5
60	-0.8	-0.8	-0.8	-4.2	-4.2	-4.2	-6.5	-6.5	-6.5
56	-0.8	-0.8	-0.8	-4.1	-4.1	-4.1	-6.3	-6.3	-6.3
52	-0.9	-0.9	-0.9	-3.8	-3.8	-3.8	-6.1	-6.1	-6.1
48	-0.8	-0.8	-0.8	-3.6	-3.6	-3.6	-5.9	-5.9	-5.9
44	-0.7	-0.7	-0.7	-3.6	-3.6	-3.6	-5.7	-5.7	-5.7
40	-0.7	-0.7	-0.7	-3.7	-3.7	-3.7	-5.6	-5.6	-5.6
36	-0.5	-0.5	-0.5	-4.1	-4.1	-4.1	-5.4	-5.4	-5.4

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
3800	37.8							
4200	49.7	34.2						
4600	61.1	46.2	30.5	29.3				
5000	72.6	57.7	42.6	37.5				
5400		69.1	54.2	45.8	35.1			
5800			65.7	54.9	43.3	32.6		
6200				64.0	52.2	40.8	32.9	
6600					73.0	61.2	49.4	38.6
7000						70.3	58.5	44.2
7400							67.6	
7800								50.6
8200								38.6
8600								57.1
9000								44.2
9400								63.6
9800								50.6
10200								70.2

- Enter Weight Adjustment table with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -90 ft/+80 ft for every 5°C above/below 4°C
Adjust "Medium" field length available by -90 ft/+80 ft for every 5°C above/below 4°C
Adjust "Poor" field length available by -120 ft/+110 ft for every 5°C above/below 4°C
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

ADVISORY INFORMATION**Slippery Runway Takeoff****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION									
	GOOD			MEDIUM			POOR			
	PRESS ALT (FT)		S.L.	4000	8000	S.L.	4000	8000	S.L.	4000
68	-4	-2	0	-10	-8	-6	-24	-21	-18	
64	-5	-3	-1	-13	-11	-9	-26	-23	-20	
60	-6	-4	-2	-15	-13	-11	-29	-26	-23	
56	-8	-6	-4	-17	-15	-13	-32	-29	-26	
52	-9	-7	-5	-19	-17	-15	-34	-31	-28	
48	-10	-8	-6	-21	-19	-17	-36	-33	-30	
44	-11	-9	-7	-22	-20	-18	-37	-34	-31	
40	-11	-9	-7	-23	-21	-19	-37	-34	-31	
36	-12	-10	-8	-25	-23	-21	-38	-35	-32	

1. Obtain V1, VR and V2 for the actual weight using the Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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ADVISORY INFORMATION**Slippery Runway Takeoff****No Reverse Thrust****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.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-0.9	-0.9	-0.9	-5.8	-5.8	-5.8	-9.8	-9.8	-9.8
64	-1.4	-1.4	-1.4	-5.8	-5.8	-5.8	-9.4	-9.4	-9.4
60	-1.6	-1.6	-1.6	-5.7	-5.7	-5.7	-8.9	-8.9	-8.9
56	-1.7	-1.7	-1.7	-5.5	-5.5	-5.5	-8.4	-8.4	-8.4
52	-1.6	-1.6	-1.6	-5.1	-5.1	-5.1	-7.7	-7.7	-7.7
48	-1.5	-1.5	-1.5	-4.7	-4.7	-4.7	-6.9	-6.9	-6.9
44	-1.3	-1.3	-1.3	-4.2	-4.2	-4.2	-6.0	-6.0	-6.0
40	-1.1	-1.1	-1.1	-3.6	-3.6	-3.6	-5.0	-5.0	-5.0

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
4000	33.1							
4400	46.6	28.9						
4800	59.4	42.7	24.8					
5200	71.7	55.6	38.6					
5600		68.1	51.8	27.8				
6000			64.4	37.8	24.8			
6400				48.4	34.7			
6800				59.4	45.2	22.8		
7200				70.3	56.1	32.7		
7600					67.0	43.0		
8000						53.9		
8400						64.8	30.3	
8800							36.4	
9200							43.0	29.1
9600							50.1	35.2
10000							57.7	41.6
10400							66.0	48.6
10800								56.2
11200								40.3
11600								47.2
12000								54.6
								62.6

- Enter Weight Adjustment table with reported braking action and dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -100 ft/+70 ft for every 5°C above/below 4°C.
Adjust "Medium" field length available by -100 ft/+70 ft for every 5°C above/below 4°C.
Adjust "Poor" field length available by -170 ft/+160 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Slippery Runway Takeoff****No Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.
60	-8	-6	-4	-20	-18	-16	-38	-34	-30
56	-10	-8	-6	-23	-21	-19	-41	-37	-33
52	-12	-10	-8	-25	-23	-21	-45	-41	-37
48	-13	-11	-9	-28	-26	-24	-47	-43	-39
44	-14	-12	-10	-30	-28	-26	-50	-46	-42
40	-15	-13	-11	-32	-30	-28	-52	-48	-44
36	-16	-14	-12	-33	-31	-29	-53	-49	-45

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 V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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Takeoff %N1**Based on engine bleed to packs on (Auto) and anti-ice on or off**

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	89.9	90.5								
50	122	90.6	91.1	91.6	92.3	93.1					
45	113	91.2	91.6	92.1	92.6	93.9	94.9	94.7	94.2		
40	104	91.7	92.1	92.6	93.0	94.3	95.3	95.3	95.3	95.0	94.3
35	95	92.0	92.5	93.0	93.4	94.7	95.9	95.8	95.8	95.1	94.5
30	86	91.8	92.8	93.2	93.6	95.0	96.5	96.4	96.4	95.7	95.0
25	77	91.0	92.1	92.9	93.6	94.5	95.9	96.3	96.7	96.2	95.6
20	68	90.3	91.3	92.1	92.8	93.8	95.1	95.5	95.9	95.9	95.9
15	59	89.5	90.5	91.3	92.0	93.0	94.3	94.7	95.1	95.3	95.3
10	50	88.7	89.7	90.5	91.2	92.1	93.4	93.9	94.3	94.4	94.6
5	41	87.9	88.9	89.7	90.4	91.3	92.6	93.0	93.4	93.6	93.7
0	32	87.1	88.1	88.9	89.6	90.5	91.8	92.2	92.6	92.7	92.9
-10	14	85.5	86.5	87.2	87.9	88.8	90.1	90.5	90.9	91.0	91.2
-20	-4	83.9	84.8	85.6	86.2	87.1	88.3	88.7	89.1	89.2	89.4
-30	-22	82.2	83.1	83.9	84.5	85.4	86.6	87.0	87.4	87.5	87.6
-40	-40	80.5	81.4	82.1	82.7	83.6	84.8	85.1	85.5	85.7	85.8
-50	-58	78.8	79.6	80.3	81.0	81.8	82.9	83.3	83.7	83.8	84.0

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-1000	8000
ENGINE BLEED TO PACKS OFF	1.0	1.0

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Assumed Temperature Reduced Thrust**Maximum Assumed Temperature (Table 1)****Based on 25% Takeoff Thrust Reduction**

OAT (°C)	PRESS ALT (1000 FT)									OAT (°F)	PRESS ALT (1000 FT)										
	-1	0	1	2	3	4	5	6	7		-1	0	1	2	3	4	5	6	7	8	
55	74	73	73							130	164	162	162								
50	71	71	69	68	66	65				120	159	158	155	153	149	147					
45	69	68	67	66	63	62	62	63	65	110	154	153	151	149	144	142	142	143	145		
40	66	66	65	64	61	60	60	60	62	100	150	148	146	145	140	138	138	137	139	141	
35	64	63	62	62	59	58	58	57	59	60	90	146	143	142	141	137	134	133	132	136	137
30	63	61	61	60	58	56	55	55	56	58	80	146	141	140	137	135	131	129	128	131	132
25	63	61	60	58	57	55	54	53	54	55	70	146	141	140	136	134	131	129	127	127	126
20 & BELOW	63	61	60	58	57	55	54	53	53	52	60 & BELOW	146	141	140	136	134	131	129	127	127	126

Maximum Takeoff %N1 (Table 2)**Based on engine bleed to packs on (Auto) and engine anti-ice on or off**

ASSUMED TEMP		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
75	167	83.0	83.9	83.8	83.5						
70	158	84.7	85.6	85.6	85.4	84.9	84.7				
65	149	86.6	87.3	87.3	87.2	87.0	87.0	87.1	87.2	87.6	87.9
60	140	88.3	88.9	89.0	89.0	89.1	89.1	89.1	89.0	89.1	89.3
55	131	89.7	90.5	90.6	90.7	91.1	91.3	91.0	90.8	90.7	90.6
50	122	90.4	91.1	91.6	92.3	93.1	93.4	92.9	92.5	92.2	91.9
45	113	91.0	91.6	92.1	92.7	93.9	94.9	94.8	94.2	93.7	93.1
40	104	91.6	92.1	92.6	93.0	94.3	95.3	95.3	95.0	94.3	
35	95	92.0	92.5	93.0	93.4	94.8	95.9	95.9	95.8	95.1	94.5
30	86	91.7	92.8	93.2	93.6	95.0	96.5	96.4	96.4	95.7	95.0
25	77	90.9		92.9	93.7	94.5	95.9	96.5	96.7	96.2	95.6
20	68	90.2				93.8				95.9	95.9
15	59	89.4									95.4
MINIMUM ASSUMED TEMP °C (°F)		32(90)	30(86)	28(82)	26(79)	24(75)	29(85)	27(81)	25(77)	20(68)	15(59)

With engine bleed to packs off, increase %N1 by 1.0.

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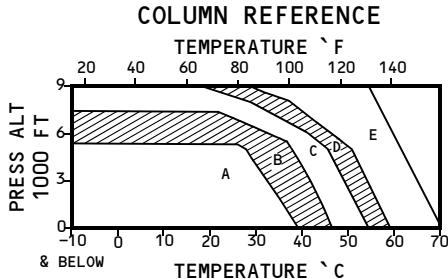
Assumed Temperature Reduced Thrust**%N1 Adjustment For Temperature Difference (Table 3)**

ASSUMED TEMP MINUS OAT		OUTSIDE AIR TEMPERATURE														
°C	°F	°C	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
		°F	-40	-4	32	41	50	59	68	77	86	95	104	113	122	131
10	18				1.6	1.6	1.6	1.5	1.5	1.5	1.4	1.4	1.4	1.3		
20	36			3.3	3.3	3.1	3.1	3.0	3.0	2.9	2.8	2.7	2.6	2.5	2.3	
30	54			4.8	4.7	4.6	4.5	4.4	4.3	4.1	3.9	3.7	3.5	3.4	3.3	
40	72			6.8	6.1	6.0	5.9	5.7	5.5	5.3	5.1	4.9				
50	90			8.1	7.4	7.2	6.9	6.7	6.3							
60	108		10.4	9.3	8.4	8.1	7.7									
70	126		11.5	10.5	9.0											
80	144		12.7	11.4	9.8											
90	162		13.8	11.9												
100	180		14.5	12.6												
110	198		14.9													

1. Determine Maximum Assumed Temperature allowed from Table 1.
2. Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).
3. Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.
4. Subtract %N1 adjustment from Maximum %N1 in Table 2.

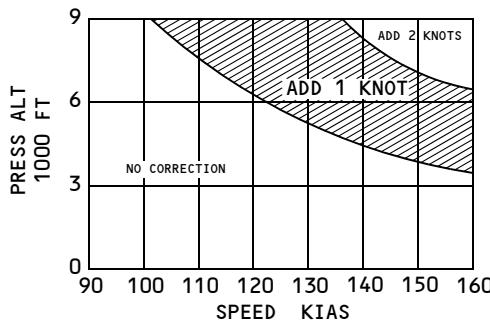
Takeoff Speeds (18.5K Derate)

Flaps 5



WEIGHT 1000 KG	SLOPE/WIND V ₁ ADJUSTMENT*			V ₁ ADJUSTMENT	
	SLOPE % DN	UP	TAIL HEAD	V ₁	NOT TO EXCEED V _R
65	-2	0	2	-1	0
55	-2	0	1	-2	0
45	-2	0	1	-3	0
35	-2	0	2	-3	0

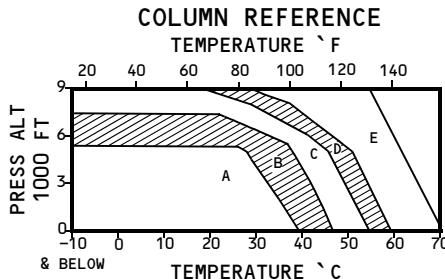
WT 1000 KG	A			B			C			D			E		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
65	152	155	158	153	156	158	154	157	158	156	157	158	157	158	158
60	146	148	152	147	149	152	149	150	152	150	151	152	151	152	152
55	139	140	146	140	142	146	142	143	146	143	144	146	145	145	146
50	131	132	139	133	134	139	134	135	139	135	136	139	137	137	139
45	122	123	132	124	125	132	125	126	132	127	127	132	128	128	131
40	113	115	125	115	116	124	116	117	124	117	118	124	119	119	123
35	103	106	118	105	107	117	106	108	117	107	109	116	109	110	116
30	92	96	110	93	97	109	95	98	109	97	100	110	98	100	108

CHECK V₁(MCG) AND MINIMUM V_R.**ALTITUDE V₁, V_R, V₂ ADJUSTMENT**

737 Flight Crew Operations Manual

Takeoff Speeds (18.5K Derate)

Flaps 15



WEIGHT 1000 KG	SLOPE/WIND V1 ADJUSTMENT*		
	SLOPE %	WIND KTS	HEAD
	DN	UP	TAIL
65	-2	0	2
55	-2	0	-1
45	-2	0	-2
35	-2	0	-3

*V1 NOT TO EXCEED VR

WT 1000 KG	A			B			C			D			E		
	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂	V ₁	V _R	V ₂
55	132	132	137	132	133	137	134	134	138	136	136	138	137	137	139
50	124	125	131	126	126	131	127	127	131	128	128	131	129	129	132
45	117	117	125	118	118	125	119	119	124	120	120	125	121	121	125
40	107	109	119	109	110	118	111	111	118	112	112	118	113	113	118
35	97	100	112	99	101	112	101	102	111	103	103	111	104	105	110
30	87	91	104	88	92	105	89	94	105	92	95	104	94	96	104

CHECK V1(MCG) AND MINIMUM VR.

V1(MCG), Minimum VR (18.5K Derate)

ACTUAL OAT	PRESSURE ALTITUDE FT												
	-1000		0		2000		4000		6000		8000		
°C	°F	V1(MCG)	MIN VR	V1(MCG)									
55	131	95	98	94	97					88	91	81	85
50	122	98	100	97	99	95	97	92	95				
40	104	102	104	102	104	100	103	98	101	94	97	88	92
30	86	105	107	104	107	103	106	101	104	99	102	93	96
20	68	105	107	105	107	104	106	102	105	100	103	96	99
10	50	106	107	106	107	104	106	102	105	101	103	97	100
-50	-58	107	108	107	108	105	107	104	106	102	104	98	100

FOR A/C OFF INCREASE V1(MCG) BY 2 KNOTS

FOR PMC OFF INCREASE V1(MCG) BY 6 KNOTS

FOR PMC OFF INCREASE MIN VR BY 5 KNOTS

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Maximum Allowable Clearway (18.5K Derate)

FIELD LENGTH (FT)	MAX ALLOWABLE CLEARWAY FOR V1 REDUCTION (FT)
4000	450
6000	500
8000	550
10000	600
12000	650
14000	700

Clearway and Stopway V1 Adjustments (18.5K Derate)

CLEARWAY MINUS STOPWAY (FT)	NORMAL V1 (KIAS)			
	100	120	140	160
800			-2	-1
600		-3	-2	-1
400	-4	-3	-2	0
200	-2	-1	-1	0
0	0	0	0	0
-400	1	1	1	1
-800	1	1	1	1

Stab Trim Setting (18.5K Derate)

C.G. % MAC	6	10	14	18	22	26	30
STAB TRIM	6 1/4	5 1/2	5	4 1/4	3 3/4	3	2 1/2

For weights at or below 45360 kg subtract 1/2 unit from above value.

For weights at or above 54430 kg add 1/2 unit from above value.

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Slush/Standing Water Takeoff (18.5K Derate)****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

18.5K DERATE FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-7.7	-8.0	-8.4	-9.6	-10.0	-10.4	-13.1	-10.5	-12.3
64	-7.4	-7.9	-8.4	-9.1	-9.9	-10.5	-12.6	-12.2	-12.7
60	-6.8	-7.5	-8.1	-8.3	-9.3	-10.1	-11.6	-12.4	-12.6
56	-6.1	-6.8	-7.6	-7.3	-8.4	-9.4	-10.2	-11.6	-12.1
52	-5.4	-6.1	-6.9	-6.4	-7.4	-8.5	-8.8	-10.2	-11.2
48	-4.8	-5.3	-6.0	-5.5	-6.3	-7.5	-7.5	-8.7	-10.1
44	-4.2	-4.6	-5.2	-4.8	-5.4	-6.3	-6.5	-7.4	-8.8
40	-3.8	-3.9	-4.4	-4.4	-4.7	-5.3	-6.3	-6.8	-7.5
36	-3.6	-3.6	-3.7	-4.2	-4.3	-4.3	-6.8	-7.3	-6.1

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
4200							31.2		
4600	31.2			33.5			38.0	30.4	
5000	38.3	28.9		40.6	31.8		44.7	35.9	30.2
5400	45.4	34.9		47.8	37.7	30.8	51.2	41.5	35.1
5800	52.8	40.8	33.3	55.4	43.6	36.0	57.6	47.1	40.1
6200	60.6	46.8	38.6	63.2	49.5	41.3	64.1	52.9	45.0
6600	68.5	53.0	43.9	70.9	55.8	46.6	70.6	58.8	49.9
7000		59.6	49.2		62.1	51.9		64.6	54.7
7400		66.1	54.7		68.4	57.2		70.4	59.6
7800		72.7	60.3		74.7	62.5			64.5
8200			65.9			67.8			69.4
8600			71.6			73.1			74.2

1. Enter Weight Adjustment table with slush/standing water depth and 18.5K derate dry field/obstacle limit weight to obtain slush/standing water weight adjustment.
2. Adjust field length available by -100 ft/+90 ft for every 5°C above/below 4°C
3. Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
4. Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Slush/Standing Water Takeoff (18.5K Derate)****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH										
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)				
	PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-7	-6	-4	0	-1	-2	0	0	0	0	0
64	-9	-8	-6	-2	-2	-3	0	0	0	0	0
60	-11	-10	-8	-5	-3	-3	0	0	0	0	0
56	-14	-12	-9	-7	-5	-3	0	0	0	0	0
52	-16	-14	-11	-10	-8	-5	0	0	0	0	0
48	-18	-16	-13	-13	-10	-6	-3	-1	0	0	0
44	-19	-18	-15	-16	-13	-8	-6	-2	0	0	0
40	-20	-19	-16	-18	-15	-10	-9	-4	0	0	0
36	-21	-20	-18	-18	-17	-13	-11	-7	-2	0	0

1. Obtain V1, VR and V2 for the actual weight using the 18.5K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

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ADVISORY INFORMATION**Slush/Standing Water Takeoff (18.5K Derate)****No Reverse Thrust****Weight Adjustment (1000 KG)**

18.5K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
72	-10.7	-11.1	-11.5	-13.1	-12.7	-12.6	-15.9	-15.7	-15.8
68	-10.0	-10.6	-10.9	-12.4	-12.7	-11.5	-15.4	-15.8	-15.3
64	-9.3	-9.9	-10.1	-11.4	-12.3	-10.4	-14.4	-15.2	-14.8
60	-8.5	-9.2	-9.3	-10.3	-11.5	-9.3	-12.9	-14.1	-14.3
56	-7.6	-8.3	-8.4	-9.1	-10.4	-8.1	-11.2	-12.6	-13.6
52	-6.7	-7.4	-7.5	-7.8	-9.2	-7.0	-9.4	-10.9	-12.7
48	-5.8	-6.5	-6.6	-6.6	-7.9	-5.9	-7.7	-9.2	-11.3
44	-5.0	-5.5	-5.6	-5.6	-6.6	-4.9	-6.3	-7.5	-9.5
40	-4.1	-4.6	-4.6	-4.7	-5.4	-4.0	-5.4	-6.0	-7.1

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
5000							29.3		
5500				29.5			37.3	29.0	
6000	32.4			38.2	27.8		46.0	35.7	30.2
6500	41.8	28.9		47.7	35.0	28.6	55.0	42.8	36.0
7000	51.9	36.4	28.7	57.7	42.6	34.8	63.9	50.2	42.0
7500	62.7	44.4	35.3	67.9	50.6	41.3		57.6	48.0
8000	74.1	52.9	42.1		59.0	48.2		65.0	53.8
8500		61.8	49.3		67.5	55.3			59.3
9000		71.2	56.9			62.5			64.6
9500			64.8						

- Enter Weight Adjustment table with reported braking action and 18.5K Derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust field length available by -160 ft/+90 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slush/standing water limited weight is lesser of weights from 1 and 3.

V1 Adjustment (KIAS)

WEIGHT (1000 KG)	SLUSH/STANDING WATER DEPTH								
	0.12 INCHES (3mm)			0.25 INCHES (6mm)			0.50 INCHES (13mm)		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
64	-16	-15	-12	-11	-10	-9			
60	-19	-18	-14	-13	-11	-9	-10	-14	-6
56	-22	-20	-16	-16	-13	-10	-5	-6	-6
52	-24	-22	-19	-19	-16	-11	-3	-2	-5
48	-26	-24	-21	-23	-19	-14	-7	-3	-3
44	-28	-26	-23	-26	-23	-17	-13	-6	-2
40	-30	-27	-25	-28	-25	-20	-19	-12	-3
36	-30	-28	-26	-28	-26	-23	-22	-17	-7

- Obtain V1, VR and V2 for the actual weight using the 18.5K Derate Dry Runway Takeoff Speeds table.
- If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff (18.5K Derate)****Maximum Reverse Thrust****Weight Adjustment (1000 KG)**

18.5K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	0.0	0.0	-3.5	-3.5	-3.5	-6.8	-6.8	-6.8
64	-0.4	-0.4	-4.0	-4.0	-4.0	-7.1	-7.1	-7.1
60	-0.8	-0.8	-4.2	-4.2	-4.2	-7.1	-7.1	-7.1
56	-1.0	-1.0	-4.2	-4.2	-4.2	-6.9	-6.9	-6.9
52	-1.0	-1.0	-4.0	-4.0	-4.0	-6.4	-6.4	-6.4
48	-0.9	-0.9	-3.7	-3.7	-3.7	-5.9	-5.9	-5.9
44	-0.8	-0.8	-3.4	-3.4	-3.4	-5.4	-5.4	-5.4
40	-0.8	-0.8	-3.2	-3.2	-3.2	-5.0	-5.0	-5.0
36	-1.0	-1.0	-3.2	-3.2	-3.2	-4.7	-4.7	-4.7

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)		
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
3400	29.3							
3800	41.6							
4200	52.9	39.2						
4600	63.8	50.8	36.7	32.6				
5000	74.6	61.6	48.6	41.1	30.9			
5400		72.4	59.4	49.9	39.4	29.2		
5800			70.3	59.0	48.1	37.7	30.1	
6200				68.0	57.2	46.3	36.0	
6600					66.2	55.3	41.8	29.0
7000					75.3	64.4	47.7	34.8
7400						73.5	54.0	40.7
7800							60.6	46.5
8200							67.1	52.7
8600							73.7	59.2
9000								45.4
9400								65.8
9800								51.4
10200								

- Enter Weight Adjustment table with reported braking action and 18.5K derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -90 ft/+80 ft for every 5°C above/below 4°C
Adjust "Medium" field length available by -90 ft/+80 ft for every 5°C above/below 4°C
Adjust "Poor" field length available by -120 ft/+110 ft for every 5°C above/below 4°C
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Slippery Runway Takeoff (18.5K Derate)****Maximum Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
68	-2	0	0	-8	-6	-4	-18	-15	-12
64	-4	-2	0	-10	-8	-6	-20	-17	-14
60	-5	-3	-1	-13	-11	-9	-23	-20	-17
56	-7	-5	-3	-15	-13	-11	-25	-22	-19
52	-9	-7	-5	-17	-15	-13	-28	-25	-22
48	-10	-8	-6	-19	-17	-15	-30	-27	-24
44	-10	-8	-6	-21	-19	-17	-32	-29	-26
40	-11	-9	-7	-22	-20	-18	-34	-31	-28
36	-12	-10	-8	-24	-22	-20	-37	-34	-31

1. Obtain V1, VR and V2 for the actual weight using the 18.5K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

ADVISORY INFORMATION**Slippery Runway Takeoff (18.5K Derate)****No Reverse Thrust****Weight Adjustment (1000 KG)**

18.5K DERATE DRY FIELD/OBSTACLE LIMIT WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)		
	S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
68	-1.0	-1.0	-1.0	-5.8	-5.8	-5.8	-9.9	-9.9	-9.9
64	-1.4	-1.4	-1.4	-5.8	-5.8	-5.8	-9.5	-9.5	-9.5
60	-1.6	-1.6	-1.6	-5.7	-5.7	-5.7	-9.0	-9.0	-9.0
56	-1.7	-1.7	-1.7	-5.5	-5.5	-5.5	-8.5	-8.5	-8.5
52	-1.6	-1.6	-1.6	-5.2	-5.2	-5.2	-7.8	-7.8	-7.8
48	-1.5	-1.5	-1.5	-4.8	-4.8	-4.8	-7.1	-7.1	-7.1
44	-1.3	-1.3	-1.3	-4.3	-4.3	-4.3	-6.2	-6.2	-6.2
40	-1.1	-1.1	-1.1	-3.6	-3.6	-3.6	-5.3	-5.3	-5.3

V1 (MCG) Limit Weight (1000 KG)

ADJUSTED FIELD LENGTH (FT)	REPORTED BRAKING ACTION							
	GOOD			MEDIUM			POOR	
	PRESS ALT (FT)			PRESS ALT (FT)			PRESS ALT (FT)	
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000
3800	31.4							
4000	38.3	20.3						
4400	51.3	34.2						
4800	63.7	47.5	30.0					
5200		60.1	43.6	23.0				
5600		72.2	56.4	33.3				
6000			68.6	43.9	30.2			
6400				54.9	40.7	27.1		
6800				65.9	51.6	37.5		
7200					62.6	48.3		
7600						59.3		
8000						70.3	28.5	
8400							34.9	
8800							41.7	27.9
9200							49.0	34.2
9600							56.9	41.0
10000							65.3	48.3
10400								56.1
10800								40.3
11200								47.5
11600								55.3
								63.6

- Enter Weight Adjustment table with reported braking action and 18.5K Derate dry field/obstacle limit weight to obtain slippery runway weight adjustment.
- Adjust "Good" field length available by -100 ft/+60 ft for every 5°C above/below 4°C.
Adjust "Medium" field length available by -100 ft/+60 ft for every 5°C above/below 4°C.
Adjust "Poor" field length available by -150 ft/+140 ft for every 5°C above/below 4°C.
- Find V1(MCG) limit weight for temperature adjusted field length and pressure altitude.
- Max allowable slippery runway limited weight is lesser of weights from 1 and 3.

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ADVISORY INFORMATION**Slippery Runway Takeoff (18.5K Derate)****No Reverse Thrust****V1 Adjustment (KIAS)**

WEIGHT (1000 KG)	REPORTED BRAKING ACTION								
	GOOD			MEDIUM			POOR		
	PRESS ALT (FT)		PRESS ALT (FT)			PRESS ALT (FT)			
S.L.	4000	8000	S.L.	4000	8000	S.L.	4000	8000	
60	-8	-6	-4	-18	-16	-14	-34	-30	-26
56	-9	-7	-5	-21	-19	-17	-38	-34	-30
52	-11	-9	-7	-23	-21	-19	-41	-37	-33
48	-12	-10	-8	-26	-24	-22	-44	-40	-36
44	-13	-11	-9	-28	-26	-24	-47	-43	-39
40	-15	-13	-11	-30	-28	-26	-49	-45	-41
36	-15	-13	-11	-32	-30	-28	-52	-48	-44

1. Obtain V1, VR and V2 for the actual weight using the 18.5K Derate Dry Runway Takeoff Speeds table.
2. If V1(MCG) limited, set V1 = V1(MCG). If not V1(MCG) limited, enter V1 Adjustment Table with the actual weight to obtain V1 speed adjustment. If adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

Takeoff %N1 (18.5K Derate)**Based on engine bleed to packs on (Auto) and anti-ice on or off**

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	87.3	87.9	87.7	87.6						
50	122	87.9	88.7	89.4	90.1	90.2					
45	113	88.5	89.3	90.0	90.6	91.3	92.0	92.6			
40	104	89.2	90.0	90.6	91.2	91.8	92.7	93.3	93.1	92.6	
35	95	89.5	90.4	91.2	91.8	92.4	93.2	93.8	93.6	93.1	92.6
30	86	89.3	90.6	91.2	91.9	92.7	93.7	94.3	94.1	93.6	93.1
25	77	88.6	89.9	90.7	91.5	92.3	93.1	94.2	94.5	94.1	93.6
20	68	87.8	89.1	89.9	90.7	91.5	92.3	93.4	93.8	93.7	93.8
15	59	87.1	88.3	89.2	90.0	90.8	91.5	92.6	92.9	92.9	93.0
10	50	86.3	87.6	88.4	89.2	90.0	90.7	91.8	92.1	92.1	92.1
5	41	85.6	86.8	87.6	88.4	89.2	89.9	91.0	91.3	91.3	91.3
0	32	84.8	86.0	86.8	87.6	88.4	89.1	90.2	90.5	90.5	90.5
-10	14	83.2	84.4	85.2	86.0	86.8	87.5	88.5	88.8	88.8	88.8
-20	-4	81.6	82.8	83.6	84.3	85.1	85.8	86.8	87.1	87.1	87.1
-30	-22	80.0	81.2	81.9	82.6	83.4	84.1	85.1	85.4	85.4	85.4
-40	-40	78.4	79.5	80.2	80.9	81.7	82.3	83.3	83.6	83.6	83.6
-50	-58	76.7	77.7	78.5	79.2	79.9	80.5	81.5	81.8	81.8	81.8

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	AIRPORT PRESSURE ALTITUDE (FT)	
	-1000	8000
ENGINE BLEED TO PACKS OFF	0.9	0.9

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Assumed Temperature Reduced Thrust (18.5K Derate)**Maximum Assumed Temperature (Table 1)****Based on 25% Takeoff Thrust Reduction**

OAT (°C)	PRESS ALT (1000 FT)								OAT (°F)	PRESS ALT (1000 FT)								
	-1	0	1	2	3	4	5	6		-1	0	1	2	3	4	5	6	7
55	69	69	69	69					130	155	155	155	155					
50	67	67	66	65	66	66			120	152	151	149	148	149	149			
45	65	65	64	63	63	62	62	62	110	148	148	145	144	144	142	142	141	141
40	63	63	62	61	61	60	60	59	100	145	144	142	140	140	138	138	136	134
35	62	61	60	59	59	58	58	57	90	142	141	139	137	136	134	134	132	128
30	61	60	59	58	57	56	56	55	80	142	140	137	135	135	132	131	128	124
25	61	60	58	57	57	56	55	53	70	142	140	137	135	134	132	131	127	124
20 & BELOW	61	60	58	57	57	56	55	53	60 & BELOW	142	140	137	135	134	132	131	127	124

Maximum Takeoff %N1 (Table 2)**Based on engine bleed to packs on (Auto) and engine anti-ice on or off**

ASSUMED TEMP		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
75	167	76.8	76.6	76.5	76.6	78.3					
70	158	79.6	79.5	79.4	79.4	80.8	80.9				
65	149	82.3	82.4	82.2	82.2	83.2	83.3	84.1	83.3	82.2	81.0
60	140	84.9	85.2	85.0	84.9	85.6	85.6	86.3	85.5	84.4	83.3
55	131	87.2	87.9	87.7	87.6	87.9	87.9	88.5	87.7	86.6	85.5
50	122	87.8	88.7	89.4	90.1	90.2	90.2	90.6	89.8	88.7	87.6
45	113	88.8	89.3	90.0	90.6	91.3	92.0	92.6	91.9	90.8	89.7
40	104	89.1	90.0	90.6	91.2	91.8	92.7	93.3	93.1	92.6	91.7
35	95	89.5	90.4	91.2	91.8	92.4	93.2	93.8	93.6	93.1	92.6
30	86	89.2	90.6	91.2	91.9	92.7	93.7	94.3	94.1	93.6	93.1
25	77	88.5	89.9	90.7	91.5	92.3	93.1	94.2	94.5	94.1	93.6
20	68	87.8	89.1	89.9	90.7	91.5	92.3	93.4	93.8	93.7	93.8
15	59	87.0	88.3	89.2	90.0	90.8	91.5	92.6	92.9	92.9	93.0
MINIMUM ASSUMED TEMP °C (°F)		32(90)	30(86)	28(82)	26(79)	24(75)	29(85)	27(81)	25(77)	23(73)	21(70)

With engine bleed to packs off, increase %N1 by 1.0.

**Assumed Temperature Reduced Thrust (18.5K Derate)
%N1 Adjustment For Temperature Difference (Table 3)**

ASSUMED TEMP MINUS OAT		OUTSIDE AIR TEMPERATURE														
°C	°F	°C	-40	-20	0	5	10	15	20	25	30	35	40	45	50	55
°F		°F	-40	-4	32	41	50	59	68	77	86	95	104	113	122	131
10	18						1.5	1.5	1.5	1.5	1.4	1.4	1.4	1.3	1.2	
20	36				3.1	3.1	3.1	3.0	2.9	2.8	2.7	2.6	2.5	2.3	2.2	
30	54				4.7	4.6	4.5	4.4	4.3	4.1	3.9	3.7	3.6	3.4	3.2	3.0
40	72			6.5	6.1	5.9	5.8	5.5	5.3	5.1	4.9	4.6				
50	90			8.1	7.3	7.0	6.7	6.4	5.3	5.1						
60	108		10.1	9.4	8.2	7.8	7.5	6.4								
70	126		11.6	10.3	8.7	8.4										
80	144		12.7	10.8	9.1	8.4										
90	162		13.2	11.1	9.2											
100	180		13.6	11.4	9.3											
110	198		13.8	11.4												

1. Determine Maximum Assumed Temperature allowed from Table 1.
2. Find Maximum %N1 from Table 2 using the desired assumed temperature (no greater than temperature from Table 1).
3. Use the difference between assumed temperature and OAT to determine the %N1 adjustment from Table 3.
4. Subtract %N1 adjustment from Maximum %N1 in Table 2.

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Max Climb %N1

Based on engine bleed to packs on (Auto) and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)/SPEED (KIAS OR MACH)								
	0	5	10	15	20	25	30	35	37
250	250	250	280	280	280	.74	.74	.74	
50	88.9	89.0	89.2						
40	89.8	90.0	90.2	90.7					
30	89.9	90.9	91.1	91.6	91.9	92.1			
20	88.4	90.5	91.8	92.5	92.8	93.0	93.2		
10	86.8	88.9	91.0	92.7	93.5	93.8	94.0	94.0	94.0
0	85.3	87.4	89.4	91.1	93.1	94.4	94.6	94.6	94.6
-10	83.7	85.7	87.7	89.4	91.3	93.1	94.6	95.2	95.2
-20	82.1	84.1	86.0	87.7	89.6	91.3	92.8	95.7	96.0
-30	80.5	82.4	84.3	85.9	87.8	89.5	90.9	93.8	94.5
-40	78.8	80.7	82.6	84.1	86.0	87.6	89.0	91.9	92.5
-50	77.1	79.0	80.8	82.3	84.1	85.7	87.1	89.9	90.5

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)								
	0	5	10	15	20	25	30	35	37
ENGINE BLEED TO PACKS OFF	0.5	0.5	0.6	0.7	0.8	0.9	0.9	0.8	0.7
PACKS HIGH	-0.2	-0.3	-0.3	-0.3	-0.4	-0.4	-0.4	-0.5	-0.6
ENGINE ANTI-ICE ON	-0.7	-0.8	-0.9	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
ENGINE & WING ANTI-ICE ON	-1.9	-2.0	-2.2	-2.4	-2.6	-2.9	-2.8	-2.9	-2.9

Go-around %N1

Based on engine bleed to packs on (Auto), engine anti-ice on or off, and wing anti-ice off

REPORTED OAT		TAT	PRESSURE ALTITUDE (FT)									
°C	°F	°C	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	58	89.8	90.5	91.1	91.8	93.3	94.2	93.9	93.6	94.6	95.6
50	122	53	90.5	91.0	91.6	92.2	93.6	94.6	94.4	94.2	94.8	95.4
45	113	48	91.1	91.5	92.1	92.6	93.9	94.9	94.8	94.8	94.9	95.1
40	104	43	91.6	92.1	92.4	93.0	94.3	95.3	95.3	95.3	95.1	94.8
35	95	38	92.0	92.5	93.0	93.4	94.8	95.9	95.9	95.9	95.1	94.5
30	86	33	92.0	92.8	93.2	93.6	95.0	96.5	96.4	96.4	95.7	95.0
25	77	28	91.2	92.0	92.8	93.5	94.5	95.9	96.3	96.8	96.3	95.7
20	68	23	90.4	91.2	92.0	92.8	93.8	95.1	95.5	96.0	96.0	96.0
15	59	18	89.7	90.4	91.2	92.0	93.0	94.3	94.7	95.2	95.3	95.4
10	50	13	88.9	89.6	90.4	91.2	92.1	93.4	93.9	94.3	94.4	94.6
5	41	8	88.1	88.8	89.6	90.4	91.3	92.6	93.0	93.5	93.6	93.8
0	32	3	87.4	88.0	88.8	89.5	90.5	91.8	92.2	92.6	92.7	92.9
-10	14	-8	85.6	86.4	87.2	87.9	88.8	90.1	90.5	90.9	91.0	91.2
-20	-4	-18	84.0	84.8	85.5	86.2	87.1	88.3	88.8	89.2	89.3	89.5
-30	-22	-28	82.4	83.1	83.8	84.5	85.4	86.6	87.0	87.4	87.5	87.7
-40	-40	-38	80.7	81.3	82.1	82.7	83.6	84.8	85.2	85.6	85.7	85.9
-50	-58	-48	78.9	79.6	80.3	80.9	81.8	82.9	83.3	83.7	83.8	84.0

%N1 Adjustments for Engine Bleeds

BLEED CONFIGURATION	TAT (°C)	
	- 60	+ 60
ENGINE BLEED TO PACKS OFF	0.8	1.0
PACKS HIGH	- 0.4	- 0.4
WING A/I ALL ENGINES	- 1.3	- 1.6
WING A/I 1 ENGINE INOP	- 2.1	- 2.6

737 Flight Crew Operations Manual

Flight With Unreliable Airspeed / Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.
Climb**Flaps Up, Set Max Climb Thrust**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		32	34	44	54	64
35000 (.73M)	PITCH ATT V/S (FT/MIN)	6.0 2700	6.0 2500	5.5 1500	5.0 800	
30000 (.73M)	PITCH ATT V/S (FT/MIN)	6.0 3400	6.0 3100	5.5 2100	5.0 1400	5.0 800
25000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	6.5 3200	6.0 3000	5.5 2100	5.5 1500	5.5 1100
20000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	8.0 4000	7.5 3800	7.0 2700	6.5 2000	6.5 1500
15000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	9.5 4800	9.5 4500	8.0 3400	7.5 2500	7.5 1900
10000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	11.5 5600	11.0 5200	9.5 3900	9.0 3000	8.5 2400
5000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	13.5 6300	13.0 5900	11.0 4400	10.0 3500	9.5 2800
SEA LEVEL (280 KIAS)	PITCH ATT V/S (FT/MIN)	16.0 7100	15.5 6600	12.5 5000	11.5 3900	10.5 3100

Cruise**Flaps Up, Adjust %N1 for Level Flight**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		34	38	42	46	50
30000 (.73M)	PITCH ATT %N1	2.0 79	2.0 79	2.5 80	2.5 81	3.0 82
10000 (280 KIAS)	PITCH ATT %N1	2.0 65	2.0 66	2.5 66	3.0 67	3.0 68

Descent**Flaps Up, Set Idle Thrust**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		34	38	42	46	50
30000 (.73M)	PITCH ATT V/S (FT/MIN)	-3.5 -4100	-3 -3800	-2.5 -3600	-2 -3400	-1.5 -3300
20000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	-2.5 -2800	-1.5 -2600	-1 -2400	-0.5 -2300	0 -2200
10000 (280 KIAS)	PITCH ATT V/S (FT/MIN)	-2.5 -2500	-2 -2300	-1.5 -2100	-0.5 -2000	0 -1900

Holding**Flaps Up, Adjust %N1 for Level Flight**

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)				
		34	38	42	46	50
10000	PITCH ATT %N1 KIAS	4.0 56 210	5.0 57 210	5.5 59 210	6.0 61 215	5.5 63 225

737 Flight Crew Operations Manual

Flight With Unreliable Airspeed / Turbulent Air Penetration
Altitude and/or vertical speed indications may also be unreliable.

Terminal Area**Adjust %N1 for Level Flight**

FLAP POSITION (SPEED)		WEIGHT (1000 KG)				
		32	36	44	52	60
FLAPS UP (GEAR UP)	PITCH ATT	3.5	4.5	5.5	7.0	7.0
	%N1	53	54	57	61	65
	KIAS	210	210	210	210	220
FLAPS 1 (GEAR UP)	PITCH ATT	4.0	4.5	6.0	7.5	8.0
	%N1	55	57	60	63	67
	KIAS	190	190	190	190	200
FLAPS 5 (GEAR UP)	PITCH ATT	3.5	4.0	5.5	7.0	7.5
	%N1	56	57	60	64	68
	KIAS	180	180	180	180	190
FLAPS 15 (GEAR DOWN)	PITCH ATT	4.0	5.0	6.5	8.5	9.0
	%N1	60	62	67	71	76
	KIAS	150	150	150	150	160

Final Approach**Gear Down, Adjust %N1 for 3° Glideslope**

FLAP POSITION		WEIGHT (1000 KG)				
		32	36	44	52	60
FLAPS 15 (VREF15+10)	PITCH ATT	5.0	5.0	5.0	5.0	5.5
	%N1	41	43	47	51	55
	KIAS	121	128	142	154	165
FLAPS 30 (VREF30+10)	PITCH ATT	2.5	2.5	2.5	2.5	3.0
	%N1	45	47	52	57	60
	KIAS	114	121	134	145	155
FLAPS 40 (VREF40+10)	PITCH ATT	1.0	1.0	1.0	1.0	1.0
	%N1	51	54	59	64	67
	KIAS	112	118	130	141	150

Performance Inflight

All Engines

Chapter PI

Section 31

Long Range Cruise Maximum Operating Altitude

Max Cruise Thrust

ISA + 10°C and Below

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	-10	33400*	33200	32300	30700	29200
62	31500	-11	34300*	33800	33000	31400	29900
60	32200	-13	35100*	34500	33700	32100	30600
58	32900	-14	36000*	35300	34400	32800	31400
56	33700	-16	36600*	36000	35200	33600	32100
54	34400	-18	37000	36700	35900	34400	32900
52	35200	-19	37000	37000	36700	35200	33700
50	36100	-21	37000	37000	37000	36000	34500
48	36900	-21	37000	37000	37000	36800	35400
46	37000	-21	37000	37000	37000	37000	36300
44	37000	-21	37000	37000	37000	37000	37000

ISA + 15°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	-4	32500*	32500*	32300	30700	29200
62	31500	-6	33400*	33400*	33000	31400	29900
60	32200	-7	34300*	34300*	33700	32100	30600
58	32900	-9	35200*	35200*	34400	32800	31400
56	33700	-10	36100*	36000	35200	33600	32100
54	34400	-12	36700*	36700	35900	34400	32900
52	35200	-14	37000	37000	36700	35200	33700
50	36100	-16	37000	37000	37000	36000	34500
48	36900	-16	37000	37000	37000	36800	35400
46	37000	-16	37000	37000	37000	37000	36300
44	37000	-16	37000	37000	37000	37000	37000

ISA + 20°C

WEIGHT (1000 KG)	OPTIMUM ALT (FT)	TAT (°C)	MARGIN TO INITIAL BUFFET 'G' (BANK ANGLE)				
			1.20 (33°)	1.25 (36°)	1.30 (39°)	1.40 (44°)	1.50 (48°)
64	30800	1	31400*	31400*	31400*	30700	29200
62	31500	0	32300*	32300*	32300*	31400	29900
60	32200	-2	33300*	33300*	33300*	32100	30600
58	32900	-3	34200*	34200*	34200*	32800	31400
56	33700	-5	35200*	35200*	35200	33600	32100
54	34400	-7	36100*	36100*	35900	34400	32900
52	35200	-8	36800*	36800*	36700	35200	33700
50	36100	-10	37000	37000	37000	36000	34500
48	36900	-10	37000	37000	37000	36800	35400
46	37000	-10	37000	37000	37000	37000	36300
44	37000	-10	37000	37000	37000	37000	37000

*Denotes altitude thrust limited in level flight, 100 fpm residual rate of climb.

737 Flight Crew Operations Manual

Long Range Cruise Control

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)							
		21	23	25	27	29	31	33	35
64	%N1	82.0	83.0	84.0	84.8	85.7	87.0	89.2	
	MACH	.706	.724	.739	.744	.745	.745	.745	
	KIAS	320	316	310	300	287	275	263	
	FF/ENG	1537	1513	1484	1443	1392	1368	1378	
60	%N1	80.6	81.8	82.8	83.8	84.6	85.5	87.1	89.7
	MACH	.690	.711	.728	.741	.745	.745	.745	.745
	KIAS	313	310	305	298	287	275	263	251
	FF/ENG	1451	1433	1409	1381	1336	1292	1280	1298
56	%N1	79.2	80.4	81.6	82.6	83.6	84.3	85.4	87.2
	MACH	.674	.694	.715	.732	.743	.745	.745	.744
	KIAS	305	302	299	294	287	275	263	252
	FF/ENG	1367	1348	1331	1308	1280	1234	1198	1195
52	%N1	77.7	78.9	80.1	81.3	82.3	83.2	84.0	85.2
	MACH	.656	.676	.697	.718	.734	.744	.745	.745
	KIAS	296	294	291	288	283	275	263	251
	FF/ENG	1283	1266	1248	1231	1209	1180	1136	1109
48	%N1	76.0	77.3	78.5	79.7	80.9	81.9	82.8	83.6
	MACH	.636	.657	.678	.699	.720	.736	.744	.745
	KIAS	287	285	283	280	277	271	263	251
	FF/ENG	1199	1183	1166	1150	1134	1112	1082	1043
44	%N1	74.1	75.5	76.8	78.0	79.2	80.4	81.4	82.3
	MACH	.614	.636	.657	.678	.700	.720	.737	.744
	KIAS	277	275	273	271	269	265	260	251
	FF/ENG	1115	1100	1084	1067	1053	1038	1018	990
40	%N1	72.1	73.5	74.8	76.1	77.4	78.6	79.7	80.7
	MACH	.591	.612	.633	.655	.677	.699	.720	.737
	KIAS	266	264	263	261	259	257	253	248
	FF/ENG	1031	1018	1003	986	971	959	945	927
36	%N1	69.8	71.2	72.6	73.9	75.3	76.5	77.8	78.9
	MACH	.566	.586	.607	.629	.651	.673	.696	.718
	KIAS	254	253	252	250	249	247	244	241
	FF/ENG	948	936	922	905	891	879	867	855

Shaded area approximates optimum altitude.

737 Flight Crew Operations Manual

Long Range Cruise Enroute Fuel and Time - Low Altitudes
Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
284	262	243	226	213	200	191	182	174	167	160	
428	395	366	341	319	300	286	273	261	250	241	
573	528	489	455	426	400	381	364	348	334	321	
718	662	612	570	533	500	477	455	435	418	402	
864	796	735	684	640	600	572	546	522	501	482	
1011	931	859	799	747	700	667	637	610	584	562	
1158	1065	983	914	854	800	763	728	697	668	642	
1305	1200	1107	1028	961	900	858	819	784	751	722	
1453	1335	1231	1143	1068	1000	953	910	871	835	802	
1601	1471	1355	1258	1175	1100	1048	1001	957	917	881	
1750	1607	1480	1374	1282	1200	1144	1091	1044	1000	961	
1899	1743	1605	1489	1389	1300	1239	1183	1131	1084	1041	
2049	1880	1730	1605	1497	1400	1334	1274	1218	1167	1121	
2200	2017	1856	1721	1604	1500	1429	1364	1304	1250	1201	
2351	2155	1982	1836	1712	1600	1524	1455	1391	1332	1280	
2503	2293	2108	1952	1819	1700	1620	1545	1477	1415	1359	
2655	2431	2234	2068	1926	1800	1715	1636	1564	1498	1438	
2808	2570	2360	2185	2034	1900	1810	1727	1650	1580	1517	
2961	2709	2487	2301	2142	2000	1905	1817	1737	1663	1597	

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	1.4	0:39	1.3	0:38	1.1	0:37	0.9	0:36	0.9	0:35
300	2.2	0:58	1.9	0:56	1.7	0:53	1.5	0:51	1.4	0:50
400	2.9	1:17	2.6	1:14	2.3	1:09	2.1	1:07	1.9	1:05
500	3.6	1:35	3.3	1:31	2.9	1:26	2.6	1:22	2.4	1:19
600	4.4	1:54	4.0	1:49	3.5	1:42	3.2	1:38	2.9	1:34
700	5.1	2:13	4.6	2:07	4.0	1:59	3.7	1:53	3.4	1:49
800	5.8	2:32	5.3	2:25	4.6	2:15	4.3	2:09	3.9	2:04
900	6.5	2:52	6.0	2:44	5.2	2:32	4.8	2:25	4.4	2:19
1000	7.2	3:11	6.6	3:02	5.8	2:49	5.3	2:41	4.9	2:34
1100	7.9	3:31	7.3	3:20	6.4	3:06	5.9	2:57	5.4	2:49
1200	8.6	3:50	7.9	3:39	6.9	3:23	6.4	3:13	5.9	3:04
1300	9.3	4:10	8.6	3:58	7.5	3:40	6.9	3:29	6.4	3:20
1400	10.0	4:30	9.2	4:17	8.1	3:57	7.5	3:45	6.9	3:35
1500	10.7	4:50	9.8	4:36	8.7	4:15	8.0	4:02	7.4	3:50
1600	11.4	5:11	10.5	4:55	9.2	4:32	8.5	4:18	7.9	4:06
1700	12.1	5:31	11.1	5:14	9.8	4:50	9.0	4:35	8.3	4:21
1800	12.8	5:52	11.7	5:34	10.3	5:07	9.6	4:51	8.8	4:37
1900	13.4	6:13	12.4	5:53	10.9	5:25	10.1	5:08	9.3	4:53
2000	14.1	6:34	13.0	6:13	11.4	5:43	10.6	5:25	9.8	5:08

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)			
	35	45	55	65
5	-0.4	0.0	0.5	1.1
10	-0.8	0.0	1.1	2.2
15	-1.1	0.0	1.6	3.3

737 Flight Crew Operations Manual

Long Range Cruise Enroute Fuel and Time - High Altitudes
Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)					
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)					
100	80	60	40	20		20	40	60	80	100	
269	252	236	223	211	200	191	182	174	167	161	
533	500	471	445	421	400	382	365	349	336	323	
797	748	704	666	631	600	573	548	525	504	485	
1062	997	939	888	842	800	764	731	700	672	647	
1328	1247	1174	1110	1052	1000	955	914	875	840	809	
1595	1498	1410	1332	1263	1200	1146	1096	1051	1009	971	
1862	1748	1646	1555	1474	1400	1337	1279	1226	1177	1133	
2130	2000	1882	1778	1685	1600	1529	1463	1402	1347	1296	
2399	2251	2118	2000	1896	1800	1720	1646	1578	1515	1458	
2669	2504	2355	2224	2107	2000	1911	1829	1753	1683	1620	
2939	2757	2592	2447	2318	2200	2102	2012	1928	1852	1782	
3211	3011	2829	2671	2529	2400	2293	2195	2103	2020	1944	
3484	3266	3068	2895	2741	2600	2485	2377	2279	2188	2106	
3757	3520	3307	3119	2952	2800	2676	2560	2454	2356	2268	
4032	3777	3546	3344	3164	3000	2867	2743	2629	2525	2430	

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	29		31		33		35		37	
	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)	FUEL (1000 KG)	TIME (HR:MIN)
200	0.8	0:35	0.8	0:35	0.7	0:35	0.7	0:35	0.7	0:35
400	1.8	1:04	1.8	1:03	1.7	1:03	1.6	1:03	1.6	1:03
600	2.9	1:33	2.7	1:32	2.6	1:31	2.5	1:31	2.5	1:31
800	3.8	2:03	3.7	2:00	3.6	1:59	3.5	1:59	3.3	1:59
1000	4.8	2:32	4.7	2:29	4.5	2:27	4.3	2:27	4.2	2:27
1200	5.8	3:02	5.6	2:59	5.4	2:56	5.2	2:55	5.1	2:55
1400	6.8	3:32	6.5	3:28	6.3	3:25	6.1	3:23	5.9	3:23
1600	7.7	4:03	7.4	3:58	7.2	3:54	7.0	3:51	6.8	3:51
1800	8.7	4:34	8.3	4:28	8.1	4:23	7.8	4:20	7.6	4:19
2000	9.6	5:05	9.2	4:58	8.9	4:52	8.6	4:49	8.4	4:48
2200	10.5	5:36	10.1	5:28	9.8	5:22	9.5	5:18	9.2	5:16
2400	11.4	6:08	11.0	5:59	10.6	5:52	10.3	5:47	10.0	5:44
2600	12.3	6:40	11.9	6:30	11.5	6:22	11.1	6:16	10.8	6:13
2800	13.2	7:12	12.7	7:02	12.3	6:52	11.9	6:46	11.6	6:42
3000	14.1	7:45	13.6	7:33	13.1	7:23	12.7	7:16	12.3	7:11

Fuel Required Adjustment (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)			
	35	45	55	65
4	-0.4	0.0	1.0	3.2
8	-0.8	0.0	1.8	5.4
12	-1.3	0.0	2.3	6.4
16	-1.7	0.0	2.6	6.4

737 Flight Crew Operations Manual

Long Range Cruise Wind-Altitude Trade

PRESSURE ALTITUDE (1000 FT)	CRUISE WEIGHT (1000 KG)														
	64	62	60	58	56	54	52	50	48	46	44	42	40	38	36
37					17	10	6	2	0	0	0	0	0	0	0
35			11	6	2	0	0	1	4	9	12	13	12	13	15
33	7	3	1	0	0	3	7	11	17	22	25	26	27	29	30
31	0	0	1	4	9	15	20	24	30	36	40	42	42	43	46
29	4	8	12	17	23	28	33	38	45	52	55	57	57	59	62
27	17	22	26	31	36	42	48	54	61	67	71	73	74	75	78
25	29	34	40	45	51	58	63	69	76	83	88	90	92	93	96
23	43	49	55	60	66	73	80	85	92	101	104	107	109	111	113

The above wind factor tables are 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**Based on .74/250 descent speed**

PRESSURE ALT (1000 FT)	21	23	25	27	29	31	33	35	37
DISTANCE (NM)	67	73	79	85	91	97	104	110	115
TIME (MINUTES)	15	17	18	19	20	21	21	22	23

Holding**Flaps Up**

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)								
	1500	5000	10000	15000	20000	25000	30000	35000	37000
64	%N1	62.6	65.4	69.4	73.4	77.6	81.3	85.0	
	KIAS	251	252	254	257	259	261	259	
	FF/ENG	1440	1410	1390	1370	1350	1340	1340	
60	%N1	61.0	63.6	67.8	71.8	76.0	79.8	83.4	88.9
	KIAS	243	244	246	248	251	253	252	246
	FF/ENG	1360	1330	1310	1280	1270	1260	1250	1320
56	%N1	59.3	61.9	65.9	70.0	74.1	78.2	81.9	86.1
	KIAS	235	235	237	239	242	244	245	241
	FF/ENG	1280	1250	1230	1200	1180	1180	1170	1190
52	%N1	57.6	60.0	63.9	68.1	72.2	76.4	80.2	84.0
	KIAS	228	227	228	230	232	235	236	231
	FF/ENG	1210	1180	1150	1120	1100	1100	1080	1090
48	%N1	55.8	58.1	61.9	66.1	70.2	74.4	78.3	82.0
	KIAS	220	219	219	220	223	225	227	225
	FF/ENG	1140	1100	1080	1050	1030	1020	1000	1010
44	%N1	54.0	56.2	59.8	63.7	67.9	72.1	76.4	80.1
	KIAS	211	210	210	210	212	215	217	217
	FF/ENG	1060	1030	1000	970	950	940	920	920
40	%N1	52.5	54.7	58.1	61.9	66.0	70.1	74.3	78.1
	KIAS	210	210	210	210	210	210	210	210
	FF/ENG	1010	980	950	920	890	870	850	850
36	%N1	51.2	53.3	56.6	60.3	64.3	68.3	72.4	76.4
	KIAS	210	210	210	210	210	210	210	210
	FF/ENG	960	930	900	870	840	820	800	790

This table includes 5% additional fuel for holding in a racetrack pattern.

Intentionally
Blank

Performance Inflight

Advisory Information

Chapter PI

Section 32

ADVISORY INFORMATION

Normal Configuration Landing Distance

Flaps 15

Dry Runway

	LANDING DISTANCE AND ADJUSTMENTS (FT)											
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ				
BRAKING CONFIGURATION	45000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 45000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF15		
MAX MANUAL	2640	350/-170	60	-90	330	30	-20	50	-50	190	50	130
MAX AUTO	3380	270/-250	80	-130	420	0	0	70	-80	330	0	10
AUTOBRAKE 3	4750	400/-420	140	-210	710	20	-20	120	-120	520	40	40
AUTOBRAKE 2	5650	550/-580	180	-270	940	80	-130	150	-150	460	250	250
AUTOBRAKE 1	6050	660/-640	210	-310	1090	190	-190	170	-170	460	820	1060

Good Reported Braking Action

MAX MANUAL	3620	290/-290	90	-160	570	80	-70	80	-80	270	220	640
MAX AUTO	3760	300/-310	100	-170	580	60	-50	80	-90	310	250	710
AUTOBRAKE 3	4760	400/-420	140	-210	720	30	-20	120	-120	520	60	180
AUTOBRAKE 2	5650	550/-580	180	-270	940	80	-130	150	-150	460	250	250
AUTOBRAKE 1	6050	660/-640	210	-310	1090	190	-190	170	-170	460	820	1060

Medium Reported Braking Action

MAX MANUAL	4770	440/-430	140	-250	920	190	-150	120	-120	350	620	2110
MAX AUTO	4770	450/-440	140	-250	910	160	-130	120	-120	400	620	2100
AUTOBRAKE 3	5110	460/-460	150	-260	960	130	-90	130	-130	520	450	1970
AUTOBRAKE 2	5780	560/-590	180	-300	1060	140	-170	160	-160	460	400	1370
AUTOBRAKE 1	6080	660/-650	210	-320	1120	240	-200	170	-170	460	890	1690

Poor Reported Braking Action

MAX MANUAL	5990	620/-590	190	-360	1400	410	-280	150	-150	410	1330	6170
MAX AUTO	5990	620/-580	190	-360	1380	410	-270	150	-150	420	1340	6210
AUTOBRAKE 3	5990	630/-590	200	-360	1390	390	-250	150	-150	490	1350	6170
AUTOBRAKE 2	6320	650/-650	200	-380	1440	360	-280	160	-160	460	1080	5840
AUTOBRAKE 1	6490	710/-690	220	-390	1480	430	-310	170	-170	460	1370	5740

Reference distance is for sea level, standard day, no wind or slope, VREF15 approach speed and two engine detent reverse thrust.

Max manual braking data valid for auto speedbrakes. Autobrake data valid for both auto and manual speedbrakes.

For max manual braking and manual speedbrakes, increase reference landing distance by 200 ft.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Normal Configuration Landing Distance****Flaps 30****Dry Runway**

	LANDING DISTANCE AND ADJUSTMENTS (FT)										
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		TEMP ADJ PER 10°C		APP SPD ADJ	REVERSE THRUST ADJ
BRAKING CONFIGURATION	45000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 45000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	ABV ISA	BLW ISA	PER 10 KTS ABOVE VREF30	ONE REV NO REV
MAX MANUAL	2530	280/-160	50	-90	320	30	-20	50	-50	190	40
MAX AUTO	3130	230/-220	70	-120	400	0	0	70	-70	320	0
AUTOBRAKE 3	4330	350/-370	120	-200	670	20	-20	110	-110	480	40
AUTOBRAKE 2	5150	470/-500	160	-260	890	70	-110	140	-140	440	170
AUTOBRAKE 1	5520	570/-560	180	-300	1030	170	-170	150	-150	430	660

Good Reported Braking Action

MAX MANUAL	3410	260/-260	80	-160	550	70	-60	70	-70	270	200	570
MAX AUTO	3530	270/-280	90	-160	560	60	-50	80	-80	310	220	630
AUTOBRAKE 3	4330	350/-370	120	-200	680	30	-20	110	-110	480	60	180
AUTOBRAKE 2	5150	470/-500	160	-260	890	70	-110	140	-140	440	170	170
AUTOBRAKE 1	5520	570/-560	180	-300	1030	170	-170	150	-150	430	660	860

Medium Reported Braking Action

MAX MANUAL	4450	400/-390	130	-240	890	180	-140	110	-110	340	540	1860
MAX AUTO	4450	400/-390	130	-240	880	160	-120	110	-110	390	540	1840
AUTOBRAKE 3	4680	410/-410	130	-250	920	120	-90	120	-120	480	440	1790
AUTOBRAKE 2	5270	490/-520	160	-280	1010	130	-150	140	-140	440	320	1220
AUTOBRAKE 1	5550	570/-570	180	-300	1070	220	-180	150	-150	430	730	1450

Poor Reported Braking Action

MAX MANUAL	5550	550/-530	170	-350	1360	390	-270	140	-140	390	1160	5350
MAX AUTO	5550	550/-520	170	-340	1340	390	-260	130	-130	400	1170	5380
AUTOBRAKE 3	5550	560/-530	170	-350	1350	380	-240	140	-140	450	1190	5360
AUTOBRAKE 2	5800	570/-580	180	-360	1390	340	-260	150	-150	430	940	5080
AUTOBRAKE 1	5950	620/-610	200	-370	1420	400	-290	160	-160	430	1170	5000

Reference distance is for sea level, standard day, no wind or slope, VREF30 approach speed and two engine detent reverse thrust.

Max manual braking data valid for auto speedbrakes. Autobrake data valid for both auto and manual speedbrakes.

For max manual braking and manual speedbrakes, increase reference landing distance by 180 ft.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Normal Configuration Landing Distance****Flaps 40****Dry Runway**

	LANDING DISTANCE AND ADJUSTMENT (FT)										
	REF DIST	WT ADJ	ALT ADJ	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	TEMP ADJ PER 10°C	APP SPD ADJ	REVERSE THRUST ADJ	PER 10 KTS ABOVE VREF40	ONE REV	NO REV
BRAKING CONFIGURATION	45000 KG LANDING WEIGHT	PER 5000 KG ABOVE/ BELOW 45000 KG	PER 1000 FT ABOVE SEA LEVEL	HEAD WIND TAIL WIND DOWN HILL UP HILL	ABV ISA BLW ISA	PER 10 KTS ABOVE VREF40	ONE REV	NO REV			
MAX MANUAL	2470	240/-150	50	-90 320 30	-20 50 -50	200	40	110			
MAX AUTO	3020	210/-210	70	-120 390 0	0 60 -60	310	0	10			
AUTOBRAKE 3	4130	320/-350	110	-190 650 20	-30 100 -100	440	40	50			
AUTOBRAKE 2	4890	440/-470	140	-250 860 80	-110 130 -130	410	160	160			
AUTOBRAKE 1	5240	530/-520	170	-290 1000 160	-160 140 -140	400	580	810			

Good Reported Braking Action

MAX MANUAL	3310	240/-250	80	-150 540 70	-60 70 -70	270	180	530			
MAX AUTO	3420	260/-270	90	-160 560 60	-50 70 -70	310	200	580			
AUTOBRAKE 3	4140	330/-350	110	-190 660 30	-30 100 -100	440	60	190			
AUTOBRAKE 2	4890	440/-470	140	-250 860 80	-110 130 -130	410	160	160			
AUTOBRAKE 1	5240	530/-520	170	-290 1000 160	-160 140 -140	400	580	810			

Medium Reported Braking Action

MAX MANUAL	4280	370/-370	120	-230 870 170	-140 100 -100	330	500	1680			
MAX AUTO	4280	380/-370	120	-230 860 150	-110 100 -100	380	490	1670			
AUTOBRAKE 3	4490	390/-390	130	-240 900 120	-100 110 -110	440	420	1660			
AUTOBRAKE 2	5010	450/-480	150	-270 980 140	-150 130 -130	410	300	1130			
AUTOBRAKE 1	5270	530/-520	170	-290 1040 200	-170 140 -140	400	650	1350			

Poor Reported Braking Action

MAX MANUAL	5310	510/-500	160	-340 1330 380	-260 130 -130	380	1050	4780			
MAX AUTO	5310	510/-490	160	-330 1310 380	-250 130 -130	390	1060	4820			
AUTOBRAKE 3	5310	520/-510	160	-340 1320 360	-240 130 -130	410	1090	4830			
AUTOBRAKE 2	5530	530/-540	170	-350 1360 340	-250 140 -140	410	870	4550			
AUTOBRAKE 1	5660	570/-570	180	-360 1390 390	-270 150 -150	400	1060	4510			

Reference distance is for sea level, standard day, no wind or slope, VREF40 approach speed and two engine detent reverse thrust.

Max manual braking data valid for auto speedbrakes. Autobrake data valid for both auto and manual speedbrakes.

For max manual braking and manual speedbrakes, increase reference landing distance by 160 ft.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Dry Runway**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 45000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 45000 KG	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS HEAD WIND	SLOPE ADJ PER 1% DOWN HILL	APPROACH SPEED PER 10 KTS UP HILL	PER 10 KTS ABOVE VREF	
ALL FLAPS UP	VREF40+55	3710	710/-280	110	-120	490	40	-40	320
ANTI-SKID INOPERATIVE	VREF40	3700	260/-270	90	-170	590	70	-60	300
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	3040	200/-210	70	-120	380	50	-50	410
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	3110	230/-220	70	-120	390	50	-50	390
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	3150	320/-230	70	-120	380	50	-40	330
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	2950	440/-200	70	-110	380	40	-30	220
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH SYSTEM A & B)	VREF15	4580	480/-380	130	-200	660	130	-120	500
STABILIZER TRIM INOPERATIVE	VREF15	2640	370/-170	60	-90	320	30	-20	180
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	2640	370/-170	60	-90	320	30	-20	180
LEADING EDGE FLAPS TRANSIT	VREF15+5	2830	410/-190	60	-100	340	30	-30	210
ONE ENGINE INOPERATIVE	VREF15	2670	400/-180	60	-100	330	30	-30	190

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance**
Dry Runway

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)								
		REF DIST FOR 45000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED	
HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF						
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	2430	290/-150	50	-90	300	30	-20	180	
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	2640	370/-170	60	-90	320	30	-20	180	
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	3070	490/-220	70	-110	360	30	-30	230	
TRAILING EDGE FLAP DISAGRE (30≤ FLAPS <40)	VREF30	2430	290/-150	50	-90	300	30	-20	180	
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	2640	370/-170	60	-90	320	30	-20	180	
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	3070	490/-220	70	-110	360	30	-30	230	
TRAILING EDGE FLAPS UP (FLAPS <1)	VREF40+40	3310	560/-240	80	-110	380	40	-30	240	

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Good Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 45000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 45000 KG	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS HEAD WIND	SLOPE ADJ PER 1% DOWN HILL	APPROACH SPEED PER 10 KTS UP HILL	PER 10 KTS ABOVE VREF	
ALL FLAPS UP	VREF40+55	4960	340/-360	140	-190	650	90	-90	290
ANTI-SKID INOPERATIVE	VREF40	4510	370/-370	120	-240	870	150	-130	350
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	4040	320/-320	110	-180	630	120	-100	470
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	4190	340/-340	120	-190	640	120	-110	470
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	4350	370/-370	120	-190	640	120	-100	430
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	3740	290/-290	100	-170	570	80	-70	280
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH SYSTEM A & B)	VREF15	4640	390/-390	130	-200	680	130	-120	500
STABILIZER TRIM INOPERATIVE	VREF15	3590	280/-280	90	-160	550	70	-70	270
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	3590	280/-280	90	-160	550	70	-70	270
LEADING EDGE FLAPS TRANSIT	VREF15+5	3880	310/-310	110	-170	580	80	-70	300
ONE ENGINE INOPERATIVE	VREF15	3760	300/-310	100	-170	580	90	-80	300

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Good Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 45000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS	SLOPE ADJ PER 1%	APPROACH SPEED		
HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF					
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	3300	250/-250	80	-150	530	70	-60	260
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	3590	280/-280	90	-160	550	70	-70	270
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	4090	290/-300	110	-170	580	80	-70	260
TRAILING EDGE FLAP DISAGRE (30≤ FLAPS <40)	VREF30	3300	250/-250	80	-150	530	70	-60	260
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	3590	280/-280	90	-160	550	70	-70	270
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	4090	290/-300	110	-170	580	80	-70	260
TRAILING EDGE FLAPS UP (FLAPS <1)	VREF40+40	4400	310/-320	120	-180	610	80	-80	270

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance****Medium Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 45000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 45000 KG	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS HEAD WIND	SLOPE ADJ PER 1% DOWN HILL	APPROACH SPEED PER 10 KTS UP HILL	PER 10 KTS ABOVE VREF	
ALL FLAPS UP	VREF40+55	6570	540/-560	210	-290	1010	210	-190	370
ANTI-SKID INOPERATIVE	VREF40	5470	500/-490	160	-340	1290	310	-240	390
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	5060	460/-450	150	-270	950	220	-190	490
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	5320	500/-490	170	-280	980	240	-200	520
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	5640	550/-530	180	-280	1000	240	-200	510
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	4950	450/-440	150	-260	910	180	-160	370
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH SYSTEM A & B)	VREF15	6010	580/-560	190	-300	1040	270	-230	570
STABILIZER TRIM INOPERATIVE	VREF15	4690	430/-420	140	-240	880	170	-140	340
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	4690	430/-420	140	-240	880	170	-140	340
LEADING EDGE FLAPS TRANSIT	VREF15+5	5100	480/-470	160	-260	920	190	-160	380
ONE ENGINE INOPERATIVE	VREF15	5170	480/-480	160	-280	980	230	-190	400

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance**
Medium Reported Braking Action

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)								
		REF DIST FOR 45000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED	
HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF						
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	4300	380/-380	130	-230	840	160	-140	330	
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	4690	430/-420	140	-240	880	170	-140	340	
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	5400	450/-460	170	-260	930	180	-160	340	
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	4300	380/-380	130	-230	840	160	-140	330	
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	4690	430/-420	140	-240	880	170	-140	340	
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	5400	450/-460	170	-260	930	180	-160	340	
TRAILING EDGE FLAP UP (FLAPS <1)	VREF40+40	5810	480/-490	180	-270	960	190	-170	350	

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Poor Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)							
		REF DIST FOR 45000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 45000 KG	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS HEAD WIND	SLOPE ADJ PER 1% DOWN HILL	APPROACH SPEED PER 10 KTS UP HILL	PER 10 KTS ABOVE VREF	
ALL FLAPS UP	VREF40+55	8180	770/-760	290	-410	1500	430	-340	440
ANTI-SKID INOPERATIVE	VREF40	6920	720/-690	230	-540	2220	960	-520	430
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 40)	VREF40	6080	610/-580	200	-380	1390	410	-320	500
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 30)	VREF30	6450	670/-630	220	-390	1430	440	-340	540
HYDRAULICS-LOSS OF SYSTEM A (FLAPS 15)	VREF15	6930	760/-700	240	-400	1470	460	-350	550
HYDRAULICS-LOSS OF SYSTEM B (FLAPS 15)	VREF15	6210	640/-600	200	-370	1370	380	-290	430
HYDRAULICS-MANUAL REVERSION (LOSS OF BOTH SYSTEM A & B)	VREF15	7350	800/-740	260	-420	1520	500	-380	610
STABILIZER TRIM INOPERATIVE	VREF15	5840	610/-570	190	-350	1320	350	-270	390
JAMMED OR RESTRICTED FLIGHT CONTROLS	VREF15	5840	610/-570	190	-350	1320	350	-270	390
LEADING EDGE FLAPS TRANSIT	VREF15+5	6360	670/-630	220	-370	1380	390	-300	440
ONE ENGINE INOPERATIVE (FLAPS 15)	VREF15	6820	710/-690	230	-420	1550	530	-390	490

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.

Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Non-Normal Configuration Landing Distance
Poor Reported Braking Action**

LANDING CONFIGURATION	VREF	LANDING DISTANCE AND ADJUSTMENT (FT)								
		REF DIST FOR 45000 KG LANDING WEIGHT	WT ADJ PER 5000 KG ABV/BLW 45000 KG	ALT ADJ PER 1000 FT ABV S.L.	WIND ADJ PER 10 KTS		SLOPE ADJ PER 1%		APPROACH SPEED	
HEAD WIND	TAIL WIND	DOWN HILL	UP HILL	PER 10 KTS ABOVE VREF						
TRAILING EDGE FLAP ASYMMETRY (30≤ FLAPS <40)	VREF30	5340	540/-510	170	-340	1280	330	-250	370	
TRAILING EDGE FLAP ASYMMETRY (15≤ FLAPS <30)	VREF15	5840	610/-570	190	-350	1320	350	-270	390	
TRAILING EDGE FLAP ASYMMETRY (1≤ FLAPS <15)	VREF40+30	6740	650/-630	230	-380	1390	370	-290	400	
TRAILING EDGE FLAP DISAGREE (30≤ FLAPS <40)	VREF30	5340	540/-510	170	-340	1280	330	-250	370	
TRAILING EDGE FLAP DISAGREE (15≤ FLAPS <30)	VREF15	5840	610/-570	190	-350	1320	350	-270	390	
TRAILING EDGE FLAP DISAGREE (1≤ FLAPS <15)	VREF40+30	6740	650/-630	230	-380	1390	370	-290	400	
TRAILING EDGE FLAP UP (FLAPS <1)	VREF40+40	7240	690/-670	250	-390	1430	390	-310	410	

Reference distance is for sea level, standard day, no wind or slope, and maximum available reverse thrust.
Max Manual assumes maximum achievable manual braking.

Actual (unfactored) distances are shown.

Includes distance from 50 ft above threshold (1000 ft of air distance).

ADVISORY INFORMATION**Recommended Brake Cooling Schedule****Reference Brake Energy Per Brake (Millions of Foot Pounds)**

WEIGHT (1000 KG)	OAT (°C)	WIND CORRECTED BRAKES ON SPEED (KIAS)*											
		60			80			100			120		
		PRESS	ALT	PRESS	ALT	PRESS	ALT	PRESS	ALT	PRESS	ALT	PRESS	ALT
70	-20	6.6	7.4	8.3	11.1	12.5	14.1	16.5	18.7	21.4	22.9	26.0	29.7
	0	7.1	7.9	8.8	11.9	13.4	15.1	17.7	20.1	22.9	24.5	27.9	31.9
	15	7.4	8.3	9.3	12.5	14.1	15.9	18.7	21.2	24.2	25.9	29.4	33.6
	20	7.5	8.4	9.4	12.7	14.3	16.2	19.0	21.5	24.6	26.3	29.9	34.1
	40	7.9	8.8	9.8	13.3	15.0	17.0	20.0	22.7	25.9	27.8	31.6	36.1
65	-20	6.2	6.9	7.8	10.4	11.7	13.2	15.5	17.5	20.0	21.4	24.3	27.8
	0	6.7	7.4	8.3	11.1	12.5	14.1	16.6	18.8	21.4	22.9	26.0	29.7
	15	7.0	7.8	8.7	11.7	13.2	14.9	17.5	19.8	22.6	24.2	27.4	31.4
	20	7.1	7.9	8.8	11.9	13.4	15.2	17.8	20.1	23.0	24.6	27.9	31.9
	40	7.4	8.2	9.2	12.5	14.0	15.9	18.7	21.2	24.2	25.9	29.5	33.7
60	-20	5.8	6.5	7.2	9.7	10.9	12.3	14.4	16.3	18.6	19.9	22.6	25.8
	0	6.3	7.0	7.8	10.4	11.7	13.2	15.4	17.5	19.9	21.3	24.2	27.6
	15	6.6	7.3	8.1	10.9	12.3	13.9	16.3	18.4	21.0	22.5	25.5	29.1
	20	6.7	7.4	8.3	11.1	12.5	14.1	16.5	18.7	21.3	22.8	25.9	29.6
	40	6.9	7.7	8.6	11.6	13.1	14.8	17.4	19.7	22.5	24.1	27.4	31.3
55	-20	5.5	6.1	6.8	9.0	10.1	11.4	13.4	15.1	17.2	18.4	20.8	23.8
	0	5.9	6.5	7.2	9.7	10.8	12.2	14.3	16.2	18.4	19.7	22.3	25.5
	15	6.1	6.8	7.6	10.2	11.4	12.8	15.1	17.0	19.4	20.7	23.5	26.9
	20	6.2	6.9	7.7	10.3	11.6	13.0	15.3	17.3	19.7	21.1	23.9	27.3
	40	6.5	7.2	8.0	10.8	12.1	13.7	16.1	18.2	20.8	22.2	25.2	28.8
50	-20	5.1	5.6	6.3	8.3	9.3	10.5	12.3	13.9	15.7	16.8	19.1	21.8
	0	5.4	6.0	6.7	8.9	10.0	11.2	13.2	14.8	16.9	18.0	20.4	23.3
	15	5.7	6.3	7.0	9.4	10.5	11.8	13.8	15.6	17.8	19.0	21.5	24.6
	20	5.8	6.4	7.1	9.5	10.7	12.0	14.1	15.9	18.1	19.3	21.9	25.0
	40	6.0	6.7	7.4	10.0	11.2	12.6	14.8	16.7	19.0	20.3	23.1	26.4
45	-20	4.7	5.2	5.8	7.7	8.6	9.6	11.2	12.6	14.3	15.3	17.3	19.7
	0	5.0	5.6	6.2	8.2	9.2	10.3	12.0	13.5	15.3	16.4	18.5	21.1
	15	5.3	5.8	6.5	8.6	9.6	10.8	12.6	14.2	16.1	17.3	19.5	22.3
	20	5.3	5.9	6.6	8.7	9.8	11.0	12.8	14.5	16.4	17.5	19.9	22.7
	40	5.5	6.2	6.8	9.1	10.2	11.5	13.5	15.2	17.3	18.5	20.9	23.9
40	-20	4.3	4.8	5.3	7.0	7.8	8.7	10.1	11.4	12.9	13.7	15.5	17.7
	0	4.6	5.1	5.7	7.5	8.3	9.3	10.9	12.2	13.8	14.7	16.6	18.9
	15	4.9	5.4	5.9	7.8	8.8	9.8	11.4	12.8	14.5	15.5	17.5	20.0
	20	4.9	5.4	6.0	8.0	8.9	10.0	11.6	13.0	14.8	15.8	17.8	20.3
	40	5.1	5.6	6.3	8.3	9.3	10.4	12.1	13.7	15.5	16.6	18.8	21.4

*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°C.

Adjusted Brake Energy Per Brake (Millions of Foot Pounds)**No Reverse Thrust**

EVENT		REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)							
RTO MAX MAN		10	15	20	25	30	35	40	
LANDING	MAX MAN	8.6	13.3	18.1	22.8	27.5	32.3	37.0	
	MAX AUTO	8.1	12.3	16.6	21.0	25.4	29.9	34.4	
	AUTOBRAKE 3	8.0	11.6	15.3	19.2	23.1	27.1	31.2	
	AUTOBRAKE 2	7.8	11.0	14.3	17.6	21.1	24.6	28.3	
	AUTOBRAKE 1	7.5	10.4	13.4	16.3	19.4	22.5	25.6	

737 Flight Crew Operations Manual

ADVISORY INFORMATION**Recommended Brake Cooling Schedule****Two Engine Detent Reverse Thrust**

REFERENCE BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)							
EVENT	10	15	20	25	30	35	40
RTO MAX MAN	10	15	20	25	30	35	40
LANDING	MAX MAN	8.2	12.5	16.7	20.9	25.0	29.0
	MAX AUTO	6.0	9.4	12.8	16.4	20.1	23.8
	AUTOBRAKE 3	3.2	5.2	7.4	9.7	12.2	14.8
	AUTOBRAKE 2	1.4	2.5	3.8	5.2	6.8	8.5
	AUTOBRAKE 1	0.6	1.3	2.1	3.0	3.9	5.0
6.2							

Cooling Time (Minutes) - Category A Brakes

ADJUSTED BRAKE ENERGY PER BRAKE (MILLIONS OF FOOT POUNDS)							
8 & BELOW	10	12	14	16	18	18.5 TO 23.7	23.8 & ABOVE
BRAKE TEMPERATURE INDICATOR READING							
UP TO 2.1	2.8	3.2	3.6	4.2	4.8	4.9 TO 6.3	6.3 & ABOVE
INFLIGHT GEAR DOWN	NO SPECIAL PROCEDURE REQUIRED	2	3	4	5	6	CAUTION
		19	32	43	53	61	
GROUND							FUSE PLUG MELT ZONE

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.

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 7 minutes.

When in fuse plug melt zone, clear runway immediately. Unless required, do not set parking brake. Do not approach gear or attempt to taxi for one hour. Tire, wheel and brake replacement may be required. If overheat occurs after takeoff, extend gear soon for at least 12 minutes.

Brake Temperature Indicator (if installed) on First Officer's Instrument Panel may be used 10 to 15 minutes after brake application to determine recommended cooling time.

Intentionally
Blank

**Performance Inflight
Engine Inoperative**
**Chapter PI
Section 33**
ENGINE INOP
Initial Max Continuous %N1
Based on .74M, engine bleed for packs auto and anti-ice off

TAT (°C)	PRESSURE ALTITUDE (1000 FT)					
	27	29	31	33	35	37
20	92.9	92.9	92.8	92.8	92.8	92.7
15	93.3	93.3	93.2	93.2	93.2	93.1
10	93.7	93.7	93.6	93.6	93.6	93.5
5	94.0	94.0	93.9	93.9	93.9	93.8
0	94.3	94.3	94.2	94.2	94.2	94.1
-5	93.7	94.6	94.5	94.5	94.5	94.4
-10	92.8	93.9	94.7	94.7	94.7	94.6
-15	91.9	93.0	93.9	95.0	95.0	94.9
-20	91.0	92.0	93.0	94.1	95.3	95.4
-25	90.1	91.1	92.0	93.2	94.4	94.9
-30	89.2	90.2	91.1	92.2	93.4	94.0
-40	87.4	88.3	89.2	90.3	91.5	92.0
-50	85.5	86.4	87.3	88.3	89.5	90.0

%N1 Adjustment for Engine Bleeds

BLEED CONFIGURATION	PRESSURE ALTITUDE (1000 FT)					
	27	29	31	33	35	37
ENGINE A/I ON	-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
ENGINE AND WING A/I ON	-3.1	-3.0	-3.0	-3.0	-3.0	-3.0

ENGINE INOP**Max Continuous %N1****33000 FT to 23000 FT Pressure Altitudes****Based on engine bleed for packs auto and anti-ice off**

33000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.58	89.6	91.6	93.5	94.4	94.0	93.5	93.2					
220	.63	89.4	91.4	93.3	94.8	94.3	93.8	93.5	93.1				
240	.68	89.1	91.0	93.0	94.8	94.6	94.0	93.7	93.4				
260	.74	88.3	90.2	92.2	94.0	94.7	94.2	93.9	93.5	93.2			
31000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.55	88.8	90.8	92.7	94.2	93.9	93.4	93.1					
220	.61	88.7	90.6	92.4	94.4	94.2	93.7	93.4	93.1				
240	.66	88.3	90.2	92.1	94.0	94.5	93.9	93.6	93.3	92.9			
260	.71	87.8	89.7	91.7	93.5	94.6	94.1	93.8	93.5	93.1			
29000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.53	88.1	90.0	91.9	93.8	93.7	93.2	92.9	92.6				
220	.58	87.9	89.8	91.8	93.6	94.1	93.6	93.3	92.9	92.6			
240	.63	87.6	89.5	91.4	93.3	94.4	93.8	93.5	93.2	92.8			
260	.68	87.1	89.1	91.0	92.8	94.5	94.0	93.7	93.4	93.0	92.6		
27000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.51	87.3	89.3	91.2	93.0	93.5	93.0	92.8	92.4				
220	.56	87.1	89.1	91.0	92.8	93.9	93.4	93.1	92.8	92.4			
240	.60	86.9	88.9	90.7	92.6	94.3	93.8	93.5	93.1	92.7	92.3		
260	.65	86.5	88.4	90.3	92.1	93.9	93.9	93.7	93.3	92.9	92.5		
25000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.49	86.6	88.5	90.4	92.2	93.4	93.0	92.7	92.4	92.0			
220	.53	86.4	88.3	90.2	92.0	93.7	93.3	93.0	92.7	92.3	91.9		
240	.58	86.2	88.1	90.0	91.8	93.6	93.6	93.3	93.0	92.6	92.2		
260	.63	85.8	87.7	89.6	91.4	93.2	93.8	93.6	93.2	92.9	92.4	92.0	
23000 FT PRESS ALT.			TAT (°C)										
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25
200	.47	85.8	87.7	89.6	91.4	93.2	92.8	92.6	92.3	91.9	91.6		
220	.51	85.6	87.5	89.4	91.2	93.0	93.1	92.9	92.5	92.2	91.8		
240	.56	85.4	87.3	89.2	91.0	92.8	93.4	93.2	92.8	92.5	92.1	91.7	
260	.60	85.2	87.1	88.9	90.8	92.5	93.8	93.5	93.1	92.8	92.4	92.0	

Anti-Ice Adjustments

BLEED CONFIGURATION			PRESS ALT (1000 FT)					
			23	25	27	29	31	33
ENGINE A/I ON			-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
ENGINE AND WING A/I ON			-3.1	-3.1	-3.1	-3.0	-3.0	-3.0

ENGINE INOP**Max Continuous %N1****21000 FT to 14000 FT Pressure Altitudes****Based on engine bleed for packs auto and anti-ice off**

21000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.45	85.0	86.9	88.8	90.6	92.4	92.7	92.5	92.2	91.9	91.5			
220	.49	84.9	86.8	88.6	90.4	92.2	93.0	92.7	92.4	92.1	91.7	91.3		
240	.54	84.7	86.6	88.4	90.2	92.0	93.3	93.0	92.7	92.4	92.0	91.6		
260	.60	84.5	86.3	88.2	90.0	91.7	93.4	93.3	93.0	92.6	92.3	91.8	91.4	
20000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-50	-40	-30	-20	-10	0	5	10	15	20	25	30
200	.44	84.7	86.5	88.4	90.2	91.9	92.7	92.4	92.1	91.8	91.5	91.1		
220	.48	84.5	86.4	88.2	90.0	91.8	92.9	92.7	92.4	92.0	91.7	91.3		
240	.53	84.3	86.2	88.0	89.8	91.6	93.2	92.9	92.6	92.3	91.9	91.5	91.1	
260	.57	84.1	86.0	87.8	89.6	91.3	93.0	93.2	92.9	92.6	92.2	91.8	91.3	
18000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-40	-30	-20	-10	0	5	10	15	20	25	30	35
200	.42	85.8	87.6	89.4	91.1	92.6	92.3	92.0	91.7	91.4	91.0			
220	.46	85.6	87.4	89.2	91.0	92.7	92.6	92.3	92.0	91.6	91.2	90.8		
240	.51	86.6	83.4	90.2	92.0	93.7	94.1	93.8	93.5	93.1	92.7	92.3		
260	.55	86.4	88.2	90.0	91.8	93.5	94.3	94.1	93.7	93.4	93.0	92.5	92.1	
17000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-40	-30	-20	-10	0	5	10	15	20	25	30	35
200	.42	87.1	89.0	90.8	92.6	94.3	94.2	93.9	93.6	93.3	92.9	92.5		
220	.46	87.0	88.8	90.6	92.4	94.1	94.4	94.1	93.8	93.5	93.1	92.7		
240	.50	86.8	88.6	90.4	92.2	93.9	94.7	94.4	94.1	93.7	93.3	92.9	92.5	
260	.54	86.6	88.4	90.2	92.0	93.7	94.5	94.6	94.3	93.9	93.6	93.2	92.7	
16000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-40	-30	-20	-10	0	5	10	15	20	25	30	35
200	.41	86.8	88.6	90.4	92.2	93.9	94.1	93.9	93.6	93.3	92.9	92.5		
220	.45	86.6	88.4	90.2	92.0	93.7	94.3	94.1	93.8	93.4	93.1	92.7		
240	.49	86.4	88.2	90.0	91.8	93.5	94.4	94.3	94.0	93.7	93.3	92.9	92.5	
260	.53	86.2	88.0	89.8	91.6	93.3	94.1	94.6	94.2	93.9	93.5	93.1	92.7	
14000 FT PRESS ALT.			TAT (°C)											
KIAS	M		-30	-20	-10	0	5	10	15	20	25	30	35	40
200	.39	87.8	89.6	91.3	93.1	93.9	93.8	93.5	93.2	92.8	92.4	92.0		
220	.43	87.6	89.4	91.2	92.9	93.7	94.0	93.7	93.4	93.0	92.6	92.2		
240	.47	87.5	89.2	91.0	92.7	93.5	94.2	93.9	93.6	93.2	92.8	92.4		
260	.51	87.3	89.0	90.8	92.5	93.3	94.2	94.1	93.8	93.4	93.0	92.6	92.1	

Anti-Ice Adjustments

BLEED CONFIGURATION			PRESS ALT (1000 FT)					
			14	16	17	18	20	21
ENGINE A/I ON			-1.0	-1.0	-1.0	-1.0	-1.0	-1.0
ENGINE AND WING A/I ON			-3.2	-3.2	-3.2	-3.2	-3.2	-3.2

ENGINE INOP**Max Continuous %N1****12000 FT to 1000 FT Pressure Altitudes****Based on engine bleed for packs auto and anti-ice off**

12000 FT PRESS ALT.			TAT (°C)										
KIAS	M	-20	-10	0	5	10	15	20	25	30	35	40	45
200	.38	88.8	90.5	92.2	93.1	93.7	93.4	93.1	92.7	92.4	91.9		
220	.41	88.6	90.4	92.1	92.9	93.7	93.6	93.3	92.9	92.5	92.1	91.7	
240	.45	88.4	90.2	91.9	92.7	93.5	93.8	93.5	93.1	92.7	92.3	91.9	
260	.49	88.3	90.0	91.7	92.5	93.3	94.0	93.7	93.3	92.9	92.5	92.0	91.6
10000 FT PRESS ALT.			TAT (°C)										
KIAS	M	-20	-10	0	5	10	15	20	25	30	35	40	45
200	.36	88.0	89.7	91.4	92.2	93.1	93.3	93.0	92.7	92.3	91.9	91.4	
220	.40	87.9	89.6	91.3	92.1	92.9	93.5	93.2	92.9	92.5	92.1	91.6	
240	.43	87.7	89.4	91.1	91.9	92.7	93.5	93.4	93.0	92.6	92.2	91.8	91.3
260	.47	87.5	89.2	90.9	91.7	92.5	93.3	93.6	93.2	92.8	92.4	92.0	91.5
7000 FT PRESS ALT.			TAT (°C)										
KIAS	M	-10	0	5	10	15	20	25	30	35	40	45	50
200	.34	86.6	88.3	89.1	89.9	90.7	91.0	91.1	91.9	92.0	91.8	91.5	91.1
220	.38	86.5	88.1	89.0	89.7	90.5	91.2	91.0	91.8	92.1	92.0	91.6	91.3
240	.41	86.4	88.0	88.8	89.6	90.4	91.2	91.0	91.6	92.1	92.1	91.8	91.4
260	.45	86.2	87.8	88.6	89.4	90.2	90.0	91.1	91.3	92.2	92.1	91.9	91.5
5000 FT PRESS ALT.			TAT (°C)										
KIAS	M	-10	0	5	10	15	20	25	30	35	40	45	50
200	.33	85.8	87.5	88.3	89.0	89.8	90.6	90.6	90.9	91.3	91.1	90.7	90.3
220	.36	85.7	87.3	88.1	88.9	89.7	90.5	90.7	90.8	91.4	91.2	90.9	90.4
240	.40	85.6	87.2	88.0	88.8	89.6	90.3	90.9	90.7	91.3	91.3	91.0	90.6
260	.43	85.4	87.0	87.8	88.6	89.3	90.1	90.9	90.8	91.2	91.4	91.1	90.7
3000 FT PRESS ALT.			TAT (°C)										
KIAS	M	-10	0	5	10	15	20	25	30	35	40	45	50
200	.32	85.0	86.6	87.4	88.2	89.0	89.8	90.5	90.2	89.8	89.4	89.0	88.5
220	.35	84.9	86.5	87.3	88.1	88.8	89.6	90.4	90.3	90.0	89.6	89.1	88.6
240	.40	84.8	86.4	87.2	87.9	88.7	89.5	90.2	90.5	90.1	89.7	89.3	88.8
260	.43	84.6	86.2	87.0	87.8	88.5	89.3	90.0	90.6	90.3	89.9	89.4	89.0
1000 FT PRESS ALT.			TAT (°C)										
KIAS	M	-10	0	5	10	15	20	25	30	35	40	45	50
200	.31	84.2	85.8	86.6	87.4	88.2	88.9	89.7	90.1	89.7	89.2	88.8	88.3
220	.34	84.1	85.7	86.5	87.2	88.0	88.8	89.5	90.2	89.8	89.4	88.9	88.4
240	.37	84.0	85.5	86.3	87.1	87.9	88.6	89.4	90.1	90.0	89.5	89.1	88.6
260	.40	83.8	85.4	86.2	87.0	87.7	88.5	89.2	90.0	90.1	89.7	89.2	88.7

Anti-Ice Adjustments

BLEED CONFIGURATION	PRESS ALT (1000 FT)					
	1	3	5	7	10	12
ENGINE A/I ON	-0.7	-0.7	-0.8	-0.8	-0.9	-0.9
ENGINE AND WING A/I ON	-2.6	-2.6	-2.8	-2.9	-3.1	-3.1

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°C & BELOW	ISA + 15°C	ISA + 20°C
64	61	235	15500	14200	12800
60	57	228	17300	16400	15100
56	53	220	18800	18000	17200
52	49	212	20600	19600	18800
48	46	204	23100	22100	20900
44	42	196	25800	24800	23700
40	38	187	28500	27600	26600
36	34	177	31100	30500	29600
32	31	167	33700	33400	32600

Includes APU fuel burn.

ENGINE INOP**MAX CONTINUOUS THRUST****Driftdown/LRC Cruise Range Capability****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)						TAILWIND COMPONENT (KTS)				
100	80	60	40	20	20	40	60	80	100	
141	131	121	113	106	100	94	90	85	81	77
290	266	246	228	213	200	188	178	169	160	153
436	399	369	343	320	300	282	267	253	240	229
580	532	491	457	426	400	377	356	337	321	305
722	663	613	570	533	500	471	445	422	401	382
863	793	734	683	639	600	566	535	507	482	460
1002	923	855	796	745	700	660	625	593	564	538
1141	1052	975	909	851	800	755	715	678	646	616
1280	1180	1095	1021	957	900	850	805	764	727	694
1417	1308	1215	1134	1063	1000	944	895	850	809	773
1555	1436	1334	1246	1168	1100	1039	985	936	891	851
1693	1564	1454	1358	1274	1200	1134	1075	1022	973	929
1831	1693	1574	1471	1380	1300	1229	1165	1107	1055	1008
1970	1822	1694	1583	1486	1400	1323	1255	1193	1137	1086
2110	1951	1815	1696	1592	1500	1418	1345	1278	1218	1164
2250	2081	1936	1809	1698	1600	1513	1434	1364	1300	1241

Driftdown/Cruise Fuel and Time

AIR DIST (NM)	FUEL REQUIRED (1000 KG)							TIME (HRS:MIN)	
	WEIGHT AT START OF DRIFTDOWN (1000 KG)								
	35	40	45	50	55	60	65		
100	0.4	0.4	0.4	0.4	0.5	0.5	0.5	0:18	
200	0.8	0.9	0.9	1.0	1.1	1.2	1.3	0:37	
300	1.2	1.4	1.5	1.7	1.8	2.0	2.2	0:56	
400	1.7	1.8	2.1	2.3	2.5	2.8	3.0	1:14	
500	2.1	2.3	2.6	2.9	3.2	3.5	3.8	1:32	
600	2.5	2.8	3.1	3.5	3.9	4.2	4.6	1:50	
700	2.9	3.3	3.7	4.1	4.5	4.9	5.3	2:07	
800	3.3	3.7	4.2	4.7	5.1	5.6	6.1	2:24	
900	3.7	4.2	4.7	5.2	5.8	6.3	6.9	2:40	
1000	4.1	4.6	5.2	5.8	6.4	6.9	7.6	2:57	
1100	4.5	5.1	5.7	6.4	7.0	7.6	8.3	3:13	
1200	4.9	5.5	6.2	7.0	7.7	8.3	9.1	3:30	
1300	5.3	6.0	6.7	7.5	8.3	9.0	9.8	3:46	
1400	5.7	6.4	7.2	8.1	8.9	9.6	10.5	4:03	
1500	6.1	6.8	7.7	8.6	9.5	10.3	11.2	4:20	
1600	6.5	7.3	8.2	9.2	10.1	10.9	12.0	4:37	

Includes APU fuel burn.

Driftdown at optimum 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°C & BELOW	ISA + 15°C	ISA + 20°C
64	5200	3000	800
62	6700	4700	3400
60	11500	6100	5600
58	12900	10700	7600
56	14400	12200	10000
54	15900	13800	11600
52	17200	15300	13200
50	17900	16900	14800
48	18700	17800	16500
46	19600	18600	17600
44	20800	19500	18500
42	22500	20700	19400
40	24200	22500	20700
38	25900	24300	22500
36	27700	26100	24500

With engine anti-ice on, decrease altitude capability by 3700 ft.

With engine and wing anti-ice on, decrease altitude capability by 8700 ft.

ENGINE INOP**MAX CONTINUOUS THRUST****Long Range Cruise Control**

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)								
		10	12	14	16	18	20	22	24	26
64	%N1 MACH KIAS FF/ENG	90.4 .561 311 2950								
60	%N1 MACH KIAS FF/ENG	88.8 .547 303 2772	90.2 .564 302 2758							
56	%N1 MACH KIAS FF/ENG	87.2 .531 294 2589	88.5 .549 293 2580	89.9 .566 292 2563	91.3 .582 289 2533					
52	%N1 MACH KIAS FF/ENG	85.4 .513 284 2406	86.8 .532 284 2396	88.1 .550 283 2387	89.5 .567 281 2363	90.9 .584 278 2333				
48	%N1 MACH KIAS FF/ENG	83.5 .495 274 2223	84.8 .513 274 2211	86.2 .532 273 2204	87.6 .550 272 2189	89.0 .568 271 2165				
44	%N1 MACH KIAS FF/ENG	81.3 .475 263 2042	82.8 .493 263 2029	84.1 .511 263 2019	85.5 .530 262 2010	86.9 .549 261 1994	88.3 .567 260 1974	89.7 .584 257 1958		
40	%N1 MACH KIAS FF/ENG	78.9 .454 251 1864	80.4 .471 251 1851	81.9 .489 251 1839	83.3 .508 251 1830	84.7 .527 250 1819	86.0 .546 250 1806	87.5 .565 248 1795	88.9 .582 246 1777	90.6 .599 243 1754
36	%N1 MACH KIAS FF/ENG	76.3 .434 240 1697	77.8 .449 239 1677	79.3 .465 239 1663	80.8 .484 239 1653	82.2 .502 238 1643	83.6 .522 238 1632	85.0 .541 238 1627	86.4 .561 236 1615	87.9 .578 234 1592
										89.6 .595 231

ENGINE INOP

MAX CONTINUOUS THRUST

Long Range Cruise Diversion Fuel and Time

Ground to Air Miles Conversion

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)				200						
100	80	60	40	20	200	190	181	173	166	159
299	272	249	230	214	400	380	362	345	330	316
608	552	504	464	430	600	570	542	517	494	473
920	834	759	697	646	800	760	722	688	658	630
1235	1118	1015	932	862	1000	949	903	860	821	787
1552	1403	1273	1167	1078	1200	1139	1082	1031	984	943
1872	1690	1532	1403	1295	1400	1328	1262	1202	1147	1099
2196	1980	1792	1640	1512	1600	1517	1441	1372	1310	1255
2524	2273	2055	1877	1730	1800	1707	1621	1543	1473	1410
2854	2566	2317	2115	1948						

Reference Fuel and Time Required at Check Point

AIR DIST (NM)	PRESSURE ALTITUDE (1000 FT)									
	10		14		18		22		26	
(NM)	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	1.4	0:42	1.2	0:40	1.1	0:39	1.0	0:38	0.9	0:38
400	2.8	1:22	2.6	1:18	2.3	1:14	2.1	1:11	2.0	1:11
600	4.2	2:03	3.9	1:56	3.5	1:50	3.3	1:46	3.1	1:46
800	5.6	2:44	5.2	2:35	4.7	2:26	4.4	2:20	4.1	2:20
1000	7.0	3:26	6.4	3:14	5.9	3:03	5.5	2:55	5.2	2:55
1200	8.3	4:08	7.7	3:54	7.1	3:40	6.6	3:30	6.2	3:30
1400	9.6	4:51	8.9	4:34	8.2	4:18	7.7	4:05	7.2	4:05
1600	10.9	5:35	10.1	5:15	9.3	4:57	8.7	4:41	8.2	4:41
1800	12.2	6:20	11.3	5:57	10.5	5:36	9.8	5:18	9.1	5:18

Fuel Required Adjustments (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)			
	35	45	55	65
5	-0.4	0.0	0.8	1.8
10	-0.9	0.0	1.6	3.5
15	-1.3	0.0	2.2	5.0

ENGINE INOP**MAX CONTINUOUS THRUST****Holding
Flaps Up**

WEIGHT (1000 KG)		PRESSURE ALTITUDE (FT)					
		1500	5000	10000	15000	20000	25000
64	%N1	79.9	82.5	86.2	90.5		
	KIAS	247	247	247	249		
	FF/ENG	2600	2580	2570	2590		
60	%N1	78.1	80.8	84.5	88.5		
	KIAS	238	239	239	241		
	FF/ENG	2440	2420	2400	2410		
56	%N1	76.1	78.9	82.7	86.6		
	KIAS	230	231	232	232		
	FF/ENG	2270	2260	2240	2230		
52	%N1	74.1	76.9	80.8	84.6	88.9	
	KIAS	221	222	224	223	225	
	FF/ENG	2110	2100	2080	2060	2070	
48	%N1	71.8	74.7	78.7	82.5	86.5	
	KIAS	211	213	215	215	216	
	FF/ENG	1950	1940	1920	1900	1890	
44	%N1	69.8	72.6	76.6	80.4	84.3	88.9
	KIAS	210	210	210	210	210	210
	FF/ENG	1820	1800	1780	1750	1740	1740
40	%N1	67.9	70.7	74.6	78.6	82.4	86.6
	KIAS	210	210	210	210	210	210
	FF/ENG	1710	1690	1660	1630	1620	1610
36	%N1	66.2	68.9	72.8	76.7	80.6	84.5
	KIAS	210	210	210	210	210	210
	FF/ENG	1610	1590	1560	1530	1510	1510

This table includes 5% additional fuel for holding in a racetrack pattern.

Performance Inflight**PMC Off****Chapter PI****Section 34****PMC OFF****Takeoff Weight Adjustments**

AIRPORT PRESSURE ALTITUDE (FT)	TEMPERATURE °C (°F)	PMC OFF TAKEOFF LIMIT WEIGHT ADJUSTMENT (1000 KG)				
		FIELD LIMIT	CLIMB LIMIT	TIRE SPEED LIMIT	BRAKE ENERGY LIMIT (NORMAL TAKEOFF)	BRAKE ENERGY LIMIT (IMPROVED CLIMB TAKEOFF)
3000 & BELOW	ABOVE 27°C (80°F)	-0.15	-0.15	-0.20	-0.70	-0.40
	27°C (80°F) & BELOW	-0.45	-0.45	-0.20	-0.70	-0.40
ABOVE 3000	ABOVE 27°C (80°F)	-1.00	-0.95	-0.21	-0.35	-0.20
	27°C (80°F) & BELOW	-1.10	-1.10	-0.25	-0.70	-0.40

Valid for Flaps 5 or Flaps 15 takeoff.

Obstacle Limit Weight Adjustments

NORMAL OBSTACLE LIMIT WEIGHT (1000 KG)	PMC OFF OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)		
	AIRPORT PRESSURE ALTITUDE (FT)		
	3000 & BELOW	ABOVE 3000	
30	-3.70		-6.80
40	-2.60		-5.20
50	-1.50		-3.60
60	-0.40		-2.00
70	0		-0.40

Valid for Flaps 5 or Flaps 15 takeoff.

Takeoff Speeds Adjustments

SPEED (KIAS)	PRESSURE ALTITUDE (FT)			
	3000 & BELOW		ABOVE 3000	
	ABOVE 27°C	27°C & BELOW	ABOVE 27°C	27°C & BELOW
V1(MCG)	6	6	4	3
V1	0	0	0	0
VR	0	0	0	0

PMC OFF**Takeoff %N1**

Based on engine bleed to packs on (Auto) and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	-0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	91.5	92.3	92.2	91.7						
50	122	92.0	92.8	93.4	93.7	93.0	93.0				
45	113	92.6	93.1	93.6	93.9	93.9	94.5	94.3	93.7		
40	104	93.1	93.6	94.0	94.2	94.3	95.1	95.0	94.9	94.8	94.5
35	95	93.2	94.1	94.6	94.8	94.8	95.5	95.7	95.6	95.8	95.7
30	86	93.0	94.5	94.3	94.5	95.0	95.4	95.6	95.8	95.8	95.8
25	77	92.2	93.7	93.7	93.7	94.4	95.5	95.3	95.1	95.4	95.8
20	68	91.5	92.9	92.9	92.9	93.6	95.5	95.7	95.8	95.8	95.7
15	59	90.7	92.1	92.1	92.1	92.8	94.9	95.1	95.1	95.1	95.1
10	50	89.9	91.3	91.3	91.3	92.0	94.1	94.3	94.3	94.3	94.3
5	41	89.1	90.5	90.5	90.5	91.2	93.2	93.4	93.4	93.4	93.4
0	32	88.3	89.7	89.7	89.7	90.4	92.4	92.6	92.6	92.6	92.6
-10	14	86.6	88.0	88.0	88.0	88.7	90.7	90.9	90.9	90.9	90.9
-20	-4	85.0	86.3	86.3	86.4	87.0	89.0	89.1	89.1	89.1	89.1
-30	-22	83.3	84.6	84.6	84.6	85.3	87.2	87.4	87.4	87.4	87.4
-40	-40	81.6	82.9	82.9	82.9	83.5	85.4	85.5	85.5	85.6	85.6
-50	-58	79.8	81.1	81.1	81.1	81.7	83.5	83.7	83.7	83.7	83.7

Based on engine bleed to packs off and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	92.4	93.3	93.2	92.7						
50	122	93.0	93.8	94.4	94.6	94.0	94.0				
45	113	93.5	94.0	94.6	94.9	94.8	95.5	95.3	94.7		
40	104	94.0	94.5	94.9	95.1	95.2	96.1	95.9	95.8	95.8	95.4
35	95	94.2	95.0	95.6	95.7	95.7	96.5	96.6	96.6	96.7	96.6
30	86	93.9	95.4	95.2	95.4	96.0	96.3	96.5	96.7	96.7	96.8
25	77	93.1	94.6	94.6	94.6	95.3	96.4	96.2	96.0	96.3	96.7
20	68	92.4	93.8	93.8	93.8	94.6	95.9	95.9	95.9	95.9	95.9
15	59	91.6	93.0	93.0	93.0	93.7	95.1	95.1	95.1	95.1	95.1
10	50	90.8	92.2	92.2	92.2	92.9	94.3	94.3	94.3	94.3	94.3
5	41	90.0	91.4	91.4	91.4	92.1	93.4	93.4	93.4	93.4	93.4
0	32	89.2	90.6	90.6	90.6	91.3	92.6	92.6	92.6	92.6	92.6
-10	14	87.5	88.9	88.9	88.9	89.6	90.9	90.9	90.9	90.9	90.9
-20	-4	85.8	87.2	87.2	87.2	87.9	89.1	89.1	89.1	89.1	89.1
-30	-22	84.1	85.5	85.5	85.5	86.1	87.4	87.4	87.4	87.4	87.4
-40	-40	82.4	83.7	83.7	83.7	84.3	85.5	85.5	85.5	85.6	85.6
-50	-58	80.6	81.9	81.9	81.9	82.5	83.7	83.7	83.7	83.7	83.7

PMC OFF**Takeoff Weight Adjustments (18.5K Derate)**

AIRPORT PRESSURE ALTITUDE (FT)	TEMPERATURE °C (°F)	PMC OFF TAKEOFF LIMIT WEIGHT ADJUSTMENT (1000 KG)				
		FIELD LIMIT	CLIMB LIMIT	TIRE SPEED LIMIT	BRAKE ENERGY LIMIT (NORMAL TAKEOFF)	BRAKE ENERGY LIMIT (IMPROVED CLIMB TAKEOFF)
3000 & BELOW	ABOVE 27°C (80°F)	-0.15	-0.15	-0.20	-0.70	-0.40
	27°C (80°F) & BELOW	-0.45	-0.45	-0.20	-0.70	-0.40
ABOVE 3000	ABOVE 27°C (80°F)	-1.00	-0.95	-0.21	-0.35	-0.20
	27°C (80°F) & BELOW	-1.10	-1.10	-0.25	-0.70	-0.40

Valid for Flaps 5 or Flaps 15 takeoff.

Obstacle Limit Weight Adjustments (18.5K Derate)

NORMAL OBSTACLE LIMIT WEIGHT (1000 KG)	PMC OFF OBSTACLE LIMIT WEIGHT ADJUSTMENT (1000 KG)	
	AIRPORT PRESSURE ALTITUDE (FT)	
	3000 & BELOW	ABOVE 3000
30	-3.70	-6.80
40	-2.60	-5.20
50	-1.50	-3.60
60	-0.40	-2.00
70	0	-0.40

Valid for Flaps 5 or Flaps 15 takeoff.

Takeoff Speeds Adjustments (18.5K Derate)

SPEED (KIAS)	PRESSURE ALTITUDE (FT)			
	3000 & BELOW		ABOVE 3000	
	ABOVE 27°C	27°C & BELOW	ABOVE 27°C	27°C & BELOW
V1(MCG)	6	6	4	3
V1	0	0	0	0
VR	0	0	0	0

PMC OFF**Takeoff %N1 (18.5K Derate)**

Based on engine bleed to packs on (Auto) and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	88.5	88.9	89.1	89.1						
50	122	89.0	89.5	90.0	90.6	91.3	91.5				
45	113	89.5	89.9	90.3	90.8	92.0	92.8	92.7	92.4		
40	104	90.1	90.3	90.7	91.2	92.4	93.1	93.2	93.3	92.9	92.3
35	95	90.3	90.4	91.1	91.5	92.8	93.4	93.4	93.7	93.2	92.8
30	86	90.1	90.4	90.8	91.3	92.9	93.7	93.7	94.0	93.5	93.1
25	77	89.3	89.6	90.3	90.8	92.1	93.1	93.5	94.2	93.8	93.4
20	68	88.6	88.8	89.5	90.0	91.3	92.3	92.7	93.4	93.4	93.4
15	59	87.8	88.1	88.7	89.2	90.5	91.5	91.9	92.6	92.6	92.6
10	50	87.1	87.3	88.0	88.5	89.8	90.7	91.1	91.8	91.8	91.8
5	41	86.3	86.6	87.2	87.7	89.0	89.9	90.3	91.0	91.0	91.0
0	32	85.5	85.8	86.4	86.9	88.2	89.1	89.5	90.2	90.2	90.2
-10	14	83.9	84.2	84.8	85.3	86.5	87.4	87.8	88.5	88.5	88.5
-20	-4	82.3	82.6	83.2	83.6	84.9	85.7	86.2	86.8	86.8	86.8
-30	-22	80.7	80.9	81.5	82.0	83.2	84.0	84.4	85.1	85.1	85.1
-40	-40	79.0	79.2	79.8	80.3	81.4	82.3	82.7	83.3	83.3	83.3
-50	-58	77.3	77.5	78.1	78.5	79.7	80.5	80.9	81.5	81.5	81.5

Based on engine bleed to packs off and anti-ice on or off

AIRPORT OAT		AIRPORT PRESSURE ALTITUDE (FT)									
°C	°F	-1000	0	1000	2000	3000	4000	5000	6000	7000	8000
55	131	89.4	89.9	90.1	90.1						
50	122	89.9	90.4	91.0	91.5	92.2	92.4				
45	113	90.5	90.8	91.3	91.8	92.9	93.8	93.7	93.3		
40	104	91.0	91.2	91.7	92.1	93.3	94.1	94.1	94.3	93.8	93.2
35	95	91.2	91.4	92.1	92.5	93.7	94.3	94.4	94.6	94.2	93.8
30	86	91.0	91.3	91.8	92.2	93.8	94.6	94.7	94.9	94.5	94.1
25	77	90.2	90.5	91.2	91.7	93.0	94.0	94.4	95.1	94.8	94.3
20	68	89.5	89.7	90.4	90.9	92.2	93.2	93.6	94.3	94.3	94.3
15	59	88.7	89.0	89.6	90.1	91.4	92.4	92.8	93.5	93.5	93.5
10	50	88.0	88.2	88.9	89.3	90.6	91.6	92.0	92.7	92.7	92.7
5	41	87.2	87.4	88.1	88.6	89.9	90.8	91.2	91.9	91.9	91.9
0	32	86.4	86.6	87.3	87.8	89.0	89.9	90.4	91.0	91.0	91.0
-10	14	84.8	85.0	85.7	86.1	87.4	88.3	88.7	89.4	89.4	89.4
-20	-4	83.2	83.4	84.0	84.5	85.7	86.6	87.0	87.6	87.6	87.6
-30	-22	81.5	81.7	82.3	82.8	84.0	84.8	85.3	85.9	85.9	85.9
-40	-40	79.8	80.0	80.6	81.1	82.3	83.1	83.5	84.1	84.1	84.1
-50	-58	78.1	78.3	78.9	79.3	80.5	81.3	81.7	82.3	82.3	82.3

Performance Inflight**Gear Down****Chapter PI****Section 35****GEAR DOWN****220 KIAS Cruise Altitude Capability****Max Cruise Thrust, 100 ft/min residual rate of climb**

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)		
	ISA + 10°C & BELOW	ISA + 15°C	ISA + 20°C
64	20500	19200	17700
62	22200	20900	19600
60	23000	21700	20400
58	23800	22600	21200
56	24600	23400	22000
54	25400	24100	22800
52	26100	24900	23600
50	26700	25500	24300
48	27300	26200	24900
46	27900	26700	25500
44	28400	27300	26100
42	29000	27900	26700
40	29500	28400	27200
38	30000	28900	27700
36	30400	29300	28100

Based on 230 KIAS for weights above 62823 kg.

GEAR DOWN**220 KIAS Cruise Control**

WEIGHT (1000 KG)		PRESSURE ALTITUDE (1000 FT)									
		10	12	14	16	18	20	22	24	26	28
64	%N1	79.7	81.3	82.8	84.4	86.1	87.9				
	MACH	.417	.432	.449	.467	.485	.505				
	KIAS	230	230	230	230	230	230				
	FF/ENG	1890	1886	1884	1884	1887	1893				
60	%N1	77.6	79.2	80.8	82.4	84.0	85.8	87.6	89.7		
	MACH	.399	.414	.430	.447	.465	.483	.503	.524		
	KIAS	220	220	220	220	220	220	220	220		
	FF/ENG	1749	1742	1739	1737	1737	1740	1746	1760		
56	%N1	76.5	78.1	79.7	81.3	82.9	84.5	86.3	88.2		
	MACH	.399	.414	.430	.447	.465	.483	.503	.524		
	KIAS	220	220	220	220	220	220	220	220		
	FF/ENG	1683	1675	1669	1666	1664	1664	1666	1676		
52	%N1	75.5	77.1	78.7	80.3	81.9	83.5	85.1	86.9	89.0	
	MACH	.399	.414	.430	.447	.465	.483	.503	.524	.545	
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1625	1615	1608	1603	1600	1598	1598	1604	1613	
48	%N1	74.6	76.2	77.8	79.4	80.9	82.5	84.2	85.9	87.8	90.1
	MACH	.399	.414	.430	.447	.465	.483	.503	.524	.545	.568
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1573	1563	1555	1549	1545	1542	1541	1545	1551	1564
44	%N1	73.7	75.3	76.9	78.5	80.1	81.7	83.3	84.9	86.8	88.9
	MACH	.399	.414	.430	.447	.465	.483	.503	.524	.545	.568
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1526	1515	1507	1501	1497	1494	1491	1494	1498	1507
40	%N1	72.8	74.5	76.1	77.7	79.4	80.9	82.5	84.1	85.9	87.9
	MACH	.399	.414	.430	.447	.465	.483	.503	.524	.545	.568
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1485	1474	1465	1458	1454	1450	1448	1450	1452	1457
36	%N1	72.1	73.8	75.4	77.0	78.7	80.3	81.8	83.4	85.1	87.0
	MACH	.399	.414	.430	.447	.465	.483	.503	.524	.545	.568
	KIAS	220	220	220	220	220	220	220	220	220	
	FF/ENG	1450	1439	1430	1423	1418	1414	1411	1411	1412	1417

Based on 230 KIAS for weights above 62823 kg.

GEAR DOWN**220 KIAS Enroute Fuel and Time****Ground to Air Miles Conversion**

AIR DISTANCE (NM)					GROUND DISTANCE (NM)	AIR DISTANCE (NM)				
HEADWIND COMPONENT (KTS)					GROUND DISTANCE (NM)	TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
333	295	263	238	218	200	189	180	171	162	155
676	598	531	479	437	400	378	357	339	323	308
1019	900	798	719	655	600	567	536	509	484	462
1362	1202	1066	960	874	800	755	714	677	644	615
1705	1505	1334	1201	1093	1000	943	892	845	804	768
2048	1807	1601	1441	1312	1200	1132	1071	1015	965	921
2391	2109	1869	1682	1531	1400	1321	1248	1183	1125	1074
2734	2412	2137	1923	1750	1600	1510	1427	1353	1286	1228
3077	2714	2404	2163	1969	1800	1698	1605	1521	1447	1381

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	2.2	0:49	2.0	0:46	1.9	0:44	1.7	0:42	1.6	0:40
400	4.6	1:36	4.2	1:31	3.9	1:26	3.6	1:21	3.4	1:17
600	6.9	2:23	6.4	2:15	6.0	2:08	5.5	2:00	5.2	1:54
800	9.2	3:10	8.6	3:00	8.0	2:49	7.4	2:40	7.0	2:30
1000	11.5	3:57	10.7	3:44	9.9	3:31	9.3	3:19	8.7	3:07
1200	13.8	4:45	12.8	4:28	11.9	4:13	11.1	3:58	10.4	3:44
1400	16.0	5:32	14.8	5:13	13.8	4:54	12.9	4:37	12.2	4:20
1600	18.2	6:19	16.9	5:57	15.8	5:36	14.7	5:16	13.8	4:57
1800	20.4	7:06	18.9	6:41	17.7	6:18	16.5	5:55	15.5	5:34

Fuel Required Adjustments (1000 KG)

REFERENCE FUEL REQUIRED (1000 KG)	WEIGHT AT CHECK POINT (1000 KG)				
	30	40	45	50	60
5	-0.4	-0.1	0.0	0.2	0.7
10	-0.6	-0.3	0.0	0.4	1.4
15	-0.9	-0.4	0.0	0.5	1.8
20	-1.0	-0.4	0.0	0.6	2.2
25	-1.0	-0.5	0.0	0.7	2.4

Based on 220 KIAS cruise and descent.

Descent at 220 KIAS

PRESSURE ALT (1000 FT)	5	10	15	17	19	21	23	25	27	29	31	33
DISTANCE (NM)	17	26	35	39	42	46	50	53	57	61	64	68
TIME (MINUTES)	6	8	10	11	12	13	13	14	15	15	16	17

GEAR DOWN**Holding
Flaps Up**

WEIGHT (1000 KG)	PRESSURE ALTITUDE (FT)						
	1500	5000	10000	15000	20000	25000	30000
64	%N1	72.9	75.7	79.7	83.6	87.9	
	KIAS	230	230	230	230	230	
	FF/ENG	2020	2000	1980	1980	1990	
62	%N1	71.3	74.1	78.2	82.2	86.4	
	KIAS	220	220	220	220	220	
	FF/ENG	1910	1890	1870	1860	1870	
60	%N1	70.8	73.6	77.6	81.6	85.8	
	KIAS	220	220	220	220	220	
	FF/ENG	1880	1860	1840	1820	1830	
58	%N1	70.3	73.0	77.1	81.0	85.1	
	KIAS	220	220	220	220	220	
	FF/ENG	1850	1820	1800	1790	1790	
56	%N1	69.8	72.5	76.5	80.5	84.5	89.3
	KIAS	220	220	220	220	220	220
	FF/ENG	1810	1790	1770	1750	1750	1770
54	%N1	69.3	72.0	76.0	80.0	84.0	88.6
	KIAS	220	220	220	220	220	220
	FF/ENG	1780	1760	1740	1720	1710	1730
52	%N1	67.5	70.2	74.2	78.3	82.3	86.7
	KIAS	210	210	210	210	210	210
	FF/ENG	1680	1650	1630	1610	1600	1600
50	%N1	67.0	69.7	73.7	77.7	81.7	86.0
	KIAS	210	210	210	210	210	210
	FF/ENG	1650	1620	1600	1570	1560	1560
48	%N1	66.5	69.1	73.1	77.2	81.1	85.3
	KIAS	210	210	210	210	210	210
	FF/ENG	1620	1590	1570	1540	1530	1530
46	%N1	66.0	68.6	72.6	76.6	80.6	84.7
	KIAS	210	210	210	210	210	210
	FF/ENG	1590	1560	1540	1510	1500	1530
44	%N1	65.5	68.1	72.0	76.1	80.1	84.2
	KIAS	210	210	210	210	210	210
	FF/ENG	1560	1540	1510	1490	1470	1490
42	%N1	65.0	67.6	71.5	75.6	79.7	83.7
	KIAS	210	210	210	210	210	210
	FF/ENG	1540	1510	1490	1460	1450	1460
40	%N1	64.6	67.2	71.1	75.1	79.2	83.2
	KIAS	210	210	210	210	210	210
	FF/ENG	1520	1490	1470	1440	1420	1430
38	%N1	64.2	66.7	70.6	74.7	78.8	82.8
	KIAS	210	210	210	210	210	210
	FF/ENG	1500	1470	1440	1410	1400	1400
36	%N1	63.8	66.3	70.2	74.3	78.4	82.4
	KIAS	210	210	210	210	210	210
	FF/ENG	1480	1450	1420	1390	1380	1380

This table includes 5% additional fuel for holding in a racetrack pattern.

Based on 230 KIAS for weights above 62823 kg.

Performance Inflight

Text

Chapter PI**Section 36**

Introduction

This chapter contains information to supplement performance data from the Flight Management Computer (FMC). In addition, sufficient inflight data is provided to complete a flight with the FMC inoperative. In the event of conflict between data presented in this chapter and that contained in the Approved Flight Manual, the Flight Manual shall always take precedence.

General**Takeoff Speeds**

The speeds presented in the Takeoff Speeds table, as well as FMC computed takeoff speeds, can be used for all performance conditions provided adjustments are made to V1 for clearway, stopway, brake deactivation, improved climb, contaminated runway situations, brake energy limits or obstacle clearance with unbalanced V1. These speeds may be used for weights less than or equal to the performance limited weight.

Normal takeoff speeds, V1, VR, and V2, with anti-skid on, are read from the table by entering with takeoff flap setting, brake release weight, and appropriate column. The appropriate column is obtained by entering the Column Reference chart with the airport pressure altitude and the actual temperature. If an Altitude Adjustment chart is provided, adjust the takeoff speeds appropriately. Slope and wind adjustments to V1 are obtained by entering the Slope and Wind V1 Adjustment table.

V1(MCG), Minimum VR

Regulations prohibit scheduling takeoff with a V1 less than minimum V1 for control on the ground, V1(MCG) and VR less than minimum VR, (1.05) VMCA. Therefore compare the adjusted V1 and VR to the V1(MCG) and Minimum VR respectively. To find V1(MCG) and Minimum VR, enter the V1(MCG), Minimum VR table with the airport pressure altitude and actual OAT. If applicable, add the adjustments shown below the table. If the adjusted V1 is less than V1(MCG), set V1 equal to V1(MCG). If the adjusted VR is less than Minimum VR, set VR equal to Minimum VR. If VR is less than V1(MCG), set VR equal to V1(MCG). If VR is limited by either V1(MCG) or Minimum VR, determine a new V2 by adding the difference between the normal VR and the higher of V1(MCG) and Min VR to the normal V2.

If it is necessary to increase V1 to V1(MCG), then provided the actual field length exceeds the minimum field length of 3900 ft no takeoff weight adjustment is necessary.

Clearway and Stopway V1 Adjustments

Takeoff speed corrections are to be applied to V1 speed when using takeoff weights based on the use of clearway and stopway.

Adjust V1 speed by the amount shown in the appropriate column. The adjusted V1 speed must not exceed VR. If the adjusted V1 speed is greater than VR, reduce V1 to equal VR.

Maximum allowable clearway limits are provided for guidance when more precise data is not available.

Assumed Temperature Takeoff

For reduced thrust takeoffs based on assumed temperature, determine V1, VR, V2 from the appropriate column for airport pressure altitude and assumed temperature. Adjust V1 for slope, wind, clearway and stopway as required. Compare adjusted V1 with V1(MCG) from table using airport altitude and actual temperature. This is a regulatory requirement to cover the case where the pilot elects to advance thrust levers to maximum takeoff thrust following the engine failure. If adjusted V1 is less than V1(MCG) set V1 equal to V1(MCG).

Stab Trim

To find takeoff stabilizer trim setting, enter the Stab Trim Setting table with takeoff flap setting and center of gravity (C.G. % MAC) and read required stabilizer trim units. For weights that meet the conditions listed, apply the adjustments shown below the table.

VREF

The Reference Speed table contains flaps 40, 30, and 15 landing speeds for a given weight. Apply wind correction shown as required.

Recommended Maneuvering Speeds

This table provides the flap speed schedule for recommended maneuvering speed. The speed schedule is a function of weight and will provide adequate maneuver margin above stall at all weights.

During flap retraction/extension, movement of the flap to the next position should be initiated when reaching the maneuver speed for the existing flap.

Slush/Standing Water Takeoff

Experience has shown that aircraft performance may deteriorate significantly on runways covered with snow, slush, standing water, or ice. Therefore a reduction in field length/obstacle limited takeoff weight and revised takeoff speeds is necessary. The information provided is intended for guidance in accordance with advisory material. The performance is based on an engine failure at the critical point during takeoff and a 15 ft. screen height at the end of the runway. Tables are provided for dispatch with all thrust reversers operative and dispatch with one or two thrust reversers inoperative.

The entire runway is assumed to be completely covered by a contaminant of uniform thickness and density. Therefore this information is conservative when operating under typical colder weather conditions where patches of slush exist and some degree of sanding is common.

Takeoffs in slush depths greater than 0.5 inches (13mm) are not recommended because of possible airplane damage as a result of slush impingement on the airplane structure. The use of assumed temperature method for reduced thrust is not allowed on contaminated runways. Interpolation for slush/standing water depths between the values shown is permitted.

Instructions for Using Tables:

Takeoff weight is determined as follows:

1. Determine the dry field length and obstacle limit weight for the takeoff flap setting.
2. Enter the Weight Adjustment table with the more limiting of the dry field length or obstacle limit weights, to obtain the weight reduction for the slush/standing water depth and airport pressure altitude.
3. When indicated, adjust field length available for temperature by the amount provided in the notes below the V1(MCG) limit weight table.
4. Enter V1(MCG) Limit Weight table 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.

The maximum allowable takeoff weight in slush/standing water is the lesser of the limit weights found in steps 2 and 4.

Takeoff speeds determination:

1. Determine takeoff speeds V1, VR and V2 for actual brake release weight using the Takeoff Speeds table in this section.

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2. If V1(MCG) limited, set V1 = V1(MCG). If not limited by V1(MCG) considerations, enter V1 Adjustment table with actual brake release weight to determine the V1 reduction to apply to V1 speed. If the adjusted V1 is less than V1(MCG), set V1 = V1(MCG).

Slippery Runway

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 used to calculate the "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate the "poor" data reflects a runway covered with wet ice. Performance is based on an engine failure at the critical point during takeoff and a 15 ft. screen height at the end of the runway. Tables are provided for dispatch with all thrust reversers operative and dispatch with one or two thrust reversers inoperative, and are used in the same manner as the Slush/Standing Water Takeoff tables.

Anti-skid Inoperative

When operating with anti-skid inoperative, the field limit weight and V1 must be reduced to account for the effect on accelerate-stop performance. A simplified method which conservatively accounts for the effects of anti-skid inoperative on a dry runway is to reduce the normal field length/obstacle limited weight by 7500 kg and the V1 associated with the reduced weight by the amount shown in the table below.

ANTI-SKID INOPERATIVE V1 ADJUSTMENT	
FIELD LENGTH (FT)	V1 ADJUSTMENT (KIAS)
6000	-31
8000	-24
10000	-19
12000	-15
14000	-12

If the resulting V1 is less than minimum V1, takeoff is permitted with V1 set equal to V1(MCG) provided the dry accelerate stop distance adjusted for wind and slope exceeds approximately 7900 ft.

Detailed analysis for the specific case from the Airplane Flight Manual may yield a less restrictive penalty.

Takeoff %N1

To find Max Takeoff %N1 based on normal engine bleed for air conditioning packs on (Auto), enter Takeoff %N1 Table with airport pressure altitude and airport OAT and read %N1. For packs off operation, apply the %N1 adjustment shown below the table. No takeoff %N1 adjustment is required for engine and wing anti-ice.

Assumed Temperature Reduced Thrust

Regulations permit the use of up to 25% takeoff thrust reduction for operation with assumed temperature reduced thrust. To find the maximum allowable assumed temperature enter the top chart with airport pressure altitude and OAT. Compare this temperature to that at which the airplane is performance limited as determined from available takeoff performance data. Next, enter the center table with airport pressure altitude and the lower of the two temperatures previously determined to obtain a maximum takeoff %N1. Do not use an assumed temperature less than the minimum assumed temperature shown. Enter the %N1 Adjustment table with OAT and the difference between the assumed and actual OAT to obtain a %N1 adjustment. Subtract the %N1 adjustment from the maximum takeoff %N1 found previously to determine the assumed temperature reduced thrust %N1.

Takeoff with assumed temperature reduced thrust is not permitted when: runway is contaminated with ice, slush, snow, or standing water; anti-skid is inoperative; or PMC is off. Use of this procedure is not recommended if potential windshear conditions exist.

Max Climb %N1

This table shows Max Climb %N1 for a 250 KIAS/280 KIAS/.74M climb speed schedule, normal engine bleed for packs on (Auto) and anti-ice off. Enter the table with airport pressure altitude and TAT and read %N1. Apply the appropriate bleed setting %N1 adjustment shown below the table. %N1 adjustments are shown for engine bleed to packs off operation, packs high operation, and wing anti-ice on.

Go-around %N1

To find Max Go-around %N1 based on normal engine bleed for packs on (Auto) and anti-ice off, enter the Go-around %N1 table with airport pressure altitude and reported OAT or TAT and read %N1. Apply the appropriate bleed setting %N1 adjustment shown below the table. %N1 adjustments are shown for engine bleed to packs off operation, packs high operation, and wing anti-ice on.

Flight with Unreliable Airspeed / Turbulent Air Penetration

Pitch attitude and average %N1 information is provided for use in all phases of flight in the event of unreliable airspeed/Mach indications resulting from blocking or freezing of the pitot system. Loss of radome or turbulent air may also cause unreliable airspeed/Mach indications. The cruise table in this section may also be used for turbulent air penetration.

Pitch attitude is shown in bold type for emphasis since altitude and/or vertical speed indications may also be unreliable.

All Engines

Long Range Cruise Maximum Operating Altitude

These tables provide the maximum operating altitude in the same manner as the FMC. Maximum altitudes are shown for a given cruise weight and maneuver capability. This table considers both thrust and buffet limits, providing the more limiting of the two. Any data that is thrust limited is denoted by an asterisk and represents only a thrust limited condition in level flight with 100 ft/min residual rate of climb. Flying above these altitudes with sustained banks in excess of approximately 15° may cause the airplane to lose speed and/or altitude.

Note that the altitudes shown in the table are limited to the maximum certified altitude of 37000 ft.

Long Range Cruise Control

These tables provide target %N1, 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 .74M 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 .74M/250 KIAS descent. Tables are presented for low altitudes and high altitudes.

To determine remaining fuel and time required, first enter the Ground to Air Miles Conversion table to convert ground distance and enroute wind to an equivalent still air distance for use with the Reference Fuel and Time

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tables. Next, enter the Reference Fuel and Time Table with air distance from the Ground to Air Miles Conversion Table and the desired altitude and read Reference Fuel and Time Required. Lastly, enter the Fuel Required Adjustment Table with the Reference Fuel and the actual weight at checkpoint to obtain fuel required to destination.

Long Range Cruise Wind-Altitude Trade

Wind is a factor which may justify operations considerably below optimum altitude. For example, a favorable wind component may have an effect on ground speed which more than compensates for the loss in air range.

Using this table, it is possible to determine the break-even wind (advantage necessary or disadvantage that can be tolerated) to maintain the same range at another altitude and long range cruise speed. The tables make no allowance for climb or descent time, fuel or distance, and are based on comparing ground fuel mileage.

Descent

Distance and time for descent are shown for a .74M/250 KIAS descent speed schedule. Enter the table with top of descent pressure altitude and read distance in nautical miles and time in minutes. Data is based on flight idle thrust descent in zero wind. Allowances are included for a straight-in approach with gear down and landing flaps at the outer marker.

Holding

Target %N1, indicated airspeed and fuel flow per engine information is tabulated for holding with flaps up based on the FMC optimum holding speed schedule. This is the higher of the maximum endurance speed and the maneuvering speed. Small variations in airspeed will not appreciably affect the overall endurance time. Enter the table with weight and pressure altitude to read %N1, IAS and fuel flow per engine.

Advisory Information

Normal Configuration Landing Distance

Tables are provided as advisory information for normal configuration landing distance on dry runways and slippery runways with good, medium, and poor reported braking action. These values are actual landing distances and do not include the 1.67 regulatory factor. Therefore, they cannot be used to determine the dispatch required landing field length.

To use these tables, enter the appropriate table for selected landing flaps and determine the reference landing distance for the selected braking configuration. Then read across the table to adjust the reference distance

for landing weight, altitude, wind, slope, temperature, approach speed, and the number of operative thrust reversers, using the values provided, to obtain the actual landing distance.

When landing on slippery runways or runways contaminated with ice, snow, slush, or standing water, the reported braking action must be considered. If the surface is affected by water, snow, or ice and the braking action is reported as "good", conditions should not be expected to be as good as on clean, dry runways. The value "good" is comparative and is intended to mean that airplanes should not experience braking or directional control difficulties when landing. The performance level used to calculate the "good" data is consistent with wet runway testing done on early Boeing jets. The performance level used to calculate "poor" data reflects runways covered with wet ice.

Use of the autobrake system commands the airplane to a constant deceleration rate. In some conditions, such as a runway with "poor" braking action, the airplane may not be able to achieve these deceleration rates. In these cases, runway slope and inoperative reversers influence the stopping distance. Since it cannot be easily determined when this becomes a factor, it is conservative to add the effects of slope and inoperative reversers when using the autobrake system.

Non-Normal Configuration Landing Distance

Advisory information is provided to support non-normal configurations that affect landing performance of the airplane. Landing distances are shown for dry runway and good, medium, and poor reported braking action. Each non-normal configuration is listed with its recommended approach speed. Landing distance can be determined for the reference landing weight and then adjusted for actual weight and pressure altitude.

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 quick turnaround limit weight. Application of the recommended cooling procedures shown will avoid brake overheat and fuse plug problems that could result from repeated landings at short time intervals or a rejected takeoff.

Engine Inoperative

Initial Max Continuous %N1

The Initial Max Continuous %N1 setting for use following an engine failure is shown. The table is based on the typical all engine cruise speed of .74M 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

Power setting is based on one engine operating with one A/C pack operating and all anti-ice bleeds off. Enter the table with pressure altitude and IAS or Mach to read %N1.

It is desirable to maintain engine thrust within the limits of the Max Cruise thrust rating. However, where thrust 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/LRC Cruise Range Capability

This table shows the range capability from the start of driftdown. Driftdown is continued to level off altitude. As weight decreases due to fuel burn, the airplane is accelerated to Long Range Cruise speed. Cruise is continued at level off altitude and Long Range Cruise speed.

To determine fuel required, enter the Ground to Air Miles Conversion table with the desired ground distance and correct for anticipated winds to obtain air distance to destination. Then enter the Driftdown/Cruise Fuel and Time table with air distance and weight at start of driftdown to determine fuel and time required. 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 Enroute 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 Long Range Cruise speed, Max Continuous thrust, and 100 ft/min residual rate of climb.

Long Range Cruise Control

The table provides target %N1, 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. To conservatively account for APU fuel burn, add 90 kg/hr to fuel flow values.

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 (KG/HR)
37	35
35	35
31	45
25	60
20	75
15	90
10	115
5	140

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 .74M/250 KIAS descent. Enter with Air Distance as determined from the Ground to Air Miles Conversion Table and read Fuel and Time required at the cruise pressure altitude. Adjust the fuel obtained for deviation from the reference weight at checkpoint as required by entering the off reference fuel corrections table with the fuel required for the reference weight and the actual weight at checkpoint. Read fuel required and time for the actual weight.

Holding

Single engine holding data is provided in the same format as the all engine holding data and is based on the same assumptions.

PMC Off

Introduction

This section contains performance data for airplane operation with the Power Management Control (PMC) OFF (PMC switch - amber INOP light illuminated) for applicable thrust ratings. Do not use assumed temperature reduced thrust with PMC Off.

Takeoff Weight Adjustment

When operating with PMC off, the normal takeoff performance limit weights should be adjusted by the amount shown in the Takeoff Weights Adjustment and Obstacle Limit Weight Adjustment tables. To determine the limit weights for PMC Off operations, enter the Takeoff Weight Adjustments table with the airport pressure altitude and OAT, then apply the adjustments to the normal PMC On limit weights for field length, climb, tire speed, and brake energy. For adjustments to takeoff obstacle limit, enter the Obstacle Limit Weight Adjustments table with the airport pressure altitude and the normal PMC On obstacle limit weight, then read the associated adjustment.

Takeoff Speed Adjustment

When operating with PMC Off, the normal takeoff speeds should be adjusted by the amount shown in the Takeoff Speeds Adjustment table. To determine the PMC Off takeoff speeds, determine the normal PMC On takeoff speeds associated with the actual takeoff weight after any adjustment necessitated by PMC Off operations, then apply the appropriate adjustments to the takeoff speeds, determined by entering the table with the airport pressure altitude and OAT. The adjusted V1 should not exceed the adjusted VR.

NOTE: The FMC does not incorporate PMC OFF performance in its takeoff speeds calculations.

Power Settings

Tables are provided to account for engine bleed effects of normal air conditioning packs operation and for engine bleed to packs off operation.

To find Max Takeoff %N1 with both PMC's Off, enter Max Takeoff %N1 table (PMC Off) for the appropriate bleed configuration with airport pressure altitude and airport OAT and read %N1. No takeoff %N1 correction is required for engine anti-ice operation up to 10°C (50°F) which is the highest temperature recommended for engine anti-ice operation.

For Maximum Climb and Go-Around thrust setting with both PMC's Off,
use PMC On %N1.

Gear Down

This section contains performance for airplane operation with the landing gear extended for all phases of flight. The data is based on engine bleeds for normal air conditioning.

Note: The Flight Management Computer System (FMCS) does not contain special provisions for operation with landing gear extended. As a result, the FMCS will generate inappropriate 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 (ETA) is available if current speed or Mach is entered into the VNAV cruise page.

Tables for gear down performance in this section are identical in format and used in the same manner as tables for the gear up configuration previously described.

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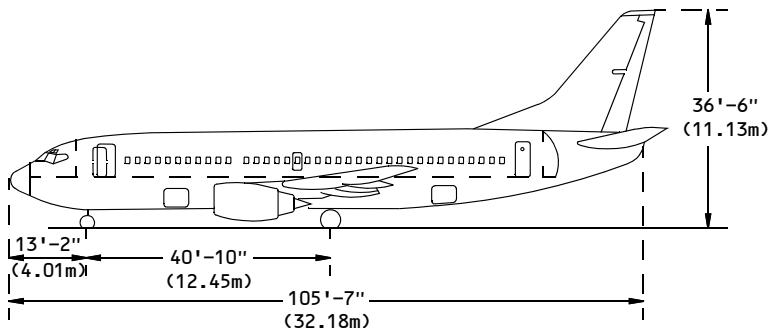
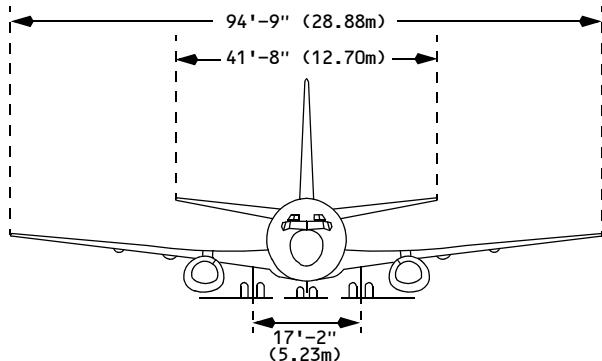
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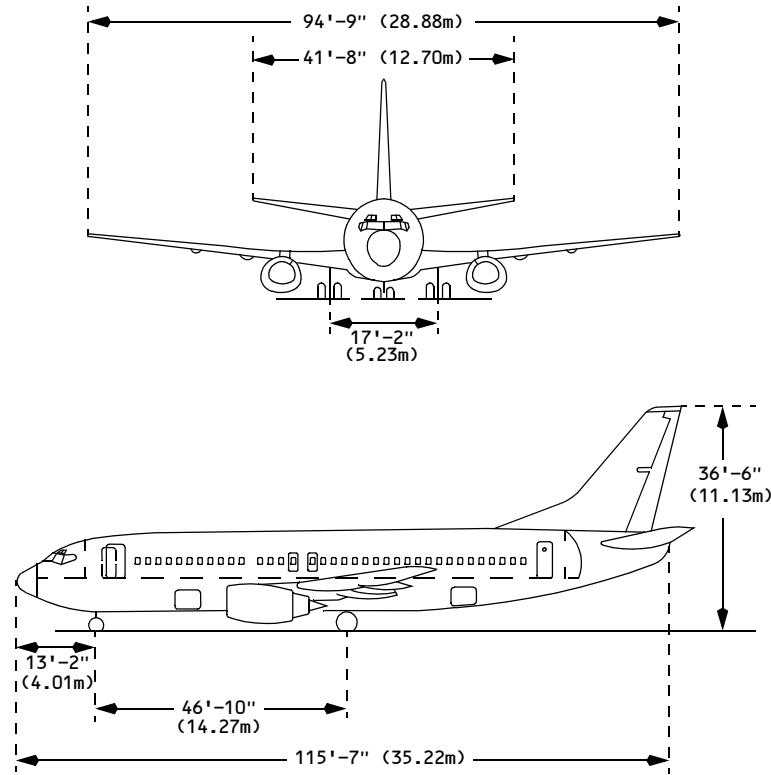
Airplane General, Emergency Equipment, Doors, Windows Dimensions

Chapter 1 Section 10

Principal Dimensions

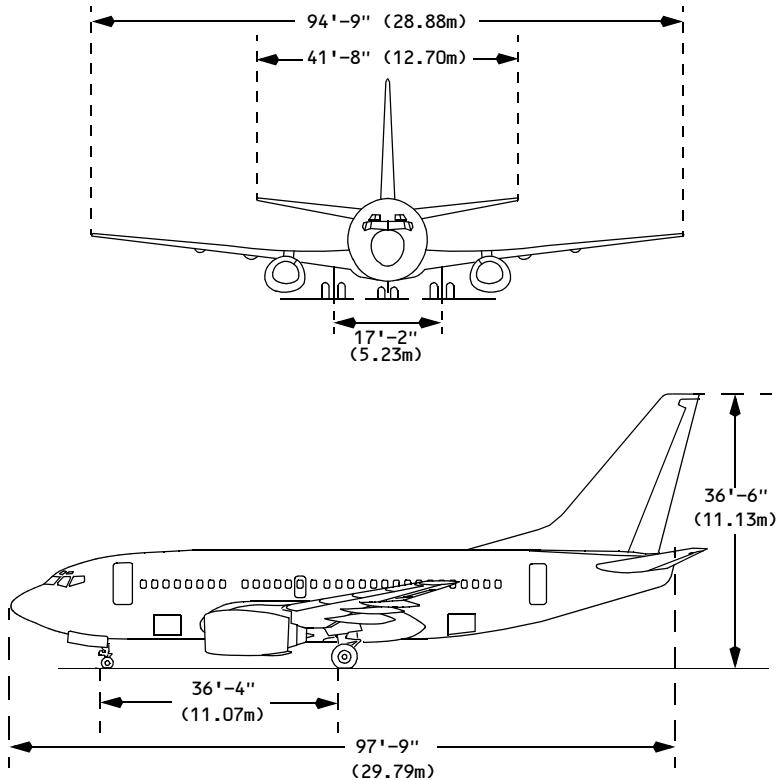


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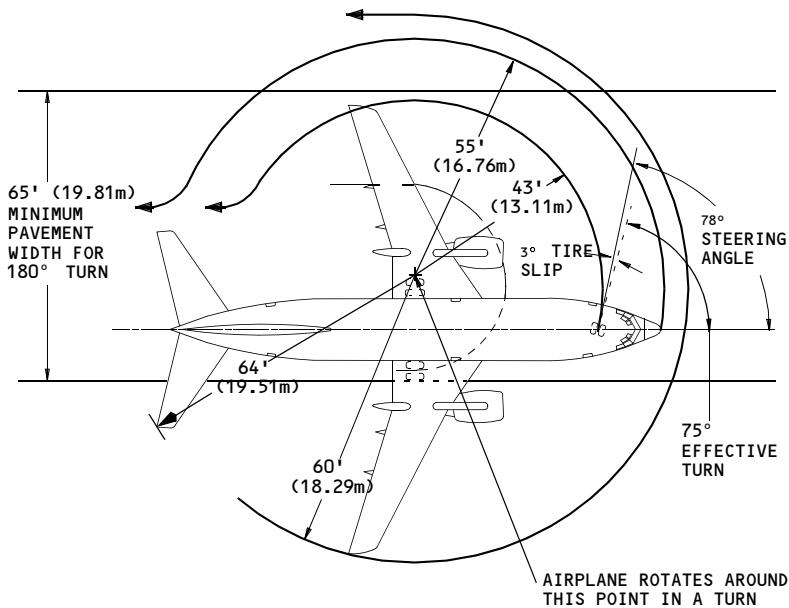
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Turning Radius

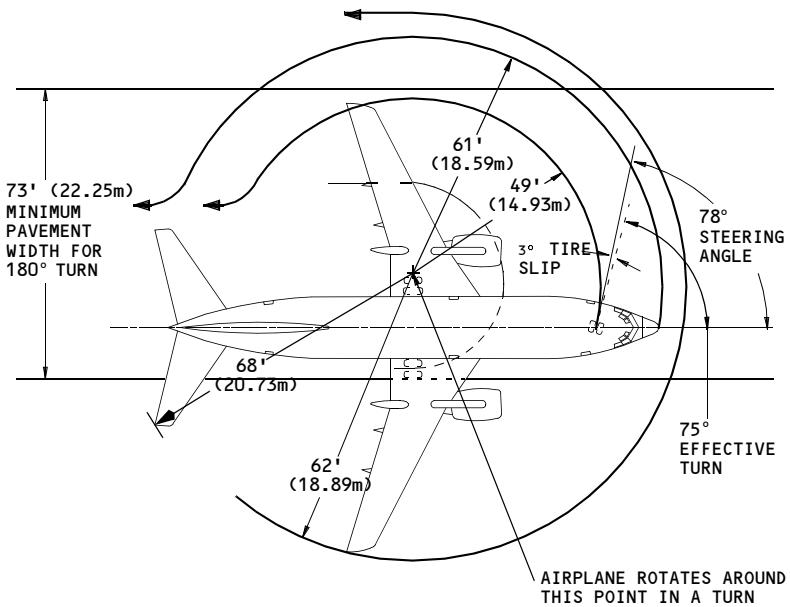
CAUTION: Landing gear geometry and sweep back of 737 airplane wings results in an outward motion of the wing tips and tail during turns.



- NOTE:**
- Turn initiated with airplane in motion.
 - Approximately idle thrust on both engines.
 - No differential braking.

737-300

CAUTION: Landing gear geometry and sweep back of 737 airplane wings results in an outward motion of the wing tips and tail during turns.

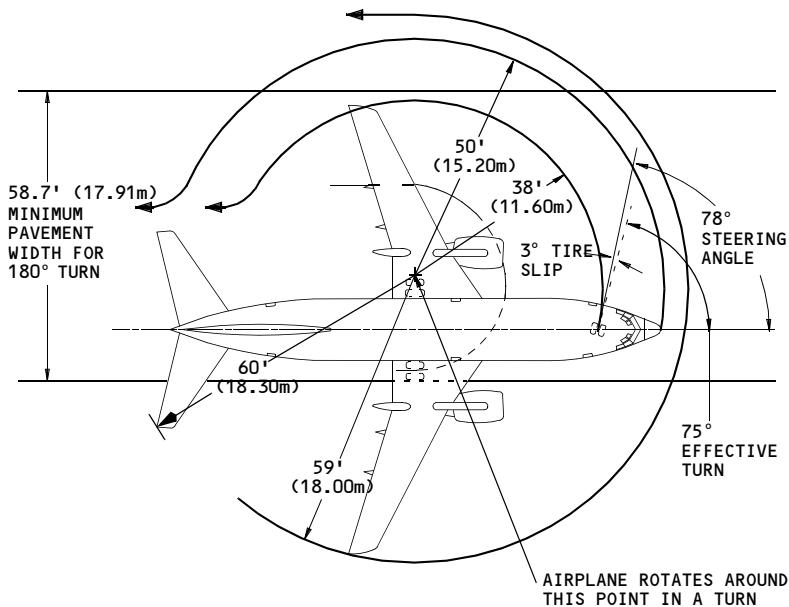


NOTE:

- Turn initiated with airplane in motion.
- Approximately idle thrust on both engines.
- No differential braking.

737-400

CAUTION: Landing gear geometry and sweep back of 737 airplane wings results in an outward motion of the wing tips and tail during turns.



NOTE:

- Turn initiated with airplane in motion.
- Approximately idle thrust on both engines.
- No differential braking.

737-500

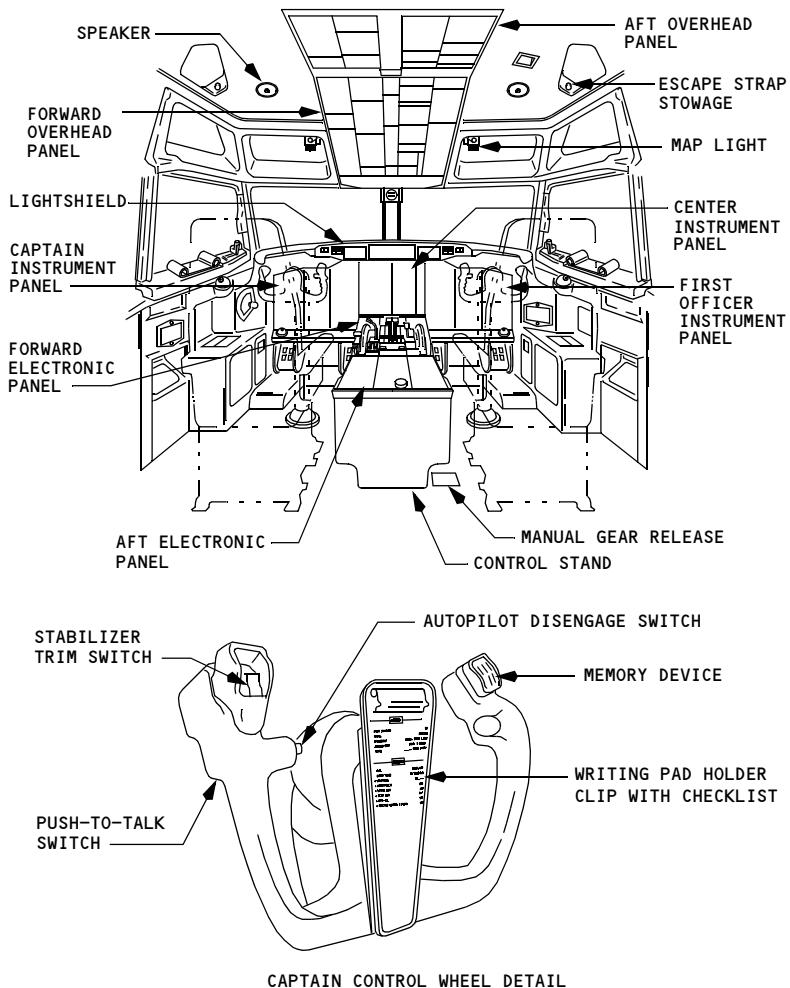
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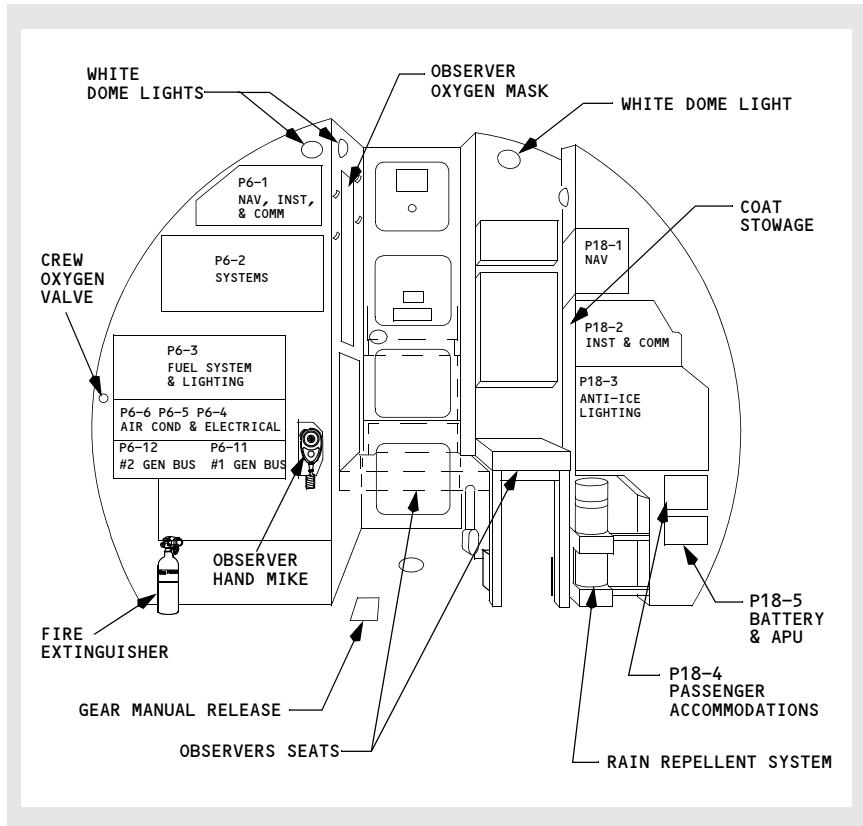
Airplane General, Emergency Equipment, Doors, Windows Instrument Panels

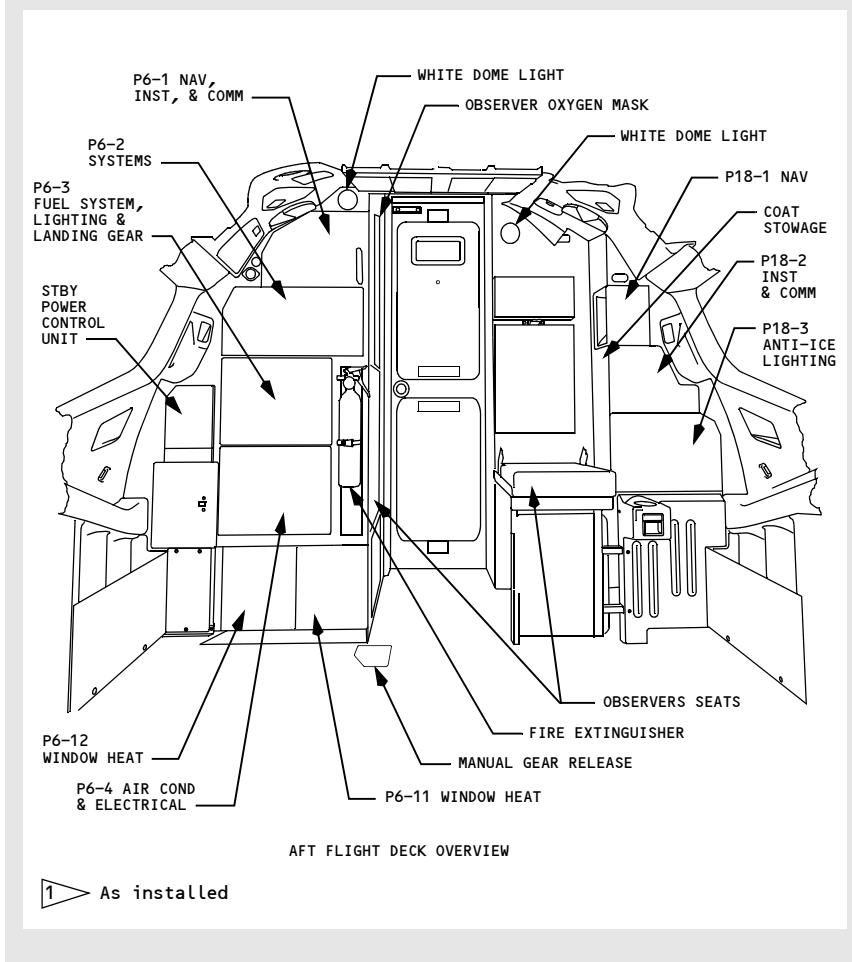
Chapter 1 Section 20

Panel Arrangement



Aft Flight Deck Overview



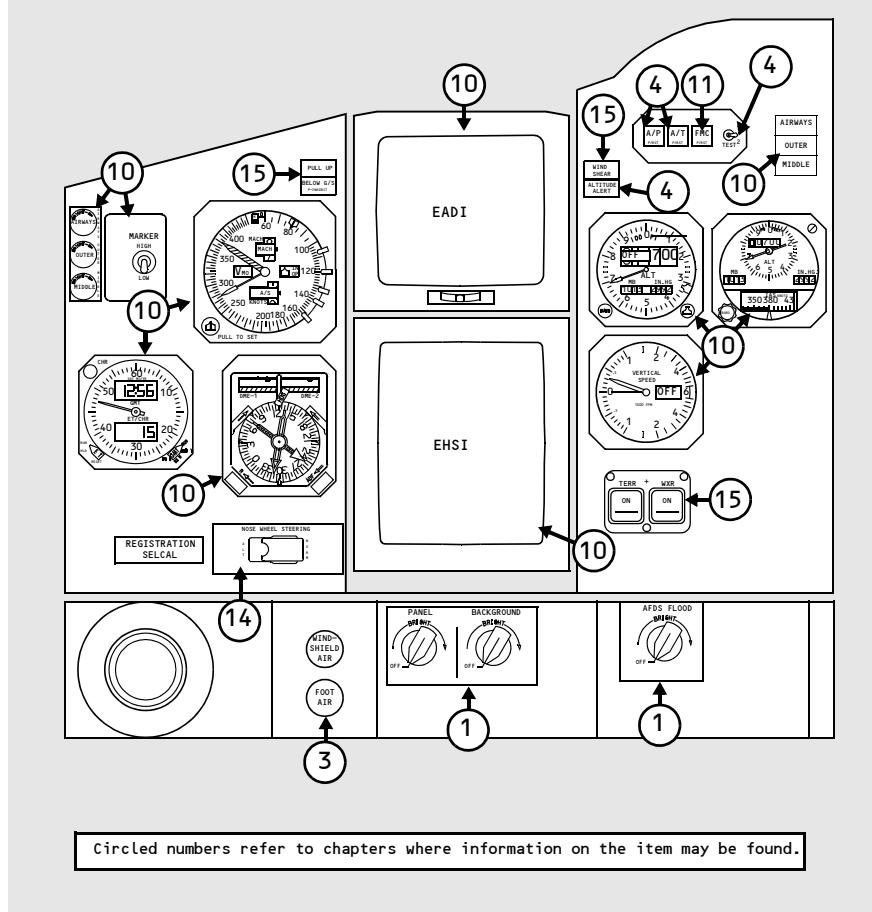


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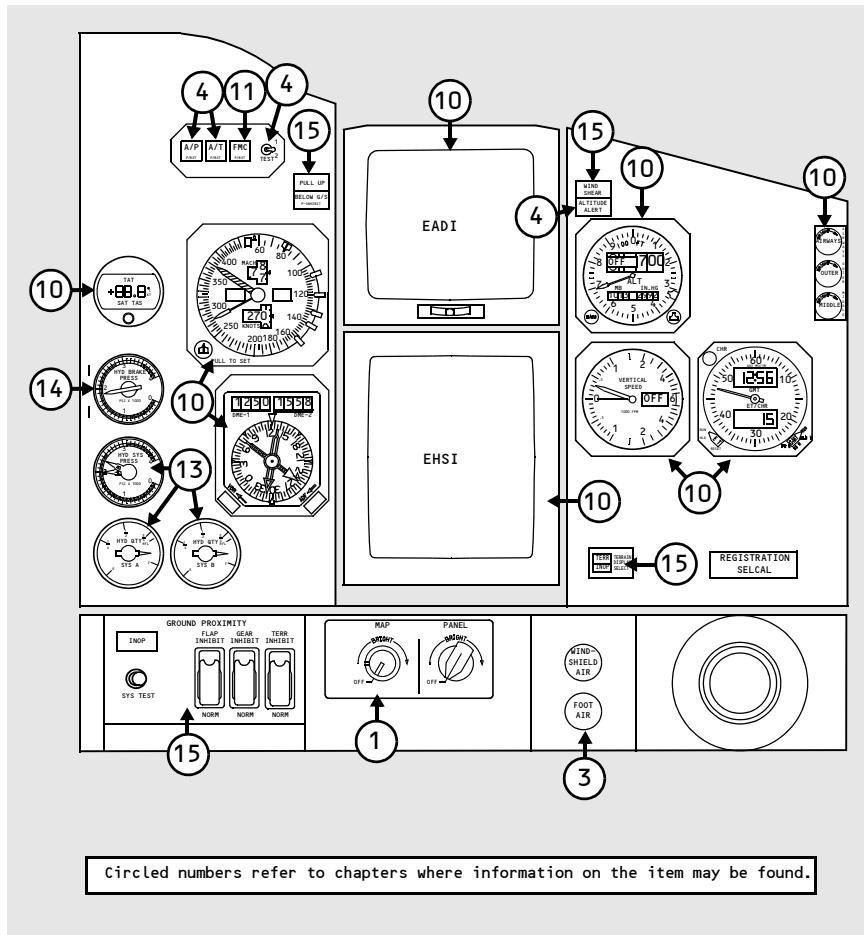
Instrument Panels

Note: The controls, panels and indicators shown in this chapter are representative of installed units and may not exactly reflect the details of the latest configuration. Refer to the corresponding chapter under system descriptions for current chapter information.

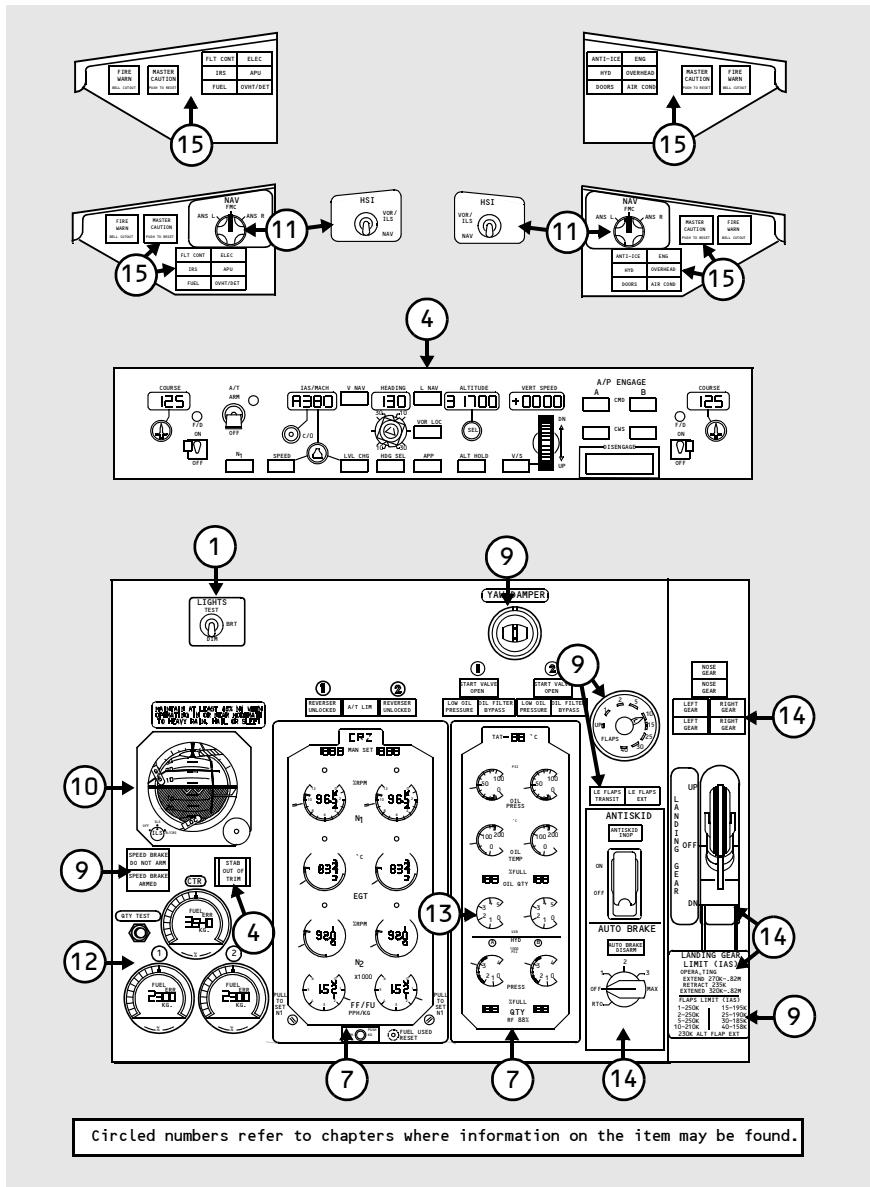
Captain's Instrument Panel



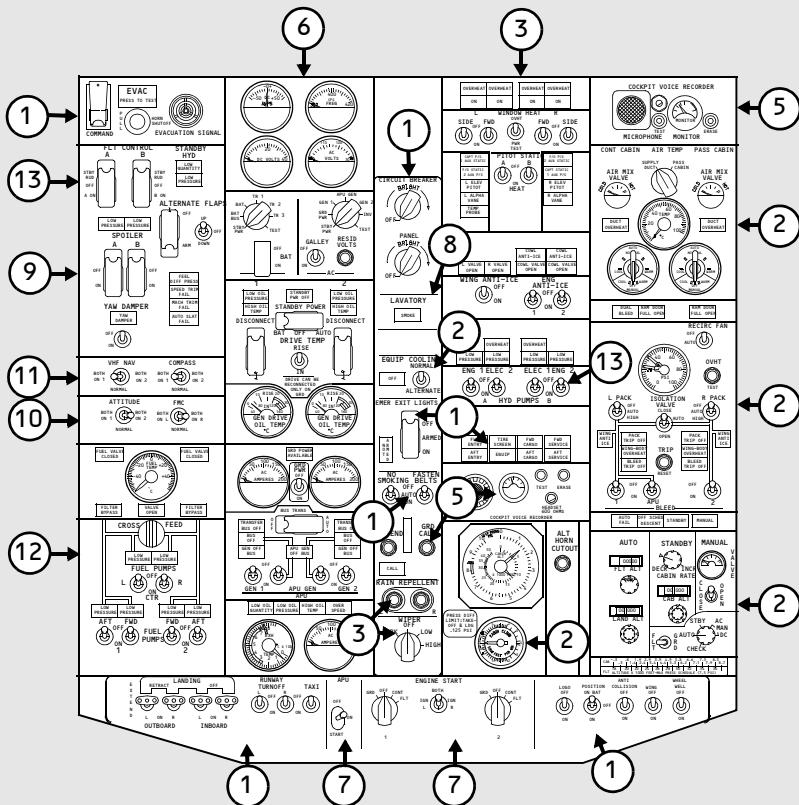
First Officer's Instrument Panel



Center Instrument Panel and Lightshield

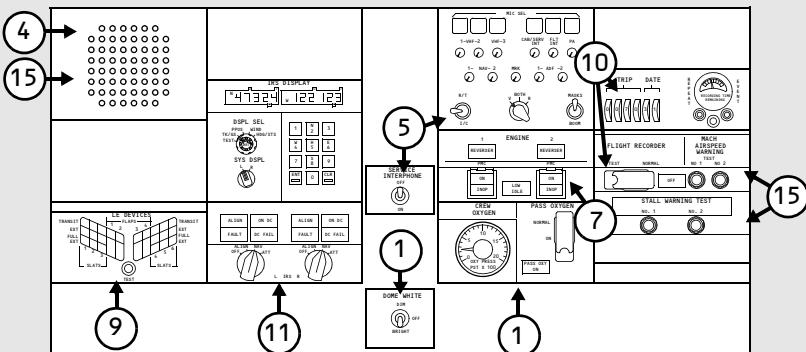


Forward Overhead Panel



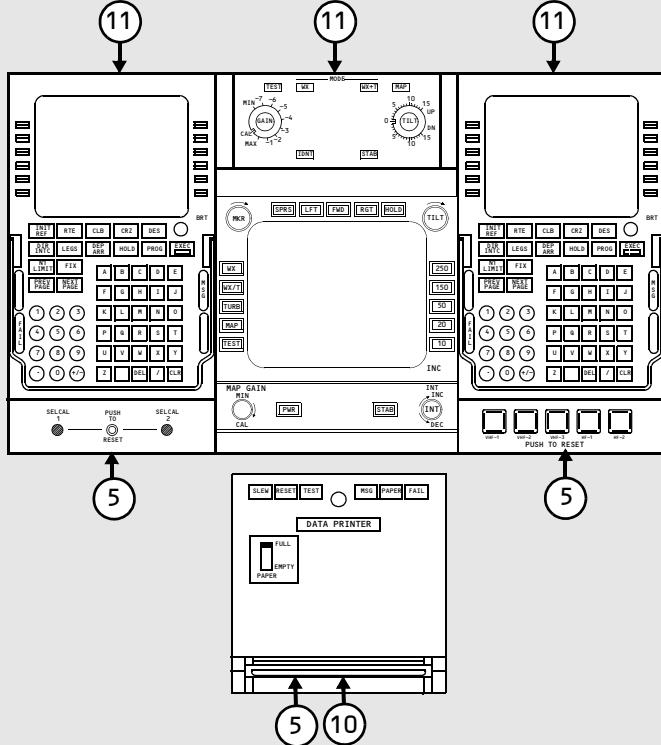
Circled numbers refer to chapters where information on the item may be found.

Aft Overhead Panel



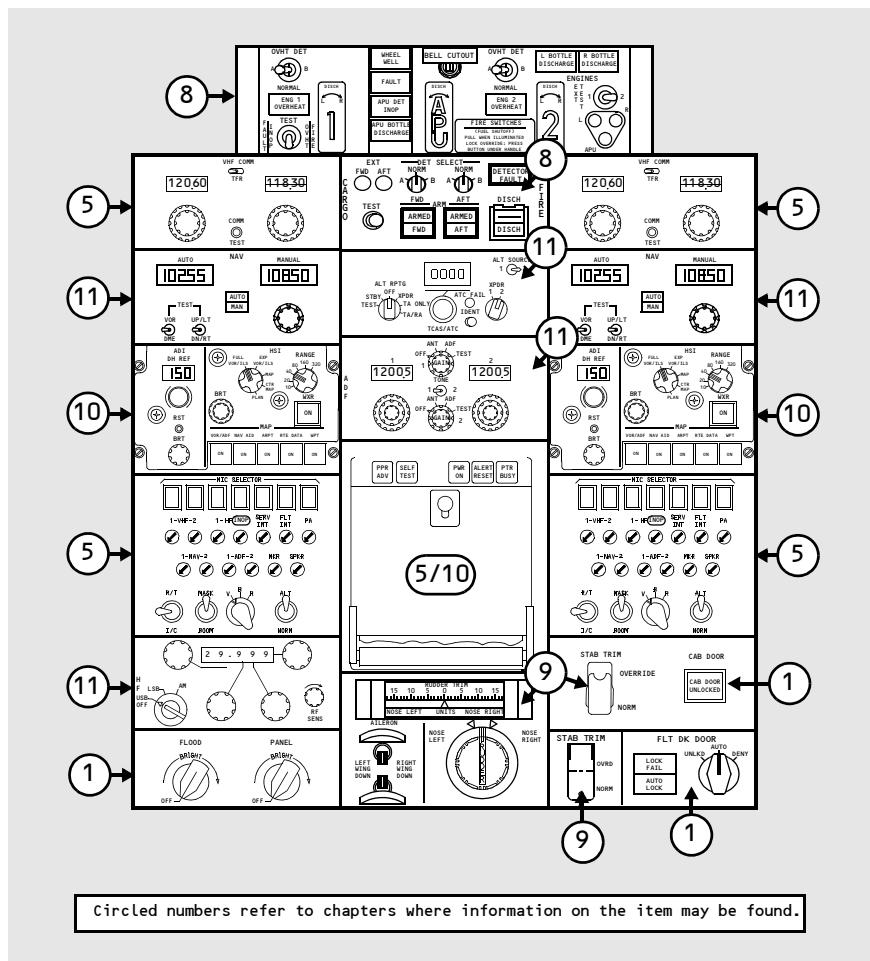
Circled numbers refer to chapters where information on the item may be found.

Forward Electronic Panel

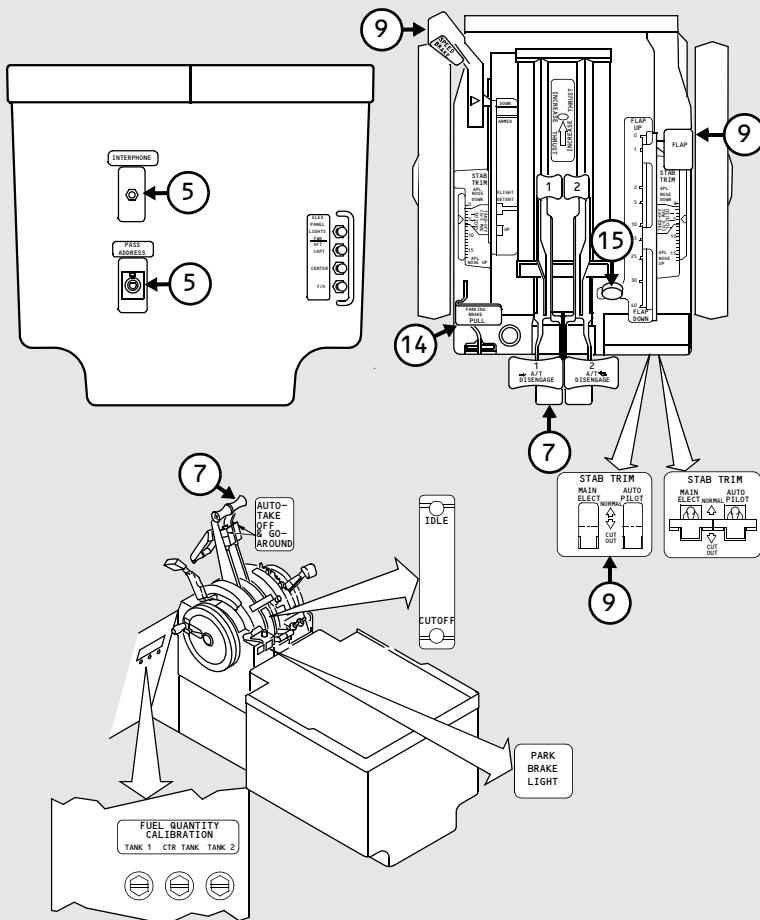


Circled numbers refer to chapters where information on the item may be found.

Aft Electronic Panel

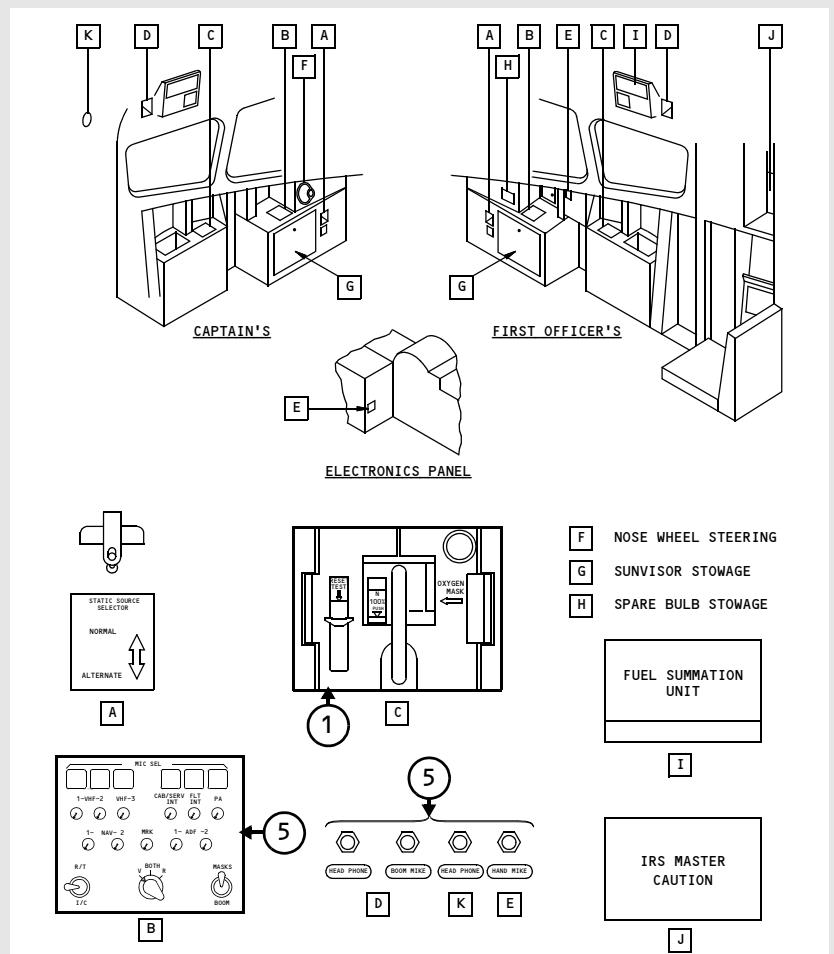


Control Stand



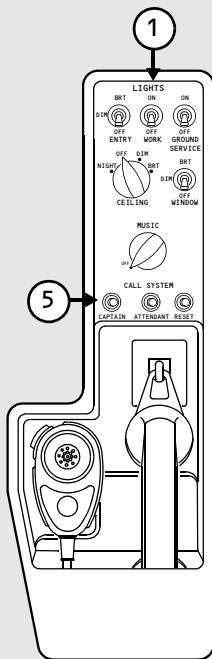
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Auxiliary Panels

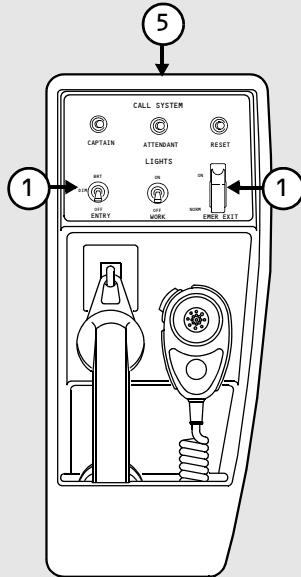


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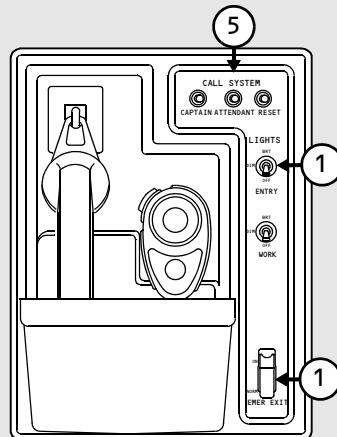
Attendant Panels



**FORWARD ATTENDANT
PANEL**

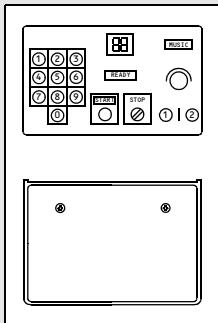


AFT ATTENDANT PANEL

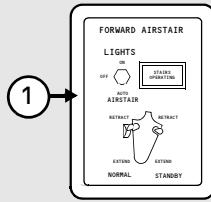


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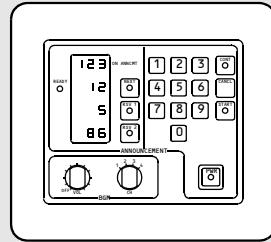
Misc Attendant Panels



**MUSIC ANNOUNCE
PANEL**



FORWARD AIRSTAIR



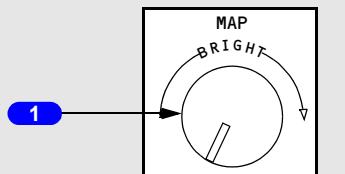
**PRERECORDED
ANNOUNCEMENT PANEL**

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Flight Deck Lighting

Map Light Controls

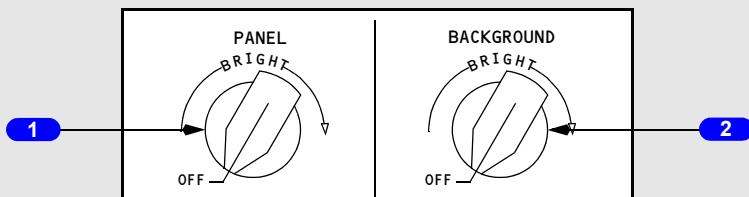


SIDEWALL PANELS

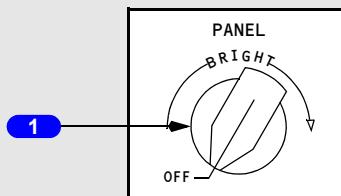
1 MAP Light Control

Push/Rotate – adjusts brightness of Captain/First Officer map lights. Pull to illuminate, and push to extinguish.

Panel and Background Lighting



CAPTAIN'S PANEL



FIRST OFFICER'S PANEL

1 PANEL Light Control

Rotate –

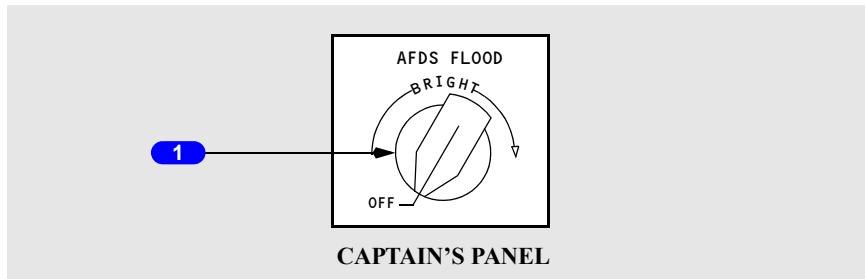
- Captain's – controls brightness of Captain's panel and instrument lighting, center instrument panel, and AFDS panel displays and edge lighting
- First Officer's – controls brightness of First Officer's panel and instrument lighting.

2 BACKGROUND Light Control

Rotate –

- Controls incandescent lighting brightness for Captain's panel, First Officer's panel, and center panel.

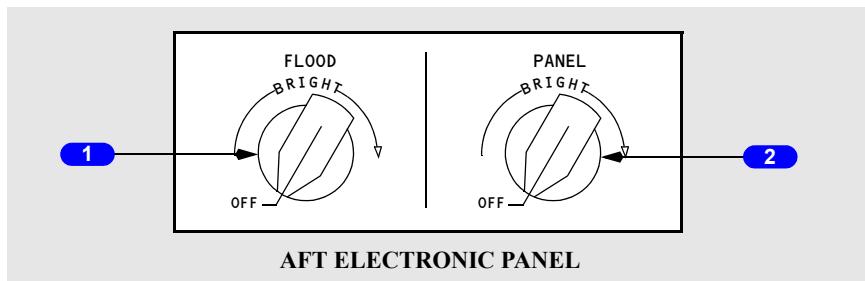
AFDS Flood Light Control



1 AFDS FLOOD Light Control

Rotate – controls brightness of lighting directed at AFDS panel.

Flood and Aft Electronic Panel Lights Controls



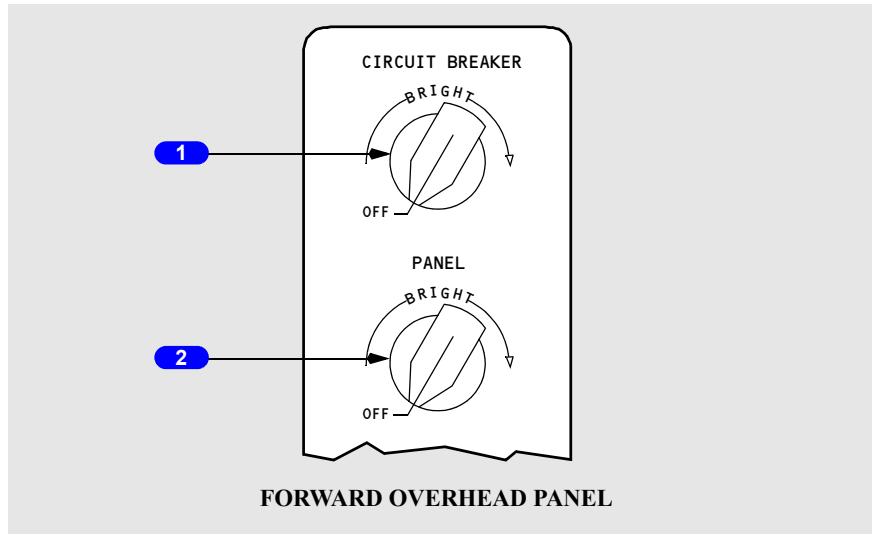
1 FLOOD Light Control

Rotate – controls brightness of overhead spotlight directed at thrust lever quadrant.

2 PANEL Light Control

Rotate – controls brightness of forward and aft electronic control panel lights.

Overhead/Circuit Breaker Panel Light Controls



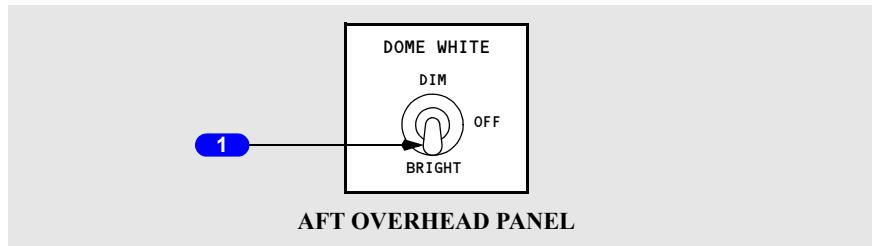
1 CIRCUIT BREAKER Light Control

Rotate – controls brightness of P-6 and P-18 circuit breaker panel lights.

2 PANEL Light Control

Rotate – controls brightness of forward and aft overhead panel lights.

Dome Light Control



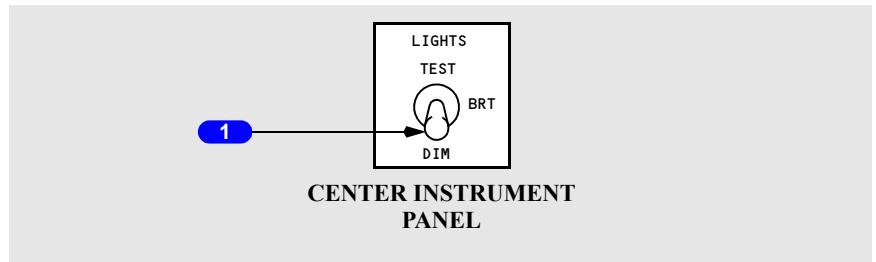
1 DOME Light Control

DIM – sets overhead dome lights to low brightness.

OFF – overhead dome lights are extinguished.

BRIGHT – sets overhead dome lights to full brightness.

Master Lights Test and Dim Switch



1 Master LIGHTS TEST and DIM Switch

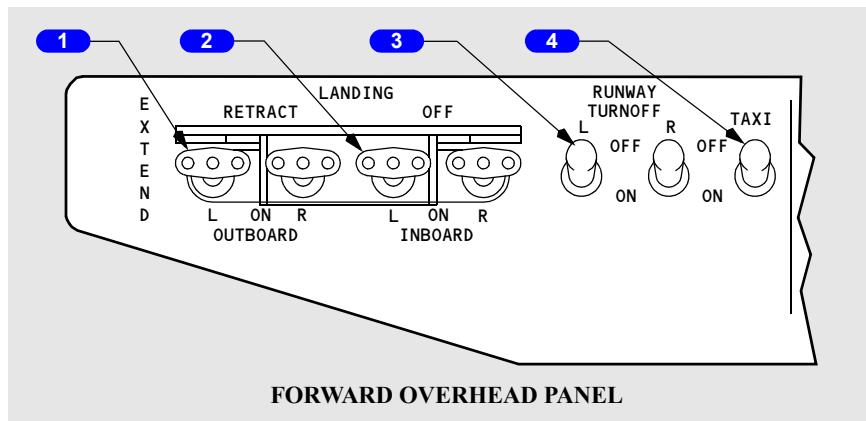
TEST – illuminates all system lights on forward and aft overhead panels, and some lights on Captain's and First Officer's instrument panels to full brightness.

BRT (bright) – sets all system lights on forward and aft overhead panels, and some lights on Captain's and First Officer's panels to full brightness.

DIM – sets all system lights on forward and aft overhead panels, and some lights on Captain's and First Officer's panels to low brightness.

Exterior Lighting

Landing, Runway Turnoff and Taxi Lights



1 OUTBOARD LANDING Light Switch

RETRACT – outboard landing lights are retracted and extinguished.

EXTEND – outboard landing lights are extended and extinguished.

ON – outboard landing lights are extended and illuminated.

2 INBOARD LANDING Light Switch

OFF – inboard landing lights are extinguished.

ON – inboard landing lights are illuminated.

3 RUNWAY TURNOFF Light Switch

OFF – runway turnoff lights located in leading edge of wing root are extinguished.

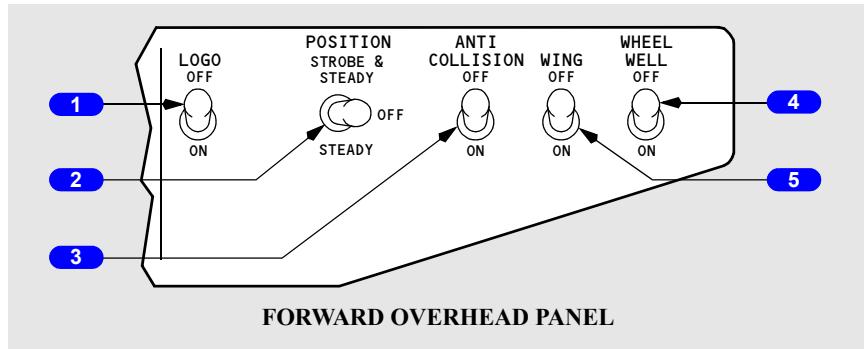
ON – runway turnoff lights are illuminated.

4 TAXI Light Switch

OFF – nose wheel taxi light extinguished.

ON – nose wheel taxi light illuminated.

Miscellaneous Exterior Lights



1 LOGO Light Switch

OFF – logo lights on each side of vertical fin extinguished.

ON – logo lights illuminated.

2 POSITION Light Switch

STROBE & STEADY – illuminates the red and green wingtip position lights, the white trailing edge wingtip lights, and the wingtip and tail strobe lights.

OFF – position lights extinguished.

STEADY – illuminates the red and green wingtip position lights and the white trailing edge wingtip lights.

3 ANTI-COLLISION Light Switch

OFF – red high intensity strobe lights extinguished.

ON – red high intensity strobe lights on upper and lower fuselage illuminated.

4 WHEEL WELL Light Switch

OFF – three wheel well lights extinguished.

ON – wheel well lights illuminated for checking landing gear down and locked stripes.

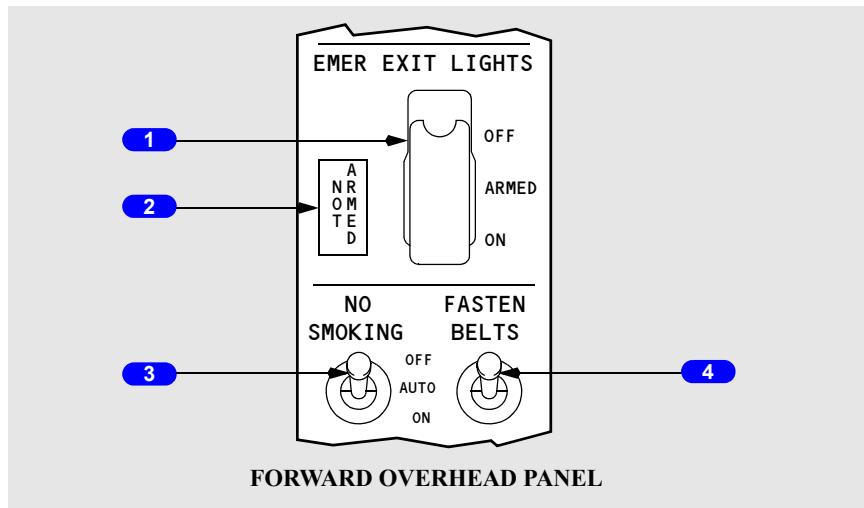
5 WING Illumination Switch

OFF – wing leading edge lights extinguished.

ON – wing leading edge lights on fuselage forward of wing illuminated.

Emergency Lighting and Passenger Signs

Flight Deck



1 Emergency Exit Lights (EMER EXIT LIGHTS) Switch (guarded)

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 to DC bus No. 1 fails or AC power is turned off.

ON – all emergency lights illuminate.

2 Emergency Exit Lights (EMER EXIT LIGHTS) NOT ARMED Light

Illuminated (amber) – EMER EXIT LIGHTS switch not in ARMED position.

3 NO SMOKING Lights Switch

OFF – the NO SMOKING signs are not illuminated.

AUTO – the NO SMOKING signs are illuminated or extinguished automatically with reference to airplane configuration (refer to the Lighting System Description section).

ON – the NO SMOKING signs are illuminated.

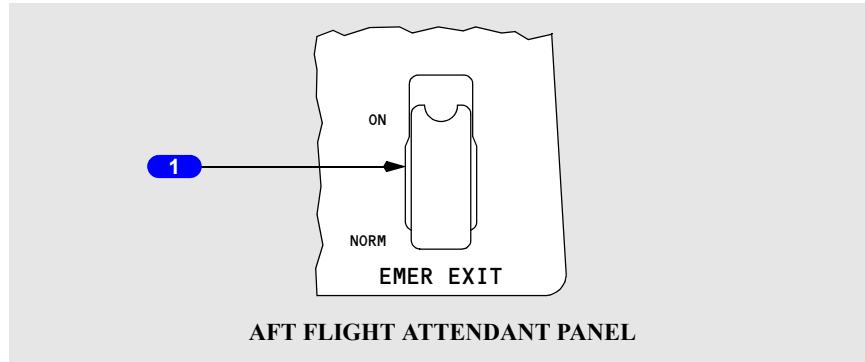
4 SEAT BELTS Lights Switch

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

AUTO – the FASTEN SEAT BELTS and RETURN TO SEAT signs are illuminated or extinguished automatically with reference to airplane configuration (refer to the Lighting System Description section).

ON – the FASTEN SEAT BELTS and RETURN TO SEAT signs are illuminated.

Passenger Cabin



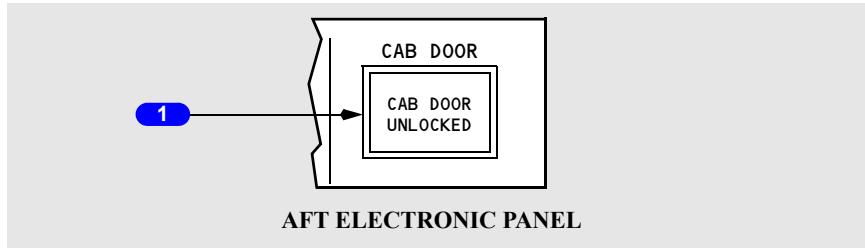
1 Passenger Cabin Emergency Exit Lights Switch (guarded, red)

ON – all interior and exterior emergency lights are illuminated.

NORM – Emergency lights OFF unless activated by the flight deck switch.

Doors

Cabin Door (as installed)

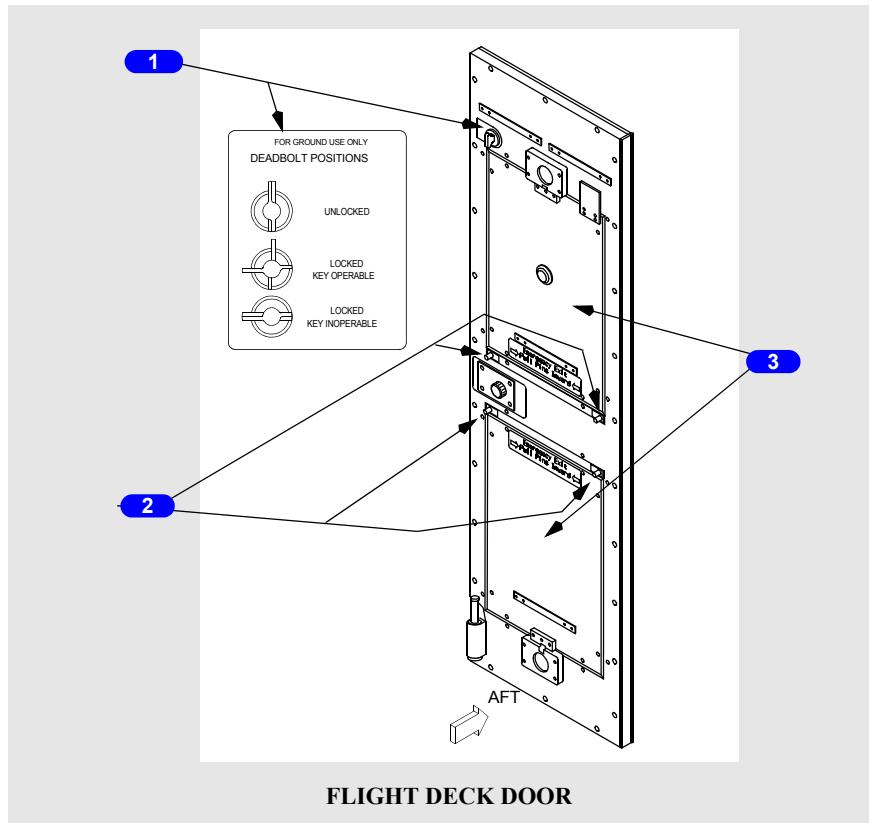


1 Cabin Door (CAB DOOR) Lock Switch

Illuminated (amber) – cabin door is unlocked.

Push – with AC power available, locks cabin door.

Flight Deck Door (as installed)



FLIGHT DECK DOOR

1 Deadbolt and Deadbolt Placard

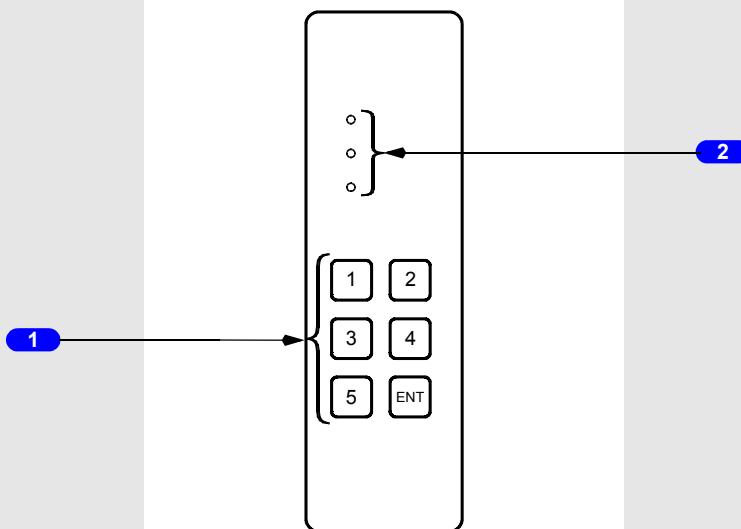
2 Release Pins

Pull pins inward - manually separates decompression panel from a jammed door to allow panel opening and egress.

3 Decompression Panel

Provides emergency egress path and automatically opens during cabin decompression.

Flight Deck Emergency Access Panel



PASSENGER SIDE DOOR POST

1 Keypad

Push - enters 3 to 8 digit emergency access code by pressing numeric then "ENT" keys. Entry of correct emergency access code sounds flight deck chime.

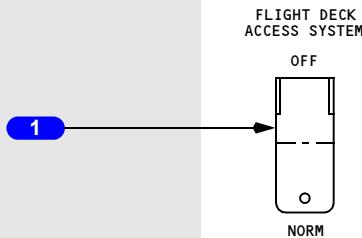
2 Access Lights

Illuminated (red) - door locked or Flight Deck Access System switch OFF.

Illuminated (amber) - correct emergency access code entered.

Illuminated (green) - door unlocked.

Flight Deck Access System Switch



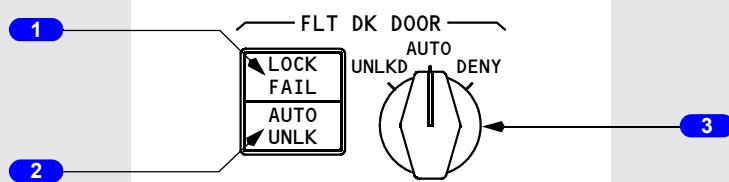
FLIGHT DECK SIDE DOOR POST

1 Flight Deck Access System Switch

OFF - removes electrical power from door lock.

NORM (Normal) - flight deck access system configured for flight.

Flight Deck Door Lock Panel



AISLE STAND

1 LOCK FAIL Light

Illuminated (amber) - Flight Deck Door Lock selector in AUTO and door lock has failed or Flight Deck Access System switch is OFF.

2 AUTO Unlock (UNLK) Light

Illuminated (amber) - correct emergency access code entered in keypad. AUTO UNLK light flashes and continuous chime sounds before timer expires and door unlocks.

3 Flight Deck (FLT DK) Door Lock Selector

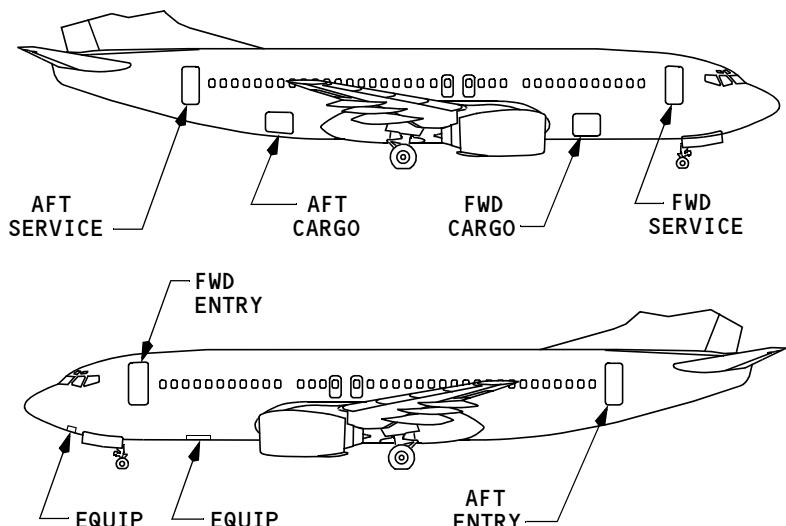
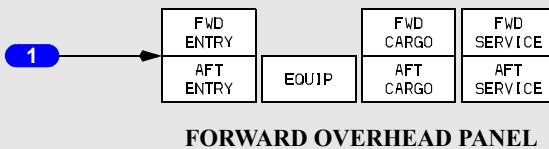
Spring loaded to AUTO. Selector must be pushed in to rotate from AUTO to UNLKD. Selector must not be pushed in to rotate from AUTO to DENY.

UNLKD - door unlocked while selector in UNLKD.

AUTO - door locked. Allows door to unlock after entry of emergency access code and expiration of timer, unless crew takes action.

DENY - rejects keypad entry request and prevents further emergency access code entry for a time period.

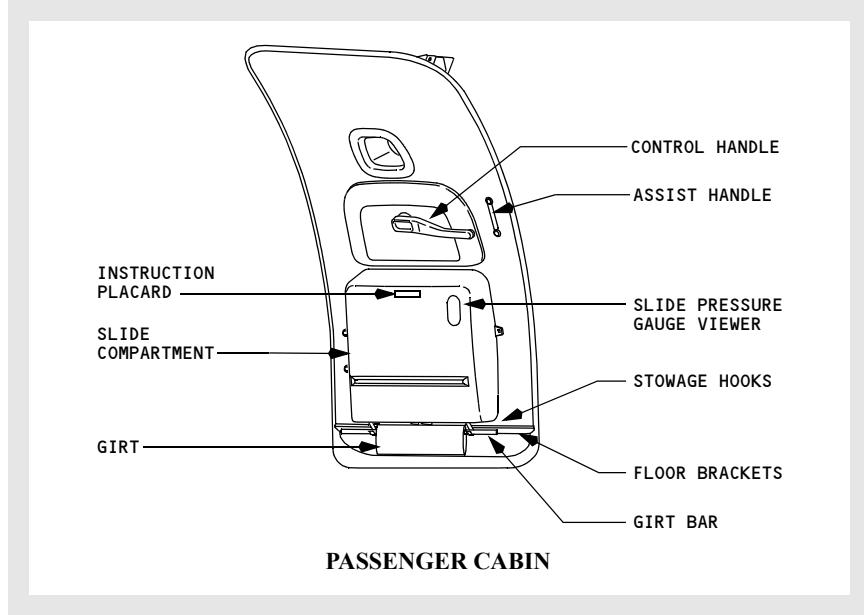
Exterior Door Annunciator Lights



1 Interior Door Annunciations

Illuminated (amber) – related door is unlocked.

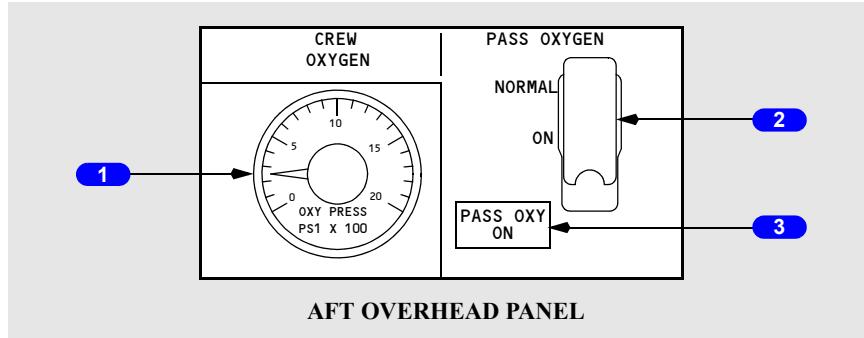
Passenger Entry/Galley Service Doors



CAUTION: Do not operate the entry or cargo with winds at the door of more than 40 knots. Do not keep doors open when wind gusts are more than 65 knots. Strong winds can cause damage to the structure of the airplane.

Oxygen

Oxygen Panel



1 Flight Crew Oxygen (CREW OXYGEN) Pressure Indicator

Indicates pressure at the crew oxygen cylinder.

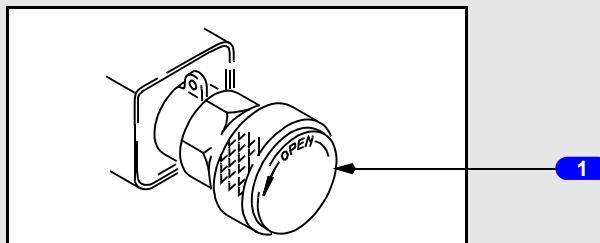
2 Passenger Oxygen (PASS OXYGEN) Switch

NORMAL – passenger masks drop and passenger oxygen system is activated automatically if cabin altitude climbs to approximately 14,000 feet

ON – activates system and drops masks if automatic function fails.

3 Passenger Oxygen On (PASS OXY ON) Light

Illuminated (amber) – passenger oxygen system is activated and masks have dropped.



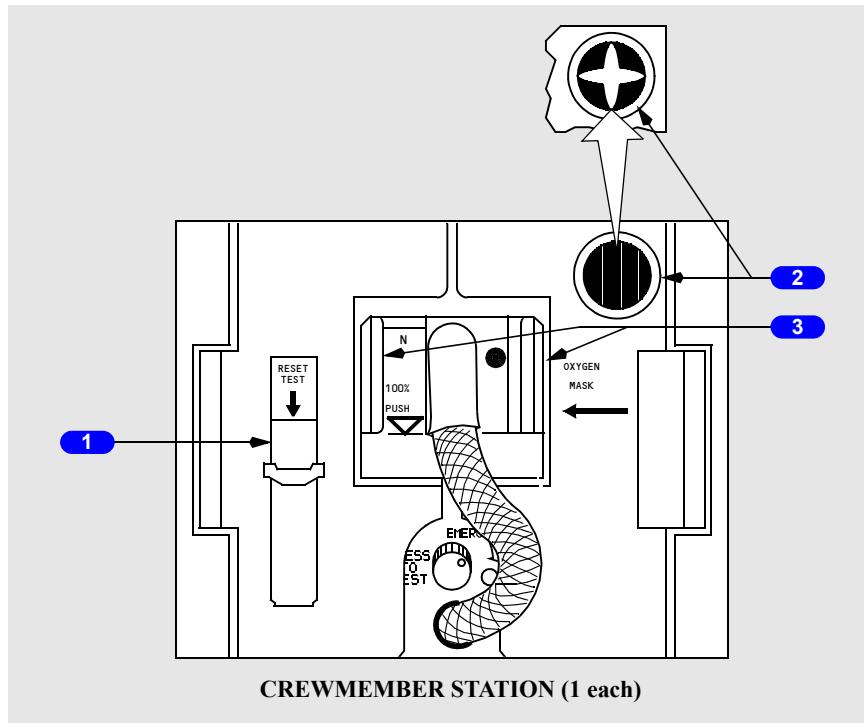
**RIGHT FLIGHT DECK BULKHEAD
BEHIND FIRST OFFICER'S SEAT**

1 Flight Crew Oxygen (CREW OXYGEN) Shutoff Valve

TURN COUNTERCLOCKWISE - Allows oxygen to flow.

TURN CLOCKWISE - Shuts off oxygen flow.

Oxygen Mask Panel



1 RESET TEST Switch

Push –

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

2 Oxygen Flow Indicator

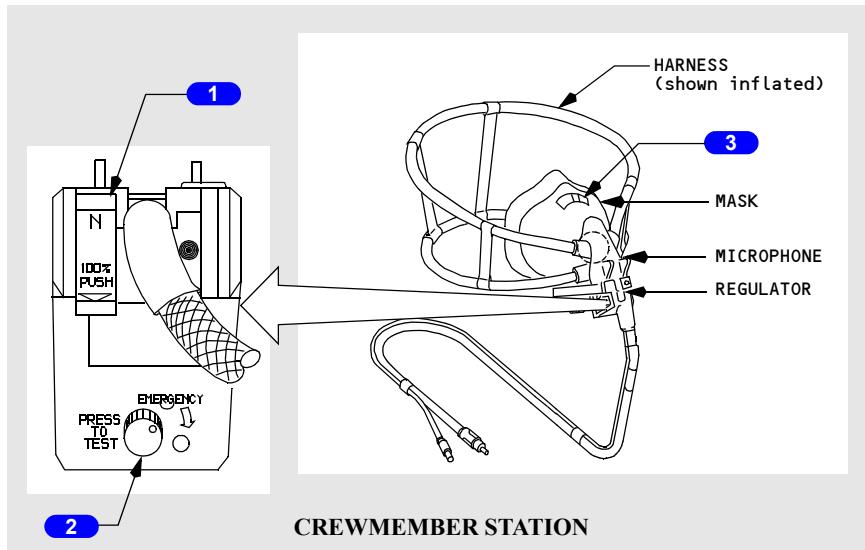
Indicates a yellow cross when oxygen is flowing.

3 Oxygen Mask Release Levers

Squeeze and pull –

- releases mask from stowage box
- initiates oxygen flow when stowage box doors open
- inflates mask harness when right lever is squeezed
- flow indicator shows a yellow cross momentarily as harness inflates

Oxygen Mask and Regulator



1 NORMAL/100% Switch

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

100% – supplies 100% oxygen on demand.

2 Oxygen Mask EMERGENCY/Test Selector (rotary)

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).

PRESS TO TEST – tests positive pressure supply to regulator.

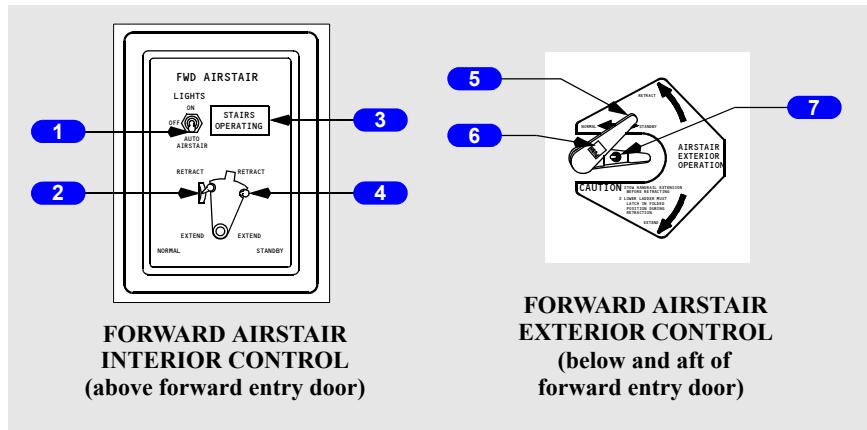
3 Smoke Vent Valve Selector

Up - vent valve closed.

Down - vent valve open, allowing oxygen flow to smoke goggles.

Forward Airstairs

Interior and Exterior Controls



1 LIGHTS Switch

AUTO – the airstair tread lights illuminate automatically upon airstair extension and extinguish upon retraction.

ON – illuminates the airstair tread lights.

OFF – airstair tread lights extinguish.

2 Normal Control Switch

Note: AC and DC electrical power must be available on airplane.

RETRACT – retracts the airstair. The handrail extensions must be stowed prior to retracting the airstair.

EXTEND – extends the airstair.

3 STAIRS Operating Light

Illuminated (amber) – indicates the airstair is in transit.

4 STANDBY Control Switch

Note: Switch must be held in while using EXTEND or RETRACT. Battery switch must be ON. For airplanes delivered prior to November, 1991, 115V AC electrical power must be available.

Extend – extends the airstair.

Retract – retracts the airstair.

CAUTION: Use of standby bypasses all safety circuits. Airstair handrail extensions must be stowed, or substantial damage could result.

5 Exterior Control Handle

Rotate clockwise – airstair extends.

Rotate counterclockwise – airstair retracts.

6 Control Handle Release

Push – extends the exterior control handle.

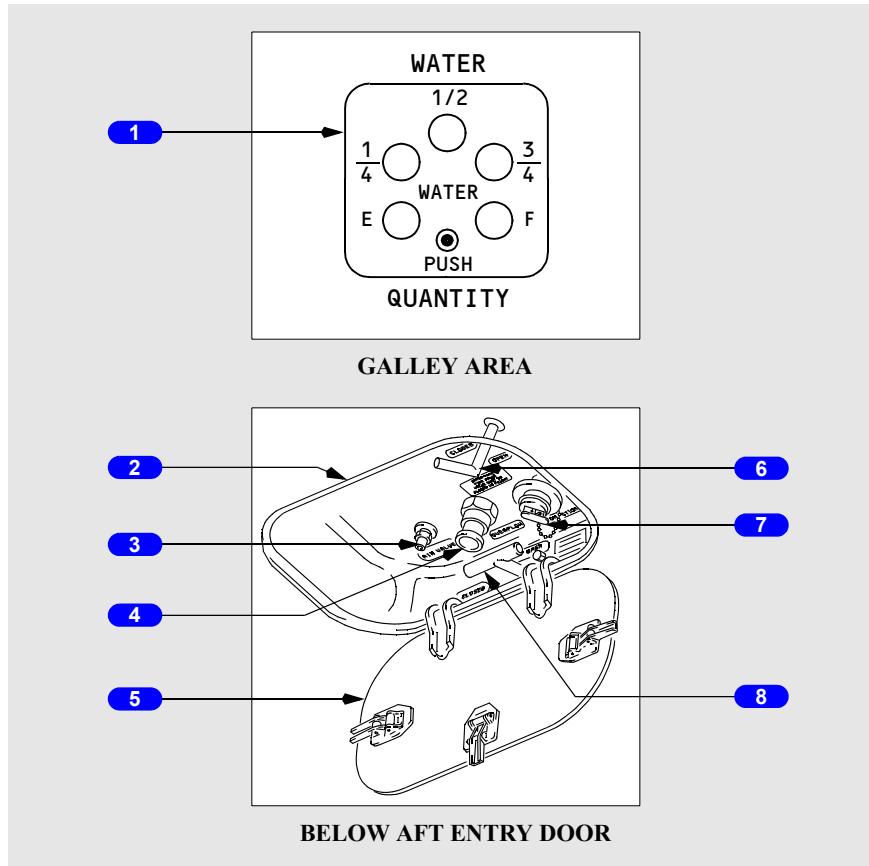
7 NORMAL/STANDBY Switch

(spring-loaded to NORMAL)

NORMAL – requires both AC and DC power.

STANDBY – requires DC power.

Water System Controls



1 Water Quantity Indicator

Push – lights illuminate to indicate quantity of water in reservoir.

Example: With reservoir half full, the E, 1/4, and 1/2 lights illuminate.

2 Water System Service Panel

3 Air Valve

Pressurizes tank and system when normal pressure sources are not available.

4 Overflow Fitting

Prevents overfilling of tank and allows venting of tank when gravity draining.

5 Access Panel

Cannot be closed unless the fill and overflow valve and tank drain valve handles are in the closed position.

6 Fill and Overflow Valve Handle

OPEN – enables filling or gravity draining water tank.

CLOSED – normal position.

7 Fill Fitting

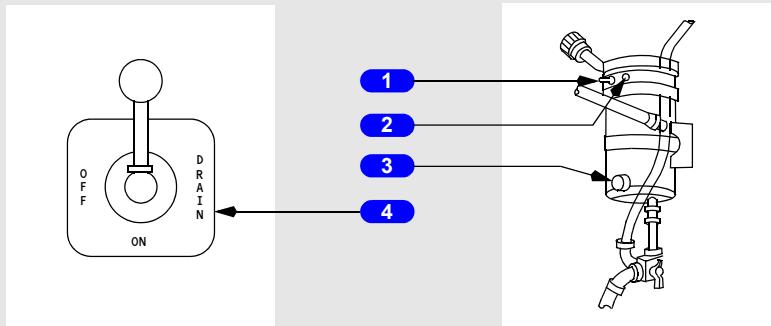
Used to fill tank.

8 Tank Drain Valve Handle

Open – drains water from tank.

Closed – normal position.

Lavatory Controls



1 Water Heater Switch

On – activates the water heater.

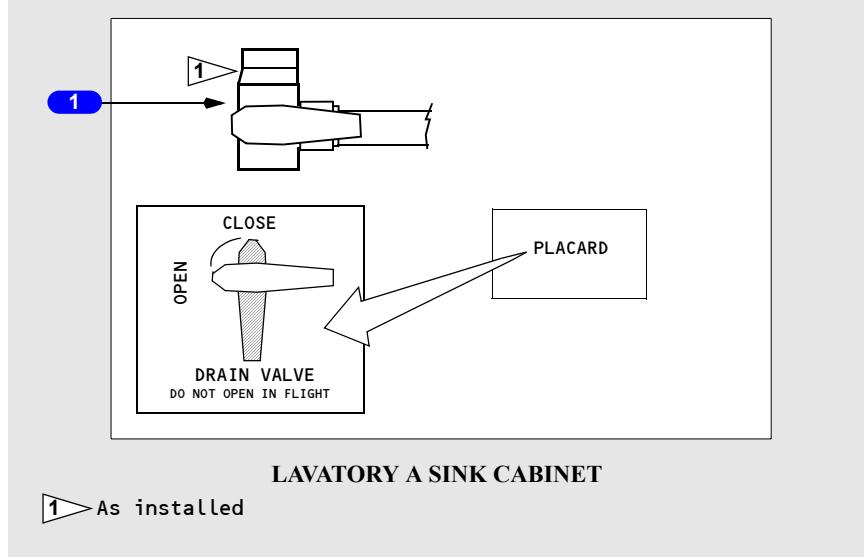
2 Water Heater Light

Illuminated – heater operating.

3 Temperature Control Switch

4 Water Shutoff and Drain Valve Control

- ON – provides water to lavatory sink faucets and heater (normal position)
- OFF – shuts off water to lavatory sink faucets and heater
- DRAIN – drains water overboard through respective drain fitting.



1 Water Supply Drain Valve

- OPEN – the drain valve allows the water to drain from all the lavatory A and galley supply lines.
- CLOSE – the water from the supply lines flows to the lavatory and galley components and does not flow overboard.

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Airplane General, Emergency Equipment, Doors, Windows Systems Description

Chapter 1

Section 40

Introduction

This chapter describes miscellaneous airplane systems, including:

- lighting systems
- oxygen systems
- fire extinguishers
- emergency equipment
- doors and windows
- cargo compartments
- emergency egress
- flight deck seats
- galleys
- water systems
- lavatories
- airstairs.

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
- logo
- position (navigation)
- strobe
- anti-collision
- wing illumination
- wheel well.

Outboard Landing Lights

Outboard landing lights are installed in the outboard flap track fairings. The lights are designed to extend and shine forward, parallel to the waterline of the airplane. The lights may be extended at any speed.

Inboard Landing Lights

Two inboard landing lights are in the wing leading edge. The lights shine forward and down in a fixed position.

Runway Turnoff Lights

Runway turnoff lights are in each wing root. The lights illuminate the area in front of the main gear.

Taxi Lights

The taxi light is mounted on the nose wheel strut and points in the same direction as the nose wheel. For increased service life of the taxi light, it is recommended that the taxi light not be used for takeoff and landing.

Logo Lights

Logo lights are located on the top of each wing tip to illuminate both sides of the vertical stabilizer.

Position Lights

The navigation lights are the standard red (left forward wingtip), green (right forward wingtip), and white (aft tip of both wings) position lights.

Strobe Lights

Three high intensity white strobe lights are installed on the left forward wing tip, right forward wing tip, and tail cone.

Anti-collision Lights

Two red anti-collision strobe lights are located on the top and bottom of the fuselage.

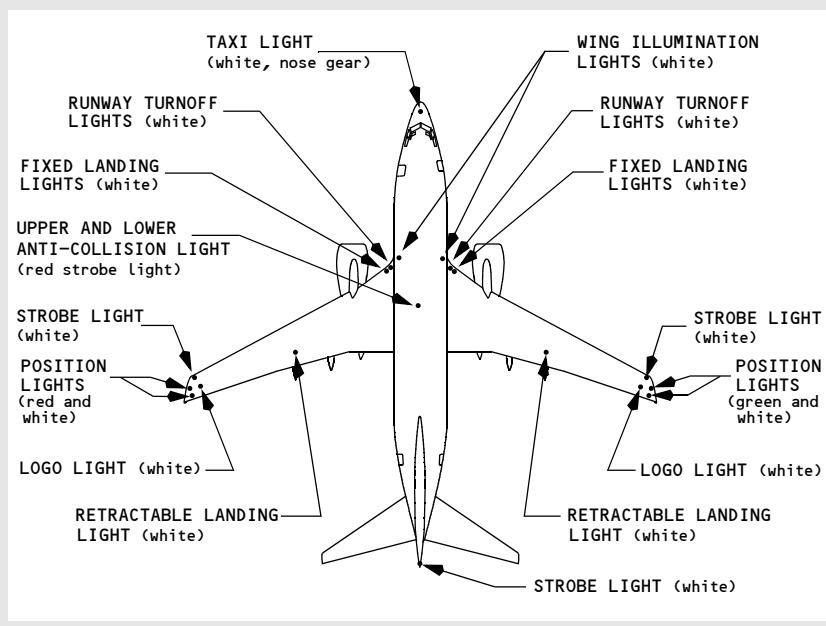
Wing Illumination Lights

Wing lights are installed on the fuselage and illuminate the leading edge of the wing.

Wheel Well Lights

Lights are installed in the wheel well of the nose gear and each main gear.

Exterior Lighting Locations



Flight Deck Lighting

Flight deck lighting is provided for panel illumination, area lighting and localized illumination. Dome lights supply general flight deck flood lighting. The glareshield supplies background light for the main instrument panels. Each instrument and instrument panel has its own integral lights. Floodlights are installed for the MCP, aisle stand, and aft circuit breaker panel.

Map lights and utility lights are available at the pilot stations, each with individual controls.

If normal electrical power is lost, standby electrical power is automatically provided to the standby compass light, dome lights, instrument flood lights and selected system information and warning lights.

Passenger Cabin Lighting

Passenger cabin lighting is supplied by incandescent and fluorescent lights. General cabin lighting is provided by window lights, ceiling lights, and entry lights. Reading lights are located above each passenger seat in the passenger service unit. Lights are also installed in the lavatories and galleys.

Passenger Cabin Signs

The passenger cabin signs are controlled by a switch on the forward overhead panel. With AUTO selected, the signs are controlled automatically by reference to landing gear and flap positions:

FASTEN BELTS and RETURN TO SEAT signs:

- illuminate when flaps or gear are extended
- extinguish when flaps and gear are retracted.

NO SMOKING signs:

- illuminate when gear is extended
- extinguish when gear is retracted.

All passenger signs can be controlled manually by positioning the respective switch to ON or OFF.

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

Emergency Lighting

Exit lights are located throughout the passenger cabin to indicate the approved emergency exit routes. The system is controlled by a switch on the overhead panel. The switch has three positions: OFF, ARMED and ON, and is guarded to the ARMED position. With the switch in the ARMED position, the emergency exit lights are normally extinguished. If electrical power to DC bus No. 1 fails or if AC power has been turned off, the emergency exit lights illuminate automatically.

The emergency exit lights may also be illuminated by a switch on the aft attendant's panel. Lifting the guard and pushing the switch ON overrides the flight deck control and illuminates the emergency exit lights. Control from this panel is available in the event of failure of the automatic control.

The flight deck aft DOME light contains a separate bulb that is powered by the emergency lighting system to provide for flight deck evacuation.

Interior Emergency Lighting

Interior emergency exit lights are located:

- in the lower inboard corner of stowage bins to illuminate the aisle
- over the entry/service and overwing emergency hatches to indicate the door and hatch exits
- in the ceiling to locate the exits and provide general illumination in the area of the exits.

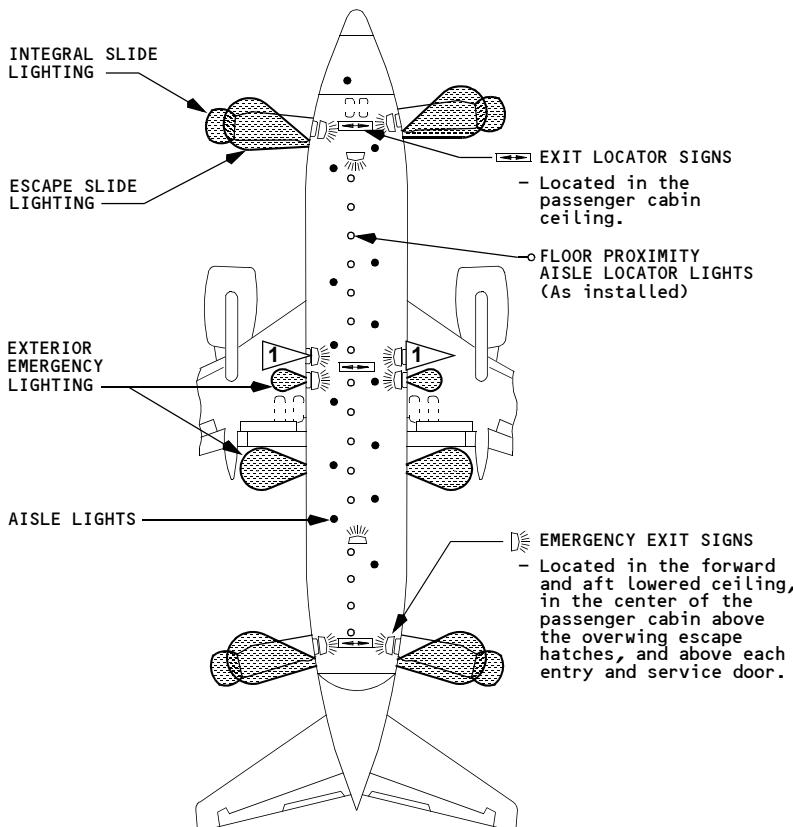
Self-illuminating exit locator signs are installed at the forward, middle, and aft end of the passenger cabin.

Floor proximity emergency escape path lighting consists of locator lights spaced at regular intervals down one side of the aisle. Lighted arrows point to overwing exits and a lighted EXIT indicator is near the floor by each door and overwing exit. Escape path markings are provided for visual guidance for emergency cabin evacuation when other sources of cabin lighting are obscured.

Exterior Emergency Lighting

Exterior emergency lights illuminate the escape slides. The fuselage-installed escape slide lights are adjacent to the forward and aft service and entry doors. Two lights are also installed on the fuselage to illuminate the overwing escape routes and ground contact area.

Emergency Exit Lighting

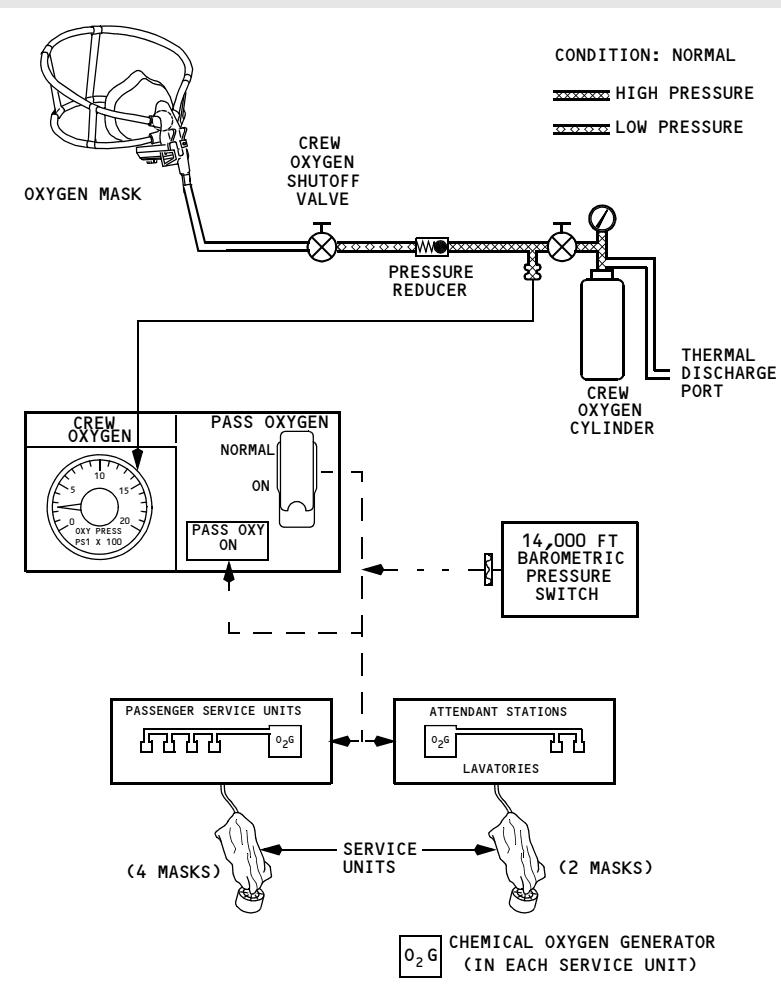


1 ▶ 737-400

Oxygen Systems

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

Oxygen System Schematic



Flight Crew Oxygen System

The flight crew oxygen system uses quick-donning diluter demand masks/regulators located at each crew station. Oxygen is supplied by a single cylinder. Oxygen pressure is displayed on the indicator located on the aft overhead panel when the battery switch is ON. Oxygen flow is controlled through a pressure-reducing regulator to supply low pressure oxygen. Normal pressure is 1850 psi.

The mask/regulator is stored in a box immediately adjacent to each crew station. To use the mask, squeeze the red Release Levers with the thumb and forefinger and remove from stowage. Squeezing the Release Levers:

- inflates the mask harness
- momentarily displays the yellow oxygen flow indicator

Place the mask over the head and release the levers. The harness contracts to fit the mask to head and face.

Oxygen flow is controlled by a regulator that is mounted on the oxygen mask. The regulator may be adjusted to supply 100% oxygen by pushing the NORMAL/100% Selector.

The observer's oxygen mask, regulator, and harness unit is the same as the pilot's.

Oxygen is available to the regulator when the flight deck shutoff valve is open. The unit does not have a flow indicator or reset-test button. The mask, regulator and harness are contained in a stowage cup.

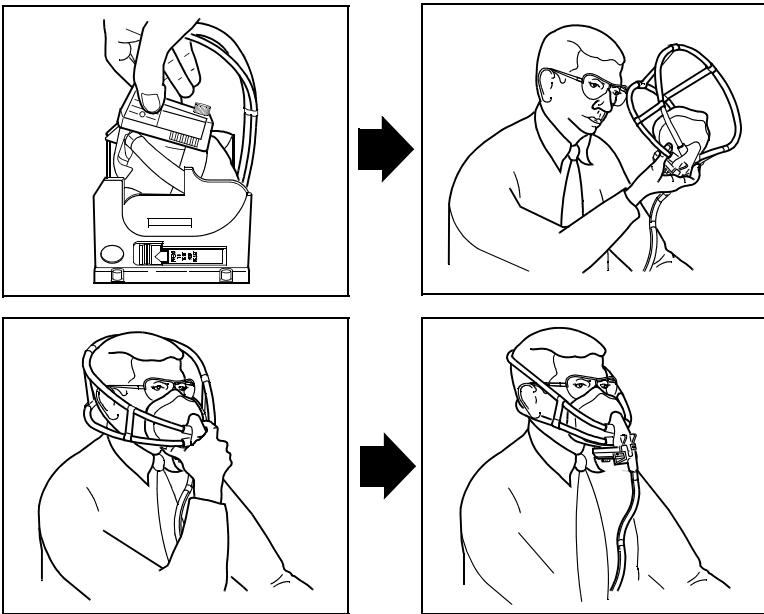
Flight Crew Oxygen Mask Usage

Donning Instructions

To don the mask, grasp the regulator with the thumb and forefinger and remove from stowage. Squeezing the inflation levers and removing from the box:

- inflates the mask harness.
- momentarily displays a colored oxygen flow indicator.
- Place the mask over the head and release the levers. The harness contracts to fit the mask to head and face.

The observer's oxygen mask, regulator, and harness unit is the same as the pilot's.



MASK DONNING

Flight Crew Portable Oxygen

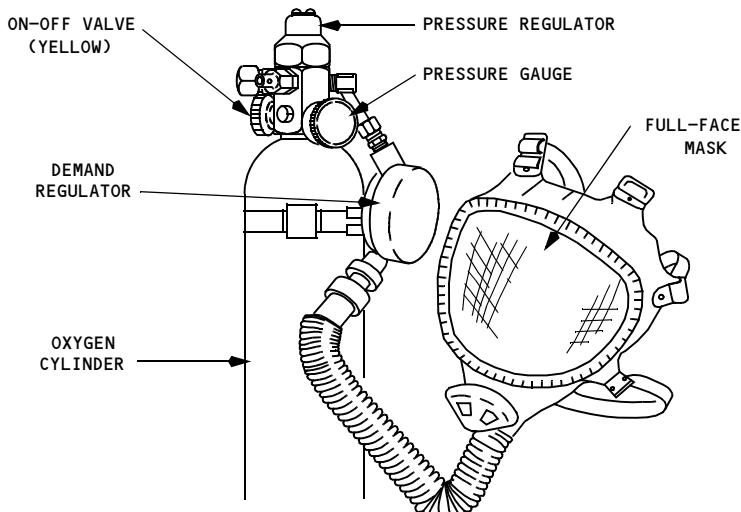
The flight crew portable oxygen unit is a completely self-contained oxygen system, offering both demand and constant flow capabilities. It consists of a portable oxygen cylinder, a pressure regulator (constant flow), an on-off valve, a pressure gauge to show oxygen supply, a demand regulator, and a sling-type carrying strap.

The portable oxygen cylinder is installed behind and adjacent to the First Officer's seat. When charged to 1800 psi at 70° Fahrenheit (21° Celsius), it contains 11 cubic feet (311 liters) of free oxygen.

The demand regulator has a connection for a demand type full-face mask and supplies 100% oxygen. Normally, the full face mask is attached to the unit and provides portable full-face and respiratory protection from hazardous smoke and fumes.

For constant flow oxygen, a bayonet-type fitting accommodates a disposable continuous flow mask. The cylinder provides oxygen for a duration of approximately 103 minutes using the 3 liter constant flow outlet.

Flight Crew Portable Oxygen Equipment



11 Cu. Ft. Cylinder			
Alt. (Feet) or Cabin Alt. Equiv.	IF DEMAND FLOW OUTLET IS USED Estimated duration in minutes*		
	Max.	Mean	Min.
0	21	12	7
5,000	25	15	9
10,000	31	18	11
15,000	37	22	13
20,000	46	27	16
25,000	57	33	20
30,000	71	41	25

*Estimated duration based on an assumed use rate of 14 LPM-ATPD (sedentary), 24 LPM-ATPD (normal activity), 40 LPM-ATPD (severe activity).

- | | |
|------------------------------------------------------------------------------|-----------------------------------------------------------------------------------------------------------------------------------|
| FOR 100% OXYGEN
(DEMAND FLOW)
USE FULL FACE
MASK | 1. TURN YELLOW KNOB OPEN
2. ATTACH FULL FACE MASK TO LARGE
OUTLET.
3. APPLY MASK TO FACE (TIGHTEN
LOWER STRAPS FIRST) |
| FOR SUPPLEMENTAL
OXYGEN
(CONSTANT FLOW)
USE REBREATHER
TYPE MASK | 1. TURN YELLOW KNOB OPEN
2. ATTACH MASK HOSE TO SMALL
CONSTANT FLOW OUTLET
3. APPLY REBREATHER TYPE MASK
TO FACE |

Portable Protective Breathing Equipment

Protective Breathing Equipment (PBE/Smoke Hood) devices for crew use (for combating fires and/or entering areas of smoke or fume accumulation) are stowed throughout the airplane. The device is placed over the head and, when activated, provides approximately 15 minutes of oxygen. Manufacturer's operating instructions are placarded on the container.

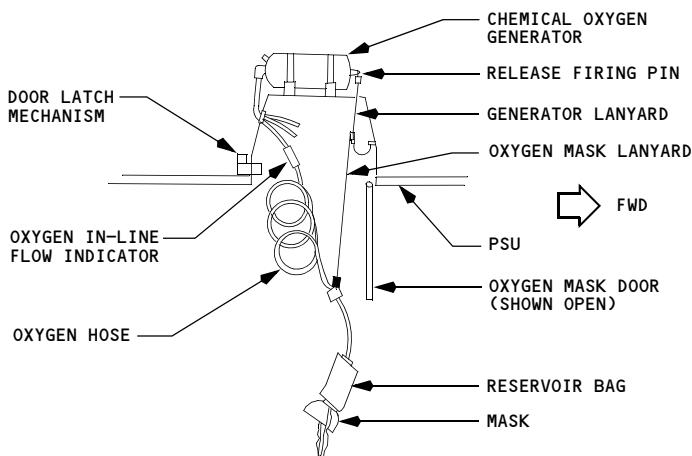
Passenger Oxygen System

The passenger oxygen system is supplied by individual chemical oxygen generators located at each Passenger Service Unit (PSU). Four continuous flow masks are connected to each generator. A generator with two masks is located above each attendant station and in each lavatory.

The system is activated automatically by a pressure switch at a cabin altitude of approximately 14,000 feet or when the Passenger Oxygen Switch on the aft overhead panel is positioned to ON. When the system is activated, the PASS OXY ON light illuminates and OVERHEAD illuminates on the Master Caution System.

Activating the system causes the masks to drop from the stowage compartments. The oxygen generators are activated when any mask in the unit is pulled down. Pulling one mask down causes all masks in that unit to come down and 100% oxygen flows to all masks. A green in-line flow indicator is visible in the transparent oxygen hose whenever oxygen is flowing to the mask. Oxygen flows for approximately 12 minutes and cannot be shut off. If the passenger oxygen is activated and a PSU oxygen mask compartment does not open, the masks may be dropped manually.

PSU Oxygen Mask Compartment



WARNING: When using passenger oxygen, the "NO SMOKING" sign should be strictly observed. Once the generator is activated, the flow of oxygen is constant, whether or not the mask is being worn.

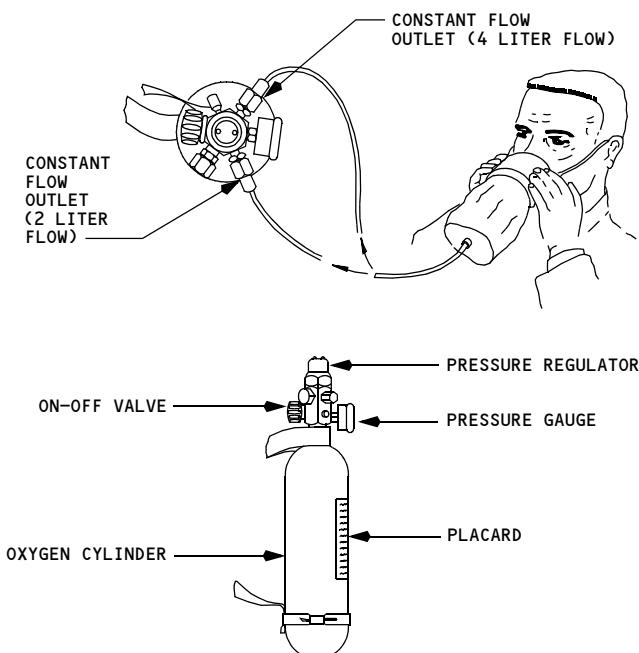
WARNING: Do not use passenger oxygen with cabin altitude below 14,000 feet when smoke or an abnormal heat source is present. The use of passenger oxygen does not prevent the passengers from inhaling smoke. Air inhaled is a mixture of oxygen and cabin air.

Passenger Portable Oxygen

First aid and supplemental portable oxygen cylinders are installed at suitable locations in the passenger cabin. The cylinders are fitted with a pressure gauge, pressure regulator and an on-off valve. The cylinders are pressurized to 1800 psi. At this pressure and a temperature of 70° Fahrenheit (21° Celsius), the cylinders have a capacity of 11 cubic feet (311 liters) of free oxygen. Two continuous flow outlets are provided on each cylinder, one regulates flow at two liters per minute for walk-around; the second outlet provides flow at four liters per minute. The four-liter flow is used for first aid.

Duration can be determined by dividing capacity by outflow (311 liters divided by 4 liters/minute = 77 minutes).

Passenger Portable Oxygen Equipment



Fire Extinguishers

Fire extinguishers are located in the flight deck and passenger cabin.

Water Fire Extinguishers

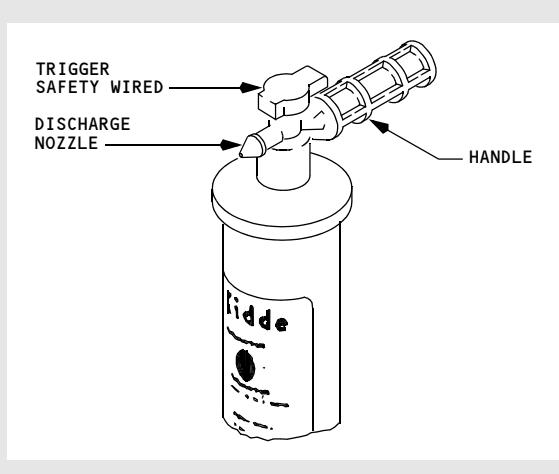
Water fire extinguishers contain a solution of water mixed with antifreeze. The container is pressurized by a CO₂ cartridge when the extinguisher handle is rotated fully clockwise. The extinguisher should be used on fabric, paper or wood fires only.

To use the water fire extinguisher:

- remove from stowage
- rotate handle fully clockwise
- aim at base of fire and press trigger.

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

Water Fire Extinguisher



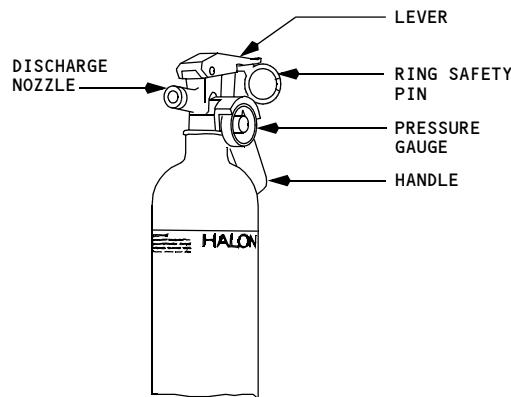
Halon (BCF) Fire Extinguishers

Halon (BCF) fire extinguishers contain a liquefied gas agent under pressure. The pressure indicator shows an acceptable pressure range, a recharge range, and an overcharged range. 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 primarily on electrical, fuel and grease fires.

To use the Halon fire extinguisher:

- remove from stowage
- hold upright and remove ringed safety pin
- aim at base of fire from a distance of six feet and press top lever
- use side-to-side motion to suppress fire.

BCF Fire Extinguisher (Halon 1211)



Fire Extinguisher Usage

Each class of fire calls for specialized action. Using the wrong extinguisher may do more harm than good. For your own protection, you should know these basic types, how to use them, and why.

CLASSES OF FIRE	EXTINGUISHER TYPE
There are three common classes of fire:	
CLASS A COMBUSTIBLE MATERIALS - paper, wood, fabric, rubber, certain plastics, etc., where quenching by water is effective.	TYPE A Water (H_2O) saturates material and prevents rekindling.
CLASS B FLAMMABLE LIQUIDS - gasoline, oils, greases, solvents, paints, burning Liquids, cooking fats, etc., where smothering action is required.	TYPE B BCF (Halon 1211)
CLASS C LIVE ELECTRICAL - fires started by short circuit or faulty wiring in electrical or electronic equipment, or fires in motors, switches, galley equipment, etc., where a nonconducting extinguisher agent is required. NOTE: Whenever possible, electrical equipment should be de-energized before attacking a class C fire.	TYPE C BCF (Halon 1211)

WARNING: THE WRONG EXTINGUISHER ON A FIRE COULD DO MORE HARM THAN GOOD. FOR EXAMPLE, **B** RATED EXTINGUISHER IS NOT AS EFFECTIVE AS H_2O ON A CLASS **A** FIRE. WATER ON FLAMMABLE LIQUID FIRES SPREAD THE FIRE. WATER ON A LIVE ELECTRICAL FIRE COULD CAUSE SEVERE SHOCK OR DEATH.

WARNING: The concentrated agent, or the by-products created by the heat of the fire, are toxic when inhaled.

WARNING: If a fire extinguisher is to be discharged in the flight deck, then all crewmembers are to wear oxygen masks and use 100% oxygen with emergency selected.

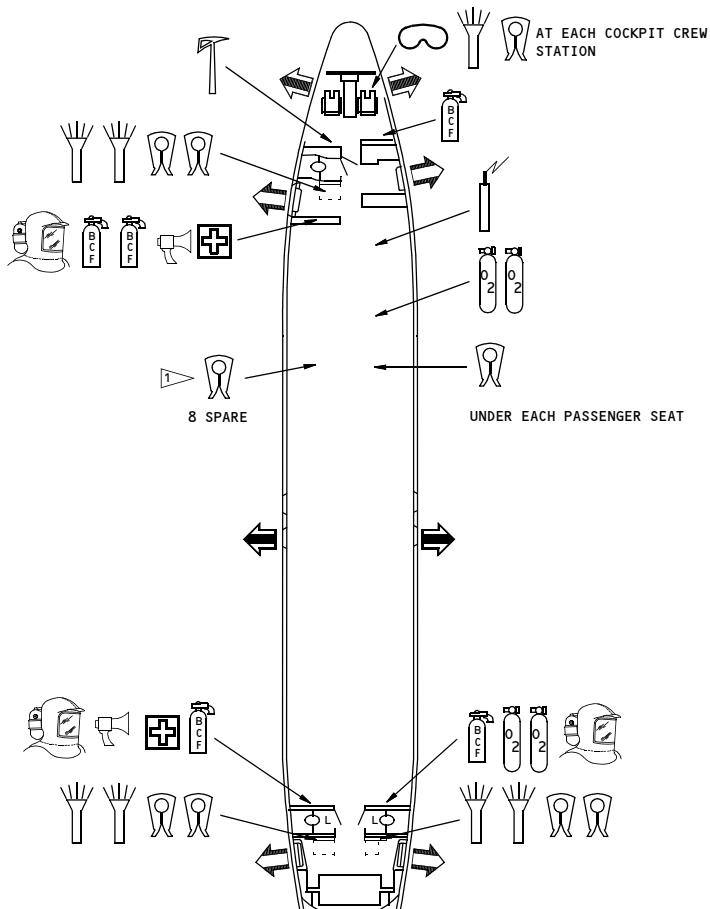
Intentionally
Blank

Emergency Equipment Symbols



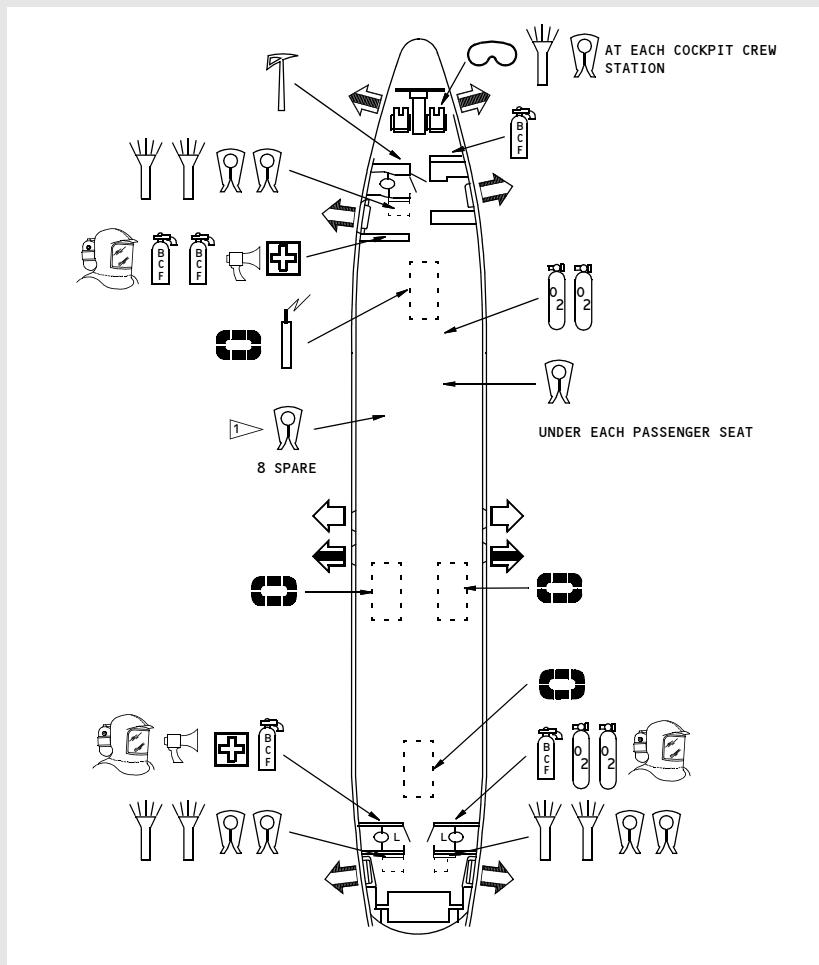
NOTE: Some symbols do not apply to all configurations.

Emergency Equipment Locations



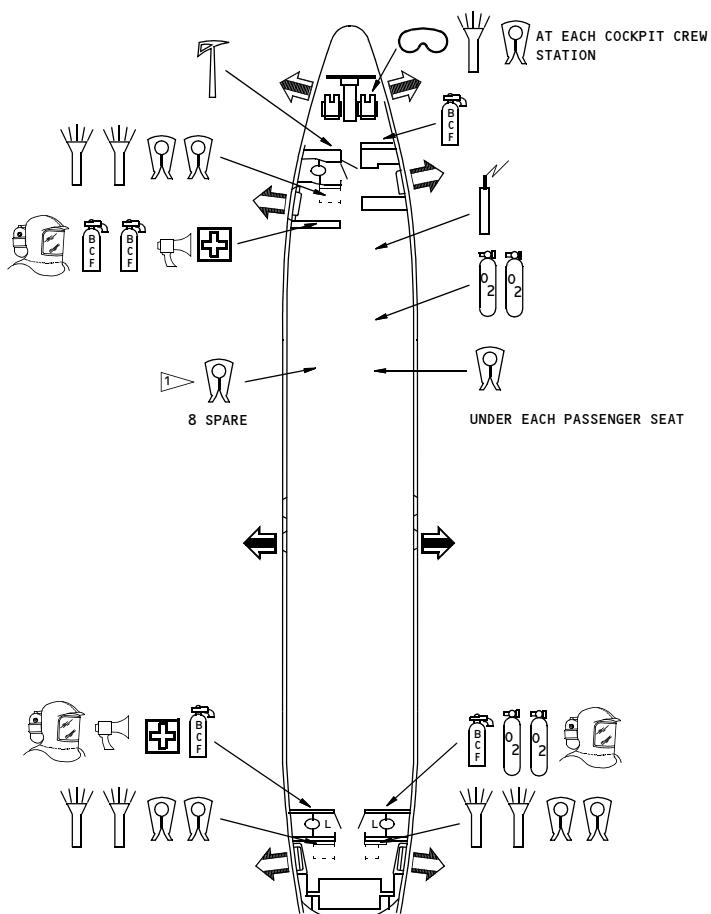
► As installed

EMERGENCY EQUIPMENT LOCATIONS
737-300



► As installed

EMERGENCY EQUIPMENT LOCATIONS
737-400



► As installed

EMERGENCY EQUIPMENT LOCATIONS
737-500

Doors and Windows

The airplane has two passenger entry doors, one cabin door (the flight deck/passenger cabin entry), two service doors, and two cargo doors. There is also a center electrical and electronic (E/E) equipment access door and an equipment compartment access door on the bottom of the airplane.

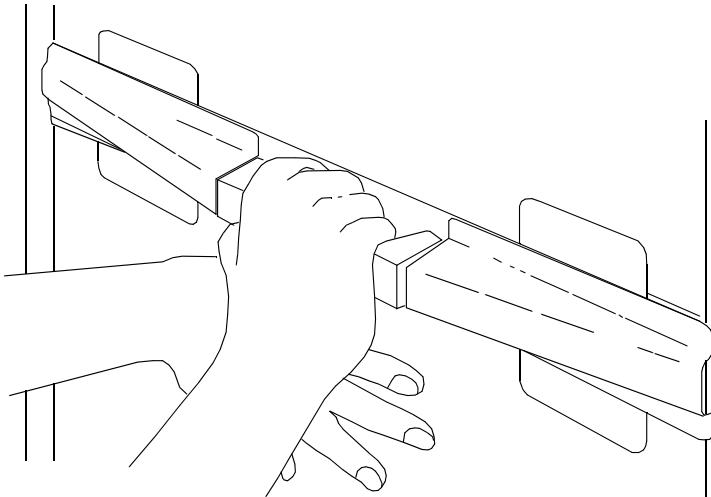
The flight deck number two windows, one on the left and one on the right, can be opened by the flight crew.

Cabin Door (as installed)

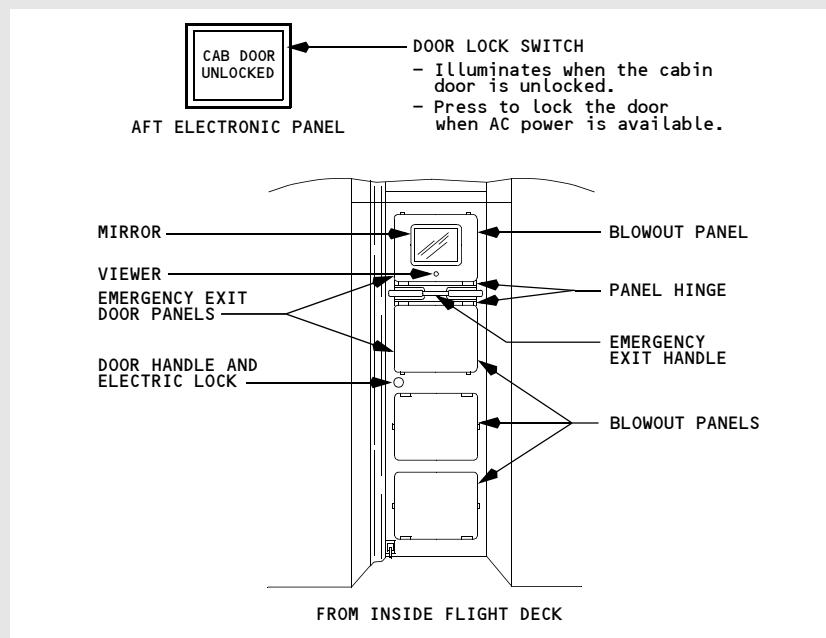
An electrical and keyed lock permits the door to be opened, closed, and locked from either side. With 115 volt AC power available, the door may be electrically locked or unlocked by pressing the door lock switch on the control stand; entrance from the passenger cabin requires a key when the door is electrically locked. The door cannot be locked without electrical power.

There are four blowout panels located in the cabin door. In the event of a sudden depressurization of the flight deck, the blowout panels hinge out from the door. This uncovers openings in the door and allows the air pressure in the flight deck and passenger cabin to equalize.

An emergency exit feature is also provided which permits the release and removal of the two upper blowout panels from the door. To operate, pull on the release handle while pressing on the panel below the release handle. Panel will not release unless both ends of handle have been pulled away from their locked position.



CABIN DOOR



CABIN DOOR

Flight Deck Door (as installed)

The flight deck door meets requirements for resistance to ballistic penetration and intruder entrance. The door opens into the passenger cabin. When closed, the door locks when electrical power is available and unlocks when electrical power is removed. A viewing lens in the door allows observation of the passenger cabin.

The door can be manually opened from the flight deck by turning the door handle. The door incorporates a deadbolt with a key lock on the passenger cabin side. Rotating both concentric deadbolt levers to the locked (horizontal) position prevents the passenger cabin key from unlocking the door. Rotating only the forward deadbolt lever to locked allows the key to unlock the door.

The flight deck access system consists of an emergency access panel, chime module, three position door lock selector, two indicator lights, and an access system switch. The emergency access panel includes a six button keypad for entering the numeric access code along with red, amber, and green lights. The red light illuminates to indicate the door is locked. When the correct emergency access code is entered, the amber light illuminates. The green light illuminates to indicate the door is unlocked.

Two indicator lights and a three position door lock selector are located on the aisle stand. Illumination of the amber LOCK FAIL light indicates the door lock has failed or the access system switch is in the OFF position.

The emergency access code is used to gain access to the flight deck in case of pilot incapacitation. A flight deck chime and illumination of the amber AUTO UNLK light indicates the correct emergency access code has been entered and the door is programmed to unlock after a time delay. Selecting the DENY position on the door lock selector denies entry and prevents further keypad entry for several minutes. To allow entry, the selector is turned to the UNLKD position which unlocks the door while held in that position. If the emergency access code is entered and the pilot takes no action, the door unlocks after expiration of the time delay. Before the door unlocks, the chime sounds continuously and the AUTO UNLK light flashes.

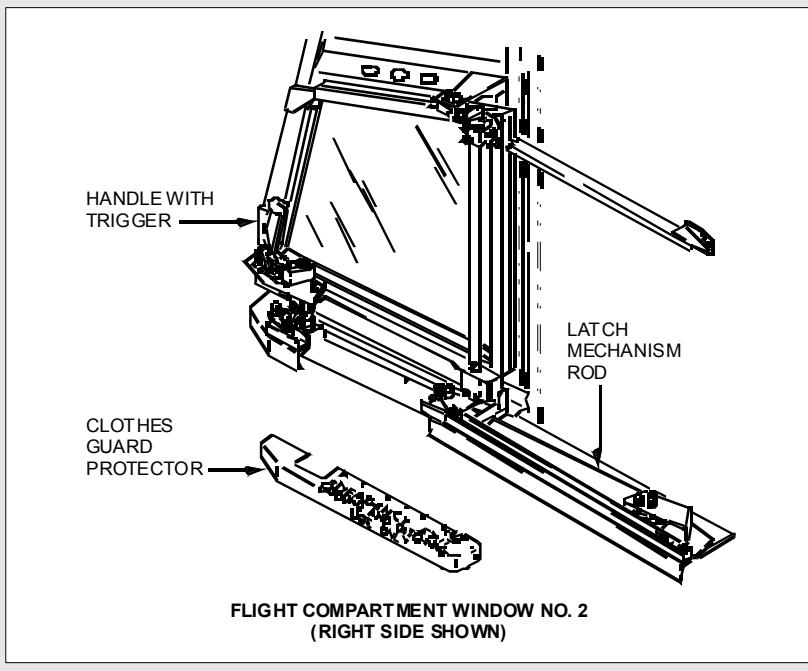
By pressing "1" then "ENT" keys on the emergency access panel, the flight deck chime will sound (if programmed).

The door incorporates two pressure sensors that unlock the decompression panels in the event pressurization is lost. The decompression panels have manual release pins. Pulling the pins frees the panels allowing egress in the event the door is jammed.

Flight Deck Number Two Windows

The flight deck number two windows can be opened on the ground or in flight and can be used for emergency evacuation. To open the window, depress the trigger and turn the handle back and inboard. After the window moves inboard, move it back until it locks in the open position.

To close the window, it must first be unlocked. Pull forward on the latch mechanism rod to unlock the window. Depress the trigger and move the window forward until the handle can be turned forward and outboard. When the trigger is released, the window latches.



Lower Cargo Compartments

The lower cargo compartments, if equipped with smoke and fire detectors and with a built-in fire extinguisher system controlled from the flight deck, satisfy the requirements for Class C compartments.

Note: The certification standards for fire safety in Class D cargo and baggage compartments have been changed. Class D compartments in airplanes used for passenger service must now comply with the standards for Class C compartments. Class C standards require that a compartment be equipped with smoke and fire detectors and with a built-in fire extinguisher system controlled from the flight deck. No inflight access is necessary, but the flight crew must be able to control the ventilating airflow into these compartments. Class D compartments in airplanes used only for cargo service must also comply with the standards for Class C, or with the detection standards for Class E compartments.

There are two cargo compartment doors on the lower right side of the fuselage. Both are plug type, inward opening pressure doors, hinged at their upper edges and operated manually from either inside or outside the airplane. Except for slight difference in shape, both doors are similar in design and operation. The door is locked closed by four latches. Each door has a balance mechanism which creates door-open force slightly more than equal to the weight of the door. The door can therefore, with little effort, be swung open, until it engages a mechanical lock. The door can be closed easily by pulling a lanyard attached to the door, releasing the uplatch, grasping the handle and closing the door.

A pressure equalization valve is in the aft bulkhead of each compartment. The valves let only enough air flow into or out of the cargo compartments to keep the pressures nearly the same as the cabin pressure.

Blowout panels in the lower cargo compartments provide pressure relief at a greater rate than the pressure equalization valve in case the airplane pressurization is lost.

Emergency Escape

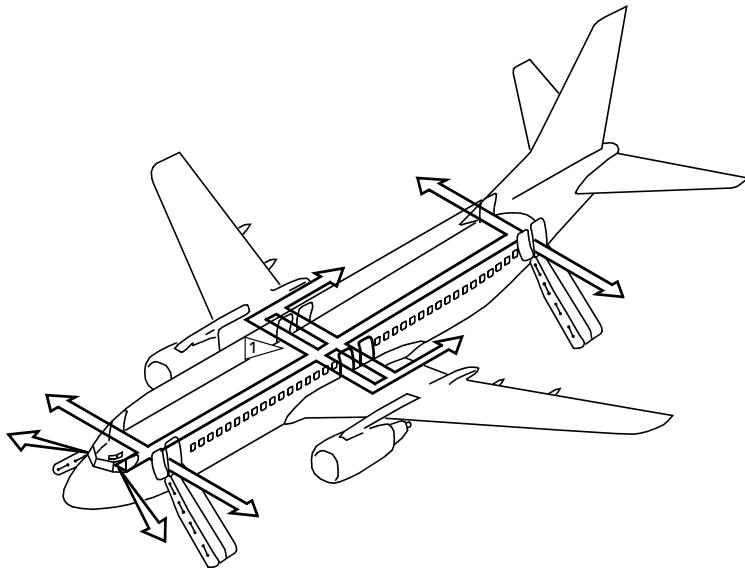
Emergency escape information included in this chapter includes:

- emergency evacuation routes
- flight deck windows
- escape slides
- escape straps
- escape hatches

Emergency Evacuation Routes

Emergency evacuation may be accomplished through four entry/service doors and two overwing escape hatches. 737-400 airplanes have four overwing escape hatches. Flight deck crew members may evacuate the airplane through two sliding flight deck windows.

Emergency Evacuation Routes



► 737-400

Flight Deck Window Emergency Egress

Flight Deck Escape Straps

An escape strap is attached to a compartment above each No. 2 window. The straps may be used by a crewmember for escape.

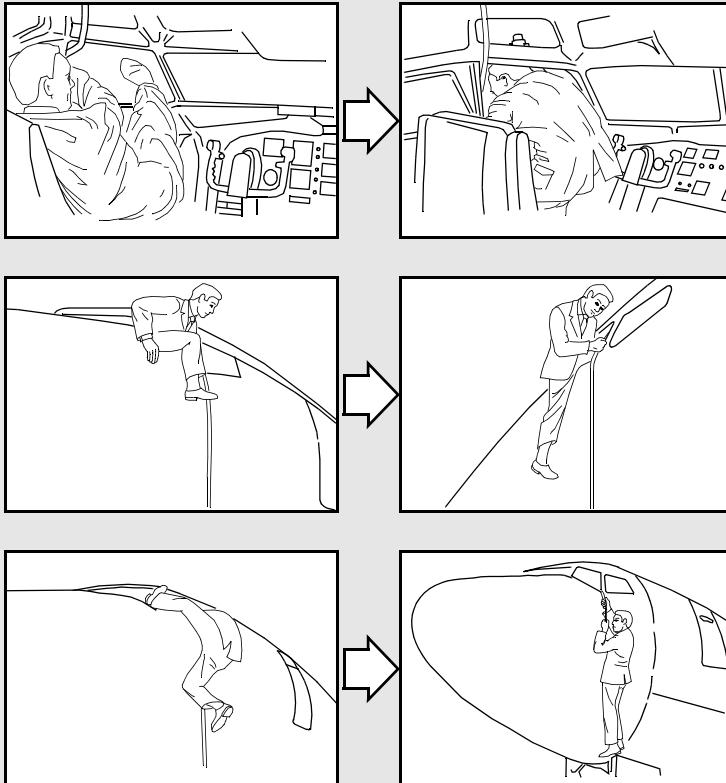
Flight Deck Number Two Windows

Flight deck sliding windows are opened by squeezing the lock release in the handle, rotating the handle inward, and sliding the window aft until it locks. The right hand window has provisions for exterior access as well.

If the flight deck number two windows must be used for emergency egress, use the following procedure:

- open the window
- open the escape strap compartment (above and aft of window)
- pull on the escape strap to ensure it is securely attached
- throw the strap out the window
- sit on the window sill with upper body outside
- exit in accordance with the following illustration.

CAUTION: Ensure the escape strap is securely fastened to the airplane.



The above illustrated method of departure would probably be the easiest for most crewmembers. This technique is difficult and should be used only in extreme emergency.

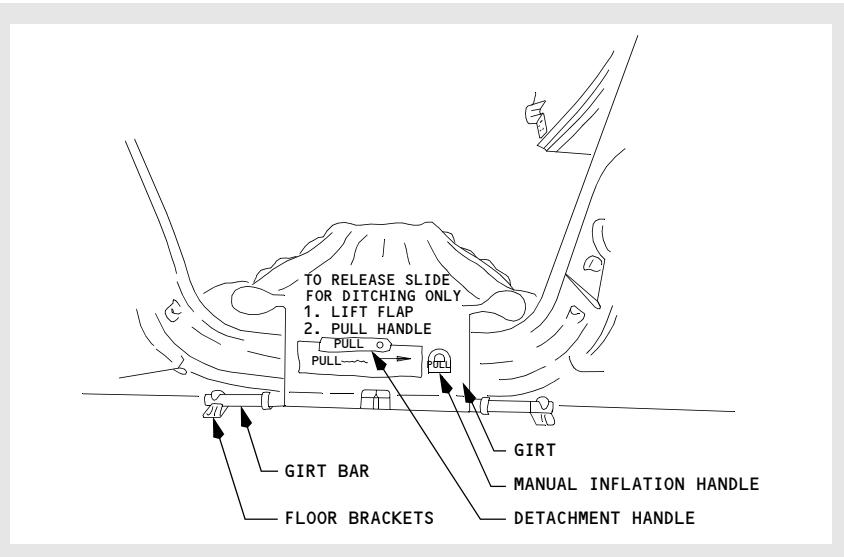
Flight Deck Escape Straps

Escape straps are attached to compartments above flight deck sliding windows. The straps may be used by crew members to lower themselves to the ground.

Escape Slide Detachment Handle

The slide has not been certified to be part of the water landing emergency equipment. In a water environment, the slide may not properly inflate when deployed. If the deployed slide is recognized to be a potential obstruction to egress, a quick release handle is provided near the top of the slide. This handle is protected by a cover and is placarded. The escape slide is detached from the airplane by pulling the detachment handle. Once detached from the door sill, the slide is tethered to the door sill by a lanyard. A properly inflated slide could be buoyant, and useful as a flotation device for passengers in the water. Hand grips are positioned along the sides of the slide.

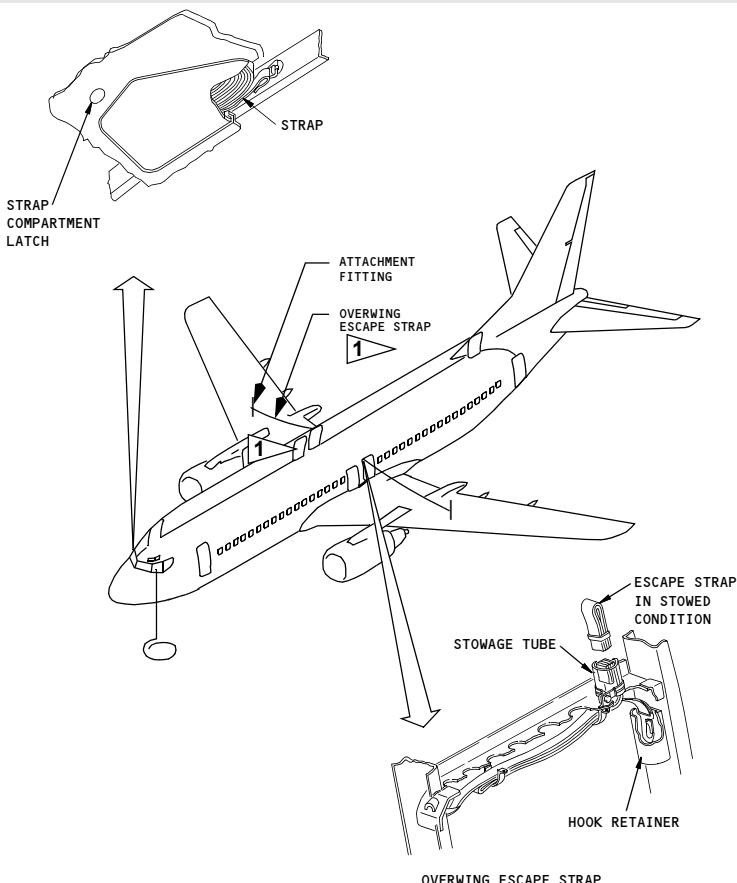
Escape Slide Detachment Handle



Overwing Escape Straps

Escape straps are installed above each emergency escape hatch frame. The overwing escape hatches must be removed to expose the straps. One end of the strap is attached to the hatch frame. The remainder of the strap is stowed in a tube extending into the cabin ceiling. To use, the strap is pulled free from its stowage and attached to a ring on the top surface of the wing. The escape strap can be used as a hand hold in a ditching emergency for passengers to walk out on the wing and step into a life raft.

Overwing Escape Straps

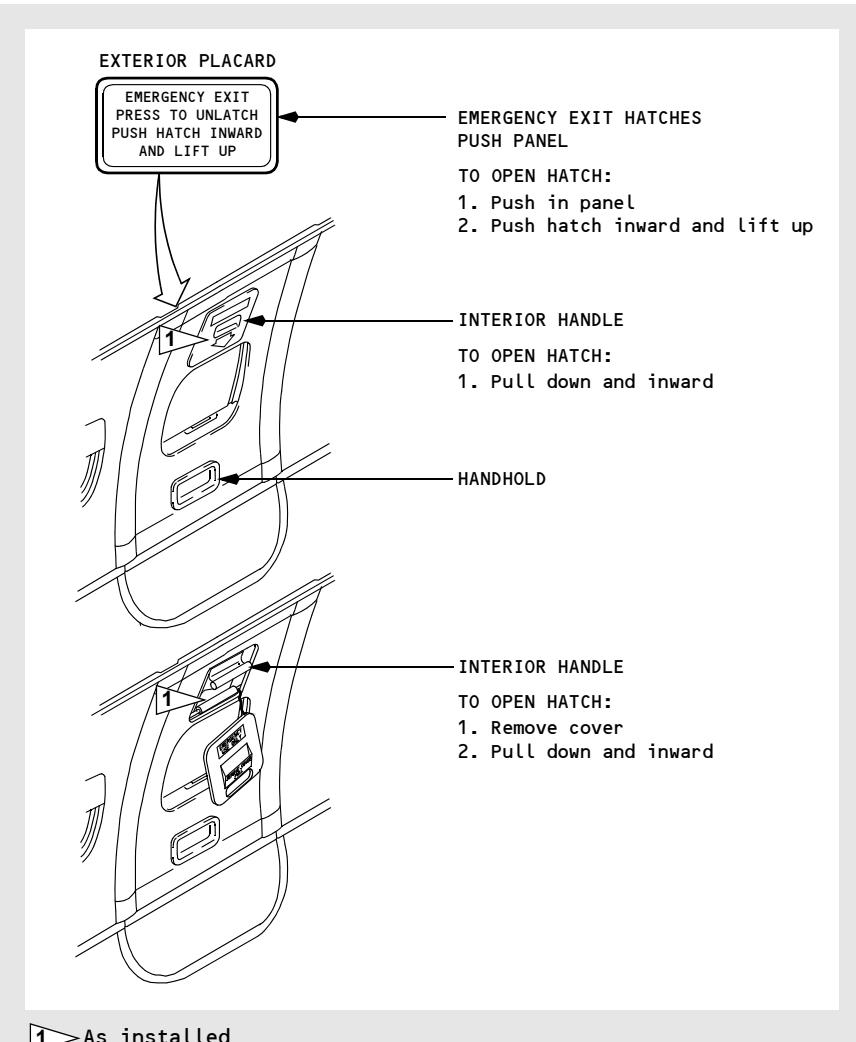


1 ▶ 737-400

Overwing Escape Hatches

Two escape hatches are located in the passenger cabin over the wings. These are plug type hatches and are held in place by mechanical locks and airplane cabin pressure. The hatches can be opened from the inside or from outside of the airplane by a spring-loaded handle at the top of the hatch. A seat back blocking an exit may be pushed forward by applying force to the top of the seat back. For safety reasons, hatches should not be removed in flight.

Overwing Escape Hatches



As installed

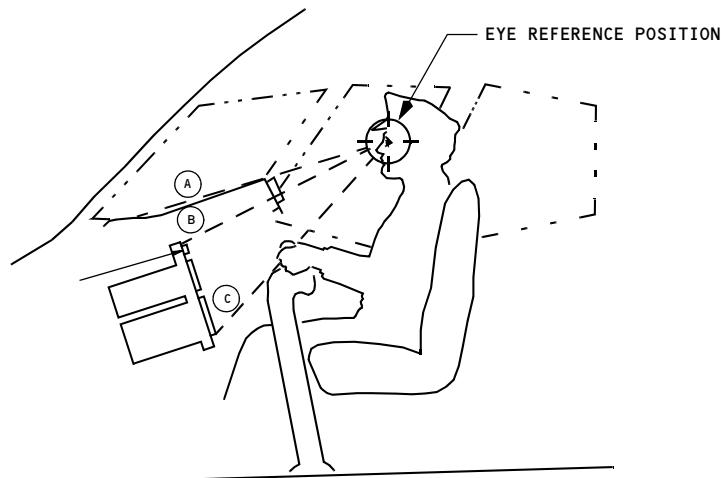
WARNING: Do not remove hatches in flight in preparation for passenger evacuation. For emergency evacuation on the ground or in water, remove hatch and place so as not to obstruct egress. The hatch may be thrown out onto the wing, placed on the seat arm rests, or placed in any other suitable location as dictated by the conditions at the time of airplane evacuation.

Pilot Seat Adjustment

Adjust the seat position with the appropriate controls to obtain the optimum eye reference position. Use the handhold above the forward window to assist. The following sight references are used:

- Sight along the upper surface of the glareshield with a small amount of the airplane nose structure visible (A)
- Sight under the glareshield to view the A/P-A/T-FMC lights panel (B)
- Sight over the control column until the bottom of the EHSI is visible (C).

Pilot Seat Adjustment



Galleys

Galleys are located in the passenger cabin to provide convenient and rapid service to the passengers. Generally, they are installed in the cabin adjacent to the forward and aft galley service doors.

In general the equipment of the galley unit consists of the following main items:

- high speed ovens
- hot beverage containers
- hot cup receptacles
- refrigeration and main storage compartments

Electrical control panel switches and circuit breakers to operate the above equipment are conveniently located within the galley work area. Storage space, miscellaneous drawers, and waste containers are also integrated in the galley units.

Electrical Power

Electricity for the galleys is 115V AC supplied from the airplane transfer buses and controlled by a switch on the overhead panel. Circuit breakers are located on the galleys and on the P-6 circuit breaker panel.

Water Service

Water is supplied to the galleys from the airplane's pressurized water system and, in an emergency, may be shut off at the galley.

Water System

The airplane's potable water system is supplied from a single tank located behind the aft cargo compartment. Fresh water is supplied to the galleys and lavatory sinks.

Quantity Indication and System Operation

A quantity indicator is located on the attendant's panel. When the "PUSH" button on the indicator is pressed, lights illuminate to show the water level.

The system is pressurized by engine bleed air or by the water system air compressor.

A shutoff valve is located in the cabinet below the sink in each lavatory. The drain position of this valve is used to drain all water overboard. Normally, the drain shutoff valves are ON.

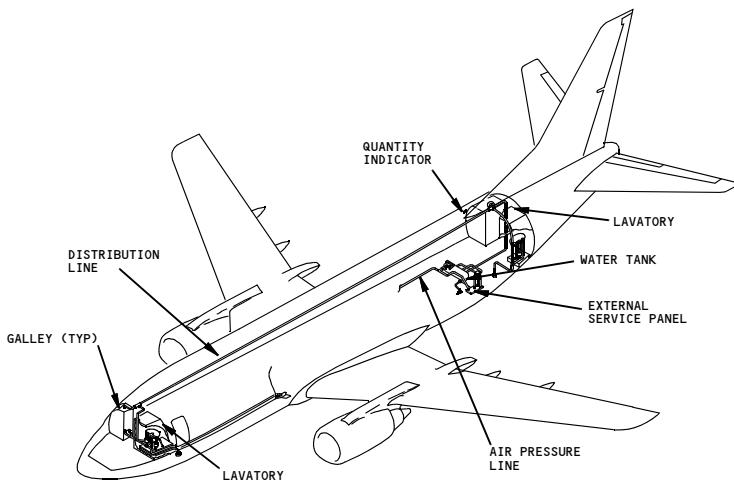
Hot Water

Hot and cold water is available in some lavatories. The water heater is located below the lavatory sink. When emptied, it heats a new water charge in four minutes. An amber light is ON when the heater is operating normally. The heater has an overheat switch which turns off the heating element if an excess temperature is reached. The heater may be turned off at any time by using a manual switch on the heater. Hot and cold water is also supplied at the galleys.

Servicing

The system is serviced from an exterior panel on the aft left side of the airplane. Pressure filling is required. Waste water from the galleys and lavatory wash basins is drained overboard through two heated drain masts. The drain masts are on the bottom of the fuselage, one forward and one aft.

Water System



Forward Airstair

The forward airstair provides the capability of boarding passengers without relying on the availability of airport ground equipment. The airstair is electrically operated and may be controlled from either inside or outside the airplane. The airstair is stowed inside a compartment just below the forward entry door. The compartment has a pressure door that automatically opens before the airstair can operate. For passenger safety, upper handrails are attached to support brackets inside the entry door after the airstair is fully extended.

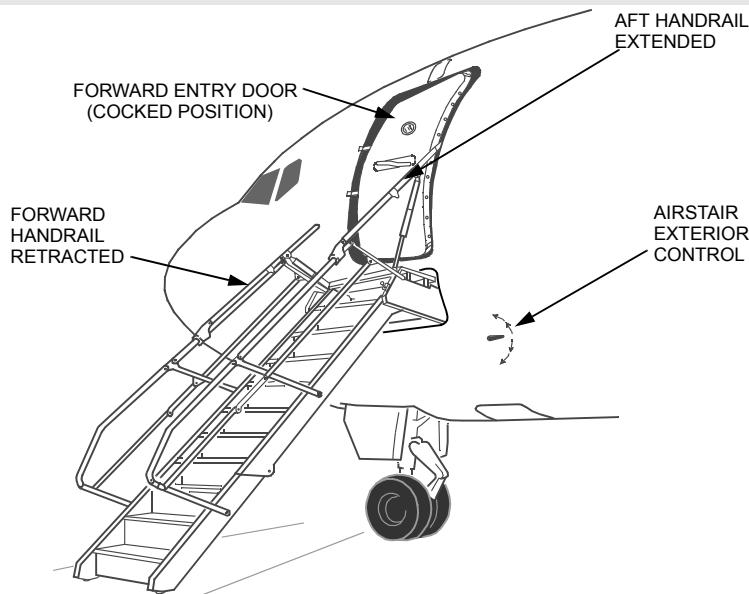
Interior Control

The interior control panel is located above the forward entry door. An amber STAIRS OPERATING light on the panel illuminates when the airstair is in transit. The airstair tread lights on the airstair steps are controlled by a single three-position airstair LIGHTS switch. With the switch in the AUTO position, the tread lights illuminate when the airstair makes contact with the ground and extinguish when the airstair retracts. The interior control panel has two modes of operation, normal and standby. The standby system provides an alternate means of electrical control in the event the normal mode of operation is not available. Normal operation requires both AC and DC power. Standby operation requires the battery switch to be ON. Both operating modes require the forward entry door to be partially open. The two airstair control switches have three positions - EXTEND, RETRACT, and a center neutral (off) position. For standby operation, hold the spring-loaded guard to the left, then select either EXTEND or RETRACT. The guard is spring-loaded to the right to prevent inadvertent operation of the airstair in standby.

Exterior Control

The exterior control is located to the right and below the airstair compartment. Operating instructions are located around the handle. When operating the airstair with the exterior control, the forward entry door need not be open. The exterior control handle by-passes the door-open requirement. The control handle is normally flush with the fuselage. Pushing the button in the center of the handle extends the handle for easy operation. The handle rotates clockwise or counterclockwise to extend or retract the airstair. A two-position switch, labeled NORMAL and STANDBY, is located in the exterior handle recess. The switch is spring-loaded to NORMAL. Holding the NORMAL/STANDBY Switch to STANDBY provides DC power from the battery bus for airstair operation. The BAT switch on the flight deck does not need to be ON when operating the airstair on standby from the exterior control panel. The control handle rotates to extend or retract airstair. The use of the standby system from either the interior or exterior control by-passes the handrail and lower ladder safety circuits. Caution must be exercised when using the standby system. If the upper handrail extensions are not properly stowed before retraction, damage to the airplane structure or damage to the airstair's handrail may result. An amber AIRSTAIR light, located on the overhead door caution annunciator panel illuminates when the airstair pressure door is unlocked. Illumination of the AIRSTAIR light also activates the DOORS annunciator light and the MASTER CAUTION lights. The Airstair light is inoperative when the main AC bus is not powered. The MASTER CAUTION and DOORS lights illuminate in normal or standby operation of the airstair.

Forward Airstair



WARNING: Use care not to fall from the airstair platform when operating the forward entry door. The small platform area and bad weather can make the door difficult to operate.

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Air Systems

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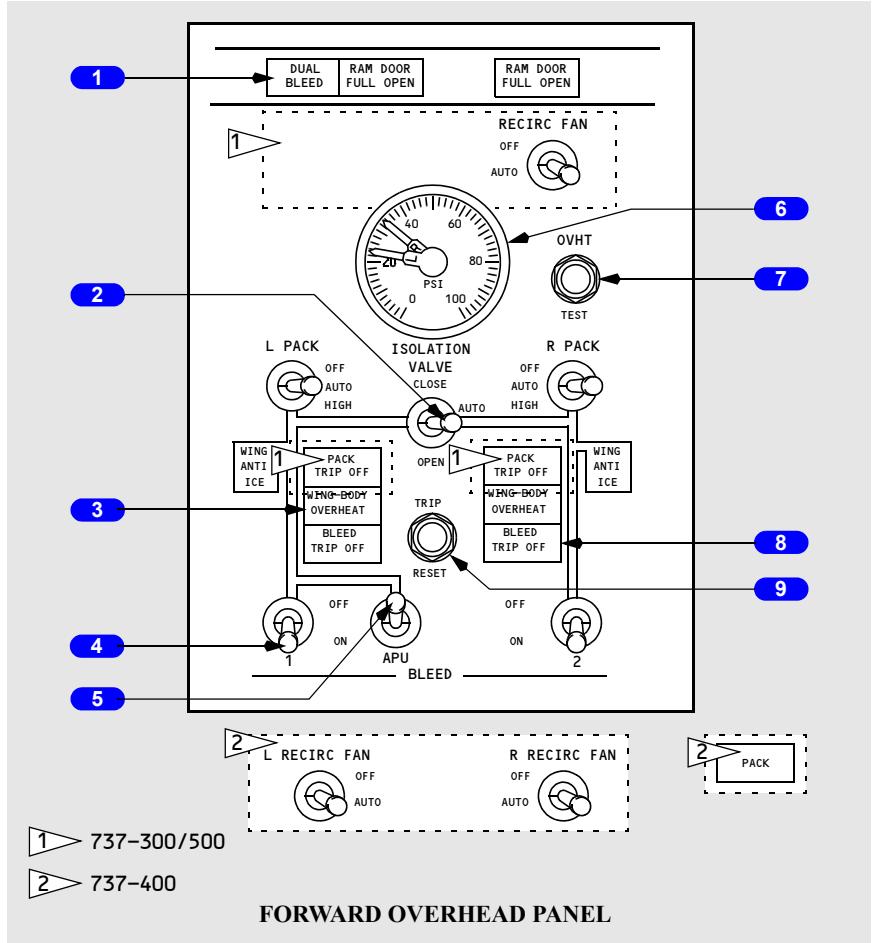
Air Systems

Controls and Indicators

Chapter 2

Section 10

Bleed Air Controls and Indicators



1 DUAL BLEED Light

Illuminated (amber) – APU bleed air valve open and engine No. 1 BLEED air switch ON, or engine No. 2 BLEED air switch ON, APU bleed air valve and isolation valve open.

2 ISOLATION VALVE Switch

CLOSE – closes isolation valve.

AUTO –

- closes isolation valve if both engine BLEED air switches are ON and both air conditioning PACK switches are AUTO or HIGH
- opens isolation valve automatically if either engine BLEED air or air conditioning PACK switch positioned OFF.

OPEN – opens isolation valve.

3 WING–BODY OVERHEAT Light

Illuminated (amber) –

- left light indicates overheat from bleed air duct leak in left engine strut, left inboard wing leading edge, left air conditioning bay, keel beam or APU bleed air duct
- right light indicates overheat from bleed air duct leak in right engine strut, right inboard wing leading edge or right air conditioning bay.

4 Engine BLEED Air Switches

OFF – closes engine bleed air valve.

ON – opens engine bleed air valve when engines are operating.

5 APU BLEED Air Switch

OFF – closes APU bleed air valve.

ON – opens APU bleed air valve when APU is operating.

6 Bleed Air DUCT PRESSURE Indicator

Indicates pressure in L and R (left and right) bleed air ducts.

7 Wing–Body Overheat (OVHT) TEST Switch

PUSH –

- tests wing–body overheat detector circuits
- illuminates both WING–BODY OVERHEAT lights.

8 BLEED TRIP OFF Light

Illuminated (amber) – excessive engine bleed air temperature or pressure

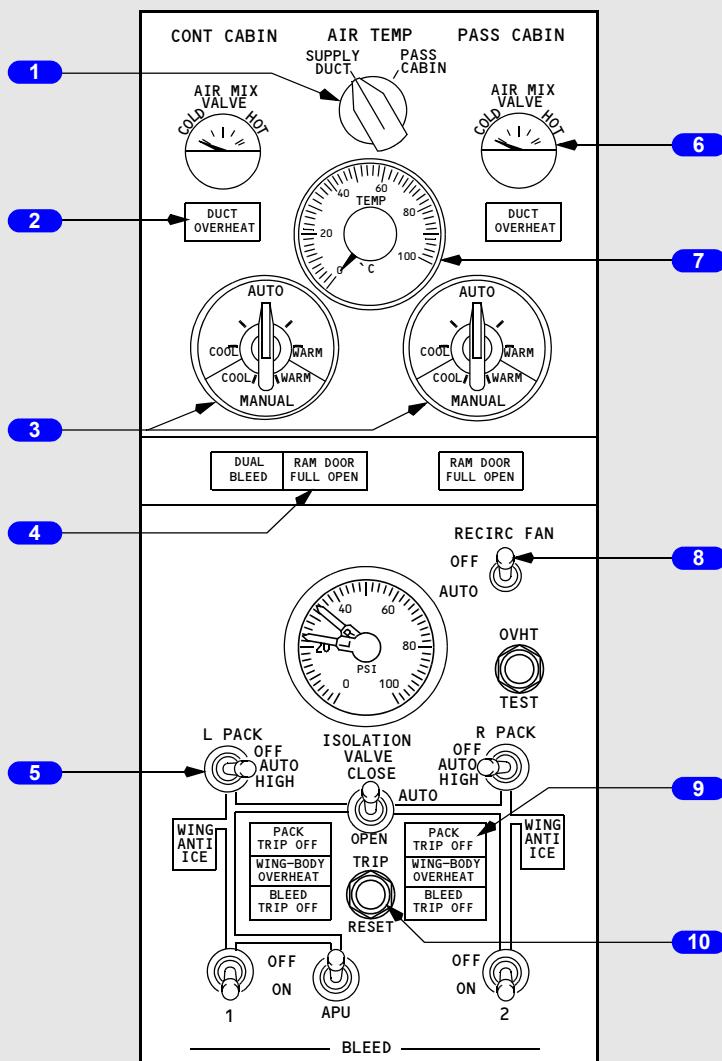
- related engine bleed air valve closes automatically
- requires reset.

9 TRIP RESET Switch

PUSH (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights (BLEED TRIP OFF, PACK and ZONE TEMP lights for 737-400)
- lights remain illuminated until reset.

Air Conditioning Controls and Indicators (737-300/500)



FORWARD OVERHEAD PANEL

1 AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – selects main distribution supply duct sensor for TEMP indicator.

PASS CABIN – selects passenger cabin sensor for TEMP indicator.

2 DUCT OVERHEAT Light

Illuminated (amber) –

- bleed air temperature in related duct exceeds limit
- air mix valves drive full cold
- requires reset.

3 Control (CONT) CABIN and Passenger (PASS) CABIN Temperature Selector

AUTO – automatic temperature controller controls passenger cabin or flight deck temperature as selected.

MANUAL – air mix valves controlled manually. Automatic temperature controller bypassed.

4 RAM DOOR FULL OPEN Light

Illuminated (blue) – indicates ram door in full open position.

5 Air Conditioning PACK Switch

OFF – pack signalled OFF.

AUTO –

- with both packs operating, each pack regulates to low flow
- with one pack operating, operating pack regulates to high flow in flight with flaps up
- when operating one pack from APU (both engine BLEED air switches OFF), regulates to high flow.

HIGH –

- pack regulates to high flow
- provides maximum flow rate on ground with APU BLEED air switch ON.

6 AIR MIX VALVE Indicator

Indicates position of air mix valves:

- controlled automatically with related temperature selector in AUTO
- controlled manually with related temperature selector in MANUAL.

7 Air Temperature (TEMP) Indicator

Indicates temperature at location selected with AIR TEMP source selector.

8 Recirculation (RECIRC) FAN Switch

OFF – fan signalled OFF

AUTO – fan signalled on except when both packs operating with either PACK switch in HIGH.

9 PACK TRIP OFF Light

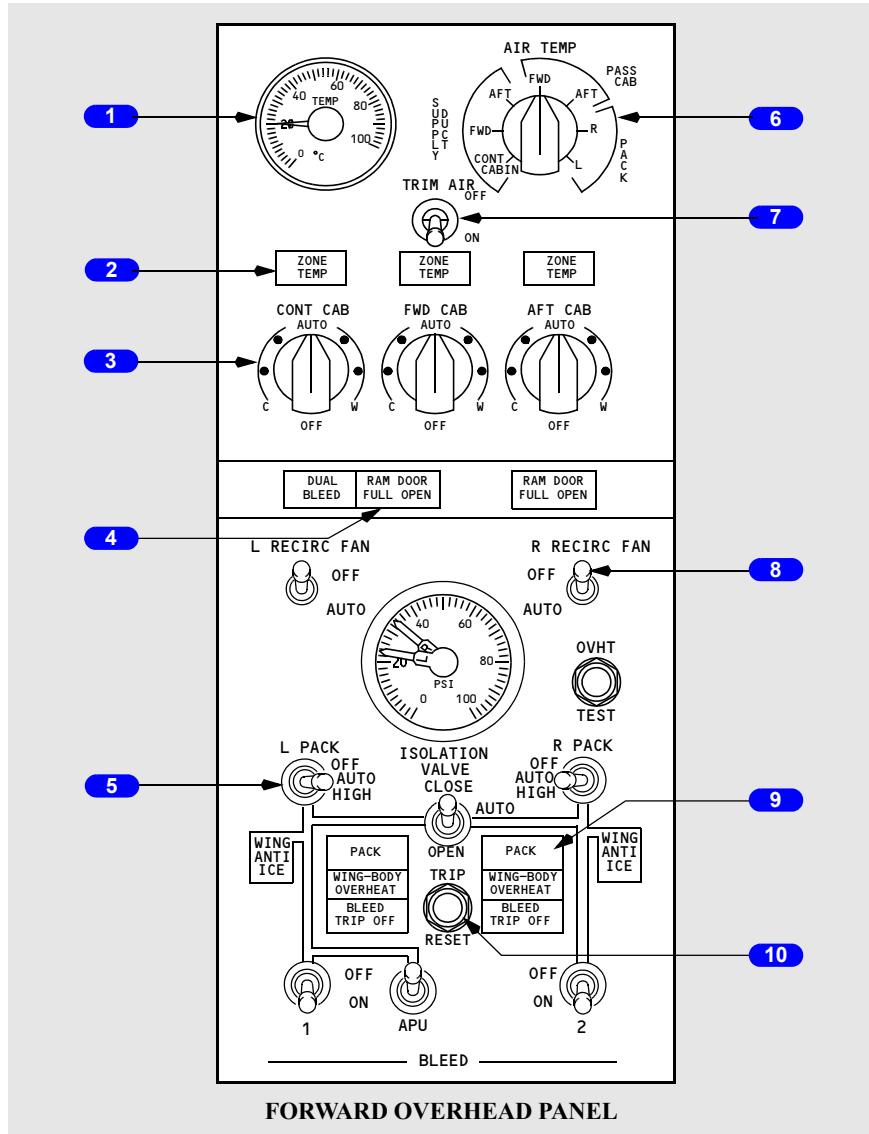
Illuminated (amber) –

- indicates pack temperature has exceeded limits
- related pack valve automatically closes and mix valves drive full cold
- requires reset.

10 TRIP RESET Switch

PUSH (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights
- lights remain illuminated until reset.

Air Conditioning Controls and Indicators (737-400)**1 Air Temperature (TEMP) Indicator**

Indicates temperature at location selected with AIR TEMP source selector

2 ZONE TEMP Lights

Illuminated (amber) –

- CONT CAB indicates a duct temperature overheat, or failure of the flight deck primary and standby temperature control
- FWD CAB or AFT CAB indicates duct temperature overheat.

During Master Caution light recall:

- CONT CAB indicates failure of the flight deck primary or standby temperature control
- either FWD CAB or AFT CAB indicates failure of the associated zone temperature control
- lights will extinguish when MASTER CAUTION is reset.

3 Temperature Selector

AUTO – provides automatic temperature control for the associated zones.

Rotating the controls towards C (cool) or W (warm) sets the desired temperature

OFF – closes the associated trim air modulating valve.

4 RAM DOOR FULL OPEN Light

Illuminated (blue) – indicates ram door in full open position.

5 Air Conditioning PACK Switch

OFF – pack signalled OFF.

AUTO –

- with both packs operating, each pack regulates to low flow
- with one pack operating, operating pack regulates to high flow in flight with flaps up
- when operating one pack from APU (both engine BLEED air switches OFF), regulates to high flow.

HIGH –

- pack regulates to high flow
- provides maximum flow rate on ground with APU BLEED air switch ON.

6 AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – selects appropriate zone supply duct temperature

PASS CABIN – selects forward or aft passenger cabin temperature

PACK – selects left or right pack temperatures.

7 TRIM AIR Switch

ON – trim air pressure regulating and shutoff valve signaled open.

OFF – trim air pressure regulating and shutoff valve signaled closed.

8 Recirculation (RECIRC) FAN Switch

OFF – fan signalled OFF

AUTO –

- in flight –
 - the left recirculation fan operates if both packs are operating unless either PACK switch is in HIGH
 - the right recirculation fan operates if both packs are operating unless both PACK switches are in HIGH.
- on the ground –
 - the left recirculation fan operates unless both PACK switches are in HIGH
 - the right recirculation fan operates even if both PACK switches are in HIGH.

9 PACK Light

Illuminated (amber) –

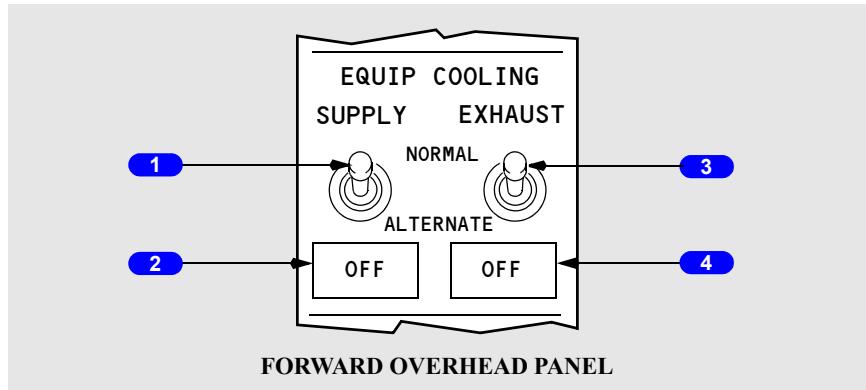
- indicates pack trip off or failure of both primary and standby pack controls
- during MASTER CAUTION light recall, indicates failure of either primary or standby pack control . Extinguishes when MASTER CAUTION is reset.

10 TRIP RESET Switch

PUSH (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK and ZONE TEMP lights
- lights remain illuminated until reset.

Equipment Cooling Panel



1 Equipment (EQUIP) COOLING SUPPLY Switch

NORMAL – normal cooling supply fan activated.

ALTERNATE – alternate cooling supply fan activated.

2 Equipment Cooling Supply OFF Light

Illuminated (amber) – no airflow from selected cooling supply fan.

3 Equipment (EQUIP) COOLING EXHAUST Switch

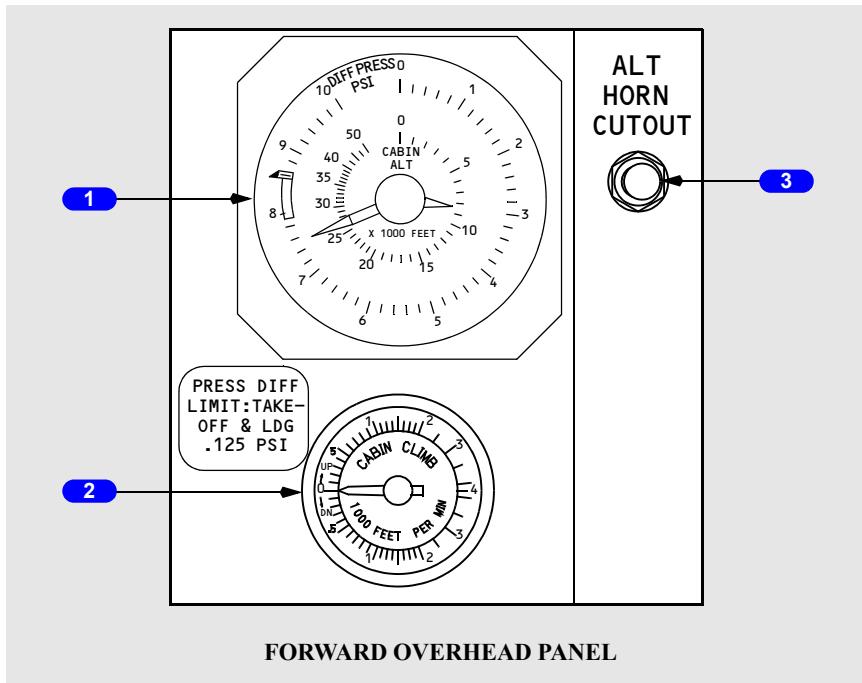
NORMAL – normal cooling exhaust fan activated.

ALTERNATE – alternate cooling exhaust fan activated.

4 Equipment Cooling Exhaust OFF Light

Illuminated (amber) – no airflow from selected cooling exhaust fan.

Cabin Altitude Panel



1 CABIN Altitude (ALT)/Differential Pressure (DIFF PRESS) Indicator

Inner Scale – indicates cabin altitude in feet.

Outer Scale – indicates the difference between cabin pressure and ambient pressure in psi.

2 CABIN Rate of CLIMB Indicator

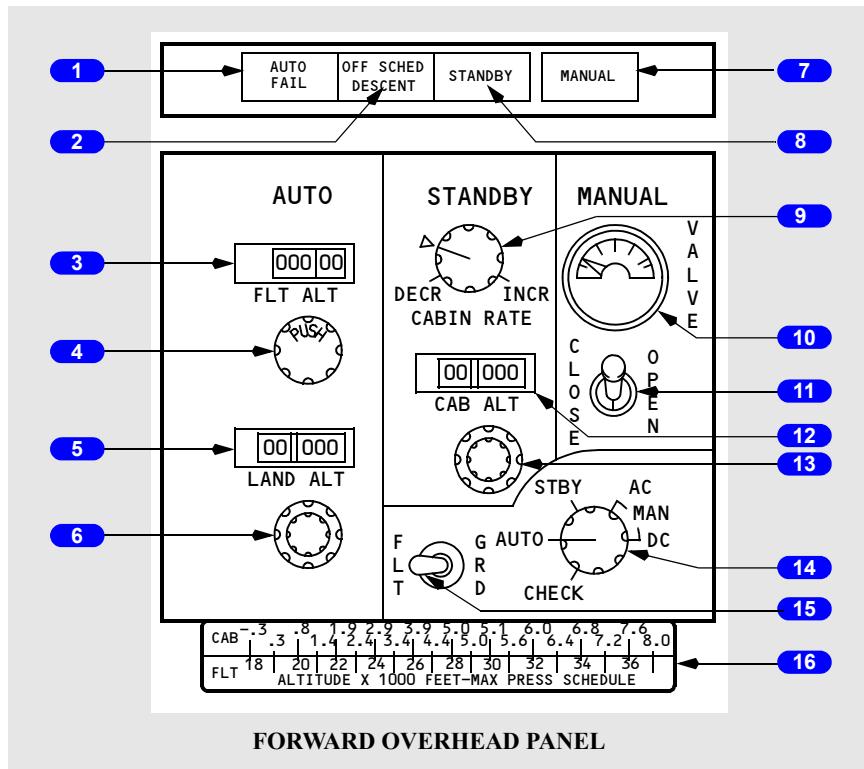
Indicates cabin rate of climb or descent in feet per minute.

3 Altitude (ALT) HORN CUTOUT Switch

PUSH –

- cuts out intermittent cabin altitude warning horn
- altitude warning horn sounds when cabin reaches 10,000 feet altitude.

Cabin Pressurization Panel



1 AUTO FAIL Light

Illuminated (amber) – automatic pressurization control failure. Control automatically transfers to the standby mode.

2 OFF Schedule (SCHED) DESCENT Light

Illuminated (amber) – airplane descended before reaching the planned cruise altitude set in the FLT ALT indicator.

3 Flight Altitude (FLT ALT) Indicator

- indicates selected cruise altitude
- set before takeoff.

4 Flight Altitude Selector

Push/rotate to set planned cruise altitude.

5 Landing Altitude (LAND ALT) Indicator

- indicates altitude of intended landing field
- set before takeoff.

6 Landing Altitude Selector

Rotate to select planned landing field altitude –

- large diameter control sets 1000 foot increments
- small diameter control sets 10 foot increments.

7 MANUAL Light

Illuminated (green) – pressurization system operating in the manual mode.

8 STANDBY Light

Illuminated (green) – pressurization system operating in the standby mode.

9 Cabin Rate Selector

- DECR – cabin altitude rate of change equals 50 ft/min
- INCR – cabin altitude rate of change equals 2000 ft/min
- Index – cabin altitude rate of change equals 300 ft/min.

10 Outflow VALVE Position Indicator

- indicates position of outflow valve
- operates in all modes.

Note: Indicator moves to the full left position when no AC power is available.

11 Outflow Valve Switch (spring-loaded to center)

CLOSE – closes outflow valve electrically with pressurization mode selector in MAN position.

OPEN – opens outflow valve electrically with pressurization mode selector in MAN position.

12 Cabin Altitude (CAB ALT) Indicator

- Indicates selected cabin altitude
- Set before takeoff.

13 Cabin Altitude Selector

Rotate to select desired cabin altitude.

- large diameter control sets 1000 foot increments
- small diameter control sets 10 foot increments.

14 Pressurization Mode Selector

AUTO – pressurization system controlled automatically.

STBY – pressurization system controlled through the standby mode.

MAN –

- pressurization system controlled manually by Outflow Valve Switch
- AC – outflow valve operates from AC power
- DC – outflow valve operates from DC power
- all auto and standby circuits bypassed

CHECK – Tests auto failure function of auto system.

15 Flight /Ground Switch

AUTO mode –

- GRD – on the ground, drives the pressurization outflow valve full open at a controlled rate and depressurizes the airplane. After takeoff, inhibited; functions the same as FLT position
- FLT – on the ground, pressurizes the cabin to approximately (-200ft) below airport elevation. After takeoff, cabin pressure is automatically controlled in climb and descent as a function of airplane altitude. In cruise, cabin pressure is held constant.

STANDBY mode –

- GRD – on the ground, drives outflow valve open at the rate selected by the Cabin Rate Selector. After takeoff, inhibited; functions the same as FLT position
- FLT – pressurizes the airplane at a rate selected by the Cabin Rate Selector to the cabin altitude selected on the Cabin Altitude Indicator (normally -200ft below takeoff field elevation).

Flight/Ground Switch (non-standard)

FLT –

- AUTO – while on the ground, pressurizes the cabin to about 200 feet below airport altitude. Inhibited in flight
- STBY – while on the ground, pressurizes the cabin to altitude selected on the CAB/ALT selector. After takeoff, inhibited
- MAN AC or MAN DC – in flight or on the ground, each time the outflow valve switch is positioned to CLOSE or OPEN, the outflow valve moves in increments.

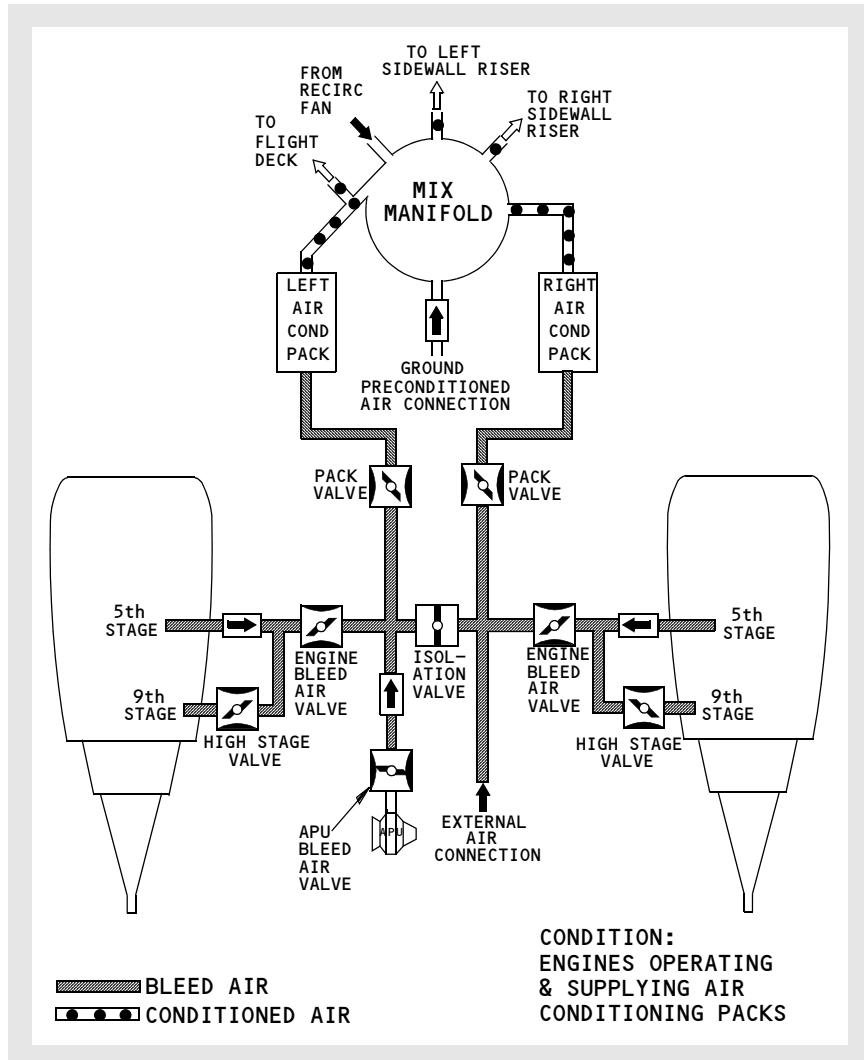
GRD –

- AUTO or STBY – while on the ground, depressurizes the airplane. Inhibited in flight
- MAN AC or MAN DC – in flight or on the ground, when the outflow valve switch is held to CLOSE or OPEN, the outflow valve moves continuously.

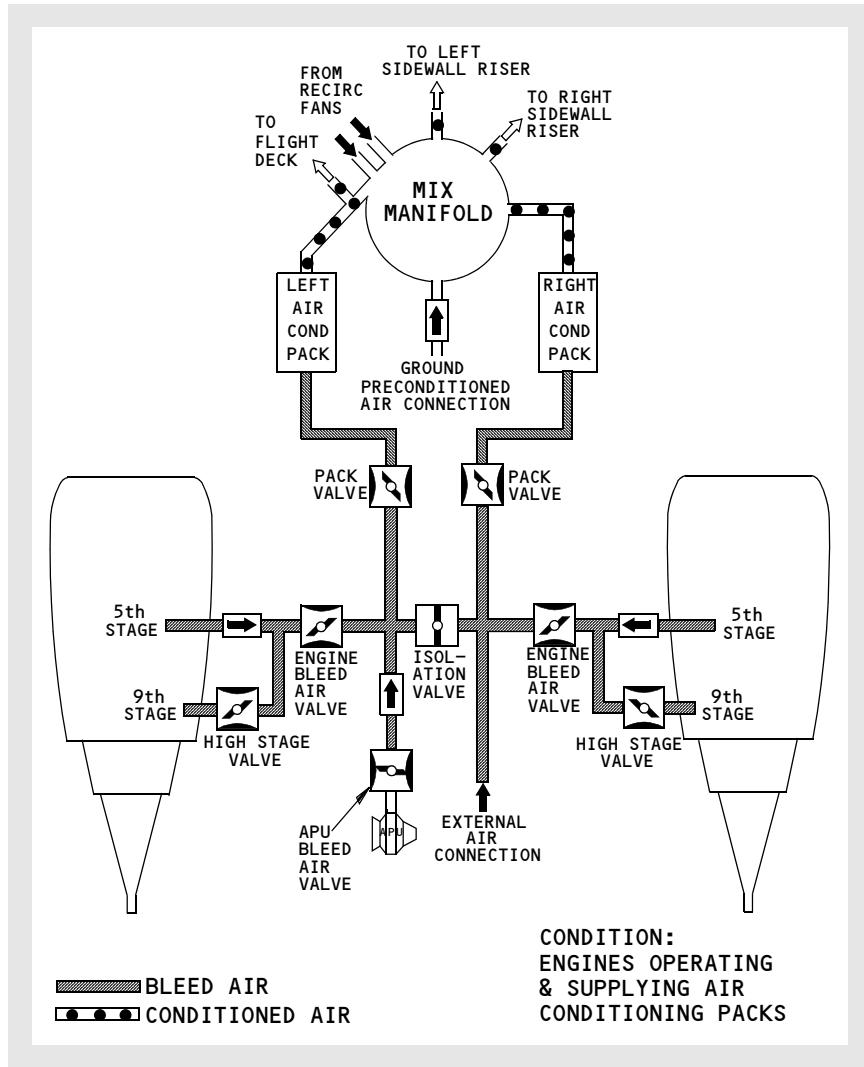
16 Cabin /Flight Altitude (CAB ALT)(FLT ALT) Placard

Used to determine setting for cabin altitude when operating in standby and manual modes.

Air Systems Schematic (737-300/500)



Air Systems Schematic (737-400)



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Air Systems

Bleed Air System Description

Chapter 2

Section 20

Introduction

Air for the bleed air system can be supplied by the engines, APU, or an external air cart/source. The APU or external cart supplies air to the bleed air duct prior to engine start. After engine start, air for the bleed air system is normally supplied by the engines.

The following systems rely on the bleed air system for operation:

- Air conditioning/pressurization
- Wing and engine thermal anti-icing
- Engine starting
- Hydraulic reservoirs pressurization
- Water tank pressurization
- Aspirated TAT probe

Switches on the air conditioning panel operate the APU and engine bleed air supply system.

Engine Bleed System Supply

Engine bleed air is obtained from the 5th and 9th stages of the compressor section. When 5th stage low pressure bleed air is insufficient for the bleed air system requirements, the high stage valve modulates open to maintain adequate bleed air pressure. During takeoff, climb, and most cruise conditions, low pressure bleed air from the 5th stage is adequate and the high stage valve remains closed.

Engine Bleed Air Valves

The engine bleed air valve acts as a pressure regulator and shutoff valve. With the engine bleed air switch ON, the valve is DC activated and pressure operated. The valve maintains proper system operating pressure and reduces bleed air outflow in response to high bleed air temperature.

Bleed Trip Sensors

Bleed trip sensors illuminate the respective BLEED TRIP OFF light when engine bleed air temperature or pressure exceeds a predetermined limit. The respective engine bleed air valve closes automatically.

Duct Pressure Transmitters

Duct pressure transmitters provide bleed air pressure indications to the respective (L and R) pointers on the bleed air duct pressure indicator. The indicator is AC operated.

Isolation Valve

The isolation valve isolates the left and right sides of the bleed air duct during normal operations. The isolation valve is AC operated.

With the isolation valve switch in AUTO, both engine bleed air switches ON, and both air conditioning pack switches AUTO or HIGH, the isolation valve is closed. The isolation valve opens if either engine bleed air switch or air conditioning pack switch is positioned OFF. Isolation valve position is not affected by the APU bleed air switch.

External Air Connection

An external air cart/source provides an alternate air source for engine start or air conditioning.

APU Bleed Air Valve

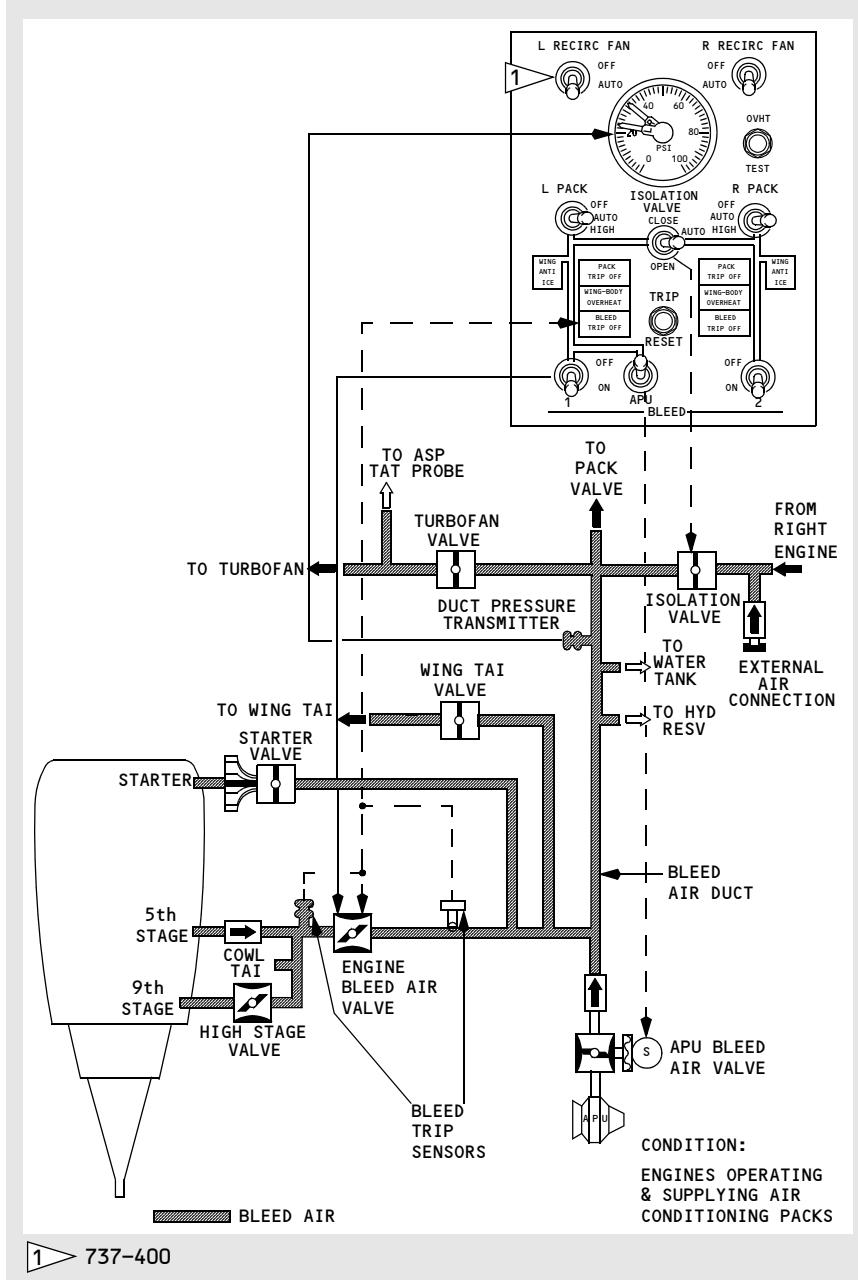
The APU bleed air valve permits APU bleed air to flow to the bleed air duct. The valve closes automatically when the APU is shut down. The APU bleed air valve is DC controlled and pressure operated.

With both the APU and engine bleed air valves open, and the engines operating at idle thrust, there is a possibility of APU bleed air backpressuring the 9th stage modulating and shutoff valve. This would cause the 9th stage valve to close.

DUAL BLEED Light

The DUAL BLEED light illuminates whenever the APU bleed air valve is open and the position of the engine bleed air switches and isolation valve would permit possible backpressure of the APU. Therefore, thrust must be limited to idle with the DUAL BLEED light illuminated.

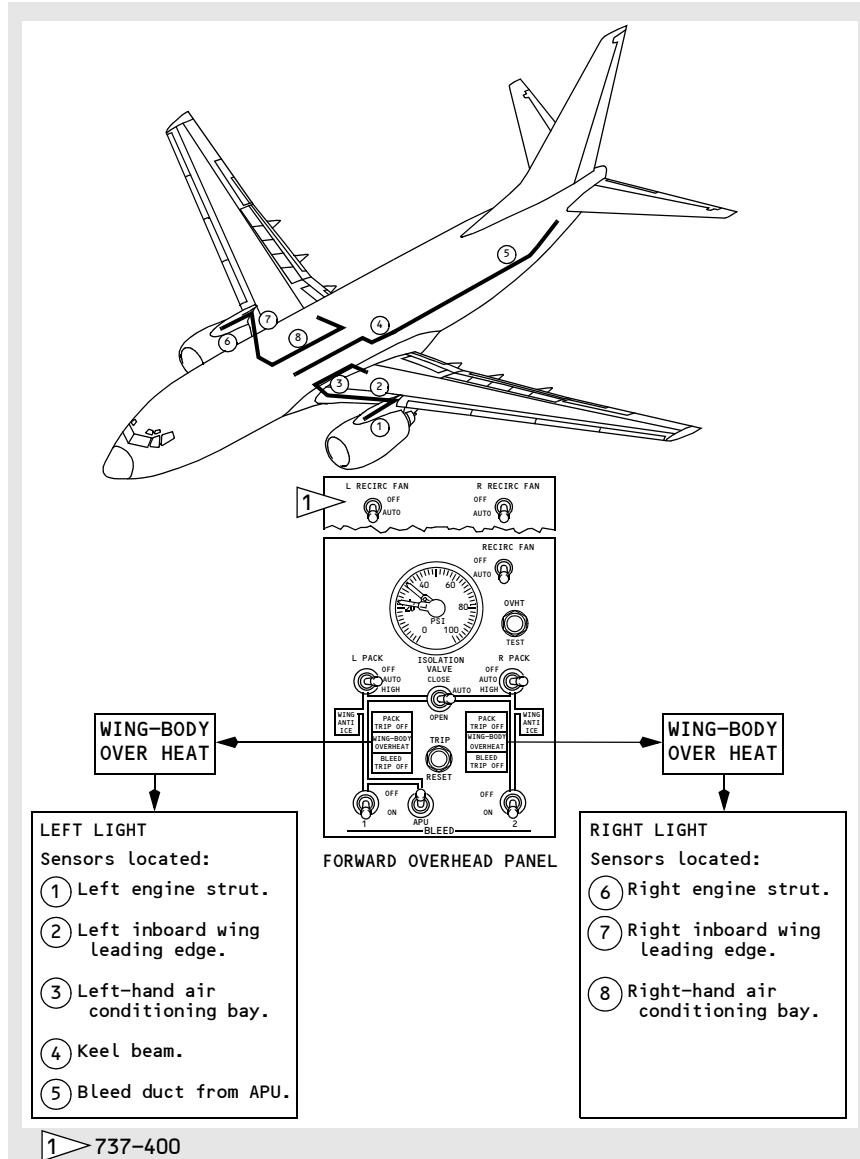
Bleed Air System Schematic



Wing-Body Overheat

A wing-body overheat condition is caused by a bleed air duct leak. It is sensed by the overheat sensors located as shown.

Wing-Body Overheat Ducts and Lights



Air Systems

Air Conditioning System Description

Chapter 2

Section 30

Preface

This section describes the air conditioning system for the 737–300 and the 737–500. For information concerning the 737–400, see section 2.31.

Introduction

The air conditioning system provides temperature controlled air by processing bleed air from the engines, APU, or a ground air source in air conditioning packs. Conditioned air from the left pack, upstream of the mix manifold, flows directly to the flight deck. Excess air from the left pack, air from the right pack, and air from the recirculation system is combined in the mix manifold. The mixed air is then distributed through the left and right sidewall risers to the passenger cabin.

Conditioned air for the cabin comes from either the airplane air conditioning system or a preconditioned ground source. Air from the preconditioned ground source enters the air conditioning system through the mix manifold.

Air Conditioning Pack

The flow of bleed air from the main bleed air duct through each air conditioning pack is controlled by the respective pack valve. Normally the left pack uses bleed air from engine No. 1 and the right pack uses bleed air from engine No. 2. A single pack in high flow is capable of maintaining pressurization and acceptable temperatures throughout the airplane up to the maximum certified ceiling.

Two pack operation from a single bleed air source is not recommended due to excessive bleed air requirements.

Airflow Control

With both air conditioning pack switches in AUTO and both packs operating, the packs provide “normal air flow.” However, with one pack not operating, the other pack automatically switches to “high air flow” in order to maintain the necessary ventilation rate. This automatic switching is inhibited when the airplane is on the ground, or in-flight with the flaps extended, to insure adequate engine power for single engine operation. Automatic switching to “high air flow” occurs if both engine bleed air switches are OFF and the APU bleed air switch is ON, regardless of flap position, air/ground status or number of packs operating.

With the air conditioning pack switch in HIGH, the pack provides "high air flow." Additionally, an "APU high air flow" rate is available when the airplane is on the ground, the APU bleed air switch is ON and either or both pack switches are positioned to HIGH. This mode is designed to provide the maximum airflow when the APU is the only source of bleed air.

Ram Air System

The ram air system provides cooling air for the heat exchangers. Operation of the system is automatically controlled by the packs through operation of ram air inlet doors.

On the ground, or during slow flight with the flaps not fully retracted, the ram air inlet doors move to the full open position for maximum cooling. In normal cruise, the doors modulate between open and closed. The RAM DOOR FULL OPEN light illuminates whenever the ram door is fully open.

A turbofan is located in each ram air exit duct. It augments the ram airflow on the ground or during slow flight (flaps not retracted). The fan operates pneumatically using bleed air. It is activated electrically, when the pack is on, by the air-ground safety sensor or flap limit switch.

Deflector doors are installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. The deflector doors extends when activated electrically by the air-ground safety sensor.

Cooling Cycle

The flow through the cooling cycle starts with bleed air passing through a heat exchanger for cooling. The air then flows to an air cycle machine for refrigeration and to a water separator which removes moisture. The processed cold air is then combined with hot air. The conditioned air flows into the mix manifold and distribution system.

Overheat protection is provided by temperature sensors located in the cooling cycle. An overheat condition causes the pack valve to close and the PACK TRIP OFF light to illuminate.

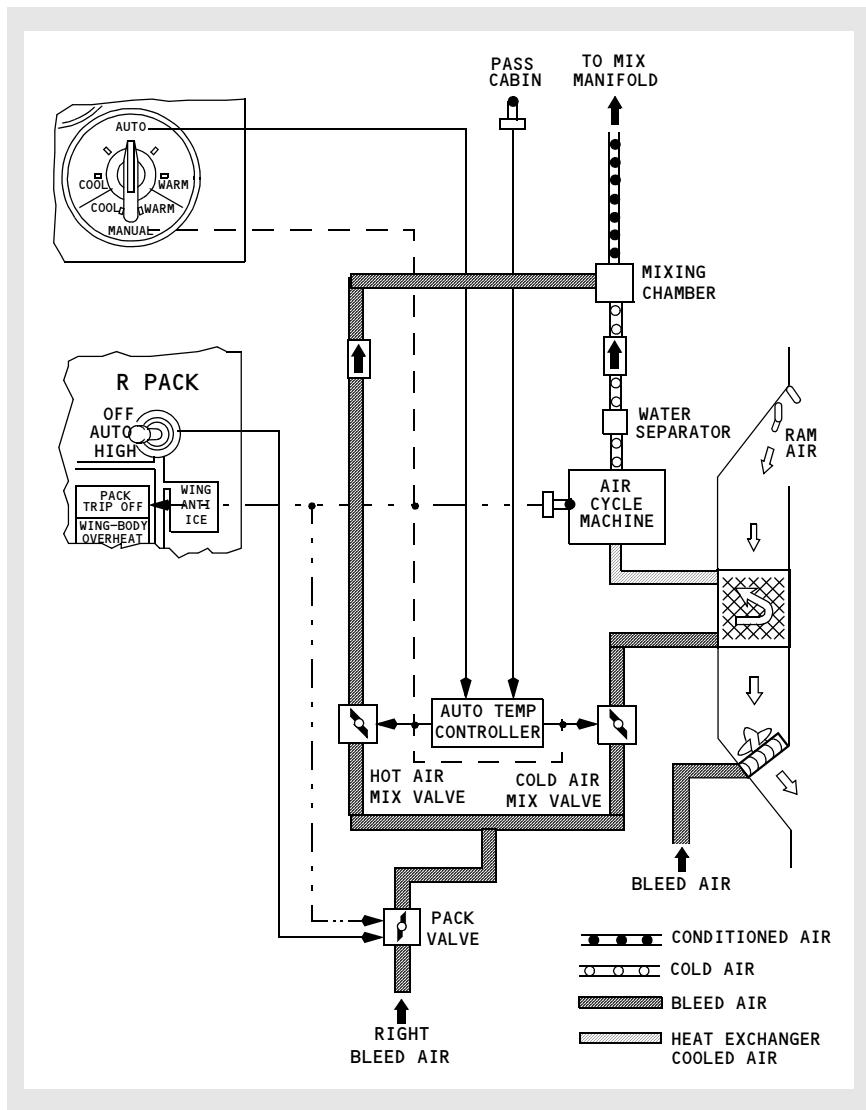
Air Mix Valves

The two air mix valves for each pack control hot and cold air according to the setting of the CONT CABIN or PASS CABIN temperature selector. Air that flows through the cold air mix valve is processed through a cooling cycle and then combined with hot air flowing from the hot air mix valve.

In the automatic temperature mode, the air mix valves are operated by the automatic temperature controller. The automatic temperature controller uses inputs from the respective temperature selector and cabin temperature sensor. The automatic temperature controller is bypassed when the temperature selector is positioned to MANUAL.

Anytime the pack valve closes, the air mix valves are driven to the full cold position automatically. This aids start-up of the cooling cycle and prevents nuisance hot air trips when the pack is turned on.

Air Conditioning Pack Schematic



Air Conditioning Distribution

Conditioned air is collected in the mix manifold. The temperature of the air is directly related to the setting of the CONT CABIN and PASS CABIN temperature selectors.

Overheat detection is provided by temperature sensors located downstream of the packs. An overheat condition causes the appropriate mix valves to drive full cold and the DUCT OVERHEAT light to illuminate. A temperature higher than the duct overheat causes the appropriate pack valve to close and the PACK TRIP OFF light to illuminate.

Flight Deck

Since the flight deck requires only a fraction of the air supply provided by the left pack, most of the left pack air output is mixed with the right pack supply and routed to the passenger cabin.

Conditioned air for the flight deck branches into several risers which end at the floor, ceiling, and foot level outlets. Air diffusers on the floor under each seat deliver continuous air flow as long as the manifold is pressurized.

Overhead diffusers are located on the flight deck ceiling, above and aft of the No. 3 windows. Each of these outlets can be opened or closed as desired by turning a slotted adjusting screw.

There is also a dual purpose valve behind the rudder pedals of each pilot. These valves provide air for warming the pilots' feet and for defogging the inside of the No. 1 windshields. Each valve is controlled by knobs located on the Captain's and First Officer's panel, respectively.

Passenger Cabin

The passenger cabin air supply distribution system consists of the mix manifold, sidewall risers, and an overhead distribution duct.

Sidewall risers go up the right and left wall of the passenger cabin to supply air to the overhead distribution duct. The overhead distribution duct routes conditioned air to the passenger cabin. It extends from the forward to the aft end of the ceiling along the airplane centerline and also supplies the sidewall diffusers.

Recirculation Fan

The recirculation fan system reduces the air conditioning system pack load and the engine bleed air demand. Air from the passenger cabin and electrical equipment bay is drawn to the forward cargo bay where it is filtered and recirculated to the mix manifold. The fan is driven by an AC motor. The fan operates with the recirculation fan switch in AUTO except with both packs on and one or both in HIGH.

Equipment Cooling

The equipment cooling system cools electronic equipment in the flight deck and the E & E bay.

The equipment cooling system consists of a supply duct and an exhaust duct. Each duct has a normal fan and an alternate fan. The supply duct supplies cool air to the flight deck displays and electronic equipment in the E & E bay. The exhaust duct collects and discards warm air from the flight deck displays, the overhead and aft electronic panels, circuit breaker panels in the flight deck, and electronic equipment in the E & E bay.

Loss of airflow due to failure of an equipment cooling fan results in illumination of the related equipment cooling OFF light. Selecting the alternate fan should restore airflow and extinguish the OFF light within approximately 5 seconds.

If an overtemperature occurs on the ground, alerting is provided through the crew call horn in the nose wheel well.

Forward Cargo Compartment

The recirculation fan system circulates air from the passenger cabin around the lining of the forward cargo compartment. On the ground, or with the cabin differential pressure less than 2.5 psi, the exhaust fan air is blown through a flow control valve and exhausted out the bottom of the airplane. With increasing airflow at greater cabin differential pressures, the flow control valve closes and exhaust air from the equipment cooling system is now diffused to the lining of the forward cargo compartment for in-flight heating.

Conditioned Air Source Connection

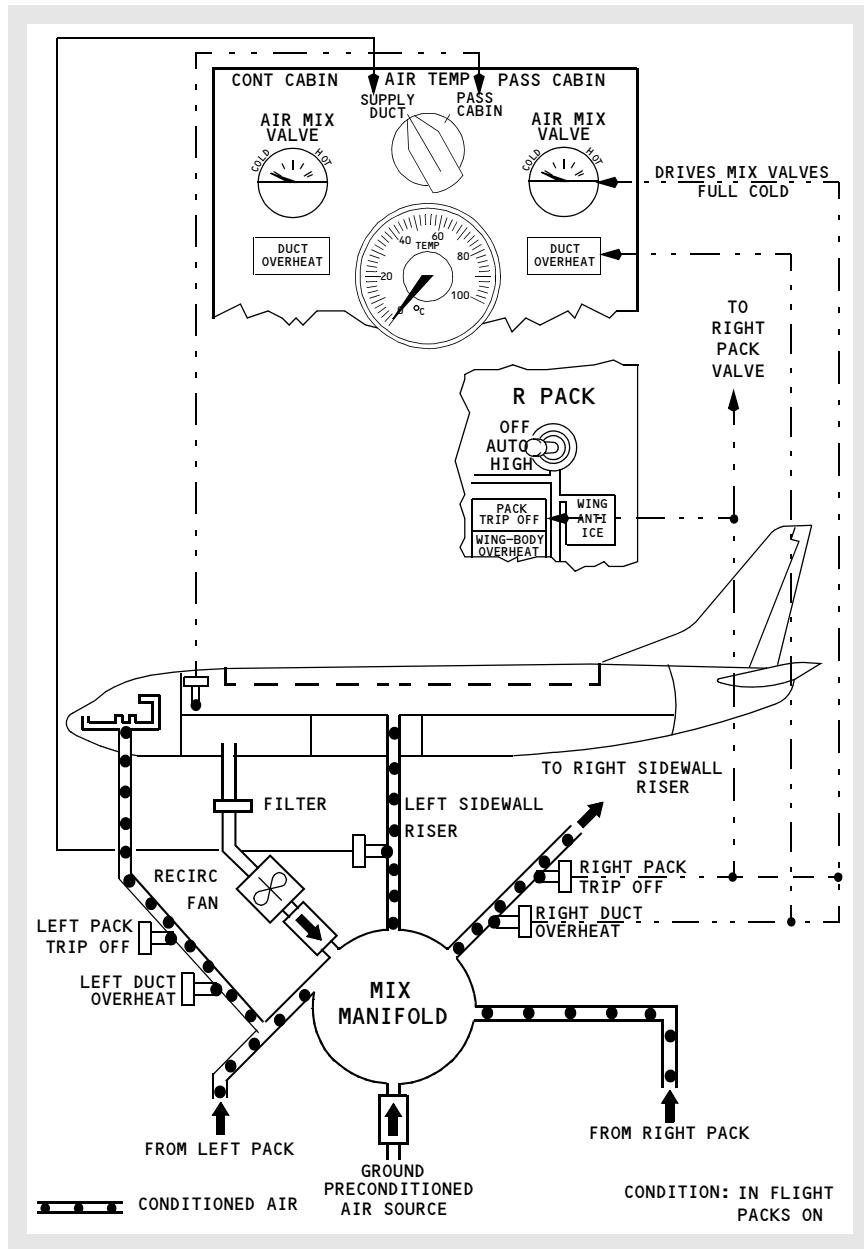
A ground air conditioning source may be connected to the mix manifold to distribute preconditioned air throughout the airplane.

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Air Systems -
Air Conditioning System
Description

Air Conditioning Distribution Schematic



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Introduction

The air conditioning system provides temperature controlled air by processing bleed air from the engines, APU, or a ground air source in air conditioning packs. Conditioned air from the left pack, upstream of the mix manifold, flows directly to the flight deck. Excess air from the left pack, air from the right pack, and air from the recirculation system is combined in the mix manifold. The mixed air is then distributed through the left and right sidewall risers to the passenger cabin.

Conditioned air for the cabin comes from either the airplane air conditioning system or a preconditioned ground source. Air from the preconditioned ground source enters the air conditioning system through the mix manifold.

Air Conditioning Pack

The flow of bleed air from the main bleed air duct through each air conditioning pack is controlled by the respective pack valve. Normally, the left pack uses bleed air from engine No. 1 and the right pack uses bleed air from engine No. 2. A single pack in high flow is capable of maintaining pressurization and acceptable temperatures throughout the airplane up to the maximum certified ceiling.

Two pack operation from a single bleed air source is not recommended due to excessive bleed air requirements.

Airflow Control

With both air conditioning pack switches in AUTO and both packs operating, the packs provide “normal air flow”. However, with one pack not operating, the other pack automatically switches to “high air flow” in order to maintain the necessary ventilation rate. This automatic switching is inhibited when the airplane is on the ground, or inflight with the flaps extended, to insure adequate engine power for single engine operation. Automatic switching to “high air flow” occurs if both engine bleed air switches are OFF and the APU bleed air switch is ON, regardless of flap position, air/ground status or number of packs operating.

With the air conditioning pack switch in HIGH, the pack provides “high air flow”. Additionally, an “APU high air flow” rate is available when the airplane is on the ground, the APU bleed air switch is ON and either or both pack switches are positioned to HIGH. This mode is designed to provide the maximum airflow when the APU is the only source of bleed air.

Ram Air System

The ram air system provides cooling air for the heat exchangers. Operation of the system is automatically controlled by the packs through operation of a ram door.

On the ground, or during slow flight with the flaps not fully retracted, the ram door moves to the full open position for maximum cooling. In normal cruise, the doors modulate between open and closed. The RAM DOOR FULL OPEN light illuminates whenever the ram door is fully open.

A turbofan is located in each ram air exit duct. It augments the ram airflow on the ground or during slow flight (flaps not retracted). The fan operates pneumatically using bleed air. It is activated electrically, when the pack is on, by the air-ground safety sensor or flap limit switch.

A deflector door is installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. The deflector door extends when activated electrically by the air-ground safety sensor.

Cooling Cycle

Flow through the cooling cycle starts with bleed air passing through a heat exchanger for cooling. The air then flows to an air cycle machine for refrigeration. The processed cold air is then combined with hot air which has bypassed the air cycle machine, then through a high pressure water separator which removes moisture. This conditioned air then flows into the mix manifold and distribution system.

Overheat protection is provided by temperature sensors located in the cooling cycle. An overheat condition causes the pack valve to close and the PACK light to illuminate.

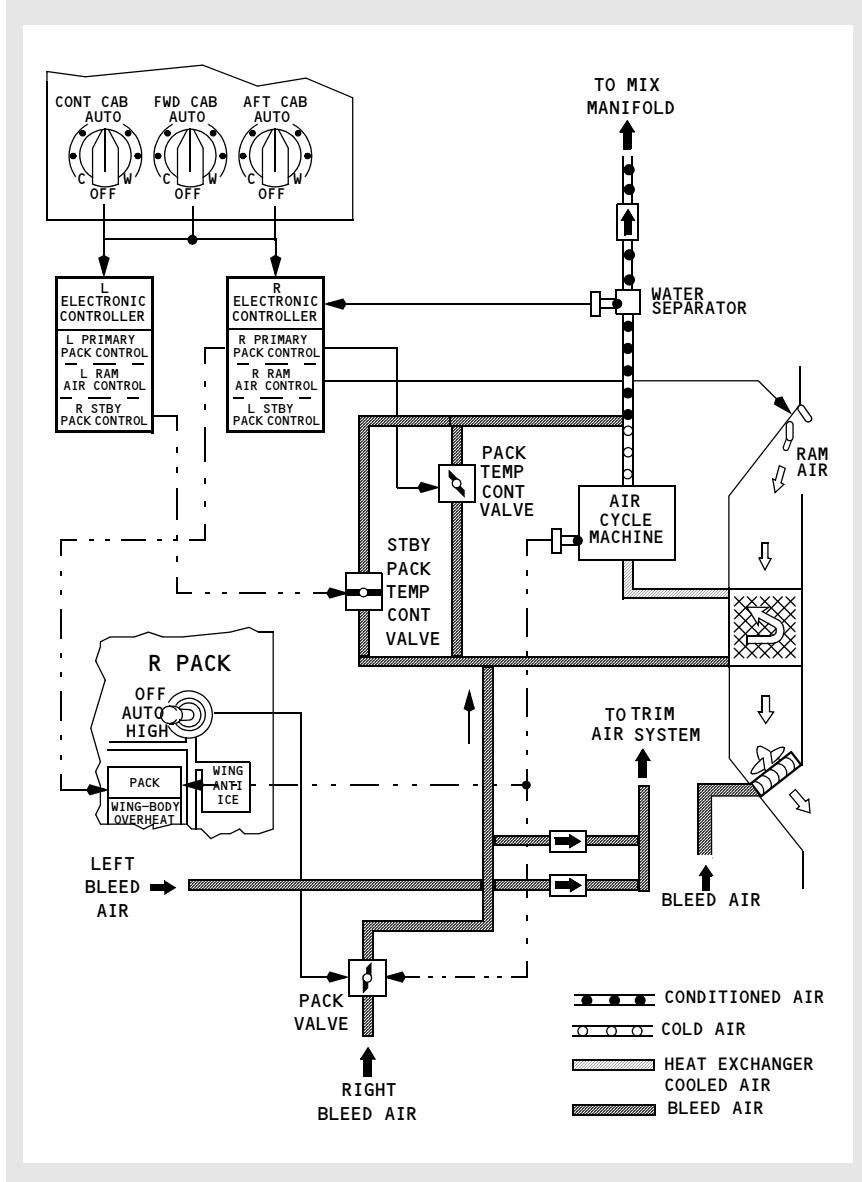
Pack Temperature Control

Electronic controllers command the pack temperature control valve toward open or closed to satisfy pack discharge requirements.

If a primary pack control fails, the affected pack is controlled by the standby pack control in the opposite controller. A primary or standby pack control failure causes the PACK, MASTER CAUTION and AIR COND System Annunciator lights to illuminate during recall.

If both the primary and the standby pack controls fail for the same pack, the PACK, MASTER CAUTION, and AIR COND System Annunciator lights illuminate. The pack will continue to operate without control unless excessive temperatures cause the pack to trip off.

Air Conditioning Pack Schematic



Zone Temperature Control

There are three zones: flight deck, forward cabin and aft cabin. Desired zone temperature is set by adjusting the individual Temperature Selectors. The selector range is approximately 65°F (18°C) to 85°F (30°C).

The packs produce an air temperature that satisfies the zone which requires the most cooling. Zone temperature is controlled by introducing the proper amount of trim air to the zone supply ducts. The quantity of trim air is regulated by individual trim air modulating valves.

During single pack operation with the TRIM AIR selected ON, zone temperature is controlled the same as during two-pack operation. During single pack operation with the TRIM AIR selected OFF, the pack attempts to produce an air temperature to satisfy the average temperature demands of all three zones.

If air in a zone supply duct overheats, the associated amber ZONE TEMP light illuminates, and the associated trim air modulating valve closes. The trim air modulating valve may be reopened after the duct has cooled by pushing the TRIP RESET Switch.

Zone Temperature Control Modes

The left electronic controller controls the aft cabin zone and provides backup control for the flight deck. The right controller controls the forward cabin zone and provides primary control for the flight deck.

Failure of the primary flight deck temperature control will cause an automatic switch to the back up control and will illuminate the CONT CAB amber ZONE TEMP light upon Master Caution Recall. Failure of both the primary and standby controls will illuminate the lights automatically.

Failure of the forward or aft cabin temperature control will cause the associated trim air modulating valve to close. The Temperature Selectors operate normally, but the Temperature Selector settings of the two passenger cabin zones will be averaged. The amber ZONE TEMP light will illuminate upon Master Caution Recall to indicate failure of the associated zone control.

Unbalanced Pack Temperature Control Mode

Any failure affecting the supply of trim air will cause the temperature control system to control both packs independently. If flight deck trim air is lost, the left pack will provide conditioned air to the flight deck at the selected temperature and the right pack will satisfy the demand of the passenger zone which requires the most cooling. If a passenger cabin zone trim air, or all trim air is lost, the forward and aft zone temperature demands will be averaged for control of the right pack.

If any individual zone is switched OFF, the Temperature Selector setting will be ignored by the temperature control system.

Standby Pack Average Temperature

If all zone controls and primary pack controls fail, the standby pack controls command the packs to produce air temperatures which will satisfy the average temperature demand of the two cabin zones. The trim air modulating valves will close. The flight deck zone Temperature Selector will have no effect on the standby pack controls.

Fixed Cabin Temperature

If all Temperature Selectors are positioned OFF, the pack controls will cause the left pack to maintain a fixed temperature of 75°F (24°C) and the right pack to maintain 65°F (18°C) as measured at the pack temperature sensor.

Air Conditioning Distribution

Conditioned air is collected in the mix manifold. The temperature of the air is directly related to the setting of the Temperature Selectors.

Overheat detection is provided by temperature sensors located downstream of the packs and the mix manifold. An overheat condition causes the appropriate trim air modulating valve to close and the ZONE TEMP light to illuminate.

Flight Deck

Since the flight deck requires only a fraction of the air supply provided by the left pack, most of the left pack output is routed to the mix manifold.

Conditioned air for the flight deck branches into several risers which end at the floor, ceiling and foot level outlets. Air diffusers on the floor under each seat deliver continuous air flow as long as the manifold is pressurized.

Overhead diffusers are located on the flight deck ceiling, above and aft of the No. 3 windows. Each of these outlets can be opened or closed as desired by turning a slotted adjusting screw.

There is also a dual purpose valve behind the rudder pedal of each pilot. These valves provide air for warming the pilots' feet and for defogging the inside of the No. 1 windshields. Each valve is controlled by knobs located on the Captain's and First Officer's panels.

Passenger Cabin

The passenger cabin air supply distribution system consists of the mix manifold, sidewall risers, and an overhead distribution duct.

Sidewall risers go up the right and left walls of the passenger cabin to supply air to the overhead distribution duct. The overhead distribution duct routes conditioned air to the passenger cabin. It extends from the forward to the aft end of the ceiling along the airplane centerline and also supplies the sidewall diffusers.

Recirculation Fan

The recirculation fan system reduces the air conditioning system pack load and the engine bleed air demand. Air from the passenger cabin and electrical equipment bay is drawn to the forward cargo bay where it is filtered and recirculated to the mix manifold. The fans are driven by AC motors. Each recirculation fan operates only if the respective RECIRC FAN switch is selected to AUTO. In flight, the left recirculation fan operates if both packs are operating unless either PACK switch is in HIGH. The right recirculation fan operates in flight if both packs are operating unless both PACK switches are in HIGH. On the ground, the left recirculation fan operates unless both PACK switches are in HIGH and the right recirculation fan operates even if both PACK switches are in HIGH.

Equipment Cooling

The equipment cooling system cools electronic equipment in the flight deck and the E & E bay.

The equipment cooling system consists of a supply duct and an exhaust duct. Each duct has a normal fan and an alternate fan. The supply duct supplies cool air to the flight deck displays and electronic equipment in the E & E bay. The exhaust duct collects and discards warm air from the flight deck displays, the overhead and aft electronic panels, circuit breaker panels in the flight deck, and electronic equipment in the E & E bay.

Loss of airflow due to failure of an equipment cooling fan results in illumination of the related equipment cooling OFF light. Selecting the alternate fan should restore airflow and extinguish the OFF light within approximately 5 seconds.

If an overtemperature occurs on the ground, alerting is provided through the crew call horn in the nose wheel well.

Forward Cargo Compartment

The forward cargo compartment is warmed in flight when more than 2.5 psi pressure differential exists. Air from the E & E compartment flows up and around the forward cargo compartment lining. The right recirculation fan maintains this warming air flow. When the right recirculation fan is off, the forward outflow valve remains open to ensure this warm air flow (except when closed in order to maintain pressurization).

Conditioned Air Source Connection

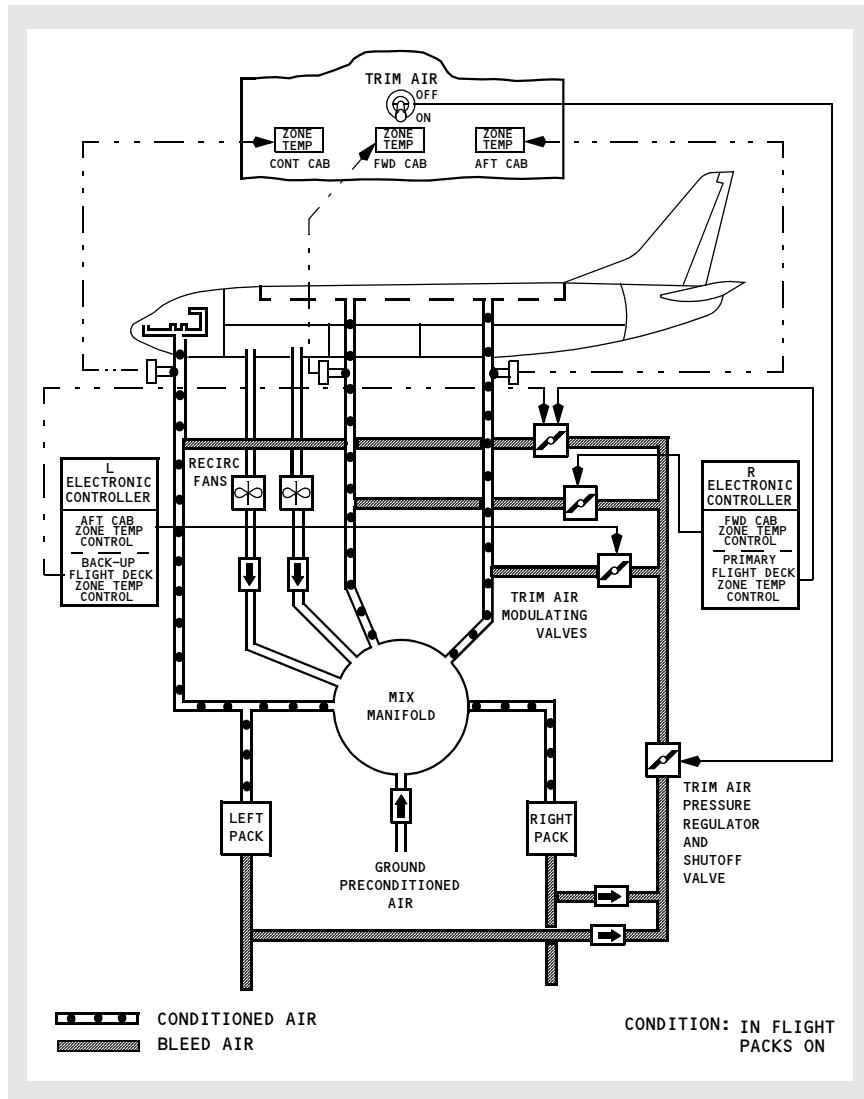
A ground air conditioning source may be connected to the mix manifold to distribute preconditioned air throughout the airplane.

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Air Systems -
Air Conditioning System
Description (737-400)

Air Conditioning Distribution Schematic



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Introduction

Cabin pressurization is controlled during all phases of airplane operation by the cabin pressure control system (CPCS). The CPCS includes one automatic controller and one standby controller available by selecting AUTO or STBY, and two manual (MAN) pilot-controlled modes.

The system uses bleed air supplied to and distributed by the air conditioning system. Pressurization and ventilation are controlled by modulating the outflow valves.

Pressure Relief Valves

Two pressure relief valves provide safety pressure relief by limiting the differential pressure to a maximum of 8.65 psi. A negative relief valve prevents external atmospheric pressure from exceeding internal cabin pressure.

Cabin Pressure Controller

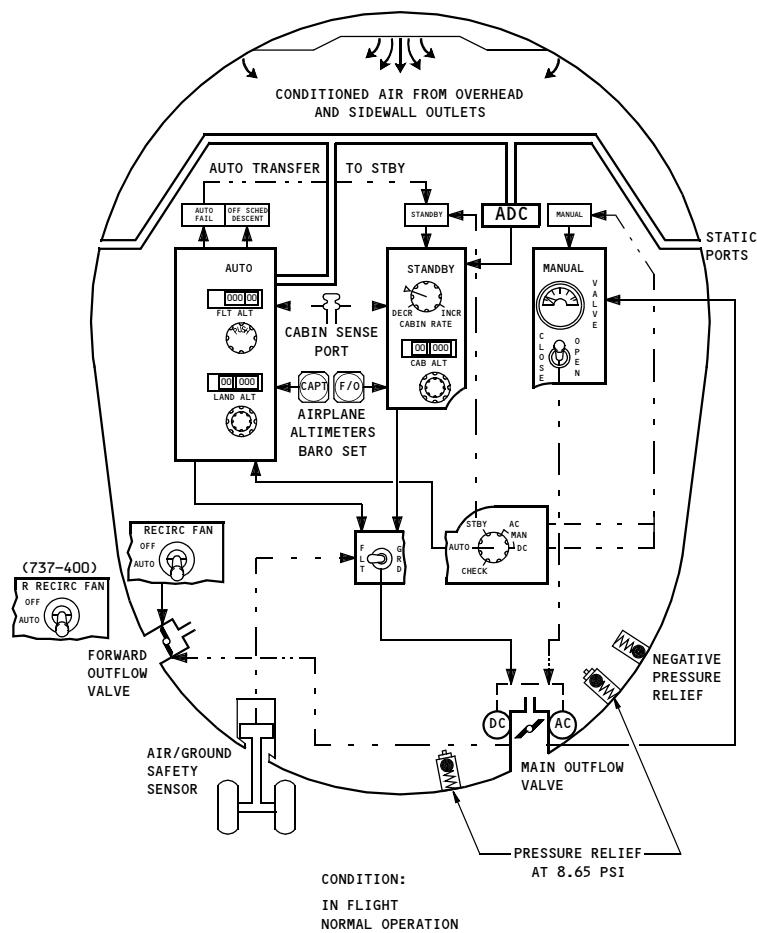
Cabin altitude is normally rate-controlled by the cabin pressure controller up to a cabin altitude of 8,000 feet at the airplane maximum certified ceiling of 37,000 feet. The cabin pressure controller controls cabin altitude in the following modes:

- AUTO – Automatic pressurization control; normal mode of operation. Uses AC motor.
- STBY – Semiautomatic pressurization control; standby mode of operation. Uses DC motor.
- MAN AC – Manual control of the system using the AC motor.
- MAN DC – Manual control of the system using the DC motor.

In the automatic mode of operation, airplane altitude is sensed directly from the static ports. In the standby mode, airplane altitude is sensed electrically from the air data computer (ADC). Barometric corrections to these pressures come from the Captain's altimeter in AUTO and the First Officer's altimeter in STBY.

The controller receives additional information from the air/ground sensor and the cabin pressure altitude sensing port.

Cabin Pressure Control System Schematic



Pressurization Outflow

Cabin air outflow is controlled by the main outflow valve, the forward outflow valve and the flow control valve. During pressurized flight, the flow control valve is closed, and the majority of the overboard exhaust is through the main and forward outflow valves. A small amount is also exhausted through toilet and galley vents, miscellaneous fixed vents, and by seal leakage.

Flow Control Valve

The flow control valve opens to exhaust the cooling air from the E & E compartment overboard during ground operation, unpressurized flight and pressurized flight below a cabin differential pressure of 2.5 psi.

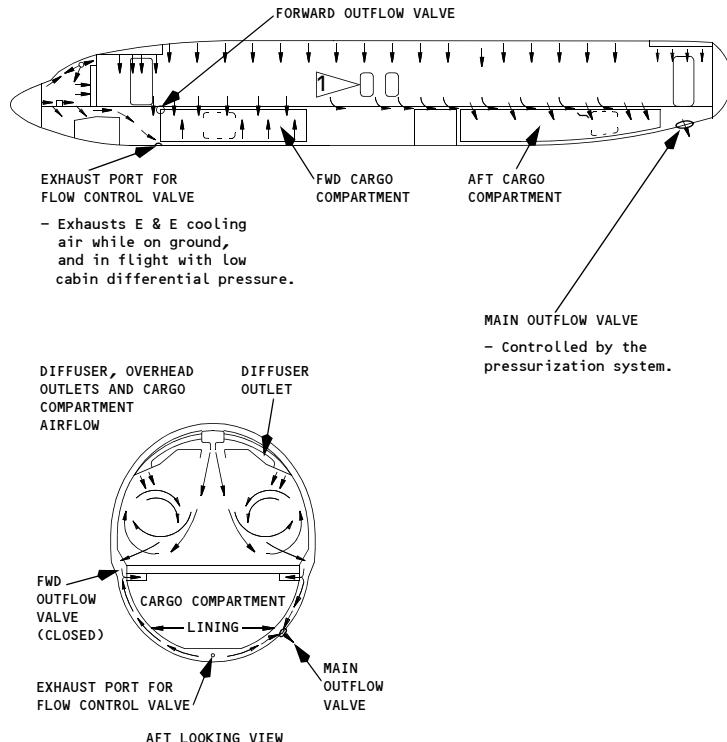
When the flow control valve closes, air is directed around the forward cargo compartment liner for inflight heating.

Outflow Valves

The main outflow valve can be actuated by either an AC or a DC motor. The AC motor is used during AUTO and MAN AC operation. The DC motor is used during STANDBY and MAN DC operation.

The forward outflow valve closes automatically to assist in maintaining cabin pressure when the main outflow valve is almost closed or when the recirculation fan (right recirculation fan on 737–400 airplanes) is operating. The forward outflow valve is the overboard discharge exit for air circulated around the forward cargo compartment. The main outflow valve is the overboard exhaust exit for the majority of the air circulated through the passenger cabin. Passenger cabin air is drawn through foot level grills, down around the aft cargo compartment, where it provides heating, and is discharged overboard through the main outflow valve.

Pressurization Outflow Schematic



1 ▶ 737-400

Auto Mode Operation

In AUTO, the pressurization control panel is used to preset two altitudes into the pressure controller:

- **FLT ALT** (flight or cruise altitude).
- **LAND ALT** (landing or destination airport altitude).

Takeoff airport altitude (actually cabin altitude) is input into the pressurization controller at all times when on the ground.

The air/ground safety sensor signals whether the airplane is on the ground or in the air. On the ground, the FLT/GRD switch is used to keep the cabin depressurized by driving the main outflow valve full open when the switch is in the GRD position. With the switch in the FLT position, the controller modulates the main outflow valve toward close, slightly pressurizing the cabin. This ground pressurization of the cabin makes the transition to pressurized flight more gradual for the passengers and crew, and also gives the system better response to ground effect pressure changes during takeoff.

In the air, the auto controller maintains a proportional pressure differential between airplane and cabin altitude. By increasing the cabin altitude at a rate proportional to the airplane climb rate, cabin altitude change is held to the minimum rate required.

When the aircraft is operated at low gross weights it is capable of sustaining rates of climb to cruising altitude greater than the pressure controller logic can reduce cabin pressure. This may result in reaching the maximum pressure differential and causing the relief valves to open and vent the cabin.

An amber OFF SCHED DESCENT light illuminates if the airplane begins to descend without having reached the preset cruise altitude; for example, a flight aborted in climb and returning to the takeoff airport. The controller programs the cabin to land at the takeoff field elevation without further pilot inputs. If the FLT ALT indicator is changed, the automatic abort capability to the original takeoff field elevation is lost.

The cruise mode is activated when the airplane climbs to within 0.25 psi of the selected FLT ALT. During cruise, the controller maintains the cabin altitude slightly below the selected LAND ALT, if the differential pressure between the selected LAND ALT and FLT ALT is less than or equal to 7.8 psid above 28,000 feet or 7.45 psid below 28,000 feet. If the differential pressure between the selected LAND ALT and FLT ALT is greater than these values, the controller maintains a pressure differential of 7.8 psid above 28,000 feet and 7.45 psid below 28,000 feet. Deviations from flight altitude can cause the pressure differential to vary as the controller modulates the outflow valve to maintain a constant cabin altitude.

The descent mode is activated when the airplane descends to 0.25 psi below the selected FLT ALT. The cabin begins a proportional descent to slightly below the selected LAND ALT. The controller programs the cabin to land slightly pressurized so that rapid changes in altitude during approach result in minimum cabin pressure changes.

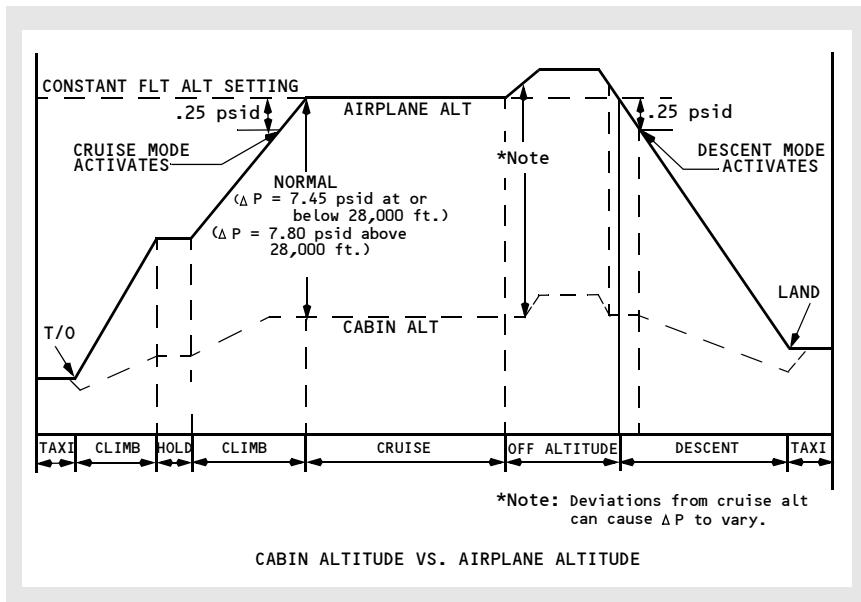
Taxiing in, the controller drives the main outflow valve slowly to full open when the FLT/GRD switch is positioned to GRD, thereby depressurizing the cabin. Having the main outflow valve full open also prevents the equipment cooling fan from depressurizing the airplane to a negative pressure.

An amber AUTO FAIL light illuminates if any one of these conditions occurs:

- Loss of AUTO AC power
- Excessive rate of cabin pressure change (1890 sea level feet/minute)
- High cabin altitude (13,875 feet).

With illumination of the AUTO FAIL Light, the pressure controller automatically trips to STANDBY mode; however, the pressurization mode selector remains in AUTO. Positioning the mode selector to STBY extinguishes the light.

Flight Path Events – Auto Mode



Standby Mode Operation

A green STANDBY light will be illuminated when the pressure controller is in the STANDBY mode.

On the ground, the GRD position of the FLT/GRD switch drives the main outflow valve full open. The FLT position drives the main outflow valve to attempt to pressurize the cabin to the selected CAB ALT. CAB ALT should be set 200 feet below the takeoff airport altitude to pressurize the cabin properly when the FLT/GRD switch is placed to FLT prior to takeoff.

In the air, by referring to the placard below the pressurization control panel, the cabin altitude indicator is set to the isobaric cabin altitude, based on the proposed flight altitude and pressure differential. Cabin rate of climb or descent is controlled by the cabin rate selector. In descent, the cabin altitude indicator is set 200 feet below landing field altitude to insure a pressurized cabin during landing.

Manual Mode Operation

A green MANUAL Light illuminates with the pressurization mode selector in MAN AC or MAN DC.

Operation in the MAN modes assumes failure of the AUTO and STANDBY modes. Manual mode allows the pilot, by using the outflow valve switch, to modulate the main outflow valve while monitoring the outflow valve position indicator. MAN AC mode uses the AC motor to control the main outflow valve; MAN DC uses the DC motor. The rate of operation in MAN AC is faster than that in MAN DC.

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737 Flight Crew Operations Manual

Anti-Ice, Rain

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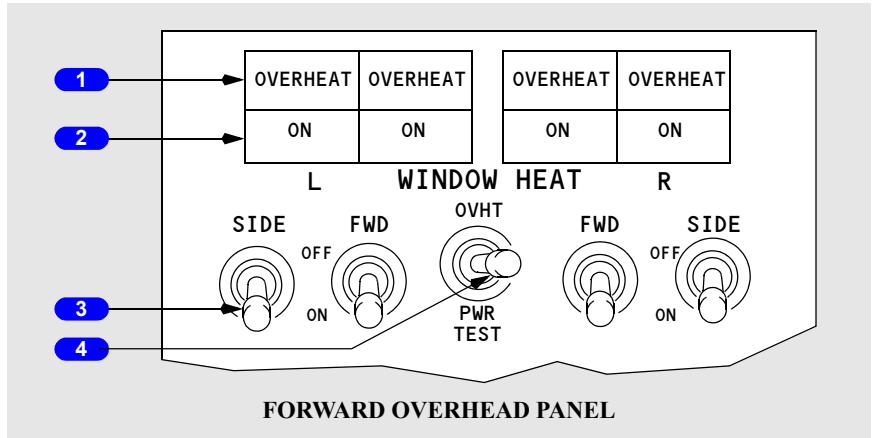
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Anti-Ice, Rain Controls and Indicators

Chapter 3 Section 10

Window Heat Panel



1 Window OVERHEAT Lights

Illuminated (amber) – overheat condition is detected.

Note: OVERHEAT light also illuminates if electrical power to window is interrupted.

2 Window Heat ON Lights

Illuminated (green) – window heat is being applied to selected window.

Extinguished –

- switch is OFF, or
- an overheat is detected, or
- a system failure has occurred, or
- system is at correct temperature.

3 WINDOW HEAT Switches

ON – window heat is applied to selected window.

OFF – window heat not in use.

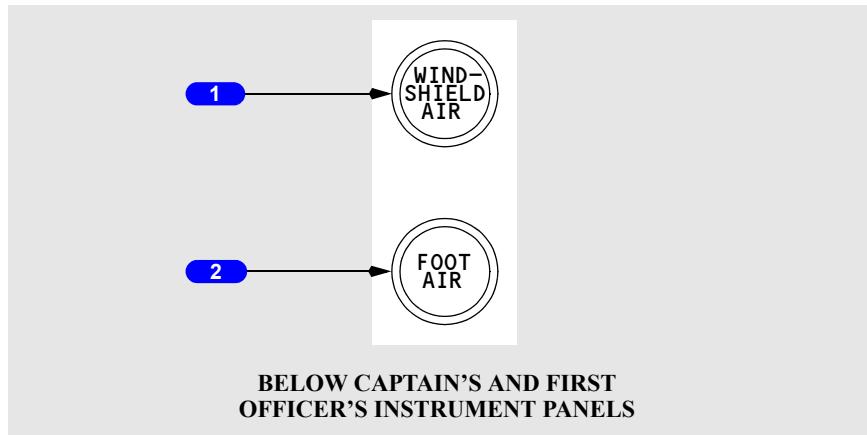
4 WINDOW HEAT Test Switch (spring-loaded to neutral)

OVHT – simulates an overheat condition.

PWR TEST – provides a confidence test.

Note: Refer to Supplementary Procedures for Window Heat Test procedures.

Windshield/Foot Air Controls



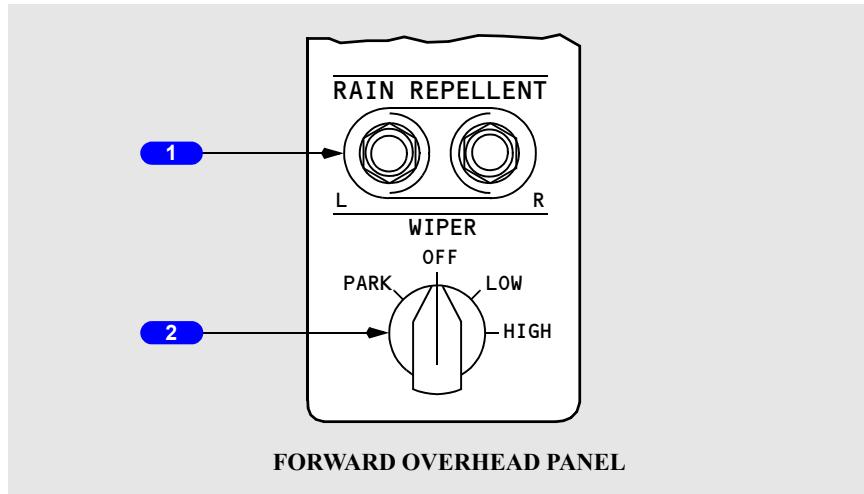
1 WINDSHIELD AIR Controls

PULL – supplies conditioned air to No. 1 windows for defogging.

2 FOOT AIR Controls

PULL – supplies conditioned air to pilots' leg positions.

Windshield Wiper Panel



1 Rain Repellent Switches

Push – applies measured amount of repellent on related window 1.

2 Windshield WIPER Selector

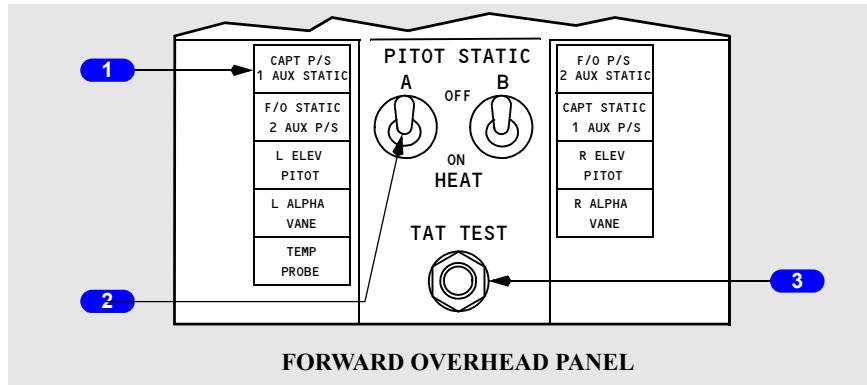
PARK – turns off wiper motors and stows wiper blades.

OFF – turns off wiper motors.

LOW – low speed operation.

HIGH – high speed operation.

Pitot Static Heat Panel



1 Pitot Static Lights

Illuminated (amber) – related probe not heated.

2 PITOT STATIC Switches

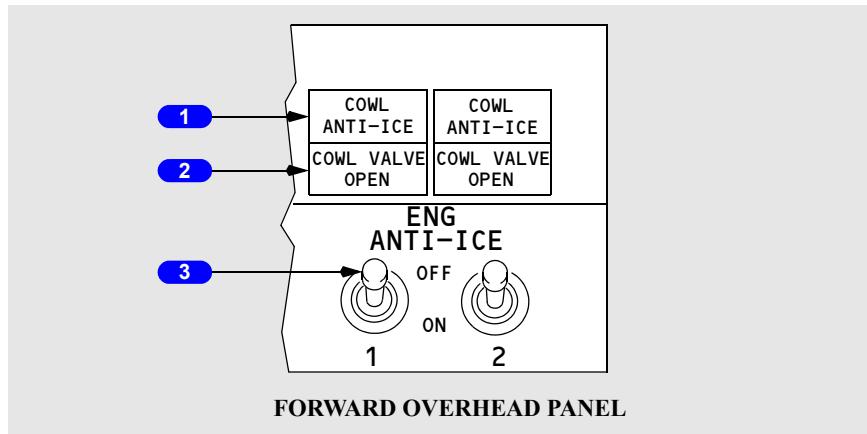
ON – power is supplied to heat related system.

OFF – power off.

3 TAT TEST Switch

Push (on ground) – power is applied to temp probe.

Engine Anti-Ice Panel



1 COWL ANTI-ICE Lights

Illuminated (amber) – indicates an overpressure or overtemperature condition in duct downstream of engine cowl anti-ice valve.

2 COWL VALVE OPEN Lights

Illuminated (blue) –

- bright – related cowl anti-ice valve is in transit, or, cowl anti-ice valve position disagrees with related ENGINE ANTI-ICE switch position
- dim – related cowl anti-ice valve is open (switch ON).

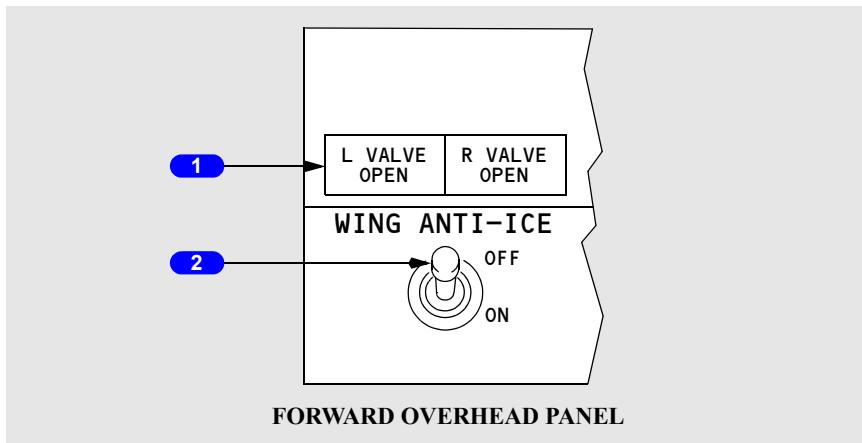
Extinguished – related cowl anti-ice valve is closed (switch OFF).

3 ENGINE ANTI-ICE Switch

ON – related engine anti-ice valve opens.

OFF – related engine anti-ice valve closes.

Wing Anti-Ice Panel



1 Wing Anti-Ice VALVE OPEN Lights

Illuminated (blue) –

- bright – related wing anti-ice control valve is in transit, or, related wing anti-ice control valve position disagrees with WING ANTI-ICE switch position
- dim – related wing anti-ice control valve is open (switch ON).

Extinguished – related wing anti-ice control valve is closed (switch OFF).

2 WING ANTI-ICE Switch

OFF – wing anti-ice control valves close.

ON (in flight) – wing anti-ice control valves open.

ON (on the ground) –

- wing anti-ice control valves open if thrust on both engines is below takeoff warning setting and temperature inside both distribution ducts is below thermal switch activation temperature
- control valves close if either engine thrust is above takeoff warning setting or thermal switch is activated in either distribution duct. Switch remains ON
- switch trips OFF at lift-off.

Anti-Ice, Rain System Description

Chapter 3 Section 20

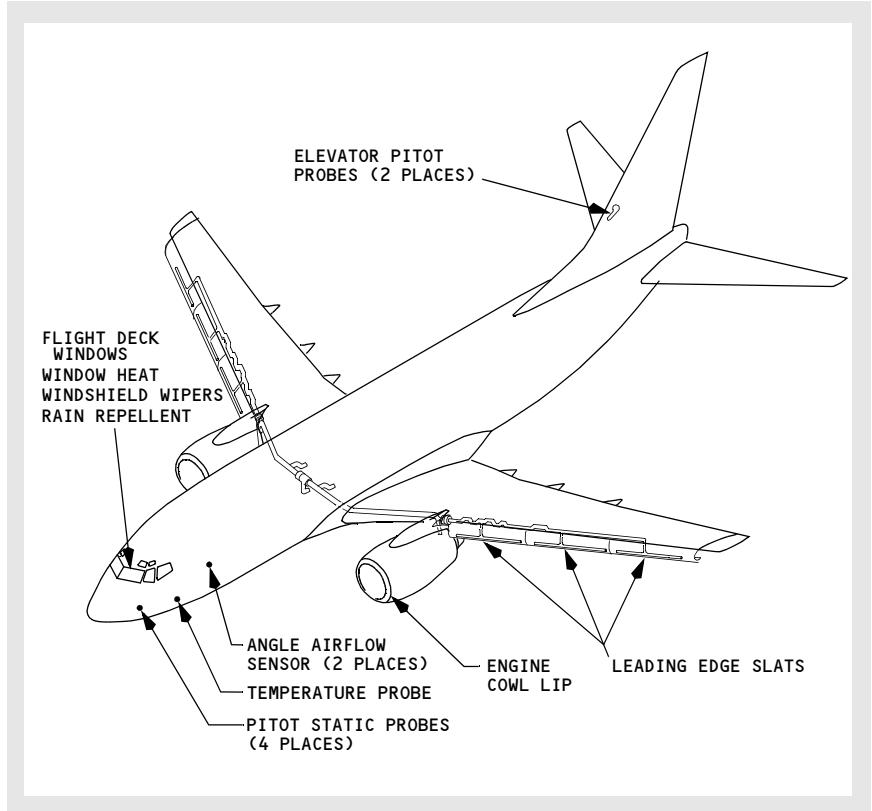
Introduction

Thermal anti-icing (TAI), electrical anti-icing, and windshield wipers are the systems provided for ice and rain protection.

The anti-ice and rain systems include:

- Flight Deck Window Heat
- Windshield Wipers and Rain Repellent
- Probe and Sensor Heat
- Engine Anti-Ice System
- Wing Anti-Ice System

Anti-Ice Components Diagram



Flight Deck Window Heat

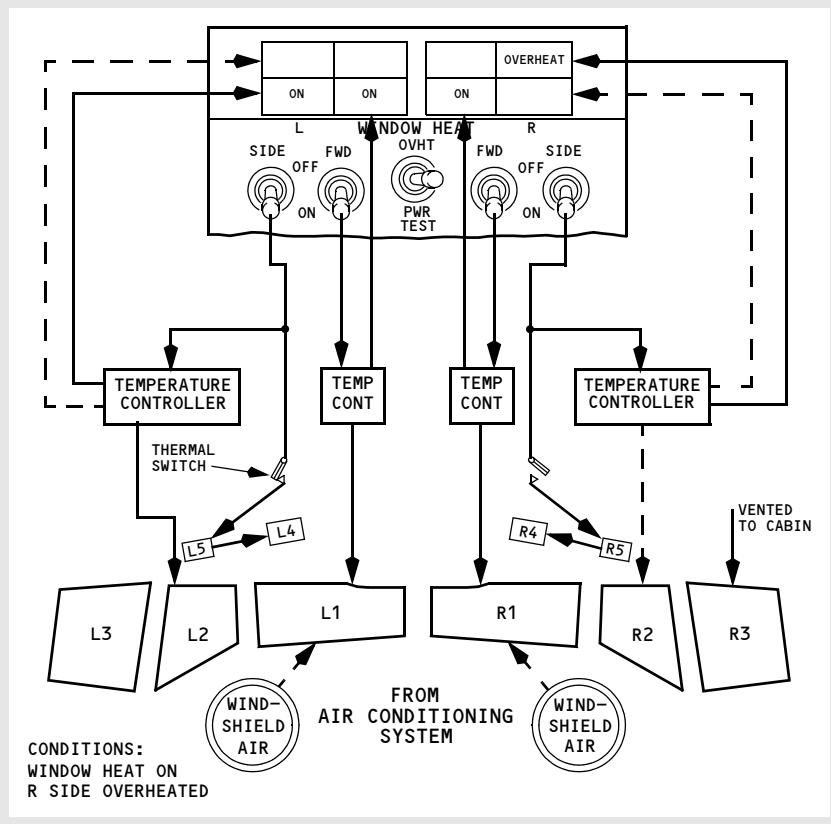
Flight deck windows 1, 2, 4 and 5 consist of glass panes laminated to each side of a vinyl core. Flight deck window 4 has an additional vinyl layer and acrylic sheet laminated to the inside surface. Flight deck window 3 consists of two acrylic panes separated by an air space.

A conductive coating on the outer glass pane of windows 1 and 2 permits electrical heating to prevent ice build-up and fogging. A conductive coating on the inner glass pane of windows 4 and 5 permits electrical heating to prevent fogging. Window 3 is not electrically heated.

Flight Deck Window Heat Operation

The FWD WINDOW HEAT switches control heat to window 1. The SIDE WINDOW HEAT switches control heat to windows 2, 4 and 5.

Temperature controllers maintain windows 1 and 2 at the correct temperature to ensure maximum strength of the windows in the event of bird impact. Power to windows 1 and 2 is automatically removed if an overheat condition is detected. A thermal switch located on window 5 opens and closes to maintain the correct temperature of windows 4 and 5.

Flight Deck Window Heat Schematic**Windshield Wipers and Rain Repellent**

The rain removal system for the forward windows consists of windshield wipers and rain repellent. One windshield wiper is located on each No. 1 window. Each wiper is electrically operated by a separate system. Both wiper systems are controlled by a common switch. Each push of a rain repellent switch applies a measured amount of repellent on the related No. 1 windshield.

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

Probe and Sensor Heat

All pitot-static probes, the total air temperature probe, and angle airflow sensors are electrically heated to prevent the formation of ice. Alternate static ports are not heated.

Engine Anti-Ice System

Engine bleed air thermal anti-icing prevents the formation of ice on the engine cowl lip. Engine anti-ice operation is controlled by individual ENG ANTI-ICE switches. The engine anti-ice system may be operated on the ground and in flight.

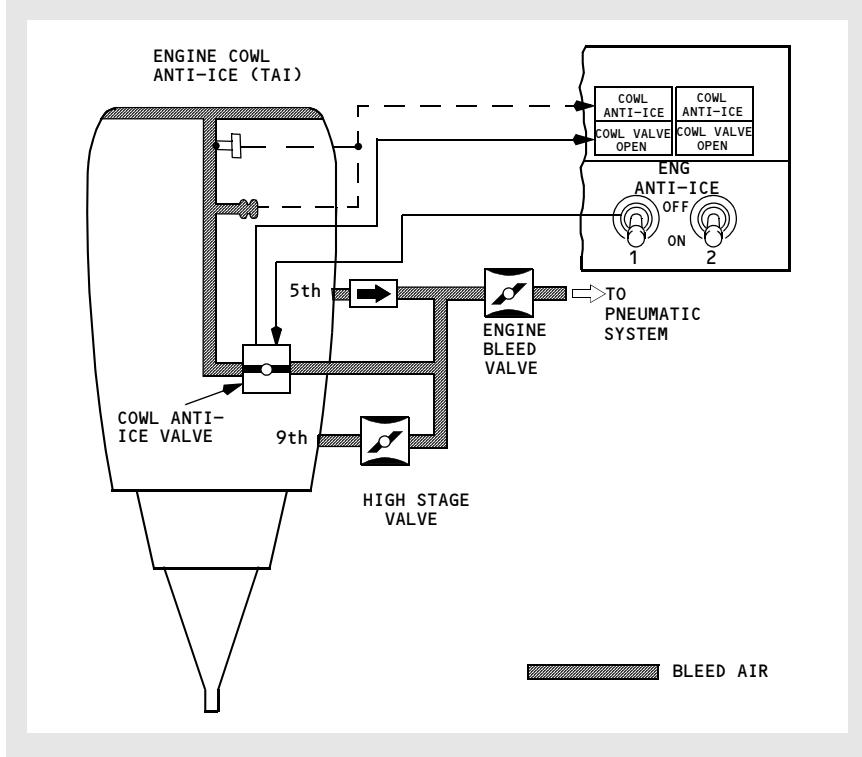
Engine Anti-Ice System Operation

Each cowl anti-ice valve is electrically controlled and pressure actuated. Positioning the ENG ANTI-ICE switches to ON allows engine bleed air to flow through the cowl anti-ice valve for cowl lip anti-icing.

If the cowl anti-ice valve fails to move to the position indicated by the ENG ANTI-ICE switch, the COWL VALVE OPEN light remains illuminated bright blue.

The amber COWL ANTI-ICE light illuminates due to excessive temperature or pressure in the duct leading from the cowl anti-ice valve to the cowl lip.

Engine Anti-Ice System Schematic



Wing Anti-Ice System

The wing anti-ice system provides protection for the leading edge slats by using bleed air. The wing anti-ice system does not include the leading edge flaps.

The wing anti-ice control valves are AC motor-operated. With a valve open, bleed air flows to the leading edge slats through a telescoping duct, and is then exhausted overboard. The wing anti-ice system is effective with the slats in any position.

Wing Anti-Ice System Operation

On the ground, positioning the WING ANTI-ICE switch ON opens both control valves if thrust on both engines is below the setting for takeoff warning activation and the temperature inside both wing distribution ducts is less than the thermal switch activation temperature.

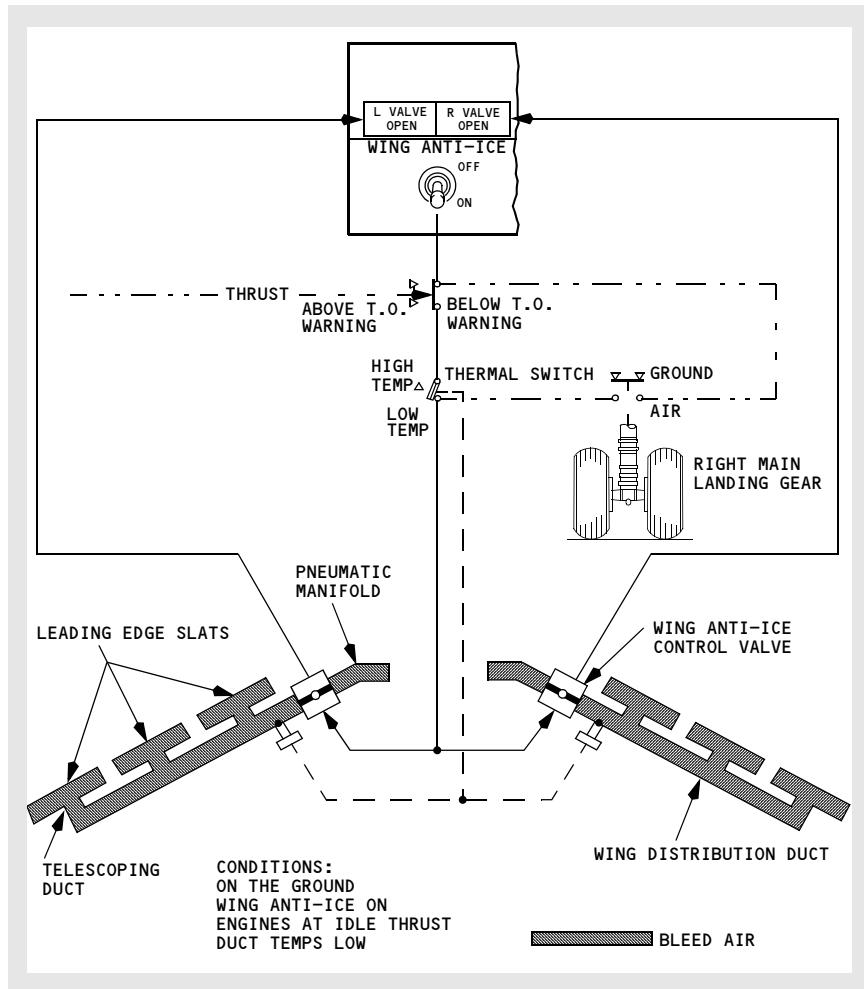
Both valves close if either engine thrust is above the takeoff warning setting or either temperature sensor senses a duct overtemperature. The valves automatically reopen if thrust on both engines is reduced and both temperature sensors are cool.

With the air/ground sensor in the ground mode and the WING ANTI-ICE switch ON, the switch remains in the ON position regardless of control valve position. The WING ANTI-ICE switch automatically trips OFF at lift-off when the air/ground sensor goes to the air mode.

In flight, both control valves open when the WING ANTI-ICE switch is positioned ON. Duct temperature and thrust setting logic are disabled and have no affect on control valve operation in flight.

Valve position is monitored by the blue VALVE OPEN lights.

Wing Anti-Ice System Schematic



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DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Automatic Flight

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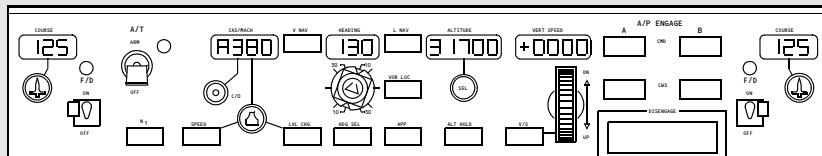
DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Automatic Flight Controls and Indicators

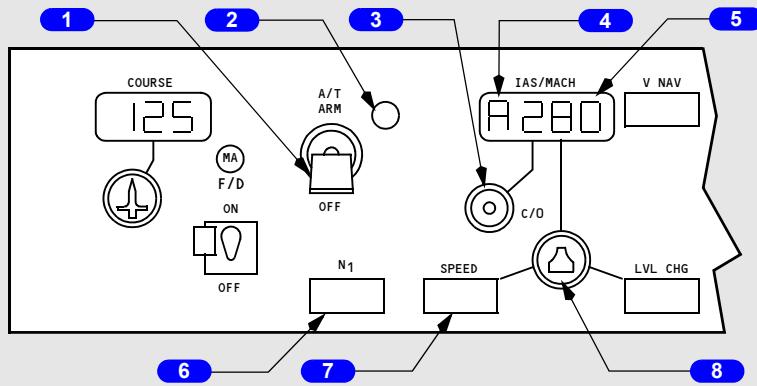
Chapter 4 Section 10

Mode Control Panel (MCP)



GLARESHIELD

Speed Controls



GLARESHIELD

1 Autothrottle (A/T) ARM Switch

ARM – Arms A/T for engagement. Magnetically held at ARM. A/T engages automatically when following AFDS modes are engaged:

- LVL CHG
- ALT ACQ
- V/S
- VNAV
- ALT HOLD
- G/S capture
- TO/GA.

OFF – disengages A/T and prevents A/T engagement.

2 Autothrottle Indicator Light

Illuminated (green) – A/T ARM switch in ARM position.

3 Changeover (C/O) Switch

Push –

- changes IAS/MACH display between IAS and MACH
- automatic changeover occurs at approximately FL260.

4 MCP Speed Condition Symbols

Overspeed or underspeed limiting symbol appears when commanded speed cannot be reached.

Underspeed limiting (flashing character “A”) – minimum speed

Overspeed limiting (flashing character “8”) –

- Vmo or Mmo limit
- landing gear limit
- flap limit

5 IAS/MACH Display

Displays speed selected by IAS/MACH selector

- display is blank when:
 - VNAV mode engaged
 - A/T engaged in FMC SPD mode
 - during 2 engine AFDS go-around
- displays 110 knots when power is first applied
- display range is:
 - 110 KIAS – Vmo in 1 kt increments
 - .60M – Mmo in .01M increments.

6 N1 Switch

Push – (light not illuminated)

- engages A/T in N1 mode if compatible with AFDS modes already engaged
- illuminates N1 switch light
- annunciates N1 autothrottle mode.

Push – (light illuminated)

- deselects N1 mode and extinguishes switch light
- engages autothrottles in ARM mode.

N1 Mode

A/T maintains thrust at N1 limit selected from FMC CDU. N1 mode engaged manually by pushing N1 switch if N1 mode is compatible with existing AFDS modes. N1 mode engages automatically when:

- engaging LVL CHG in climb (except during period for 2 1/2 minutes after lift-off)
- engaging VNAV in climb.

7 SPEED Switch

Push – (light not illuminated)

- engages A/T in SPEED mode if compatible with engaged AFDS modes
- illuminates SPEED switch light
- annunciates MCP SPD autothrottle mode
- maintains speed in MCP IAS/MACH display.

Push – (light illuminated)

- deselects speed mode and extinguishes switch light
- engages A/T in ARM mode.

Speed Mode

Autothrottle holds speed in IAS/MACH display or a performance or limit speed. Speed mode engaged manually by pushing SPEED switch if speed mode is compatible with existing AFDS modes. Speed mode engages automatically when:

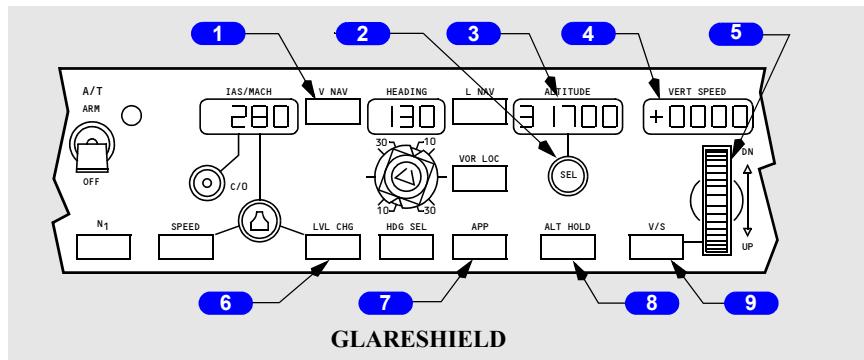
- ALT ACQ engages
- ALT HOLD engages
- V/S engages
- G/S capture occurs.

A/T does not set thrust above displayed N1 limit, however, A/T can exceed N1 value manually set by N1 Manual Set Knob.

8 IAS/MACH Selector

Rotate –

- sets speed in IAS/MACH display and positions airspeed cursor
- selected speed is reference speed for AFDS and A/T
- not operative when IAS/MACH display is blank.

Vertical Navigation**1 VNAV Switch**

Push –

- VNAV switch light illuminates
- pitch mode annunciates VNAV SPD, VNAV PTH
- A/T mode annunciates FMC SPD, N1, RETARD, or ARM
- IAS/MACH display blanks and airspeed cursors positioned to FMC commanded airspeed.

VNAV Mode

The FMC commands AFDS pitch and autothrottle to fly vertical profile selected on FMC CDUs. Profile includes climb, cruise, descent, speeds, and can also include waypoint altitude constraints.

Note: If the airplane is between the FMC target altitude (depicted on the RTE LEGS page for the active waypoint) and the manually entered MCP target altitude, VNAV will not engage. To enable VNAV, adjust the FMC or MCP target altitude as appropriate.

Climb –

- autothrottle holds FMC thrust limit
- AFDS holds FMC target speed
- automatic level off occurs at MCP altitude or VNAV altitude, whichever is reached first.

Cruise –

- autothrottle holds FMC target speed
- AFDS holds FMC altitude
- selecting a lower MCP altitude arms FMC to automatically begin descent upon arrival at FMC top of descent point.

Descent –

- VNAV SPD descent
 - autothrottle holds idle
 - AFDS holds FMC target speed
- VNAV PTH descent
 - autothrottle holds idle but can command FMC SPD mode if ground speed becomes too slow to maintain FMC vertical path
 - AFDS tracks FMC descent path
 - automatic level-off occurs at MCP altitude or VNAV altitude, whichever is reached first
 - VNAV constrained level-off annunciates VNAV PTH.

Inhibited below 400 ft. RA or if performance initialization not complete.

VNAV mode is terminated by any one of the following:

- Selecting another pitch mode
- Glideslope capture
- Transition of glideslope intercept waypoint
- flaps extended beyond 15 (prior to FMC U7.1)
- Crosstrack greater than RNP while active leg has a nav data base vertical angle (FMC U7.1 or later, but prior to U10.3)

2 Altitude Selector (SEL)

Rotate –

- sets altitude in ALTITUDE display in 100 foot increments
- arms V/S mode if rotated while in ALT HOLD at selected altitude

3 ALTITUDE Display

Displays selected altitude

- displayed altitude is reference for altitude alerting and automatic level-offs
- altitude range is 0 to 50,000 feet in 100 foot increments
- displays previously selected altitude when power first applied

4 Vertical Speed (VERT SPEED) Display

Displays:

- blank when V/S mode not active
- present V/S when V/S mode is engaged with V/S switch
- selected V/S when V/S set with thumbwheel
- range is -7900 to +6000 fpm.

Displays in increments of:

- 50 fpm if V/S is less than 1000 fpm
- 100 fpm if V/S is 1000 fpm or greater.

5 Vertical Speed Thumbwheel

Rotate –

- DN –
 - sets vertical speed in VERT SPEED display
 - increases rate of descent or reduces rate of ascent
- UP –
 - sets vertical speed in VERT SPEED display.
 - increases rate of ascent or reduces rate of descent

6 Level Change (LVL CHG) Switch

Push –

- LVL CHG switch light illuminates
- pitch mode annunciates MCP SPD for climb or descent
- autothrottle mode annunciates N1 for climb and RETARD followed by ARM for descent
- IAS/MACH display and airspeed cursors display target speed.

LVL CHG Mode

The LVL CHG mode coordinates pitch and thrust commands to make automatic climbs and descents to preselected altitudes at selected airspeeds.

A LVL CHG climb or descent is initiated by:

- selecting a new altitude
- pushing LVL CHG switch
- setting desired airspeed.

Climb –

- autothrottle holds limit thrust
- AFDS holds selected airspeed.

Descent –

- autothrottle holds idle thrust
- AFDS holds selected airspeed.

Airspeed –

- if a speed mode is active when LVL CHG is engaged, this speed is retained as target speed
- if a speed mode is not active when LVL CHG is engaged, existing speed becomes target speed
- speed can be changed with MCP IAS/MACH Selector.

The LVL CHG mode is inhibited after glideslope capture.

7 Approach (APP) Switch

(See Lateral Navigation)

8 Altitude Hold (ALT HLD) Switch

Push –

- engages ALT HOLD command mode
- commands pitch to hold uncorrected barometric altitude at which switch was pressed
- annunciates ALT HOLD pitch mode and illuminates ALT HLD switch light.

Altitude Hold Command Mode

ALT HOLD mode commands pitch to hold either:

- MCP selected altitude
 - pitch mode annunciates ALT HOLD
 - ALT HLD switch light extinguishes
- uncorrected barometric altitude at which ALT HLD switch was pressed if not at MCP selected altitude
 - pitch mode annunciates ALT HOLD
 - ALT HLD switch light illuminates.

When in ALT HOLD at selected MCP altitude:

- selecting a new MCP altitude illuminates the ALT HLD switch light and arms V/S mode
- LVL CHG, V/S, and VNAV climb and descent functions are inhibited until a new MCP altitude is selected.

ALT HOLD mode is inhibited after G/S capture.

The selected MCP altitude is referenced to:

- Captain's barometric altimeter setting for A A/P and F/D.
- First Officer's barometric altimeter setting for B A/P and F/D.

Note: After ALT HOLD engages, changes in altimeter barometric settings do not change the selected altitude reference.

9 Vertical Speed (V/S) Switch

Push –

- arms or engages V/S command mode
- commands pitch to hold vertical speed
- engages A/T in speed mode to hold selected airspeed
- annunciates V/S pitch mode and illuminates V/S switch light.

Vertical Speed Command Mode

The V/S mode commands pitch to hold selected vertical speed and engages A/T in SPEED mode to hold selected airspeed. V/S mode has both an armed and an engaged state.

Engaged –

- annunciates V/S pitch mode
- vertical speed display changes from blank to present vertical speed
- desired vertical speeds can be selected with vertical speed thumbwheel.

V/S becomes armed if:

- pitch mode is ALT HLD at selected MCP altitude and
- new MCP altitude is selected (more than 100 feet from current altitude).

With V/S armed, V/S mode is engaged by moving vertical speed thumbwheel.

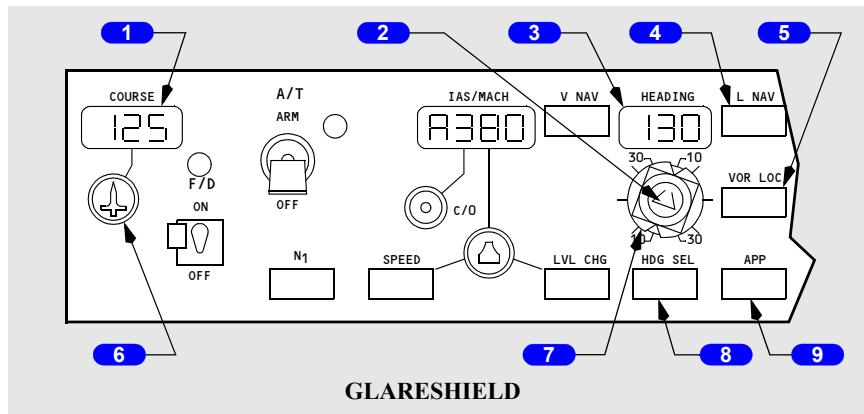
V/S mode automatically engages if ALT ACQ mode is engaged and a new MCP altitude is selected which is more than 100 feet different from previously selected altitude

- Vertical speeds can be selected which command flight toward or away from selected altitude.

Inhibited if:

- ALT HOLD mode is active at selected MCP altitude
- glide slope captured in APP mode.

Lateral Navigation



1 COURSE Display

Displays course set by course selector.

Note: Different courses and frequencies on two VHF NAV receivers can cause disagreement between Captain and FO F/D displays and affect A/P operation.

2 Heading Selector

Rotate –

- sets heading in HEADING display
- positions selected heading bugs on both HSIs.

3 HEADING Display

Displays selected heading – same heading as HSI selected heading bug.

4 LNAV Switch

Push –

- commands AFDS roll to intercept and track the active FMC route
- annunciates LNAV as roll mode and illuminates LNAV switch light.

LNAV Mode

In LNAV mode, the FMC controls AFDS roll to intercept and track active FMC route. Active route is entered and modified through FMC CDUs and can include SIDs, STARs, and instrument approaches.

LNAV engagement criteria:

- active route entered in FMC
- within 3 NM of active route, LNAV engagement occurs with any airplane heading
- outside of 3 NM, airplane must:
 - be on intercept course of 90 degrees or less
 - intercept route segment before active waypoint.

LNAV automatically disconnects for following reasons:

- reaching end of active route
- reaching a route discontinuity
- intercepting or missing the intercept of a selected approach course in VOR LOC or APP modes (VOR/LOC armed)
- selecting HDG SEL
- loss of capture criteria.

5 VOR Localizer (LOC) Switch

Push –

- commands AFDS roll to capture and track selected VOR or LOC course
- annunciates VOR/LOC armed or engaged as roll mode and illuminates VOR LOC switch light.

VOR LOC Mode

Pushing the VOR LOC switch selects VOR mode if a VOR frequency is tuned or selects LOC mode if a localizer frequency is tuned.

The VOR mode provides roll commands to track selected VOR course.

The LOC mode provides roll commands to track selected localizer course along inbound front course bearing.

The selected course can be intercepted while engaged in:

- LNAV
- HDG SEL
- CWS R if an autopilot is engaged in CMD.

The capture point is variable and depends on intercept angle and closure rate.

Localizer capture occurs not later than 1/2 dot deviation. Course capture is indicated when VOR/LOC annunciation changes from armed to engaged.

While engaged in VOR or LOC modes:

- A autopilot and Captain's F/D use information from Captain's course selector and No. 1 VHF NAV receiver
- B autopilot and First Officer's F/D use information from First Officer's course selector and No. 2 VHF NAV receiver
- different courses and/or frequencies for two VHF NAV receivers can cause disagreement between the Captain's and First Officer's F/D displays and affect A/P operation.

Note: When a localizer frequency is selected, VHF NAV radios automatically switch from tail antenna to nose antenna when VOR/LOC is annunciated (armed or engaged). If antenna switching does not occur, LOC mode is inhibited.

Note: Localizer backcourse tracking is not available.

6 Course Selector

Sets course in COURSE display for related VHF NAV receiver, AFDS and HSI. Two course selectors and COURSE displays are located on the MCP.

Rotate Captain's course selector – provides selected course information to:

- A FCC
- No. 1 VHF NAV receiver
- Captain's HSI course pointer and course deviation bar.

Note: In VOR LOC or APP mode, the A A/P and Captain's F/D use selected course and navigation data from the No. 1 VHF NAV receiver.

Rotate First Officer's course selector – provides selected course information to:

- B FCC
- No. 2 VHF NAV receiver
- First Officer's HSI course pointer and course deviation bar.

Note: In VOR LOC or APP mode, B A/P and First Officer's F/D use selected course and navigation data from No. 2 VHF NAV receiver.

7 Bank Angle Selector

Rotate –

- Sets maximum bank angle for AFDS operation in HDG SEL or VOR modes
- commanded bank angle can be selected at 10, 15, 20, 25, or 30 degrees.

8 Heading Select (HDG SEL) Switch

Push –

- engages HDG SEL command mode
- commands roll to follow selected heading
- annunciates HDG SEL as FMA roll mode and illuminates HDG SEL switch light.

Heading Select Command Mode

The HDG SEL mode commands roll to turn to and maintain heading shown in MCP HEADING display:

- initial selection commands turn in shortest direction toward selected heading bug
- after mode engagement, roll commands are given to turn in same direction as rotation of heading selector
- bank angle limit is established by bank angle selector
- HDG SEL mode automatically disengages upon capture of selected radio course in VOR LOC and APP modes (VOR/LOC armed).

9 Approach (APP) Switch

Push –

- illuminates APP switch light
- arms the AFDS for localizer and glideslope capture
- roll mode annunciates VOR/LOC armed
- pitch mode annunciates G/S armed
- enables engagement of both autopilots.

APP Mode

The approach mode arms AFDS to capture and track localizer and glideslope and can be engaged for dual or single autopilot operation.

One VHF NAV receiver must be tuned to an ILS frequency before approach mode can be engaged. With one VHF NAV receiver tuned, onside AFDS is enabled for guidance and operation.

For dual autopilot operation, both VHF NAV receivers must be tuned to the ILS frequency and both autopilots must be selected in CMD prior to 800 feet RA.

APP mode operation:

- localizer must be captured prior to glideslope
- localizer can be intercepted in HDG SEL, LNAV, or CWS R
- glideslope capture occurs at 2/5 dot below glideslope
- APP switch light extinguishes after localizer and glideslope capture.

After localizer and glideslope capture, APP mode can be disengaged by:

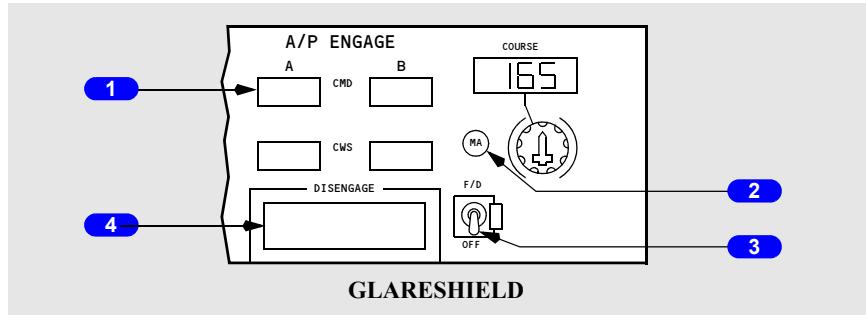
- pushing a TO/GA switch
- disengaging autopilot(s) and turning off both F/D switches
- retuning the VHF NAV receiver.

While engaged in the APP mode:

- the A autopilot and Captain's F/D use information from Captain's Course Selector and No. 1 VHF NAV receiver
- the B autopilot and First Officer's F/D use information from First Officer's Course Selector and No. 2 VHF NAV receiver
- different courses and/or frequencies for the two VHF NAV receivers can cause disagreement between Captain's and First Officer's F/D displays and affect A/P operation.

Note: After localizer and glideslope capture during a dual autopilot approach, CWS cannot be engaged by manually overriding pitch and roll. Manual override of autopilots causes autopilot disengagement.

Autopilot / Flight Director



1 Autopilot Engage Switch

Push –

CMD

- engages related autopilot in command mode (switch illuminates)
- enables all command modes for AFDS in addition to autopilot CWS operation
- selecting a second A/P in CMD disengages the first A/P, unless in APP mode.

CWS

- engages related autopilot in control wheel steering mode (switch illuminates)
- pitch and roll are controlled through application of control wheel and column pressure
- if attitudes acquired exceed autopilot limits, autopilot returns to attitude limits when control pressure is released
- flight directors can be operated in command modes while an autopilot is engaged in CWS.

2 Master (MA) Flight Director Indicators (white letters)

If a F/D switch is ON, the light indicates which FCC is controlling the F/D modes.

- Illuminated – related FCC is controlling F/D modes.
- Extinguished – F/D modes are controlled from opposite FCC.
- Both lights illuminated – each FCC is controlling modes for related F/D.

3 Flight Director (F/D) Switch

Left F/D switch activates command bars on Captain's ADI. Right F/D switch activates command bars on First Officer's ADI.

ON –

- enables command bar display on related pilot's ADI
- command bars are displayed if command pitch and/or roll modes are engaged
- displays FD in A/P status display if A/P is OFF or engaged in CWS
- on ground, arms pitch and roll modes for engagement in TO/GA and WINGS LEVEL when TO/GA switch is pushed
- in flight with A/P ON and F/Ds OFF, turning a F/D switch ON engages F/D in currently selected A/P modes.

OFF – Command bars retract from related pilot's ADI.

4 Autopilot Disengage Bar

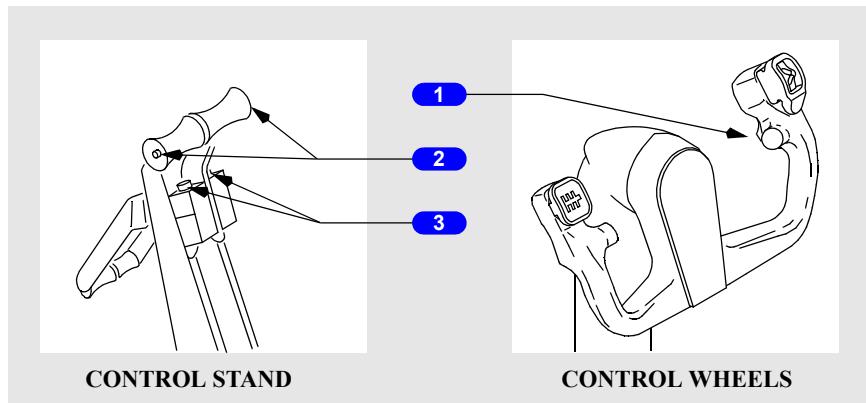
Push down –

- disengages both autopilots
- exposes yellow background
- prevents autopilot engagement.

Lift up –

- enables autopilot engagement
- conceals yellow background.

Autopilot / Autothrottle Controls



1 Autopilot Disengage Switch

Push –

- disengages both autopilots
- A/P disengage lights flash
- A/P disengage warning tone sounds for a minimum of two seconds

- second push extinguishes disengage lights and silences disengage warning tone
- if autopilot automatically disengages, extinguishes A/P Disengage lights and silences A/P warning tone.

2 Autothrottle Disengage Switches

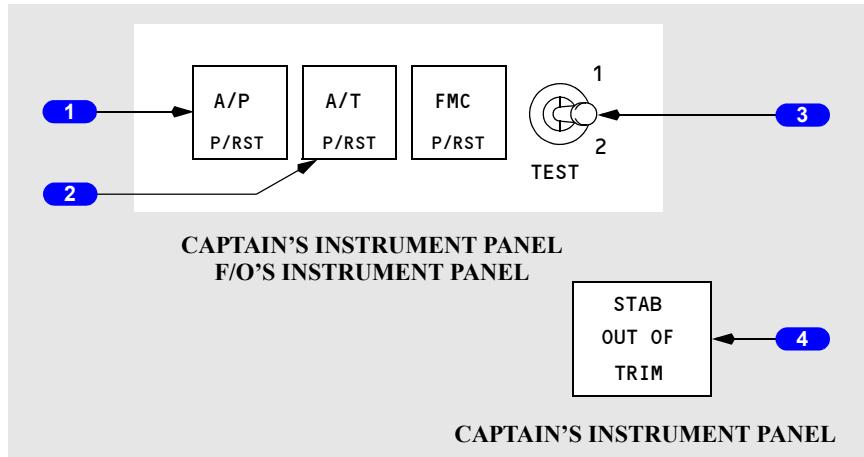
Push –

- disengages autothrottle
- A/T disengage lights flash
- A/T ARM switch trips OFF
- second press extinguishes A/T disengage lights
- extinguishes A/T disengage lights after automatic A/T disengagement.

3 Takeoff/Go-Around (TO/GA) Switches

Push – engages AFDS and A/T in takeoff or go-around mode if previously armed.

Autopilot / Autothrottle Indicators



1 Autopilot (A/P) Disengage Light

Illuminated (red) –

- flashing – autopilot has disengaged (tone sounds)
 - reset by pushing either disengage light or either A/P disengage switch
- steady –
 - stabilizer out of trim below 800 feet RA on dual channel approach
 - ALT ACQ mode inhibited during A/P go-around if stabilizer not trimmed for single A/P operation

-
- disengage light test switch held in position 2
 - automatic ground system tests fail.

Illuminated (amber) –

- flashing – autopilot has automatically reverted to CWS pitch or roll while in CMD
 - resets when either light is pressed or another mode engaged
- steady – disengage light test switch held in position 1.

2 Autothrottle (A/T) Disengage Light

Illuminated (red) –

- flashing – autothrottle has disengaged
- steady – disengage light test switch held in position 2.

Illuminated (amber) –

- flashing – indicates autothrottle speed error if speed not held within +10 or -5 knots of commanded speed when all of the following conditions exist:
 - in flight
 - flaps not up
 - A/T engaged in MCP SPD or FMC SPD mode
 - automatic test of flashing function is performed if the A/T is engaged under the above conditions when more than 150 seconds have passed since liftoff
 - amber light flashes for 2 seconds, remains extinguished for 2 seconds, then flashes again for 2 seconds
- steady – disengage light test switch held in position 1.

3 Disengage Light TEST Switch

TEST 1 – illuminates autopilot/autothrottle disengage and FMC alert lights steady amber.

TEST 2 – illuminates autopilot/autothrottle disengage lights steady red and FMC alert light steady amber.

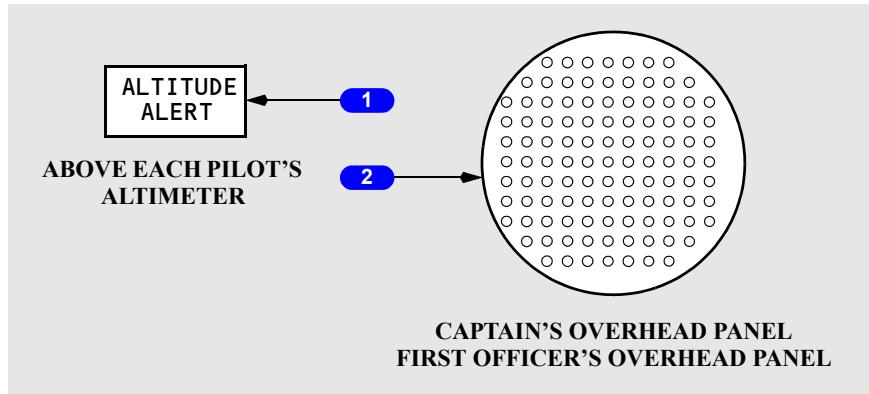
Spring-loaded to center position.

4 Stabilizer Out Of Trim (STAB OUT OF TRIM) Light

Operates only with autopilot engaged. Remains extinguished with autopilot not engaged.

Illuminated (amber) – autopilot not trimming stabilizer properly.

Altitude Alert



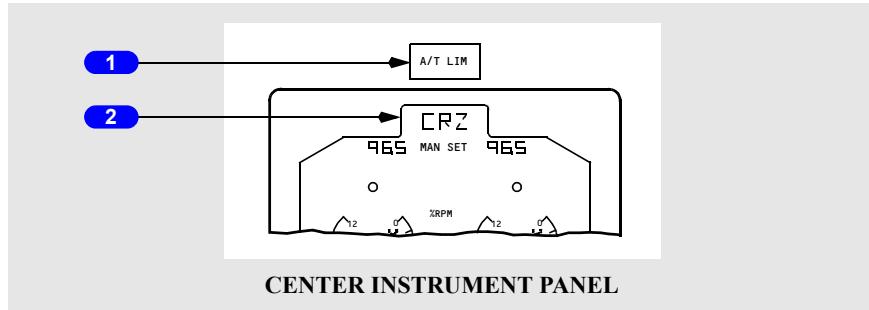
1 ALTITUDE ALERT Light

Illuminated (amber) – airplane is approaching or departing selected altitude.

2 Speaker

Transmits alert tone when airplane approaches or departs selected altitude.

Thrust Mode Display



1 Autothrottle Limit (A/T LIM) Light

Illuminated (white) – Indicates A/T computer is calculating a degraded N1 limit for the affected engine or engines.

2 Thrust Mode Display

N1 limit reference is the active N1 limit for autothrottle and manual thrust control.

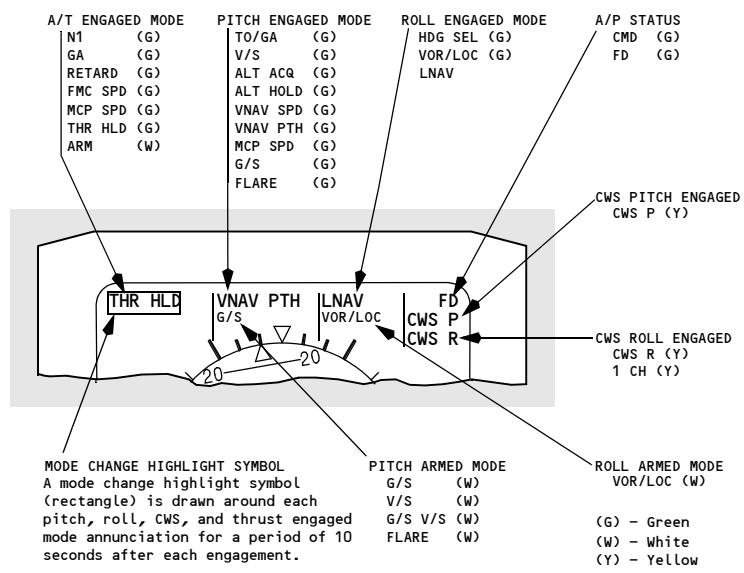
N1 limit reference is also displayed by N1 reference bugs with N1 SET control in AUTO position.

N1 limit reference is normally calculated by the FMC.

Thrust mode display/Thrust mode annunciator panel annunciations are:

- R - Reduced. Can appear with TO or CLB
 - TO - Takeoff
 - CLB - Climb
 - CRZ - Cruise
 - G/A - Go-around
 - CON - Continuous
 - —— FMC not computing thrust limit.

Flight Mode Annunciations (FMAs)



CAPTAIN'S EADI FIRST OFFICER'S EADI

Automatic Flight System Description

Chapter 4 Section 20

General

The automatic flight system (AFS) consists of the autopilot flight director system (AFDS) and the autothrottle (A/T). The flight management computer (FMC) provides N1 limits and target N1 for the A/T and command airspeeds for the A/T and AFDS.

The AFDS and A/T are controlled using the AFDS mode control panel (MCP) and the FMC. Normally, the AFDS and A/T are controlled automatically by the FMC to fly an optimized lateral and vertical flight path through climb, cruise and descent.

AFS mode status is displayed on the flight mode annunciation on each pilot's EADI.

Autopilot Flight Director System

The AFDS is a dual system consisting of two individual flight control computers (FCCs) and a single mode control panel.

The two FCCs are identified as A and B. For A/P operation, they send control commands to their respective pitch and roll hydraulic servos, which operate the flight controls through two separate hydraulic systems.

For F/D operation, each FCC positions the F/D command bars on the respective ADI.

MCP Mode Selector Switches

The mode selector switches are pushed to select desired command modes for the AFDS and A/T. The switch illuminates to indicate mode selection and that the mode can be deselected by pressing the switch again. While a mode is active, deselection can be automatically inhibited, indicated by the switch being extinguished.

When engagement of a mode would conflict with current AFS operation, pushing the mode selector switch has no effect. All AFDS modes can be disengaged either by selecting another command mode or by disengaging the A/P and turning the F/Ds off.

Autopilot Engagement Criteria

Each A/P can be engaged separately in CMD or CWS. A/P engagement in CMD or CWS is inhibited unless both of the following pilot-controlled conditions are met:

- No force is being applied to the control wheel
- The STAB TRIM AUTOPILOT cutout switch is at NORMAL.

Only one A/P can be engaged at a given time unless the approach (APP) mode is engaged. Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides control through landing and touchdown or an automatic go-around.

In single A/P operation, full automatic flare and touchdown capability and A/P go-around capability are not available.

If an autopilot is engaged in CMD with one or both F/Ds operating in command modes and the F/D command bars are not within approximately 1/2 scale of being centered, the A/P automatically engages in CWS for pitch and/or roll, and the F/D command bars retract.

Autopilot Disengagement

The A/P automatically disengages when any of the following occurs:

- Pushing either A/P disengage switch
- Pushing either Takeoff/Go-around (TO/GA) switch with a single A/P engaged in CWS or CMD below 2000 feet RA
- Pushing either TO/GA switch after touchdown with both A/Ps engaged in CMD
- Moving the A/P engage paddle to OFF
- Activating either pilot's control wheel trim switch
- Moving the STAB TRIM AUTOPILOT cutout switch to CUTOUT
- Loss of respective hydraulic system pressure
- Repositioning the EFI transfer switch
- Either left or right IRS system failure or FAULT light illuminated
- Loss of electrical power or a sensor input which prevents proper operation of the engaged A/P and mode.

Note: Loss of the system A engine-driven hydraulic pump and a heavy demand on system A may cause A/P A to disengage.

AFS Failures

Power interruption or loss may cause disengagement of the AFDS and/or A/T. Re-engagement is possible after power is restored.

Dual channel A/P operation is possible only when two generators are powering the busses.

Two independent radio altimeters provide radio altitude to the related FCC. The Captain's radio altimeter provides radio altitude to the A/T. With a radio altimeter inoperative the autopilot will disconnect two seconds after LOC and GS capture, and the A/T will not retard at flare.

Flight Director Display

Turning a F/D switch ON displays command bars on the respective pilot's ADI if command pitch and roll modes are engaged. If command pitch and roll modes are not engaged, the F/D command bars do not appear. The F/Ds can be operated with or without the A/P and A/T. F/D command modes can be used with an A/P engaged in CWS.

F/D commands operate in the same command modes as the A/P except:

- The takeoff mode is a F/D only mode
- Dual F/D guidance is available for single engine operation
- The F/D has no landing flare capability. F/D command bars retract from view at approximately 50 feet RA on an ILS approach.

Normally, FCC A drives the captain's command bars and FCC B drives the first officer's command bars. With both F/D switches ON, the logic for both pilot's F/D modes are controlled by the master FCC, and both FMA displays show the same mode status.

The master FCC is indicated by illumination of the related master (MA) F/D indicator light. The master FCC is determined as follows:

- With neither A/P engaged in CMD, the FCC for the first F/D turned on is the master
- With one or both A/Ps engaged in CMD, the FCC for the first A/P in CMD is the master FCC, regardless of which F/D is turned on first.

F/D modes are controlled directly from the respective FCC under certain conditions. This independent F/D operation occurs when neither A/P is engaged in CMD, both F/D switches are ON and one of the following mode conditions exists:

- APP mode engaged with LOC and G/S captured
- GA mode engaged and below 400 feet RA
- TO mode engaged and below 400 feet RA.

Independent F/D operation is indicated by illumination of both MA lights. When independent operation terminates, the MA light extinguishes on the slaved side.

If a generator is lost during a F/D TO or GA, or while in dual F/D APP mode below 800 feet, the FCC on the unaffected side positions the F/D command bars on both ADIs. If the F/D MA light on the affected side had been illuminated, it extinguishes upon electrical bus transfer.

AFDS Status Annunciation

The following AFDS status annunciations are displayed in the A/P status display located on the EADI:

- CMD (one or both autopilots are engaged)
- FD (the flight director is ON and the autopilot is either OFF or engaged in CWS)
- CWS P (pitch mode engaged in CWS)
- CWS R (roll mode engaged in CWS).

AFDS Flight Mode Annunciations

The flight mode annunciations are displayed on the EADI. The modes are in these categories:

- autothrottle
- pitch
- roll
- autopilot status

Engaged or captured modes are shown at the top of the flight mode annunciation boxes in large green letters. Armed modes are shown in smaller white letters at the bottom of the flight mode annunciation boxes.

Autothrottle Modes

- N1 – The autothrottle maintains thrust at the selected N1 limit displayed on the thrust mode display
- GA – The autothrottle maintains thrust at reduced go-around setting or full go-around N1 limit
- RETARD – Displayed while autothrottle moves thrust levers to the aft stop; RETARD mode is followed by ARM mode
- FMC SPD – The autothrottle maintains speed commanded by the FMC; the autothrottle is limited to the N1 value shown on the thrust mode display
- MCP SPD – The autothrottle maintains speed set in the MCP IAS/MACH display; the autothrottle is limited to the N1 value shown on the thrust mode display
- THR HLD – The thrust lever autothrottle servos are inhibited. The pilot can set the thrust levers manually
- ARM – No autothrottle mode engaged. The thrust lever autothrottle servos are inhibited; the pilot can set thrust levers manually

Pitch Modes

- TO/GA – Takeoff

Engaged for takeoff by turning both F/D switches ON and pressing either TO/GA switch. Both F/Ds must be ON to engage TO/GA prior to starting takeoff.

The AFDS commands pitch attitude in the following order:

- 10 degrees nose down until 60 knots IAS
- 15 degrees nose up after 60 knots IAS
- 15 degrees nose up after lift-off until a sufficient climb rate is acquired. Then, pitch is commanded to maintain MCP speed plus 20 knots.

TO/GA can also be engaged for takeoff with F/D switches OFF if a TO/GA switch is pushed after 80 knots IAS below 2,000 feet AGL and prior to 150 seconds after lift-off.

- TO/GA – Go-around

Engaged for go-around by pressing the TO/GA switch under the following conditions:

- In flight below 2,000 feet radio altitude
- Not in takeoff mode
- Either F/D ON or OFF

The F/Ds command 15 degrees nose up pitch and roll to hold the approach ground track at time of go-around engagement. After reaching a programmed rate of climb, pitch commands the maneuvering speed for each flap setting based on maximum weight calculations.

- VNAV –

VNAV is engaged by pushing the VNAV switch. With a VNAV mode engaged, the FMC commands AFDS pitch and A/T modes to fly the vertical profile selected on the FMC CDUs.

- VNAV SPD – The AFDS maintains the FMC speed displayed on the airspeed cursor and/or the CDU CLIMB or DESCENT pages
- VNAV PTH – The AFDS maintains FMC altitude or descent path with pitch commands.
- V/S (armed) – V/S mode can be engaged by moving Vertical Speed thumbwheel
- V/S (engaged) – Pitch commands hold selected vertical speed
- ALT ACQ – Transition maneuver entered automatically from a V/S, LVL CHG, or VNAV climb or descent to selected MCP altitude. Engages but does not annunciate during VNAV transition
- ALT HOLD – Pitch commands hold MCP selected altitude or uncorrected barometric altitude at which ALT HOLD switch was pushed
- MCP SPD – Pitch commands maintain IAS/MACH window airspeed or Mach
- G/S (armed) – The AFDS is armed for G/S capture
- G/S (engaged) – The AFDS follows the ILS glideslope.

- **FLARE (armed)** – During a dual A/P ILS approach, FLARE is displayed after LOC and G/S capture and below 1500 feet RA. The second A/P couples with the flight controls, and A/P go-around mode arms.
- **FLARE (engaged)** – During a dual A/P ILS approach, flare engages at 50 feet radio altitude. FLARE accomplishes the autoland flare maneuver.

Roll Modes

- **LNAV** – The AFDS intercepts and tracks the active FMC route. Either of the following capture criteria must be met:
 - On any heading and within 3 NM of the active route segment
 - If outside of 3 NM of active route segment, airplane must be on an intercept course of 90 degrees or less and intercept the route segment before the active waypoint.
- **HDG SEL** – The airplane is turning to or is on the heading selected in the MCP heading display
- **VOR/LOC (armed)** – AFDS is armed to capture selected VOR or LOC COURSE
- **VOR/LOC (engaged)** – AFDS tracks selected VOR course or tracks selected localizer course along the inbound front course bearing.

Autopilot Control Wheel Steering

CWS Engage Switch Selected

Pressing a CWS engage switch engages the A/P pitch and roll axes in the CWS mode and displays CWS P and CWS R on the FMAs.

With CWS engaged, the A/P maneuvers the airplane in response to control pressures applied by either pilot. The control pressure is similar to that required for manual flight. When control pressure is released, the A/P holds existing attitude.

If aileron pressure is released with 6 degrees or less bank, the A/P rolls the wings level and holds existing heading. This heading hold feature with bank less than 6 degrees is inhibited when any of the following conditions exists:

- Below 1,500 feet RA with the landing gear down
- After F/D VOR capture with TAS 250 knots or less
- After F/D LOC capture in the APP mode.

Pitch CWS with a CMD Switch Selected

The pitch axis engages in CWS while the roll axis is in CMD when:

- A command pitch mode has not been selected or was deselected
- A/P pitch has been manually overridden with control column force. The force required for override is greater than normal CWS control column force. This manual pitch override is inhibited in the APP mode with both A/Ps engaged

CWS P is annunciated on the FMAs while this mode is engaged. Command pitch modes can then be selected.

When approaching a selected altitude in CWS P with a CMD engage switch selected, CWS P changes to ALT ACQ. When at the selected altitude, ALT HOLD engages.

If pitch is manually overridden while in ALT HOLD at the selected altitude, ALT HOLD changes to CWS P. If control force is released within 250 feet of the selected altitude, CWS P changes to ALT ACQ, the airplane returns to the selected altitude, and ALT HOLD engages. If the elevator force is held until more than 250 feet from the selected altitude, pitch remains in CWS P.

Roll CWS with a CMD Engage Switch Selected

The roll axis engages in CWS while the pitch axis is in CMD when:

- A command roll mode has not been selected or was deselected
- A/P roll has been manually overridden with control wheel force. The force required for override is greater than the normal CWS control wheel force.

CWS R is annunciated on the FMAs while this mode is engaged.

CWS R with a CMD engage switch illuminated can be used to capture a selected radio course while the VOR/LOC or APP mode is armed. Upon intercepting the radial or localizer, the F/D and A/P annunciations change from CWS R to VOR/LOC engaged, and the A/P tracks the selected course.

Autothrottle System

The A/T system provides automatic thrust control from the start of takeoff through climb, cruise, descent, approach and go-around or landing. In normal operation, the FMC provides the A/T system with N1 limit values.

The A/T moves the thrust levers with a separate servo motor on each thrust lever. Manually positioning the thrust levers does not cause A/T disengagement unless 10 degrees of thrust lever separation is exceeded during a dual channel approach after FLARE armed is annunciated. Following manual positioning, the A/T may reposition the thrust levers to comply with computed thrust requirements except while in the THR HLD and ARM modes.

The A/T system operates properly with the PMCs ON or OFF. In either case, the A/T computer controls to the FMC N1 limits. During A/T operation, it is recommended that both PMCs be ON or both OFF, as this produces minimum thrust lever separation. A/T takeoffs may be performed with both PMCs OFF.

Autothrottle Engagement

Moving the A/T arm switch to ARM arms the A/T for engagement in the N1, MCP SPD or FMC SPD mode. The A/T arm switch is magnetically held at ARM and releases to OFF when the A/T becomes disengaged.

A general summary of A/T mode engagement is as follows:

- A/T SPD or N1 modes automatically engage when AFDS command pitch modes become engaged
- Engaging LVL CHG or VNAV climb modes automatically engages the A/T N1 mode
- Engaging LVL CHG or VNAV descent modes automatically engages the A/T in RETARD and then ARM when thrust is at idle
- If not in a VNAV mode, engagement of ALT ACQ or ALT HOLD automatically engages the A/T in the MCP SPD mode; otherwise the A/T remains in FMC SPD.
- Engagement of G/S capture automatically engages the A/T in the MCP SPD mode.

Autothrottle Disengagement

Any of the following conditions or actions disengages the A/T:

- Moving the A/T Arm switch to OFF
- Pressing either A/T Disengage switch
- An A/T system fault is detected
- Two seconds have elapsed since landing touchdown
- Thrust levers become separated more than 10 degrees during a dual channel approach after FLARE armed is annunciated.

Additionally, on some airplanes, a thrust split monitor disengages the autothrottle if autopilot roll control requires significant spoiler deployment and thrust levers become separated. The thrust split monitor is active when flaps are less than 15, and the A/T is not engaged in the takeoff or go-around mode.

A/T disengagement is followed by A/T Arm switch releasing to OFF and flashing red A/T Disengage lights. The A/T Disengage lights do not illuminate when the A/T automatically disengages after landing touchdown.

Altitude Alerting System

Altitude alerting references the altitude selected on the MCP. Alerting occurs when approaching or departing the selected altitude. Altitude alerting is inhibited when wing flaps are extended to 25 or greater, or while G/S is captured.

Alerting consists of a momentary tone and illumination of an ALTITUDE ALERT light located adjacent to each pilot's primary altimeter.

Acquisition Alerting

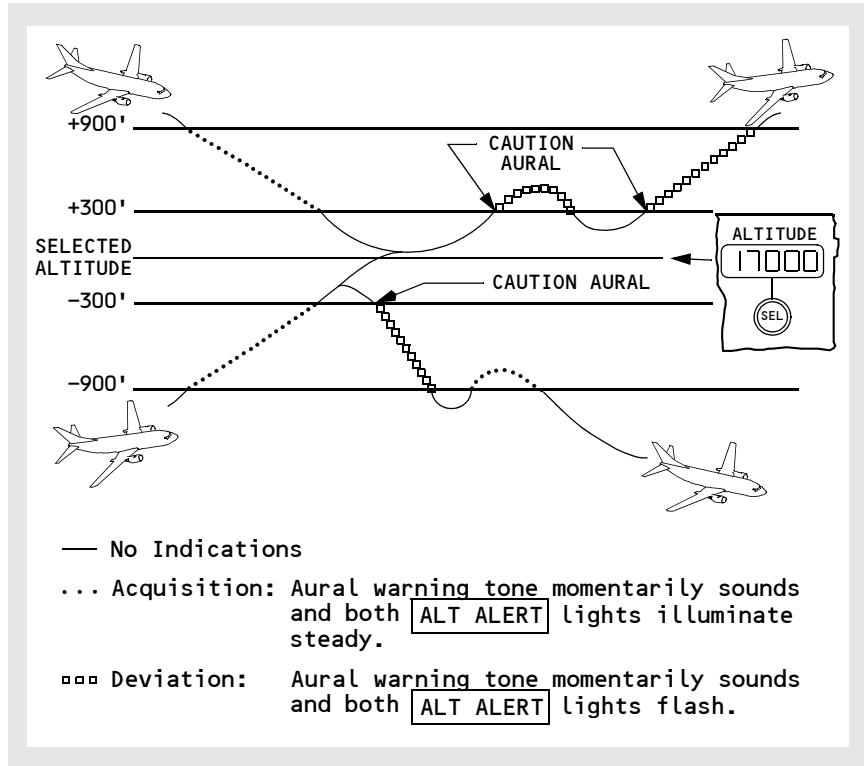
When approaching within 900 feet of selected altitude both ALTITUDE ALERT lights illuminate steady, and a momentary tone sounds. When at 300 feet from selected altitude, both ALTITUDE ALERT lights extinguish.

Deviation Alerting

Upon deviating from the selected altitude by more than 300 feet, a momentary tone sounds, and the ALTITUDE ALERT lights flash. Flashing continues until one of the following occurs:

- Altitude deviation becomes less than 300 feet.
- Altitude deviation becomes more than 900 feet.
- A new altitude is selected.

Altitude Alert



Automatic Flight Operations

The phases of flight for automatic flight operations are:

- Takeoff and climb
- Enroute
- Approach and landing
- Go-around

Automatic Flight Takeoff and Climb

Takeoff is a flight director only function of the TO/GA mode. Flight director pitch and roll commands are displayed, and the autothrottle maintains takeoff N1 thrust limit as selected from the FMC. The autopilot may be engaged after takeoff.

Both F/Ds must be ON to engage the takeoff mode prior to starting the takeoff. The F/D takeoff mode is engaged by pressing the TO/GA switch on either thrust lever. The FMAs display FD as the A/P status, TO/GA as the pitch mode, and blank for the roll mode.

During takeoff, pushing a TO/GA switch engages the autothrottle in the N1 mode. The A/T annunciation changes from ARM to N1 and thrust levers advance toward takeoff thrust.

The F/D can also be engaged in the takeoff mode with the F/D switches off. If a TO/GA switch is pushed after 80 knots below 2000 feet AGL and prior to 150 seconds after lift-off, the F/D command bars automatically appear for both pilots.

During takeoff, prior to 60 KIAS:

- the pitch command is 10 degrees nose down
- the roll command is wings level
- the autothrottle is engaged in the N1 mode
- thrust levers advance until the engines reach takeoff thrust
- the FMAs display N1 for the autothrottle mode, TO/GA for the pitch mode, and blank for the roll mode for airplanes which maintain wings level.

At 60 knots, the F/D pitch commands 15 degrees nose up.

At 84 knots (64 knots for airplanes with an earlier autothrottle computer), the A/T mode announces THR HLD.

At lift-off:

- the pitch command continues at 15 degrees until sufficient climb rate is acquired. Pitch then commands MCP speed (normally V2) plus 20 knots.
- if an engine failure occurs during takeoff, the pitch command target speed is:
 - V2, if airspeed is below V2
 - existing speed, if airspeed is between V2 and V2 + 20

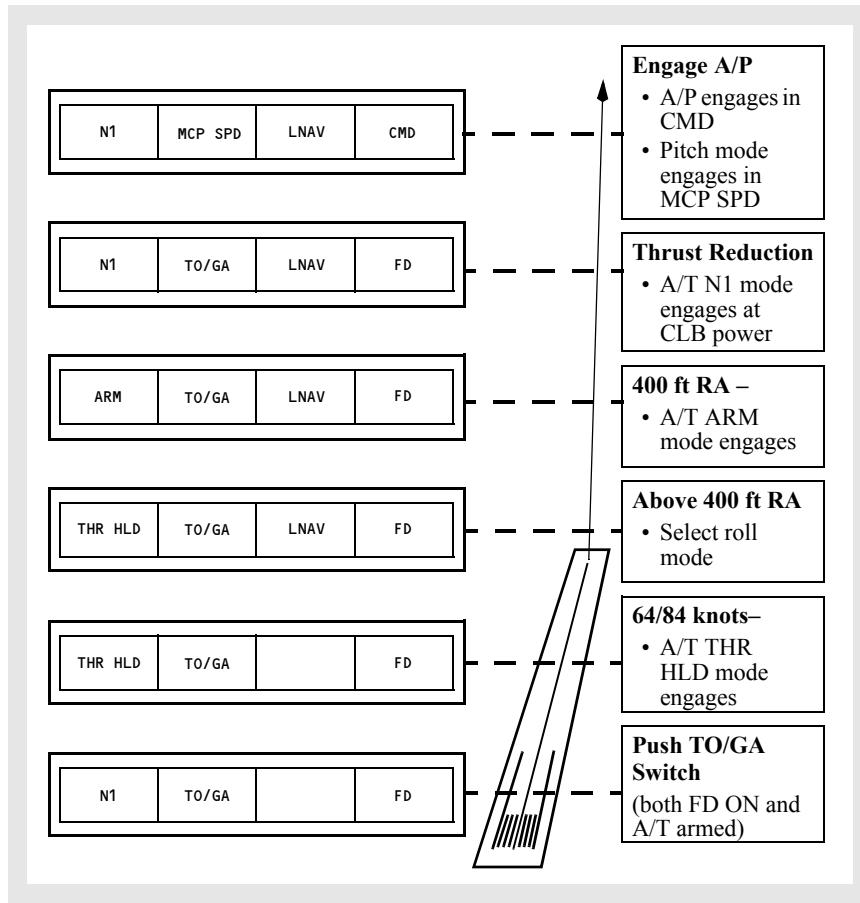
- V2 + 20, if airspeed is above V2 + 20
- the roll command maintains wings level (annunciation blank).

After lift-off:

- the A/T remains in THR HLD until 400 feet RA is reached and approximately 18 seconds have elapsed since liftoff. A/T annunciation then changes from THR HLD to ARM and reduction to climb thrust can be made by pressing the N1 switch.
- automatic thrust reduction to climb power occurs when VNAV, ALT ACQ or ALT HOLD is engaged. Until 2 1/2 minutes after liftoff, automatic thrust reduction is inhibited when engaging LVL CHG or V/S modes.
- flight director engaged status is terminated by engaging an autopilot in CMD (CMD replaces FD in A/P status display)
 - pitch engages in LVL CHG and pitch mode FMA is MCP SPD
 - MCP IAS/Mach display and airspeed cursor change to V2 + 20 knots
 - roll mode maintains HDG SEL unless previously changed to LNAV or VOR/LOC.

To terminate the takeoff mode below 400 feet RA, both F/D switches must be turned OFF. Above 400 feet RA, selection of another pitch mode or engaging an autopilot will terminate the takeoff mode; other F/D roll modes can be also selected.

Automatic Flight Takeoff Profile



Automatic Flight En Route

The autopilot and/or the flight director can be used after takeoff to fly a lateral navigation track (LNAV) and a vertical navigation track (VNAV) provided by the FMC.

Other roll modes available are:

- VOR course (VOR/LOC)
- heading select (HDG SEL).

Other pitch modes available are:

- altitude hold (ALT HOLD)
- level change (MCP SPD)
- vertical speed (V/S).

Automatic Flight Approach and Landing

The AFDS provides guidance for single A/P non-precision approaches. The VOR/LOC switch arms the AFDS for VOR or localizer tracking. Descent prior to the Final Approach Fix may be accomplished using VNAV, LVL CHG, or V/S. VOR/LOC, LNAV, or HDG SEL may be used for the roll mode.

The AFDS provides guidance for single or dual A/P precision approaches. The approach mode arms the AFDS to capture and track the localizer and glide slope.

Approach (APP) Mode Dual Autopilots

Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides fail passive operation through landing flare and touchdown or an automatic go-around. During fail passive operation, the flight controls respond to the A/P commanding the lesser control movement. If a failure occurs in one A/P, the failed channel is counteracted by the second channel such that both A/Ps disconnect with minimal airplane maneuvering and with aural and visual warnings to the pilot.

One VHF NAV receiver must be tuned to an ILS frequency before the approach mode can be selected. For a dual A/P approach, the second VHF NAV receiver must be tuned to the ILS frequency and the corresponding A/P engaged in CMD prior to 800 feet RA.

Localizer and Glide Slope Armed

After setting the localizer frequency and course, pressing the APP switch selects the APP mode. The APP switch illuminates, and VOR/LOC and G/S annunciate armed. The APP mode permits selecting the second A/P to engage in CMD. This arms the second A/P for automatic engagement after LOC and G/S capture and when descent below 1500 RA occurs.

The localizer can be intercepted in the HDG SEL, CWS R or LNAV mode. Glide slope capture cannot occur prior to localizer capture.

Localizer Capture

The LOC capture point is variable and depends on intercept angle and rate of closure, and capture occurs no later than 1/2 dot. Upon LOC capture, VOR/LOC annunciates captured, 1 CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

Glide Slope Capture

The G/S cannot be captured prior to localizer capture. The G/S can be captured from above or below. Capture occurs at 2/5 dot and results in the following:

- G/S annunciates captured
- previous pitch mode disengages
- APP light extinguishes if localizer has also been captured

-
- airplane pitch tracks the G/S
 - GA displayed on thrust mode display (N1 thrust limit).

After VOR/LOC and G/S are both captured, the APP mode can be exited by:

- pressing a TO/GA switch
- disengaging A/P and turning off both F/D switches
- retuning a VHF NAV receiver.

After LOC and G/S Capture

Shortly after capturing both LOC and G/S and below 1500 feet RA:

- the second A/P couples with the flight controls
- test of the ILS deviation monitor system is performed and the G/S and LOC displays turn amber and flash
- FLARE armed is annunciated
- the 1 CH annunciation extinguishes
- A/P go-around mode arms but is not annunciated.

Note: After localizer and glideslope capture during a dual autopilot approach, CWS cannot be engaged by manually overriding pitch and roll. Manual override of autopilots causes autopilot disengagement.

The A/Ps disengage and the F/D command bars retract to indicate an invalid ILS signal.

800 Feet Radio Altitude

The second A/P must be engaged in CMD by 800 feet RA to execute a dual channel A/P approach. Otherwise, CMD engagement of the second A/P is inhibited.

400 Feet Radio Altitude

The stabilizer is automatically trimmed an additional amount nose up. If the A/Ps subsequently disengage, forward control column force may be required to hold the desired pitch attitude.

If FLARE is not armed by approximately 350 feet RA, both A/Ps automatically disengage.

Flare

The A/P flare maneuver starts at approximately 50 feet RA and is completed at touchdown:

- FLARE engaged is annunciated and F/D command bars retract
- The A/T begins retarding thrust at approximately 27 feet RA so as to reach idle at touchdown. A/T FMA annunciates RETARD

- The A/T automatically disengages approximately 2 seconds after touchdown
- The A/P must be manually disengaged after touchdown. Landing rollout is executed manually after disengaging the A/P.

Automatic Flight Approach

The AFDS provides guidance for single A/P non-precision approaches. The VOR/LOC switch arms the AFDS for VOR or localizer tracking. Descent prior to the final approach fix may be accomplished using VNAV, LVL CHG, or V/S. V/S is the appropriate mode for descent on final approach. VOR/LOC, LNAV, or HDG SEL may be used for the roll mode.

The AFDS provides guidance for single A/P precision approaches. The approach mode arms the AFDS to capture and track the localizer and glide slope.

Approach (APP) Mode Single A/P

A single A/P ILS approach can be executed by engaging only one A/P in CMD. Single A/P approach operation is the same as dual, with the following exceptions:

- Full automatic flare and touchdown capability are not available. FLARE is not annunciated, and stabilizer trim bias is not applied
- An A/P go-around is not available.

One VHF NAV receiver must be tuned to an ILS frequency before the approach mode can be selected.

Localizer and Glide Slope Armed

After setting the localizer frequency and course, pressing the APP switch selects the APP mode. The APP switch illuminates, and VOR/LOC and G/S annunciate armed. The APP mode permits selecting the second A/P to engage in CMD. This arms the second A/P for automatic engagement after LOC and G/S capture and when descent below 1500 RA occurs.

The localizer can be intercepted in the HDG SEL, CWS R or LNAV mode. Glide slope capture cannot occur prior to localizer capture.

Localizer Capture

The LOC capture point is variable and depends on intercept angle and rate of closure, and capture occurs no later than 1/2 dot. Upon LOC capture, VOR/LOC annunciates captured, 1 CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

Glide Slope Capture

Glide slope capture cannot occur prior to localizer capture. The G/S can be captured from above or below. Capture occurs at 2/5 dot and results in the following:

- G/S annunciates captured
- previous pitch mode disengages
- APP light extinguishes if localizer has also been captured
- airplane pitch tracks the G/S
- GA displayed on thrust mode display (N1 thrust limit).

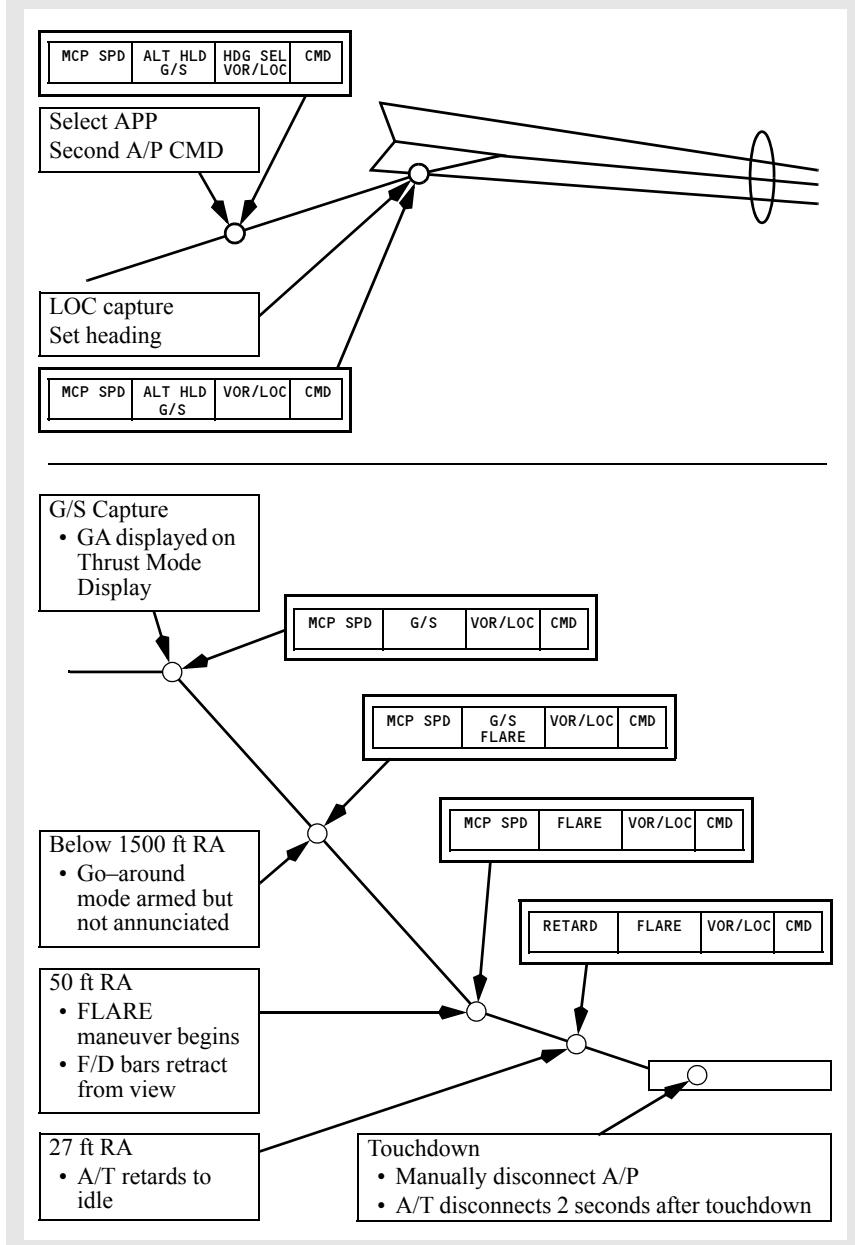
After VOR/LOC and G/S are both captured, the APP mode can be exited by:

- pressing a TO/GA switch
- retuning a VHF NAV receiver

At approximately 50 feet RA, the F/D command bars retract.

The autopilot must be manually disengaged prior to landing.

Automatic Flight Approach Profile



Go-Around

Go-Around (GA) mode is engaged by pushing either TO/GA switch. An A/P go-around requires dual A/P operation and is armed when FLARE armed is annunciated. If both A/Ps are not operating, a manual F/D go-around is available.

With the A/T Arm switch at ARM, the A/T go-around mode is armed when descending below 2000 feet RA, with or without the AFDS engaged. Once armed, the A/T go-around mode can be engaged until 2 seconds have elapsed after landing touchdown.

A/P Go-Around

The A/P GA mode requires dual A/P operation and is available after FLARE armed is annunciated and prior to the A/P sensing touchdown.

With the first push of either TO/GA switch:

- A/T (if armed) engages in GA and the A/T Engaged Mode annunciation on the FMA indicates GA
- Thrust advances toward the reduced go-around N1 to produce 1000 to 2000 fpm rate of climb
- Pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- F/D pitch commands 15 degrees nose up until reaching programmed rate of climb. F/D pitch then commands maneuvering speed for each flap setting based on maximum weight calculations
- F/D roll commands hold current ground track. The Roll Engaged Mode annunciation on the FMA is blank
- The IAS/Mach display blanks
- The airspeed cursor displays maneuvering speed for existing flap setting based on maximum weight calculations.

Note: If the go-around mode is selected after touchdown and prior to A/T disengagement, the A/Ps disengage and the A/Ts may command GA thrust.

With the second push of either TO/GA switch after A/T reaches reduced go-around thrust, the A/T advances to the full go-around N1 limit.

TO/GA mode termination from A/P go-around:

- Below 400 feet RA, the AFDS remains in the go-around mode unless both A/Ps and F/Ds are disengaged
- Above 400 feet RA, select a different pitch or roll mode.
 - If the roll mode is changed first:
 - the selected mode engages in single A/P roll operation and is controlled by the A/P which was first in CMD
 - pitch remains in dual A/P control in TO/GA mode.
 - If the pitch mode is changed first:

- the selected mode engages in single A/P pitch operation and is controlled by the A/P which was first in CMD
 - the second A/P disengages
 - the roll mode engages in CWS R.
- The A/T GA mode is terminated when:
 - another pitch mode is selected
 - ALT ACQ annunciates engaged.

Note: The pitch mode cannot be changed from TO/GA until sufficient nose-down trim has been input to allow single channel A/P operation. This nose-down trim is automatically added by the A/P to reset the trim input made by the A/P at 400 feet RA and 50 feet RA during the approach.

With pitch mode engaged in TO/GA, ALT ACQ engages when approaching the selected altitude, and ALT HOLD engages at the selected altitude if the elevator position is satisfactory for single A/P operation.

- If elevator position is not satisfactory for single A/P operation:
 - ALT ACQ is inhibited
 - A/P disengage lights illuminate steady red
 - pitch remains in TO/GA.

Note: To extinguish A/P disengage lights, disengage A/Ps or select higher altitude on MCP

F/D Go-Around

If both A/Ps are not engaged, a manual F/D only go-around is available under the following conditions:

- Inflight below 2000 feet RA
- Not in takeoff mode.

With the first push of either TO/GA switch:

- A/T (if armed) engages in GA and advances thrust toward the reduced go-around N1 to produce 1000 to 2000 fpm rate of climb. The A/T Engaged Mode annunciation on the FMA indicates GA
- Autopilot (if engaged) disengages
- Pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- F/D pitch commands 15 degrees nose up until reaching programmed rate of climb. F/D pitch then commands maneuvering speed for each flap setting based on maximum weight calculations
- F/D roll commands approach ground track at time of engagement. The Roll Engaged Mode annunciation on the FMA is blank

-
- The IAS/Mach display blanks
 - The airspeed cursor displays maneuvering speed for existing flap setting based on maximum weight calculations.

With the second push of either TO/GA switch (if A/T engaged and after A/T reaches reduced go-around thrust):

- The A/T advances to the full go-around N1 limit

TO/GA mode termination from F/D go-around:

- Below 400 feet RA, both F/D switches must be turned off.
- Above 400 feet RA, select a different pitch or roll mode.
 - If the roll mode is changed first:
 - F/D roll engages in the selected mode
 - the F/D pitch mode remains in TO/GA.
 - If the pitch mode is changed first:
 - F/D pitch engages in the selected mode.
 - the F/D roll mode automatically changes to HDG SEL
 - The A/T GA mode (if engaged) is terminated when:
 - another pitch mode is selected
 - ALT ACQ annunciates engaged.

Note: Engaging an A/P in CMD automatically engages the A/P and F/Ds in LVL CHG for pitch and HDG SEL for roll.

Single Engine F/D Go-Around

With a push of either TO/GA switch:

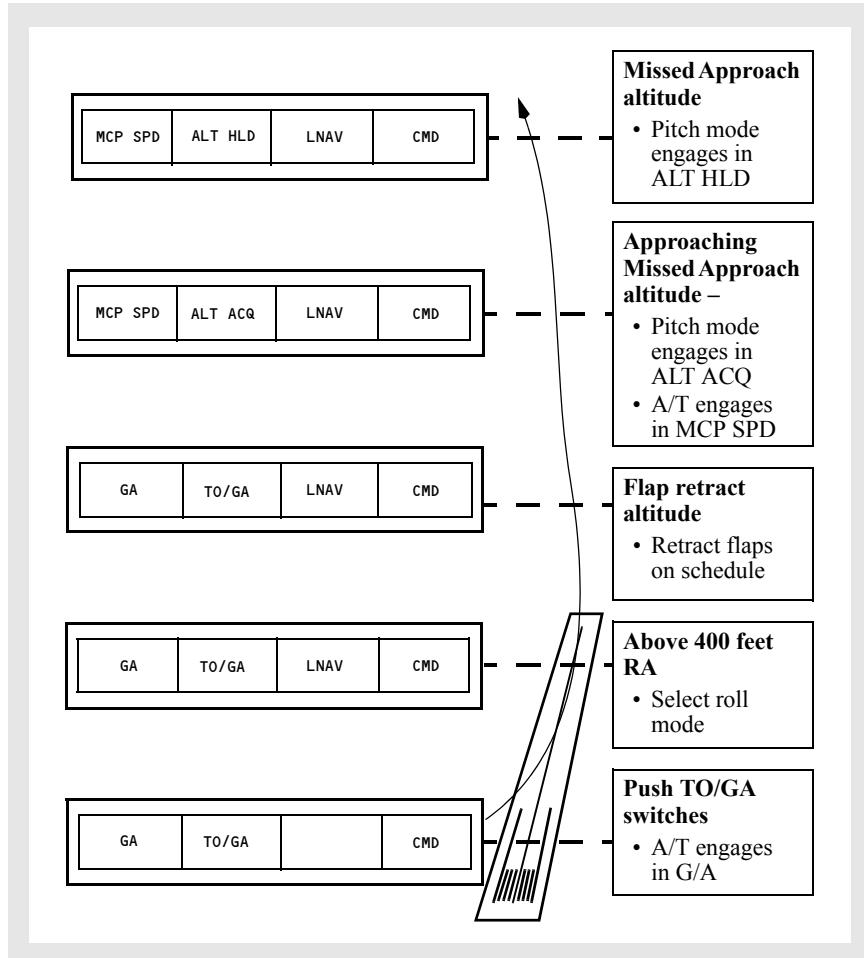
- F/D roll commands hold current ground track. The Roll Engaged Mode annunciation on the FMA is blank
- Pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- The F/D target speed is displayed on IAS/Mach display
- The F/D target speed is displayed on the airspeed cursor
- F/D pitch commands 13 degrees nose up. As climb rate increases, F/D pitch commands maintain a target speed.
 - If engine failure occurs prior to go-around engagement, then F/D target speed is the selected MCP speed.
 - If engine failure occurs after go-around engagement, then F/D target speed depends on whether ten seconds have elapsed since go-around engagement:
 - If prior to ten seconds, the MCP selected approach speed becomes target speed
 - If after ten seconds and the airspeed at engine failure is within five knots of the go-around engagement speed, the airspeed that existed at go-around engagement becomes target speed

- If after ten seconds and the airspeed at engine failure is more than five knots above go-around engagement speed, then the current airspeed becomes target speed.

Note: The target speed is never less than V2 speed based on flap position unless in windshear conditions.

F/D commanded acceleration cannot occur until a higher speed is selected on the MCP IAS/Mach display.

Automatic Flight Go-Around Profile



AFS Operation in Windshear

General

The autopilot and flight director provide positive corrective action to counteract most windshears. The autothrottle system also aids in windshear recovery by providing quick response to any increase or decrease in speed. The commanded levels of power may be beyond what the average pilot might consider necessary but, in fact, are required by the situation.

Takeoff or Go-Around

If windshear is encountered during F/D takeoff or go-around, the F/D pitch command bar provides commands to maintain V2 + 20 kts until vertical speed decreases to approximately +600 fpm. At this point, the F/D pitch bar commands a 15 degree nose-up pitch attitude. If vertical speed continues to decrease, the F/D continues to command a 15 degree pitch attitude until a speed of approximately stick shaker is reached. It then commands pitch attitudes which result in intermittent activation of the stick shaker. As the airplane transits the windshear condition, the F/D programming reverses. As climb rate increases above approximately +600 fpm, the F/D commands pitch attitudes which result in acceleration back to V2 + 20 kts. The A/P and F/D both operate in a similar manner during A/P or F/D go-around.

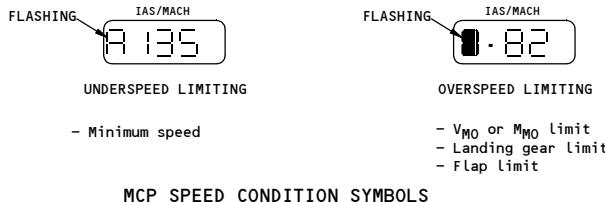
Approach and Landing

If windshear is encountered during an ILS approach, both the F/D and A/P attempt to hold the airplane on altitude, or on glideslope after glideslope capture, without regard to angle of attack or stick shaker limitations. Airspeed could decrease below stick shaker and into a stall if the pilot does not intervene by pressing the TO/GA switch or disconnecting the A/P and flying manually.

WARNING: Although the F/D, A/P and A/T may be performing as previously described, severe windshear may exceed the performance capability of the system and/or the airplane. In this situation, the flight crew must, if necessary to avoid ground contact, be prepared to disconnect the autothrottle, advance thrust levers to the forward stop, disconnect the autopilot and manually fly the airplane.

Command Speed Limiting and Reversion Modes

AFS command limiting and reversion operation is independent of the stall warning and mach/airspeed warning systems.



Command Speed Limiting

The AFS provides speed, pitch and thrust commands to avoid exceeding the following limit speeds:

- Vmo/Mmo
- Wing flap placards
- Landing gear placard
- Minimum speed.

The commanded speed can be equal to, but will not exceed a limit speed.

Speeds greater than Vmo/Mmo cannot be selected from the MCP. Speeds can be selected which exceed flap and gear placards or are less than minimum speed.

Minimum speed is based on angle of attack and is approximately 1.3 Vs for the current flap configuration. It is sensed by the angle of attack vanes, one on either side of the forward fuselage.

If a speed greater than a placard speed, or less than minimum speed is selected, the AFS allows acceleration or deceleration to slightly short of the limit, then commands the limit speed. The overspeed or underspeed limiting symbol appears in the MCP IAS/Mach display when the commanded speed cannot be reached.

Either pitch or thrust, whichever is engaged in a speed mode, attempts to hold the limit speed. The commanded limit speed and MCP speed condition symbol, remain until another speed is selected which does not exceed the limit. A speed 15 kts greater than the minimum speed must be selected to remove the underspeed limiting symbol.

Reversion Modes

During some flight situations, speed control by the AFDS or A/T alone could be insufficient to prevent exceeding a limit speed. If this occurs, AFDS or A/T modes automatically revert to a more effective combination. The reversion modes are:

- Placard limit reversion (gear, flap or Vmo/Mmo)
- Minimum airspeed reversion

Mode reversion occurs slightly before reaching the limit speed. Both the AFDS and A/T have reversion modes which activate according to the condition causing the reversion.

Placard Limit Reversion

When one of the placard limit reversions (gear, flap or Vmo/Mmo) is reached, the overspeed limiting symbol appears in the MCP IAS/Mach display and the following occurs:

- If the AFDS is engaged but not in speed or CWS mode, and the A/T is armed but not in speed control, the A/T reverts to SPEED and controls speed to slightly below the placard limit.
- If the AFDS or A/T is in speed control, speed is maintained slightly below the placard limit.
- for VMO/MMO only, if the A/T is engaged in a speed mode and the thrust levers are at idle, the AFDS, if in a V/S mode, will automatically engage to LVL CHG mode.
- If the A/T is not available, no reversion response to gear or flap placard speeds is available. The AFDS reverts to speed control for Vmo/Mmo speed limiting.

Minimum Speed Reversion

The AFDS and A/T do not control to a speed which is less than minimum speed for the current flap configuration. This speed is approximately 1.3 Vs. Minimum speed, FMC speed, or selected speed, whichever is higher, becomes the AFS commanded speed. If actual speed becomes equal to or slightly less than the minimum speed, the underspeed limiting symbol appears in the MCP IAS/Mach display, and if operating in the V/S mode, the AFDS reverts to LVL CHG. The AFDS will also revert to LVL CHG from VNAV PTH, except when capturing or flying a level segment.

The AFDS commands a speed 5 knots greater than minimum speed. Selecting a speed 15 knots greater than minimum speed reactivates normal MCP speed selection control. The AFDS commands nose down pitch to increase airspeed if the thrust levers are not advanced. When actual speed becomes 15 knots greater than minimum speed, the underspeed limiting symbol disappears.

The A/P disengages, and the F/D command bars retract when in a LVL CHG climb with a command speed equal to minimum speed and a minimum rate of climb cannot be maintained without decelerating.

Minimum speed reversion is not available when the A/T is OFF.

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737 Flight Crew Operations Manual

Communications

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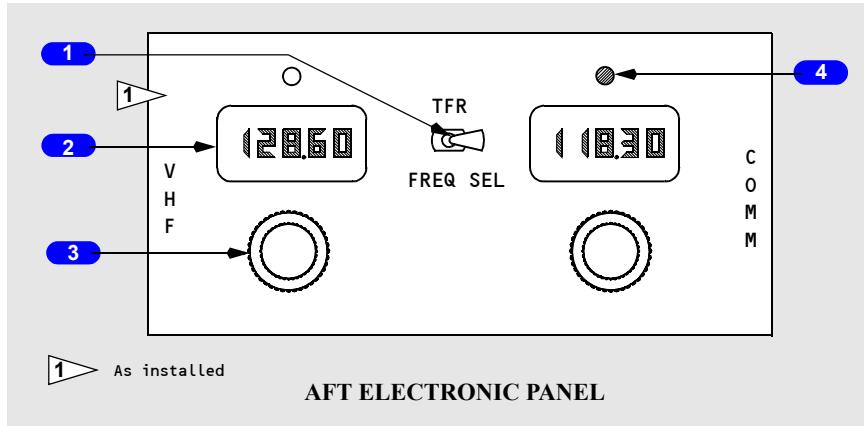
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VHF Communication Panel



1 VHF Communications Transfer (TFR) Switch

Selects which frequency as active for the transceiver.

2 Frequency Indicator

Indicates selected frequency.

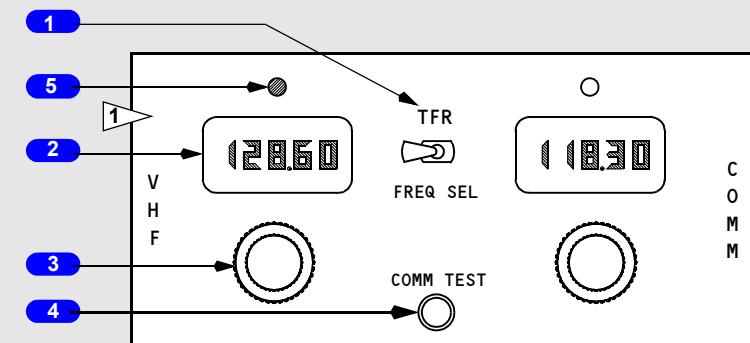
3 Frequency Selector

Rotate – selects frequency in related indicator:

- outer selector changes three left digits
- inner selector changes two right digits.

4 Active Frequency Light

Illuminated (white)–indicates related frequency is selected.



1 As installed

AFT ELECTRONIC PANEL

1 VHF Communications Transfer (TFR) Switch

Selects which frequency as active for the transceiver.

2 Frequency Indicator

Indicates selected frequency.

3 Frequency Selector

Rotate – selects frequency in related indicator:

- outer selector changes three left digits
- inner selector changes two right digits.

4 Communication (COMM) TEST Switch

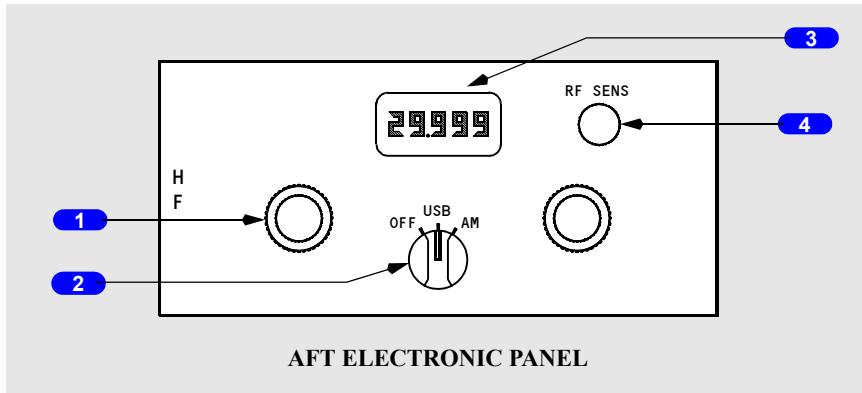
Push –

- removes automatic squelch feature, permitting reception of background noise and thereby testing receiver operation
- improves reception of weak signals.

5 Active Frequency Light

Illuminated (white) – indicates related frequency is selected.

HF Communication Panel



1 Frequency Selector

Rotate – selects frequency.

2 Mode Selector

OFF – transceiver not powered.

USB (Upper Sideband) – transmits and receives on higher side of frequency.

AM (Amplitude Modulation) – transmits and receives on selected frequency with a carrier wave.

3 Frequency Indicator

- indicates selected frequency
- frequency range from 2,000 to 29,000 megahertz.

4 RF/HF Sensitivity Control

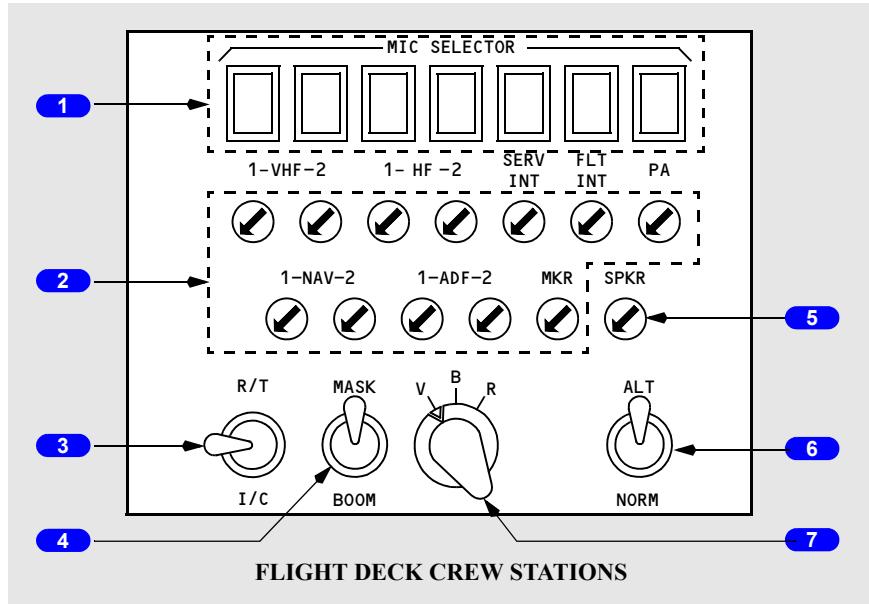
Rotate – controls sensitivity of receiver.

- (clockwise) increases sensitivity for reception of weak or distant stations
- (counterclockwise) decreases sensitivity to reduce noise and static.

Note: decreasing sensitivity too far prevents reception, including SELCAL monitoring of HF radio.

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Audio Selector Panel (ASP)



1 Transmitter Selector (MIC SELECTOR) Switches

Illuminated (white) – related switch is active.

Push –

- selects related communication system for transmission
- only one switch may be selected at a time; pushing a different switch deselects active switch
- receiver also selected on regardless of whether related receiver switch is on.

2 Receiver Switches

Illuminated (white) – related switch is active.

Rotate – adjusts volume.

Push –

- receiver selected for related communication system or navigation receiver
- multiple switches may be selected

Push again – deselects related system or receiver.

3 Push-to-talk Switch

(spring-loaded to neutral position)

R/T (radio-transmit) – keys oxygen mask or boom microphone for transmission as selected by transmitter selector.

I/C (Intercom) – keys oxygen mask or boom microphone for direct transmission over flight interphone and bypasses transmitter selector.

4 MASK-BOOM Switch

MASK – selects oxygen mask for transmissions.

BOOM – selects boom microphone for transmissions.

5 Speaker (SPKR) Switch

Illuminated (white) – SPKR switch is active.

Push – audio from selected receiver switches is heard on overhead speaker.

Rotate – adjusts overhead speaker volume.

Push again – deselects audio from selected receiver switches to be heard on overhead speaker.

6 Alternate-Normal (ALT-NORM) Switch

NORM (Normal) – ASP operates normally.

ALT (Alternate) – ASP operates in degraded mode.

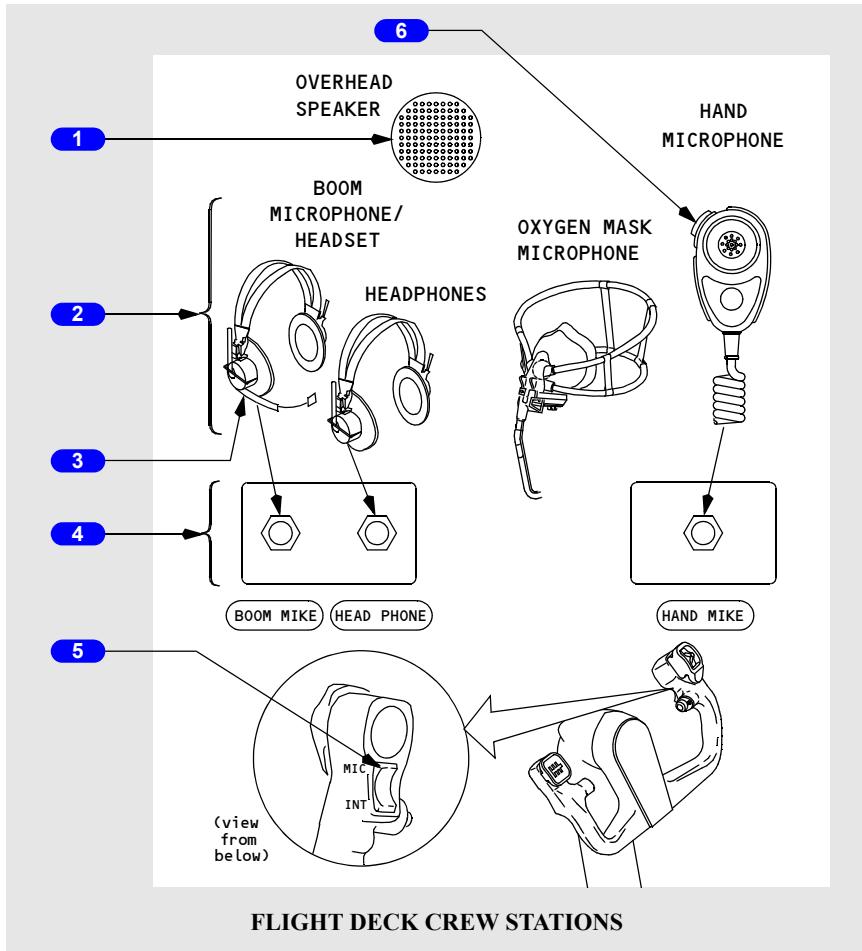
7 Filter Switch

V (Voice) – receive NAV and ADF voice audio.

B (Both) – receive NAV and ADF voice and range audio.

R (Range) – receive NAV and ADF station identifier range (code) audio.

Miscellaneous Communication Controls (Typical)



1 Overhead Speaker

Monitors audio from related pilot's ASP.

2 Standard Microphones

Choose desired microphone for voice transmission through selected radio, interphone system, or passenger address (PA).

3 Headset or Headphones

Monitors audio from related ASP.

4 Communication Jacks

Used for appropriate microphone or headphone plugs.

5 Push-To-Talk Switch

MIC (microphone) –

- keys oxygen mask or boom microphone for transmission, as selected by ASP transmitter selector.
- Same as using ASP PTT switch (R/T position).

OFF – center position.

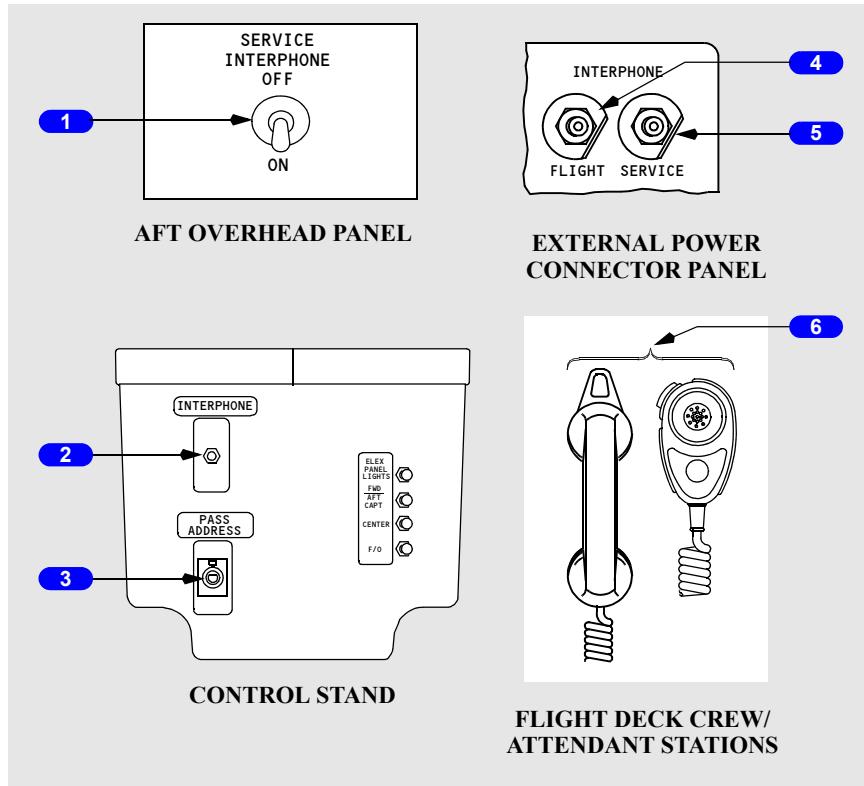
INT (interphone) –

- keys oxygen mask or boom microphone for direct transmission over flight interphone
- bypasses ASP transmitter selector
- same as using ASP PTT switch (I/C position).

6 Push-To-Talk Switch

Push – keys hand microphone for transmission, as selected by ASP transmission selector.

Interphone and Passenger Address Controls



1 SERVICE INTERPHONE Switch

OFF –

- external jacks are deactivated
- communication between flight deck and flight attendants is still possible.

ON – adds external jacks to service interphone system.

2 Service INTERPHONE Handset Jack

With microphone installed, used to communicate with flight attendant stations:

- with SERVICE INTERPHONE switch ON, also used to communicate with any external jack location
- bypasses ASP.

3 Passenger Address (PASS ADDRESS) Hand Microphone Jack

With microphone installed:

- used to make PA announcements
- bypasses ASPs.

4 FLIGHT INTERPHONE Jack

Connects ground crew to Flight Interphone system.

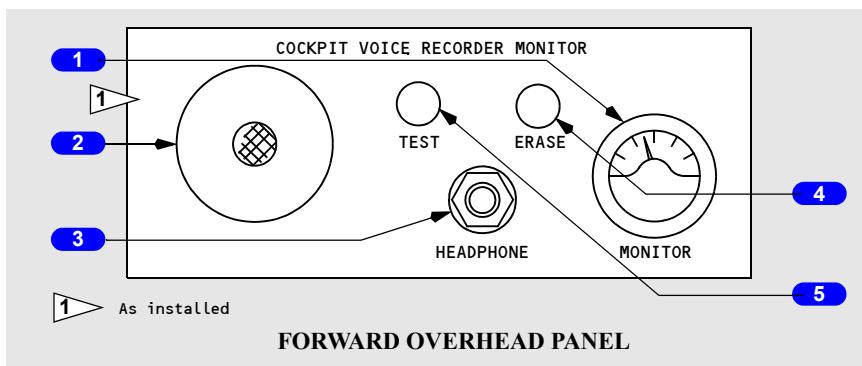
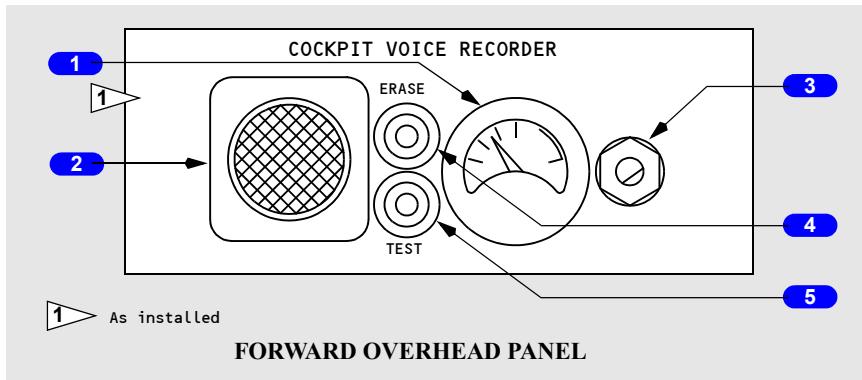
5 SERVICE INTERPHONE Jack

Connects ground crew to Service Interphone system if Service Interphone switch is ON.

6 Flight Deck / Attendant PA Hand Microphone

Used to make PA announcements.

Cockpit Voice Recorder



1 Monitor Indicator

Pointer deflection indicates recording or erasure on all four channels (approximately a one second delay); during test, pointer rises into green band.

2 Area Microphone

Active anytime 115V AC is applied to airplane.

3 HEADSET Jack

Headset may be plugged into jack to monitor tone transmission during test, or to monitor playback of voice audio.

4 ERASE Switch

Push (14 seconds) –

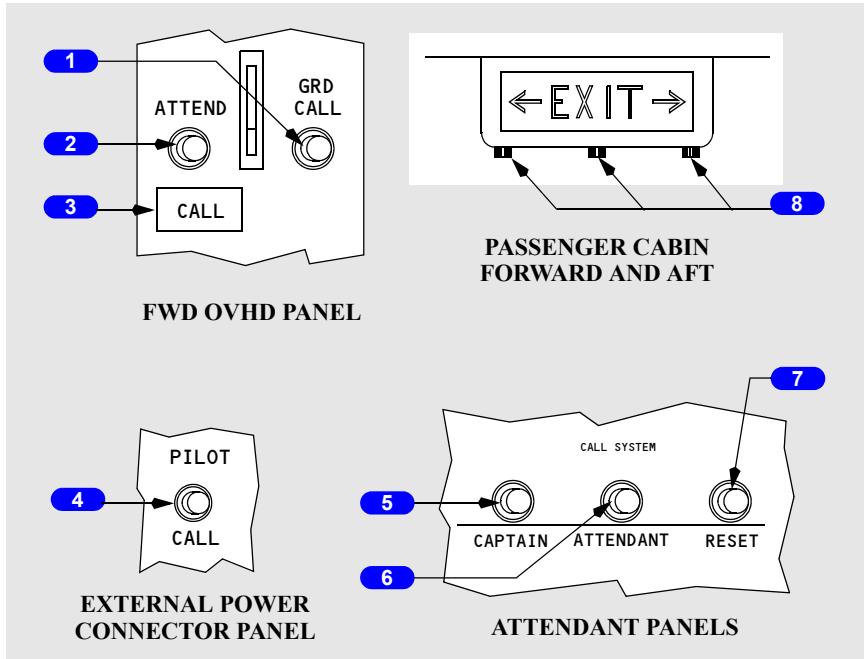
- all four channels are erased
- monitor indicator momentarily deflects
- operates only when airplane is on ground and parking brake is set.

5 TEST Switch

Push –

- after a slight delay, monitor indicator rises into green band
- a tone may be heard through a headset plugged into HEADSET jack.

Call System



1 Ground Call (GRD CALL) Switch

Push – sounds a horn in nose wheel well until released.

2 Attendant Call (ATTEND CALL) Switch

Push –

- sounds a two-tone chime in the passenger cabin.
- illuminates both pink master call lights.

3 Flight Deck CALL Light

Illuminated (blue) – flight deck is being called by flight attendants or ground crew.

Extinguished when Captain Call or Pilot Call switch released.

4 PILOT CALL Switch

Push – sounds a single-tone chime in flight deck.

Flight deck CALL light extinguished when switch is released.

5 CAPTAIN Call Switch

Push – sounds a single-tone chime in flight deck

Flight deck CALL light extinguished when switch is released.

6 ATTENDANT Call Switch

Push –

- sounds a two-tone chime in passenger cabin
- illuminates both pink master call lights.

7 Call RESET Switch

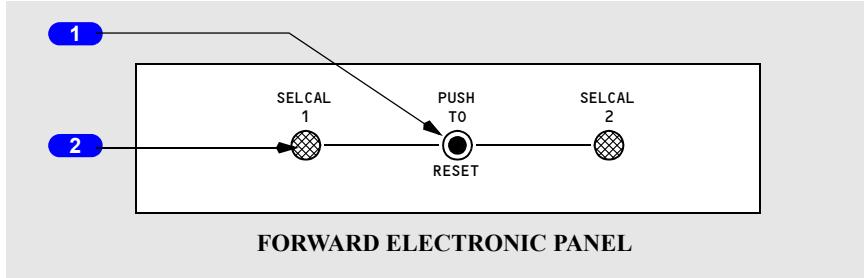
Push – extinguishes both pink master call lights.

8 Master Call Light

Illuminated –

- amber – a lavatory call switch is activated or smoke has been detected in a lavatory
- pink – flight deck or other flight attendant station is calling
- blue – a passenger seat call switch is activated.

Selective Calling Panel (SELCAL)



1 SELCAL Reset Switch

Push – extinguishes SELCAL light and resets decoder.

2 SELCAL Light

Illuminated –

- alerts crew that communication is desired on a communication radio
- SELCAL 1 light illuminates for a call on VHF –1 or HF
- SELCAL 2 light illuminates for a call on VHF– 2.

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Communications System Description

Chapter 5 Section 20

Introduction

The communication system includes:

- radio communication system
- interphone communication system
- cockpit voice recorder system
- communication crew alerting system

The communication systems are controlled using the:

- audio selector panels
- radio tuning panels

Audio Systems and Audio Selector Panels

An ASP is installed at the Captain, First Officer, and Observer stations. Each panel controls an independent crew station audio system and allows the crewmember to select the desired radios, navigation aids, interphones, and PA systems for monitoring and transmission.

Transmitter selectors on each ASP select one radio or system for transmission by that crewmember. Any microphone at that crew station may then be keyed to transmit on the selected system.

Receiver switches select the systems to be monitored. Any combination of systems may be selected. Receiver switches also control the volumes at the respective crew stations. Audio from each ASP is monitored using a headset/headphones or the related pilot's speaker.

Speakers and Headsets

Each crew station has a headset or headphone jack. The Captain and First Officer have speakers on the ceiling above their seats. There is no speaker at the observer station. Headset volume is controlled by the receiver switches. Speaker volume is controlled by the receiver switches and also the speaker switch.

Audio warnings for altitude alert, GPWS, and windshear are heard at preset volumes. They cannot be controlled or turned off by the crew.

Microphones

Hand microphones and boom microphones may be plugged into the related jacks at the flight deck crew stations. Each oxygen mask also has an integral microphone.

Each hand microphone has a PTT switch to key the selected audio system. The PTT switches on the control wheel or ASP are used to key the oxygen mask or boom microphone, as selected by the MASK-BOOM switch. The MASK-BOOM switch does not affect the operation of the hand microphone.

Normal Audio System Operation

The Captain, First Officer, and Observer audio systems are located in a common remote electronics unit in the E & E compartment. They function independently and have separate circuit breakers. The audio systems are normally controlled by the related ASPs through digital or computerized control circuits.

Degraded Audio System Operation (airplanes with ALT-NORM switch)

If the remote electronics unit or ASP malfunctions, the ASP cannot control the remote electronics unit. Audio system operation can be switched to a degraded mode by placing the ALT-NORM switch to ALT. In this mode, the ASP at that station is inoperative and the crewmember can only communicate on one radio.

The ASP transmitter selectors are not functional, and any transmission from that station is on the radio shown on the chart below. The transmitter selector for the usable radio illuminates when a station is operating in the degraded mode. The receiver switches are not functional, and only the usable radio is heard at a preset volume, through the headset. The speaker and speaker switch are not functional at that station. In addition, the flight interphone and service interphone cannot be used. The control wheel PTT switch INT position and the ASP PTT switch I/C, or on some airplanes, INT position are not functional, since the flight interphone is not functional.

The mask and boom microphones can be used for transmission on the usable radio. The MASK-BOOM , or on some airplanes, BOOM-OXY switch works normally in the degraded mode. The mask and boom microphones can be keyed with the control wheel PTT switch MIC position or the ASP PTT switch R/T position. The hand microphone is not usable in the degraded mode of operation.

Audio warnings for altitude alert, GPWS, and windshear are not heard on an audio system operating in the degraded mode.

An audio system operating in the degraded mode cannot access the passenger address system through the audio control panel. The crewmember can still use the service interphone handset and PA microphone if they are installed on the control stand.

CREW STATION AUDIO SYSTEM IN DEGRADED MODE	RADIO AVAILABLE FOR TRANSMISSION AND RECEPTION AT DEGRADED STATION
CAPTAIN	VHF-1
FIRST OFFICER	VHF-2
OBSERVER	VHF-1

Flight Interphone System

The flight interphone system is an independent communication network. Its primary purpose is to provide private communication between flight deck crewmembers without intrusion from the service interphone system. The ground crew may also the use flight interphone through a jack at the external power receptacle.

The pilots can transmit directly over the flight interphone by using the control wheel PTT switch. Alternatively, any crewmember with an ASP can transmit/receive over the flight interphone by using their related ASP and normal PTT switches. Any standard microphone may be used with the flight interphone system.

Service (Attendant) Interphone System

The service interphone system provides intercommunication between the flight deck, Flight Attendants, and ground personnel. Flight deck crewmembers communicate using either a separate handset (if installed) or their related ASP and any standard microphone.

The Flight Attendants communicate between flight attendant stations or with the flight deck using any of the attendant handsets. Anyone who picks up a handset/microphone is automatically connected to the system.

External jacks for use by maintenance or service personnel can be added to the system by use of the service interphone switch.

Passenger Address System

The passenger address (PA) system allows flight deck crewmembers and flight attendants to make announcements to the passengers. Announcements are heard through speakers located in the cabin and in the lavatories.

The flight deck crewmembers can make announcements using a PA hand microphone or by using any standard microphone and the related ASP. Flight Attendants make announcements using PA hand microphones located at their stations. The attendants use the PA to play recorded music for passenger entertainment.

PA system use is prioritized. Flight deck announcements have first priority and override all others. Flight Attendant announcements override the music system. The forward attendant has priority over the aft attendant.

Call System

The call system is used as a means for various crewmembers to gain the attention of other crewmembers and to indicate that interphone communication is desired. Attention is gained through the use of lights and aural signals (chimes or horn). The system can be activated from the flight deck, either flight attendant station, or from the external power receptacle. Passengers may also use the system to call an attendant, through the use of individual call switches at each seat.

The flight deck may be called from either flight attendant station or by the ground crew. The ground crew may only be called from the flight deck. Flight Attendants may be called from the flight deck, the other attendant station, or from any passenger seat or lavatory. Master call lights in the passenger cabin identify the source of incoming calls to the attendants.

Call system chime signals are audible in the passenger cabin through the PA system speakers. The PA speakers also provide an alerting chime signal whenever the NO SMOKING or FASTEN SEAT BELT signs illuminate or extinguish.

Location of Call Originator	Called Position	Visual Signal at Called Position	Aural Signal at Called Position
Flight deck	Attendant station	Pink master call light	Two-tone chime
Flight deck	Nose wheel well		Horn in nose wheel well
Attendant station	Flight deck	Blue flight deck call light	Single high-tone chime
External Power Service Panel	Flight deck	Blue flight deck call light	Single high-tone chime
Flight deck	Passenger cabin	NO SMOKING or FASTEN BELT signs illuminate/extinguish	Single low-tone chime

Selective Calling (SELCAL)

A ground station desiring communication with the flight deck can use the SELCAL system. SELCAL monitors selected frequencies on VHF and HF radios. Each airplane is assigned a unique four-letter SELCAL identification code. When the system receives an incoming call from a ground station, a two-tone chime sounds, and the related SELCAL light illuminates.

VHF Communications

Primary short-range voice communication is provided in the VHF range by two or three independent radios. Each radio provides for selection of an active frequency and an inactive (preselected) frequency. Voice transmission and reception are controlled at the related ASP.

VHF-3 communication on airplanes equipped with three VHF transceivers is used in conjunction with ACARS. Frequency tuning for this radio is provided by the ACARS system.

VHF-1 is located on the left aft electronic panel, VHF-2 on the right. The VHF-1 antenna is located on the upper fuselage, VHF-2 and VHF-3 on the lower fuselage.

HF Communications

HF transmission and reception are controlled at the related ASP. When the HF transmitter is keyed after a frequency change, the antenna tunes. A steady or intermittent tone may be heard through the audio system. While tuning, the tone can last as long as 7 seconds. If the system fails to tune, the tone will last more than 7 seconds, to a maximum of 15 seconds. The antenna is located in the vertical stabilizer.

Note: Keying HF transmitter on the ground may cause oil and fuel quantity indicators to fluctuate if one or more of the following conditions exist:

- cargo or passenger entry door open
- service interphone microphone plugged into service interphone jack
- airplane grounding wire attached to airplane
- ground power cart connected.

Cockpit Voice Recorder

The cockpit voice recorder uses four independent channels to save the last 30 minutes of flight deck audio. Recordings older than 30 minutes are automatically erased. One channel records flight deck area conversations using the area microphone. The other channels record individual ASP output (headset) audio and transmissions for the pilots and observer.

ACARS System

The ARINC Communication Addressing and Reporting System (ACARS) is an addressable digital data link system which permits exchange of data and messages between an airplane and a ground-based operations center utilizing the onboard VHF-3 communication system.

The ACARS airborne subsystem provides for the manual entry of routine data such as departure/arrival information. Also possible is manual entry of addresses (telephone codes) of parties on the ground for voice communications.

The airborne system consists of a management unit (MU) in the E & E compartment, and interactive display unit (IDU), and a multiport printer. Data is entered and automatically transmitted to the ground operations center.

Page Routines

When the IDU is initially powered up (AC busses powered), it establishes contact with the ACARS and the digital flight data acquisition unit (DFDAU). The IDU screen then displays the MAIN MENU. This is the root page for accessing all other ACARS pages. Return to this MAIN MENU is possible by touching the MENU cue on any displayed page.

When a cue is touched on the IDU screen, the cue name is highlighted in reverse video. Moving the finger to another cue without breaking screen contact returns the cue first touched to normal video and highlights the new cue being touched. Releasing the highlighted cue activates the cue's function.

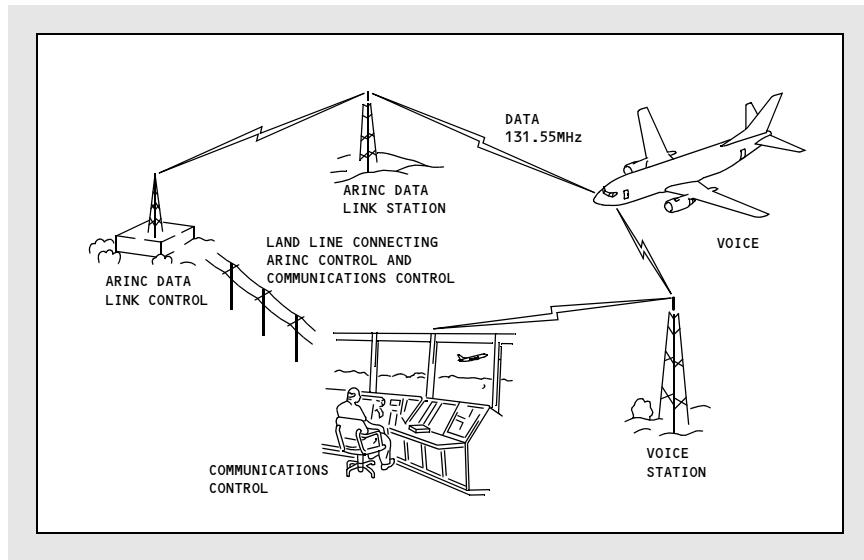
The following cues are special in that they always perform the same functions: MENU, RTN, ENT, CLR, SEND, RE-DO, and VOX. Other cues are advisory cues. Advisory cues appear in place of **** on the standard ACARS menu. Some advisory cues flash from normal to reverse video: FAIL, DATA, SELC, MSG, and INIT. Other advisories are displayed in normal video: NOCOM, VOICE; and in reverse video: FAIL.

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Communications -
System Description

ACARS System Diagram



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Electrical

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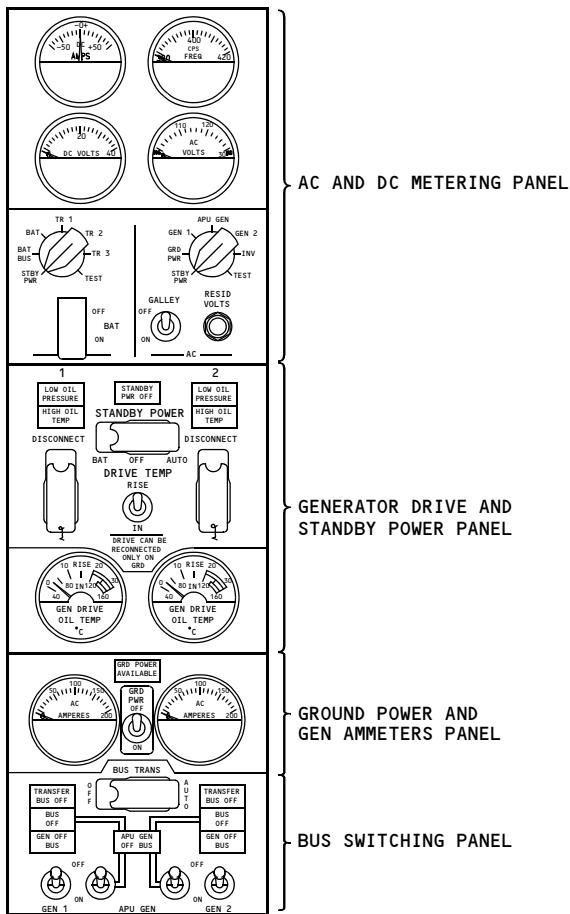
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737 Flight Crew Operations Manual

Electrical Controls and Indicators

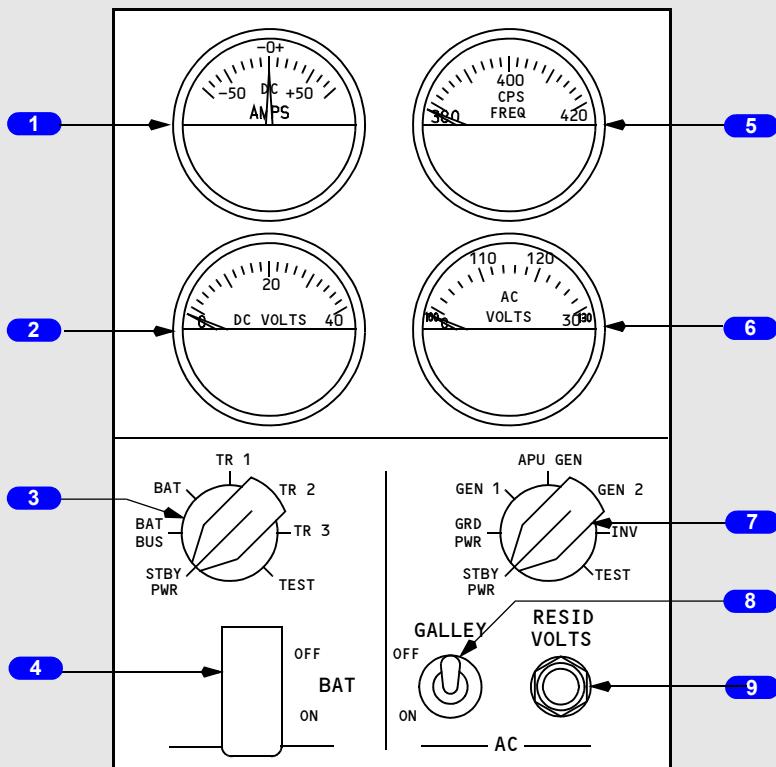
Chapter 6 Section 10

Electrical Panel



FORWARD OVERHEAD PANEL

AC and DC Metering Panel



FORWARD OVERHEAD PANEL

1 DC Ammeter

Indicates current of source selected by DC meter selector.

2 DC Voltmeter

Indicates voltage of source selected by DC meter selector.

3 DC Meter Selector

Selects the DC source for the DC voltmeter and DC ammeter indications
TEST - used by maintenance.

4 Battery (BAT) Switch

OFF –

- removes power from battery bus and switched hot battery bus when operating with normal power sources available.
- removes power from battery bus, switched hot battery bus, DC standby bus, static inverter, and AC standby bus when battery is only power source.

ON (guarded position) -

- provides power to switched hot battery bus.
- energizes relays to provide automatic switching of standby electrical system to battery power with loss of normal power in flight.

5 AC Frequency Meter

Indicates frequency of source selected by AC meter selector.

6 AC Voltmeter

130V scale - indicates voltage of source selected on the AC meter selector.

30V scale - indicates residual voltage of generator selected when RESID VOLTS switch is pressed.

7 AC Meter Selector

Selects the AC source for the AC frequency meter and AC voltmeter.

TEST - used by maintenance.

8 GALLEY Power Switch

OFF – removes electrical power from galleys.

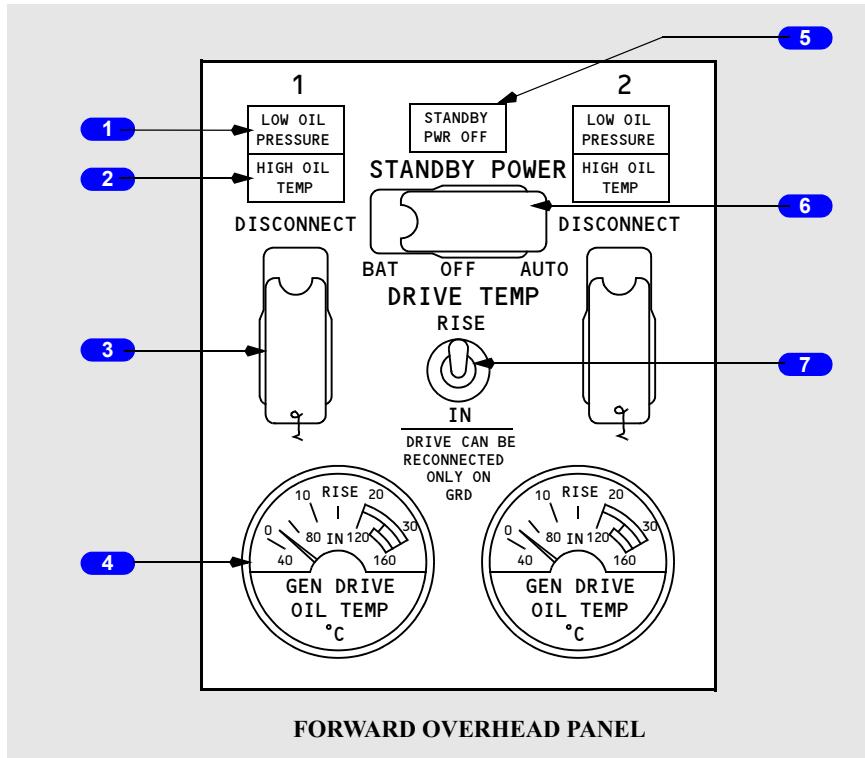
ON – electrical power is supplied to galleys when both AC generator busses are powered.

9 Residual Volts (RESID VOLTS) Switch

PRESS - 30V scale of AC voltmeter indicates residual voltage of generator selected.

Associated generator switch must be OFF. With associated generator switch ON, AC voltmeter drives off scale and residual voltage cannot be read.

Generator Drive and Standby Power Panel



1 LOW OIL PRESSURE Lights

Illuminated (amber) – generator drive oil pressure is below minimum operating limits.

2 High Oil Temperature (HIGH OIL TEMP) Lights

Illuminated (amber) - generator drive oil temperature exceeds operating limits.

3 DISCONNECT Switches (guarded and safetied)

Disconnects generator drive.

Generator drive cannot be re-engaged in the air.

4 Generator Drive Oil Temperature (GEN DRIVE OIL TEMP) Indicator

Displays the temperature of the oil used in the generator drive.

IN scale (inner) - Displays the temperature of the oil entering the generator drive.

RISE scale (outer) - Displays the temperature rise within the generator drive.

- Higher than normal temperature rise indicates excessive generator load or poor condition of the generator drive
- Lack of adequate cooling will generally cause the temperature RISE to decrease.

5 Standby Power (STANDBY PWR OFF) Light

Illuminated (amber) - AC standby bus is inactive.

6 STANDBY POWER Switch

AUTO (guarded position) –

- In flight, or on the ground, and AC transfer busses powered:
 - AC standby bus is powered by AC transfer bus 1
 - DC standby bus is powered by DC bus 1.
- In flight, loss of all AC power
 - AC standby bus is powered by the battery bus through the static inverter
 - DC standby bus is powered by the battery bus
 - a fully charged battery will provide a minimum of 30 minutes of standby power.
- On the ground, loss of all AC power - No automatic transfer of power. AC and DC standby busses are not powered.

OFF (center position) –

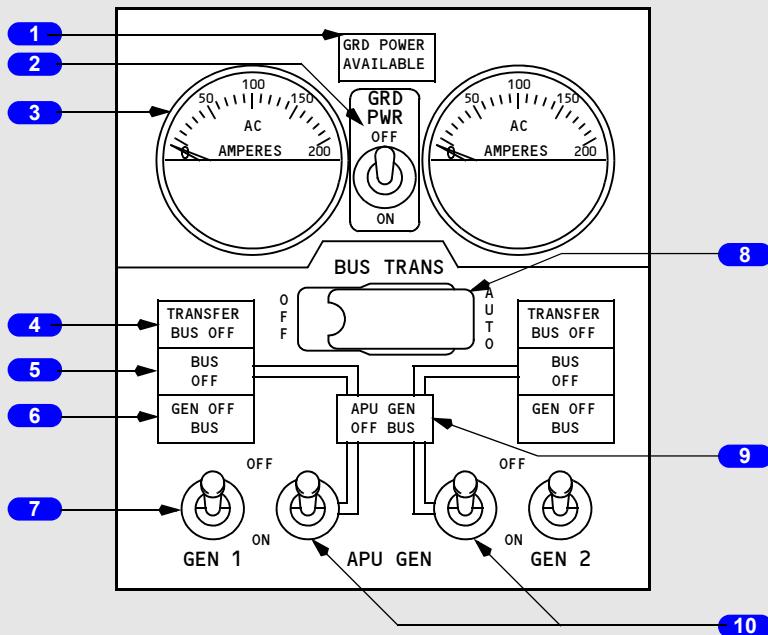
- STANDBY PWR OFF light illuminates
- AC standby bus, static inverter, and DC standby bus are not powered.

BAT (unguarded position) –

- AC standby bus is powered by the battery bus through the static inverter
- DC standby bus is powered by the battery bus
- The battery bus is powered by the hot battery bus, regardless of the battery switch position.

7 Drive Temperature (DRIVE TEMP) Switch

RISE/IN - Selects RISE or IN temperature to be displayed on the GEN DRIVE OIL TEMP indicator.

Bus Switching**FORWARD OVERHEAD PANEL****1 Ground Power (GRD POWER AVAILABLE) Light**

Illuminated (blue) – external power bus is powered by ground power supply. Remains illuminated as long as ground power source is attached outside the airplane.

2 Ground Power (GRD PWR) Switch

Three position switch, spring-loaded to neutral.

OFF – disconnects ground power from both generator busses.

ON – if momentarily moved to the ON position and ground power is available:

- removes previously connected power from AC generator busses
- connects ground power to both AC generator busses if power quality is correct
- switches the ground service bus to the generator bus 1
- deactivates the ground service switch.

3 AC Ammeter

Indicates engine generator load in amperes.

4 TRANSFER BUS OFF Light

Illuminated (amber) – related transfer bus is inactive.

5 BUS OFF Light

Illuminated (amber) – related generator bus is inactive.

6 Generator Off Bus (GEN OFF BUS) Light

Illuminated (blue) – related generator is not supplying the generator bus.

7 Generator Switch (GEN 1/GEN 2)

Three position switch, spring-loaded to neutral.

OFF - disconnects related engine generator from the generator bus.

ON - connects related engine generator to the generator bus if the power quality is correct. Disconnects the previous power source.

8 Bus Transfer (BUS TRANS) Switch

AUTO (guarded position) - upon failure of one engine generator bus, its transfer bus is switched to the active generator bus. Allows TR1 and TR2 to be operated in parallel.

OFF - Isolates transfer busses by preventing operation of the bus transfer relays, and opens TR3 disconnect relay. Prevents the battery charger from switching to its alternate source of power, main bus 2.

9 APU Generator Off Bus (GEN OFF BUS) Light

Illuminated (blue) – APU is at its operating speed and not powering a generator bus.

10 APU Generator (GEN) Switch

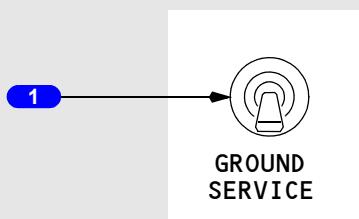
Three position switch, spring-loaded to center position.

OFF - disconnects the APU from the generator bus.

ON – connects the APU generator output to the generator bus if the quality is correct.

Note: In flight, if one generator bus is powered by the APU and the other APU GEN switch is moved to ON, the second generator bus will not connect to the APU generator.

Ground Service Switch



FWD ATTENDANT PANEL

1 GROUND SERVICE Switch

Solenoid held ON, spring-loaded to OFF.

Provides manual control of ground service bus. Enables servicing airplane using external power without activating generator busses.

- ON – connects the ground service bus to the external AC bus. Trips off when the GRD PWR switch is ON
- OFF – disconnects external AC bus from the ground service bus.

**Electrical
System Description****Chapter 6
Section 20****Introduction**

Primary electrical power is provided by two engine driven generators which supply three-phase, 115 volt, 400 cycle alternating current. Each generator supplies its own bus system in normal operation and can also supply essential loads of the opposite side bus system when one generator is inoperative.

Transformer rectifier (TR) units and a battery supply DC power. The battery also provides backup power for the AC and DC standby systems. The APU operates a generator and can supply power to both AC generator busses on the ground or one AC generator bus in flight.

There are two basic principles of operation for the 737 electrical system:

- There is no paralleling of the AC sources of power.
- The source of power being connected to a generator bus automatically disconnects an existing source.

The electrical power system may be categorized into three main divisions: the AC power system, the DC power system, and the standby power system.

Electrical Power Generation**Engine Generators**

Primary power is obtained from two engine driven generators. Each generator is part of a generator drive unit which maintains a constant frequency throughout the normal operating range of the engine. The generator is coupled directly to the engine and operates whenever the engine is running.

APU Generator

The APU generator can supply primary power on the ground and can serve as a backup for either generator in flight. The APU generator is identical to the engine generators but has no generator drive unit, since the APU itself is governed and will maintain a constant speed. As the only power source, the APU generator can meet electrical power requirements for all ground conditions and all essential flight requirements.

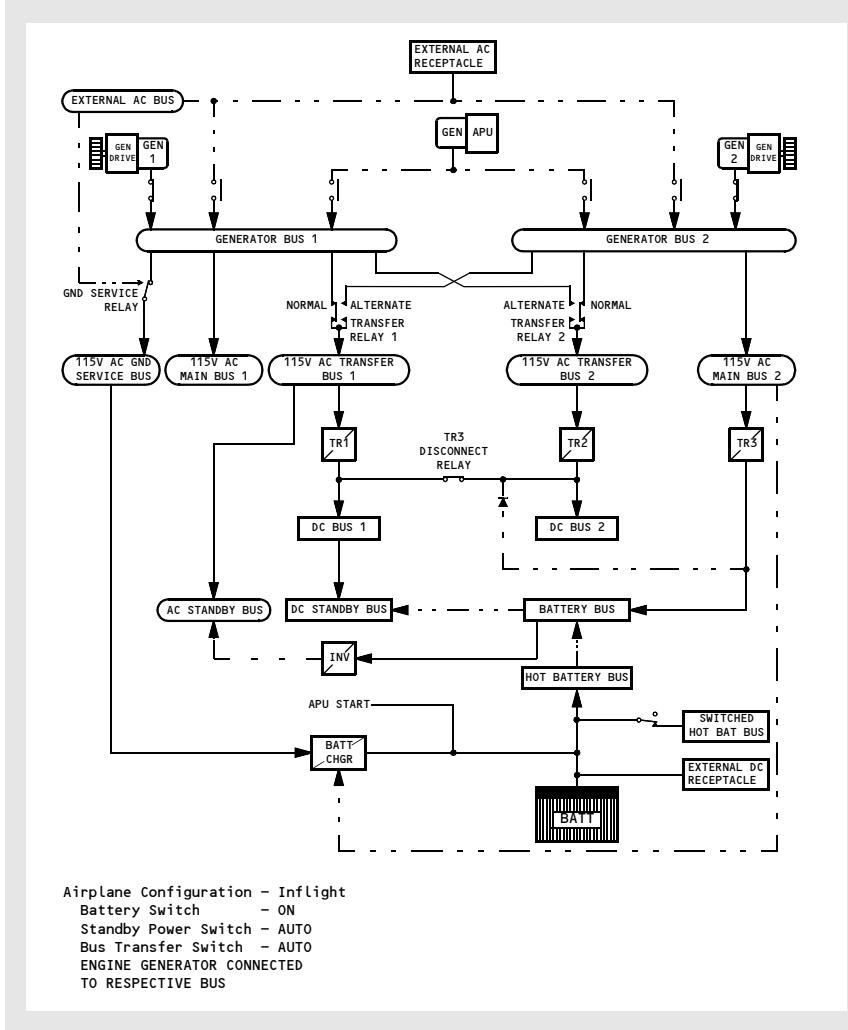
External Ground Power

An external AC power receptacle located near the nose gear wheel well, on the lower right side of the fuselage, allows the use of an external power source. Status lights on a panel adjacent to the receptacle permit the ground crew to determine if external power is being used. A GRD POWER AVAILABLE light provides flight deck indication that an AC ground power source is attached outside the airplane. A GRD PWR switch allows connection of external power to both generator busses.

The battery switch must be ON for the GRD PWR switch to be operable. Positioning the battery switch to OFF will automatically disconnect the GRD PWR switch.

Ground Service

For ground servicing, a ground service switch is located on the forward attendant's panel. The switch provides ground power directly to the AC ground service bus for utility outlets, cabin lighting and the battery charger without powering all airplane electrical busses. The ground service switch is magnetically held in the ON position and is overridden when the GRD PWR switch is positioned to ON.

Electrical Power Schematic**Single Battery****AC Power System**

Each AC power system consists of a generator bus, a main bus, and a transfer bus. The left AC power system also includes a ground service bus. Transfer bus 1 supplies power to the AC standby bus. If the source powering either AC power system fails or is disconnected, a transfer relay automatically selects the opposite generator bus as an alternate power source for the transfer bus.

Generator busses can be powered from the engine generators by momentarily positioning the related generator switch to ON. This connects the voltage regulator to the generator and connects the generator to its associated generator bus. Selecting a new power source disconnects the existing power source.

When the APU is operating, selecting either APU GEN switch ON connects APU power to its associated generator bus. On the ground, the APU can supply electrical power to both generator busses.

With the airplane on the ground and external power available, selecting the GRD PWR switch ON connects external power to both generator busses. The APU or an engine generator can supply power to one generator bus while external power supplies the other generator bus.

In flight, each engine generator normally powers its own generator bus. If an engine generator is no longer supplying power, the APU generator may be used to power one generator bus. Since the entire electrical system is powered from the two generator busses, all electrical components can be powered with any two operating generators.

Bus Transfer System

The generator busses supply the heavy electrical loads including supplying power to the transfer and main busses. The transfer busses carry the essential electrical loads, and the main busses carry the non-essential loads.

If a generator trips off, its generator bus and main bus will not be powered. Each transfer bus has a transfer relay which automatically selects the opposite generator bus as its power source. The BUS TRANS switch must be in the AUTO position to enable this transfer.

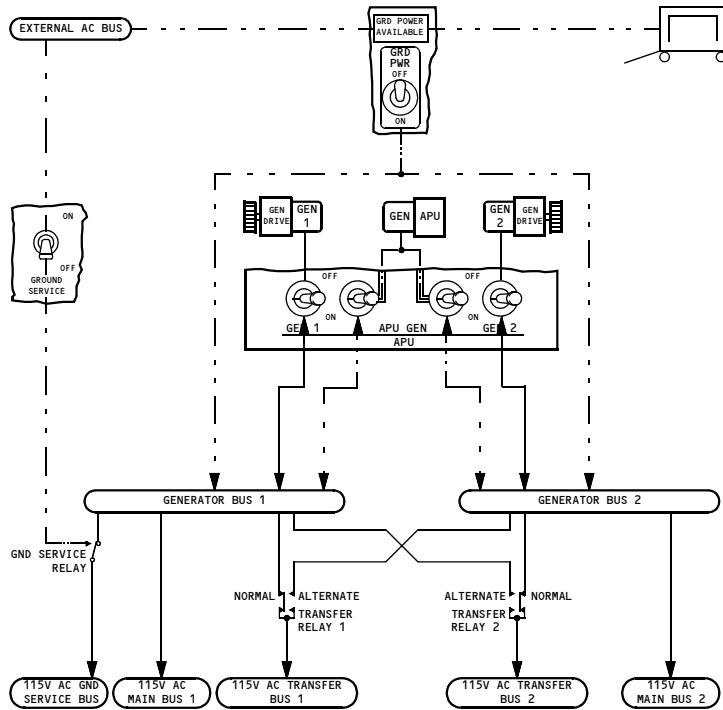
Automatic Galley Load Shedding

In flight, all galley power is automatically removed when operating on one generator. This automatic galley load shedding feature reduces the total electrical load on the remaining generator, protecting it from overload.

APU Automatic Galley Load Shedding

Galley electrical loads will automatically be shed should the total airplane electrical power requirements exceed design limits with the APU providing electrical power.

AC Power Schematic



Airplane Configuration:

Battery Switch - ON
Standby Power Switch - AUTO
Bus Transfer Switch - AUTO
ENGINE GENERATOR CONNECTED TO RESPECTIVE BUS

Electrical Power Controls and Monitoring

Generator Drive

Each engine driven generator is connected to its engine through a generator drive unit. Each generator drive is a self-contained unit consisting of an oil supply, cooler, instrumentation and disconnect device which provides for complete isolation of the generator in the event of a malfunction.

Operating conditions of the generator drive can be observed on the generator drive oil temperature indicator. Oil temperature is measured as it enters and leaves the generator drive. Temperature of oil entering the generator is indicated on the IN scale. Temperature differential between outlet and inlet is indicated as RISE - (out temperature minus in temperature). During normal operation, the oil temperature rise should be less than 20 deg. C. Readings above 20 deg. C indicate excessive generator load or poor condition of the drive and are used by maintenance in troubleshooting drive problems.

The amber HIGH OIL TEMPERATURE light illuminates when oil temperature in the internal oil tank exceeds limitations. The amber LOW OIL PRESSURE light illuminates when oil pressure is below the operating limit. When the generator has been disconnected, the LOW OIL PRESSURE light will be on, and the HIGH OIL TEMPERATURE light remains on until the oil is cooled.

A generator drive disconnect switch is installed. This switch disconnects the generator from the engine in the event of a generator drive malfunction. Reactivation of the generator may be accomplished only on the ground by maintenance personnel.

AC Voltmeter and Frequency Meter

AC voltage and frequency may be read on the AC voltmeter and frequency meter for standby power, ground power, generator No. 1, APU generator, generator No. 2 and the static inverter. Frequency is indicated only when the generator is electrically excited. The voltage regulator automatically controls the generator output voltage.

Current readings for the two engine generators and the APU generator may be read on the AC ammeter.

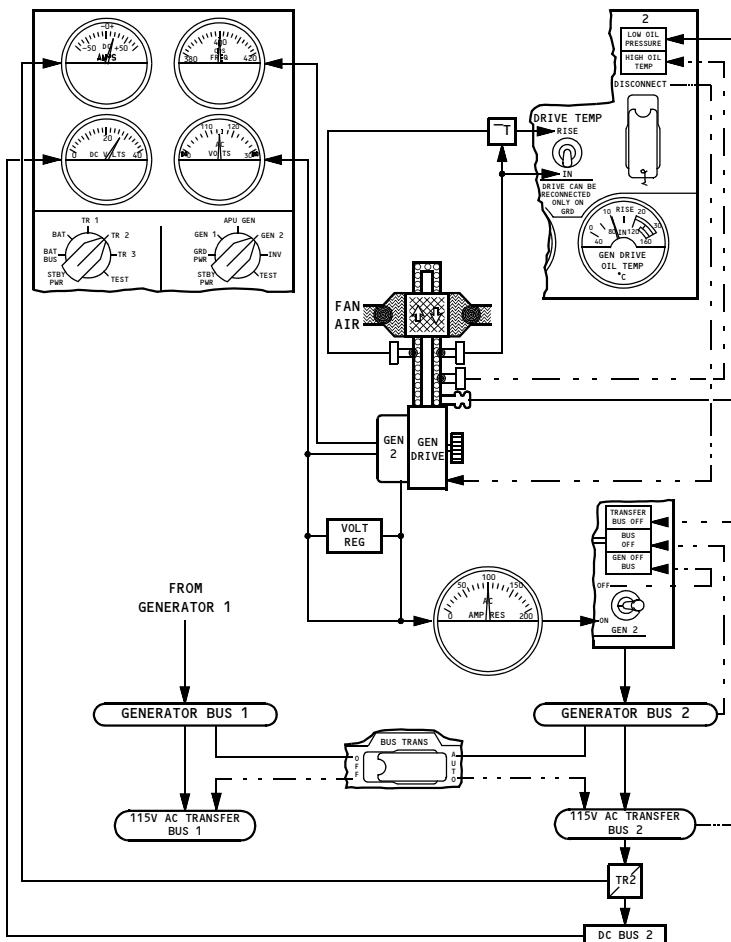
The TEST position is used by maintenance and connects the voltage and frequency meter to the power systems test module for selection of additional reading points.

DC Voltmeter and Ammeter

DC voltage and amperage may be read on the DC voltmeter and ammeter for the battery and each of the three TRs. Standby power and the battery bus will display only DC voltage.

The TEST position is used by maintenance.

Electrical Power Controls and Monitoring Schematic



DC Power System

28 volt DC power is supplied by three TR units, which are energized from the AC transfer busses and main bus 2. The battery provides 28V DC power to loads required to be operative when no other source is available.

Transformer Rectifier Units

The TRs convert 115 volt AC to 28 volt DC, and are identified as TR1, TR2, and TR3.

TR1 and TR2 receive AC power from transfer bus 1 and transfer bus 2, respectively. TR3 receives AC power from main bus 2.

Under normal conditions, DC bus 1 and DC bus 2 are connected in parallel via the TR3 disconnect relay. In this condition, TR1 and TR2 are each powering DC bus 1 and DC bus 2. TR3 powers the battery bus and serves as a backup power source for TR1 and TR2.

The TR3 disconnect relay automatically opens, isolating DC bus 1 from DC bus 2, under the following conditions:

- At glide slope capture during a flight director or autopilot ILS approach. This isolates the DC busses during approach to prevent a single failure from affecting both navigation receivers and flight control computers
- Bus transfer switch positioned to OFF.

Battery Power

A 24 volt nickel–cadmium battery is located in the electronics compartment. The battery can supply part of the DC system. Battery charging is automatically controlled. A fully charged battery has sufficient capacity to provide standby power for a minimum of 30 minutes. Battery voltage range is 22–30 volts.

DC busses powered from the battery following a loss of both generators are:

- battery bus
- DC standby bus
- hot battery bus
- switched hot battery bus

The switched hot battery bus is powered whenever the battery switch is ON.

The hot battery bus is always connected to the battery. There is no switch in this circuit. The battery must be above minimum voltage to operate units supplied by this bus.

Battery Charger

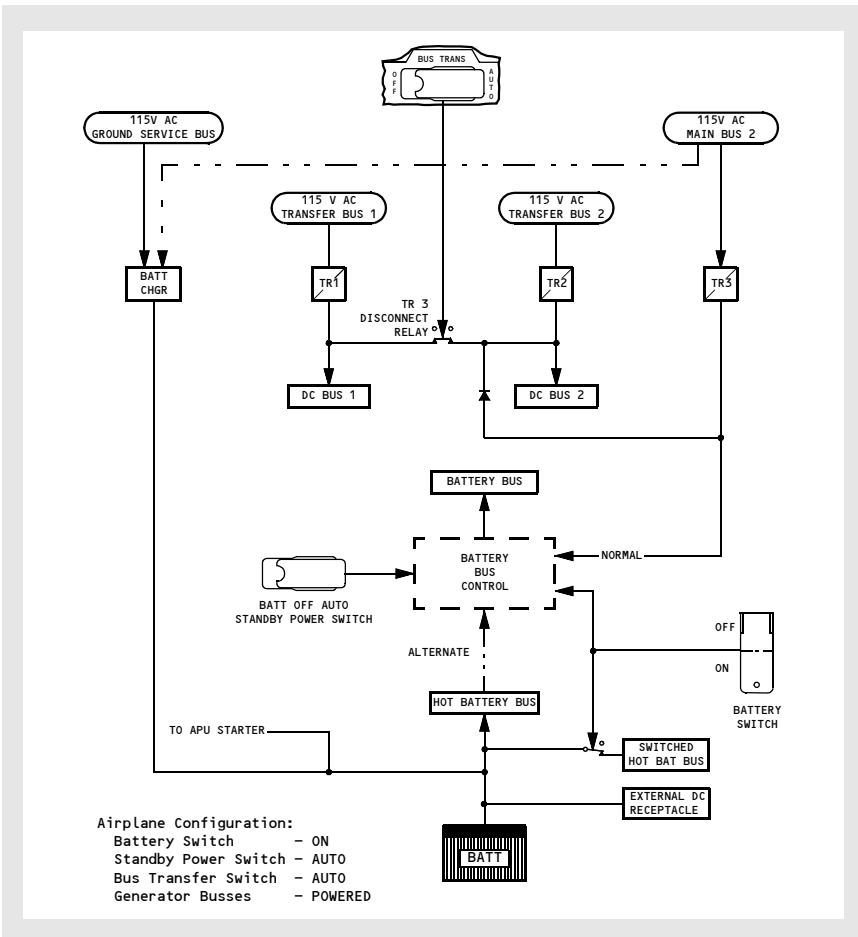
The purpose of the battery charger is to restore and maintain the battery at full electrical power. The battery charger is powered through AC ground service bus with provisions for automatic switching to main bus 2 when the ground service bus is unpowered.

DC Power Receptacle

An auxiliary 28V DC power receptacle is provided near the battery in the electronic compartment. A placard located adjacent to the receptacle gives complete instruction for connecting external DC power. With external DC power connected, the battery is paralleled with the DC external power source and the external power source will power all circuits normally supplied by the battery. In the event that the airplane battery is depleted, the APU can be started using DC external power.

DC Power System Schematic

Single Battery



Standby Power System

Normal Operation

The standby system provides 115V AC and 24V DC power to minimum essential systems in the event of loss of all engine or APU generator AC power. The standby power system consists of:

- the battery
- static inverter
- AC standby bus
- DC standby bus
- battery bus
- hot battery bus
- switched hot battery bus.

During normal operation the guarded standby power switch is in AUTO and the battery switch is ON. This configuration provides an alternate power source in case of partial loss as well as complete transfer to battery power if all normal power is lost. The AC standby bus is normally powered from AC transfer bus 1. The DC standby bus is powered by DC bus No. 1; the battery bus is powered by TR3; the hot battery bus and switched hot battery bus are powered by the battery.

Alternate Operation

The alternate power source for standby power is the battery. In flight, with the standby power switch in the AUTO position, the loss of all engine and APU power causes the battery to power the standby loads. The AC standby bus is powered from the battery bus via the static inverter. The DC standby bus, battery bus, and switched hot battery bus are powered by the battery.

In flight, if either transfer bus 1 or DC bus 1 loses power, both standby busses automatically switch to the battery bus.

A fully charged battery has sufficient capacity to provide power to the minimum essential flight instruments, communications and navigation equipment for a minimum of 30 minutes.

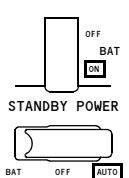
On the ground, with the loss of all AC power, the AC and DC standby busses are unpowered with the standby power switch in AUTO. The air/ground safety sensor inhibits the transfer to battery power to prevent discharging the battery. If the standby power switch is positioned to BAT, the air/ground safety sensor is bypassed and the AC and DC standby busses are powered.

Static Inverter

The static inverter converts 24 volt DC power from the battery to 115V AC power to supply the AC standby bus during the loss of normal electrical power. The power supply to the inverter is controlled by the standby power switch and the battery switch on the overhead panel.

Standby Power System Schematic

Single Battery



Airplane configuration - Inflight or
On The Ground
Battery Switch - ON
Standby Power Switch - AUTO
GENERATOR BUSSES POWERED

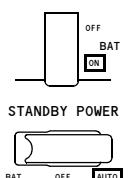
TRANSFER BUS NO. 1

T R 1

DC BUS NO. 1

DC STANDBY BUS

AC STANDBY BUS



Airplane configuration - Inflight
Battery Switch - ON
Standby Power Switch - AUTO
GENERATOR BUSSES NOT POWERED

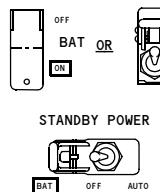
DC STANDBY BUS

BATTERY BUS

AC STANDBY BUS

INV

HOT BAT BUS



Airplane configuration - Inflight or
On The Ground
Battery Switch - ON or OFF
Standby Power Switch - BAT
GENERATOR BUSSES POWERED
OR NOT POWERED

DC STANDBY BUS

BATTERY BUS

AC STANDBY BUS

INV

HOT BAT BUS



All Generators Inoperative

The following list identifies the significant equipment that operates when the battery is the only source of electrical power and is powering the standby busses.

Airplane General, Emergency Equipment, Doors and Windows

- emergency instrument flood lights
- entry lights (dim) (hot battery bus)
- position lights
- standby compass light
- white dome lights
- flight crew and passenger oxygen
- standby forward airstair operation

Air Systems

- A/C pack valves
- altitude warning horn
- manual pressurization control
- PACK TRIP OFF lights
- BLEED TRIP OFF lights

Engines, APU

- N1, N2, fuel flow, EGT indications
- right igniters
- starter valves
- thrust reversers (switched hot battery bus)
- APU operation (start attempts not recommended above 25,000 feet)

Communications

- flight interphone system
- passenger address system
- VHF No. 1

Electrical

- STANDBY POWER OFF light
- external power control (hot battery bus)
- APU & engine generator power control (switched hot battery bus)

Flight Instruments

- clocks (hot battery bus)
- standby airspeed/altitude indicator
- standby horizon indicator
- standby magnetic compass

Fire Protection

- APU and engine fire extinguisher bottles (hot battery bus)
- APU and engine fire detection system

Fuel

- crossfeed valve
- engine fuel shutoff valves (hot battery bus)
- fuel quantity indicators
- FUEL VALVE CLOSED lights (switched hot battery bus)

Hydraulics

- engine hydraulic shutoff valves
- standby rudder shutoff valves

Landing Gear

- ANTIISKID INOP light
- inboard antiskid system
- parking brake
- landing gear indicator lights

Navigation

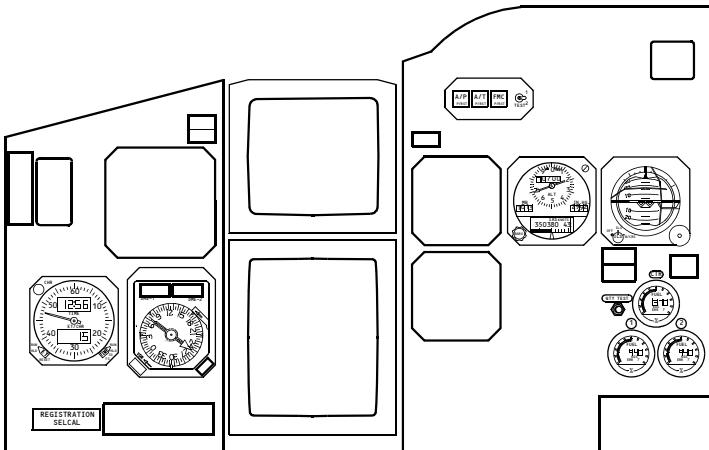
- ADF No. 1
- captain's RDMI
- left IRS - AC
- left & right IRS - DC (switched hot battery bus)
- VHF NAV No. 1

Warnings

- aural warnings
- master caution recall system
- stall warning system

Basic Equipment Operating – Instrument Panels

Captain Instrument Panel



The standby power system utilizes the battery as a source of power to supply the above depicted flight instruments.

CAUTION: AS SOON AS THE AIRPLANE LANDS, THE STANDBY POWER SWITCH SHOULD BE POSITIONED TO "BAT" TO ENERGIZE THE ABOVE ELECTRONICS AND FOR VHF-1 COMMUNICATIONS.

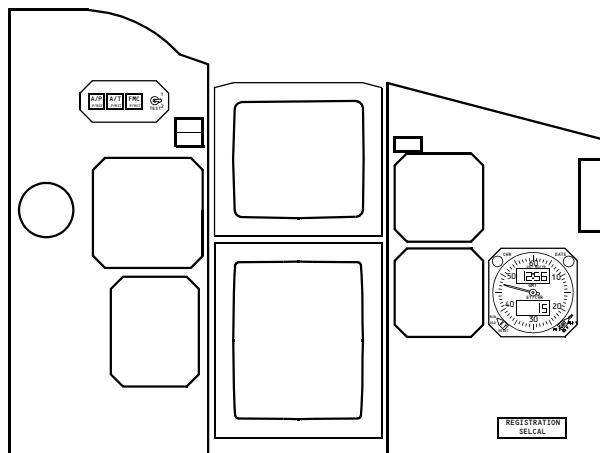
NOTE: All of the Captain's instruments including the engine and fuel quantity indicators, that are powered by standby power are also integrally lighted by standby power.

Airplane Configuration – Inflight
Battery Switch – ON
Standby Power Switch – AUTO

This illustration shows the instruments which are useable with only the battery and standby busses powered.

Indicates Inoperative Instruments

First Officer Instrument Panel



Airplane Configuration - Inflight
Battery Switch - ON
Standby Power Switch - AUTO

This illustration shows the instruments which are useable with only the battery and standby busses powered.

Indicates Inoperative Instruments

Electrical System Power Distribution**No. 1 Generator Inoperative**

Failure In Flight, Transfer Busses Normal

Inoperative Components	Indication
No.1 tank forward fuel pump	LOW PRESSURE light
Center tank right fuel pump	LOW PRESSURE light
Galley(s)	Inoperative
No.1 Generator	GEN OFF BUS light
No.1 Generator bus	BUS OFF light
Left forward window heat	ON light – extinguished
Right side window heat	ON light – extinguished
Left No.4 & 5 window heat	Inoperative
Left elevator pitot heat	L ELEV PITOT light
System B electric pump	LOW PRESSURE light
Left outboard landing light	Inoperative
Right inboard landing light	Inoperative
Left runway turnoff light	Inoperative
Nose gear taxi light	Inoperative
Equipment cooling normal	OFF light
Right recirculation fan	Inoperative

No. 2 Generator Inoperative

Failure In Flight, Transfer Busses Normal

Inoperative Components	Indication
No.2 tank forward fuel pump	LOW PRESSURE light
Center tank left fuel pump	LOW PRESSURE light
Fuel temperature indicator	Inoperative
Galley(s)	Inoperative
No.2 Generator	GEN OFF BUS light
Generator bus No. 2	BUS OFF light
TR unit No.3	TR No.3 voltage - Zero
Left side window heat	ON light – extinguished
Right forward window heat	ON light – extinguished
Right No.4 & 5 window heat	Inoperative
Right elevator pitot heat	R ELEV PITOT light
TEMP PROBE Heat	TEMP PROBE light
System A electric pump	LOW PRESSURE light
Right outboard landing light	Inoperative
Left inboard landing light	Inoperative
Right runway turnoff light	Inoperative
Equipment cooling - Alternate	If switch is to alternate, OFF light
Left recirculation fan	Inoperative

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Engines, APU

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DO NOT USE FOR FLIGHT

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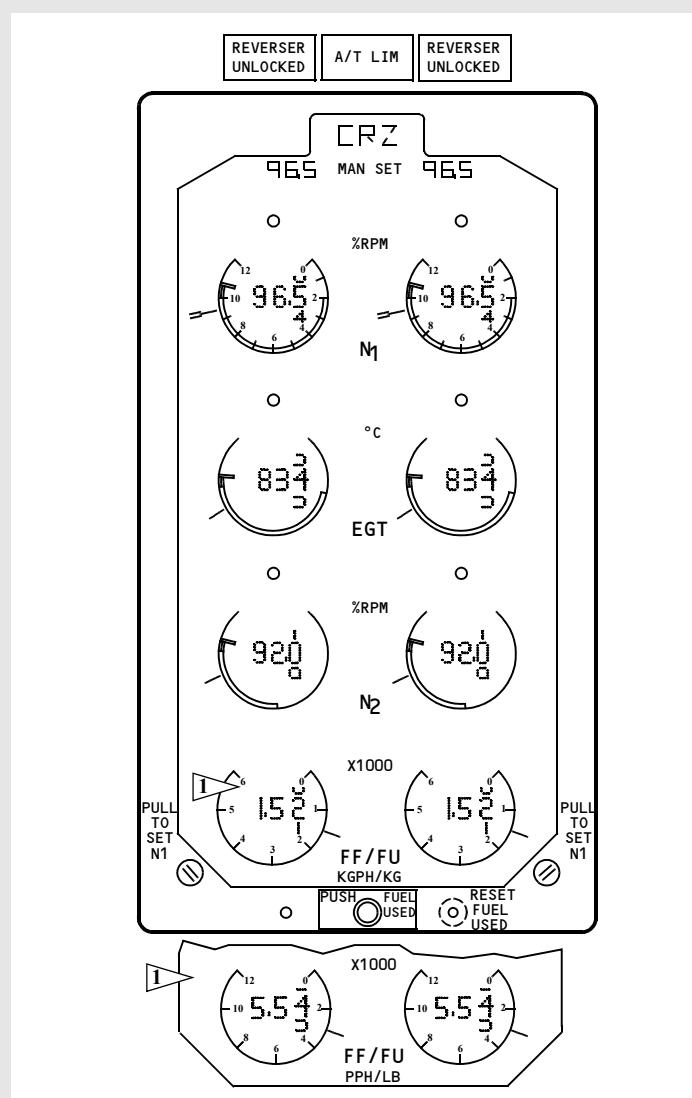
Engines, APU

Controls and Indicators

Chapter 7

Section 10

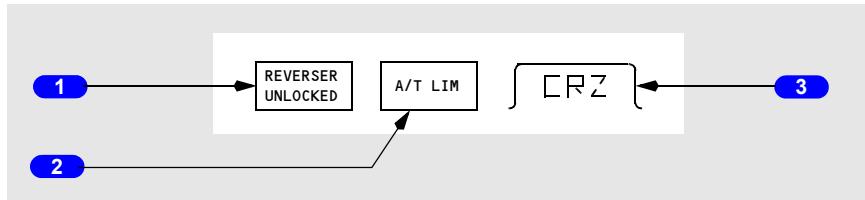
Engine Instrument System (EIS) Primary Panel



► As installed

CENTER INSTRUMENT PANEL

Reverser Unlocked, Autothrottle Limit, and Thrust Mode Display



1 Reverser Unlocked Light

Illuminated (amber) – Indicates the thrust reverser is unlocked.

2 Autothrottle Limit (A/T LIM) Indication

Illuminated (white) – A/T computer is calculating a single fixed N1 thrust limit for affected engine(s) when FMC calculations become invalid or if either engine N1 is less than 18%.

3 Thrust Mode Display

Displays the active N1 limit reference mode.

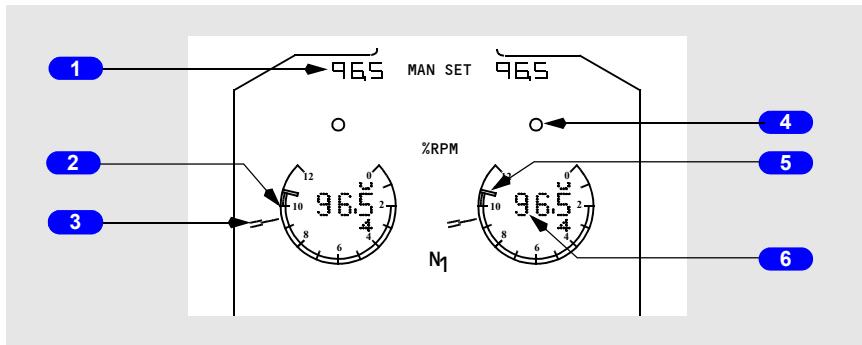
With N1 manual set knob pushed in, active N1 limit is displayed by reference N1 bugs. If knob is pulled out, FMC computed N1 is disabled.

Active N1 limit is normally calculated by FMC.

Thrust mode display annunciations are:

- R – reduced (can appear with TO or CLB)
- TO – takeoff
- CLB – climb
- CRZ – cruise
- G/A – go-around
- CON – continuous
- —— FMC not computing thrust limit.

N1 Indications



1 N1 Manual Set Indication

Set by N1 manual set knob.

Blank when manual set knob is pushed in.

2 N1 RPM Indication (green)

Displays N1 % RPM.

3 Reference N1 Bug (yellow)

With N1 manual set knob pushed in:

- positioned by FMC
- based on N1 limit page and takeoff reference page
- displays active N1 limit for A/T operation.

With N1 manual set knob pulled out:

- displays crew selected N1 limit
- has no effect on A/T operation.

4 Warning Light

Illuminated (red) –

- indicates the N1 limit has been reached or exceeded
- remains illuminated until N1 is reduced below the limit.

Note: Failure of an N1 input signal to the primary EIS panel will cause the affected display pointer and digital counter to slew to their lower stops and hold for two seconds. The pointer will then disappear and the counter will display dashes. An internal failure will cause the display(s) to simply blank.

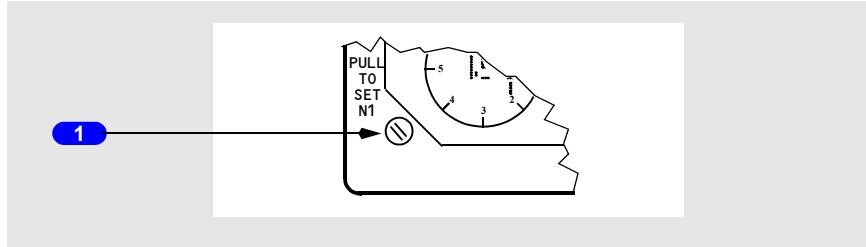
5 N1 Red Radial

Shows N1 % RPM operating limit.

6 N1 RPM Readout (digital)

Displays N1 % RPM.

N1 Manual Set Knob



1 N1 Manual Set Knob

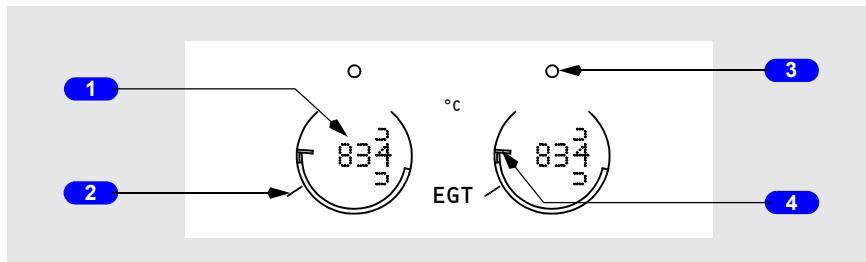
Push in –

- reference N1 bug set by FMC based on N1 limit page and takeoff reference page
- blanks N1 manual set indication.

Pull out –

- disables FMC input signal
- rotation sets desired N1 RPM in the N1 manual set indication and moves the reference N1 bug to the corresponding location.

EGT Indications



1 Exhaust Gas Temperature (EGT) Readout (digital)

Displays engine EGT in degrees C.

If flashing, indicates the abnormal start advisory system has sensed conditions which may lead to an abnormal engine start.

2 Exhaust Gas Temperature (EGT) Indication (green)

Displays engine EGT in degrees C.

3 Warning Light

Illuminated (red) –

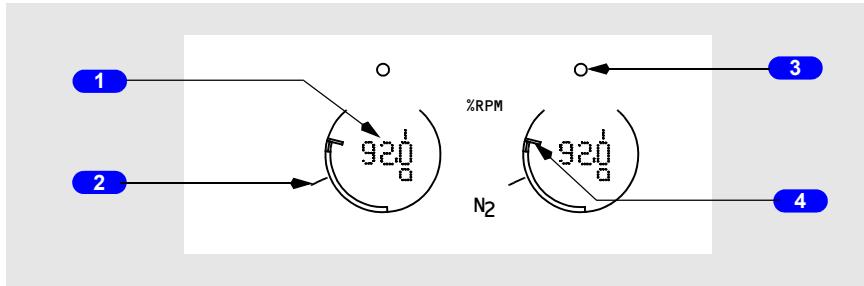
- indicates the EGT limit has been reached or exceeded
- remains illuminated until EGT is reduced below the limit.

4 Exhaust Gas Temperature (EGT) Red Radial

Displays maximum takeoff EGT limit.

Note: Failure of an EGT input signal to the primary EIS panel will cause the affected display pointer and digital counter to slew to their lower stops and hold for two seconds. The pointer will then disappear and the counter will display dashes. An internal failure will cause the display(s) to simply blank.

N2 Indications



1 N2 Readout (digital)

Displays N2 % RPM.

2 N2 RPM Indication (green)

Displays N2 % RPM.

3 Warning Light

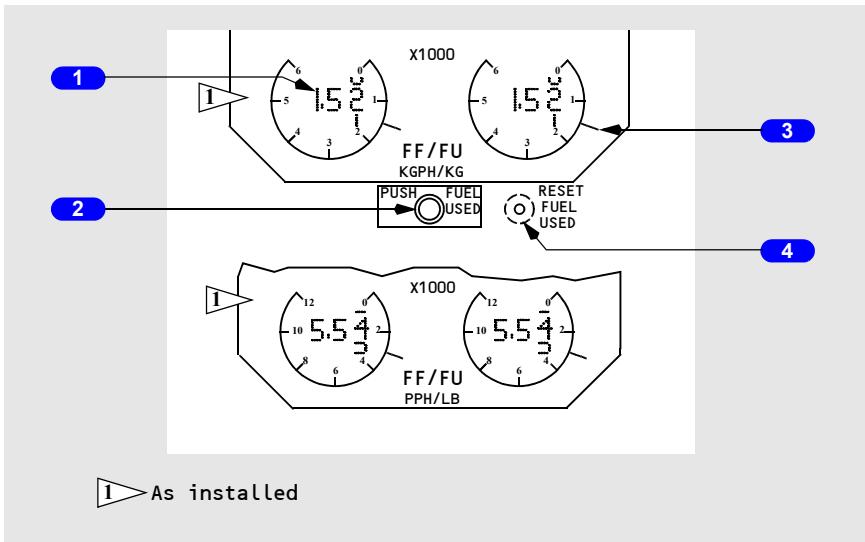
Illuminated (red) –

- indicates the N2 limit has been reached or exceeded
- remains illuminated until N2 is reduced below the limit.

4 N2 Red Radial

Displays N2 % RPM operating limit.

Note: Failure of an N2 input signal to the primary EIS panel will cause the affected display pointer and digital counter to slew to their lower stops and hold for two seconds. The pointer will then disappear and the counter will display dashes. An internal failure will cause the display(s) to simply blank.

Fuel Flow/Fuel Used Indications**1 Fuel Flow/Fuel Used (FF/FU) Readout (digital)**

Normally displays the present rate of fuel flow in pounds or kilograms per hour X 1000.

After the fuel used reset switch has been pushed, this readout displays current fuel used for one second, decreases to zero, then displays fuel flow.

After the fuel flow/used switch is pushed, this readout shows fuel used since the last reset. After 10 seconds, display automatically reverts to fuel flow.

2 Fuel Flow/Used Switch

Push – digital readout shows fuel used since last reset. After 10 seconds, display automatically reverts to fuel flow.

3 Fuel Flow Indicator

Indicates rate of fuel flow in pounds or kilograms per hour at all times.

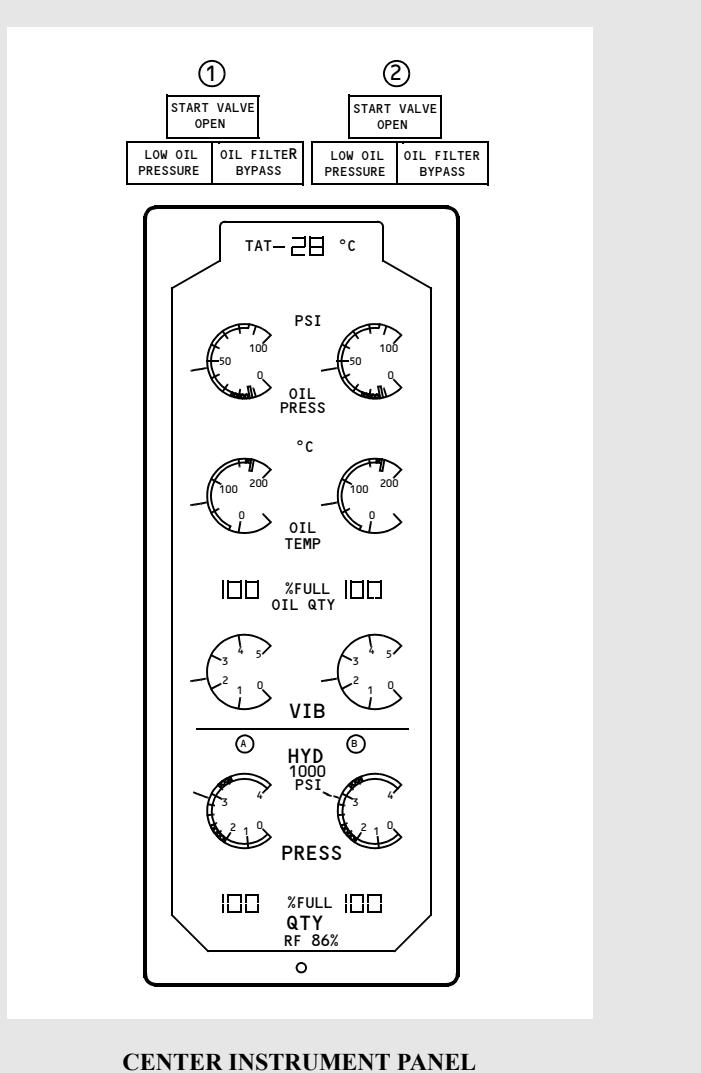
4 FUEL USED RESET Switch (recessed)

Push –

- resets computed fuel used to zero
- digital readout displays current fuel used for one second, decreases to zero, then fuel flow
- resets abnormal start advisory system.

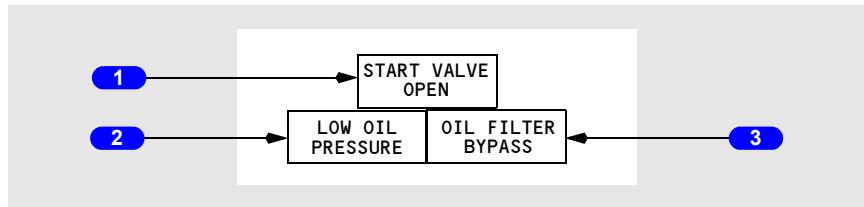
Note: Failure of a fuel flow input signal to the primary EIS panel will cause the affected display pointer and digital counter to slew to their lower stops and hold for two seconds. The pointer will then disappear and the counter will display dashes. An internal failure will cause the display(s) to simply blank.

Engine Instrument System (EIS) Secondary Panel



CENTER INSTRUMENT PANEL

Caution Lights



1 START VALVE OPEN Light

Illuminated (amber) – related engine start valve is open and air is being supplied to the starter.

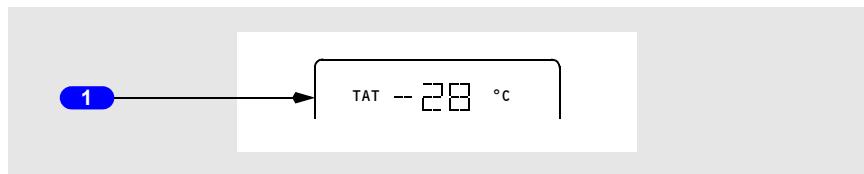
2 LOW OIL PRESSURE Light

Illuminated (amber) – related engine oil pressure is at or below the red radial.

3 OIL FILTER BYPASS Light

Illuminated (amber) – indicates an impending bypass of scavenge oil filter.

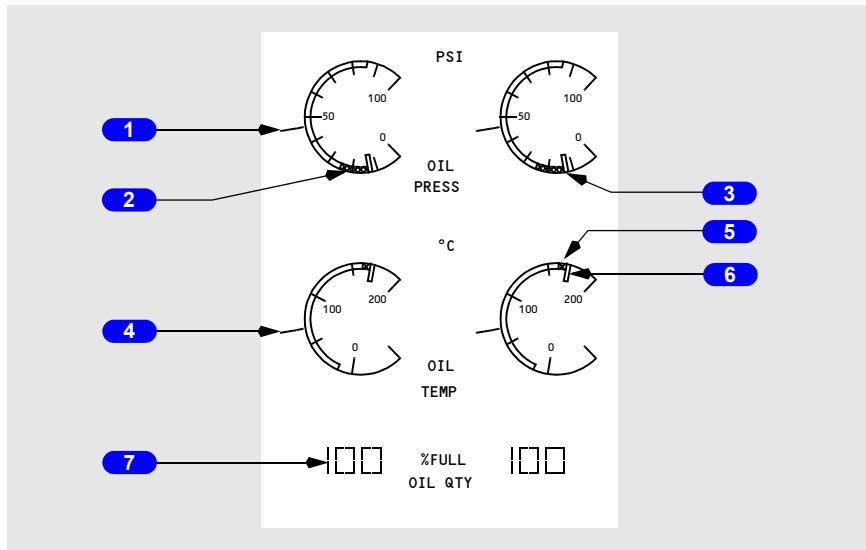
Total Air Temperature Indication



1 Total Air Temperature (TAT) Indicator

Displays total air temperature in degrees C.

Engine Oil Indications



1 Oil Pressure (OIL PRESS) Indication (green)

Displays engine oil pressure in psi.

Note: Oil pressure is unregulated and is primarily a function of engine speed (N2).

2 Low Oil Pressure Yellow Band

With takeoff thrust set, indicates minimum oil pressure limit.

Note: Yellow band is valid only at takeoff thrust.

3 Low Oil Pressure Red Radial

Indicates minimum oil pressure limit.

4 Oil Temperature (OIL TEMP) Indication (green)

Displays engine oil temperature in degrees C.

5 High Oil Temperature Yellow Band

Indicates oil temperature caution range.

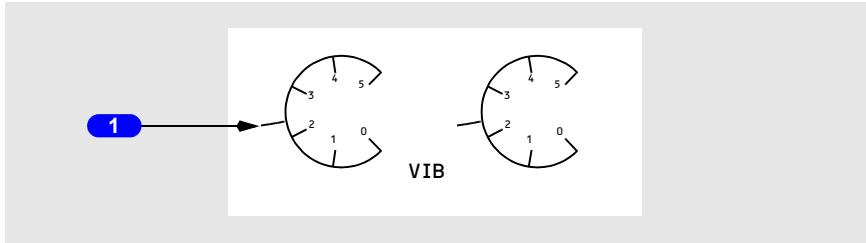
6 High Oil Temperature Red Radial

Indicates maximum oil temperature limit.

7 Oil Quantity (OIL QTY) Indication

Displays engine oil quantity in percentage of full quantity.

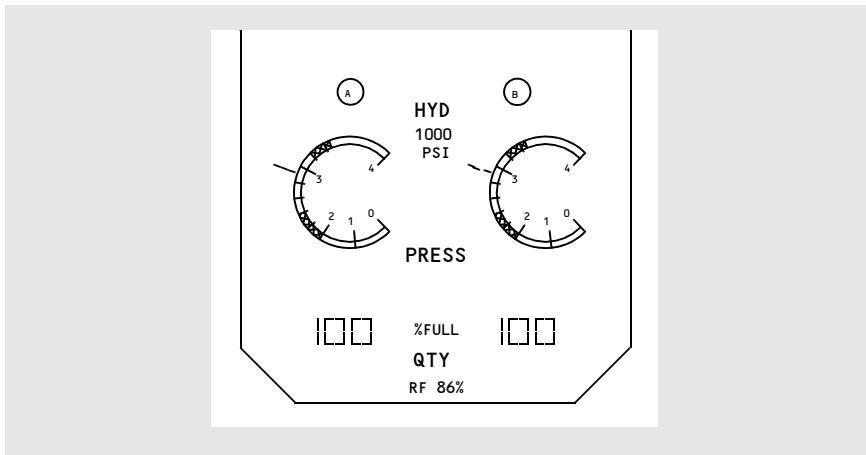
Engine Vibration Indications



1 Airborne Vibration (VIB) Monitor (green)

Indicates engine vibration level.

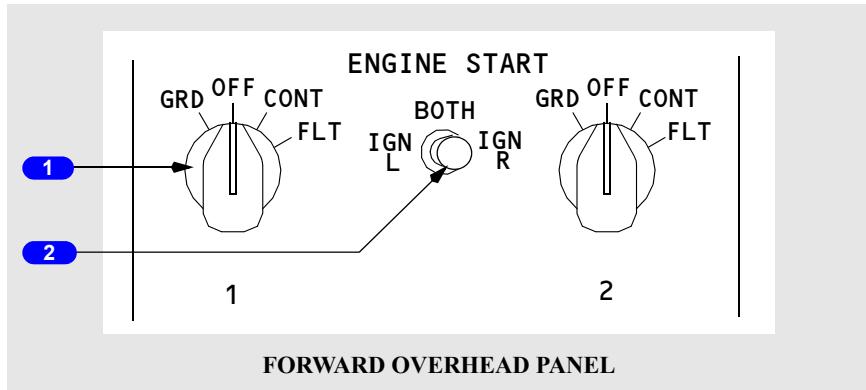
Hydraulic System Pressure and Quantity Indications



Described in Chapter 13 – Hydraulics.

Note: Failure of an input signal to the secondary EIS panel will cause an affected pointer to blank or an affected digital counter to display dashes. An internal failure will cause either type of display to blank.

Engine Start Switches



1 ENGINE START Switches

GRD –

- opens start valve
- closes engine bleed air valve
- provides ignition to selected igniter(s) when engine start lever is moved to IDLE
- releases to OFF at starter cutout.

OFF – ignition off

CONT – provides ignition to selected igniter(s) when engine start lever is in IDLE.

FLT –

- provides ignition to both igniters when engine start lever is in IDLE
- ignition select switch is bypassed when the Engine Start switch is in FLT.

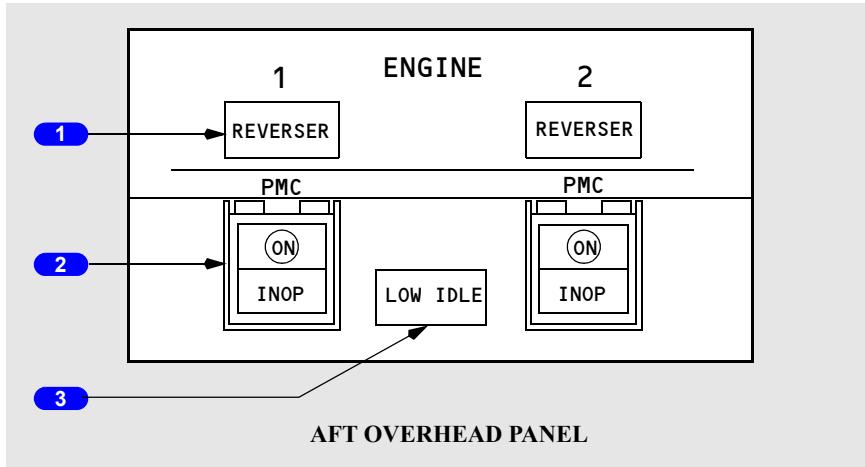
2 Ignition Select Switch

IGN L – selects the left igniter for use on both engines.

BOTH – selects both igniters for use on both engines.

IGN R – selects the right igniter for use on both engines.

Engine Panel



1 REVERSER Light

Illuminated (amber) – one or more of following has occurred:

- isolation valve or thrust reverser control valve is not in commanded position
- thrust reverser sleeve position sensors are in disagreement
- auto-restow circuit has been activated

2 Power Management Control (PMC) Switch

ON (ON in view – white) – PMC is selected ON.

INOP (INOP in view – amber) – PMC is inoperative when engine speed is above 46% N2, or the PMC is selected OFF.

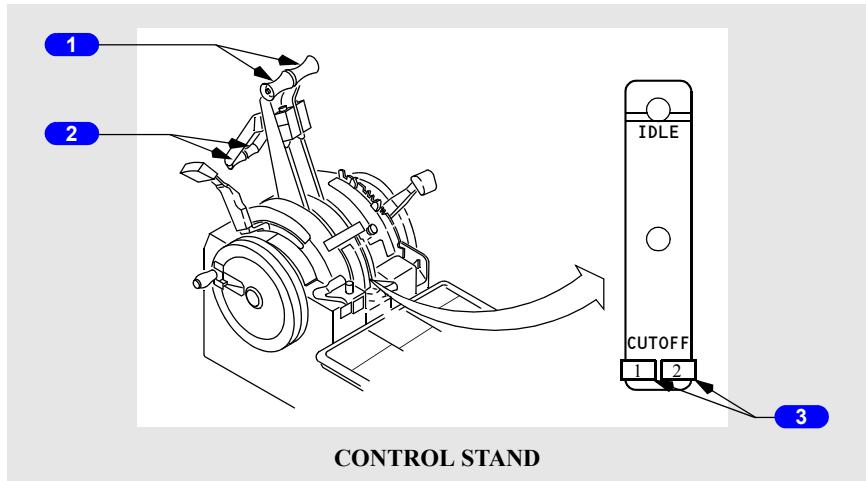
3 LOW IDLE Light

Illuminated (amber) –

- the thrust lever for either engine is near idle and the MEC on either engine is not commanded to maintain high idle RPM in flight
- the speed of either engine is below 25% N1 in flight

If an engine start lever is in CUTOFF, the light is deactivated.

Engine Controls



1 Forward Thrust Levers –

- control engine thrust
- cannot be advanced if the related reverse thrust lever is in the deployed position.

2 Reverse Thrust Levers –

- control engine reverse thrust
- cannot select reverse thrust unless related forward thrust lever is at IDLE.

Note: Reverse thrust lever is blocked at reverse idle position until related thrust reverser is more than 60% deployed.

Note: Movement of reverse thrust lever into reverse thrust engages locking pawl preventing forward thrust lever from moving. Terminating reverse thrust removes locking pawl and restores forward thrust lever movement ability.

3 Engine Start Levers

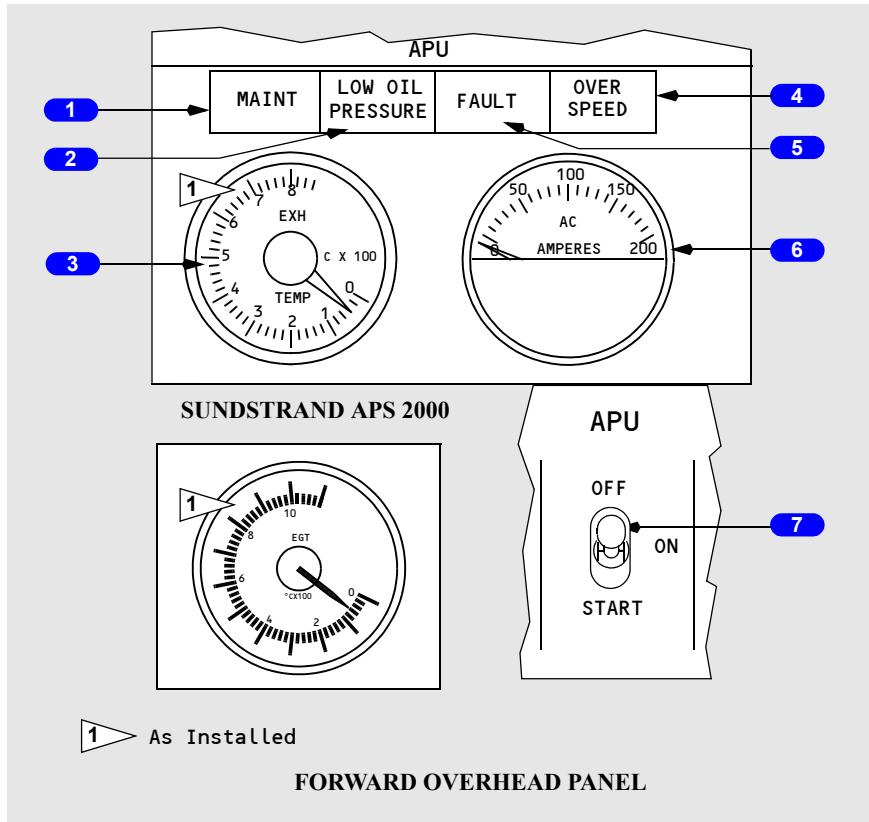
IDLE –

- energizes ignition system
- electrically opens engine fuel shutoff valve in the wing leading edge outboard of the pylon
- mechanically opens MEC shutoff valve.

CUTOFF –

- closes both engine fuel shutoff valve and MEC shutoff valve
- de-energizes ignition system.

APU



1 APU Maintenance (MAINT) Light

Illuminated (blue) – APU maintenance problem exists:

- APU may be operated.
- light is disarmed when APU switch is OFF.

2 APU LOW OIL PRESSURE Light

Illuminated (amber) –

- during start until the APU oil pressure is normal
- oil pressure is low causing an automatic shutdown (after start cycle is complete)
- if light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes.
- light is disarmed when APU switch is OFF.

3 APU Exhaust Gas Temperature (EGT) Indicator

Displays APU EGT

EGT indicator remains powered for 5 minutes after APU shutdown.

4 APU OVERSPEED Light

Illuminated (amber) –

- APU RPM limit has been exceeded resulting in an automatic shutdown.
- overspeed shutdown protection feature has failed a self-test during an abnormal APU start or shutdown.
- if light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes.
- light is disarmed when APU switch is OFF.

5 APU FAULT Light

Illuminated (amber) –

- a malfunction exists causing APU to initiate an automatic shutdown.
- if light is illuminated when APU switch is placed to OFF, light extinguishes within 5 minutes.
- Additional restarts may be attempted.
- light is disarmed when APU switch is OFF.

6 APU Generator AC Ammeter

Displays APU generator load current

7 APU Switch

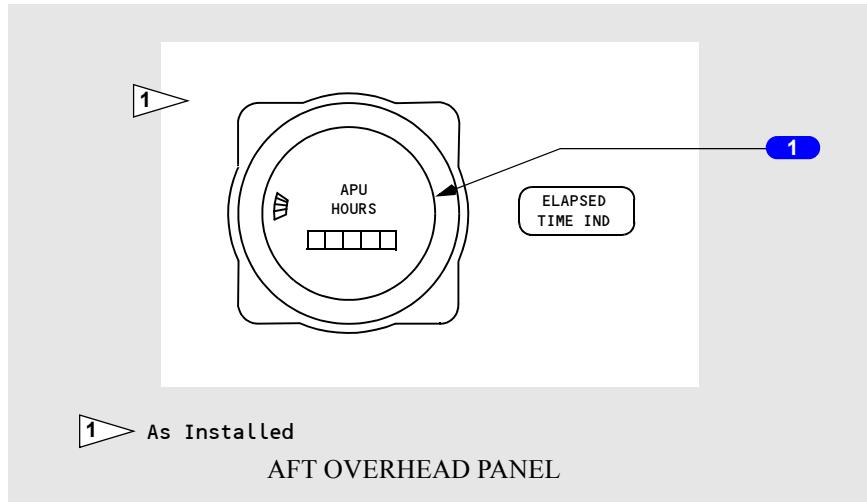
OFF – normal position when APU is not running.

- positioning switch to OFF with APU running initiates APU shutdown, trips APU generator off the bus(es), if connected, and closes APU bleed air valve. On some airplanes, the APU continues to run for a 30 second cool down period before it automatically shuts down. An immediate shutdown can be accomplished by pulling the APU fire switch or the APU fire control handle in the main wheel well.

ON – normal position when APU is running.

START (momentary) – positioning APU switch from OFF to START and releasing it to ON initiates an automatic start sequence.

APU Hours Indicator



1 APU Hours Indicator

Indicates elapsed hours of APU operation since last reset.

Intentionally
Blank

Introduction

The airplane is powered by two CFM56–3 engines. The engine is a dual rotor axial flow turbofan. The N1 rotor consists of a fan, a three stage booster section connected by a through shaft to a four stage low pressure turbine. The N2 rotor consists of a high pressure compressor and a high pressure turbine. The N1 and N2 rotors are mechanically independent. The N2 rotor drives the engine gearbox. A bleed air powered starter motor is connected to the N2 rotor.

The main engine control (MEC) schedules fuel to provide the thrust called for by the forward thrust lever setting. The fuel flow is further refined electronically by the power management control (PMC) without moving the thrust levers.

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. The forward thrust levers control forward thrust from idle to maximum. With the PMCs ON or OFF, 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. The reverse thrust levers control thrust from reverse idle to maximum reverse.

Certain engine malfunctions can result in airframe vibrations from the windmilling engine. As the airplane transitions from cruise to landing, there can be multiple, narrow regions of altitudes and airspeeds where the vibration level can become severe. In general, airframe vibrations can best be reduced by descending and reducing airspeed. However, if after descending and reducing airspeed, the existing vibration level is unacceptable, and if it is impractical to further reduce airspeed, the vibration level may be reduced to a previous, lower level by a slight increase in airspeed.

Engine Indications

Engine indications are displayed on the center instrument panel by the Engine Instrument System (EIS). N1, EGT, N2, and FF/FU are the primary indications and are displayed as both digital readouts and round dial/moving pointer indications. N1, EGT, and N2 have operating and caution ranges and limits indicated by green and yellow bands and red radials. When the round red warning light above the indicator is illuminated it indicates the limit for the engine parameter displayed below it has been reached or exceeded. The red warning light remains illuminated until the engine parameter is reduced below the limit.

Oil pressure and oil temperature indications are displayed with a round dial/moving pointer. Operating and caution ranges and limits are displayed with green and yellow bands and red radials. The oil quantity indicator displays a digital readout of quantity as a percentage of full.

The airborne vibration monitor indications are displayed with a round dial/moving pointer.

N1, N2, oil quantity, and engine vibration are displayed directly from the engine sensors.

Power Management Control (PMC)

The thrust control system consists of a hydromechanical MEC unit and a PMC unit mounted on each engine. The PMC is an electronic system with limited authority over the MEC.

The PMC uses MEC power lever angle, N1 speed, and inlet temperature and pressure to adjust, or trim, the MEC to obtain the desired N1 speed. The PMC adjusts fuel flow as a function of thrust lever angle.

The PMC provides a constant thrust climb feature once the thrust lever is set at the beginning of climb. Thus, when thrust is set for the climb, the PMC automatically maintains that thrust throughout the climb profile with no further thrust lever adjustments. If the thrust lever is repositioned, the PMC maintains the setting corresponding to the new thrust lever angle.

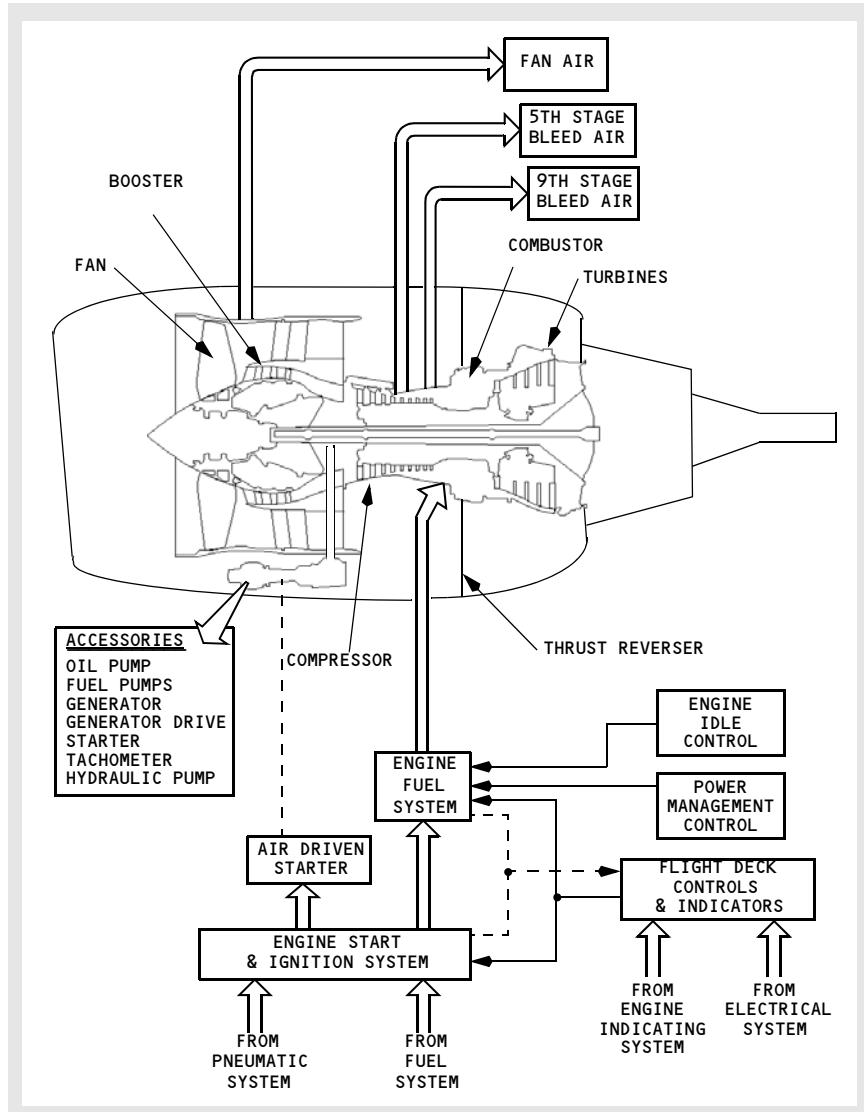
The PMC includes failure detection and annunciation modules which detect PMC failures and provide a signal to the crew. For detectable failure conditions, the PMC schedules a slow N1 drift over approximately 30 seconds and then illuminates the PMC INOP light, the ENG system annunciator, and the MASTER CAUTION lights. For a PMC failure, the PMC can be selected OFF by a switch on the aft overhead panel. The engine speed is then controlled by the hydromechanical MEC only. The PMC INOP Light is suppressed below starter cutout engine speed.

Idle RPM

There are two engine idle speeds, low idle and high idle.

The minimum engine speed for all flight phases is high idle, which varies with flight conditions. As temperature and airspeed decrease, high idle speed also decreases. The average high idle setting is approximately 32% N1.

To reduce braking activity, engine idle speed is reduced to low idle, approximately 22% N1, four seconds after touchdown. The four second delay is provided to enhance engine speed acceleration for reverse thrust.

Power Plant Schematic

Engine Fuel System

Fuel is delivered under pressure from fuel pumps located in the fuel tanks. The fuel enters the engine through the fuel shutoff valve. The fuel passes through the first stage engine fuel pump where pressure is increased. It then passes through two fuel/oil heat exchangers where engine oil heats the fuel. A fuel filter then removes contaminants. Fuel automatically bypasses the filter if the filter becomes saturated. Before the fuel bypass occurs, the fuel FILTER BYPASS alert illuminates on the fuel control panel. The second stage engine fuel pump provides high pressure fuel to the main engine control (MEC). As the fuel leaves the second stage pump, a portion of the fuel is diverted to run the hydromechanical portion of the MEC. This fuel is filtered again and then routed through the fuel heater a second time. The MEC meters the correct amount of fuel to the combustor.

The engine fuel shutoff valve and MEC fuel shutoff valve allow fuel flow to the engine when both valves are open. The valves are open when the engine fire warning switch is in and the start lever is in IDLE. The engine fuel shutoff valve closes when either the start lever is in CUTOFF or the engine fire warning switch is out. The MEC fuel shutoff valve closes only when the start lever is in CUTOFF. The FUEL VALVE CLOSED light on the fuel control panel indicates engine fuel shutoff valve position.

Fuel flow is measured after the MEC fuel shutoff valve and is displayed on the center instrument panel. Fuel flow information is also provided to the FMS.

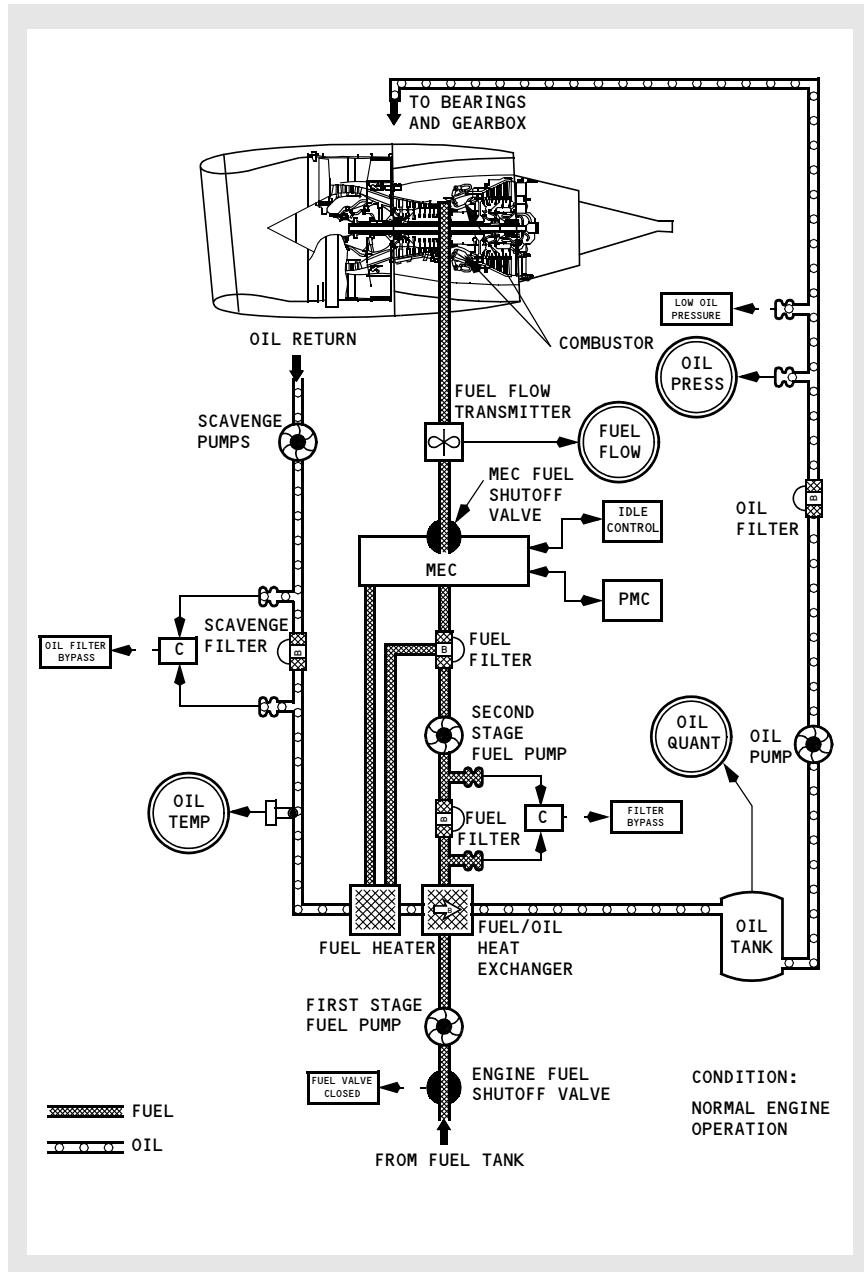
Engine Oil System

Oil from the individual engine tank is circulated under pressure through the engine to lubricate the engine bearings and accessory gearbox. Oil quantity is displayed on the oil quantity indicator, located on the center instrument panel.

The oil system is pressurized by the engine driven oil pump. Oil from the pump is filtered and then passes to the engine bearings and gearbox. Sensors for the oil pressure indicator and LOW OIL PRESSURE light are located downstream of the oil filter prior to engine lubrication.

Oil is returned to the oil tank by engine driven scavange pumps. From the scavange pumps the oil passes through a scavange filter. If the filter becomes saturated with contaminants, oil automatically bypasses the filter. Prior to the oil bypassing the scavange filter, the OIL FILTER BYPASS illuminates on the center instrument panel.

Scavenge oil temperature is sensed as the oil returns to the oil tank and is displayed on the oil temperature indicator, located on the center instrument panel. The oil then passes through the fuel/oil heat exchanger, where it is cooled by engine fuel prior to returning to the oil tank.

Engine Fuel and Oil System Schematic

Engine Start System

Starter operation requires pressurized air and electrical power. Air from the bleed air system powers the starter motor. The APU, an external ground cart, or the other operating engine provides the bleed air source.

In the GRD position, the engine start switch uses DC power from the battery bus to close the engine bleed air valve and open the start valve to allow pressure to rotate the starter. When the start valve opens, an amber START VALVE OPEN light on the center instrument panel illuminates. The starter rotates the N2 compressor through the accessory drive gear system. When the engine accelerates to the recommended value (25% or max motoring), moving the engine start lever to the IDLE position opens the fuel valves and causes the MEC to supply fuel to the combustor where the fuel ignites. At starter cutout speed (approximately 46% N2), power is removed from the engine start switch holding solenoid. The engine start switch returns to OFF, the engine bleed air valve returns to the selected position, and the start valve closes.

Abnormal Start Advisory System

The abnormal start advisory system monitors N2, fuel flow, EGT, and outside air temperature during ground engine starts to detect conditions which may lead to an abnormal engine start. The crew is alerted to such a situation by the flashing EGT digital display.

During an engine start, the alert indication will occur if:

- the EGT exceeds a calculated EGT limit based on inputs of N2 and outside air temperature
- the EGT reaches 725°C
- the engine fails to accelerate properly after N2 reaches 32%.

If a normal start occurs, the alert indication can be reset by pressing the fuel used reset switch on the EIS panel. The alert indication is automatically reset when zero fuel flow is sensed.

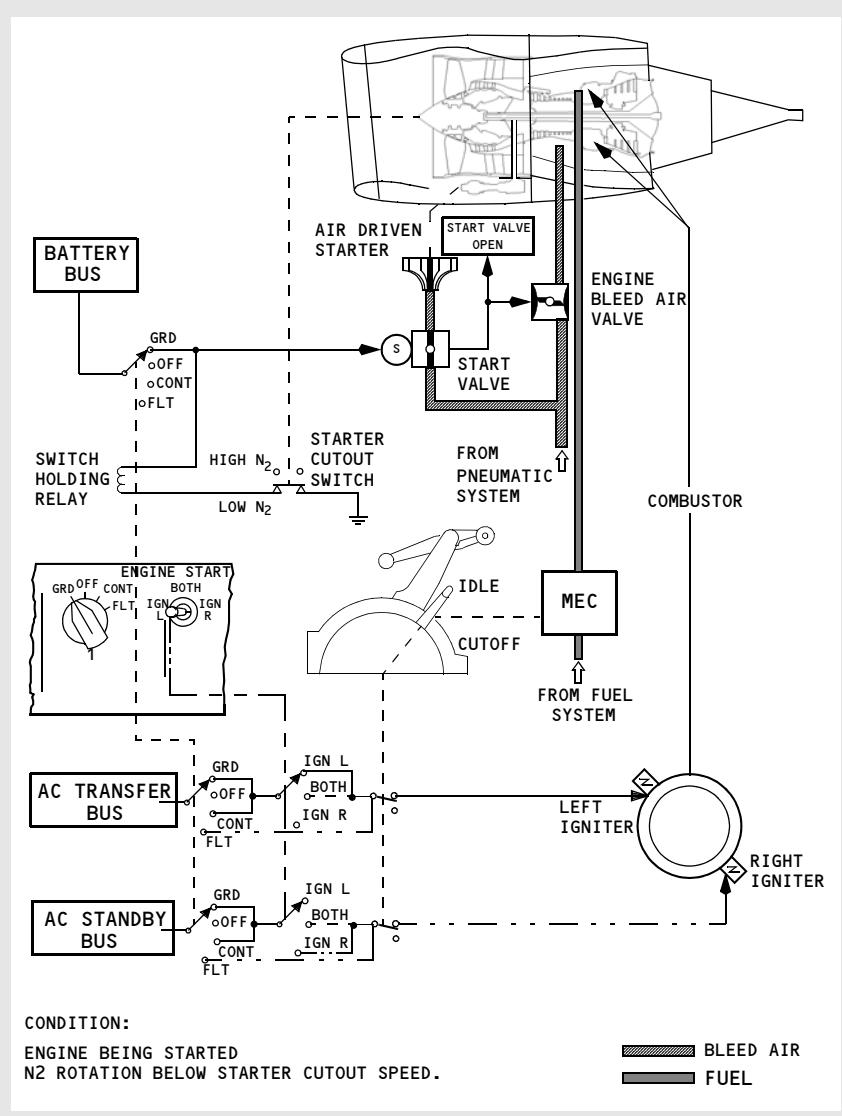
Engine Ignition System

Each engine has two igniters. The ignition select switch selects either the left, right, or both igniters for both engines. The ignition select switch is bypassed when the engine start switch is in FLT.

IGN L, powered by the AC transfer bus, provides high energy ignition to the left igniter. IGN R, powered by the AC standby bus, provides high energy ignition to the right igniter.

With the engine start switch in the GRD position, the selected igniter(s) are energized when the engine start lever is positioned to IDLE. The CONT position energizes the selected igniter(s) continuously. The FLT position energizes both igniters when the engine start lever is positioned to IDLE.

Engine Start and Ignition System Schematic



Thrust Reverser

Each engine is equipped with a hydraulically operated thrust reverser, consisting of left and right translating sleeves. Aft movement of the reverser sleeves causes blocker doors to deflect fan discharge air forward, through fixed cascade vanes, producing reverse thrust. The thrust reverser is for ground operations only and is used after touchdown to slow the airplane, reducing stopping distance and brake wear.

Hydraulic pressure for the operation of engine No. 1 and engine No. 2 thrust reversers comes from hydraulic systems A and B, respectively. If hydraulic system A or B fails, alternate operation for the affected thrust reverser is available through the standby hydraulic system. When the standby system is used, the affected thrust reverser deploys and retracts at a slower rate, and some thrust asymmetry can be anticipated.

The thrust reverser can be deployed when either radio altimeter senses less than 10 feet altitude, or when the air/ground safety sensor is in the ground mode. Movement of the reverse thrust levers is mechanically restricted until the forward thrust levers are in the idle position.

When reverse thrust is selected, the isolation valve opens, and the thrust reverser control valve moves to the deploy position, allowing hydraulic pressure to unlock and deploy the reverser system. An interlock mechanism restricts movement of the reverse thrust lever until the reverser sleeves have approached the deployed position. When either reverser sleeve moves from the stowed position, the amber REVERSER UNLOCKED light on the center instrument panel illuminates. As the thrust reverser reaches the deployed position, the reverse thrust lever can be raised to detent No. 2. This position provides adequate reverse thrust for normal operations. When necessary, the reverse thrust lever can be pulled beyond detent No. 2, providing maximum reverse thrust.

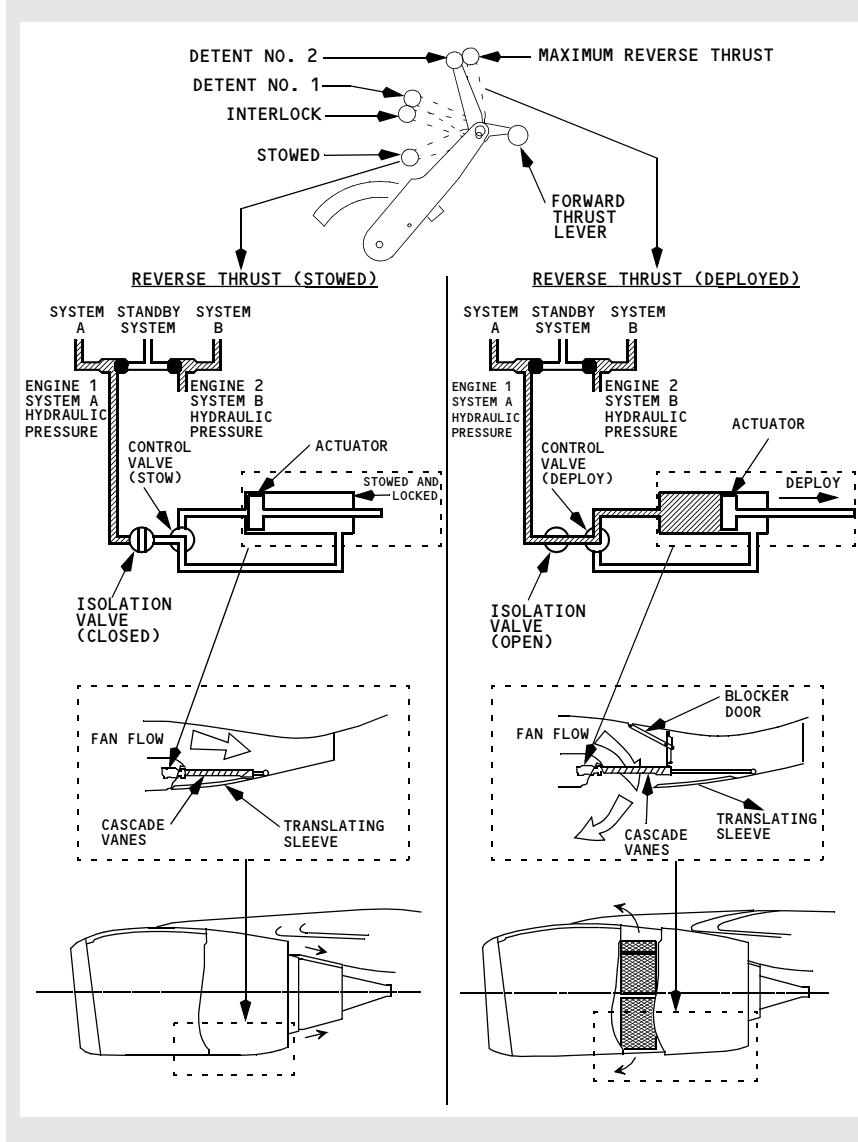
Downward motion of the reverse thrust lever past detent No. 1 commands the reverser to stow. Once the thrust reverser is commanded to stow, the control valve moves to the stow position allowing hydraulic pressure to stow and lock the reverser sleeves. After the thrust reverser is stowed, the isolation valve closes.

The REVERSER light, located on the aft overhead panel, illuminates when the thrust reverser is commanded to stow and extinguishes 10 seconds later when the isolation valve closes. Any time the REVERSER light illuminates for more than approximately 12 seconds, a malfunction has occurred, and the MASTER CAUTION and ENG system annunciation lights illuminate.

When the reverser sleeves are in the stowed position, a hydraulically operated locking actuator inhibits motion to each reverser sleeve until reverser extension is selected. Additionally, an auto-restow circuit compares the actual reverser sleeve position and the commanded reverser position. In the event of incomplete stowage or uncommanded movement of the reverser sleeves toward the deployed position, the auto-restow circuit opens the isolation valve and commands the control valve to the stow position, directing hydraulic pressure to stow the reverser sleeves. Once the auto-restow circuit is activated, the isolation valve remains open and the control valve is held in the stowed position until the thrust reverser is commanded to deploy or until corrective maintenance action is taken.

WARNING: Actuation of the thrust reversers on the ground without suitable precautions is dangerous to ground personnel.

Thrust Reverser Schematic

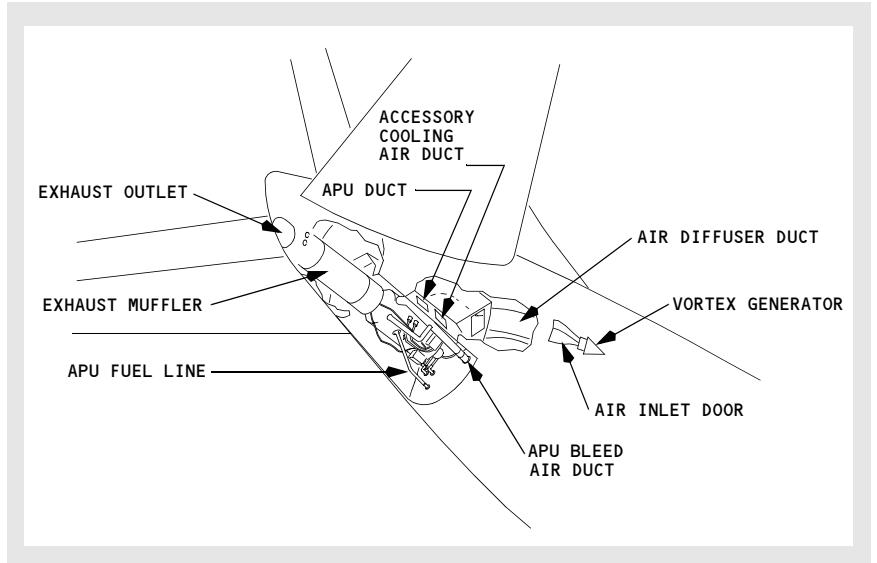


Introduction

The auxiliary power unit (APU) is a self-contained gas turbine engine installed within a fireproof compartment located in the tail of the airplane.

The APU supplies bleed air for engine starting or air conditioning. An AC electrical generator on the APU provides an auxiliary AC power source.

APU Location



APU Operation

The APU operates up to the airplane maximum certified altitude.

The APU supplies bleed air for one air conditioning pack either on the ground or in flight. Both generator busses can be powered on the ground. In flight only one generator bus can be powered.

APU Fuel Supply

Fuel to start and operate the APU comes from the left side of the fuel manifold when the AC fuel pumps are operating. If the AC fuel pumps are not operating, fuel is suction fed from the No. 1 tank. During APU operation, fuel is automatically heated to prevent icing.

With the APU operating and AC electrical power on the airplane busses, operate at least one fuel boost pump to supply fuel under pressure to the APU.

APU Engine and Cooling Air

APU engine and cooling air is routed to the APU through an automatically operated air inlet door located on the right side of the fuselage. APU exhaust gases are discharged overboard through an exhaust muffler.

The APU oil cooler and electrical generator are provided positive cooling airflow by a gear-driven fan.

Electrical Requirements for APU Operation

APU operation requires the following:

- APU fire switch on the overheat/fire panel must be IN
- APU fire control handle on the APU ground control panel must be IN
- Battery switch must be ON.

Electrical power to start the APU comes from the airplane battery.

Moving the battery switch to OFF on the ground shuts down the APU.

APU Start

The automatic start sequence begins by moving the APU switch momentarily to START. This initiates opening of the air inlet door. When the APU inlet door reaches the full open position the start sequence begins. After the APU reaches the proper speed, ignition and fuel are provided. When the APU is ready to accept a bleed air or electrical load the APU GEN OFF BUS light illuminates.

If the APU does not reach the proper speed with the proper acceleration rate within the time limit of the starter, the start cycle automatically terminates. The start cycle may take as long as 135 seconds.

Operate the APU for one full minute before using it as a bleed air source. This one minute stabilization is recommended to extend the service life of the APU.

APU Shutdown

Moving the APU switch to OFF shuts down the APU, trips the APU generator, and closes the APU bleed air valve. On some airplanes, the APU continues to run for a 30 second cooling period before it automatically shuts down. Shutdown can also be accomplished by pulling the APU fire switch.

Fuel Control Unit (FCU)

A Fuel Control Unit (FCU) controls APU engine speed and exhaust gas temperature. Automatic shutdown protection is provided for overspeed conditions, low oil pressure, high oil temperature, APU fire, and fuel control unit failure. Control air input is provided to the fuel control unit through a solenoid operated three-way control valve.

The control air pressure is modulated in response to EGT changes. When electrical load and bleed air extraction combine to raise the EGT above acceptable levels, the bleed air valve will modulate toward the closed position. In the event of an overtemperature, the APU will shut down, and the FAULT light will illuminate.

APU Automatic Galley Load Shedding

Galley electrical loads will automatically be shed should the total airplane electrical power requirements exceed design limits with the APU generator providing electrical power.

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DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Fire Protection

Table of Contents

Chapter 8

Section 0

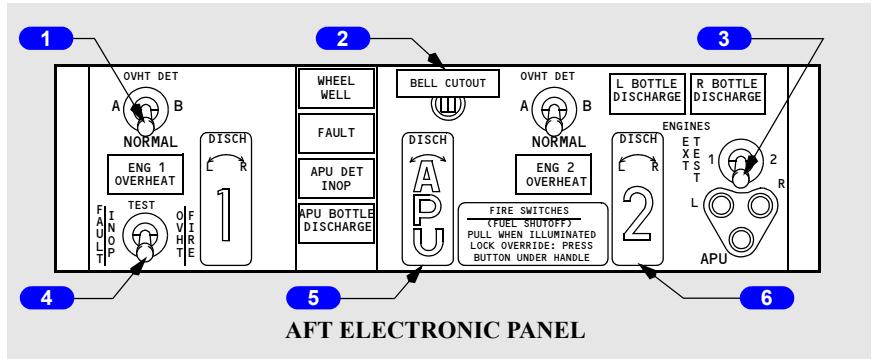
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Fire Protection Controls and Indicators

Chapter 8 Section 10

Overheat/Fire Protection Panel Switches



1 Overheat Detector (OVHT DET) Switch

NORMAL – detection loop A and loop B are active.

A – detection loop A is active.

B – detection loop B is active.

2 Fire Warning BELL CUTOUT Switch

Push –

- extinguishes both master FIRE WARN lights
- silences the fire warning bell
- silences the remote APU fire warning horn (on the ground only)
- resets the system for additional warnings.

3 Extinguisher (EXT) TEST Switch

(spring-loaded to center)

1 or 2 – tests bottle discharge circuits for all three extinguisher bottles.

4 FAULT/Inoperative (INOP) and Overheat (OVHT)/FIRE TEST Switch

(spring-loaded to center)

FAULT/INOP – tests fault detection circuits for both engines and the APU.

OVHT/FIRE – tests overheat and fire detection loops on both engines and APU, and wheel well fire detector

Note: See Fire and Overheat Detection System Fault Test in Section 20.

5 APU Fire Switch

Illuminated (red) –

- indicates fire in APU
- unlocks APU fire switch.

Note: Master FIRE WARN lights illuminate, fire warning bell sounds, APU fire warning horn in main wheel well sounds (on ground only), and APU fire warning light flashes.

In – normal position, mechanically locked if no fire signal.

Up –

- arms APU extinguisher circuit
- closes APU fuel shutoff valve, APU bleed air valve, and APU inlet door
- trips generator control relay and breaker
- allows APU fire switch to rotate.

Rotate (left or right) –

- discharges APU fire bottle.

6 Engine Fire Switch

Illuminated (red) –

- indicates fire in related engine
- unlocks related engine fire switch.

Note: Master FIRE WARN lights illuminate and fire warning bell sounds.

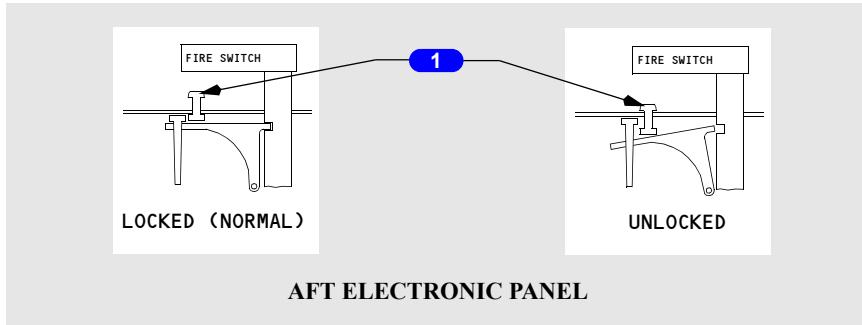
In – normal position, mechanically locked if no fire signal.

Up –

- arms one discharge squib on each engine fire extinguisher
- closes fuel, hydraulic shutoff and engine bleed air valves
- disables thrust reverser
- trips generator control relay and breaker
- deactivates engine driven hydraulic pump LOW PRESSURE light
- allows engine fire switch to rotate.

Rotate (left or right) – discharges related fire bottle.

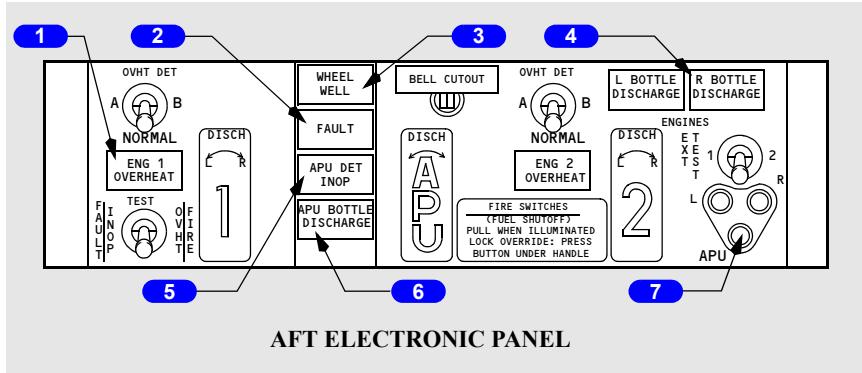
Fire Switch Override



1 Fire Switch Override

Push – unlocks fire switch.

Overheat/Fire Protection Panel Lights



1 Engine (ENG) OVERHEAT Light

Illuminated (amber) – indicates overheating in related engine.

Note: MASTER CAUTION and OVHT/DET system annunciator lights illuminate.

2 FAULT Light

Illuminated (amber) – with the overheat detector switch in NORMAL – indicates both detector loops for an engine have failed.

Illuminated (amber) – with the overheat detector switch in A or B – indicates the related loop for an engine has failed.

Note: MASTER CAUTION and OVHT/DET system annunciation lights do not illuminate.

3 WHEEL WELL Fire Warning Light

Illuminated (red) – indicates fire in main gear wheel well

Note: Master FIRE WARN lights illuminate and fire warning bell sounds.

4 Engine BOTTLE DISCHARGE Light

Illuminated (amber) – indicates related fire extinguisher bottle has discharged.

5 APU Detector Inoperative (DET INOP) Light

Illuminated (amber) – indicates APU detector loop has failed.

Note: MASTER CAUTION and OVHT/DET system annunciation lights illuminate.

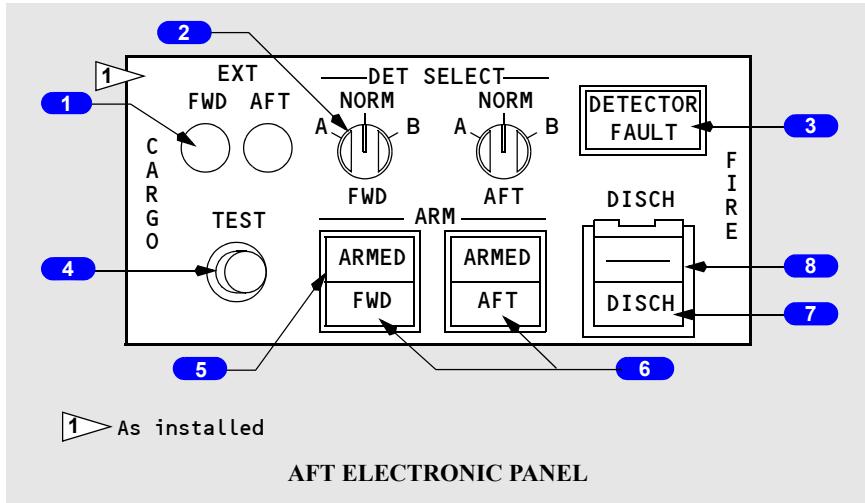
6 APU BOTTLE DISCHARGE Light

Illuminated (amber) – indicates APU extinguisher bottle has discharged.

7 Extinguisher Test (EXT TEST) Lights

Illuminated (green) – EXT TEST switch is positioned to 1 or 2 and circuit continuity is normal.

Cargo Fire Panel



1 Extinguisher (EXT) Test Lights

Illuminated (green) - Cargo Fire TEST switch is pushed and fire bottle discharge squib circuit continuity is normal.

2 Detector Select (DET SELECT) Switches

NORM - detection loop A and B are active.

A - detection loop A is active.

B - detection loop B is active.

3 DETECTOR FAULT Light

Illuminated (amber) - one or more detectors in the related loop(s) has failed.

4 Cargo Fire TEST Switch

PUSH - tests circuits for both forward and aft cargo fire detector loops and suppression system.

Note: See Cargo Fire System Tests in Section 20.

5 Cargo Fire ARMED Switches

PUSH -

- FWD ARMED - extinguisher armed for the forward cargo compartment
- AFT ARMED - extinguisher armed for the aft cargo compartment.

6 Cargo Fire (FWD/AFT) Warning Lights

Illuminated (red) -

- at least one detector in each loop detects smoke
- with power failed in one loop, at least one detector on the remaining loop detects smoke.

Note: Master FIRE WARN lights illuminate and fire warning bell sounds.

7 Cargo Fire Bottle Discharge (DISCH) Light

Illuminated (amber) - indicates the extinguisher bottle has discharged

8 Cargo Fire Discharge (DISCH) Switch

PUSH - if system is armed, discharges the extinguisher bottle.

Master Fire Warning Light



1 Master Fire Warning (FIRE WARN) Light

Illuminated (red) – indicates a fire warning (or system test) in engine, APU, main gear wheel well, or cargo compartments (on some airplanes)

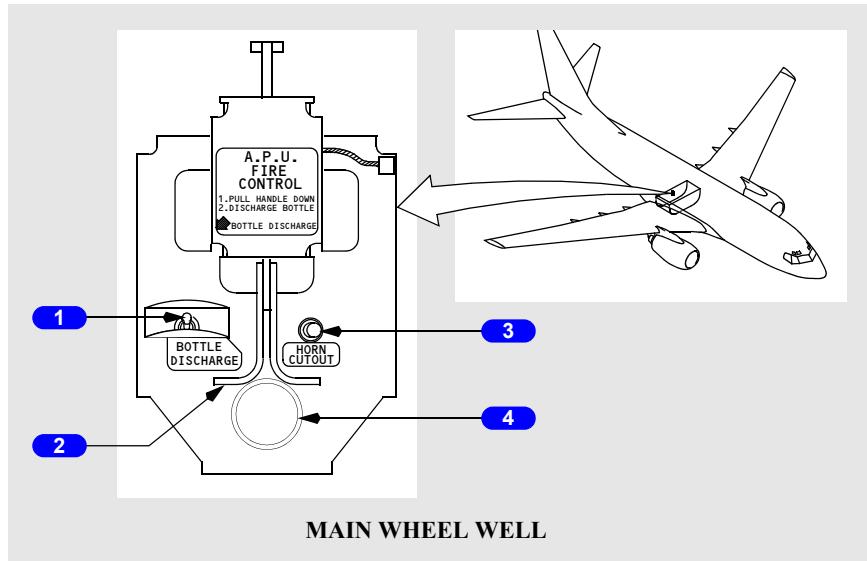
- fire warning bell sounds
- if on ground, remote APU fire warning horn sounds.

Push –

- extinguishes both master FIRE WARN lights
- silences the fire warning bell
- silences the remote APU fire warning horn
- resets the system for additional warnings.

Note: Pushing fire warning bell cutout switch on overheat/fire protection panel results in same actions.

APU Ground Control Panel



1 APU BOTTLE DISCHARGE Switch

(spring-loaded to the right and safetied.)

Left – discharges APU extinguisher.

Note: Armed only if APU fire control handle is pulled at this panel.

2 APU Fire Control Handle

Up – normal position.

Down –

- arms APU BOTTLE DISCHARGE switch (on this panel only)
- closes APU fuel shutoff, bleed air valve and APU inlet door
- trips generator control relay and breaker.

3 APU Fire Warning HORN CUTOUT Switch

Push –

- silences fire alarm bell
- silences APU fire warning horn
- causes APU fire warning light to stop flashing but remain illuminated.

4 APU Fire Warning Light

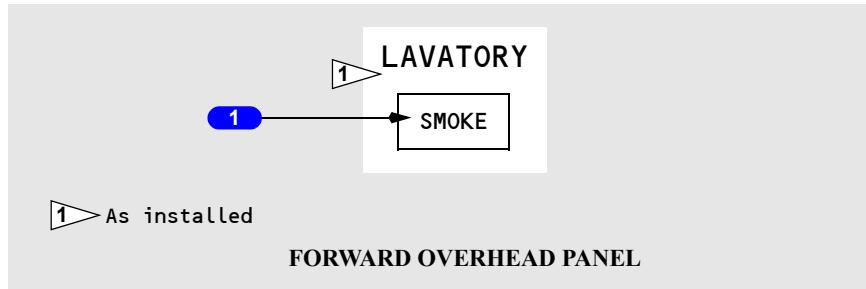
Illuminated (red flashing) – indicates fire in APU.

Note: Also, flight deck fire warning bell sounds and APU fire warning horn in main wheel well.

Illuminated (red steady) – indicates APU fire warning HORN CUTOUT switch has been pushed following an APU fire indication.

Lavatory Fire

Lavatory Smoke Detection



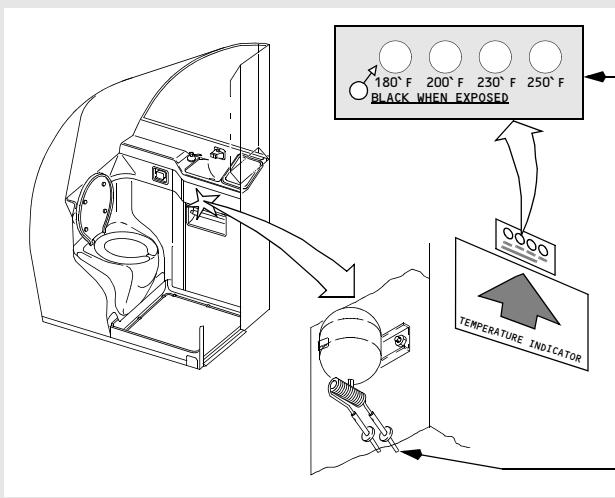
1 LAVATORY SMOKE Light

Illuminated (amber) –

- smoke has been detected in a lavatory or
- a test is being conducted.

Note: MASTER CAUTION and OVERHEAD system annunciator lights illuminate.

Lavatory Fire Extinguisher



BELOW LAVATORY SINK

1 TEMPERATURE INDICATOR Placard

White – normal condition.

Black – exposed to high temperatures.

2 Heat Activated Nozzles

Flat black – normal condition.

Aluminum – indicates extinguisher has discharged.

On early airplanes one nozzle discharges toward the towel disposal container, the other under the sink. On later airplanes (illustrated) both nozzles discharge toward the towel disposal container.

Intentionally
Blank

Fire Protection System Description

Chapter 8 Section 20

Introduction

There are fire detection and extinguishing systems for:

- engines
- lavatories
- APU
- cargo compartments
(as installed)

The engines also have overheat detection systems.

The main gear wheel well has a fire detection system, but no fire extinguishing system.

Engine Fire Protection

Engine fire protection consists of these systems:

- engine overheat and fire detection powered by the battery bus
- engine fire extinguishing powered by the hot battery bus.

Engine Overheat and Fire Detection

Each engine contains two overheat/fire detector loops. Each loop provides both fire and overheat detection. As the temperature of a detector increases to a predetermined limit, the detector senses an overheat condition. At higher temperatures, the detector senses a fire condition. Normally, both detector loops must sense a fire or overheat condition to cause an engine overheat or fire alert. The ENG OVERHEAT light or engine fire switch remains illuminated until the temperature drops below the onset temperature.

An OVHT DET switch for each engine, labeled A, B, and NORMAL, permits selection of either loop A or B, or both A and B, as the active detecting loops.

The system contains a fault monitoring circuit. If one loop fails with the OVHT DET switch in NORMAL, that loop is automatically deselected and the remaining loop functions as a single loop detector. There is no cockpit indication of single loop failure. If both loops fail on an engine, the FAULT light illuminates and the system is inoperative.

If the OVHT DET switch is positioned to A or B, the system operates as a single loop system. The non-selected loop is not monitored. If the selected loop fails, the FAULT light illuminates and the system is inoperative.

The indications of an engine overheat are:

- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- the related ENG OVERHEAT light illuminates.

The indications of an engine fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the related engine fire switch illuminates
- all related engine overheat alert indications illuminate.

Engine Fire Extinguishing

The engine fire extinguisher system consists of two engine fire extinguisher bottles, two engine fire switches, two BOTTLE DISCHARGE lights, and an EXT TEST switch. Either or both bottles can be discharged into either engine.

The engine fire switches are normally locked down to prevent inadvertent shutdown of an engine. Illumination of an engine fire switch or ENG OVERHEAT light unlocks the engine fire switch. The switches may also be unlocked manually.

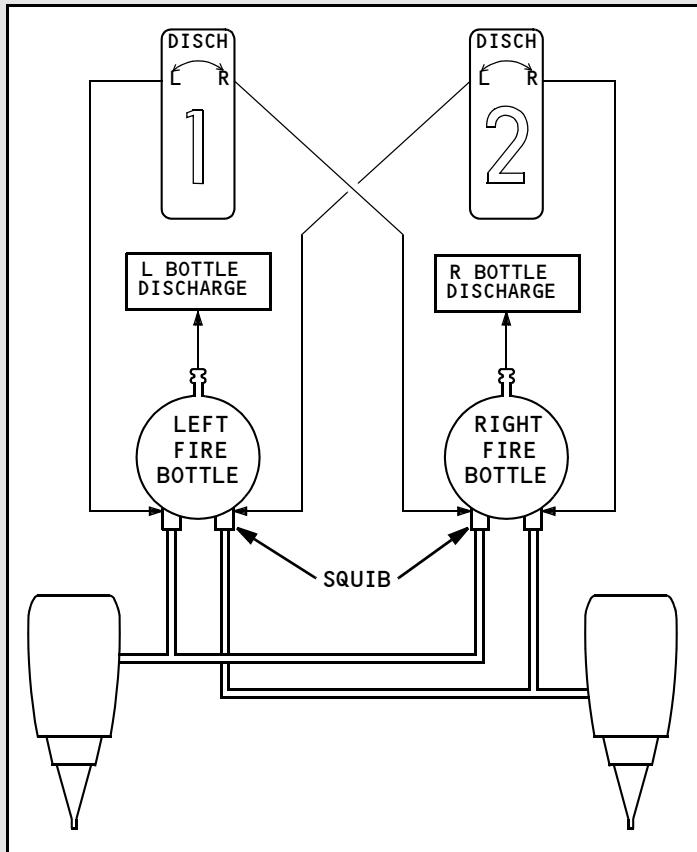
Pulling the engine fire switch up:

- closes the related engine fuel shutoff valve
- closes the related engine bleed air valve resulting in loss of wing anti-ice to the affected wing and closure of bleed air operated pack valve
- trips the generator control relay and breaker
- closes the hydraulic fluid shutoff valve. The engine driven hydraulic pump LOW PRESSURE light is deactivated
- disables thrust reverser for the related engine.
- allows the engine fire switch to be rotated for discharge
- arms one discharge squib on each engine fire extinguisher bottle.

Rotating the engine fire switch electrically “fires” a squib, discharging the extinguishing agent into the related engine. Rotating the switch the other way discharges the remaining bottle.

The L or R BOTTLE DISCHARGE light illuminates a few seconds after the engine fire switch is rotated, indicating the bottle has discharged.

Engine Fire Extinguisher Schematic



APU Fire Protection

APU fire protection consists of these systems:

- APU fire detection powered by the battery bus.
- APU fire extinguishing powered by the hot battery bus.

APU Fire Detection

A single fire detection loop is installed on the APU. As the temperature of the detector increases to a predetermined limit, the detector senses a fire condition. The APU fire switch remains illuminated until the temperature of the detector has decreased below the onset temperature.

The system contains a fault monitoring circuit. If the loop fails, the APU DET INOP light illuminates indicating the APU fire detection system is inoperative.

The indications of an APU fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the APU fire switch illuminates
- the APU automatically shuts down
- the APU fire warning horn in the main wheel well sounds, (on the ground only), and the APU fire warning light flashes.

APU Fire Extinguishing

The APU fire extinguisher system consists of one APU fire extinguisher bottle, an APU fire switch, an APU BOTTLE DISCHARGE light, and an EXT TEST switch. The APU ground control panel located in the right main wheel well also contains an APU fire warning light, an APU BOTTLE DISCHARGE switch, an APU fire control handle and APU HORN CUTOUT switch.

The APU fire switch is normally locked down to prevent inadvertent shutdown of the APU. Illumination of the APU fire switch unlocks the switch. The switch may also be unlocked manually.

Pulling the APU fire switch up:

- provides backup for the automatic shutdown feature
- deactivates the fuel solenoid and closes the APU fuel shutoff valve
- closes the APU bleed air valve
- closes the APU air inlet door
- trips the APU generator control relay and breaker
- allows the APU fire switch to be rotated for discharge
- arms the APU fire extinguisher bottle squib.

Rotating the APU fire switch in either direction electrically “fires” the squib discharging the extinguishing agent into the APU. The APU BOTTLE DISCHARGE light illuminates after a few seconds, indicating the bottle has discharged.

Main Wheel Well Fire Protection

Main wheel well fire protection consists of fire detection powered by the No. 1 AC transfer bus.

Note: The main wheel well has no fire extinguishing system. The nose wheel well does not have a fire detection system.

Main Wheel Well Fire Detection

A single fire detector loop is installed in the main wheel well. As the temperature of the detector increases to a predetermined limit, the detector senses a fire condition. The WHEELWELL fire warning light remains illuminated until the temperature of the detector has decreased below the onset temperature.

The indications for a main wheel well fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the WHEEL WELL fire warning light illuminates.

Cargo Compartment Fire Protection (as installed)

Cargo fire protection consists of these systems:

- cargo compartment smoke detection powered by DC bus 1 and DC bus 2
- cargo compartment fire extinguishing powered by the hot battery bus.

Cargo Compartment Smoke Detection

The forward and aft cargo compartments each have smoke detectors in a dual loop configuration. Normally, both detection loops must sense smoke to cause an alert. These loops function in the same manner as the engine overheat/fire detection loops.

Cargo Compartment Fire Warning

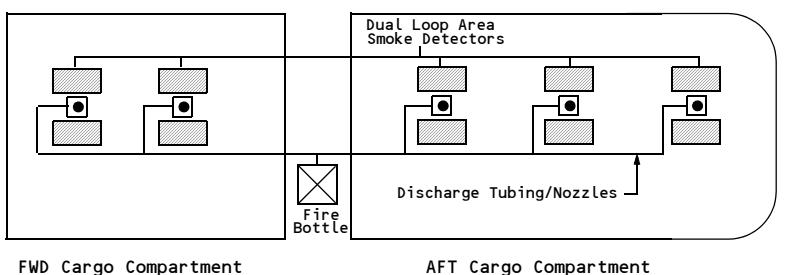
The indications of a cargo compartment fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the FWD/AFT cargo fire warning light(s) illuminates.

Cargo Compartment Fire Extinguishing

A single fire extinguisher bottle is installed in the air conditioning mix bay on the forward wing spar. Detection of a fire in either the forward or aft compartment will cause the FWD or AFT cargo fire warning light to illuminate. The extinguisher is armed by pushing the appropriate cargo fire ARMED switch. Once armed, the system is discharged by pushing the cargo fire DISCH switch. This results in the total discharge of the bottle contents into the selected compartment. The cargo fire DISCH light illuminates once the bottle is discharged. It may take up to 30 seconds for the light to illuminate.

Cargo Fire Extinguisher Schematic



Lavatory Fire Protection

Lavatory fire protection consists of these systems:

- lavatory smoke detection
- lavatory fire extinguishing (heat activated).

Lavatory Smoke Detection

The lavatory smoke detection system monitors for the presence of smoke. When smoke is detected:

- an aural warning sounds over the passenger address system
- the red alarm indicator light on the lavatory smoke detector panel illuminates
- pressing the interrupt switch silences the aural warning. If smoke is still present when the switch is released, the alarm will sound again
- on some airplanes flight deck LAVATORY SMOKE, OVERHEAD system annunciator, and MASTER CAUTION lights illuminate

When smoke is no longer present the system automatically resets.

Lavatory Fire Extinguisher System

A fire extinguisher system is located beneath the sink area in each lavatory. When a fire is detected:

- fire extinguisher operation is automatic
- flight deck has no indication of extinguisher discharge.

Fire and Overheat System Tests

The fire and overheat detection systems can be tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch. Extinguisher continuity can be tested by pushing and holding the EXT TEST switch. All test indications clear when switches are released.

FAULT/INOP Test Detection

The fault detection circuits for both the engines and the APU are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the FAULT/INOP position.

The indications for the FAULT/INOP test are:

- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- the FAULT light illuminates
- the APU DET INOP light illuminates.

OVERHEAT/FIRE Test Detection

The overheat and fire detection loops on both engines, the APU, and the fire detector in the wheel well are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the OVHT/FIRE position.

The indications for the OVHT/FIRE test are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- both engine fire switches illuminate
- the APU fire switch illuminates
- both ENG OVERHEAT lights illuminate
- the WHEEL WELL fire warning light illuminates if AC power is available
- on the ground, the APU fire warning horn sounds and the APU fire warning light in the main wheel well flashes.

Note: During an OVERHEAT/FIRE Test, the FAULT light will illuminate if one or more detectors in the loop(s) has failed.

Extinguisher Test

When the EXT TEST switch is positioned to 1 or 2, the green EXT TEST lights illuminate, verifying circuit continuity from the squib to the engine fire switch.

Cargo Fire System Tests (as installed)

The cargo fire detection and suppression system can be tested by pushing and holding the cargo fire TEST switch. This sends a test signal to the forward and aft cargo fire detector loops and verifies continuity of the extinguisher bottle squib circuits. All test indications clear when the TEST switch is released.

Cargo Fire TEST

The indications for the Cargo Fire test are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the extinguisher test lights illuminate
- the FWD and AFT cargo fire warning lights illuminate when all detectors in selected loop(s) respond to the fire test
- the cargo fire bottle DISCH light illuminates

Note: The fire warning BELL CUTOUT switch on the Overheat/Fire Protection panel can silence the fire warning bell and extinguish the master FIRE WARN lights

Note: During a Cargo Fire Test, the DETECTOR Fault light will illuminate if one or more detectors in the loop(s) has failed.

Note: Individual detector faults can only be detected by a manually initiated test. The MASTER CAUTION light does not illuminate.

Note: At the end of cargo fire testing, a four second delay allows all applicable indications to extinguish at the same time.

Cargo Fire Extinguisher Test

When the Cargo Fire TEST button is pushed, the green EXT lights illuminate, verifying the fire bottle discharge squib circuit continuity is normal.

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Flight Controls

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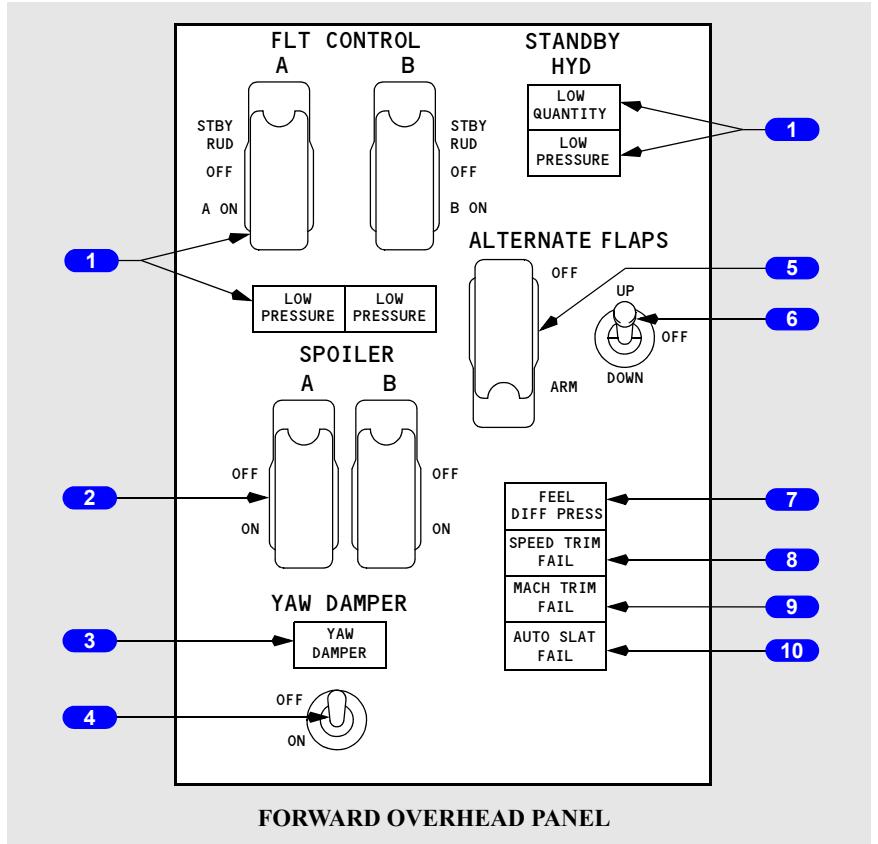
Flight Controls

Controls and Indicators

Chapter 9

Section 10

Flight Control Panel (before Rudder System Enhancement Program (RSEP) modification)



1 Refer to Chapter 13 – Hydraulics

2 Flight SPOILER Switches (guarded to ON)

Used for maintenance purposes only.

OFF – closes the respective flight spoilers shutoff valve.

3 YAW DAMPER Light

Illuminated (amber) – yaw damper is not engaged.

4 YAW DAMPER Switch

OFF – disengages yaw damper.

ON – engages yaw damper to rudder power control unit.

5 ALTERNATE FLAPS Master Switch (guarded to OFF)

OFF – normal operating position.

ARM – closes trailing edge flap bypass valve, activates standby pump, and arms the ALTERNATE FLAPS position switch.

6 ALTERNATE FLAPS Position Switch

Functions only when the ALTERNATE FLAPS master switch is in ARM.

UP –

- electrically retracts trailing edge flaps
- leading edge devices remain extended and cannot be retracted by the alternate flaps system.

OFF – normal operating position.

DOWN (spring loaded to OFF) –

- (momentary) fully extends leading edge devices using standby hydraulic pressure
- (hold) electrically extends trailing edge flaps.

7 Feel Differential Pressure (FEEL DIFF PRESS) Light

Armed when the trailing edge flaps are up.

Illuminated (amber) – indicates excessive differential pressure in the elevator feel computer.

8 SPEED TRIM Failure (FAIL) Light

Illuminated (amber) –

- indicates failure of the speed trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

9 MACH TRIM Failure (FAIL) Light

Illuminated (amber) –

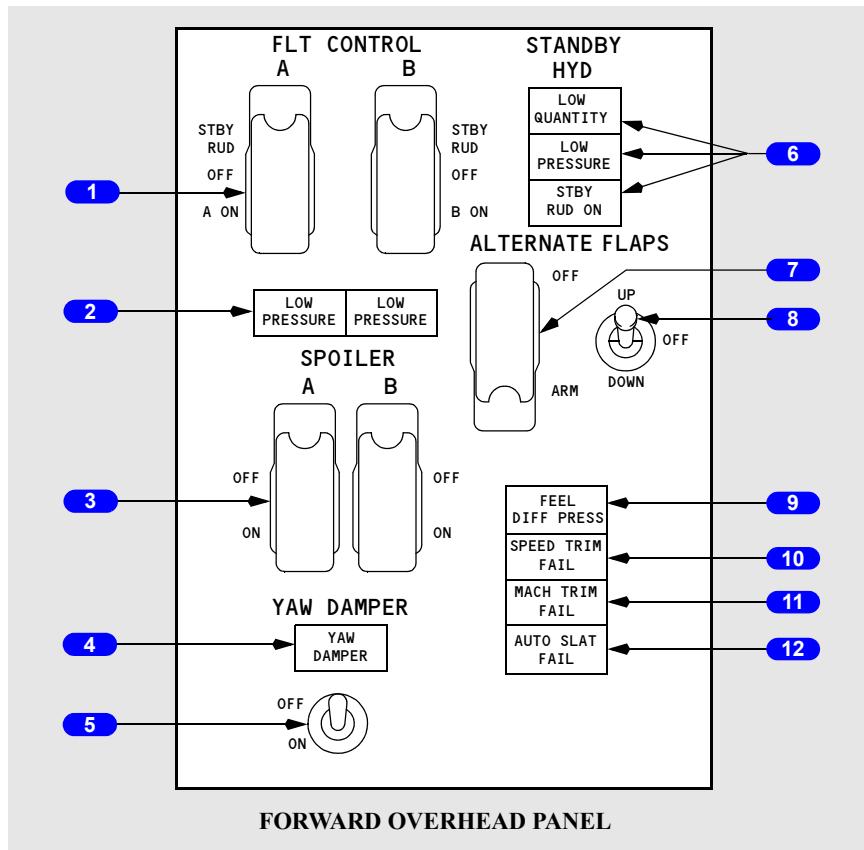
- indicates failure of the Mach trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

10 Automatic (AUTO) SLAT Failure (FAIL) Light

Illuminated (amber) –

- indicates failure of both auto slat computers.
- indicates failure of a single autoslat computer when illuminated during MASTER CAUTION recall and extinguishes when master caution system is reset.

Flight Control Panel (after RSEP modification)



1 FLIGHT CONTROL Switches

STBY RUD - activates standby pump and opens standby rudder shutoff valve to pressurize standby rudder power control unit.

OFF - closes flight control shutoff valve isolating ailerons, elevators, and rudder from associated hydraulic system pressure.

ON (guarded position) - normal operating position.

2 Flight Control LOW PRESSURE Lights

Illuminated (amber) -

- indicates low hydraulic system (A or B) pressure to ailerons, elevator and rudder
- deactivated when associated FLT CONTROL switch is positioned to STBY RUD and standby rudder shutoff valve opens
- the A system light indicates A system pressure is low when full RPR pressure is commanded.

Note: The A system light will remain illuminated for approximately five seconds after A hydraulic system is activated.

3 Flight SPOILER Switches (guarded to ON)

Used for maintenance purposes only.

OFF - closes the respective flight spoilers shutoff valve.

4 YAW DAMPER Light

Illuminated (amber) - yaw damper is not engaged.

5 YAW DAMPER Switch

OFF – disengages yaw damper.

ON – engages yaw damper to rudder power control unit.

6 STANDBY HYD Lights

STANDBY HYDRAULIC LOW QUANTITY Light

Illuminated (amber) -

- indicates low quantity in standby hydraulic reservoir
- always armed.

STANDBY HYDRAULIC LOW PRESSURE Light

Illuminated (amber) –

- indicates output pressure of standby pump is low
- armed only when standby pump operation has been selected or automatic standby function is activated.

STBY RUD ON Light

Illuminated (amber) – indicates the standby hydraulic system is commanded on to pressurize the standby rudder power control unit.

7 ALTERNATE FLAPS Master Switch

OFF - (guarded position) - normal operating position.

ARM - closes trailing edge flap bypass valve, activates standby pump, and arms ALTERNATE FLAPS position switch.

8 ALTERNATE FLAPS Position Switch

Functions only when the ALTERNATE FLAPS master switch is in ARM.

UP –

- electrically retracts trailing edge flaps
- leading edge devices remain extended and cannot be retracted by the alternate flaps system.

OFF – normal operating position.

DOWN (spring loaded to OFF) –

- (momentary) fully extends leading edge devices using standby hydraulic pressure
- (hold) electrically extends trailing edge flaps.

9 Feel Differential Pressure (FEEL DIFF PRESS) Light

Armed when the trailing edge flaps are up.

Illuminated (amber) – indicates excessive differential pressure in the elevator feel computer.

10 SPEED TRIM Failure (FAIL) Light

Illuminated (amber) –

- indicates failure of the speed trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

11 MACH TRIM Failure (FAIL) Light

Illuminated (amber) –

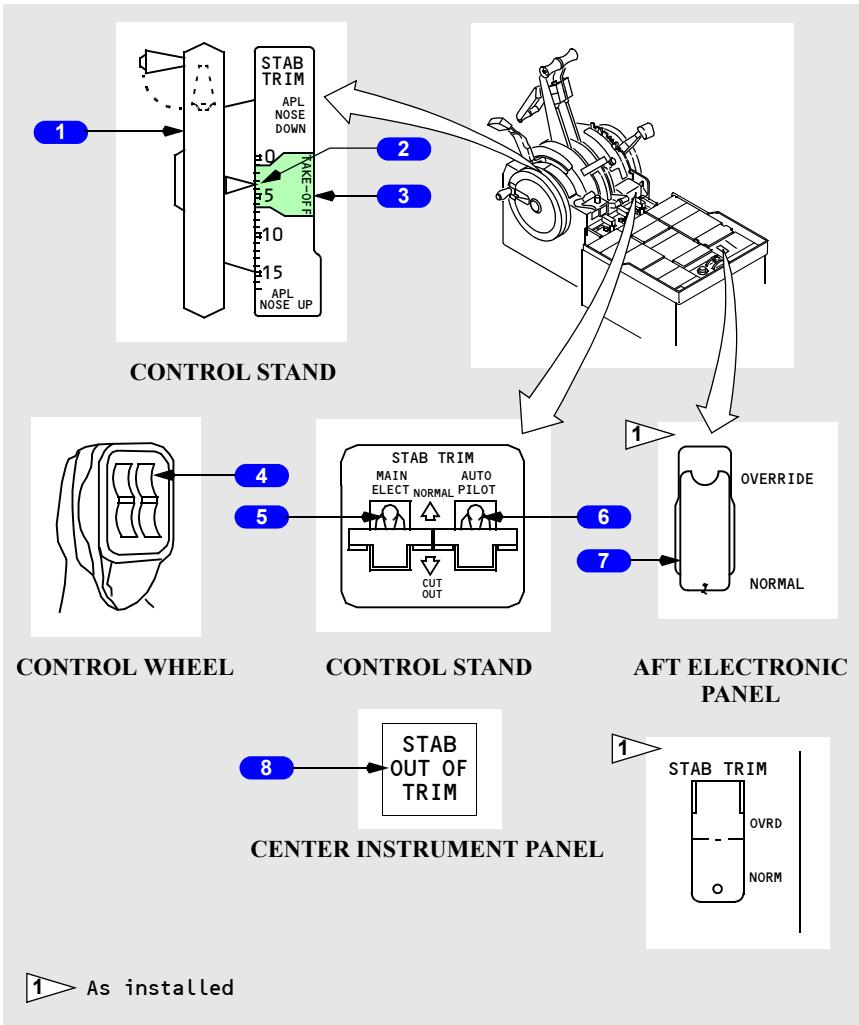
- indicates failure of the Mach trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

12 Automatic (AUTO) SLAT Failure (FAIL) Light

Illuminated (amber) –

- indicates failure of both auto slat computers.
- indicates failure of a single autoslat computer when illuminated during MASTER CAUTION recall and extinguishes when master caution system is reset.

Stabilizer



1 Stabilizer Trim Wheel

- provides for manual operation of stabilizer
- overrides any other stabilizer trim inputs
- rotates when stabilizer is in motion.

Note: handle should be folded inside stabilizer trim wheel for normal operation

2 Stabilizer Trim Indicator

Indicates units of airplane trim on the adjacent scale.

3 Stabilizer Trim Green Band Range

Corresponds to allowable range of trim settings for takeoff

4 Stabilizer Trim Switches (spring-loaded to neutral)

Push (both) –

- electrically commands stabilizer trim in desired direction
- autopilot disengages if engaged.

5 Stabilizer Trim Main Electric (MAIN ELECT) Cutout Switch

NORMAL – normal operating position.

CUTOOUT – deactivates stabilizer trim switch operation.

6 Stabilizer Trim AUTOPILOT Cutout Switch

NORMAL – normal operating position.

CUTOOUT –

- deactivates autopilot stabilizer trim operation
- autopilot disengages if engaged.

7 Stabilizer Trim Override Switch

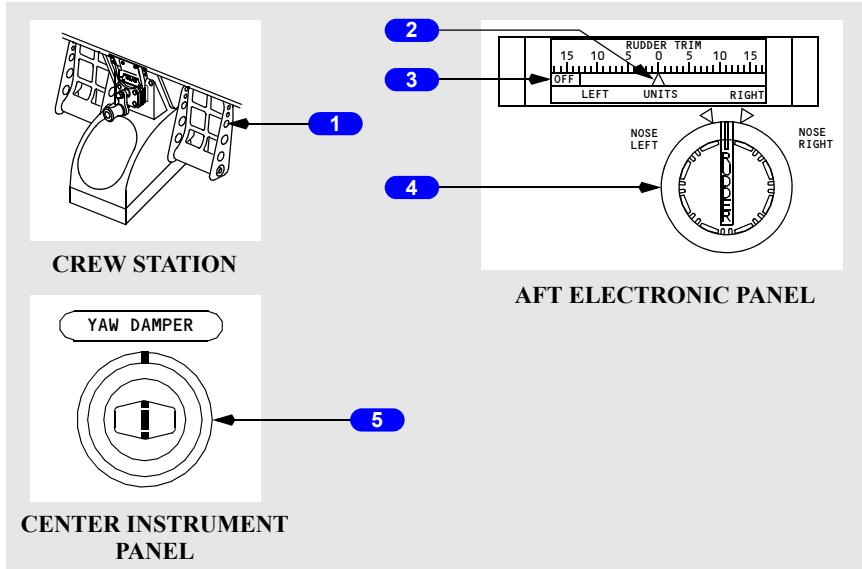
OVERRIDE – bypasses the control column actuated stabilizer trim cutout switches to restore power to the stabilizer trim switches

NORM – normal operating position.

8 STAB OUT OF TRIM Light

Refer to Chapter 4 – Automatic Flight

Rudder



1 Rudder Pedals

Push –

- controls rudder position
- permits limited nose gear steering up to 7 degrees each side of center.

2 Rudder Trim Indicator

Indicates units of rudder trim.

3 Rudder Trim OFF Flag

Illuminated (amber) (in view) – rudder trim indicator is inoperative.

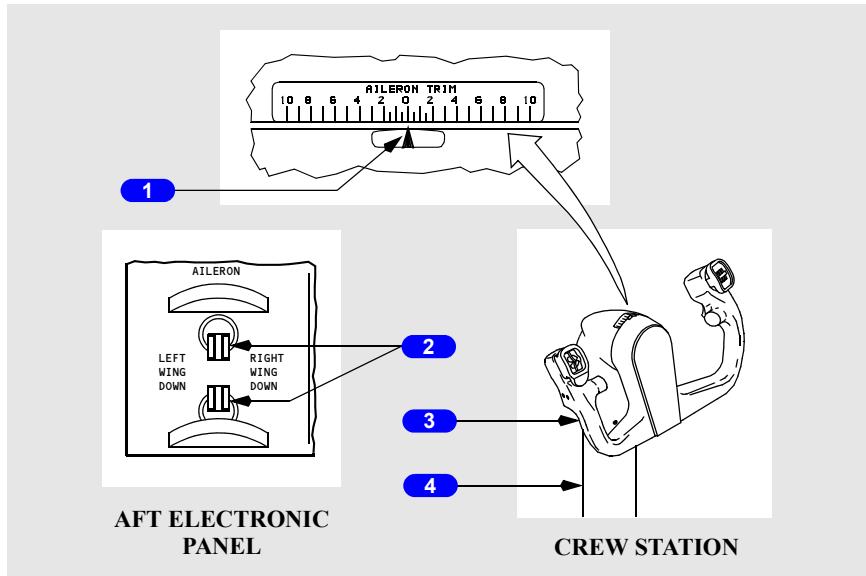
4 Rudder Trim Control (spring-loaded to neutral)

Rotate – electrically trims the rudder in the desired direction.

5 YAW DAMPER Indicator

- indicates yaw damper movement of rudder
- pilot rudder pedal inputs are not indicated.

Aileron / Elevator / Flight Spoilers



1 AILERON TRIM Indicator

Includes units of aileron trim.

2 AILERON TRIM (spring-loaded to the neutral position)

Movement of both switches repositions the aileron neutral control position.

3 Control Wheel

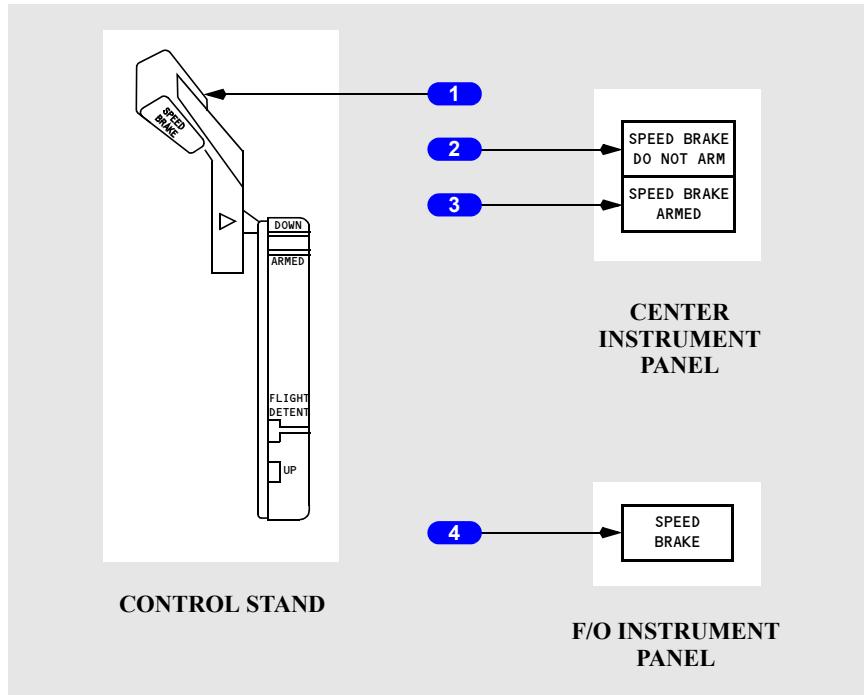
Rotate – operates ailerons and flight spoilers in desired direction.

4 Control Column

Push/Pull –

- operates elevators in the desired direction
- movement opposing stabilizer trim stops electric trimming.

Speed Brakes



1 SPEED BRAKE Lever

DOWN (detent) – all flight and ground spoiler panels in faired position.

ARMED –

- automatic speed brake system armed
- upon touchdown, the SPEED BRAKE lever moves to the UP position, and all flight and ground spoilers extend.

FLIGHT DETENT – all flight spoilers are extended to their maximum position for inflight use.

UP – all flight and ground spoilers are extended to their maximum position for ground use.

2 SPEED BRAKE DO NOT ARM Light

Light deactivated when SPEED BRAKE lever is in the DOWN position.

Illuminated (amber) – indicates abnormal condition or test inputs to the automatic speed brake system.

3 SPEED BRAKE ARMED Light

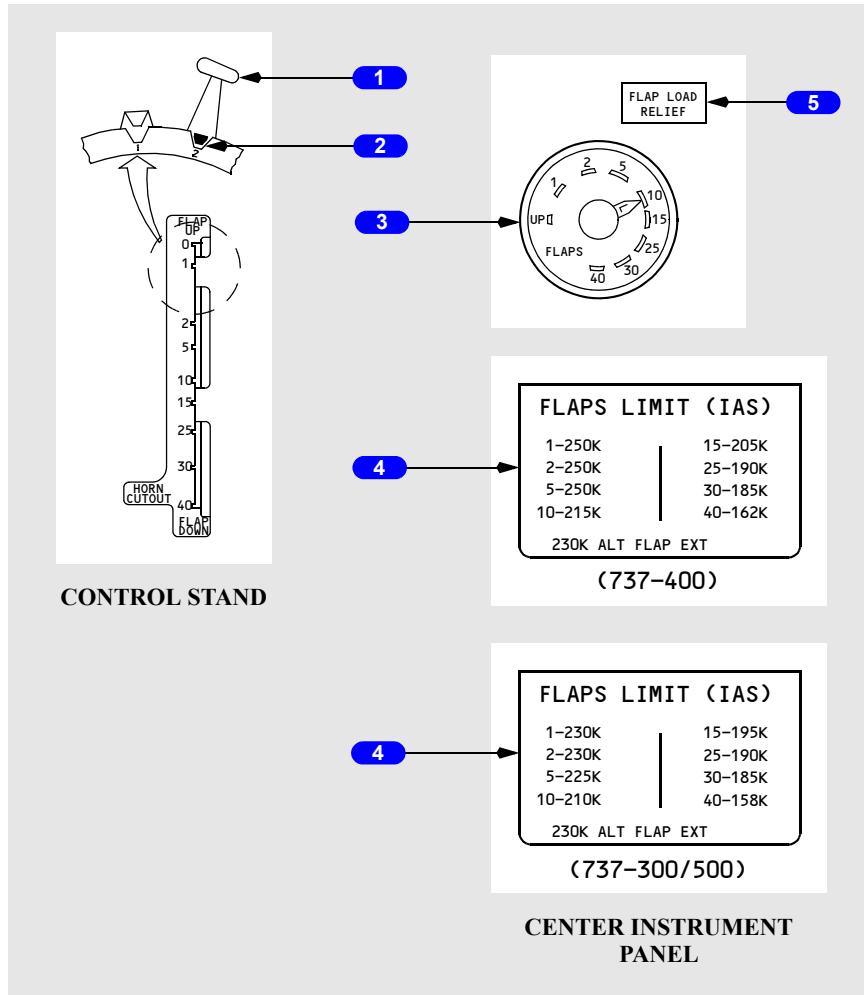
Light deactivated when SPEED BRAKE lever is in the DOWN position.

Illuminated (green) – indicates valid automatic speed brake system inputs.

4 SPEED BRAKE Caution Light

Flashing (amber) – indicates air/ground sensor in air position, SPEED BRAKE lever aft of ARMED position and flaps extended beyond position 10.

Trailing Edge Flaps



1 Flap Lever

- selects position of flap control valve, directing hydraulic pressure for flap drive unit
- position of the leading edge devices is determined by selecting trailing edge flap position
- flap position 40 arms the flap load relief system.

2 Flap Gates

Prevents inadvertent flap lever movement beyond:

- position 1 – to check flap position for one engine inoperative go-around
- position 15 – to check flap position for normal go-around.

3 Flap Position Indicator

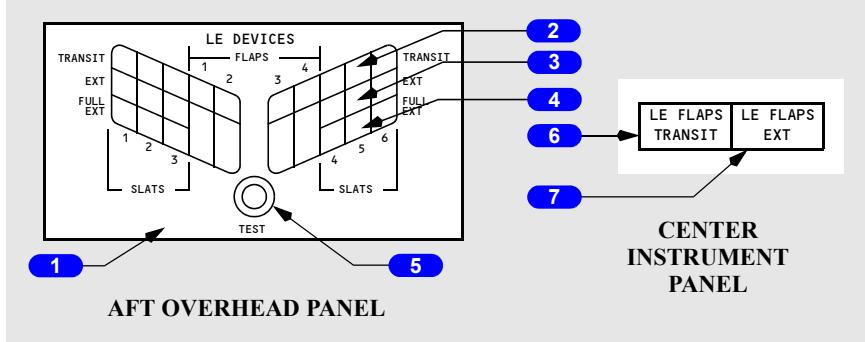
- indicates position of left and right trailing edge flaps
- provides trailing edge flaps asymmetry protection.

4 FLAPS LIMIT Placard

5 FLAP LOAD RELIEF Light

Illuminated (amber) – indicates flaps have retracted from 40 to 30 due to excess airspeed.

Leading Edge Devices



1 Leading Edge Devices (LE DEVICES) Annunciator Panel

Indicates position of individual leading edge flaps and slats.

Extinguished – related leading edge device retracted.

2 Leading Edge Devices TRANSIT Lights

Illuminated (amber) – related leading edge device in transit.

3 Leading Edge Devices Extended (EXT) Lights

Illuminated (green) – related leading edge slat in extended (intermediate) position.

4 Leading Edge Devices FULL Extended (EXT) Lights

Illuminated (green) – related leading edge device in full extended position.

5 Leading Edge Annunciator Panel TEST Switch

Press – tests all annunciator panel lights.

6 Leading Edge Transit (LE FLAPS TRANSIT) Light

Illuminated (amber) – any leading edge device in transit, or not in programmed position with respect to trailing edge flaps.

Note: Light is inhibited during autoslat operation in flight.

7 Leading Edge (LE) FLAPS Extended (EXT) Light

Illuminated (green) –

- all leading edge flaps extended and all leading edge slats in extended (intermediate) position (trailing edge flap positions 1, 2 and 5)
- all leading edge devices in full extended position (trailing edge flap positions 10 through 40).

Flight Controls System Description

Chapter 9 Section 20

Introduction

The primary flight control system uses conventional control wheel, column, and pedals linked mechanically to hydraulic power control units which command the primary flight control surfaces; ailerons, elevators and rudder. The flight controls are powered by redundant hydraulic sources; system A and system B. Either hydraulic system can operate all primary flight controls. The ailerons and elevators may be operated manually if required. The rudder may be operated by the standby hydraulic system if system A and system B pressure is not available.

The secondary flight controls, high lift devices consisting of trailing edge (TE) flaps and leading edge (LE) flaps and slats (LE devices), are powered by hydraulic system B. In the event hydraulic system B fails, the TE flaps can be operated electrically. Under certain conditions the power transfer unit (PTU) automatically powers the LE devices. (Refer to Chapter 13, Hydraulics, Power Transfer Unit). They can also be extended using standby hydraulic pressure.

Pilot Controls

The pilot controls consist of:

- two control columns
- two control wheels
- two pairs of rudder pedals
- SPEED BRAKE lever
- FLAP lever
- STAB TRIM cutout switches
- STAB TRIM override switch
- stabilizer trim switches
- stabilizer trim wheel
- AILERON trim switches
- RUDDER trim control
- YAW DAMPER switch
- ALTERNATE FLAPS master switch
- alternate flaps position switch
- FLT CONTROL switches
- flight SPOILER switches

The control wheels are connected through transfer mechanisms which allow the pilots to bypass a jammed control or surface.

There is a rigid connection between both pairs of rudder pedals.

The SPEED BRAKE lever allows manual or automatic symmetric actuation of the spoilers.

Flight Control Surfaces

Pitch control is provided by:

- two elevators
- a movable horizontal stabilizer.

Roll control is provided by:

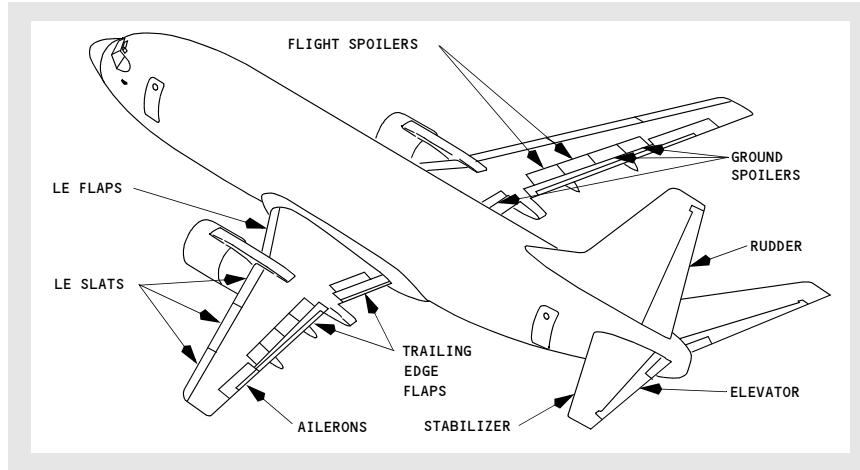
- two ailerons
- four flight spoilers.

Yaw control is provided by a single rudder. During takeoff, the rudder becomes aerodynamically effective between 40 and 60 knots.

TE flaps, and LE flaps and slats provide high lift for takeoff, approach, and landing.

In the air symmetric flight spoilers are used as speed brakes. On the ground symmetric flight and ground spoilers destroy lift and increase braking efficiency.

Flight Control Surfaces Location



Roll Control

The roll control surfaces consist of hydraulically powered ailerons and flight spoilers, which are controlled by rotating either control wheel.

Ailerons

The ailerons provide roll control around the airplane's longitudinal axis. The ailerons are positioned by the pilots' control wheels. The A and B FLT CONTROL switches control hydraulic shutoff valves. These valves can be used to isolate ailerons, elevators and rudder, from the related hydraulic system pressure.

The Captain's control wheel is connected by cables to the aileron power control units (PCUs) through the aileron feel and centering unit. The First Officer's control wheel is connected by cables to the spoiler PCUs through the spoiler mixer. The two control wheels are connected by a cable drive system which allows actuation of both ailerons and spoilers by either control wheel. With total hydraulic power failure the ailerons can be mechanically positioned by rotating the pilots' control wheels. Control forces are higher due to friction and aerodynamic loads.

Aileron Transfer Mechanism

If the ailerons or spoilers are jammed, force applied to the Captain's and the First Officer's control wheels will identify which system, ailerons or spoilers, is usable, and which control wheel, Captain's or First Officer's, can provide roll control. If the aileron control system is jammed, force applied to the First Officer's control wheel provides roll control from the spoilers. The ailerons and the Captain's control wheel are inoperative. If the spoiler system is jammed, force applied to the Captain's control wheel provides roll control from the ailerons. The spoilers and the First Officer's control wheel are inoperative.

Aileron Trim

Dual AILERON trim switches, located on the aft electronic panel, must be pushed simultaneously to command trim changes. The trim electrically repositions the aileron feel and centering unit, which causes the control wheel to rotate, and redefines the aileron neutral position. The amount of aileron trim is indicated on a scale on the top of each control column.

If aileron trim is used with the autopilot engaged, the trim is not reflected in the control wheel position. The autopilot overpowers the trim and holds the control wheel where it is required for heading/track control. Any aileron trim applied when the autopilot is engaged can result in an out of trim condition and an abrupt rolling movement when the autopilot is disconnected.

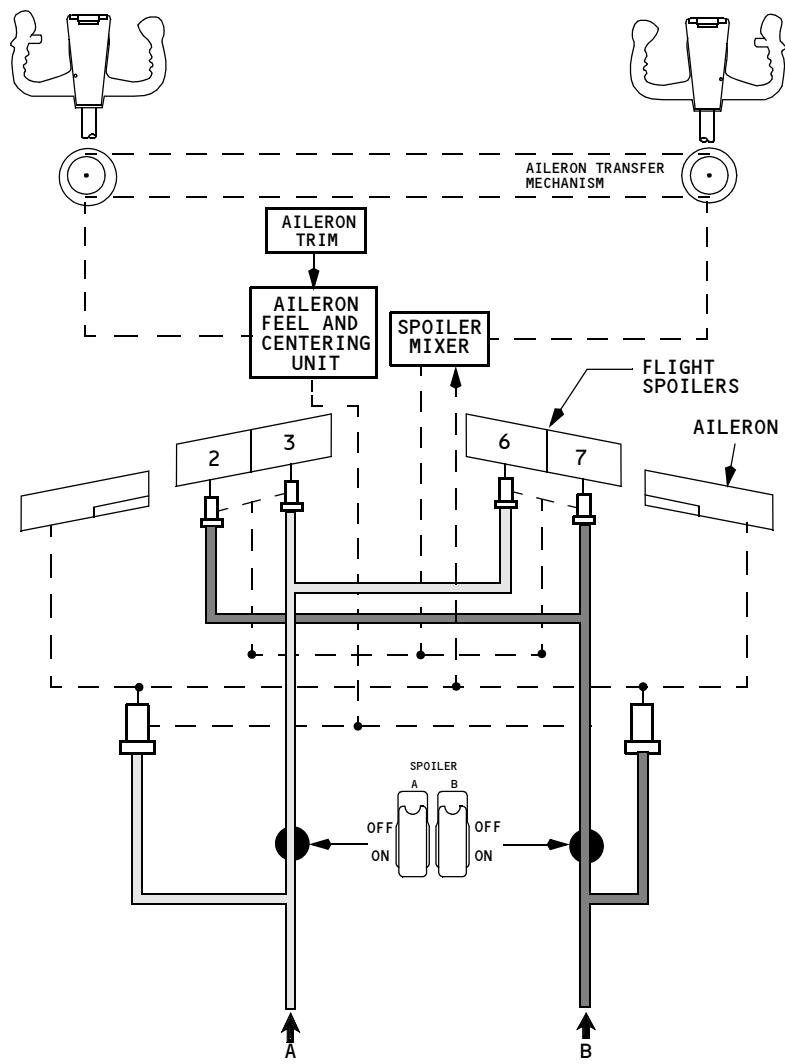
Flight Spoilers

Two flight spoilers are located on the upper surface of each wing. Each hydraulic system, A and B, is dedicated to a different set of spoilers to provide isolation and maintain symmetric operation in the event of hydraulic system failure. Hydraulic pressure shutoff valves are controlled by the two flight SPOILER switches.

Flight spoiler panels are used as speed brakes to increase drag and reduce lift, both in flight and on the ground. The flight spoilers also supplement roll control in response to control wheel commands. A spoiler mixer, connected to the aileron cable-drive, controls the hydraulic power control units on each spoiler panel to provide spoiler movement proportional to aileron movement.

The flight spoilers rise on the wing with up aileron and remain faired on the wing with down aileron. When the control wheel is displaced more than approximately 10°, spoiler deflection is initiated.

Roll Control Schematic



Pitch Control

The pitch control surfaces consist of hydraulically powered elevators and an electrically powered stabilizer. The elevators are controlled by forward or aft movement of the control column. The stabilizer is controlled by either the stabilizer trim switches on the control wheel, the autopilot, or manual trim.

Elevators

The elevators provide pitch control around the airplane's lateral axis. The elevators are positioned by the pilots' control columns. The A and B FLT CONTROL Switches control hydraulic shutoff valves for the elevators.

Cables connect the pilots' control columns to elevator power control units (PCUs) which are powered by hydraulic system A and B. The elevators are interconnected by a torque tube. With loss of hydraulic system A and B the elevators can be mechanically positioned by forward or aft movement of the pilots' control columns. Control forces are higher due to friction and aerodynamic loads.

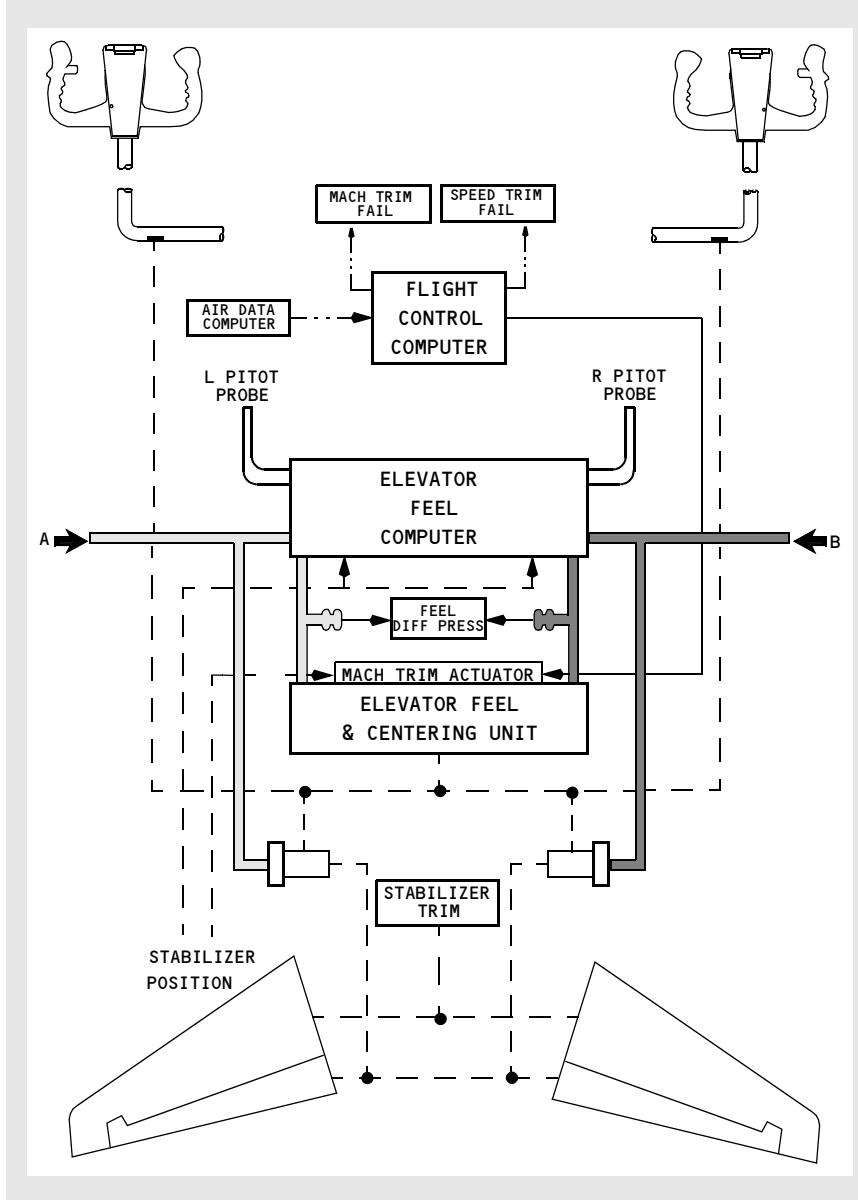
Elevator Feel System

The elevator feel computer provides simulated aerodynamic forces using airspeed (from the elevator pitot system) and stabilizer position. Feel is transmitted to the control columns by the elevator feel and centering unit. To operate the feel system the elevator feel computer uses either hydraulic system A or B pressure, whichever is higher. When either hydraulic system or elevator feel pitot system fail, excessive differential hydraulic pressure is sensed in the elevator feel computer and the FEEL DIFF PRESS light illuminates.

Mach Trim System

A Mach trim system provides speed stability at the higher Mach numbers. Mach trim is automatically accomplished above Mach .615 by adjusting the elevators with respect to the stabilizer as speed increases. The flight control computers use Mach information from the flight data computer to compute a Mach trim actuator position. The Mach trim actuator repositions the elevator feel and centering unit which adjusts the control column neutral position.

Pitch Control Schematic



Stabilizer

The horizontal stabilizer is positioned by the main electric trim motor controlled through either the stabilizer trim switches on the control wheel or by the autopilot trim servo motor. The stabilizer may also be positioned by manually rotating the stabilizer trim wheel.

Stabilizer Trim

Stabilizer trim switches on each control wheel actuate the electric trim motor through the main electric stabilizer trim circuit when the airplane is flown manually. With the autopilot engaged, stabilizer trim is accomplished through the autopilot stabilizer trim circuit. The main electric and autopilot stabilizer trim have two speed modes: high speed with flaps extended, and low speed with flaps retracted. If the autopilot is engaged, actuating either pair of stabilizer trim switches automatically disengages the autopilot. The stabilizer trim wheels rotate whenever electric stabilizer trim is actuated.

The STAB TRIM MAIN ELEC cutout switch and the STAB TRIM AUTOPILOT cutout switch, located on the control stand, are provided to allow the autopilot or main electric trim inputs to be disconnected from the stabilizer trim motor.

Control column actuated stabilizer trim cutout switches stop operation of the main electric and autopilot trim when the control column movement opposes trim direction. When the STAB TRIM override switch is positioned to OVERRIDE, electric trim can be used regardless of control column position.

Manual stabilizer control is accomplished through cables which allow the pilot to position the stabilizer by rotating the stabilizer trim wheels. The stabilizer is held in position by two independent brake systems. Manual rotation of the trim wheels can be used to override autopilot or main electric trim. The effort required to manually rotate the stabilizer trim wheels may be higher under certain flight conditions. Grasping the stabilizer trim wheel will stop stabilizer motion.

Stabilizer Trim Operation with forward or AFT CG

In the event the stabilizer is trimmed to the end of the electrical trim limits, additional trim is available through the use of the manual trim wheels. If manual trim is used to position the stabilizer beyond the electrical trim limits, the stabilizer trim switches may be used to return the stabilizer to electrical trim limits.

Stabilizer Position Indication and Green Band

Stabilizer position is displayed in units on two STAB TRIM indicators located inboard of each stabilizer trim wheel. The STAB TRIM indicators also display the TAKEOFF green band indication.

The trim authority for each mode of trim is limited to:

- Main Electric Trim
 - Flaps retracted 2.5 to 12.5 units (-300)
 - Flaps retracted 2.8 to 12.5 units (-400/500)
 - Flaps extended 0.25 to 12.5 units
- Autopilot Trim 0.25 to 14.0 units
- Manual Trim 0 to 17.0 units

The green band range of the STAB TRIM indicator shows the takeoff trim range. An intermittent horn sounds if takeoff is attempted with the stabilizer trim outside the takeoff trim range.

Speed Trim System

The speed trim system is designed to improve flight characteristics during operations with a low gross weight, aft center of gravity, high thrust. It monitors inputs of stabilizer position, thrust lever position, airspeed, and vertical speed and then trims the stabilizer using the autopilot stabilizer trim. It operates most frequently during takeoffs and go-arounds. Conditions for speed trim operation are listed below:

- Flaps not up (737–300)
- Flaps up or down (737–400/500)
- Airspeed 100 – 300 KIAS
- 10 seconds after takeoff
- 5 seconds following release of trim switches
- N1 above 60%
- Autopilot not engaged
- Sensing of trim requirement

Yaw Control (before Rudder System Enhancement Program (RSEP) modification)

Yaw control is accomplished by a hydraulically powered rudder and a yaw damper system. The rudder is controlled by displacing the rudder pedals. The yaw damping functions are controlled by the yaw damper rate gyro.

Rudder

The rudders provide yaw control around the airplane's vertical axis. The A and B FLT CONTROL switches control hydraulic shutoff valves for the rudder and the standby rudder.

Each set of rudder pedals is connected by cables to the main and standby rudder PCUs through the rudder feel and centering unit. The main rudder PCU is powered by hydraulic system A and B while the standby rudder PCU is powered by the standby hydraulic system. The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. It can be activated manually through the FLT CONTROL switches or automatically. (Refer to Chapter 13, Hydraulics, Standby Hydraulic System)

A rudder pressure reducer is connected to the A system hydraulic line upstream of the main rudder PCU. Hydraulic pressure to the rudder is reduced when the airplane climbs above 1000 feet AGL. Hydraulic pressure returns to normal when the airplane descends through 700 feet AGL, or if B hydraulic system depressurizes, or whenever the N1 difference between the left and right engines exceeds 45%.

Rudder Trim

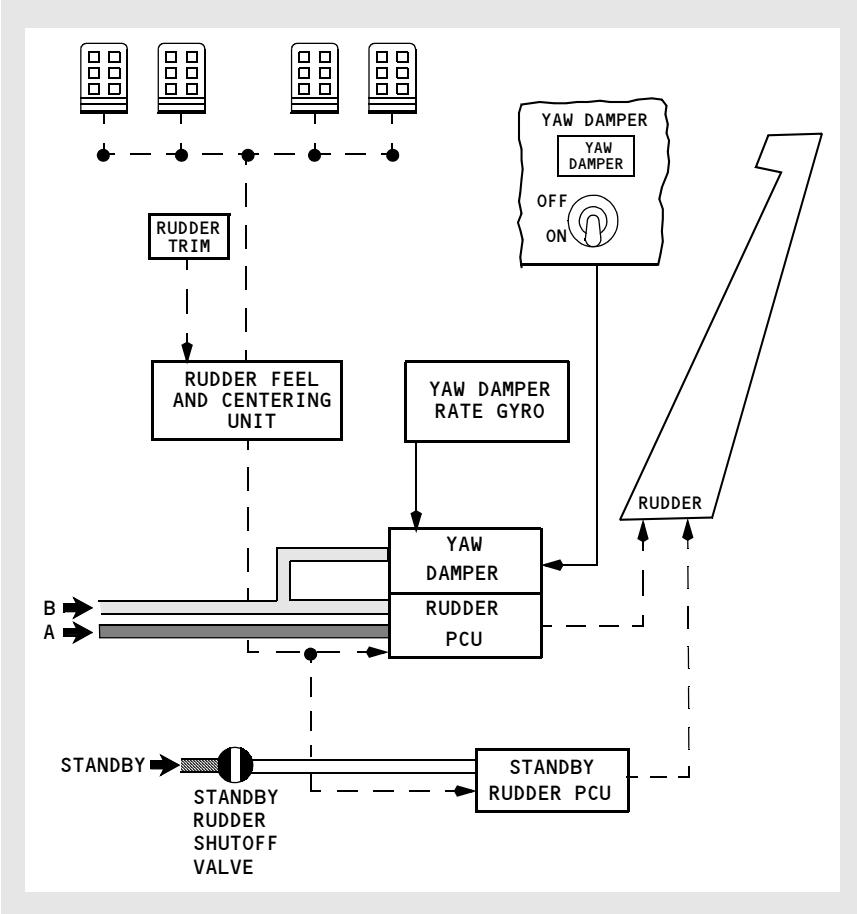
The RUDDER trim control, located on the aft electronic panel, electrically repositions the rudder feel and centering unit which adjusts the rudder neutral position. The rudder pedals are displaced proportionately. The rudder trim indicator displays the rudder trim position in units.

Yaw Damper

The yaw damper system prevents unwanted (Dutch) roll and provides turn coordination. The yaw damper coupler receives inputs from the yaw rate gyro and the air data computer. It then provides inputs to the rudder through the main rudder PCU. At higher airspeeds the amount of yaw damper rudder deflection decreases. No rudder pedal movement results from yaw damper operation.

The yaw damper uses hydraulic system B pressure only. If hydraulic system B pressure is lost the yaw damper system is inoperative but the YAW DAMPER switch remains in the ON position until the B FLT CONTROL switch is positioned to OFF or STBY RUD. Then the YAW DAMPER switch disengages and the amber YAW DAMPER light illuminates and the YAW DAMPER cannot be reengaged.

Yaw Control Schematic (before RSEP modification)



Yaw Control (after Rudder System Enhancement Program (RSEP) modification)

Yaw control is accomplished by a hydraulically powered rudder and a yaw damper system. The rudder is controlled by displacing the rudder pedals. The yaw damping functions are controlled by the yaw damper coupler (YDC).

Rudder

The rudder provides yaw control about the airplane's vertical axis. The A and B FLT CONTROL switches control hydraulic shutoff valves for the rudder and the standby rudder.

Each set of rudder pedals is mechanically connected by cables to the input levers of the main and standby rudder PCUs. The main PCU consists of two independent input rods, two individual control valves, and two separate actuators; one for Hydraulic system A and one for Hydraulic system B. The standby rudder PCU is controlled by a separate input rod and control valve and is powered by the standby hydraulic system. All three input rods have individual jam override mechanisms that allow input commands to continue to be transferred to the remaining free input rods if an input rod or downstream hardware is hindered or jammed.

A rudder pressure reducer (RPR) is connected to the Hydraulic system A line upstream of the main rudder PCU. A rudder pressure limiter (RPL) is incorporated in the Hydraulic system B part of the main rudder PCU. Both the RPR and RPL limit hydraulic pressure to the rudder when full rudder authority is not required. Hydraulic pressure to the rudder is limited when the airplane climbs above 1000 feet AGL. Hydraulic pressure is returned to normal when the airplane descends through 700 feet AGL, or if B hydraulic system depressurizes, or whenever the N1 difference between the left and right engines exceeds 45%. This function limits full rudder authority in flight after takeoff and before landing. The Yaw Damper Coupler (YDC) controls both the RPR and the RPL respectively, for Hydraulic system A and Hydraulic system B of the main rudder PCU.

The main rudder PCU contains a Force Fight Monitor (FFM) that detects opposing pressure (force fight) between A and B actuators. This may occur if either system A or B input is jammed or disconnected. The FFM output is used to automatically turn on the Standby Hydraulic pump, open the standby rudder shutoff valve pressurizing the standby rudder PCU, and illuminate the STBY RUD ON, Master Caution, and Flight Control (FLT CONT) lights.

The standby rudder PCU is powered by the standby hydraulic system. The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. With the standby PCU powered the pilot retains adequate rudder control capability. It can be operated manually through the FLT CONTROL switches or automatically. (Refer to Chapter 13, Hydraulics, Standby Hydraulic System)

An amber STBY RUD ON light illuminates when the standby rudder hydraulic system is commanded on. The standby rudder system can be pressurized with either Flight Control switch, automatically during takeoff or landing (Refer to Chapter 13, Hydraulics, Standby Hydraulic System) or automatically by the Force Fight Monitor. The STBY RUD ON light illumination actives Master Caution and Flight Control warning lights on the Systems Annunciation Panel.

Rudder Trim

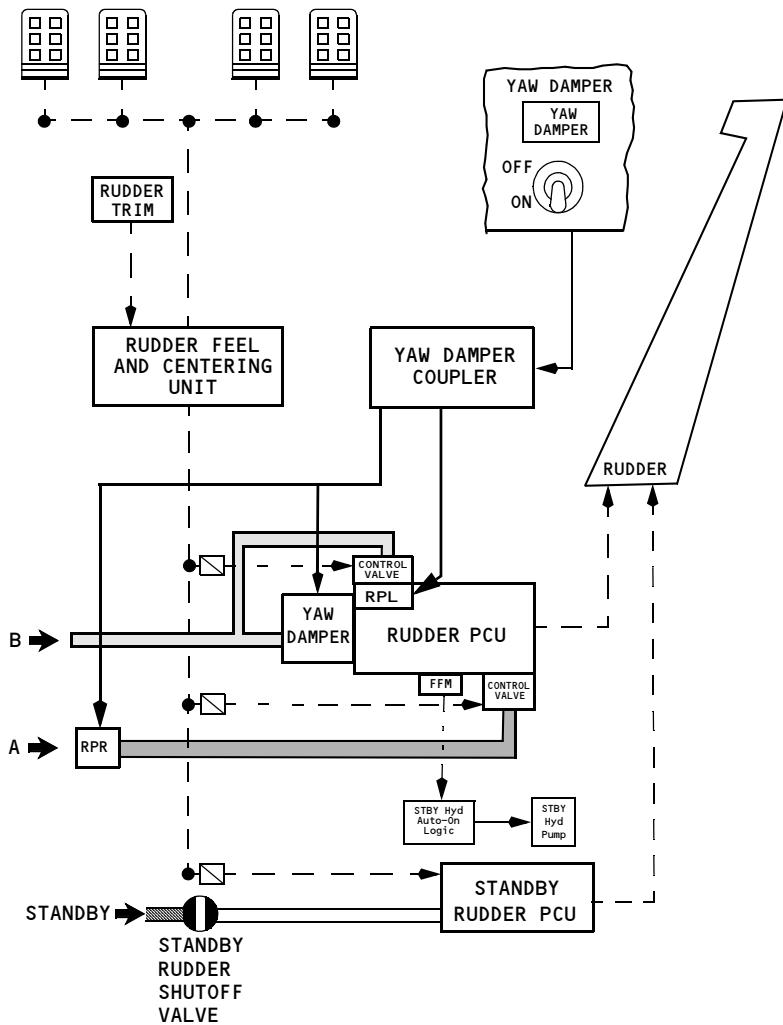
The RUDDER trim control, located on the aft electronic panel, electrically repositions the rudder feel and centering unit which adjusts the rudder neutral position. The rudder pedals are displaced proportionately. The rudder trim indicator displays the rudder trim position in units.

Yaw Damper

The yaw damper system prevents unwanted (Dutch) roll and provides turn coordination. The yaw damper coupler receives inputs from the yaw rate gyro and the air data computer. It then provides inputs to the rudder through the main rudder PCU. At higher airspeeds the amount of yaw damper rudder deflection decreases. No rudder pedal movement results from yaw damper operation.

The yaw damper uses hydraulic system B pressure only. If hydraulic system B pressure is lost the yaw damper system is inoperative but the YAW DAMPER switch remains in the ON position until the B FLT CONTROL switch is positioned to OFF or STBY RUD. Then the YAW DAMPER switch disengages and the amber YAW DAMPER light illuminates and the YAW DAMPER cannot be reengaged.

Yaw Control Schematic (after RSEP modification)



Speed Brakes

The speed brakes consist of flight spoilers and ground spoilers. Hydraulic system A powers all six ground spoilers, three on the upper surface of each wing. The SPEED BRAKE lever controls the spoilers. When the SPEED BRAKE lever is actuated all the spoilers extend when the airplane is on the ground, and only the flight spoilers extend when the airplane is in the air.

In Flight Operation

Operating the SPEED BRAKE lever in flight causes all flight spoiler panels to rise symmetrically to act as speed brakes. Caution should be exercised when deploying flight spoilers during a turn, as they greatly increase roll rate. When the speed brakes are in an intermediate position roll rates increase significantly. Moving the SPEED BRAKE lever past the FLIGHT detent causes buffeting and is not recommended in flight.

Ground Operation

During landing, the auto speed brake system operates when these conditions occur:

- SPEED BRAKE lever is in the ARMED position
- SPEED BRAKE ARMED light is illuminated
- both thrust levers are retarded to IDLE
- main landing gear wheels spin-up (more than 60 kts) – SPEED BRAKE lever automatically moves to the UP position, and the flight spoilers deploy
- right main landing gear strut compresses on touchdown, causing the mechanical linkage to open the ground spoiler bypass valve, and the ground spoilers deploy

If a wheel spin-up signal is not detected, when the air/ground system senses ground mode, the SPEED BRAKE lever moves to the UP position, and all spoiler panels deploy automatically.

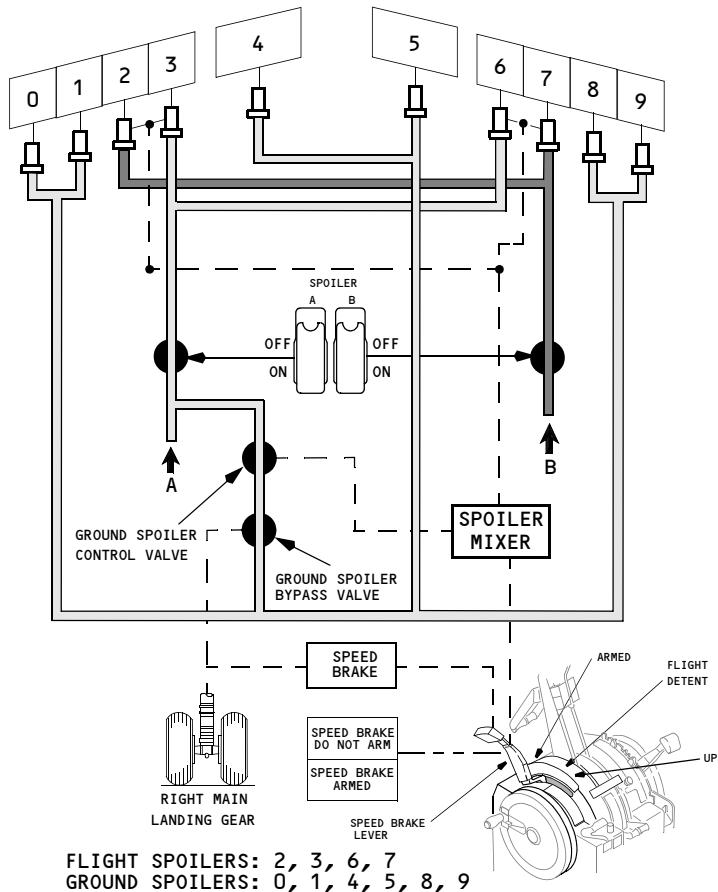
During a rejected takeoff (RTO), the auto speed brake system operates when these conditions occur:

- main landing gear wheels spin-up (more than 60 kts)
- takeoff is rejected, both thrust levers are retarded to IDLE and the reverse thrust levers are positioned for reverse thrust – SPEED BRAKE lever automatically moves to the UP position and all spoilers deploy.

After a RTO or landing, if either thrust lever is advanced, the SPEED BRAKE lever automatically moves to the DOWN detent and all spoiler panels retract. The spoiler panels may also be retracted by manually moving the SPEED BRAKE lever to the DOWN detent.

The SPEED BRAKE caution light flashes continuously if the Speed Brake Lever is aft of the ARMED position, the air/ground sensor is in the air position, and the flaps are extended beyond position 10.

Speed Brakes Schematic



Flaps and Slats

The flaps and slats are high lift devices that increase wing lift and decrease stall speed during takeoff, low speed maneuvering and landing.

LE devices consist of four flaps and six slats: two flaps inboard and three slats outboard of each engine. Slats extend to form a sealed or slotted leading edge depending on the TE flap setting. The TE devices consist of triple slotted flaps inboard and outboard of each engine.

TE flap positions 1–15 provide increased lift; positions 15–40 provide increased lift and drag. Flap positions 15, 30 and 40 are normal landing flap positions. Flaps 15 is normally limited to airports where approach climb performance is a factor. Runway length and condition must be taken into account when selecting a landing flap position.

To prevent excessive structural loads from increased Mach at higher altitude, flap extension above 20,000 feet should not be attempted.

Flap and Slat Sequencing

LE devices and TE flaps are normally extended and retracted by hydraulic power from system B. When the FLAP lever is in the UP detent, all flaps and LE devices are commanded to the retracted or up position. Moving the FLAP lever aft allows selection of flap detent positions 1, 2, 5, 10, 15, 25, 30 or 40. The LE devices deployment is sequenced as a function of TE flaps deployment.

When the FLAP lever is moved from the UP position to the 1, 2, or 5 position, the TE flaps extend to the commanded position and the LE:

- flaps extend to the extended position, and
- slats extend to the extended (intermediate) position.

When the FLAP lever is moved beyond the 5 position the TE flaps extend to the commanded position and the LE:

- flaps remain at the extended position, and
- slats extend to the full extended position.

The LE devices sequence is reversed upon retraction.

Mechanical gates hinder inadvertent FLAP lever movement beyond flaps 1 for one engine inoperative go-around, and flaps 15 for normal go-around.

Indicator lights on the center instrument panel provide overall LE devices position status. The LE DEVICES annunciator on the aft overhead panel indicates the positions of the individual flaps and slats.

Flap Load Relief

A flap load limiter provides a TE flap load relief function which protects the flaps from excessive air loads. This function is operative at the flaps 40 position only. The FLAP lever does not move, but the flap position indicator displays flap retraction and re-extension and the FLAP LOAD RELIEF light illuminates.

When the flaps are set at 40 the TE flaps:

- retract to 30 if airspeed exceeds 158 knots (-300/500)
- re-extend when airspeed is reduced to 153 knots.
- retract to 30 if airspeed exceeds 162 knots (-400)
- re-extend when airspeed is reduced to 157 knots.

Autoslats

At flap positions 1, 2 and 5 an autoslat function is available that moves the LE slats to FULL EXTEND if the airplane approaches a stall condition.

The autoslat system is designed to enhance airplane stall characteristics at high angles of attack during takeoff or approach to landing. When TE flaps 1 through 5 are selected, the LE slats are in the extend position. As the airplane approaches the stall angle, the slats automatically drive to the full extended position, prior to stick shaker activation. The slats return to the extend position when the pitch angle is sufficiently reduced below the stall critical attitude.

Autoslat operation is normally powered by hydraulic system B. An alternate source of power is provided by system A through a power transfer unit (PTU) if a loss of pressure is sensed from the higher volume system B engine driven pump. The PTU uses system A pressure to power a hydraulic motorized pump, pressurizing system B fluid to provide power for the autoslat operation. (Refer to Chapter 13, Hydraulics, Power Transfer Unit)

Alternate Extension

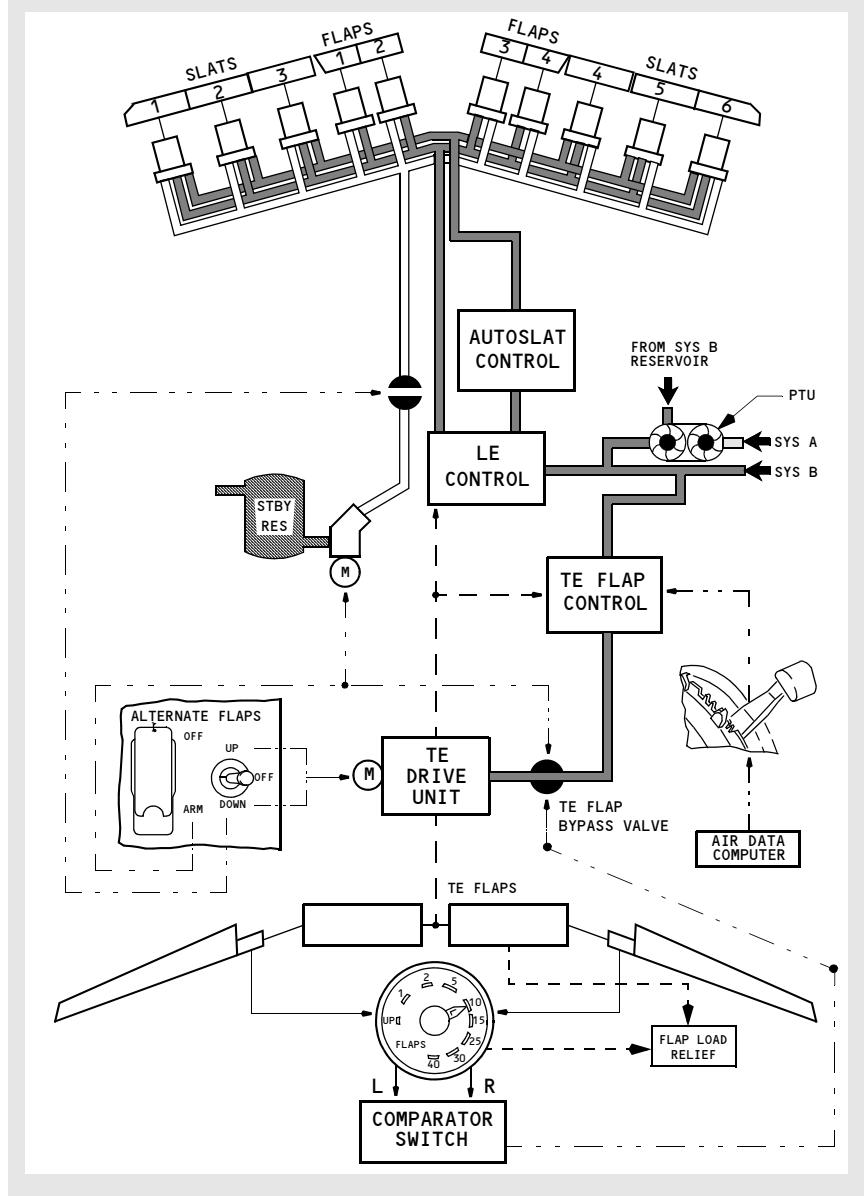
In the event that hydraulic system B fails, an alternate method of extending the LE devices, and extending and retracting the TE flaps is provided.

The TE flaps can be operated electrically through the use of two alternate flap switches. The guarded ALTERNATE FLAPS master switch closes a flap bypass valve to prevent hydraulic lock of the flap drive unit and arms the ALTERNATE FLAPS position switch. The ALTERNATE FLAPS position switch controls an electric motor that extends or retracts the TE flaps. The switch must be held in the DOWN position until the flaps reach the desired position. No asymmetry protection is provided through the alternate (electrical) flap drive system.

Note: The LE devices cannot be retracted by the standby hydraulic system.

When using alternate flap extension the LE flaps and slats are driven to the full extended position using power from the standby hydraulic system. In this case the ALTERNATE FLAPS master switch energizes the standby pump, and the ALTERNATE FLAPS position switch, held in the down position momentarily, fully extends the LE devices.

Leading Edge Devices and Trailing Edge Flaps Schematic



High Lift Device Protection and Indication

Trailing Edge Flap Asymmetry

When a trailing edge asymmetry develops, a comparator switch closes the TE flap bypass valve, removing hydraulic power from the flap drive unit. The flap position will be displayed as a needle split on the flap position indicator.

Leading Edge Device Improper Position

When a leading edge device is in an improper position the LE FLAPS TRANSIT light remains illuminated and one of the following indications is displayed on the LE Devices Annunciator Panel:

- amber TRANSIT light illuminated
- incorrect green EXT or FULL EXT light illuminated
- no light illuminated.

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Flight Instruments, Displays

Chapter 10

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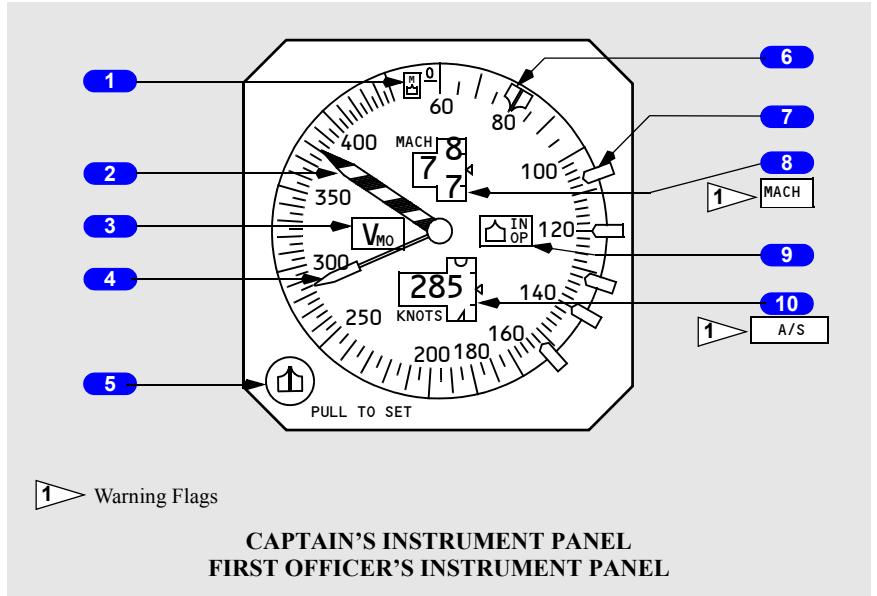
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Conventional Flight Instruments

Mach/Airspeed Indicator



1 Airspeed Cursor Mode Annunciator

- auto mode: out of view.
- manual mode: in view.

2 Vmo Pointer

Indicates the maximum operating (indicated) airspeed in knots.

3 Vmo Flag

In view – indicates the Vmo pointer is inoperative.

4 Airspeed Pointer

Indicates airspeed in knots.

5 Airspeed Cursor Control

- push in –
 - auto mode
 - airspeed cursor is position from the AFDS FCC
- pull out –
 - manual mode
 - airspeed cursor is positioned by rotating the control.

6 Airspeed Cursor

- indicates target airspeed
- positioned manually or automatically, as selected by the airspeed cursor control.

7 Airspeed Markers

Positioned manually to the desired airspeed reference.

8 Mach Digital Counter

- shows Mach number, from .40 to .99 Mach, in digital form
- masked below .40 Mach
- digits are covered by a warning flag when the display is unreliable.

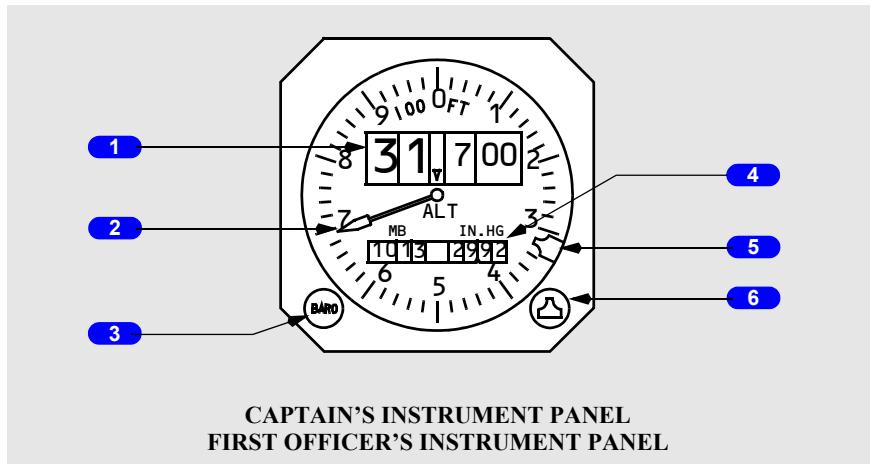
9 Airspeed Cursor Flag

- manual mode: retracted
- auto mode: in view if airspeed cursor signals, as determined by the AFDS FCC, are unreliable.

10 Airspeed Digital Counter

- digital display of indicated airspeed in knots
- warning flag covers the counter when the airspeed pointer and airspeed digital counter are unreliable.

Altimeter



1 Digital Counter

Indicates current altitude in increments of thousands, hundreds and twenty feet.

- warning flag appears whenever the ADC signal is lost or a malfunction exists
- green flag appears in the left window when the altitude is below 10,000 feet
- a NEG flag appears in the two left-hand windows when altitude below zero feet is displayed.

2 Altitude Pointer

Makes one revolution each one thousand feet.

3 Barometric Setting Control

Rotate – adjusts barometric settings.

4 Barometric Setting Window

Displays barometric correction (in millibars and inches of mercury) as set by the barometric setting control.

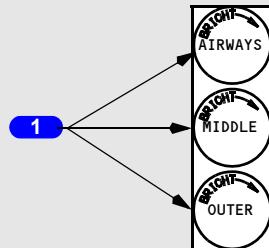
5 Reference Altitude Marker

Manually positioned to the desired reference altitude using the reference altitude marker control.

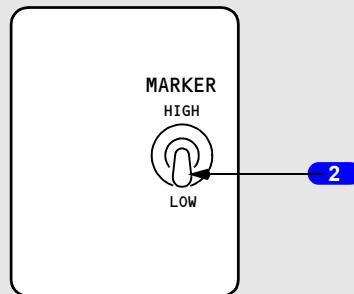
6 Reference Altitude Marker Control

Used to manually set the reference altitude marker.

Marker Beacon



CAPTAIN'S INSTRUMENT PANEL
FIRST OFFICER'S INSTRUMENT PANEL



CAPTAIN'S INSTRUMENT PANEL

1 Marker Beacon Lights

AIRWAYS (white) – illuminates over an inner or airways marker beacon.

MIDDLE (amber) – illuminates over a middle marker beacon.

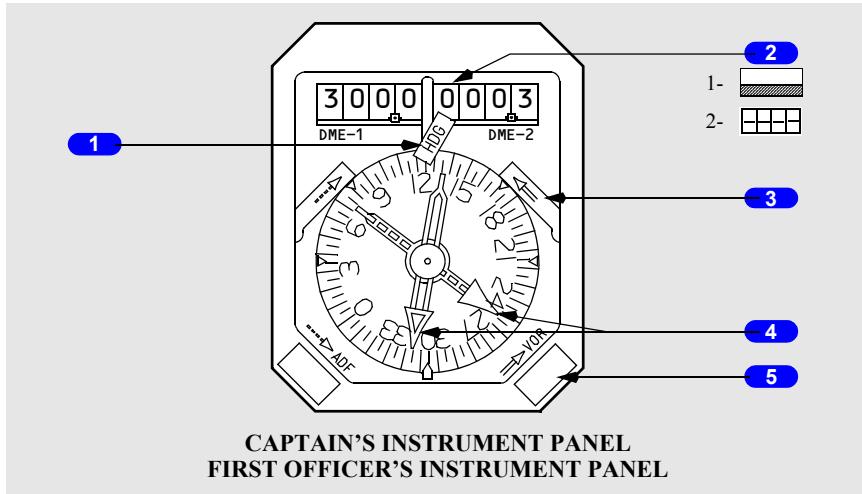
OUTER (blue) – illuminates over an outer marker beacon.

2 Marker Beacon Switch

HIGH – selects high sensitivity of receiver.

LOW – selects low sensitivity of receiver.

Radio Distance Magnetic Indicator



1 Heading Warning Flag

In view –

- selected compass signal is invalid
- RDMI power failure.

2 DME Indicator

Indicates DME distance from selected DME station in nautical miles (300 nautical miles maximum).

Warning Flags

- 1 –
 - electrical power lost
 - invalid DME receiver.
- 2 –
 - DME receiver powered but not receiving a DME station
 - agility tuning in progress.

3 Bearing Pointer Warning Flag

In view –

VOR mode:

- RDMI power failure
- VHF NAV signal unreliable

ADF mode – RDMI power failure

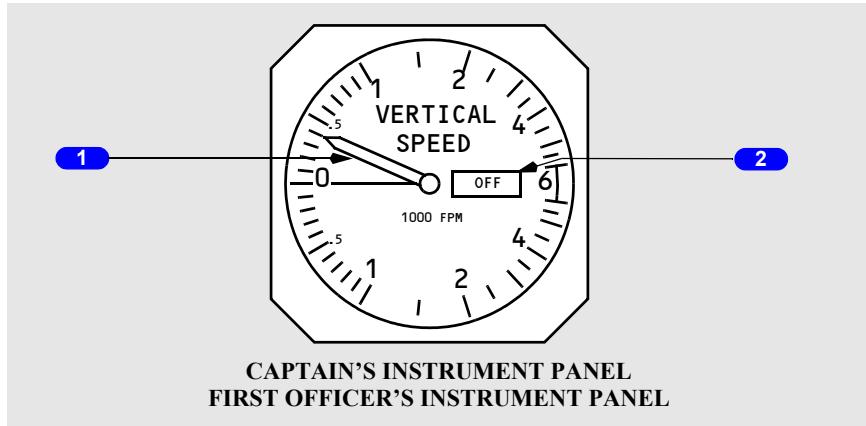
4 Bearing Pointers

- Narrow pointer uses signals from the VHF NAV receiver No. 1 or ADF receiver No. 1.
- wide pointer uses signals from the VHF NAV receiver No. 2 or ADF receiver No. 2.

5 VOR/ADF Bearing Pointer Switch

Push – selects related VOR or ADF for the bearing pointer.

Vertical Speed Indicator



1 Vertical Speed Pointer

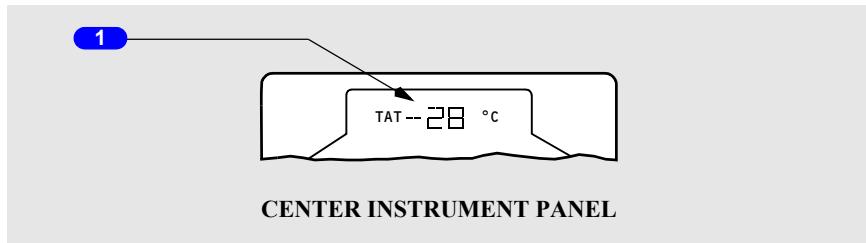
- depicts rate of climb or descent from 0 to 6,000 feet per minute
- indicates zero when IRS vertical speed is unreliable.

2 OFF Flag

In view –

- respective VSI and/or ADC has failed
- selected IRS vertical speed data are unreliable.

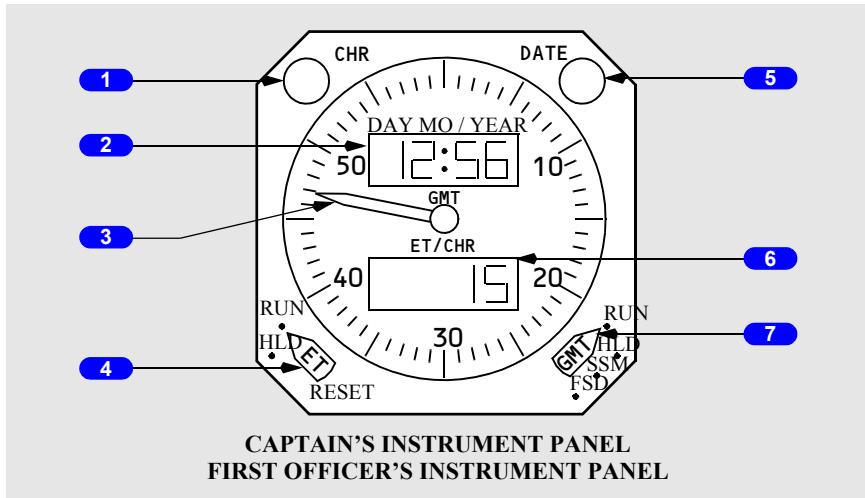
Air Temperature



1 Digital Display

Displays TAT (deg C) indications in digital form.

Clock



1 Chronograph (CHR) Control

Push – Controls the start, stop and reset functions of the CHR display and second hand with successive pushing. This will override any existing ET display.

2 Time/Date Window

- displays time (hours, minutes) when time is selected with the time/date selector
- alternately displays day–month and year when date is selected with the time/date selector.

3 Chronograph Second Hand

- indicates chronograph seconds
- controlled by the CHR control.

4 Elapsed Time (ET) Selector (three position, rotary)

Controls the elapsed time function.

RESET – returns ET display to zero (spring loaded to HLD).

HLD (hold) – stops the elapsed time display.

RUN – starts the elapsed time display.

5 Date Control

Push – displays date (day, month) alternating with year

Push – returns display to time.

6 Elapsed Time (ET)/Chronograph Window

- displays elapsed time (hours, minutes) or chronograph minutes
- the chronograph display replaces the elapsed time display
- elapsed time continues to run in the background and displays after the chronograph is reset.

7 Time Control (four position, rotary)

Sets the time and date when the time/date selector is set to manual

FS D (fast slew, day) –

- advances hours when time is selected with the time/date selector
- advances days when date is selected with the time/date selector

SS M (slow slew, month) –

- advances minutes when time is selected with the time/date selector
- advances months when date is selected with the time/date selector

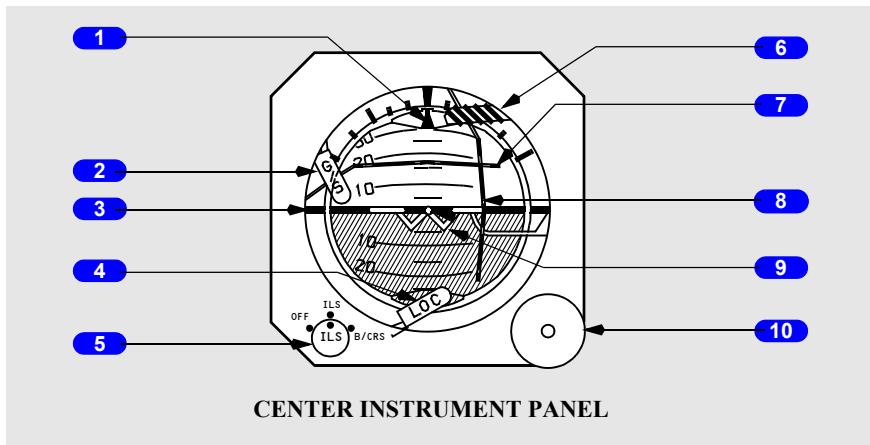
HLD Y (hold, year) –

- stops the time indicator and sets the seconds to zero when time is selected with the time/date selector
- advances years when date is selected with the time/date selector

RUN – starts the time indicator.

Standby Flight Instruments

Standby Horizon



1 Bank Indicator and Scale

Scale marks are at 0, 10, 20, 30, 45 and 60 degrees.

2 Glideslope Flag

In view – glideslope receiver has failed.

3 Horizon Line and Pitch Angle Scale

Pitch scale is in 5 degree increments.

4 LOC Flag

In view – Localizer receiver has failed.

5 Approach Mode Selector

OFF – glideslope and localizer pointers retracted from view.

ILS – glideslope and localizer pointers in view; ILS signals provided by the No. 1 ILS receiver.

B/CRS – reverses sensing for localizer pointer during back course approaches; glideslope pointer not displayed.

6 GYRO Flag

In view – attitude is unreliable and power has been lost.

7 Glideslope Pointer and Deviation Scale

- pointer indicates glideslope position
- pointer is not displayed when
 - approach selector is off
 - no computed data exists
 - glideslope receiver has failed
- scale indicates deviation.

8 Localizer Pointer and Deviation Scale

- pointer indicates localizer position
- pointer is not displayed when
 - approach selector is off
 - no computed data exists
 - localizer receiver has failed
- scale indicates deviation.

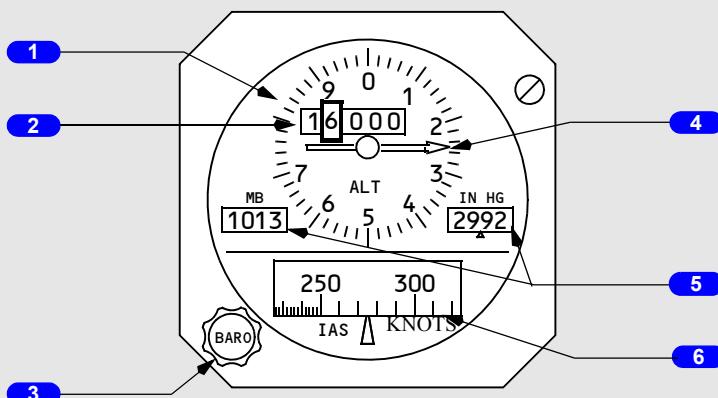
9 Airplane Symbol

10 Caging Control

Pull – provides fast erection (caging) of the gyro.

Release – control retracts.

Standby Altimeter/Airspeed Indicator



CENTER INSTRUMENT PANEL

1 Standby Altimeter

Indicates current altitude in feet.

2 Digital Counter

Indicates thousands of feet

- a green flag appears in the left window when altitude is less than 10,000 feet
- a striped flag appears in the left window when altitude is less than zero feet.

3 Barometric Setting Control

Rotate – adjusts the barometric correction in both barometric windows.

4 Altitude Pointer

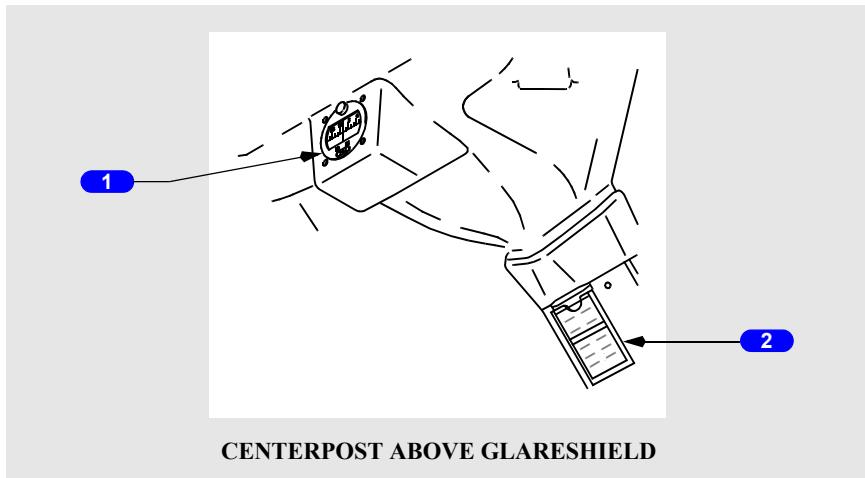
Indicates hundreds of feet.

5 Barometric Setting Windows

Displays barometric correction in millibars and inches of mercury as set by the barometric setting control.

6 Standby Airspeed Indicator

Indicates current airspeed in knots.

Standby Magnetic Compass

CENTERPOST ABOVE GLARESHIELD

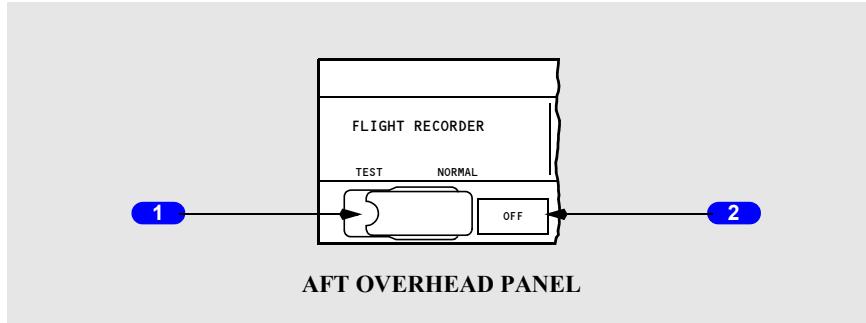
1 Standby Magnetic Compass

Displays magnetic heading.

2 Standby Magnetic Compass Correction Card

Provides appropriate heading corrections.

Flight Recorder



1 Flight Recorder Test Switch

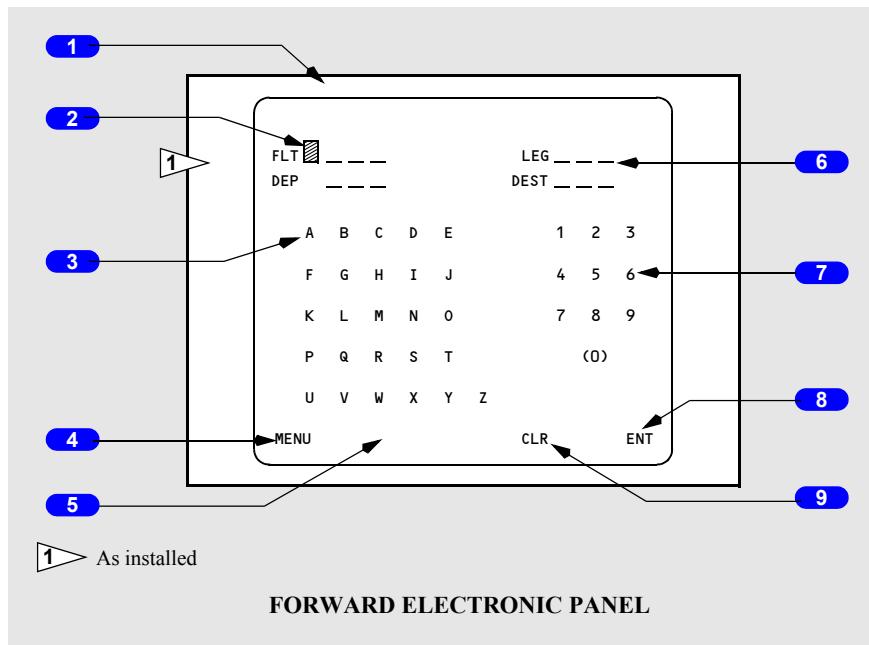
NORMAL (guarded position) –

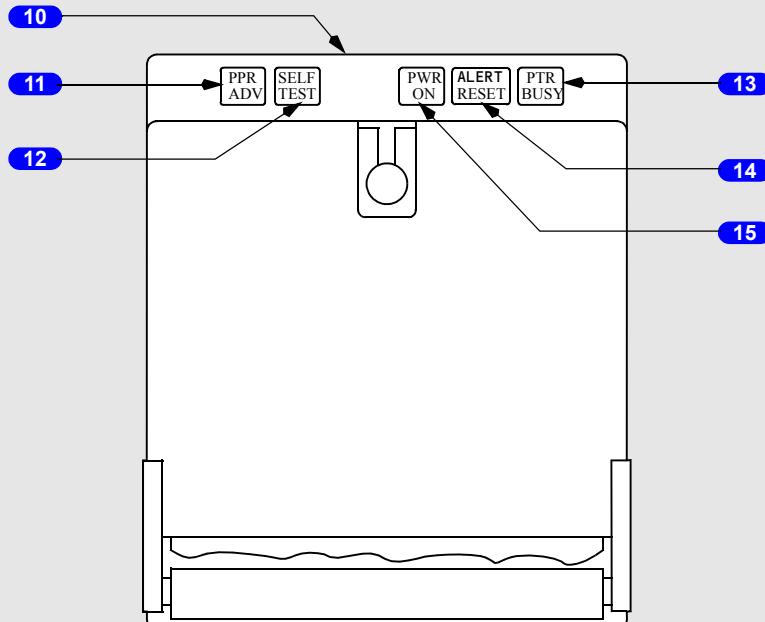
- in flight – the recorder operates anytime electrical power is available
- on the ground – either engine must also be operating.

TEST – bypasses the engine oil pressure switches and the air ground switch to power the flight recorder on the ground.

2 OFF Light

Illuminated (amber) – indicates the recorder is not operating or the test is invalid. May indicate power failure, loss of input data, or electronic malfunction.

Aircraft Condition Monitoring System (ACMS)**Interactive Display Unit and Printer**



AFT ELECTRONIC PANEL

1 Interactive Display Unit (IDU)

Push – marks specific occurrence for future reference.

2 Cursor (typical)

Moves right as each character is entered.

3 Alpha Pad

Touch – individual characters are entered in data display.

4 MENU Cue

Touch – displays previous menu.

5 Advisory Space

Advisory may be displayed as flashing, reverse, or normal video.

6 Data Display

Data appears here as entered.

7 Numerical Pad

Touch – individual characters are entered in data display.

8 Enter (ENT) Cue

Touch – enters data and turns page if entering final data.

9 Clear (CLR) Cue

Touch – blanks character under cursor and to its right.

10 ACMS Printer**11 Paper Advance (PPR ADV) Switch**

Push – advances printer paper as long as switch is held down.

12 SELF TEST Switch

Push – produces a test pattern as long as switch is depressed.

13 Printer Busy (PTR BUSY) Light

Illuminated (amber) – printer is processing message text.

14 ALERT RESET Switch

Push – resets aural/visual printer alert.

15 Power On (PWR ON) Light

Illuminated (green) – power is applied to printer.

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Flight Instruments, Displays System Description

Chapter 10 Section 20

Introduction

The flight instruments provide information to aid the pilots in controlling the airplane throughout its flight regime. The electric flight instruments receive input from one of the two air data computers. The pneumatic flight instruments receive input directly from the pitot–static system.

Air Data System

The air data system consists of the pitot–static system and the air data computers. The system provides pitot and/or static pressure information to various flight instruments and airplane systems. The pressure information is provided in one of two ways; either directly from the pitot–static system, or indirectly from an air data computer.

Pitot Static System

The pitot–static (P/S) system provides pitot and static pressure inputs to pressure-sensing instruments and systems which have functions that vary with altitude and/or airspeed.

There are four primary P/S systems; the Captain's, the First Officer's, No. 1 auxiliary, and No. 2 auxiliary. The pilots' systems are used by the flight instruments and air data computers. The auxiliary systems are used by various airplane systems.

The alternate static system provides static pressure inputs to the standby airspeed indicator/standby altimeter.

Pressure inputs to the primary P/S systems are provided by four combination pitot and static probes located the forward fuselage. Each probe provides one pitot and two static inputs. The alternate static ports are located on each side of the fuselage. All static systems are cross-connected for dynamic balance.

A separate pitot system with probes mounted on the vertical stabilizer is provided for the elevator feel system.

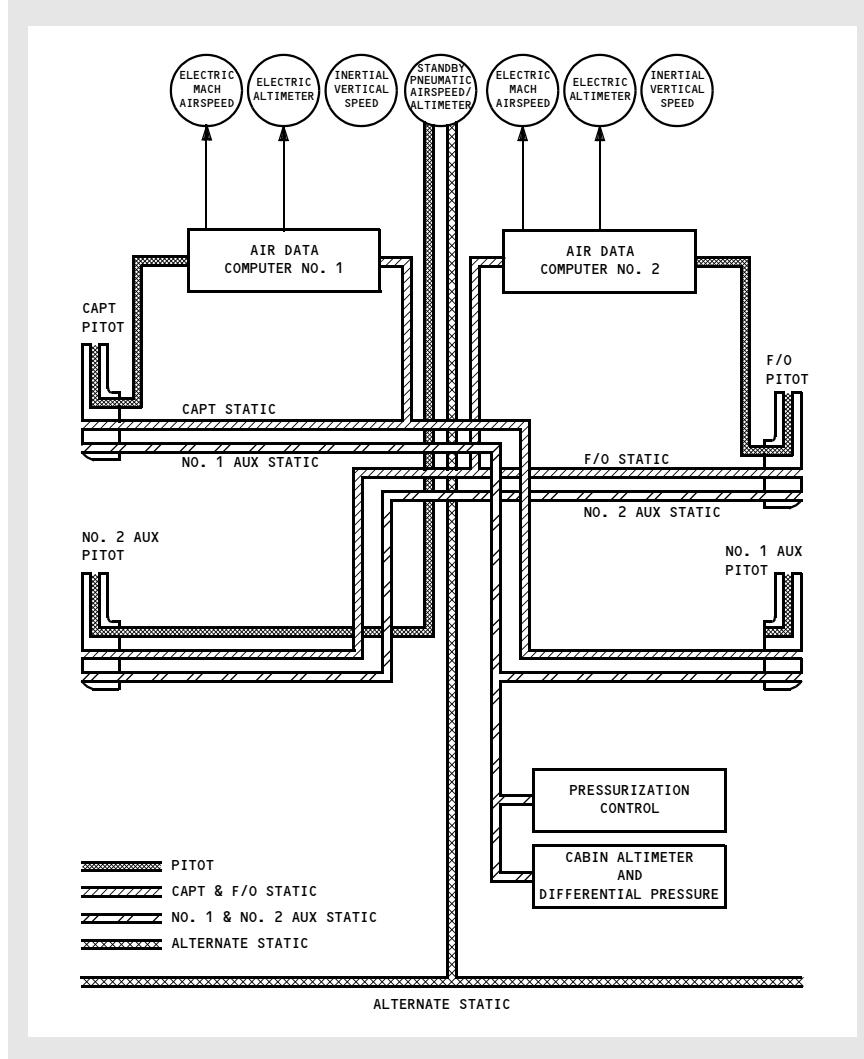
A blocked or frozen pitot and/or static system may affect the following primary airplane system

- FMC
- autothrottle
- Mach/airspeed indicator
- Vmo/Mmo warning
- altimeter

- vertical speed indicator
- IRS
- true airspeed
- static air temperature
- flap load relief system
- elevator feel system
- flight control computers
- ground proximity warning system
- altitude alert
- cabin pressure
- flight recorder
- transponder altitude reporting
- stall warning computers
- TAT
- yaw damper
- Mach trim
- symbol generator

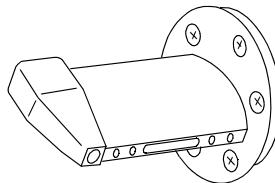
Air Data Computers

Two air data computers (ADCs) are installed. Each ADC receives pitot and static pressure inputs from the respective pilot's P/S system. The ADCs convert these pressure inputs to electrical signals which are used to operate various flight instruments and airplane systems. The ADC computers are powered whenever the AC busses are powered.

Pitot-Static System Schematic

Total Air Temperature

One aspirated TAT probe is installed. It provides independent temperature data to each ADC. Total air temperature data derived from ADC No.1 is used by the left IRS, the FMC, autothrottle, FCC "A" and the air temperature indicator. Total air temperature derived data from ADC No. 2 is used by the right IRS, the FMC, autothrottle and FCC "B."



ASPIRATED TAT PROBE

LEFT FORWARD FUSELAGE

737 Flight Crew Operations Manual

The inflight TAT indication is comprised of outside air temperature (OAT) plus all of the ram rise. On the ground, with an air conditioning pack switched to AUTO or HIGH, the TAT indication is approximately OAT. In flight, the following table is used to convert indicated TAT to true OAT.

	INDICATED MACH NUMBER									
	.30	.40	.50	.60	.70	.73	.76	.78	.80	.82
IND TAT - °C	TRUE OUTSIDE AIR TEMPERATURE - DEGREES C									
70			47	39	37	35	33	31	29	27
65		49	42	35	33	30	28	26	25	23
60	49	44	37	30	28	25	24	22	21	19
55	49	45	40	33	26	24	21	19	18	16
50	45	40	35	28	21	19	17	15	13	11
45	40	35	30	23	17	15	12	11	9	7
40	35	30	25	19	12	10	8	6	4	3
35	30	26	20	14	8	6	3	1	0	-2
30	25	21	16	10	3	1	-1	-3	-5	-6
25	20	16	11	5	-2	-3	-6	-7	-9	-11
20	15	11	6	0	-6	-8	-10	-12	-13	-15
15	10	6	2	-5	-11	-13	-15	-16	-18	-19
10	5	1	-3	-9	-15	-17	-19	-21	-22	-24
5	0	-3	-8	-14	-20	-21	-24	-25	-27	-28
0	-5	-8	-13	-18	-24	-26	-28	-30	-31	-33
-5	-10	-13	-18	-23	-29	-31	-33	-34	-35	-37
-10	-15	-18	-22	-28	-33	-35	-37	-39	-40	-41
-15	-20	-23	-27	-32	-38	-39	-42	-43	-44	-46
-20	-24	-27	-32	-37	-42	-44	-46	-47	-49	-50
-25	-29	-32	-36	-42	-47	-49	-51	-52	-53	-55
-30	-34	-37	-41	-46	-51	-53	-55	-57	-58	-59
-35	-39	-42	-46	-51	-56	-58	-60	-61	-62	-63
-40	-44	-47	-51	-56	-61	-62	-64	-65	-66	-68

NOTE: Probe Recovery Factor is 100%.

Static Air Temperature

Static air temperature, displayed on the CDU PROGRESS page, is derived from the TAT by ADC No. 1.

Angle-of-Attack

There are two angle-of-attack sensors, one located on each side of the forward fuselage. The vanes measure airplane angle-of-attack relative to the air mass.

Primary Flight Instruments

Mach/Airspeed Indicators

Two electric Mach/airspeed indicators display indicated airspeed, Mach, and Vmo derived from the respective air data computer.

The airspeed cursor on each pilot's indicator can be automatically positioned through the related flight control computer (FCC) using inputs from the flight management computer (FMC) or from the speed selector on the AFDS mode control panel. Each airspeed cursor can also be manually positioned.

Altimeters

Two electric altimeters indicate current altitude in feet, derived from the respective air data computer. The altimeters have a range of –1,000 to 50,000 feet.

Vertical Speed Indicators

Two inertial vertical speed indicators display instantaneous vertical speed derived from the respective inertial reference system.

Clocks

Two electronic clocks are installed, with two digital displays on each clock. Either coordinated universal time (UTC) or local time may be set on the upper time display. The lower ET/CHR display is used for either elapsed time or the chronograph. Separate controls are provided for each display.

Standby Flight Instruments

Standby Horizon Indicator

The standby horizon indicator provides attitude information that is independent of the primary attitude displays. The indicator is powered by the battery bus and remains powered after the loss of all normal AC power as long as battery power is available. The gyro reaches operational speed approximately 60 seconds after power is applied. The indicator requires three minutes to achieve accuracy requirements.

In event of battery bus failure, due to a loss of power or to an overheat condition, the Gyro Failure Flag appears in view. The Gyro Failure Flag also appears if the gyro rotor speed is low.

Standby Altimeter/Airspeed Indicator

Standby altitude and airspeed are displayed on a single indicator.

The standby altimeter indicates current altitude in feet. It receives static pressure from the alternate static ports. The altimeter has a range of –1,000 to 50,000 feet.

The standby airspeed indicator provides current airspeed in knots. It receives ram pressure from the No. 2 auxiliary pitot probe and static pressure from the alternate static ports.

Standby Magnetic Compass

A standard liquid-damped magnetic standby compass is provided. A card located near the compass provides heading correction factors.

Flight Recorder

The flight recorder provides a permanent record on tape of selected operational and systems information such as altitude, heading, acceleration, and airspeed. The recorder is housed in a sealed, fire-resistant container located behind an access door in the aft cabin ceiling.

Operational and systems information is automatically recorded whenever the flight recorder is powered. On the ground, the recorder begins operating as the low oil pressure switch closes during either engine start. Oil pressure switches are bypassed in the air, and the flight recorder is powered even with both engines shut down as long as electrical power is available.

Aircraft Condition Monitoring System (ACMS)

The ACMS consists of a digital flight data recorder (DFDR), accelerometer, airborne printer, control display unit (CDU), and digital flight data acquisition unit (DFDAU).

The DFDAU receives signals representing certain flight conditions and airplane systems' operating performance and converts them to a digital form for recording on the DFDR.

The DFDR records airplane system and flight data on a continuous loop of magnetic tape. The tape is of sufficient length to record the last 25 hours of operation. The DFDR is located in the aft fuselage area.

The CDU contains the controls and indicators for operation of the ACMS.

The printer allows data to be printed as required.

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737 Flight Crew Operations Manual

Flight Instruments, Displays

Electronic Flight Instrument System (EFIS)

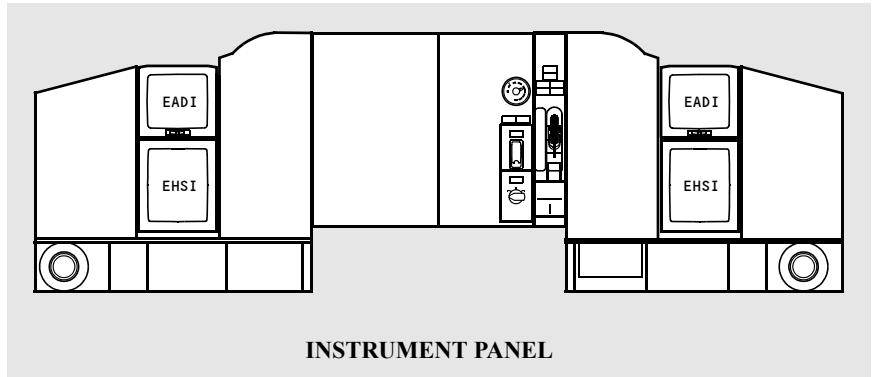
Chapter 10

Section 30

Introduction

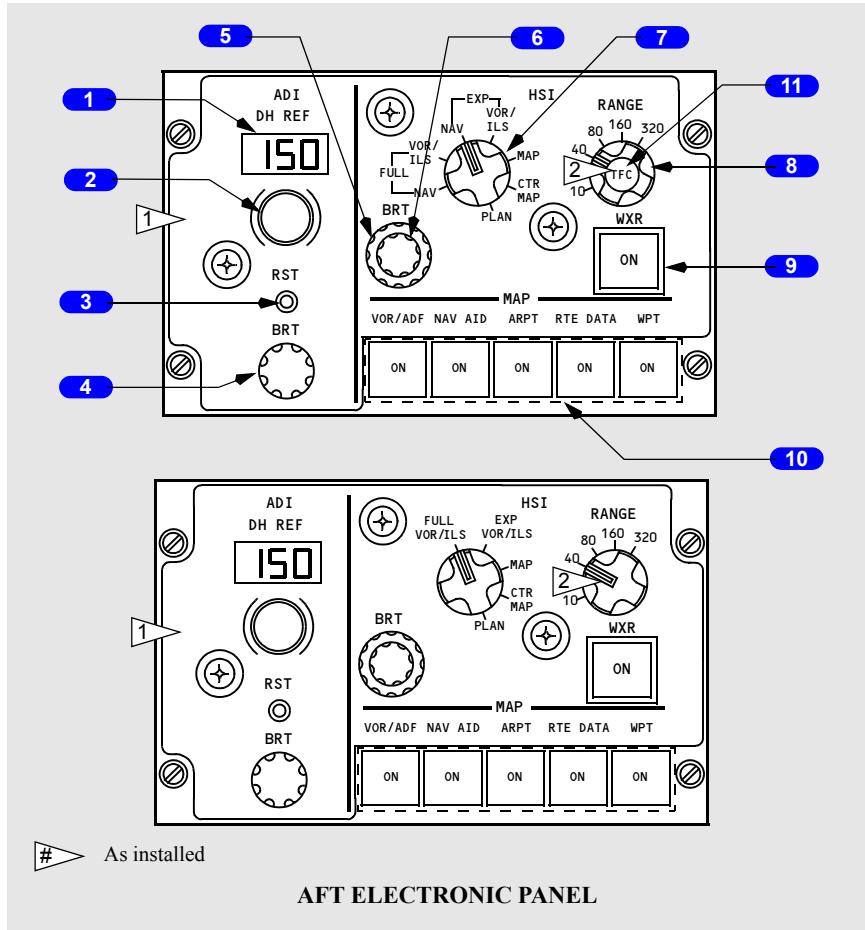
The electronic flight instrument system (EFIS) presents a dynamic color display of the parameters necessary for flight path control. The displays provide the following information:

Primary flight instruments are electronically displayed on the Captain's and First Officer's panels. They consist of an Electronic Attitude Director Indicator (EADI) and an Electronic Horizontal Situation Indicator (EHSI).



EFIS Control Panel

The left EFIS control panel controls the Captain's EADI and EHSI. The right EFIS control panel controls the First Officer's EADI and EHSI.



1 Decision Height Reference Indicator

- displays selected decision height
- display on EADI blanks when a negative decision height is selected.

2 Decision Height Selector

Rotate - selects decision height for DH alerting.

3 Decision Height Reset Switch

Push –

- resets DH alert on related EADI
- changes RA display from yellow to white
- blanks radio height alert on related EADI.

4 EADI Brightness Control

Rotate – adjusts brightness of EADI display.

5 EHSI Brightness (outer)

Rotate – adjusts brightness of EHSI display.

6 EHSI Brightness (inner)

Rotate – adjusts brightness of weather radar display.

7 EHSI Mode Selector

(see following pages)

8 EHSI Range Selector

Rotate – Selects nautical mile range for MAP, CTR MAP, PLAN, and weather radar displays.

9 Weather Radar Switch

Push – energizes weather radar transmitter and displays weather radar information (refer to Chapter 11, Flight Management, Navigation)

10 Map Switches

Push –

- selects detailed information displays
- displays can be selected simultaneously
- illuminated white when selected
- second push removes the information.

VOR/ADF - Displays VOR and/or ADF relative bearing radials /ADF pointer head and tail if VOR/ADF receivers are tuned to usable stations and valid data is being received.

Navigation Aids (NAV AID) –

- displays FMC data base high altitude navigation aids on map scales 80, 160, or 320 NM
- displays all FMC data base navigation aids if on map scales 10, 20, or 40 NM.

Airports (ARPT) – displays all airports stored in FMC data base which are within viewable map area of EHSI.

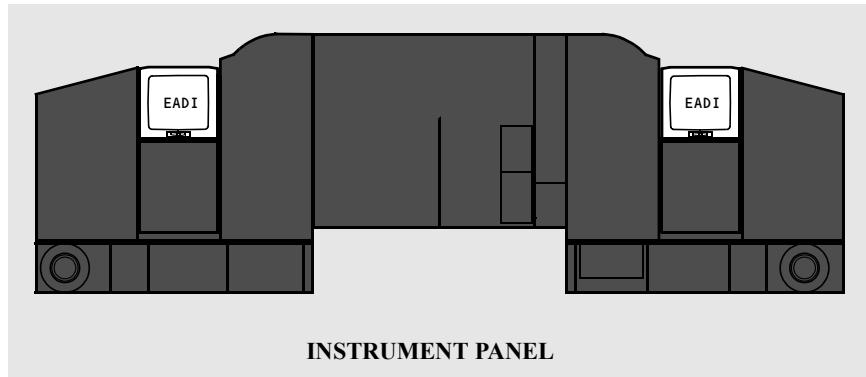
Route Data (RTE DATA) – displays altitude constraint (if applicable) and ETA for each active route waypoint.

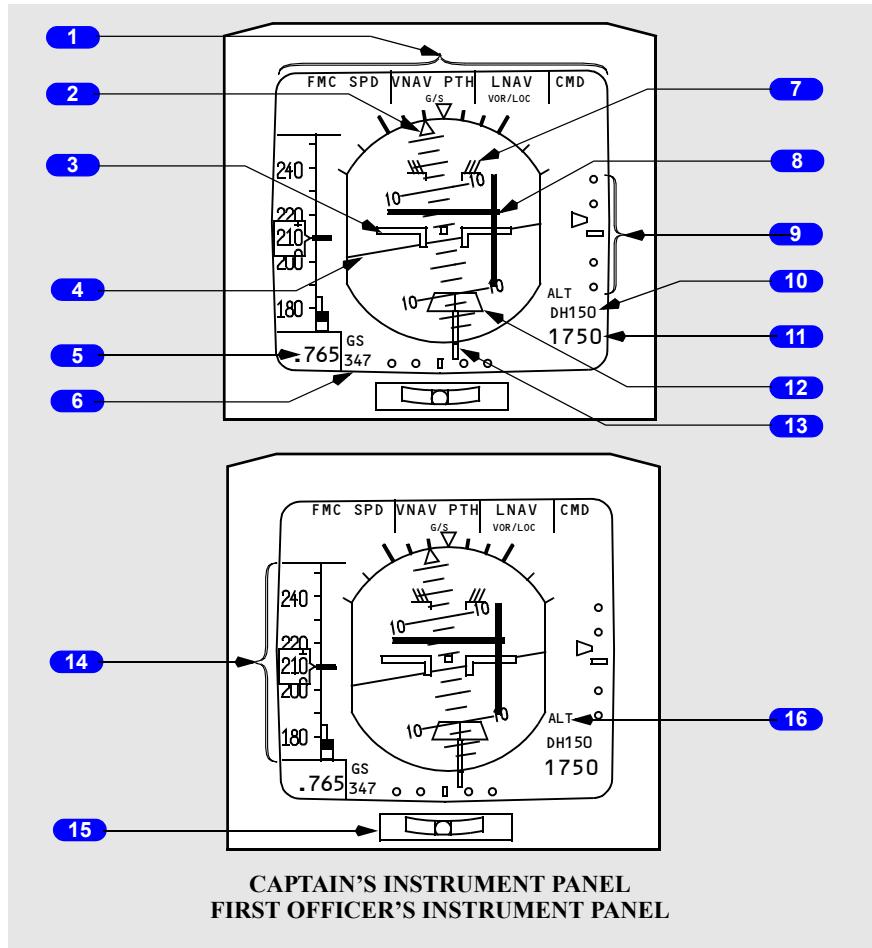
Waypoints (WPT) – displays waypoints in FMC data base not in flight plan route if selected range is 40 NM or less.

11 Traffic (TFC) Switch

- displays or removes TCAS information on EHSI
- removes TCAS FAIL message, if displayed.

Electronic Flight Instrument Displays



Electronic Attitude Director Indicator (EADI) Display**1 Flight Mode Annunciations**

(See Automatic Flight, Chapter 4).

2 Bank Indicator and Scale (white)

Provides fixed reference for the bank pointer; scale marks are at 0, 10, 20, 30, 45, and 60 degrees.

3 Airplane Symbol (black with white outline)

Indicates airplane attitude relative to the horizon.

4 Horizon Line and Pitch Scale (white)

5 Current Mach (white)

- displayed when Mach increases above .40 Mach
- display blanked when Mach decreases below .38 Mach.

6 Groundspeed (GS) (white)

Displays FMC/IRS groundspeed in knots.

7 Pitch Limit Indicator (yellow)

Indicates pitch attitude corresponding to stick shaker activation.

8 Flight Director Command Bars (magenta)

- displayed when related FD switch is ON and valid command steering is available, or during automatic operation of the FD
- blanked when the respective FD switch is OFF or command steering becomes invalid.

9 Glide Slope Pointer and Deviation Scale (magenta/white)

- pointer indicates glide slope position
- scale indicates deviation
- pointer not displayed when glide slope unusable or when track and front course on the MCP differ by more than 90° (back course).

10 Decision Height (green)

- displays selected decision height as set on the EFIS control panel when radio altitude is above 1,000 feet AGL
- blank when negative DH selected.

11 Radio Altitude (white)

- displays radio altitude below 2500 feet AGL
- blanked above 2500 feet AGL
- changes color from white to yellow when below selected DH on descent
- changes back to white:
 - when passing selected DH plus 75 feet during go-around
 - after touchdown
 - after pressing RST switch on EFIS control panel.

12 Rising Runway (green)

- displayed when localizer pointer is in view and radio altitude is valid
- rises towards airplane symbol when radio altitude is below 200 feet AGL.

13 Localizer Pointer and Deviation Scale (magenta/white)

- pointer indicates localizer position
- scale indicates deviation
- when LOC is engaged and deviation is slightly more than one half dot, scale expands (not shown)
- pointer blanked when ILS LOC signal is too weak to be usable.
- at low radio altitudes, with autopilot engaged, scale turns yellow and pointer flashes to indicate excessive localizer deviation.

14 Speed Tape

(See following pages).

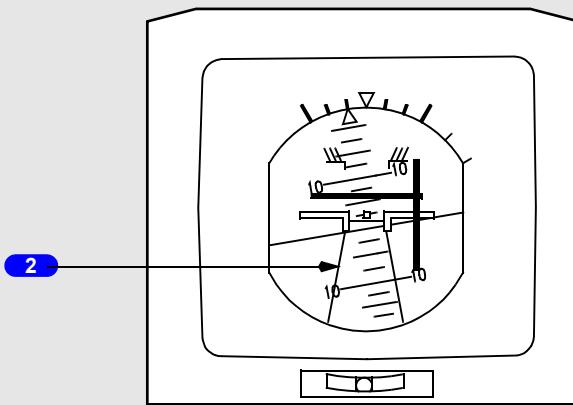
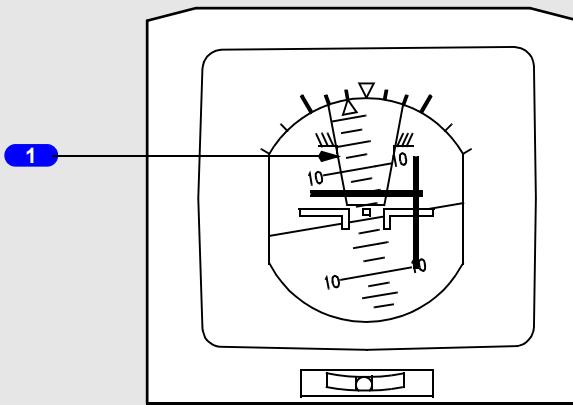
15 Slip Indicator

Indicates slip or skid during turns.

16 Radio Height Alert (white)

- displayed during a descent when radio altitude decreases to 2,500 feet AGL
- display is turned off when:
 - airplane descends below 500 feet AGL
 - airplane climbs above 2,500 feet AGL prior to descending to 500 feet
 - when reset (RST) button on EFIS control panel is pushed.

EADI TCAS Display



Airplanes with TCAS

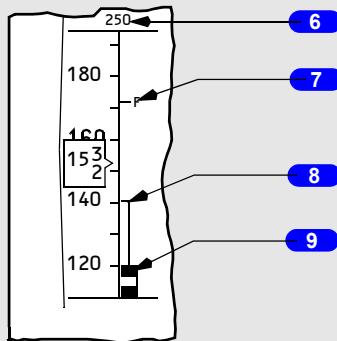
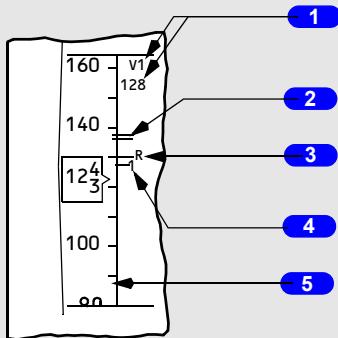
1 TCAS RA Pitch Command (red)

- down advisory
- displayed during RA condition
- indicates pitch attitude to be avoided for traffic separation.

2 TCAS RA Pitch Command (red)

- up advisory
- displayed during RA condition
- indicates pitch attitude to be avoided for traffic separation.

EADI Speed Tape



CAPTAIN'S EADI
FIRST OFFICER'S EADI

1 V1 (Decision Speed) (green)

- displayed after manual entry on the FMC/CDU TAKEOFF REF page
- displayed in this location during initial takeoff roll when V1 is beyond the displayed range.

2 FMC/MCP Command Speed (magenta)

Displayed in this location when the FMC/MCP command speed is in the displayed range.

3 Vr (Rotation Speed) (green)

Displayed after manual entry on the FMC/CDU TAKEOFF REF page.

4 V1 (Decision Speed) (green)

This symbol replaces digital V1 display (upper right corner of the speed tape) when the V1 speed is within the displayed range.

5 Speed Tape Scale (white)

- scrolls up or down in response to ADC calibrated airspeed
- range is 45 to 420 knots.

6 FMC/MCP Command Speed (magenta)

Displayed in this location when the FMC/MCP command speed is above displayed range.

7 Minimum Flap Retraction Speed (green)

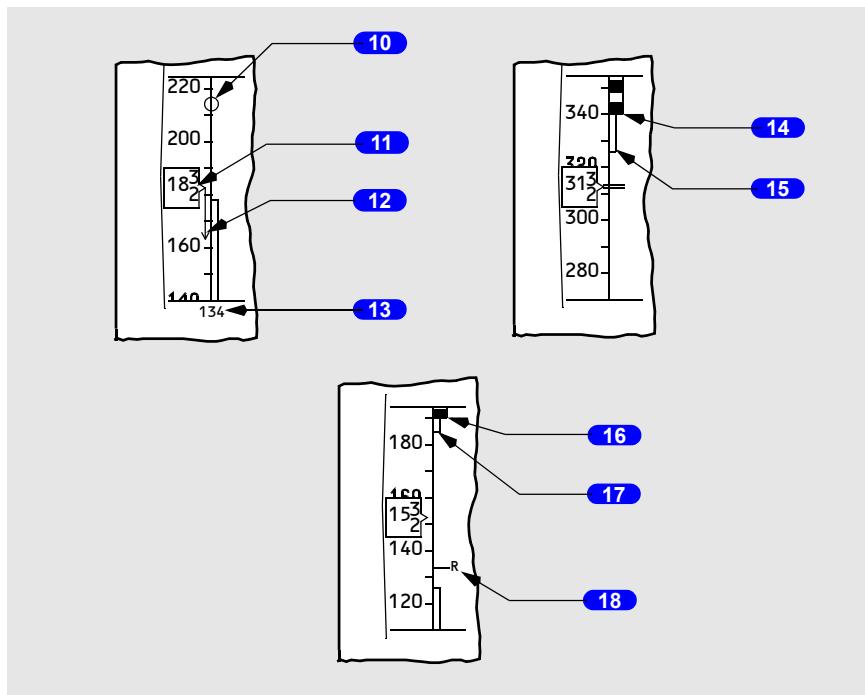
Displayed on speed tape during takeoff or go-around.

8 Minimum Maneuver Speed (yellow)

Top of hollow yellow bar indicates minimum maneuver speed.

9 Stick Shaker Speed (red and black)

Top of barber pole indicates speed at which stick shaker is activated.



10 Flaps Up Maneuvering Speed (green)

Displayed when flaps are up.

11 Rolling Digits Display (white)

- indicates current airspeed
- position is fixed relative to ADI display.

12 Airspeed Trend Arrow (green)

Tip of arrow depicts predicted airspeed within the next 10 seconds based on present airspeed and acceleration.

13 FMC/MCP Command Speed (magenta)

Displayed in this location when the FMC/MCP command speed is below displayed range.

14 Max Operating Speed (red and black)

Indicates Vmo/Mmo.

15 High Speed Buffet Limit

Bottom of yellow bar indicates speed that provides .3G maneuver margin to high speed buffet at high altitudes.

16 Placard Speed (red and black)

Indicates gear extended placard speed or flap extended placard speed for selected flap position, as applicable.

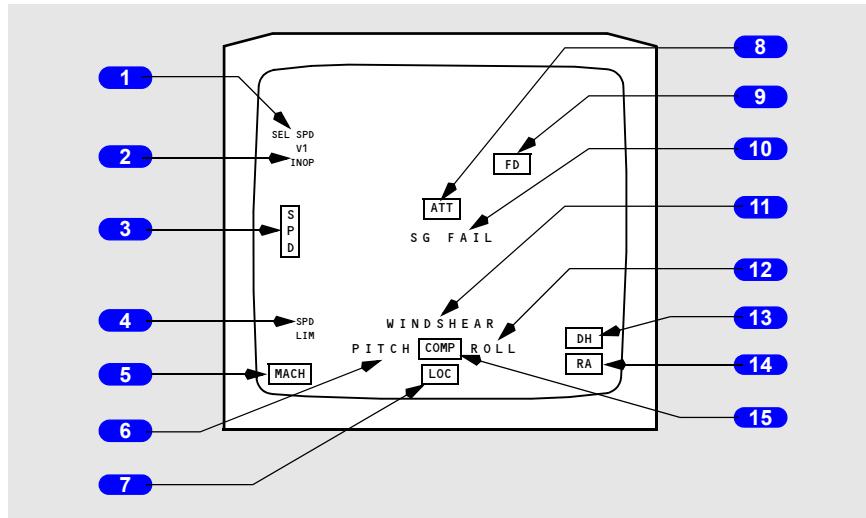
17 Next Flap Position Placard Speed (yellow)

Bottom of hollow yellow bar indicates the flap extended placard speed for the next normal flap position.

18 Vref Speed (green)

Indicates the Vref speed for the landing flap configuration as selected on the FMC/CDU APPROACH REF page.

EADI System Failure Flags and Annunciations



1 Selected Speed Annunciation (yellow)

Command speed symbol and displays inoperative.

2 V1 Inoperative Annunciation (yellow)

V1 display inoperative.

3 Speed Flag (yellow)

Speed tape display inoperative.

4 Speed Limit Annunciation (yellow)

Displays related to stick shaker and Maximum Operating Speeds failed.

5 Mach Flag (yellow)

Mach number display failed.

6 Pitch Comparator Annunciation (yellow)

Captain's and F/O's pitch angle displays differ by more than 3 degrees.

7 Localizer Flag (yellow)

Localizer deviation display on EADI failed.

8 Attitude Flag (yellow)

Attitude display failed.

9 Flight Director Flag (yellow)

Pitch and/or roll flight director commands failed.

10 Symbol Generator Fail Annunciation (yellow)

Selected symbol generator failed.

11 Windshear Warning Annunciation (red)

Ground proximity computer has detected a windshear condition.

12 Roll Comparator Annunciation (yellow)

Captain's and F/O's bank angle displays differ by more than 3 degrees.

13 Decision Height Flag (yellow)

Selected decision height display failed.

14 Radio Altitude Flag (yellow)

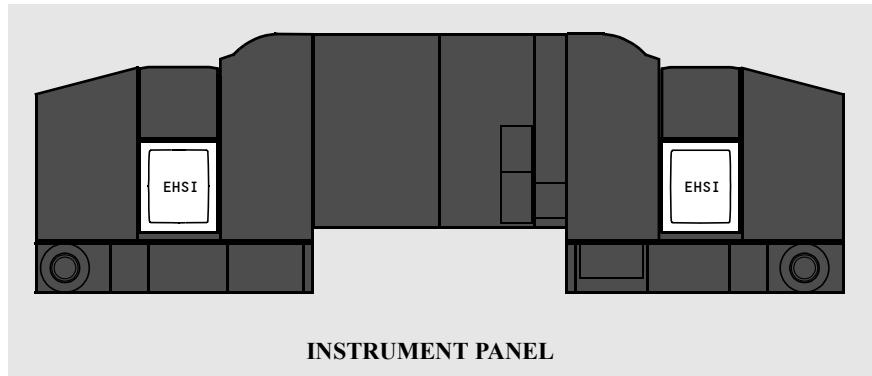
Radio altitude display failed.

15 Pitch and Roll Comparator Function Flag (yellow)

Comparator function failed.

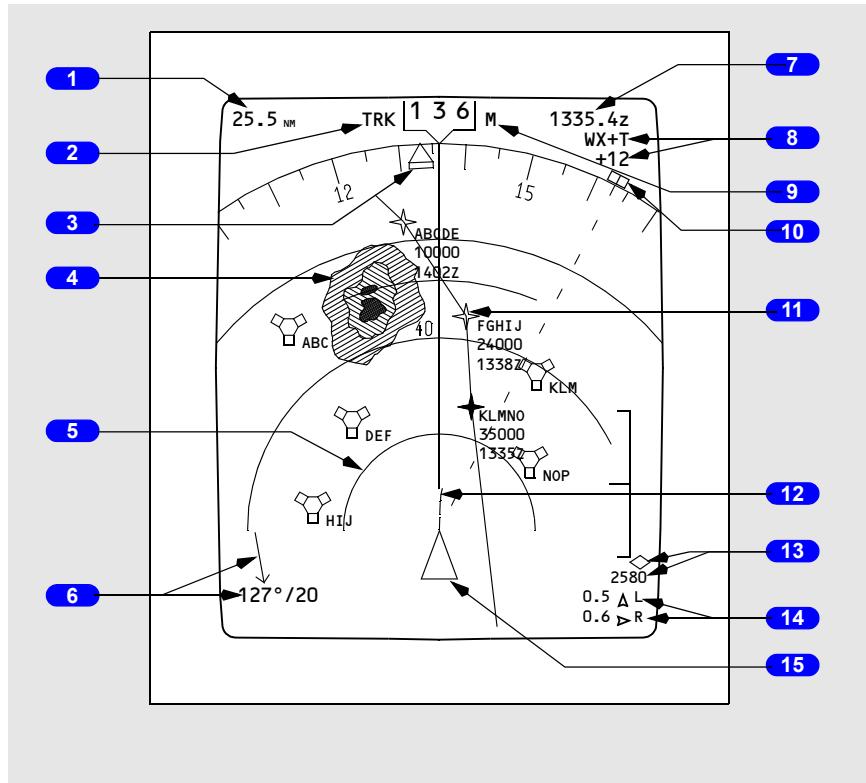
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EHSI Displays



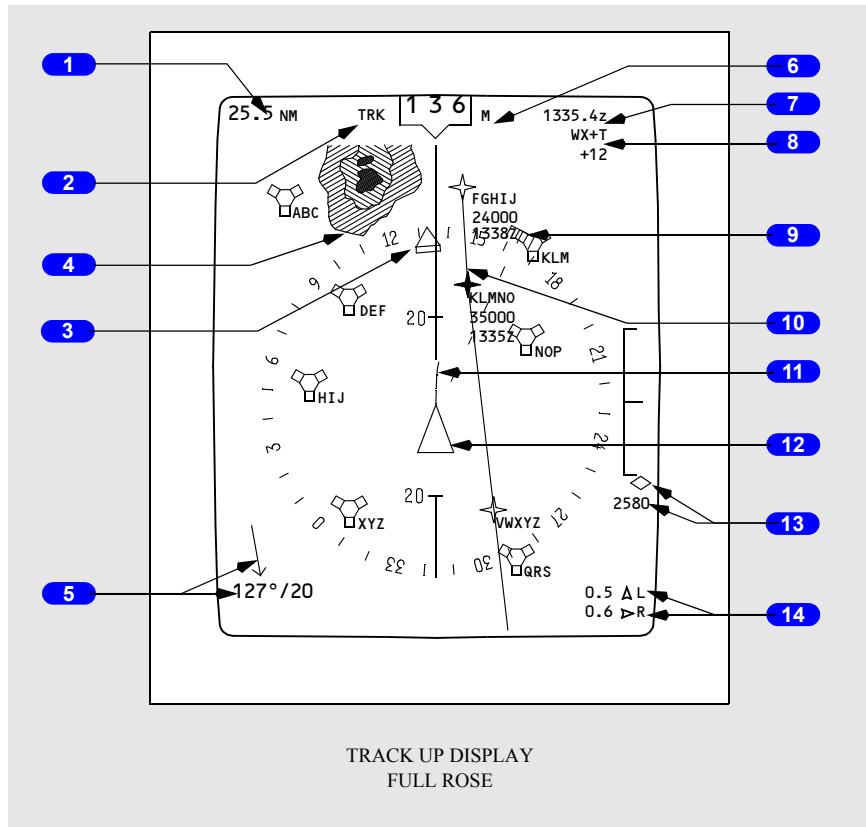
Note: A detailed explanation of the navigation symbology immediately follows this section.

MAP Mode



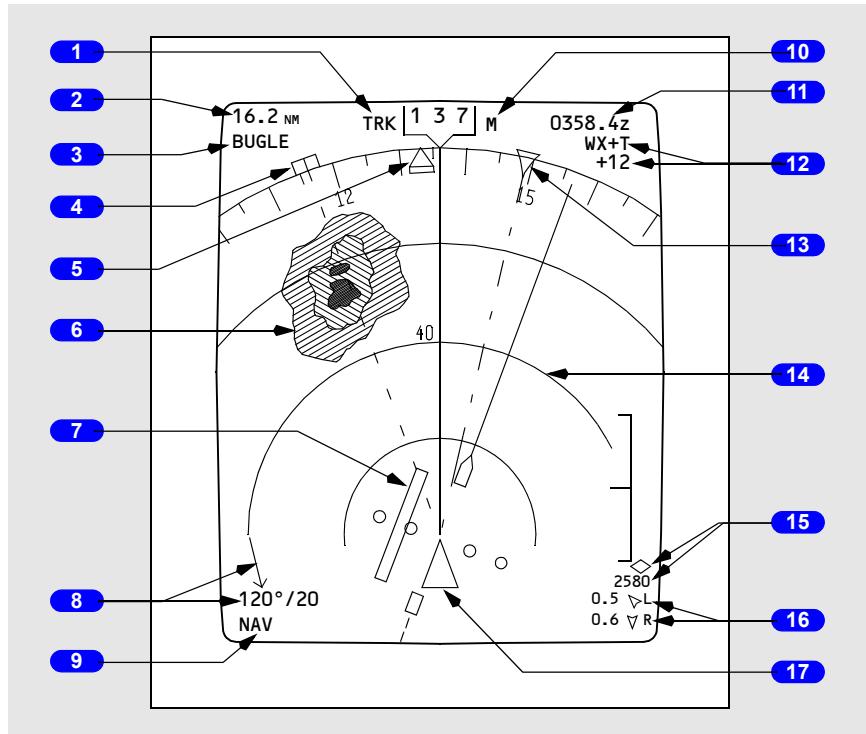
1 Distance to Next Active Waypoint**2 Current Track****3 Heading Pointer****4 Weather Radar Returns****5 Weather Range Arcs****6 Wind Direction and Speed****7 Estimated Time of Arrival at Next Active Waypoint****8 Weather Radar Annunciations****9 Magnetic/True Reference****10 Selected Heading Bug****11 Active LNAV Route****12 Position Trend Vector****13 Vertical Deviation Scale and Pointer****14 Position Difference Display****15 Airplane Symbol**

Center MAP Mode



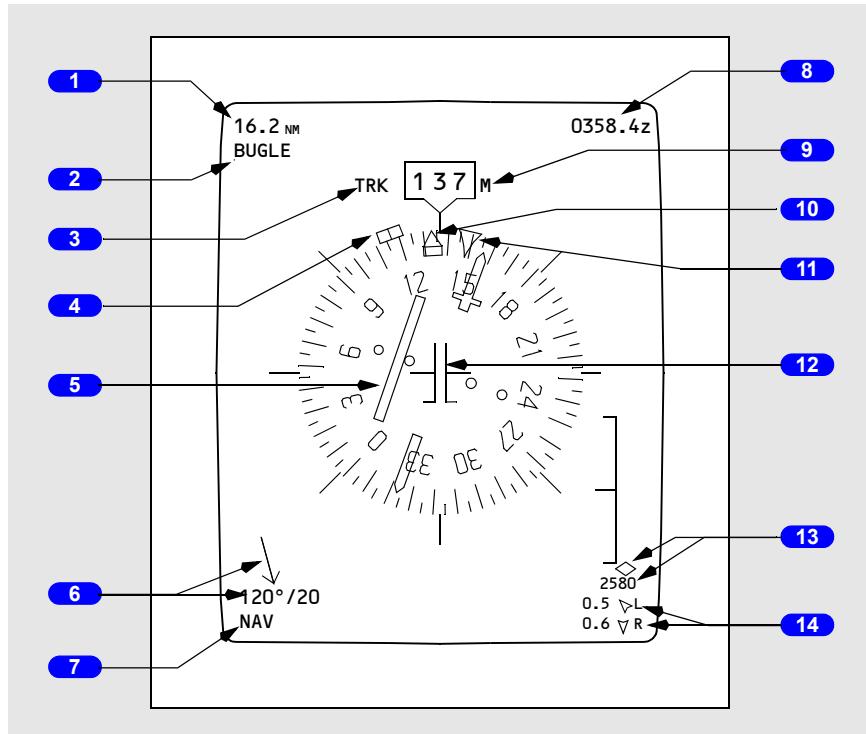
- 1 Distance to Next Active Waypoint**
- 2 Current Track**
- 3 Heading Pointer**
- 4 Weather Radar Returns**
- 5 Wind Direction and Speed**
- 6 Magnetic/True Reference**
- 7 Estimated Time of Arrival at Next Active Waypoint**
- 8 Weather Radar Annunciations**
- 9 Selected Heading Bug**
- 10 Active Route**
- 11 Position Trend Vector**
- 12 Airplane Symbol**
- 13 Vertical Deviation Scale and Pointer**
- 14 Position Difference Display**

Expanded Navigation Mode (As Installed)



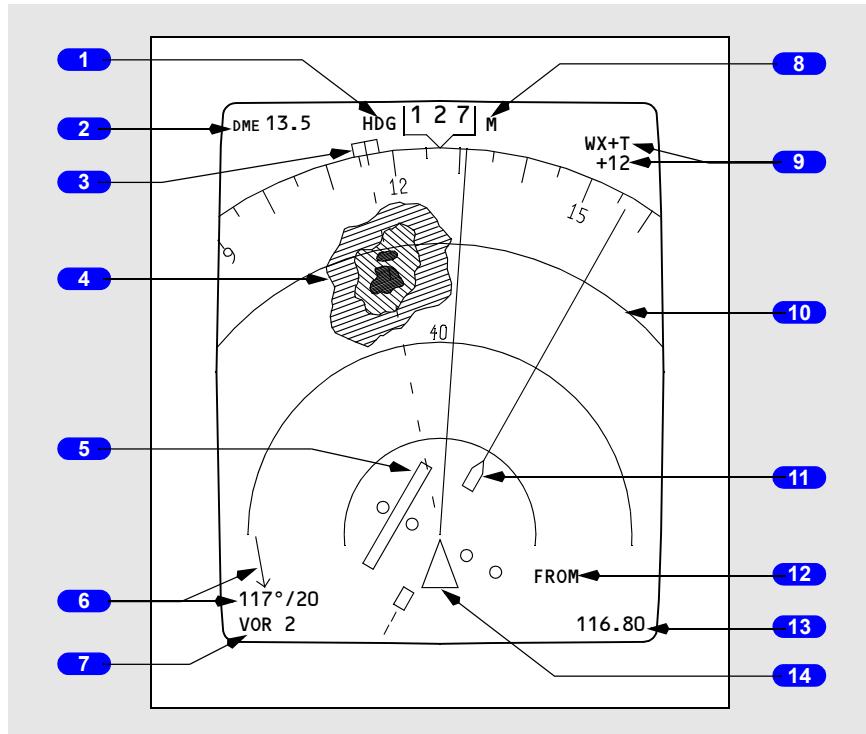
- 1 Current Track**
- 2 Distance to Next Active Waypoint**
- 3 Active Waypoint Name**
- 4 Selected Heading Bug**
- 5 Heading Pointer**
- 6 Weather Radar Returns**
- 7 Lateral Deviation Indicator and Deviation Scale**
- 8 Wind Direction and Speed**
- 9 Nav Data Source**
- 10 Magnetic/True Reference**
- 11 Estimated Time of Arrival at Next Active Waypoint**
- 12 Weather Radar Annunciations**
- 13 Waypoint Bearing Pointer**
- 14 Weather Range Arcs**
- 15 Vertical Deviation Scale and Pointer**
- 16 Position Difference Display**
- 17 Airplane Symbol**

Full Rose Navigation Mode (As Installed)



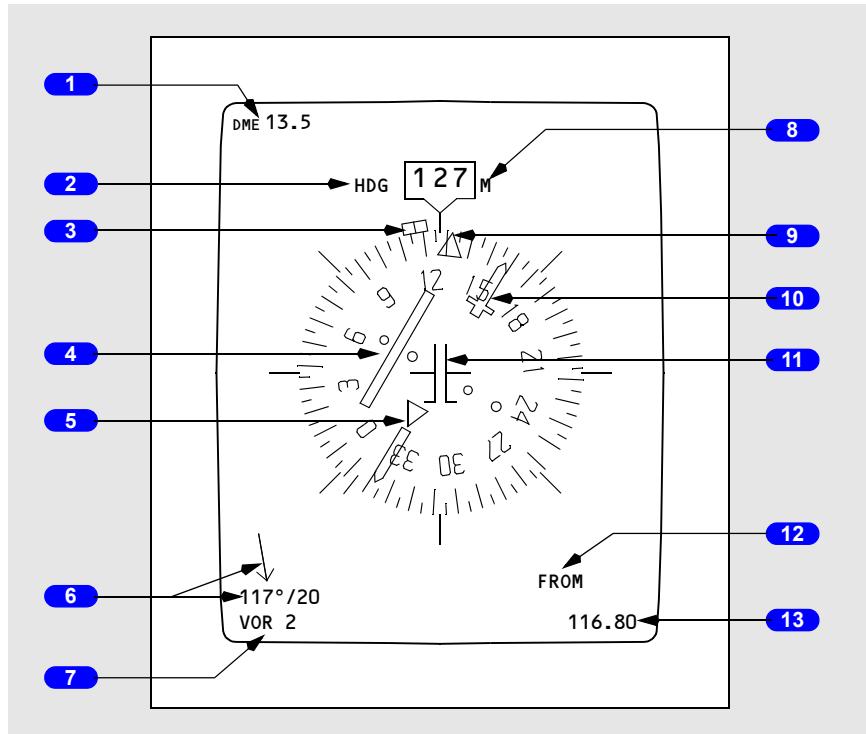
- 1 Distance to Next Active Waypoint**
- 2 Active Waypoint Name**
- 3 Current Track**
- 4 Selected Heading Bug**
- 5 Lateral Deviation Indication and Scale**
- 6 Wind Direction and Speed**
- 7 Nav Data Source**
- 8 Estimated Time of Arrival at Next Active Waypoint**
- 9 Magnetic/True Reference**
- 10 Heading Pointer**
- 11 Waypoint Bearing Pointer**
- 12 Airplane Symbol**
- 13 Vertical Deviation Scale and Pointer**
- 14 Position Difference Display**

Expanded VOR Mode



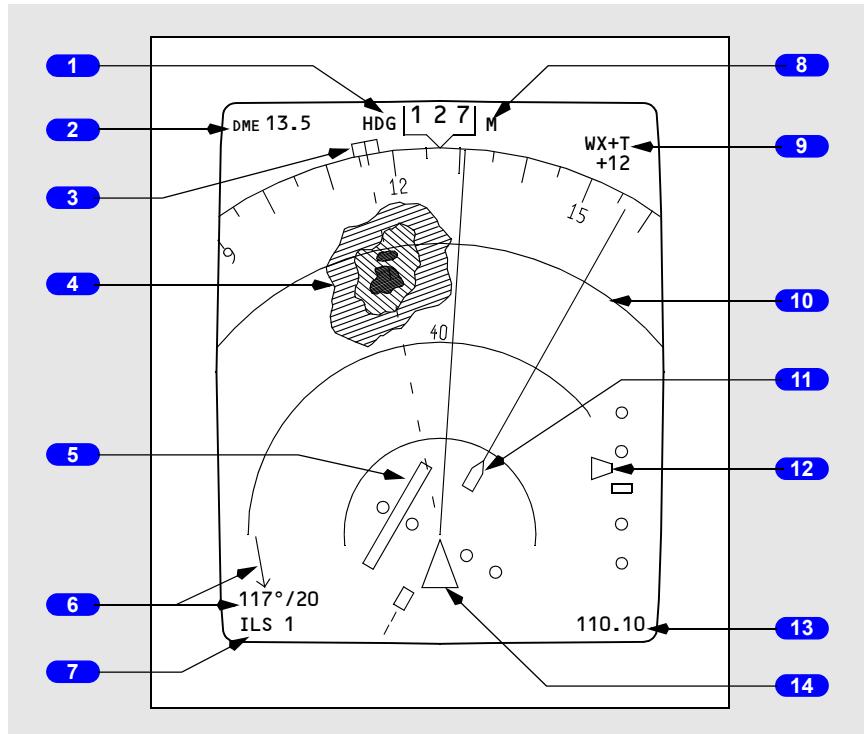
- 1 Current Heading**
- 2 Reference VOR DME**
- 3 Selected Heading Bug**
- 4 Weather Radar Returns**
- 5 Lateral Deviation Indication and Scale**
- 6 Wind Direction and Speed**
- 7 Reference VOR Receiver**
- 8 Magnetic/True Reference**
- 9 Weather Radar Annunciations**
- 10 Weather Range Arcs**
- 11 Selected Course Pointer**
- 12 TO/FROM Indication**
- 13 Reference VOR Frequency**
- 14 Airplane Symbol**

Full Rose VOR Mode



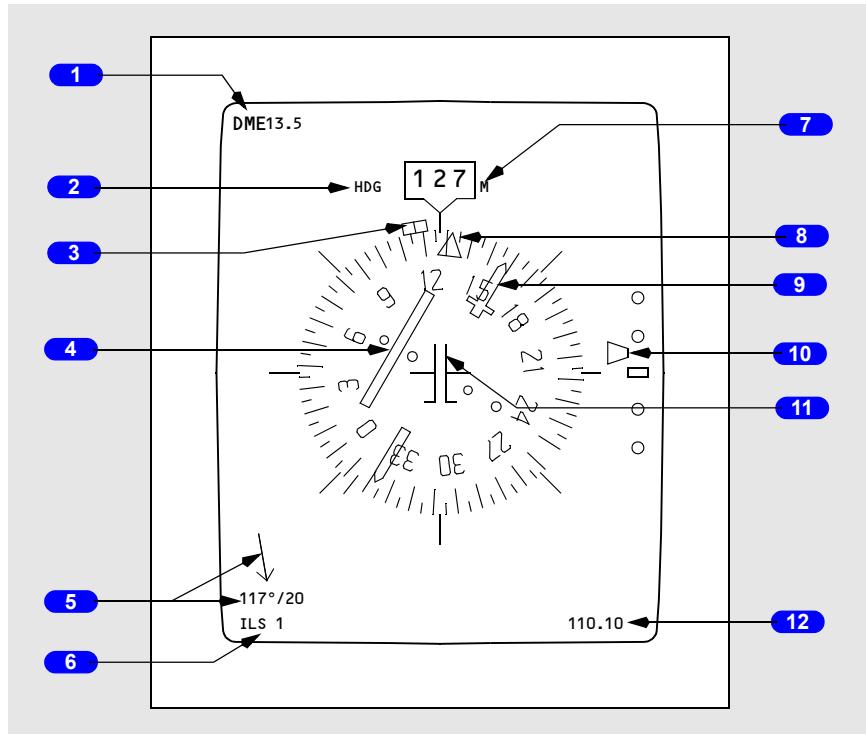
- 1 Reference VOR DME**
- 2 Current Heading**
- 3 Selected Heading Bug**
- 4 Lateral Deviation Indication and Scale**
- 5 TO/FROM Indication**
- 6 Wind Direction and Speed**
- 7 Reference VOR Receiver**
- 8 Magnetic/True Reference**
- 9 Drift Angle Pointer**
- 10 Selected Course Pointer**
- 11 Airplane Symbol**
- 12 TO/FROM Indication**
- 13 Reference VOR Frequency**

Expanded ILS Mode



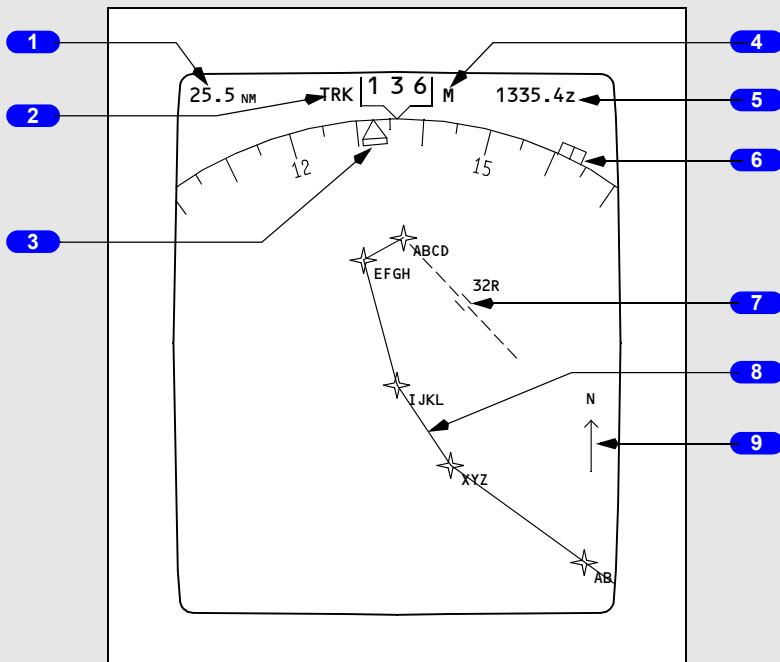
- 1 Current Heading**
- 2 Reference ILS DME**
- 3 Selected Heading Bug**
- 4 Weather Radar Returns**
- 5 Localizer Deviation Indication and Scale**
- 6 Wind Direction and Speed**
- 7 Reference ILS Receiver**
- 8 Magnetic/True Reference**
- 9 Weather Radar Annunciations**
- 10 Weather Range Arcs**
- 11 Selected Course Pointer**
- 12 Glideslope Pointer and Scale**
- 13 Reference ILS Frequency**
- 14 Airplane Symbol**

Full Rose ILS Mode



- 1 Reference ILS DME**
- 2 Current Heading**
- 3 Selected Heading Bug**
- 4 Lateral Deviation Indication and Scale**
- 5 Wind Direction and Speed**
- 6 Reference ILS Receiver**
- 7 Magnetic/True Reference**
- 8 Drift Angle Pointer**
- 9 Selected Course Pointer**
- 10 Glideslope Pointer and Scale**
- 11 Airplane Symbol**
- 12 Reference ILS Frequency**

Plan Mode



- 1 Distance to Next Active Waypoint**
- 2 Current Track**
- 3 Heading Pointer**
- 4 Magnetic/True Reference**
- 5 Estimated Time of Arrival at Next Active Waypoint**
- 6 Selected Heading Bug**
- 7 Airport and Runway**
- 8 Active Route**
- 9 True North Pointer**

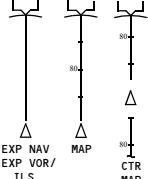
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EHSI Symbology

The following symbols can be displayed, depending on EFIS control panel switch selections. Colors indicate the following:

- W (white) – present status, range scales
- G (green) – active or selected mode and/or dynamic conditions
- M (magenta/pink) – command information, pointers, symbols, fly-to condition, weather radar turbulence
- C (cyan/blue) – nonactive or background information
- A (amber) – cautions, faults, flags
- R (red) – warnings
- B (black) – blank area, off condition.

Heading, Track, and Wind

Symbol	Name	Applicable Mode(s)	Remarks
TRK 0 6 2 M	Track orientation (G), current track (W), and track reference (G)	MAP CTR MAP FULL NAV EXP NAV PLAN	Displays TRK as the orientation, the current track, and M or TRU as the reference, and points to the heading on the compass rose.
HDG 0 6 2 M	Heading orientation (G), current heading (W), heading reference (G), and heading pointer (W)	FULL VOR/ ILS EXP VOR/ ILS	Displays HDG as the display orientation, current heading, M or TRU as the heading reference, and points to the heading on the compass rose.
■	Selected heading bug (M) and reference line (M)	All	Displays the MCP-selected heading. A dashed line (M) extends from the marker to the airplane symbol (except for PLAN mode).
	Track line and range scale (W)	MAP CTR MAP EXP NAV EXP VOR/ ILS	Displays present ground track based on airplane heading and wind. The displayed range numeric value(s) is (are) one-half the actual selected range. With heading-up orientation (VOR/ILS mode), the track line will be rotated left or right at an angle equal to the drift angle.
	Drift Angle Pointer (W)	FULL VOR/ ILS	Displays present ground track. Replaces track line when a full rose mode is selected.

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Symbol	Name	Applicable Mode(s)	Remarks
M OR 	Heading/track reference (G), box (W) in TRU, box (A) if TRU displayed in descent	ALL	Indicates heading/track is referenced to magnetic north or true north. On transition from TRU to M, a highlight box is displayed around M for 10 seconds. When TRU is the reference, the highlight box is displayed full time (white).
	Expanded compass (W)	MAP EXP NAV EXP VOR/ ILS PLAN	Displays 70 degrees of compass rose.
	Full compass rose (W) Fixed reference marks (W)	FULL NAV FULL VOR/ ILS	The compass rose rotates through 360 degrees as a function of airplane heading or track. Fixed reference marks are evenly spaced at 45 degree intervals.
	Center Map full compass rose(W)	CTR MAP	The compass rotates through 360 degrees as a function of airplane track.
	Current heading pointer (W)	MAP CTR MAP EXP NAV FULL NAV PLAN	Points to current heading on the compass rose.

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Symbol	Name	Applicable Mode(s)	Remarks
	Waypoint bearing pointer (M)	EXP NAV FULL NAV	Displays relative bearing to active waypoint.
	Wind direction/ speed and wind arrow (W)	All except PLAN	Indicates wind speed and direction, with respect to display orientation and heading/track reference. Displayed if wind magnitude is greater than 6 knots and blanked if wind magnitude becomes less than 4 knots.

Radio Navigation

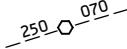
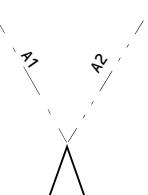
Symbol	Name	Applicable Mode(s)	Remarks
VOR 1, 2 ILS 1, 2 NAV	HSI nav data source(G)	FULL NAV EXP NAV FULL VOR/ ILS EXP VOR/ ILS	Indicates the source of the displayed navigation data. In the VOR/ILS mode the displayed data source is a function of the tuned frequency (VOR or LOC). In the NAV mode, "NAV" indicates the data source is the FMC.
116.80	ILS/VOR frequency display (G)	FULL VOR/ ILS EXP VOR/ ILS	Displays frequency of manually tuned navaid. The word "AUTO" is displayed in place of the frequency if the VHF NAV radio is in the auto tune mode.
DME 124	DME distance (W)	FULL VOR/ ILS EXP VOR/ ILS	Indicates DME distance to the reference navaid.
↑ ↓ ↔	ADF 1 pointer head and tail (G) ADF 2 pointer head and tail (G)	FULL NAV EXP NAV FULL VOR/ ILS EXP VOR/ ILS PLAN MAP CTR MAP	Indicates bearing to (head) or from (tail) the tuned station. Displayed in MAP/ CTR MAP modes on some airplanes only.
○ ○ ○ ○	Lateral deviation indicator (M) and scale (W)	FULL NAV EXP NAV FULL VOR/ ILS EXP VOR/ ILS	Displays ILS, VOR, or FMC course deviation. ILS normal scale: 1 dot = 1× (approx) ILS expanded scale: 1 dot = 1/2× (approx) VOR: 1 dot = 5× NAV: 1 dot = 2NM

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Symbol	Name	Applicable Mode(s)	Remarks
	Selected course pointer (W) and line (M)	EXP NAV EXP VOR/ ILS	Displays selected course as set by the related MCP course selector. (VOR/ILS) or by the FMC (NAV).
	Selected course pointer (W) TO/FROM pointer (W)	FULL NAV FULL VOR/ ILS	Displays selected course as set by the related MCP course selector (VOR/ILS) or by the FMC (NAV). TO/FROM pointer is displayed when VOR navigation is being used.
	Glideslope pointer (M) and scale (W)	FULL VOR/ ILS EXP VOR/ ILS	Displays glideslope position and deviation.
	To/From indication (W)	FULL VOR/ ILS EXP VOR/ ILS	Displays VOR TO/FROM indication.

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Symbol	Name	Applicable Mode(s)	Remarks
  	VOR (C, G), DME/TACAN (C, G), VORTAC (C, G) Manually tuned VOR radials (G)	MAP CTR MAP PLAN	When the EFIS control panel NAV AID switch is selected on, appropriate navaids are displayed. All navaids contained in the FMC data base and within the MAP area are displayed when the selected range is 10, 20 or 40 NM. Only high altitude navaids are displayed when the selected range is 80, 160, 320 NM. Navaids not being used are displayed in cyan. Tuned VHF navaids are displayed in green, regardless of NAV AID switch selection. When a navaid is manually tuned, the selected course and reciprocal are displayed.
	VOR radials (G)	MAP CTR MAP	When the VOR/ADF switch is selected on and a valid VOR signal is received, the station radial is displayed.
	ADF bearings (G)	MAP CTR MAP	When the VOR/ADF switch is selected on and a valid ADF signal is received, the relative bearing to the tuned ADF station is displayed.

MAP

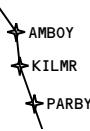
Symbol	Name	Applicable Mode(s)	Remarks
	Airplane symbol (W)	MAP CTR MAP EXP NAV EXP VOR/ ILS PLAN	Current airplane position is at the apex of the triangle.
	Airplane symbol (W)	FULL NAV FULL VOR/ ILS	Current airplane position is at the center of the symbol.
	Position trend vector (W) (dashed line)	MAP CTR MAP	Predicts position at the end of 30, 60, and 90 second intervals, based on bank angle and ground speed. Each segment represents 30 seconds. Selected range determines the number of segments displayed: <ul style="list-style-type: none"> Range > 20 NM, 3 segments Range = 20 NM, 2 segments Range = 10 NM, 1 segment
ABCDE	Active waypoint identifier (M)	FULL NAV EXP NAV	Indicates the active flight plan waypoint, the next waypoint on the route of flight.
124 NM	Active waypoint distance (W)	MAP CTR MAP FULL NAV EXP NAV PLAN	Distance to the active waypoint.
0835.4z	Active waypoint ETA (W)	MAP CTR MAP FULL NAV EXP NAV PLAN	Indicates FMC-calculated ETA at the active waypoint.

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Symbol	Name	Applicable Mode(s)	Remarks
ALERT	Course change Alert annunciation (A)	FULL NAV EXP NAV	Displayed 10 seconds prior to course change or 10 seconds prior to sequencing a waypoint if no course change is required. Removed as APL begins roll to new course or when waypoint is sequenced.
⊕ AMBBOY	Standard Waypoint: active (M), inactive (W)	MAP CTR MAP PLAN	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route.
° _____	Conditional Waypoint: active (M), inactive (W)	MAP CTR MAP PLAN	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route. Data with parentheses for conditional waypoints indicates type of conditional waypoint (altitude, "VECTORS", "INTC", etc.)
△ MLF	Off route waypoint (C)	MAP CTR MAP PLAN	When the EFIS control panel WPT switch is selected on, waypoints not on the selected route are displayed, for ranges of 10, 20, or 40 NM.

Flight Instruments, Displays
 Electronic Flight Instrument System **DO NOT USE FOR FLIGHT**
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Symbol	Name	Applicable Mode(s)	Remarks
	Flight plan route: active (M), modified (W), inactive (C)	MAP CTR 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. An offset route, selected through the FMC (U7), is displayed with a dot-dash line (M) parallel to the active route.
	Route data: active waypoint (M), inactive waypoint (W)	MAP CTR MAP PLAN	When the EFIS control panel RTE DATA switch is selected on, altitude constraints and ETAs for route waypoints are displayed.
	Holding pattern: active route (M), modified route (W), inactive route (C)	MAP CTR MAP PLAN	A holding pattern appears when in the flight plan. The holding pattern appears as a fixed size if the selected range is greater than 80 NM. A scaled representation of the holding pattern is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the holding fix.

Symbol	Name	Applicable Mode(s)	Remarks
	Procedure turn: active (M), modified (W), inactive (C)	MAP CTR MAP PLAN	A procedure turn appears when in the flight plan. The procedure turn appears as a fixed size if the selected range is greater than 80 NM. A scaled representation of the procedure turn is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the procedure turn. A procedure turn can be displayed if FMC software version U6 (or a more recent version) is installed, and provided that the Nav data base contains Procedure Turn data.
	Altitude range arc (G)	MAP CTR MAP	Based on present vertical speed and ground speed, indicates the approximate map position where the MCP altitude is reached.
<input type="radio"/> T/C <input type="radio"/> T/D <input type="radio"/> S/C <input type="radio"/> E/D	Altitude profile point and identifier (G)	MAP CTR MAP PLAN	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.
<input type="radio"/> T/D-XXXXX			Indicates intermediate T/D points for level flight path segments during descent. Level flight path segment altitude is displayed.

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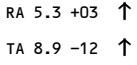
Symbol	Name	Applicable Mode(s)	Remarks
○			Deceleration points have no identifier.
[]	VNAV path pointer (M) and deviation scale (W)	MAP CTR MAP FULL NAV EXP NAV	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates +/- 400 feet deviation. Digital display is provided when the pointer indicates more than +/- 400 feet.
○ KABC 22L	Airport and runway (W)	MAP CTR MAP PLAN	Displayed when selected as the origin or destination and selected range is 80, 160, or 320 NM.
○ KTEB	Airport (C)	MAP CTR MAP PLAN	Displayed if the EFIS control panel ARPT switch is selected on. Origin and destination airports are always displayed, regardless of switch selection.
/ / / / 22L	Airport and runway (W)	MAP CTR MAP PLAN	Displayed when selected as the origin or destination and selected range is 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.
○ R060 ABC	Selected reference point and bearing distance information (G)	MAP CTR MAP PLAN	Displays the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).
○	Weather radar returns (R, A, G, M)	MAP CTR MAP EXP NAV EXP VOR/ ILS	The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence is displayed in magenta.

Symbol	Name	Applicable Mode(s)	Remarks
4.5 \triangleright_L 4.3 Δ_R	Position difference display (W)	MAP CTR MAP FULL NAV EXP NAV	<p>Numbers – indicate the position difference in NM between the present FMC position and the L IRS and R IRS present positions. The selected IRS source is displayed on the first line.</p> <p>Arrows – indicate the relative bearing to the related IRS present position.</p> <p>L or R – indicates which IRS present position the displayed position difference corresponds to.</p> <p>Displayed when the position difference of the L IRS and/or R IRS exceeds the position difference limits.</p>
	North up arrow (G)	PLAN	Indicates map background is oriented and referenced to true north.
	Range arcs (W)	MAP EXP NAV EXP VOR/ ILS	<p>Displayed in EXP NAV and EXP VOR/ILS modes when the EFIS WXR switch is selected on or TCAS TFC switch is selected.</p> <p>Range arcs are displayed in MAP mode with or without WXR or TFC selected.</p>

Radar

Symbol	Name	Applicable Mode(s)	Remarks
VAR/MAP +12	Weather radar Annunciations (G)	MAP CTR MAP EXP NAV EXP VOR/ ILS	<p>These symbols are displayed only when the weather radar switch on the EFIS control panel is selected on. (refer to Chapter 11, Flight Management, Navigation).</p> <p>GAIN – VAR indicates that gain control is not in CAL (calibrated) detent.</p> <p>MODE:</p> <ul style="list-style-type: none">• MAP – weather radar is operating in map mode• WX – weather radar is operating in weather mode• WX+T – weather radar is operating in weather mode with turbulence detection enabled• TEST – weather radar is in test mode, and test pattern is displayed <p>TILT – indicates antenna tilt angle.</p>

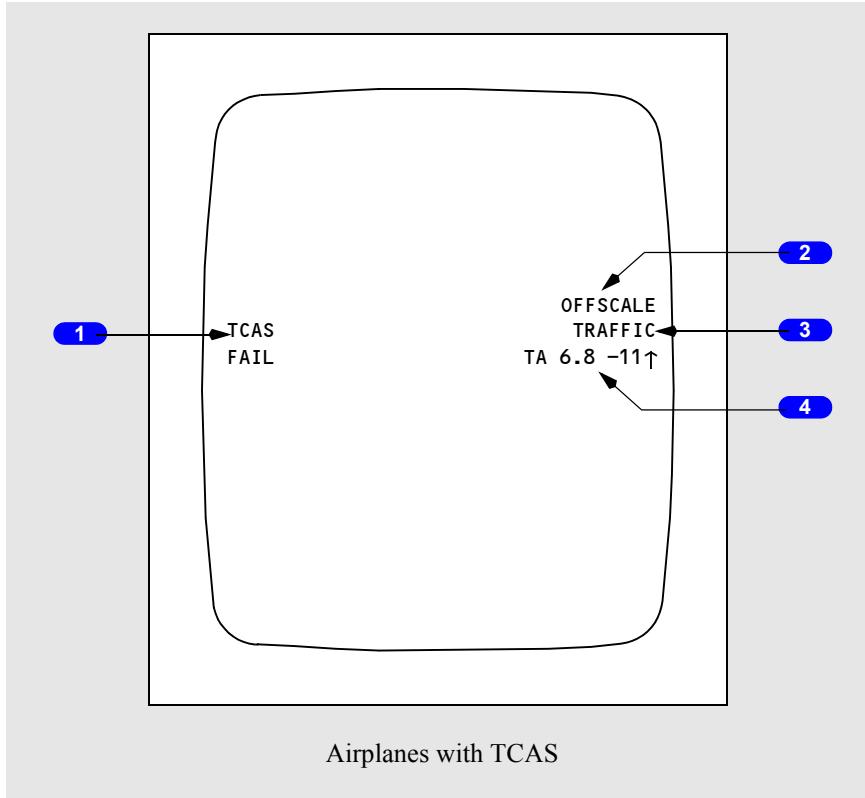
TCAS

Symbol	Name	Applicable Mode(s)	Remarks
	TCAS resolution advisory (RA), relative altitude (R)	MAP CTR MAP EXP NAV EXP VOR/ ILS	These symbols are displayed only when the EFIS control panel traffic (TFC) switch is selected on. Refer to Chapter 15, Warning Systems.
	TCAS traffic advisory (TA), relative altitude (A)		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.
	TCAS proximate traffic, relative altitude (W)		For relative altitude symbols, the number and related signs indicate altitude of traffic in hundreds of feet relative to the airplane.
	TCAS other traffic, relative altitude (W)		For absolute altitude symbols, the number indicates altitude of traffic in thousands and hundreds of feet.
	TCAS TA, absolute altitude		For both relative and absolute altitude, 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 CTR MAP EXP NAV EXP VOR/ ILS	Message provides traffic type, range in NM, altitude and vertical direction.

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Symbol	Name	Applicable Mode(s)	Remarks
TRAFFIC	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 selected on.
OFFSCALE	TCAS off scale message (RA-R, TA-A)	MAP CTR MAP EXP NAV EXP VOR/ ILS	Displayed whenever RA or TA traffic is outside the traffic area covered by the selected range. Displayed only if the EFIS control panel TFC switch is selected on.
TFC	TCAS mode (B)	MAP CTR MAP EXP NAV EXP VOR/ ILS	Indicates the TCAS display is active; the EFIS control panel TFC switch is selected on.
TA ONLY	TCAS mode (B)	All	Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off.
TCAS TEST	TCAS mode (B)	All	Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.
TCAS OFF	TCAS mode (A)	All	Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA, whether EFIS control panel TFC switch is selected on or off. Not displayed if TCAS is failed or in test.
TCAS FAIL	TCAS mode (A)	All	Indicates TCAS failure, whether EFIS control panel TFC switch is selected on or off. Once displayed, can be cycled on/off with the TFC switch.

EHSI TCAS Messages



1 TCAS Mode Display

TFC (green) – TFC selected on EFIS control panel in the MAP, VOR, or ILS mode.

TCAS TEST (white) – TCAS in test mode.

TCAS FAIL (amber) – TCAS failed.

TA ONLY (green) – TCAS TA ONLY mode is selected (displayed in all EHSI modes whether TFC is selected or not).

TCAS OFF (white) – TCAS is selected OFF (displayed in MAP, VOR, and ILS modes).

2 OFFSCALE

Displayed (amber) – TA traffic beyond EHSI display range.

Displayed (red) – RA traffic beyond EHSI display range.

3 TRAFFIC

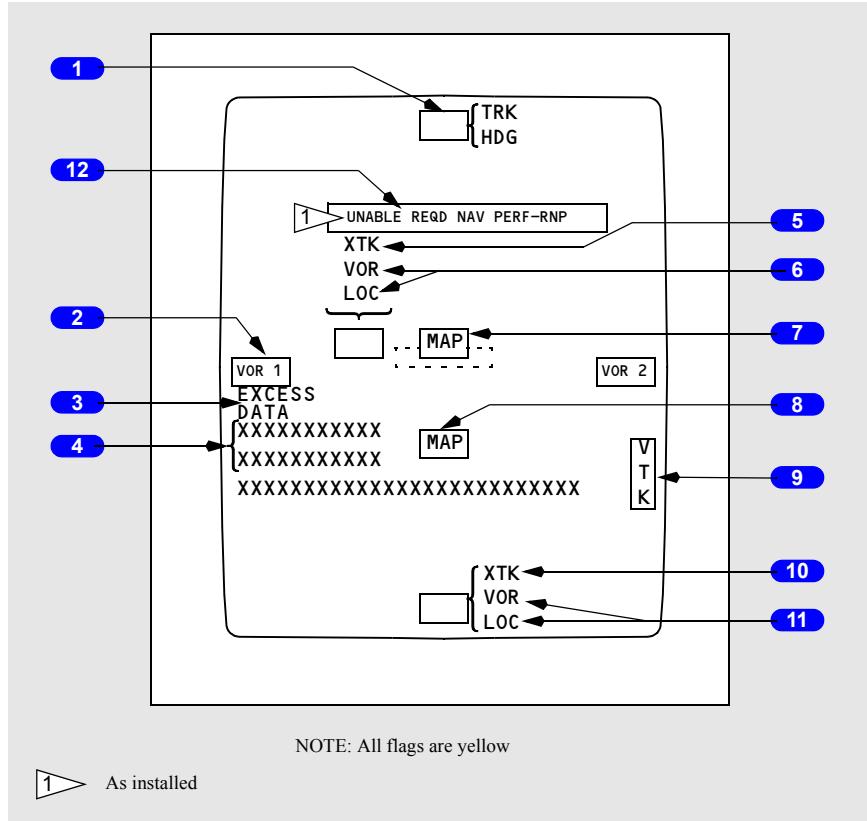
Displayed (amber) – TA condition exists

Displayed (red) – RA condition exists.

4 No Bearing Messages

Displayed (red or amber) – No bearing information available for traffic (see EHSI symbology chart for display).

EHSI System Failure Flags and Annunciations



1 Track (TRK) or Heading (HDG) Flag

Track or heading data has failed.

2 VOR Flag

Indicates failure of a VOR display on the EHSI (displayed here if the MAP or CTR MAP mode is selected and the VOR/ADF switch is on).

3 EXCESS DATA Annunciation

- refresh rate of MAP display has dropped below limit
- display may flicker at lower refresh rates.

4 WXR Annunciations (left justified, two lines)

- WXR FAIL – indicates weather radar has failed (no weather data displayed)
- WXR WEAK – indicates weather radar calibration fault
- WXR ATT – indicates loss of attitude stabilization for antenna
- WXR STAB – indicates antenna stabilization is off
- WXR DSPY – indicates loss of display unit cooling or an overheat condition of the EHSI. Weather radar display is blanked.

5 Crosstrack (XTK) Deviation Flag

Indicates failure of the FMC crosstrack deviation data (displayed here if the FULL NAV mode is selected).

6 VOR, LOC Flag

Indicates failure of the EHSI VOR or LOC display (displayed here if the FULL VOR/ILS mode is selected).

7 MAP Flag

Indicates failure of associated FMC generated map display (displayed here if CTR MAP mode is selected).

8 MAP Flag

Displayed here if MAP mode is selected.

9 Vertical Track (VTK) Flag (typical location)

Indicates failure of the FMC vertical track data.

10 Crosstrack (XTK) Deviation Flag

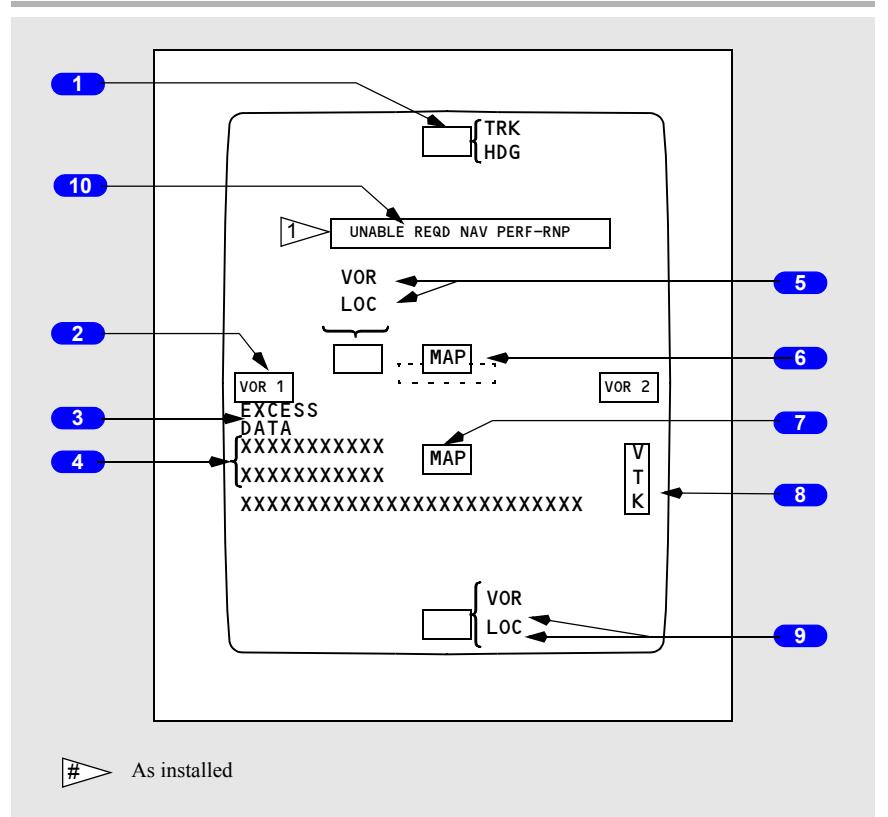
Displayed here if the EXP NAV mode is selected.

11 VOR, LOC Flag

Displayed here if the EXP VOR/ILS mode is selected.

12 NAV Advisory Message

UNABLE REQD NAV PERF–RNP – Indicates that FMC ANP is not sufficient for the current special RNP (displayed here if MAP or CTR MAP is selected). See Chapter 11, Section 31, Flight Management System Operation, for further details.



1 Track (TRK) or Heading (HDG) Flag

Track or heading data has failed.

2 VOR Flag

Indicates failure of a VOR display on the EHSI (displayed here if the MAP or CTR MAP mode is selected and the VOR/ADF switch is on).

3 EXCESS DATA Annunciation

- refresh rate of MAP display has dropped below limit
- display may flicker at lower refresh rates.

4 WXR Annunciations (left justified, two lines)

- WXR FAIL – indicates weather radar has failed (no weather data displayed)
- WXR WEAK – indicates weather radar calibration fault

- WXR ATT – indicates loss of attitude stabilization for antenna
- WXR STAB – indicates antenna stabilization is off
- WXR DSPY – indicates loss of display unit cooling or an overheat condition of the EHSI. Weather radar display is blanked.

5 VOR, LOC Flag

Indicates failure of the EHSI VOR or LOC display (displayed here if the FULL VOR/ILS mode is selected).

6 MAP Flag

Indicates failure of associated FMC generated map display (displayed here if CTR MAP mode is selected).

7 MAP Flag

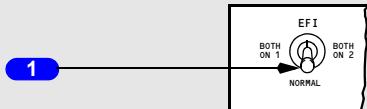
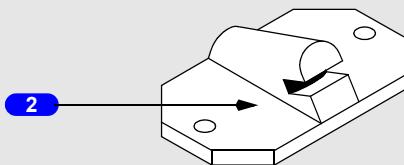
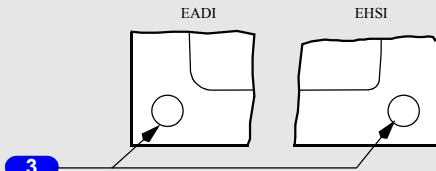
Displayed here if MAP mode is selected.

8 Vertical Track (VTK) Flag (typical location)

Indicates failure of the FMC vertical track data.

9 VOR, LOC Flag

Displayed here if the EXP VOR/ILS mode is selected.

EFI Transfer Switch and EFIS Light Sensors**FORWARD OVERHEAD PANEL****GLARESHIELD****CAPT INSTRUMENT PANEL
F/O INSTRUMENT PANEL****CAPT INSTRUMENT PANEL
F/O INSTRUMENT PANEL****1 Electronic Flight Instrument (EFI) Transfer Switch**

NORMAL – Captain's and First Officer's EFIS displays are generated from their related symbol generators.

BOTH ON 1 – Both EFIS displays are generated from the No. 1 symbol generator.

BOTH ON 2 – Both EFIS displays are generated from the No. 2 symbol generator.

2 Remote Light Sensor

Provides automatic adjustment of EFIS EADI and EHSI display brightness as a function of ambient light coming through the associated forward window.

3 Integral Light Sensors

Provide automatic control of EFIS EADI and EHSI display brightness as a function of ambient light striking the face of the display units.

4 Instrument Transfer Switch (INSTR SWITCH) Light

ILLUMINATED—one or both of the instrument transfer switches (EFI or IRS) has been moved out of the normal position.

Flight Instruments, Displays EFIS System Description

Chapter 10 Section 40

Introduction

The electronic flight instrument system (EFIS) consists of two symbol generators (SGs), two control panels (CPs), two electronic attitude director indicators (EADIs or ADIs), two electronic horizontal situation indicators (EHSIs or HSIs), and ambient light sensing units. The EFIS utilizes information provided by a variety of aircraft systems to generate the appropriate visual presentations on the EHSI and EADI. Data relating primarily to navigation is provided by aircraft systems such as the navigation radios, flight management computer (FMC), and the inertial reference systems (IRSSs). Data relating primarily to automatic flight is provided by the flight control computers (FCCs), the autothrottle (A/T), and the FMC. Data which is used to display current aircraft state information is provided by the air data computers (ADCs) and the IRSSs. Automatic adjustment of the display intensity for each display unit is provided by the ambient light sensing units. Flight crew control of the EFIS displays is accomplished by positioning the various controls on the respective EFIS control panels to the desired settings.

EFIS Failure Flags and Annunciations

In addition to the normal EFIS displays, various failure annunciations, flags, or indications may be displayed on the EADI or EHSI.

The location of the different failure flags and annunciations is depicted in the EADI and EHSI SYSTEM FAILURE FLAGS AND ANNUNCIATIONS figures included in the EFIS controls and indicators section.

Not all EFIS displays will be replaced by a failure flag or annunciation if the signal from the sending unit has failed. In these instances, failure is indicated by removal of the data or the affected portions of the display.

Note: The EFIS displays respond to a VHF NAV receiver failure by removing the associated magenta deviation bar and/or pointer. In response to an ADF receiver failure, the associated display symbol(s) (ADF pointers or vectors) are removed from the EHSI.

EFIS Symbol Generator

Two symbol generators form the heart of the EFIS. The SGs receive inputs from various aircraft systems, then generate the proper visual displays for the related EADI and EHSI.

EFIS Control Panels

Each SG is connected to an EFIS control panel. Using the related EFIS control panel, a flight crew member can select the EHSI display mode, the EHSI display options, the EHSI display range, the EADI decision height reference, and the EHSI weather radar display option. The EFIS control panels also allow the flight crew to adjust the EADI, EHSI, and weather radar display brightness levels.

Electrical Power

The electronic flight instrument system operates on 115 volt AC power. With loss of all airplane generators, the Captain's and the First Officer's EFIS are inoperative. The Standby Instruments provide a backup source of information in this event.

EFIS Cooling

The Battery Bus energizes the Equipment Cooling Normal Supply fan which cools the Electronic Flight Instrument System. If the Equipment Cooling Normal Supply fan does not operate, the EFIS will become hot. When EFIS gets too hot it will automatically stop operation by first becoming mono-chromatic, and then, after 60 minutes or more, the EFIS will power down.

Electronic Attitude Director Indicator

The EADI presents conventional EADI displays for attitude (pitch and roll), flight director commands, localizer deviation and glide slope deviation. In addition, the EADI displays information relating to autoflight system mode annunciations, airplane speed (Vmo/Mmo, minimum speeds, CAS, placards, V1, Vr, etc.), pitch limit, Mach, ground speed, radio height alert, decision height, and radio altitude.

Attitude Display

Airplane attitude data is provided by the IRSs. The IRS's pitch and roll attitude information is valid throughout 360 degrees of rotation in each axis.

Mode Annunciations

Mode annunciations for the A/T and the AFDS are displayed at the top of the EADI displays. A detailed description of the various autoflight mode annunciations and their meanings is contained in Chapter 4.

Flight Director Commands

Flight director guidance commands from the selected FCC are displayed via the flight director symbol on the EADI.

Glide Slope and Localizer Deviation Displays

Glide slope and localizer deviation scales appear when a localizer frequency is tuned on the associated VHF NAV receiver. A valid signal is required before the deviation pointer is displayed.

The normal localizer deviation scale is one degree per dot. When the course deviation is approximately 5/8 degree deviation (5/8 dot) and VOR/LOC is engaged, the scale automatically expands to indicate 1/2 degree deviation per dot. The scale remains expanded until after landing rollout or on a go-around with radio altitude greater than 200 feet.

On a backcourse approach, the symbol generator reverses the polarity of the localizer deviation pointer on the EADI. The reversal occurs when the airplane track differs from selected MCP course by more than 90 degrees. Thus, when the frontcourse is set in the MCP course display, the EADI and EHSI course deviation display will agree on both a frontcourse and a backcourse approach. Additionally, the glideslope scale is not displayed for a backcourse approach.

ILS Deviation Warning

ILS deviation monitoring alerts the flight crew of excessive LOC or G/S deviations. This alerting function is operative during single or dual A/P channel ILS approach. The alerting system is armed when the airplane descends below 1,500 feet radio altitude (RA) with the LOC and G/S captured. If the Captain's or the F/O's LOC deviation exceeds one-half dot expanded scale (one-fourth dot standard scale), the respective LOC scale changes color from white to yellow, and the miniature runway stem flashes.

If the Captain's or F/O's G/S deviation exceeds one dot deviation, the respective G/S scale changes color from white to yellow, and the G/S pointer flashes. G/S deviation alerting will not be initiated below 100 feet RA, but continues to operate below this altitude if the alert was triggered prior to descent below 100 feet RA.

Each pilot's alerting system self-tests upon becoming armed at 1,500 feet RA. This self-test generates a two-second LOC and G/S deviation alerting display on each EADI.

Rising Runway Symbol

The rising runway symbol is an integral part of the LOC deviation display and is positioned at the top of the LOC deviation pointer. The rising runway symbol is displayed in addition to the digital radio altitude display and gives an additional cue to the flight crew of the aircraft's close proximity to the ground as the airplane descends below 200 feet radio altitude. Full scale, vertical movement of the rising runway represents the last 200 feet of radio altitude. Zero feet radio altitude is indicated as the top of the runway symbol rises to the base of the airplane symbol.

The requirements for display of the rising runway symbol are as follows:

- valid ILS/LOC frequency selected
- valid radio altitude data
- radio altitude less than 2,500 feet.

If any of the above conditions are not met, the runway symbol is not displayed.

Pitch/Roll Comparator

A yellow “PITCH” or “ROLL” alerting annunciation is displayed on both EADIs if either symbol generator detects a difference of more than 3 degrees between the Captain’s and F/O’s pitch or roll displays. A short time delay is incorporated to minimize nuisance annunciations.

Radio Height Alert

The radio height alert is triggered when the airplane descends below 2,500 feet AGL. The alert is turned off when the airplane continues to descend below 500 feet AGL or climbs above 2,500 feet AGL, or after pressing the decision height reset switch on the EFIS control panel.

Digital Radio Altitude and Decision Height

When radio altitude is less than 2,500 feet, a digital display of radio altitude is depicted in the lower right hand corner of the EADI. At all other times, the digital radio altitude display is blanked.

When a positive decision height has been selected on the related EFIS control panel, the letters “DH” and the decision height are displayed just above the digital radio altitude display of the associated EADI.

When descending through the selected DH, a DH alert occurs which replaces the green “DH” letters and decision height with a large, yellow “DH” that flashes momentarily, then remains steady yellow. At the same time the DH alert is triggered, the digital radio altitude display also changes from white to yellow.

The DH alert is reset if any one of the following occurs:

- the DH Reset Switch on the EFIS Control Panel is pressed
- the radio altitude increases to DH +75 feet
- the radio altitude is equal to zero feet (i.e. during touchdown).

Note: Following an electrical power interruption, the DH value defaults to 200 feet.

Mach Display

The current Mach number from the related air data computer (ADC) is displayed if the following are satisfied:

- accelerating – Mach is equal to or greater than .40
- decelerating – Mach previously above .40 and still greater than .38.

Ground Speed Display

A digital presentation of the current ground speed is displayed. The ground speed data is received from the FMC or the IRS, with the FMC being the primary source. The numeric range is from 0 knots to 999 knots.

Pitch Limit Symbol

The position of the pitch limit symbol is a function of the stall warning computer. the pitch limit symbol appears any time the flaps are extended.

During takeoff, the pitch limit symbol is fixed at 15 degrees pitch attitude until the stall warning computer commands a value greater than 15 degrees (at approximately 100 knots). Above this speed, the position of the pitch limit symbol is a function of the various inputs to the stall warning computer and is limited to a maximum of 30 degrees of pitch.

In general, the pitch limit symbol is programmed so that stick shaker activation will coincide with a pitch attitude equal to the pitch limit symbol indication.

In a rapid pull up, the pitch attitude may exceed the pitch limit symbol indication for a brief period of time without initiating the stick shaker warning.

On some airplanes delivered in 1989 and earlier, when light weight, the stick shaker may be activated by the low speed limit logic of the stall warning computer even though the pitch limit symbol is positioned slightly above the airplane symbol.

Speed Tape Display

The speed tape display consists of a graduated scale which moves relative to a fixed airspeed reference pointer. The pointer contains a rolling digit readout of current airspeed. Various symbols related to airplane performance are positioned on the speed tape. An explanation of the various speed tape symbols follows.

Speed Tape Scale

A range of approximately 84 knots is displayed on the speed tape. Numbers are placed on the tape at 20 knot intervals from 40 knots to 420 knots. The speed tape scale scrolls up and down, and current airspeed is indicated by the digital readout.

Digital Readout

A digital readout of the current calibrated airspeed is located within the fixed airspeed reference pointer. The units digit “rolls” continuously based on the current fractional unit value of the calibrated airspeed to emulate the rolling digit readout of a conventional electrical/mechanical airspeed indicator.

Airspeed Trend Arrow

A green arrow of variable length which points to the predicted airspeed that the airplane will achieve within the next 10 seconds. This prediction is based on the present airspeed and airspeed acceleration. The airspeed trend arrow is not displayed unless its magnitude is greater than 4 knots. The airspeed trend arrow is removed when its magnitude becomes less than 3 knots.

Command Speed

The command speed is displayed as a magenta, double-line cursor located on the speed tape scale if the command speed is within the currently displayed speed tape range. It is displayed in a numerical form, above or below the speed tape scale, if the command speed is not within the currently displayed speed tape range. The indicated command speed is equivalent to the selected speed on the MCP or to the FMC command speed, whichever is applicable.

Maximum Operating Speed (VMO/MMO or Gear/Flap Placards)

The maximum operating speed is represented by the high speed red and black barber pole. The position of the maximum operating speed symbol is a function of data supplied to the symbol generator from the stall warning computer. The maximum operating speed is the lower of the gear-extended placard speed, the flaps-extended placard speed, or VMO/MMO.

High Speed Buffet Limit

The high speed buffet limit is represented by the bottom of a hollow yellow bar that extends from the bottom of the VMO/MMO symbol at high altitude. As the airplane climbs to altitudes above 25,000 feet, the yellow bar begins to extend to give an indication of the speed that would provide a .3G margin to high speed buffet. At lower altitudes, the VMO/MMO speed is more limiting and the high speed buffet limit symbol is no longer visible. Since the stall warning computer uses FMC gross weight to calculate the high speed buffet margin speed, this display is not available if the FMC is inoperative or unable to compute gross weight.

Next Flap Placard Speed

The next flap placard speed uses the same symbol as the high speed buffet limit. If the airplane is in the air, and flaps are lowered, the hollow yellow bar extends from the high speed end of the speed tape. The end of the hollow yellow bar now represents the placard speed for the next normal flap position. Next flap placard speeds are displayed only for those flap positions that would normally be used during an approach and landing. The next flap placard symbol is blanked when current flap position equals the selected landing flap configuration on the FMC/CDU APPROACH REF page or when the flaps are being retracted.

Flaps Up Maneuvering Speed

Flaps up maneuvering speed is indicated by a small green circle on the speed tape. This speed is an output of the stall warning computer and is based on the actual gross weight as computed by the FMC. It represents the best airspeed (climb or driftdown) for an airplane in the clean configuration. This function is not enabled until flaps are up.

V1 (decision) Speed

V1 speed is depicted by a green “–1” located opposite the V1 speed on the speed tape if the V1 speed is within the displayed range. If the selected V1 speed is not within the displayed range, a green “V1” with the numeric value of the V1 speed is displayed at the high speed end of the speed tape.

Before the V1 speed is displayed on the speed tape, V1 must be entered on the FMC/CDU TAKEOFF page.

VR (Rotation) Speed

VR speed is depicted by a green “–R” located opposite the rotation speed if the rotation speed is within the displayed range. The “–R” symbol is blanked if the rotation speed is not within the displayed range.

Before the VR speed is displayed on the speed tape, VR must be entered on the FMC/CDU TAKEOFF page.

VREF (Reference) Speed

The Vref speed is represented by the “–R” symbol. The FMC/CDU APPROACH REF page displays Vref speeds based on the current gross weight for three landing flap settings. The flight crew may select the FMC computed speed or manually enter another value into the field corresponding to the desired landing flap configuration. This speed will then be transmitted by the FMC, and the symbol generator will display the “–R” symbol opposite that speed on the speed tape.

Note: The FMC updates the computed Vref speeds (small-size characters) as fuel is burned off based on fuel totalizer inputs. A Vref value does not update once it has been selected for transmission to the speed tape. If the flight crew manually inserts a gross weight on the APPROACH REF page, the FMC computed Vref speeds will be based solely on the manually entered gross weight as long as the APPROACH REF page remains in view. A manually entered gross weight is not updated as fuel is burned off.

Minimum Flap Retraction Speed

Minimum flap retraction speed is indicated by a green “–F” on the right side of the speed tape. This speed is computed by the stall warning computer. It represents the speed that will provide the minimum maneuver speed (depicted by the end of the low speed yellow bar) for the next normal flap position (i.e., flap positions 5, 1, or UP only). The display will respond to the effects of extending the flight spoilers.

Minimum Maneuvering Speed

Represented by the end of the low speed hollow yellow bar. If the airplane is at low altitude, and is flown at this speed, a .3G maneuver margin to stick shaker is provided. This would allow for a 40-degree bank turn while maneuvering in level flight.

If the airplane is at high altitude and is flown at the minimum maneuver speed, a .3G maneuver margin to low speed buffet is provided as opposed to a .3G to stick shaker margin. Since the stall warning computer uses FMC gross weight to calculate the minimum maneuver speed at high altitudes, this symbol is not displayed at high altitude if the FMC gross weight is not available.

The display will reflect the effect of extending the flight spoilers.

Stick Shaker Speed

Represented by the end of the low speed red and black striped barber pole. This speed represents the airspeed at which the angle of airflow vanes will activate the stick shaker warning. The source of the stick shaker airspeed is the stall warning computer. The display will reflect the effects of extending the flight spoilers.

Electronic Horizontal Situation Indicator (EHSI)

General

Each EHSI presents an electronically generated color display of conventional HSI navigation data (VOR/ILS and NAV modes). Each EHSI is also capable of displaying the airplane's flight progress on a plan view map (MAP and CTR MAP modes), or the airplane's flight plan on a plan view map oriented to true north (PLAN mode).

Excluding operation in the FULL NAV, FULL VOR/ILS, and PLAN modes, each EHSI also serves as a weather radar display when the WXR Switch on the respective EFIS Control Panel is ON.

During normal operation, each EHSI receives information from its own symbol generator. Each symbol generator receives data from a variety of aircraft systems to support the EHSI displays.

Display Orientation

The various displays on the EHSI are oriented in one of two ways, either "heading-up" or "track-up." With "heading-up" orientation, all displayed data is referenced to aircraft heading as shown at the twelve o'clock position on the compass rose. With "track-up" orientation, all displayed data is referenced to aircraft track as shown at the twelve o'clock position on the compass rose.

During normal operation, heading reference data is supplied to each EHSI from the respective IRS.

Airplane track data is supplied by the FMC. If the FMC track data should become unreliable, track data is automatically supplied by the respective IRS.

EFIS Control Panel

The EFIS control panels provide selection of the EHSI display mode, display range, display brightness, weather radar display (ON or OFF and display brightness), and MAP data options. During normal operation, each panel controls the display for the related EHSI.

The selectable display modes are:

- MAP
- CTR MAP (Center Map)
- FULL NAV (Full Rose Navigation)
- EXP NAV (Expanded Rose Navigation)
- FULL VOR/ILS (Full Rose VOR/ILS)
- EXP VOR/ILS (Expanded Rose VOR/ILS)
- PLAN

On some airplanes -

The selectable display modes are:

- MAP
- CTR MAP (Center Map)
- FULL VOR/ILS (Full Rose VOR/ILS)
- EXP VOR/ILS (Expanded Rose VOR/ILS)
- PLAN

MAP Mode

The MAP mode displays a plan view of the airplane's position relative to the FMC flight plan and/or FMC data base waypoints and navaids. The FMC flight plan and/or FMC data base waypoints and navaids and other map symbols are displayed on the map background. The map background moves relative to the fixed airplane symbol. Displayed information includes airplane heading; airplane track; route of flight; curved trend vector(s); range to altitude; wind direction and velocity; distances; ETA's; altitude constraints; FMC database airports, navaids, waypoints; VOR/ADF bearing radials; ADF bearing pointers; and weather radar displays.

The map display is a "track-up" oriented display.

CTR MAP Mode

The CENTER MAP mode provides the same data as the MAP mode with the exception that the airplane symbol is located at the center of the display so that map data behind the airplane is within the viewing area.

FULL and EXP NAV Modes (as installed)

The navigation mode is used when a conventional display of FMC navigation course deviation is desired. In addition to the conventional FMC course deviation data displayed, the NAV mode also displays distance to the active waypoint, active waypoint identifier, ETA's or ETE's, ADF bearing pointers (if an ADF bearing is being received), wind direction and magnitude, and system source annunciation.

The NAV mode may be displayed with a conventional, FULL compass rose, or with a simplified, EXPANDED compass rose format.

The NAV mode display is a "track-up" oriented display.

FULL and EXP VOR/ILS Modes

The VOR/ILS mode is useful when tracking or referencing VHF radio navigation signals using a VHF navigation receiver. The VOR/ILS mode displays course deviation using conventional EHSI presentations.

In addition to the conventional navigation data displayed, the VOR/ILS mode also displays DME distance to the navaid, ADF bearing pointers (if an ADF bearing is being received), wind direction and velocity, system source annunciation, and selected frequency (not displayed if in auto tune mode).

The VOR/ILS mode may be displayed with a conventional, FULL compass rose, or with a simplified, EXPANDED compass rose format.

The VOR/ILS mode display is a “heading-up” oriented display.

PLAN Mode

The PLAN mode is a map display which may be used to view an FMC flight plan route, either in total for a short route, or waypoint-by-waypoint for a longer route. The PLAN mode display is oriented to true north.

Weather Radar Display

Display of weather radar returns on the EHSI is enabled or disabled by the WXR switch on the respective EFIS control panel. Radar returns can be displayed in all EHSI modes except the FULL NAV, FULL VOR/ILS and PLAN modes. A more detailed discussion of weather radar operation is contained in Chapter 11.

Instrument Transfer Switching

During normal operation, each pilot's EFIS displays utilize independent inertial reference system (IRS) and symbol generator (SG) inputs. In the event of IRS or SG failure, input sources may be switched. Other related instrument transfer switching is discussed in Chapter 11.

The EFI transfer switch determines the SG source for the Captain's and F/O's EADI and EHSI displays. With the EFI Transfer Switch in the NORMAL position, the No. 1 SG provides display symbols for the Captain's EFIS displays, and the No. 2 SG provides display symbols for the F/O's EFIS displays. If the EFI transfer switch is in the BOTH ON 1 position, both sets of displays utilize symbols provided by the No. 1 SG, and the No. 2 SG is turned off. If the EFI transfer switch is in the BOTH ON 2 position, both sets of displays utilize symbols provided by the No. 2 SG, and the No. 1 SG is turned off. The autopilot will use data only from a single IRU source when the EFI transfer switch is in either the BOTH ON 1 or BOTH ON 2 position.

The IRS transfer switch selects the IRS that supplies inputs to the respective SG as well as to other airplane systems (see Chapter 11). With the IRS transfer switch in the NORMAL position, the left IRS provides inputs to the No. 1 SG, and the right IRS provides inputs to the No. 2 SG. If the IRS transfer switch is positioned to BOTH ON L, the left IRS provides data to both SG's. If the IRS transfer switch is positioned to BOTH ON R, the right IRS provides data to both SG's.

Light Sensing and Brightness Control

There are two sets of ambient light sensors that automatically adjust the brightness of the EADI and EHSI displays. The Captain's and F/O's displays are independently adjusted. Two remote light sensors, located on the instrument glare shield, adjust brightness of the associated EADI and EHSI as a function of light coming through the forward windows. Two integral light sensors, located in the EADI and EHSI instrument bezels (one per display unit), work in parallel to adjust the brightness of the EADI and EHSI displays as a function of ambient light shining on the face of either display. Manual adjustment of the display brightness, above and below the brightness level set by the automatic system, is accomplished by adjusting the brightness controls on the associated EFIS control panel.

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Flight Management, Navigation

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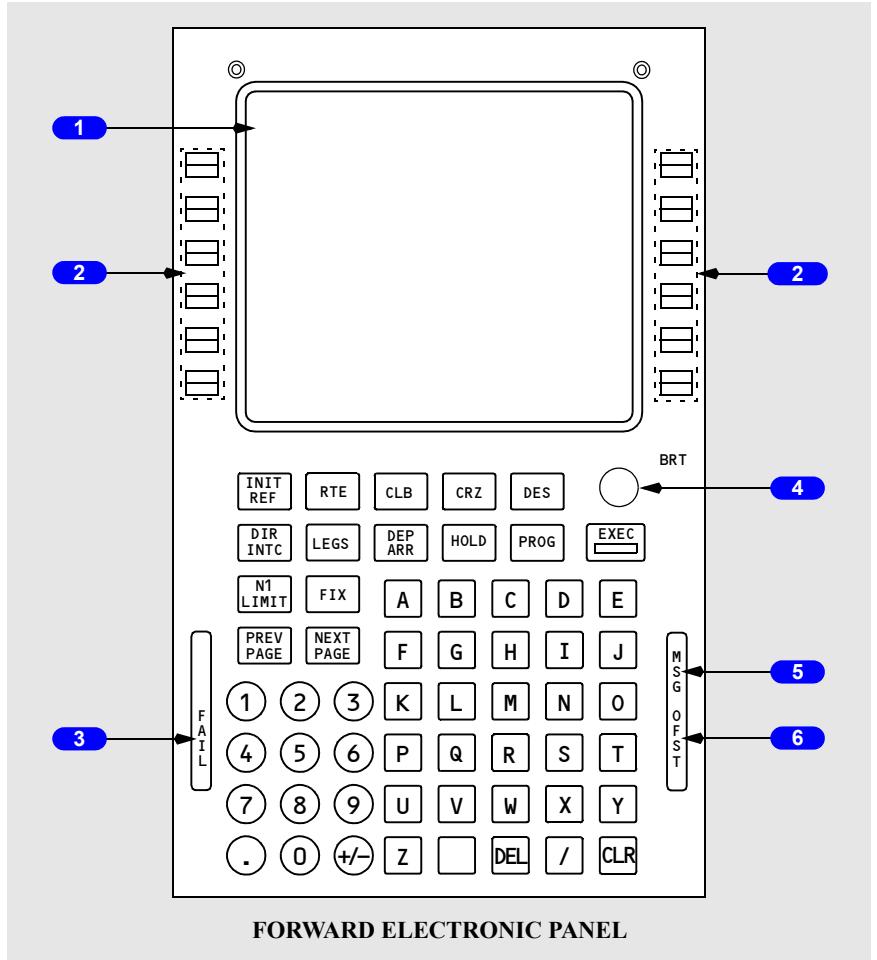
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Flight Management, Navigation Controls and Indicators

Chapter 11 Section 10

Flight Management System

Control Display Unit (CDU)



1 Control Display Unit (CDU) Display

Shows FMS data pages.

2 Line Select Keys

Push –

- moves data from scratchpad to selected line
- moves data from selected line to scratchpad
- selects page, procedure, or performance mode as applicable
- deletes data from selected line when DELETE is shown in scratchpad.

3 FAIL Light

Illuminated (amber) – the FMC has failed.

4 Brightness Control

Rotate – controls display brightness.

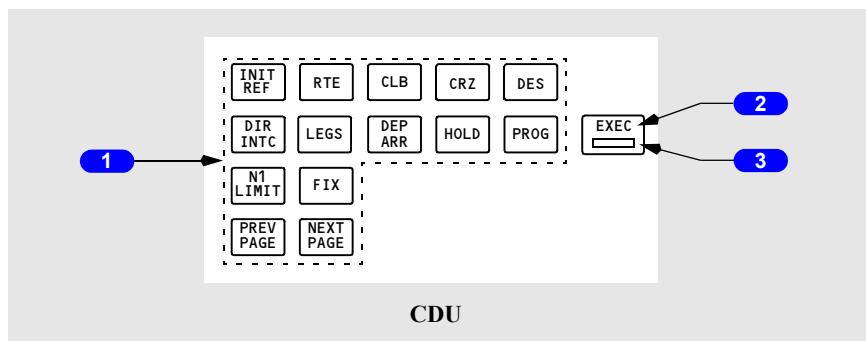
5 Message (MSG) Light

Illuminated (white) – scratchpad message is shown.

6 Offset (OFST) Light (U7 and on)

Illuminated (white) – LNAV gives guidance for lateral route offset.

Function and Execute Keys



1 CDU Function Keys

Push –

- INIT REF – shows page for data initialization or for reference data
- RTE – shows page to input or change origin, destination, or route
- CLB – shows page to view or change climb data
- CRZ – shows page to view or change cruise data
- DES – shows page to view or change descent data

- DIR INTC – shows page to modify route to fly directly from present position to any waypoint or to intercept any course to any waypoint
- LEGS –
 - shows page to evaluate or modify lateral and vertical data
 - shows page to control PLAN mode display
- DEP ARR – shows page to input or change departure and arrival procedures
- HOLD – shows page to create holding patterns and show holding pattern data
- PROG – shows page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- N1 LIMIT – shows page to view or change N1 thrust limits
- FIX – shows page to create reference points on map display
- PREV PAGE – shows previous page of related pages (for example, LEGS pages)
- NEXT PAGE – shows next page of related pages.

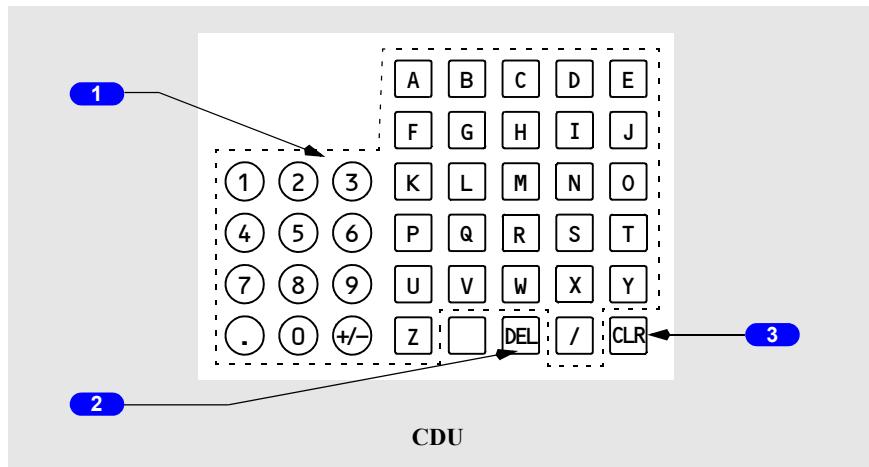
2 Execute (EXEC) Key

Push –

- makes data modification(s) active
- extinguishes execute light.

3 Execute Light

Illuminated (white) – active data is modified but not executed.

Alpha/Numeric and Miscellaneous Keys

1 Alpha/Numeric Keys

Push –

- puts selected character in scratchpad
- Slash (/) key – puts “/” in scratchpad
- Plus Minus (+/-) key – first push puts “–” in scratchpad. Subsequent pushes alternate between “+” and “–”.

2 Delete (DEL) Key

Push – puts DELETE in scratchpad.

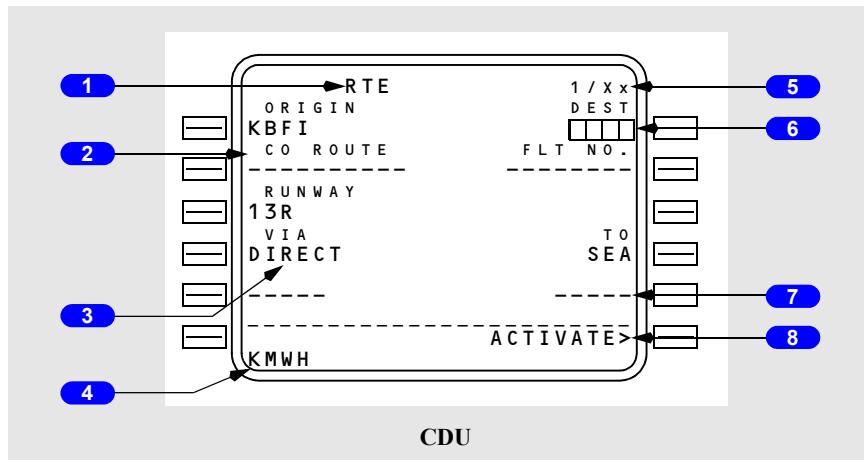
3 Clear (CLR) Key

Push –

- clears the last scratchpad character
- clears scratchpad message.

Push and hold – clears all scratchpad data.

CDU Page Components



1 Page Title

Subject or name of data shown on page.

ACT (active) or MOD (modified) shows whether page contains active or modified data.

2 Line Title

Title of data on line below.

3 Line

Shows –

- prompts
- selections
- options
- data.

4 Scratchpad

Shows messages, alpha-numeric entries or line selected data.

5 Page Number

Left number is page number. Right number is total number of related pages.

6 Boxes

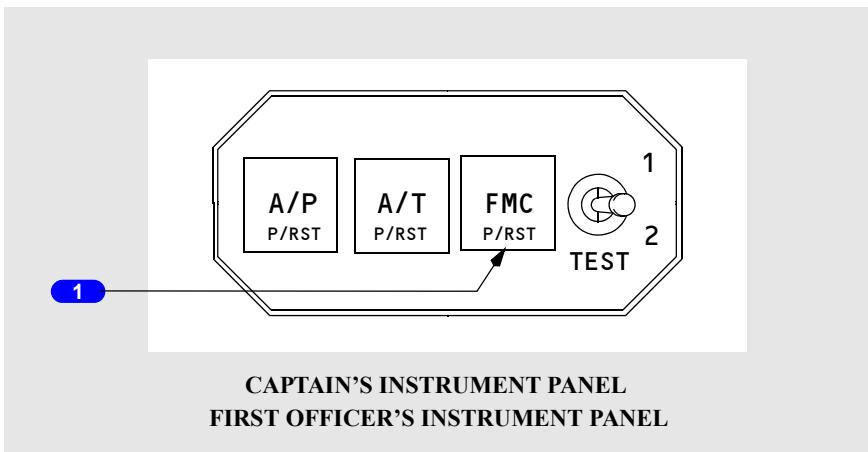
Data input is mandatory.

7 Dashes

Data input is optional. The data is not mandatory.

8 Prompts

Show pages, select modes, and control displays. Caret “<” or “>” is before or after prompt.

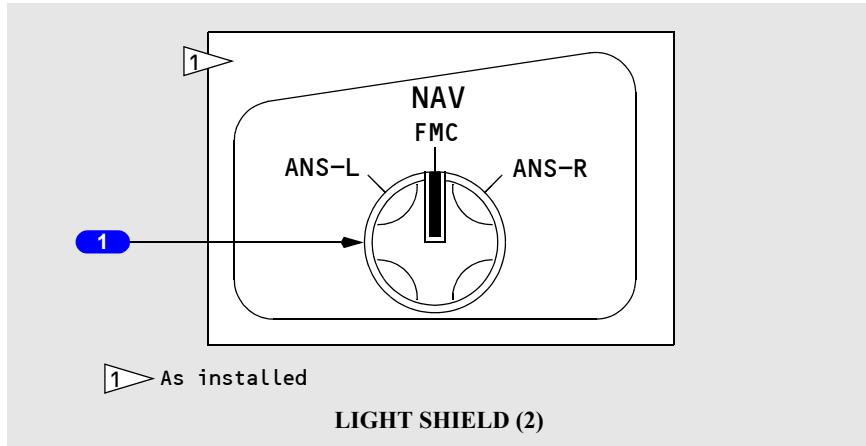
FMC Alert Light

1 FMC Alert Light

Illuminated (amber) –

- the FAIL light on both CDUs is illuminated, or
- an alerting message exists for both CDUs, or
- test switch is in position 1 or 2.

Push – both pilots' FMC alert lights extinguish.

Navigation Mode Selector**1 Navigation (NAV) Mode Selector**

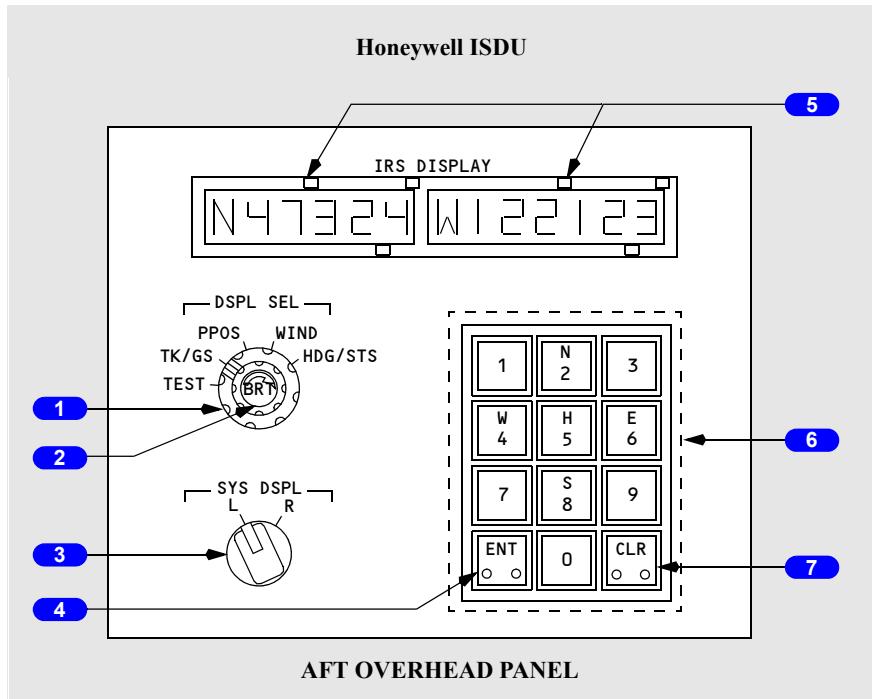
When the associated flight control computer (FCC A or FCC B) is the master, the respective selector (Captain or First Officer) determines the source of guidance and control commands provided to the AFDS. The selector also determines the source for data displays.

FMC – The flight management computer is providing AFDS LNAV and VNAV commands and display information.

ANS L – The left ANCDU of the alternate navigation system is providing AFDS LNAV commands and display information.

ANS R – The right ANCDU of the alternate navigation system is providing AFDS LNAV commands and display information.

When the selector is not in the FMC position, only NAV mode information is provided to the EHSIs.

Inertial System**IRS Display Unit (ISDU)****1 Display Selector (DSPL SEL)**

TEST (spring-loaded to TK/GS) –

- all lights in data displays and on the mode selector unit momentarily illuminate, followed by a 10 second self-test
- use only during alignment.

TK/GS –

- left window displays true track (course)
- right window displays present ground speed (knots).

PPOS –

- left window displays present latitude
- right window displays present longitude.

WIND –

- left window displays present inflight true wind direction
- right window displays present inflight wind speed (knots).

HDG/STS –

- left window displays present true heading
- right window displays any applicable maintenance status codes
- during alignment, right window displays minutes remaining until alignment is complete. For alignments greater than 7 minutes, the window displays 7 until the time remaining reaches 6 minutes. The display then counts down in one minute intervals.

2 Brightness (BRT) Control

Rotate – adjusts brightness of the data displays.

3 System Display (SYS DSPL) Selector

L – selects left IRS for the data displays.

R – selects right IRS for the data displays.

4 Enter (ENT) Key

Illuminated (white) – N, S, E, W, or H entries are being keyed.

Push – keyed data is entered into IRS following completion of valid self-test for reasonableness.

5 Data Displays

Two windows display data for the IRS selected with the system display selector

- type of data displayed is normally determined by the display selector
- keyboard entry of present position or magnetic heading overrides the selected display
- last digit of each window is for a decimal place (tenths).

6 Keyboard

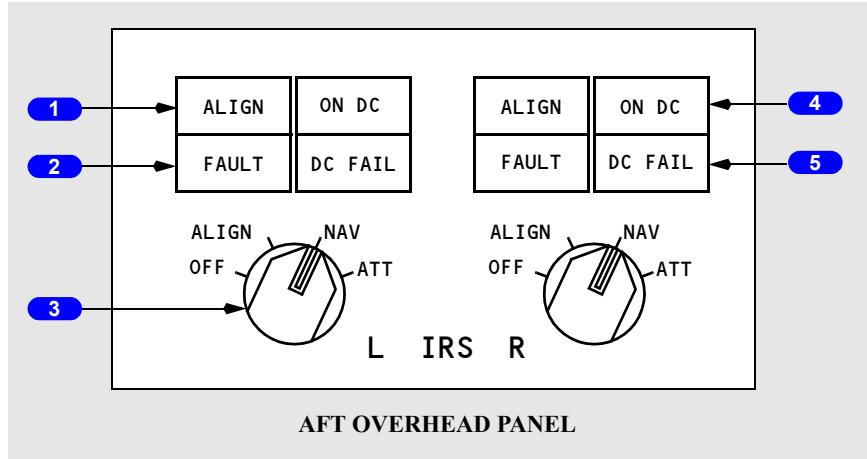
Push –

- alpha keys:
 - data displays are controlled by the keyboard when the N, S, E, W (latitude/longitude) or H (heading) keys are pushed
 - pushing an alpha key arms the keyboard for numeric entries.
- numeric keys:
 - permit manual entry of present position when ALIGN light is illuminated
 - permit manual entry of magnetic heading when either mode selector is in ATT.

7 Clear (CLR) Key

Illuminated (white) – an ENT attempt has failed (entry not accepted by IRS).

Push – clears data display of any data not yet entered or accepted. If illuminated, cue lights extinguish.

IRS Mode Selector Unit**1 ALIGN Light**

Illuminated (white) –

- steady – the related IRS is operating in the ALIGN mode, the initial ATT mode, or the shutdown cycle
- flashing – alignment cannot be completed due to IRS detection of:
 - significant difference between previous and entered positions (unreasonable present position) or
 - no present position entry.

Extinguished –

- IRS not in ALIGN mode
- with mode selector in NAV, alignment is complete, and all IRS information is available
- with mode selector in ATT, attitude information is available. Heading information is available following entry of initial magnetic heading.

2 FAULT Light

Illuminated (amber) – a system fault affecting the related IRS ATT and/or NAV modes has been detected.

3 Inertial Reference System (IRS) Mode Selector

OFF –

- alignment is lost
- all electrical power is removed from the system after a 30 second shutdown cycle.

ALIGN –

- rotating the selector from OFF to ALIGN initiates the alignment cycle
- rotating the selector from NAV to ALIGN automatically updates alignment and zeroes ground speed error.

NAV (detented position) –

- system enters the NAV mode after completion of the alignment cycle and entry of present position
- in NAV mode, all IRS information is available to airplane systems for normal operations.

ATT – provides only attitude and heading information:

- attitude information is invalid (attitude flag in view) until ALIGN light is extinguished
- heading information is invalid (heading flags in view) until the actual magnetic heading is manually entered and the ALIGN light is extinguished
- position and ground speed information is not available until the IRS is aligned on the ground
- the selector must be cycled to OFF before reselecting ALIGN or NAV.

4 ON DC Light

Illuminated (amber) –

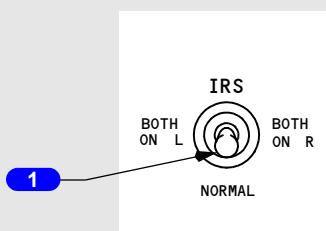
- the related IRS is operating on DC power from the switched hot battery bus (AC power not normal)
- if on the ground, the ground-call horn in the nose wheel well sounds, providing an alert that a battery drain condition exists
- momentary illumination is normal during alignment self-test.

5 DC FAIL Light

Illuminated (amber) –

- DC power for the related IRS is not normal
- if the other lights are extinguished, the IRS is operating normally on AC power.

IRS Transfer Switch



FORWARD OVERHEAD PANEL

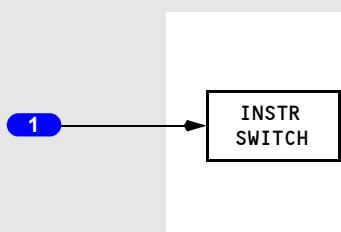
1 Inertial Reference System (IRS) Transfer Switch

BOTH ON L – switches the flight instruments attitude and heading source to left IRS.

NORMAL – flight instruments attitude and heading source is from default IRS.

BOTH ON R – switches the flight instruments attitude and heading source to right IRS.

Instrument Transfer Switch Light



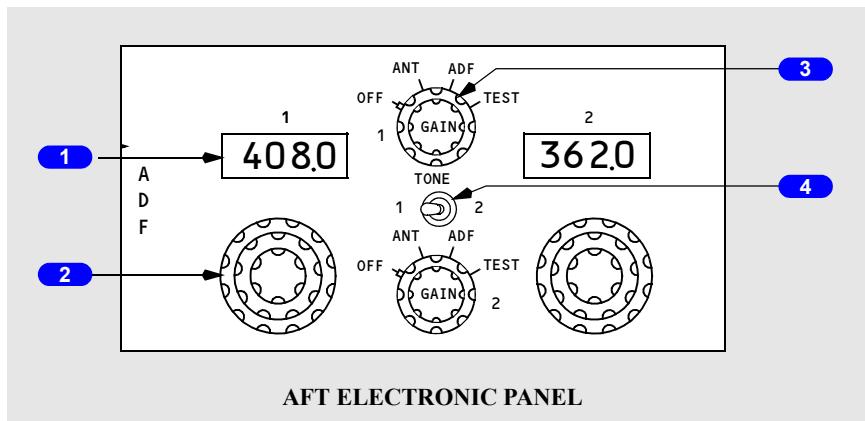
CAPTAIN'S INSTRUMENT PANEL
FIRST OFFICER'S INSTRUMENT PANEL

1 Instrument Transfer Switch Light (INSTR SWITCH)

Illuminated (amber) – one or both of the instrument transfer switches (EFI or IRS) has been moved from the normal position.

Radio Navigation Systems

Automatic Direction Finding (ADF) Control



1 Frequency Indicator

Indicates the frequency selected with the related frequency selector.

2 Frequency Selector

Rotate –

- outer knob sets the hundreds number
- middle knob sets the tens number
- inner knob sets the tenths and ones number.

3 Mode Selector

OFF – removes power from associated receiver.

ANT – receiver sends only station audio.

ADF – receiver sends bearing and station audio.

TEST – ADF bearing pointer indicates 45 degrees left of lubber line.

GAIN – adjusts receiver gain.

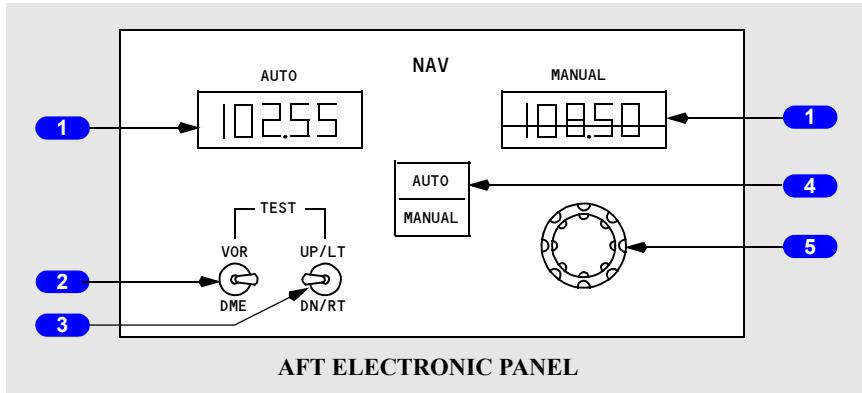
4 TONE Switch

1 – adds tone to ADF receiver No. 1 audio.

2 – adds tone to ADF receiver No. 2 audio.

CENTER – disables tones.

VHF Navigation Control



1 Frequency Indicators

AUTO –

- displays frequency automatically tuned by the FMC
- display is blank when MANUAL tuning is selected
- displays dashes during agility tuning.

MANUAL –

- indicates the frequency selected by the frequency selector
- a red bar appears over MANUAL frequency when AUTO tuning is selected.

2 VOR/DME TEST Switch

VOR –

- with a VOR frequency tuned and a course of 000 selected:
 - deviation bar moves to centered position
 - bearing pointer slews to 180 degrees
 - the TO/FROM ambiguity indicates FROM.

DME –

- with a DME tuned:
 - shows DME fail flag
 - DME displays dashes
 - all zeroes (not to exceed 000.5) appear.

3 ILS TEST Switch

UP/LT –

- With ILS frequency tuned and a course within 90 degrees of airplane heading:
 - pointers display one dot up and one dot left.

DN/RT –

- With ILS frequency tuned and a course within 90 degrees of airplane heading:
 - pointers display one dot low and one dot right.

4 AUTO/MANUAL Switch

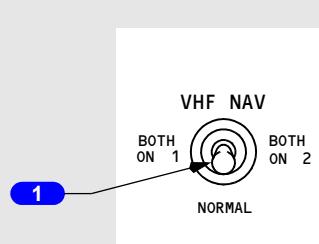
AUTO (illuminates white) – tuning automatically accomplished by the FMC.

MANUAL (illuminates white) – tuning accomplished manually by rotating the frequency selector.

5 Frequency Selector

Rotate – manually selects the desired frequency.

VHF NAV Transfer Switch



FORWARD OVERHEAD PANEL

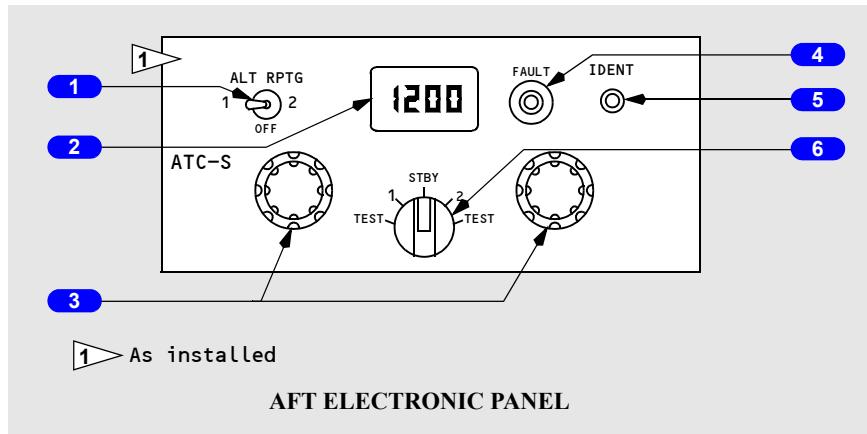
1 VHF NAV Transfer Switch

BOTH ON 1 – switches the VHF navigation source to VHF NAV receiver No. 1.

NORMAL – VHF navigation source is from default VHF NAV receiver.

BOTH ON 2 – switches the VHF navigation source to VHF NAV receiver No. 2.

Transponder Panel

**AFT ELECTRONIC PANEL**

1 Altitude Reporting (ALT RPTG) Switch

- 1 – enables altitude reporting from air data computer No. 1.
- OFF – transponder operates without altitude reporting.
- 2 – enables altitude reporting from air data computer No. 2.

2 Air Traffic Control (ATC) Code Indicator

Shows transponder code.

3 Air Traffic Control (ATC) Code Selectors

Rotate – sets transponder code in transponder.

4 FAULT Light

Illuminated (amber) – indicates transponder malfunction.

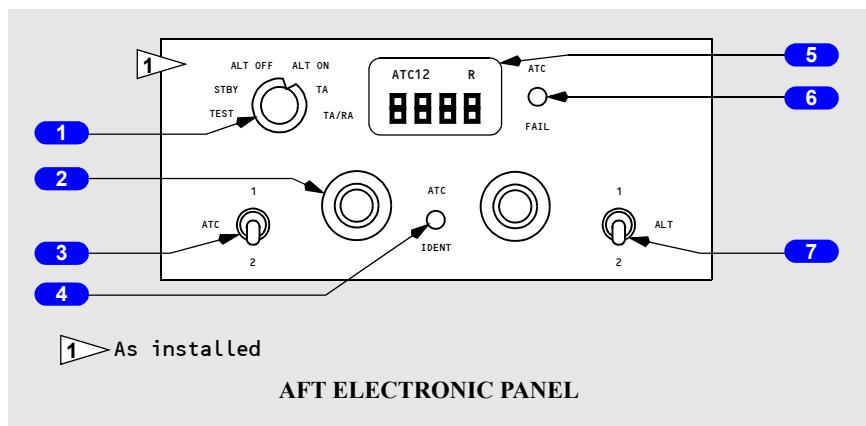
5 Identification (IDENT) Switch

Push – transmits an identification signal.

6 Transponder Mode Selector

- TEST – starts ATC transponder functional test for transponder No. 1.
- 1 – selects transponder No. 1.
- STBY – does not transmit.
- 2 – selects transponder No. 2.

TEST – starts ATC transponder functional test for transponder No. 2.



1 Transponder Switch

TEST – the ATC FAIL light illuminates to indicate the selected transponder is operational.

STBY – disables transponder modes.

Note: Transponder modes are enabled only when the airplane is airborne, except for mode S, which operates continuously when the transponder mode selector is out of STBY.

ALT OFF – transponder operates without altitude reporting.

ALT ON – transponder operates with altitude reporting.

TA – enables display of traffic advisory TCAS targets.

TA/RA – enables display of traffic advisory and resolution advisory TCAS targets.

Refer to Chapter 15, Warning Systems.

2 Air Traffic Control (ATC) Code Selector

Rotate – sets transponder code in transponder.

3 Transponder Selector

1 – selects transponder No. 1.

2 – selects transponder No. 2.

4 Air Traffic Control Identification (ATC IDENT) Switch

Push – transmits an identification signal.

5 Air Traffic Control (ATC) Code Indicator

Shows transponder code.

Shows operating transponder (1 or 2).

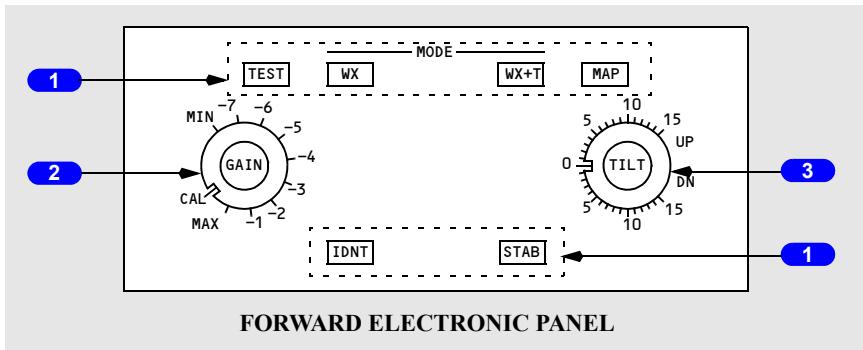
6 Transponder Air Traffic Control (ATC) FAIL Light

Illuminated – indicates transponder malfunction or test.

7 Altitude Reporting Switch

1 – enables altitude reporting from Air Data Computer No. 1.

2 – enables altitude reporting from Air Data Computer No. 2.

Weather Radar Panel**1 Weather Radar Mode Switches**

Push – selects mode.

- TEST – shows test pattern on map display with WXR selected (except in PLAN mode) and tests transmitter (transmits only up to one second).
- WX – shows weather radar returns at selected gain level
- WX+T (turbulence) – shows weather radar returns and turbulence. Turbulence display is available on the EHSI if the selected map range is 50 nautical miles or less

Note: Turbulence detection requires presence of detectable precipitation.
Clear air turbulence cannot be detected by radar.

- MAP – shows ground returns at selected gain level

- IDNT – suppresses ground return in WX and WX+T modes
- Note:** Continuous operation is not recommended because weather return intensity may be reduced.
- STAB – stabilizes the system from the IRS, placing the antenna under control of the receiver-transmitter to correct for changes in airplane attitude.

2 GAIN Control

Rotate – sets gain in WX, WX+T, and MAP modes.

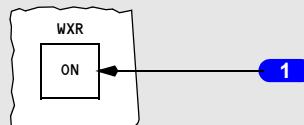
CAL (calibrated) – gain is set to calibrated level in the full counterclockwise position.

3 TILT Control

Rotate clockwise – radar antenna tilts up to selected degrees from horizon.

Rotate counterclockwise – radar antenna tilts down to selected degrees from horizon.

Weather Radar Power - EFIS



EFIS CONTROL PANEL

1 Weather Radar Switch

Push - energizes the weather radar transmitter allowing display of weather radar returns on the EHSI.

Flight Management, Navigation Navigation Systems Description

Chapter 11 Section 20

Introduction

Navigation systems include the flight management system (FMS); inertial reference system (IRS); radio navigation systems (ADF, DME, ILS, marker beacons, and VOR); transponder; and weather radar.

Flight Management System

The flight management system (FMS) is comprised of the following components:

- flight management computer system (FMCS)
- autopilot/flight director system (AFDS)
- autothrottle (A/T)
- inertial reference systems (IRS).

Each of these components is an independent system, and each can be used independently or in various combinations. The term FMS refers to the concept of joining these independent components together into one integrated system which provides continuous automatic navigation, guidance, and performance management.

The integrated FMS provides centralized flight deck control of the airplane's flight path and performance parameters. The flight management computer, or FMC, is the heart of the system, performing navigational and performance computations and providing control and guidance commands.

The primary flight deck controls are the AFDS MCP, two control display units (CDUs), and two electronic flight instrument system (EFIS) control panels. The primary displays are the CDUs, electronic attitude director indicator (EADI), electronic horizontal situation indicator (EHSI), and thrust mode display.

The FMC uses crew entered flight plan information, airplane systems data, and data from the FMC navigation database and performance database to calculate airplane present position, and pitch, roll, and thrust commands required to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route information are sent to the respective pilot's EHSI. The EFIS control panels are used to select the desired information for navigation display. The mode control panel is used to select the autothrottle, autopilot, and flight director operating modes.

Inertial System

The inertial system computes airplane position, ground speed, and attitude data for the flight instruments, flight management system, autoflight system, and other systems. The major components of the inertial system are the inertial reference units (IRUs), an inertial system display unit (ISDU), IRS mode select unit (MSU), and an IRS transfer switch.

Inertial Reference System

Two independent IRSs are installed. Each IRS has three sets of laser gyros and accelerometers. The IRSs are the airplane's sole source of attitude and heading information, except for the standby attitude indicator and standby magnetic compass.

In their normal navigation mode, the IRSs provide attitude, true and magnetic heading, acceleration, vertical speed, ground speed, track, present position, and wind data to appropriate airplane systems. IRS outputs are independent of external navigation aids.

IRS Alignment

An IRS must be aligned and initialized with airplane present position before it can enter the navigation (NAV) mode. The present position is normally entered through the FMC CDU. If the present position cannot be entered through the FMC CDU, it may be entered through the ISDU keyboard. The airplane must remain stationary during alignment.

Normal alignment, between $70^{\circ} 12'$ north and $70^{\circ} 12'$ south latitudes is initiated by rotating the MSU switch from OFF to NAV. The IRS performs a short power test, during which the ON DC light illuminates. When the ON DC light extinguishes and the ALIGN light illuminates, the alignment process begins. Airplane present position should be entered at this time. The IRS will automatically enter the NAV mode after approximately 10 minutes, and the ALIGN light will extinguish.

High latitude alignment, at latitudes between $70^{\circ} 12'$ and $78^{\circ} 15'$, requires an extended alignment time. Alignment is initiated by rotating the MSU switch from OFF to ALIGN. After 17 minutes the MSU switch must be rotated to the NAV position. The IRS will then immediately enter the NAV mode.

Magnetic variation between 73° north and 60° south is stored in each IRS memory. The data corresponding to the present position are combined with the true heading to determine magnetic heading. If magnetic variation information is not available, special navigation equipment is required to provide true heading to the EHSIs.

If the latitude/longitude position is not within 4 NM of the origin airport, the CDU scratchpad message VERIFY POSITION is displayed. If the entered latitude/longitude position does not pass the IRS internal comparison tests, the scratchpad message ENTER IRS POSITION is displayed.

The flashing ALIGN light alerts the crew that the position entered does not pass one of the two internal comparison tests and should be checked for accuracy. If the entered position does not agree with the last stored position, the first internal test is failed, and the ALIGN light will flash. If the same position is reentered, the IRS will accept the position and continue the alignment process. A second internal position test compares the entered latitude with the system-computed latitude. If this test is failed, the ALIGN light will again flash. If two consecutive entries of the same position do not pass the second internal position test, the FAULT light will illuminate. If the test is passed, the IRS will proceed to complete the alignment process and enter NAV mode.

During transit or through-flight stops with brief ground times, a thirty second fast realignment and zeroing of ground speed error may be performed by selecting ALIGN while the airplane is parked. Present position should be simultaneously updated by manually entering latitude and longitude prior to selecting NAV.

Note: If the airplane is moved during alignment or fast realignment, the IRSs automatically begin the full alignment process, and shutdown is not necessary. (For aircraft manufactured after 01/1990).

Loss of Alignment

If an IRS loses both AC and DC power, the alignment is lost. Alignment can be lost if the MSU switch is moved out of the NAV position.

If alignment is lost in-flight, the navigation mode (including present position and ground speed outputs) is inoperative for the remainder of the flight. However, selecting ATT allows the attitude mode to be used to relevel the system and provide an attitude reference. The attitude mode requires approximately thirty seconds of straight and level unaccelerated flight to complete releveling. Some attitude errors may occur during acceleration, but will be slowly removed after acceleration stops.

The attitude mode can also provide heading information, but to establish compass synchronization the crew must manually enter the initial magnetic heading. Drift of up to 15 degrees per hour can occur in the IRS heading. Therefore, when in ATT mode, an operating compass system must be periodically cross-checked and an updated magnetic heading entered in the IRS, as required.

IRS Entries

Manual IRS entries of present position or magnetic heading are normally accomplished on the POS INIT page of the FMC/CDU. The ISDU may also be used.

IRS Power

The IRSs can operate on either AC or DC power. The left IRS is normally powered from the AC standby bus, and the right IRS from the AC transfer bus 2. If AC power is not normal, either or both systems automatically switch to backup DC power from the switched hot battery bus. Backup DC power to the right IRS is automatically terminated if AC power is not restored within five minutes.

Initial power-up requires battery bus power available and the IRS mode selector to be in ALIGN, NAV, or ATT. If the IRS is turned off, it must complete a full realignment cycle before the airplane can be moved.

If AC electrical power is subsequently removed from the airplane, the switched hot battery bus continues to supply electrical power to the IRS. The ON DC light illuminates, and the horn in the landing gear wheel well sounds to alert maintenance personnel that the IRS is on battery power.

When the IRS mode selector is turned OFF, the IRS remains powered for approximately 30 seconds. The ALIGN light illuminates until the system is completely shut down.

Inertial System Display Unit (ISDU)

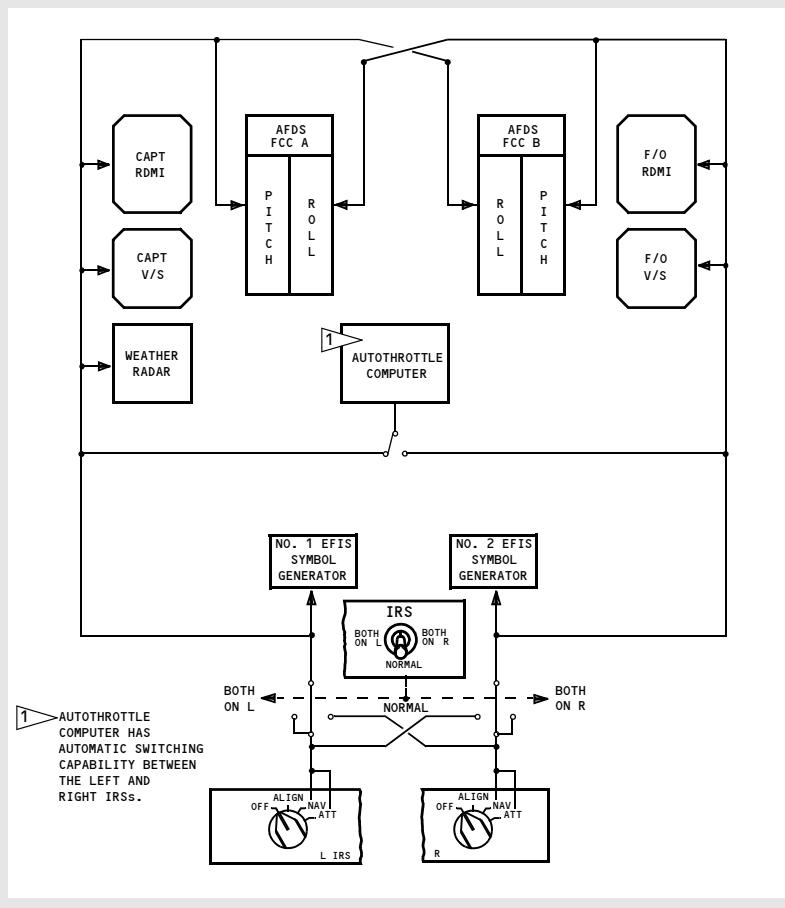
The ISDU is located on the aft overhead panel and displays data according to the position of the display selector and system selector. The ISDU also contains a keyboard for entry of present position and heading.

Mode Select Unit (MSU)

The MSU is located on the aft overhead panel and is used to select the operating mode for each IRS. Indicator lights on the MSU show status of each IRS.

IRS Transfer Switch

Should either IRS fail, the IRS transfer switch is used to switch all associated systems to the functioning IRS.

IRS Instrument Transfer Switch Schematic**Radio Navigation Systems****Automatic Direction Finding (ADF)**

An automatic direction finding (ADF) system enables automatic determination of magnetic and relative bearings to selected facilities.

Two ADF receivers are installed. The ADF bearing signals are sent to the pointers on the EHSIs and RDMIs. The audio is heard by using the ADF receiver control on the audio selector panel.

If heading or track information is lost or invalid, ADF bearing pointers on the EHSI will not be displayed, and the ADF bearing pointers on the RDMI will not display the correct magnetic bearing. Relative bearings indicated by pointers may be correct if the receiver is operating.

Distance Measuring Equipment (DME)

Two DME systems are installed. Each may be tuned automatically by the FMC or manually on the VHF navigation control panel. The position of the AUTO/MANUAL switch determines the tuning mode.

With the AUTO mode selected, the FMC autotunes DME receivers as necessary for position updating. During normal operations, two different DME signals or a collocated DME and VOR signal provide an accurate radio geographical position to the FMC.

DME distance is displayed on the EHSIs and RDMDs when the receivers are tuned to a VOR/DME station or a collocated DME and localizer facility.

Instrument Landing System (ILS)

Two ILS receivers are installed. They are controlled by manual tuning on the VHF navigation control panels.

ILS information is displayed on the EADIs and EHSIs. The ILS localizer and glideslope can also be displayed on the standby horizon.

LOC updating of the FMC occurs only after the ILS is manually tuned. The tuned ILS frequency is displayed in the VOR/ILS display mode.

Very High Frequency Omni Range (VOR)

Two VOR receivers and two control panels are installed. The VHF navigation control panel is used to select VOR and ILS frequencies. Each may be tuned automatically by the FMC or manually on the VHF navigation control panel. The position of the AUTO/MANUAL switch determines the tuning mode.

VOR information is displayed on the EHSIs and RDMDs. VOR-DME radio updating is available in the automatic or manual modes if a valid, in-range, VOR-DME station is selected.

Left and right VOR bearings are displayed on the RDMI when a valid in-range VOR station is tuned and the respective VOR/ADF bearing pointer switch is in the VOR position. The EHSI displays course deviation when operating in the VOR mode.

VHF NAV Transfer Switch

Should either VOR receiver fail, the VHF NAV transfer switch enables selection of the opposite VHF NAV receiver for display.

ATC Transponder

Two ATC transponders are installed and controlled by a single control panel. The ATC transponder system transmits a coded radio signal when interrogated by ATC ground radar. Altitude reporting capability is provided.

Transponders may also transmit information, such as flight number, airspeed or groundspeed, magnetic heading, altitude, GPS position, etc., depending on the level of enhancement. Airport equipment monitors airplane position on the ground when the transponder is active through Mode S capability (mode selector not in STANDBY or OFF). TCAS modes should not be used on the ground for ground tracking.

On airplanes with TCAS, TCAS is controlled from the transponder panel. The TCAS system is described in Chapter 15.

Weather Radar

The X band color weather radar system detects and locates various types of precipitation bearing clouds along the flight path of the airplane and gives the pilot a visual indication in color of the clouds' intensity.

In WX mode, the radar displays a cloud's rainfall intensity by displaying colors contrasted against a black background. Areas of heaviest rainfall appear in red, the next level of rainfall in yellow, and the least rainfall in green.

In WX+T mode, the radar displays normal precipitation and precipitation associated with turbulence. When the radar detects a horizontal flow of precipitation with velocities of 5 or more meters per second toward or away from the radar antenna, that target display becomes magenta. This magenta area is associated with heavy turbulence. The detection of turbulence is automatically limited to a 50 nautical mile range, regardless of the selected range.

In MAP mode, the radar displays surfaces in red, yellow, and green (most reflective to least reflective).

These displays enable identification of coastlines, hilly or mountainous regions, cities, or large structures. Ground mapping mode can be useful in areas where ground-based navigation aids are limited.

The radar system performs only the functions of weather detection and ground mapping. It should not be used or relied upon for proximity warning or anticollision protection.

The IDNT mode activates the ground clutter reduction feature. Signals that are determined to have a high probability of originating from ground returns will be automatically removed from the display. Some portions of weather targets may be removed as well. The IDNT mode is provided for analysis by the pilot and is not for continuous use.

Flight Management, Navigation Flight Management System Description

Chapter 11 Section 30

Introduction

The flight management system (FMS) aids the flight crew in managing automatic navigation, in-flight performance optimization, 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 (bugs) on the airspeed and N1 indicators to assist in flying efficient profiles.

The flight crew enters the desired route and flight data into the CDU(s). The FMS then uses its navigation database, airplane position, and supporting system data to calculate commands for manual or automatic flight path control.

The FMS can automatically tune the navigation radio(s) and determine LNAV courses. The FMS navigation database provides the necessary data to fly routes, SIDs, STARs, holding patterns, and (U6 and on) procedure turns. (U7 and on) Lateral offsets from the programmed route can be calculated and commanded.

For vertical navigation, computations include items such as fuel burn data, optimum speeds, and recommended altitudes. Cruise altitudes and crossing altitude restrictions are used to compute VNAV commands. When operating in the Required Time of Arrival (RTA) mode, the computations include required speeds, takeoff times, and en route progress information.

Flight Management Computer (FMC)

The basis of the flight management system is the flight management computer. Since the term FMC is universally understood, it is used here for standardization and simplification.

Different FMC configurations may be installed due to a software update program. For example, terminology such as “U5” or “U10” is used throughout the manual when necessary to identify information which is unique to a specific FMC configuration. A reference such as “U7 and on”, for example, includes U7 and all updates higher than U7. A reference such as “U7 to U10.5A”, for example, includes U7 and U10.5A and all updates between U7 and U10.5A, but not updates before U7 or after U10.5A. References to an FMC update with more than one version, such as U10, would be used for information not specific to U10.5 or U10.5A, etc. The FMC/CDU IDENT page permits flight crew identification of the installed update.

The FMC uses flight crew-entered flight plan information, airplane systems data, and data from the FMC navigation database to calculate airplane present position, and pitch, roll, and thrust commands required to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route information are sent to EHSIs. The EFIS control panels are used to select the desired information for EHSI display. The mode control panel is used to select the autothrottle, autopilot, and flight director operating modes. Refer to the following chapters for operation of these other systems:

- Chapter 4, Automatic Flight
- Chapter 10, Flight Instruments, Displays.

The FMC and CDU are used for en route and terminal area navigation and to supplement primary navigation means when conducting other types of nonprecision approaches.

The FMC satisfies the requirements of Basic Area Navigation (B-RNAV) when operated in accordance with this Operations Manual.

A single FMC is not certified as a sole source of navigation system. It is certified to navigate accurately in conjunction with an accurate radio navaid environment.

Airplanes which are equipped with the Alternate Navigation System (ANS) are certified for operations outside radio navaid coverage, due to the independent position monitoring capability afforded by the ANCDU and the capability to navigate using the IRS positions if the FMC position should become unreliable.

When external position updating is not available, the FMC uses the IRS position as reference. When the IRS is the only position reference, the FMC applies an automatic correction to the IRS position to determine the most probable FMC position. This correction factor is developed by the FMC's monitoring IRS performance during periods of normal position updating to determine the typical IRS error value. It is important to note that, when external position updating is not available, navigation accuracy may be less than required. Flight crews should closely monitor FMC navigation, especially when approaching the destination. The accuracy of the FMC navigation should be determined during descent phase by using radio navaids and radar information if available.

Note: Inaccurate position updating may cause the airplane to deviate from the desired track.

Control Display Units (CDUs)

Two identical, independent CDUs provide the means for the flight crew to communicate with the FMC. The crew may enter data into the FMC using either CDU, although simultaneous entries should be avoided. The same FMC data and computations are available on both CDUs; however, each pilot has control over what is displayed on an individual CDU.

On airplanes with an ANCDU, there is an alternate mode of navigation using the ANCDU's own internal computer. ANCDU capability is similar to an inertial navigation system and provides backup navigation if the FMC fails. The ANCDU provides IRS based lateral navigation capability only.

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Flight Management, Navigation Flight Management System Operation

Chapter 11 Section 31

Introduction

When first powered, the FMS is in the preflight phase. As a phase is completed, the FMS automatically transitions to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete.

Preflight

During preflight, flight plan and load sheet information are entered into the CDU. The flight plan defines the route of flight from the origin to the destination and initializes LNAV. Flight plan and load sheet information provide performance information to initialize VNAV.

Required preflight information consists of:

- initial position
- route of flight
- performance data
- takeoff data.

Optional preflight data includes:

- navigation database
- SID
- STAR
- RTA data
- cruise wind
- reduced takeoff and climb thrust limits.

Each required or optional data item is entered on specific preflight pages.

Preflight begins with the IDENT page. If the IDENT page is not displayed, it can be selected from the IDENT prompt on the INIT/REF INDEX page. Visual prompts provide assistance in selecting the appropriate CDU pages. Preflight pages can be manually selected in any order.

After entering and checking the necessary data on each preflight page, the lower right line select key is pushed to select the next page. When ACTIVATE is selected on the RTE page, the execute light illuminates. The EXEC key is then pushed to complete the task of making the route active before continuing with the preflight.

If a standard instrument departure (SID) is to be entered into the route, the departure/arrival (DEP/ARR) page is selected. After selecting the desired SID, the resulting modification must be appropriately linked to the existing route and executed. This can be accomplished on the RTE or RTE LEGS page.

When all required preflight entries are complete, the preflight status prompts on the TAKEOFF REF page are no longer displayed.

Takeoff

The takeoff phase begins with selection of TO/GA and extends to the thrust reduction altitude where climb thrust is normally selected.

Climb

The climb phase begins at the thrust reduction altitude and extends to the top of climb (T/C) point. The T/C point is where the airplane reaches the cruise altitude entered on the PERF INIT page.

Cruise

The cruise phase begins at the T/C point and extends to the top of descent (T/D) point. Cruise can include step climbs and en route descents.

Descent

The descent phase begins at the T/D point or when either a level change or vertical speed descent is initiated. The descent phase extends to the beginning of the approach phase.

Approach

The approach phase begins two miles from the first waypoint of a published approach or approach transition selected from the ARRIVALS page.

Flight Complete

After landing, 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.

FMC and CDU Terminology

The following paragraphs describe FMC and CDU terminology. Unless stated otherwise (i.e., “CDU” only”) the term “CDU” shall be generic and be applicable to the CDU, MCDU, or ANCDU as appropriate.

Active – flight plan information currently being used to calculate LNAV or VNAV guidance commands.

Activate – designating an entered route as the active route for navigation. It is a two step process:

- push the ACTIVATE prompt.
- push the execute (EXEC) key.

Altitude restriction – a crossing restriction at a waypoint.

Delete – remove FMC data and revert to default values, dash or box prompts, or a blank entry using the DELETE key.

Econ – a speed schedule calculated to minimize operating cost. The economy speed is based on the flight crew CDU-entered cost index. A low cost index reflects high fuel costs and results in a lower cruise speed.

Enter – placing an entry into the CDU scratchpad and then line selecting the information to the desired location. New characters can be typed, or existing data can be line selected into the scratchpad.

Erase – removing flight crew-entered information, which has resulted in a modification, by pushing the ERASE prompt.

Execute – making modified information part of the active flight plan by pushing the EXEC key.

Inactive – route, climb, cruise, or descent information not currently being used to calculate LNAV or VNAV commands.

Initialize – entering information required to make the system operational.

Message – information the FMC automatically writes in the scratchpad to inform the flight crew of a system condition.

Modify – active data that is changed but not yet executed. When a modification is made to the active route or performance mode, MOD is displayed in the page title, ERASE appears next to line select key 6 left, and the execute key illuminates.

Prompt – CDU displays that aid the flight crew in accomplishing a task. Prompts can be boxes, dashes, or a caredt (< or >) line to remind the flight crew to enter or validate information.

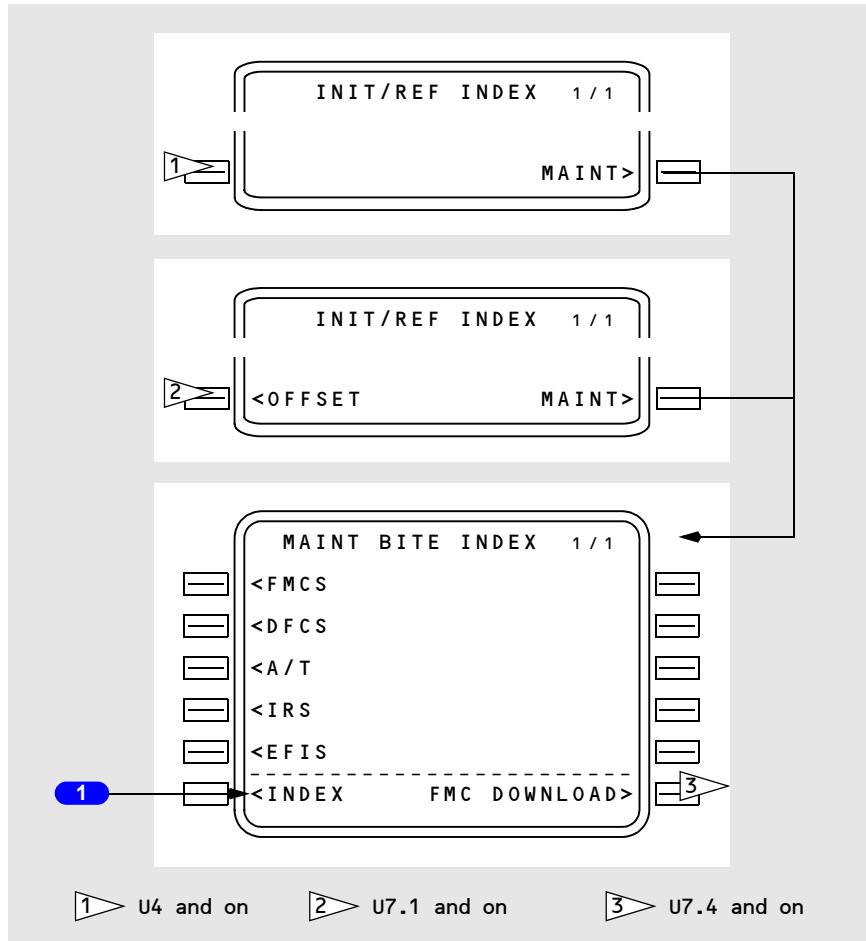
Select – pushing a key to obtain the desired information or action, or to copy selected data to the scratchpad.

Speed restriction – an airspeed limit associated with a specified altitude or waypoint.

Waypoint – a point on the route. It can be a fixed point such as a latitude and longitude, VOR or ADF station, airway intersection, or a non-fixed point such as a conditional waypoint. A conditional waypoint is not necessarily associated with a land reference; it reflects a time position, or altitude requirement. An example of a conditional waypoint is “when reaching 1000 feet”.

Maintenance Index Page

The MAINT BITE INDEX page is available only on the ground and provides access to data for use by maintenance personnel.



1 INDEX

Push - displays the INIT/REF INDEX page.

Navigation Position

The FMC determines present position from the IRS and navigation radios. The FMC uses its calculated present position to generate lateral steering commands along the active leg to the active waypoint.

FMC Position Update

On the ground, the FMC calculates present position based on IRS data.

On the ground prior to takeoff, FMC position update to the takeoff runway threshold position can be done on the TAKEOFF REF page.

In flight, the FMC position is continually updated from the navigation radios and IRS. Updating priority is based on the availability of valid data from the supporting systems.

The FMC position is derived from a mathematical combination of the positions determined by the IRS and radio systems. It represents the FMC's estimate of the actual position of the airplane. Its accuracy varies according to the accuracy of the other position determining systems.

FMC position updates from navigation sensor positions are used in the following priority order:

- two or more DME stations
- one VOR with a collocated DME
- one localizer and collocated DME
- one localizer.

The station identifiers and frequencies of the selected radio navigation aids are displayed on the (U1 through U6) PROGRESS and (U4, U5, and U6) POS SHIFT pages or (U7 and on) NAV STATUS page 1/2.

With the AUTO/MANUAL switch in AUTO, DME radios are automatically tuned by the FMC. The stations to be tuned are selected based upon the best available signals (in terms of geometry and strength) for updating the FMC position. Radio position is determined by the intersection of two DME arcs.

AUTO tuning uses any of several radio modes. The primary mode tunes the radios to separate DME-capable stations. If required, a single radio can cycle between two DME-capable stations. This process is referred to as "agility tuning." The lowest priority radio mode is the use of both VOR and DME from a single station. The FMC does not use VOR information beyond a range of 25 NM.

Note: With both navigation radios in AUTO tuning, if the FMC determines that a navigation radio is unreliable for position updating, it deselects the unreliable radio and uses the good radio for agility tuning. The FMC will tune the unreliable radio to 108.0, which will be displayed in the automatic frequency indicator location.

With the radios selected to MAN, the FMC continues to update its position using manually tuned DME or VOR/DME stations if the tuned stations meet the FMC position updating requirements. ILS frequencies can only be tuned manually, although the FMC will also tune a DME associated with an ILS frequency.

FMC position fixing is more accurate when using DME information only. Best accuracy is with AUTO DME–DME tuning, because the FMC selects stations based on best geometry. Position fixing based on VOR/DME updating is less accurate due to inherent VOR bearing errors, especially when tuning manually. If desired, the crew may inhibit the use of VOR bearing or DME information from a specific VOR/DME station.

If the DME radios fail, or if suitable DME stations are not available, FMC navigation is based on IRS position information only. The two VHF Nav radios are used by the FMC for localizer updating during an ILS approach and by the crew for navigation monitoring.

Note: The FMC is designed to automatically reject unreliable navaid data during FMC position updating. However, in certain conditions, navaids which are in error may satisfy the reasonableness criteria and provide the FMC with an inaccurate radio position. One of the most vulnerable times is when a radio position update occurs just after takeoff. This is usually manifested in an abrupt heading correction after engaging LNAV. The position shift can be seen on the map, which will shift the desired track and runway symbol to a position significantly different from that displayed during ground roll.

Note: If the flight crew observes either of these indications, and an extended period of IRS NAV ONLY flight follows, the FMC should be carefully monitored.

When adequate radio updating is not available, the EHSI map may display a shift error. This error results in the displayed position of the airplane, route, waypoints, and navigation aids shifted from their actual positions.

An across track, undetected map shift may result in the airplane flying a ground track that is offset from the desired track. An along track, undetected 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 EHSI map with data from the ILS, VOR, DME, and ADF systems.

Navigation Performance (U7 and On)

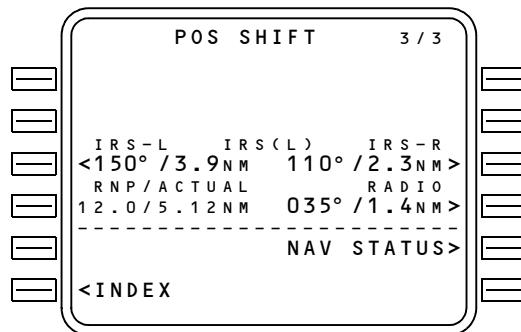
The FMC uses data from the navigation systems to accurately calculate the position of the airplane. The current FMC position is shown on line 1 of the POS REF page 2/3.

The FMC position is derived from a mathematical combination of the positions determined by the IRS, and radio systems. It represents the FMC's estimate of the actual position of the airplane. Its accuracy varies according to the accuracy of the other position determining systems.

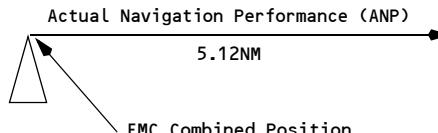
Actual Navigation Performance (ANP)

Actual navigation performance (ANP) is the FMC's estimate of the quality of its position determination. It is shown on POS SHIFT page 3/3 and on RTE LEGS pages. ANP represents the estimated maximum position error with 95% probability. That is, the FMC is 95% certain that the airplane's actual position lies within a circle with a radius of the ANP value around the FMC position. The lower the ANP value, the more confident the FMC is of its position estimate.

Actual Navigation Performance



* Radio Position
 $035^\circ / 1.4 \text{ NM}$



IRS(L) Position
 $150^\circ / 3.9 \text{ NM}$

Actual Aircraft Position Lies Within the ANP Circle

Required Navigation Performance (RNP)

The FMC supplies a default required navigation performance (RNP) value for oceanic, en route, terminal, and approach environments. RNP can also be supplied by the Navigation Database or may be entered by the crew. Actual navigation performance (ANP) should not exceed RNP.

Environment	Default RNP	Time to Alert
Oceanic	12.0 NM	80 sec.
En route	2.0 NM	80 sec.
Terminal	1.0 NM	60 sec.
Approach	0.5 NM	10 sec.

(U7.1 to U10.2A) If ANP exceeds the displayed RNP value, the UNABLE REQD NAV PERF-RNP message will be displayed on the CDU scratchpad after the designated time to alert has elapsed. When in the approach environment, an additional amber UNABLE REQD NAV PERF-RNP will be displayed on the MAP. The amber FMC lights located on the forward instrument panel will also illuminate with the annunciation of this message. If ANP exceeds a default RNP value for the current navigation environment, the IRS NAV ONLY message is displayed in the scratchpad after the designated time to alert has elapsed. RNP is shown on the POS SHIFT and RTE LEGS pages.

Lateral Navigation (LNAV)

LNAV provides steering commands to the next waypoint. If selected, LNAV engages when laterally within 3 nautical miles of the active route leg. If outside of 3 nautical miles of the active route leg, LNAV engages if on an intercept heading of 90 degrees or less and the intercept will occur before the active waypoint. 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 can supply commands to fly a constant heading, track, or follow arcs required by a procedure.

Waypoints

Waypoint (navigation fix) identifiers are displayed on the CDU and EHSI.

The CDU message NOT IN DATA BASE is displayed if a manually entered waypoint identifier is not stored 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 Waypoint Names

VHF – waypoints located at VHF navaids (VOR/DME/LOC) are identified by the official one, two, three, or four character facility identifier. Examples:

- Los Angeles VORTAC – LAX
- Tyndall TACAN – PAM
- Riga, Latvia – RIX.

NDB – waypoints located at NDBs are identified by use of the station identifier.
Example:

- Fort Nelson, CAN – YE.

Fix Waypoint Names

Fixes with one-word names – waypoints located at fixes with names containing five or fewer characters are identified by the name. Examples:

- DOT
- ACRA
- ALPHA.

Long Waypoint Names

Names with more than five characters are abbreviated using the following rules sequentially until five characters remain. Double letters are deleted. Examples:

- KIMMEL becomes KIMEL
- COTTON becomes COTON
- RABBITT becomes RABIT.

Keep the first letter, first vowel and last letter. Delete other vowels starting from right to left. Examples:

- ADOLPH becomes ADLPH
- BAILEY becomes BAILY
- BURWELL becomes BURWL.

Keep the last letter, then delete consonants from right to left. Examples:

- ANDREWS becomes ANDRS
- BRIDGEPORT becomes BRIDT
- HORSBA becomes HORSA.

Fixes with multiword names use the first letter of the first word and abbreviate the last word, using the above rules sequentially until a total of five characters remain. Examples:

- CLEAR LAKE becomes CLAKE
- ROUGH ROAD becomes RROAD.

Unnamed Point Waypoint Names

Unnamed turn points, intersections, and DME fixes – 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):

- INW – 18 – INW18
- CSN – 106 – 06CSN
- TCS – 89 – TCS89.

Unnamed flight information region (FIR), upper flight information region (UIR), and controlled airspace reporting points – waypoints located at unnamed FIR, UIR, and controlled airspace reporting points are identified by the three-letter airspace type identification followed by a two-digit sequence number.

Unnamed oceanic control area reporting points – positions in the northern hemisphere use the letters N and E, while positions 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 | • S52° W075° becomes 5275W |
| • N75° W170° becomes 75N70 | • S07° W120° becomes 07W20 |
| • N50° E020° becomes 5020E | • S50° E020° becomes 5020S |
| • N06° E110° becomes 06E10 | • S06° E110° becomes 06S10. |

Procedure Arc Fix Waypoint Names

Unnamed terminal area fixes along a DME arc procedure – unnamed 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. Examples:

- EPH252°/24 = D252X
- EPH145°/24 = D145X
- GEG006°/20 = D006T.

An unnamed waypoint along a DME arc with a radius greater than 26 miles is identified as an unnamed turn point that is not coincidental with a named waypoint. Examples:

- CPR338°/29 = CPR29
- GEG079°/30 = GEG30.

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
- CPR201°/29 = CP29C.

Procedure Fix Waypoint Names

Marker beacons – a marker beacon is 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 appropriate prefix:

- | | |
|----------------------------------|--------------------------------------------|
| • RX – runway extension fix | • BM – back course marker |
| • FA – VFR final approach fix | • MD – minimum descent altitude |
| • CF – final approach course fix | • A – (+ an alpha) step down fix |
| • FF – final approach fix | • RW – runway threshold |
| • IF – initial approach fix | • MA – missed approach point other than RW |
| • OM – outer marker | • TD – touchdown point inboard of RW. |
| • MM – middle marker | |
| • IM – inner marker | |

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
- ()M – MLS
- ()T – TACAN
- ()R – RNAV.

Examples: CI32R, PV15, FN24L.

Unnamed turn points – 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 – airport reference points are identified by the ICAO identifier.

Duplicate Waypoint Names

Duplicate identifiers – should application of these rules result in more than one waypoint having the same identifier, then a CDU page change occurs when an attempt is made to enter the duplicated identifier.

The page title is SELECTDESIRED WPT.

The page lists the latitude and longitude of waypoints with the same identifier and the type of facility or waypoint. Selecting the latitude/longitude of the desired waypoint enters the correct waypoint on the original page. See chapter 11, section 42, "Select Desired Waypoint Page" for additional information.

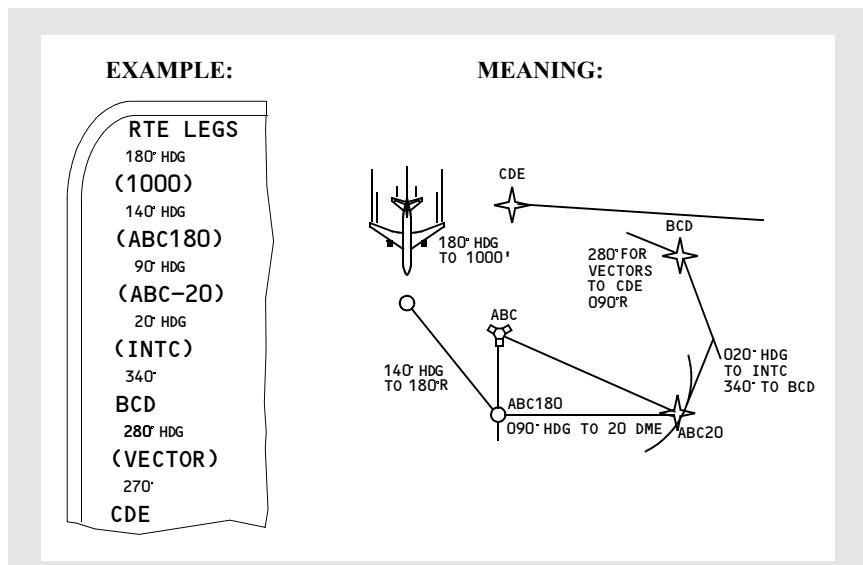
When a waypoint identifier is listed in the route more than once, certain route modifications (such as DIRECT TO or HOLD) use the first occurrence of the waypoint even if the second occurrence is selected. If a new waypoint entry is attempted that has the same identifier as a waypoint already in the route, the SELECT DESIRED WPT page will not be displayed and the first waypoint will be used. To use the second occurrence waypoint, the first occurrence waypoint must be deleted from the route.

Conditional Waypoint Names

Conditional waypoints are automatically entered into a route as a result of selecting a procedure on a DEPARTURES or ARRIVALS page. Normally, conditional waypoints cannot be manually entered on a RTE or RTE LEGS page. These waypoints are events when a condition occurs and are not at a geographically-fixed position. The types of conditions are:

- passing through an altitude
- flying a heading to a radial or DME distance
- intercepting a course
- heading vector to a course or fix.

Altitude and course intercept conditional waypoints are displayed on the CDU inside (parentheses) marks. The following diagram depicts conditional waypoints.



Note: All waypoints except BCD and CDE are examples of conditional waypoints.

Manually Entered Latitude/ Longitude Waypoint Names

Pilot defined waypoints entered as a latitude and longitude are displayed in a five-character format. The first three characters are WPT followed by a two digit sequence number. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude are full degrees. Examples:

- N47° W008° is entered as N47W008 and displayed as WPT01
- N47° 15.4' W008° 3.4' is entered as N4715.4W00803.4 and displayed as WPT02.

Manually Entered Place–Bearing/Distance or Place–Bearing/Place–Bearing Waypoint Names

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.

Manually Entered Along–Track Waypoint Names

Along–track waypoints are a special case of place–bearing/distance waypoints applied to the current route. When a waypoint is desired on the route where none exists, the along–track waypoint feature creates the desired waypoint without creating a route discontinuity.

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 route course takes the place of the bearing which is not entered. 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 is displayed as VAM01
- ELN/-30 is 30 miles before ELN on the present route, and is displayed as ELN01.

EFIS Map Displays

The route is displayed on the EHSI in the map, center map, and plan modes. The display color and format represent the following status:

- an inactive route is displayed as a cyan dashed line
- an activated but not yet executed route is displayed as a cyan dashed line
- the active route is displayed in magenta
- modifications to an active route are displayed as dashed white lines
- modified waypoints are displayed in white
- (U7 and on) executed route offsets are displayed as a dot-dash magenta line.

Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

Speed/Altitude Restrictions

VNAV controls the path and speed to comply with waypoint crossing restrictions. Waypoint crossing restrictions are entered on the LEGS page waypoint line by pushing the applicable key on the right side of the CDU. Barometric altitude restrictions must be below the cruise altitude to be valid. Values entered as part of a procedure and manually entered restrictions are shown in large font. FMC predicted values do not act as restrictions, and are shown in small font.

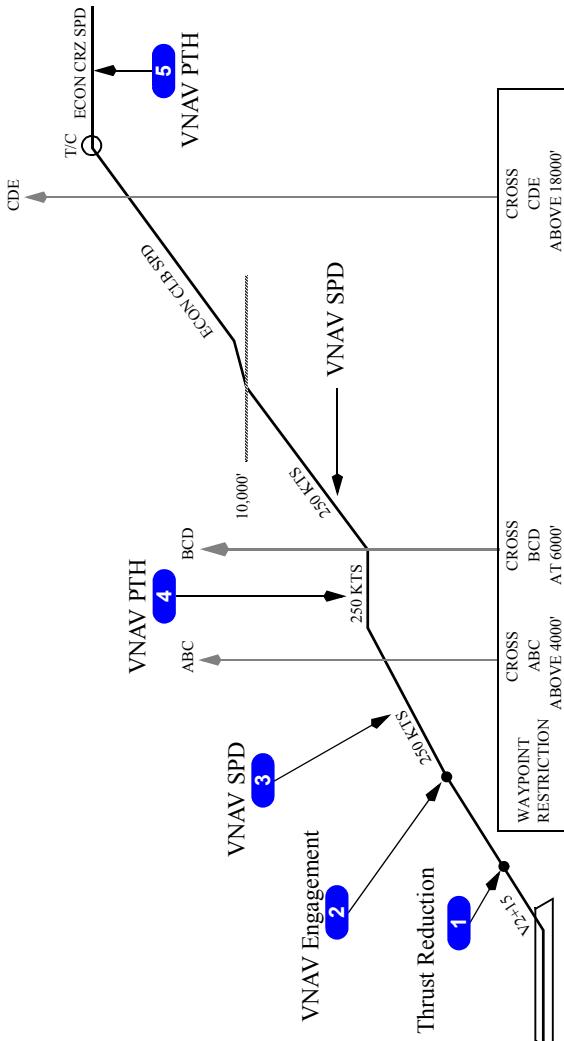
Waypoints can have altitude, airspeed, or both airspeed/altitude restrictions.

All airspeed restrictions are considered by the FMC as at or below restrictions.

At or above altitude restrictions are entered with a suffix letter A (example: 220A). At or below altitude restrictions are entered with a suffix letter B (example: 240B). Mandatory altitude restrictions are entered without any suffix letter (example: 270/).

Altitude restrictions that are between two altitudes are displayed with the lower limit first, followed by a suffix letter A, then the upper limit, followed by a suffix letter B (example: 220A240B).

Takeoff and Climb



1 Thrust Reduction

Climb thrust is selected by pushing the N1 switch.

2 VNAV Engagement

VNAV commands an airspeed increase to the planned climb speed profile, limited by configuration.

3 VNAV Climb

The VNAV climb profile uses VNAV SPD at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude restrictions that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

Note: Selection of ENG OUT on the CLB page provides the crew with advisory engine out performance information. (Prior to U7.5) If activated all subsequent performance predictions are blanked and VNAV is unavailable until a climb page other than ENG OUT is activated.

If the climb speed profile cannot achieve an altitude restriction, the UNABLE NEXT ALTITUDE scratchpad message is shown.

4 Climb Restrictions

VNAV enters the VNAV PTH mode to remain within departure or waypoint restrictions. Speed maintained during this time can be:

- procedure based speed restriction
- waypoint speed restriction
- default VNAV climb speed
- manually entered climb speed.

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 is shown any time the FMC calculates a change from a climb phase to a cruise phase, such as a step climb.

The T/C point is shown on the map as a green open circle with the label T/C.

Cruise

At cruise altitude, the FMC sets cruise speed at the default or pilot entered speed until reaching the top-of-descent (T/D) point. Alternate cruise speed options are:

- long range (LRC)
- flight crew entered speed.

Cruise thrust is set as required to maintain level flight at the target speed, with the autothrottle engaged. The FMC uses maximum range cruise speed if cost index is set to zero.

Fuel and ETA predictions are based on a constant altitude cruise unless a step climb altitude is entered.

Step Climb

If a step climb altitude is entered in the CRZ page STEP altitude, the FMC calculates the point where the step climb should begin.

The distance and ETA to the next step point are shown on the CRZ and PROGRESS pages.

The next step point is shown on the map as a green open circle with the label S/C.

Descent

VNAV can perform a descent in either of two modes – path descent or speed descent. During a path descent, the FMC uses idle thrust and pitch control to maintain a vertical path, similar to a glideslope in three dimensions. During a speed descent, the FMC uses idle thrust and pitch control to maintain a target descent speed, similar to a level change descent.

Top Of Descent (T/D)

The point where the cruise phase changes to the descent phase is the top of descent. T/D is calculated from an end of descent (E/D) point.

The T/D point is shown on the map as a green open circle with the label T/D.

On airplanes with FMC update U7.2 and on, intermediate T/D points show on the map as green open circles with the label T/D-XXXXX (altitude). Intermediate T/D points exist when path segments between altitude restricted waypoints produce a level path segment. The intermediate T/D point shows where the descent will resume.

End of Descent (E/D) (After UPDATE U7.0 and on)

The FMC calculates a descent path based on airspeed restrictions, altitude restrictions and the end of descent (E/D) point. The E/D point is shown on the map as a green open circle with the label E/D. The E/D is the last of the following which is not preceded by a lateral discontinuity:

- (U7 and on) the runway threshold for approaches with a runway waypoint on the RTE LEGS page, or
- (U7 and on) the missed approach point for approaches not showing a runway waypoint on the RTE LEGS page, or

Entering an instrument arrival procedure provides an E/D point.

If there is no E/D point, FMC predictions assume a computed profile to 1000 feet above the destination field elevation, at a position which will vary according to selection of arrival procedures. The FMC will provide a slowdown profile for approach. VNAV path descent is not available if there is no E/D point.

VNAV Descent and Approach Path

The descent path starts at the calculated top of descent (T/D) point and includes waypoint altitude restrictions. The path is based on:

- idle thrust
- speedbrakes retracted
- descent wind speed decreasing with decreasing altitude
- applicable target speed.

After the first “at” or “at or below” restriction, the path angle is level until intercepting the idle thrust descent path to the next altitude constrained waypoint.

Normally, the target speed is economy speed above the airspeed restriction altitude and 240 knots below that altitude, until deceleration for approach. VNAV will not permit descent below the airspeed restriction altitude until the airspeed is at or below the restricted value plus ten knots.

The start and end of the airport speed restriction deceleration segment is shown on the map as a green open circles with no labels.

Target speeds are changed by entries on the DESCENT page. Entries made on the LEGS page are “at or below” and may limit the target speed. Wind and thrust assumptions are changed on the DES FORECASTS page.

VNAV Path Descent

An E/D point must be defined in order to accomplish a path descent. It may be defined manually or by the selection of an arrival procedure.

The FMC defaults to the path descent mode for planning purposes. If the necessary information for a path descent is not available by the time the airplane reaches the T/D point, the FMC will revert to the speed descent mode.

The path descent normally begins automatically at the calculated T/D point, provided the MCP altitude is reset for the descent. If descent is not initiated by the T/D, a path descent may not be achievable. At the T/D, the FMC commands idle thrust and adjusts pitch to follow the descent path.

The descent complies with waypoint altitude restrictions by following the calculated vertical path.

Note: A path descent uses the target speed for planning purposes only. There is no attempt to maintain the target speed during the idle portion of the descent.

A path descent will automatically revert to a speed descent, or VNAV will disengage, if all required parameters are not maintained during descent.

Note: When descending in VNAV PTH, the FCC will disengage VNAV and switch to LVL CHG if actual speed becomes equal to or slightly less than the minimum speed, denoted by the underspeed limiting symbol in the MCP IAS/Mach window. This can also happen in turbulence or gusty conditions when the minimum speed may momentarily increase due to G loading. See section 4.20, Minimum Speed Reversion.

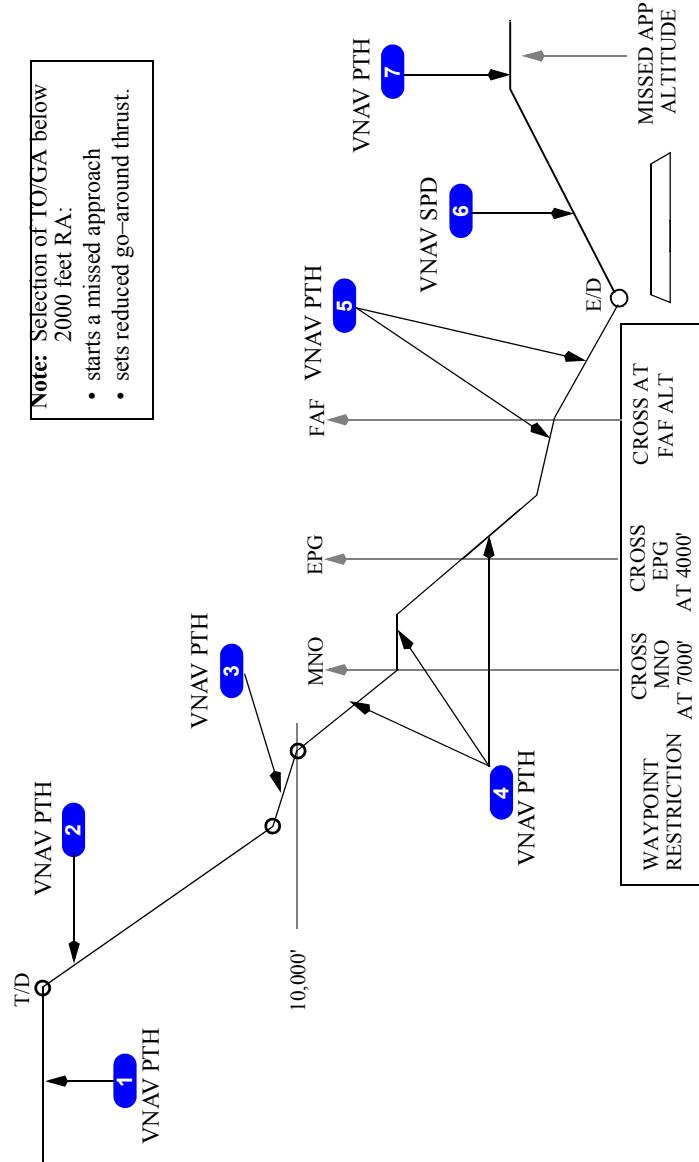
The FMC uses a special program called “Energy Compensation” at certain times during an ACT PATH DES. This program goes into effect when the MCP has been temporarily set to an altitude above the planned descent path. The airspeed cursor will slowly move toward a slower airspeed while the “TARGET” speed on the FMC remains constant. The airspeed reduction improves the capability of recapturing the planned descent path. When the airplane is cleared to resume the descent, the airspeed will slowly build up to the FMC target speed as the airplane recaptures the planned descent path.

The CDU message DRAG REQUIRED is displayed if an unexpected tailwind results in a significant increase in airspeed to maintain path. The CDU message DES PATH UNACHIEVABLE is displayed if the FMC determines that the planned descent profile cannot be accomplished. VNAV disengages if a limit speed will be exceeded.

(U7.1 to U10.2A) A path descent must be initiated while within the allowable cross-track error for LNAV, however LNAV may be disengaged during descent while remaining in the path mode. To maintain a path descent under these conditions, the airplane must remain within a distance equal to the RNP from the LNAV course. If this distance is exceeded, VNAV will change to speed descent if no vertical angle is specified for the current leg. VNAV will disengage if there is a vertical angle specified and LNAV is not engaged.

(U5 to U7) To initiate a path descent LNAV must be engaged. If LNAV is disengaged during a path descent, VNAV will change to a speed descent.

VNAV Cruise and Path Descent Profile (Non-Precision Approach)



1 Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

2 Descent

After top of descent, FMC is in descent mode and VNAV changes to economy descent speed and descends in VNAV PTH.

3 Speed Restriction Deceleration

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV PTH.

When at restricted speed, VNAV commands decreased pitch and descends in VNAV PTH.

4 Altitude Restrictions

The VNAV path conforms to altitude restrictions at MNO, EPG, and the FAF. If required, VNAV uses a level path until intercepting the idle thrust descent path to the next altitude constrained waypoint.

5 Approach

VNAV descends and starts approach in VNAV PTH at the commanded speed.

6 Missed Approach (U6 and on)

When TOGA is pushed during approach, or when crossing the missed approach point, VNAV disengages.

When VNAV is selected during missed approach, VNAV engages in VNAV SPD.

7 Missed Approach Level Off (U6 and on)

At missed approach altitude VNAV changes to VNAV PTH.

VNAV Speed Descent

A speed descent may be selected manually by selecting the SPEED prompt on the PATH DES page. With no E/D specified, the speed descent is the only descent mode available.

The speed descent maintains the target speed. Normally, the target speed is economy above the airspeed restriction altitude and 240 knots below that altitude, until deceleration is necessary for the approach. VNAV will not permit descent below the altitude restriction until the airspeed is at or below the restricted value.

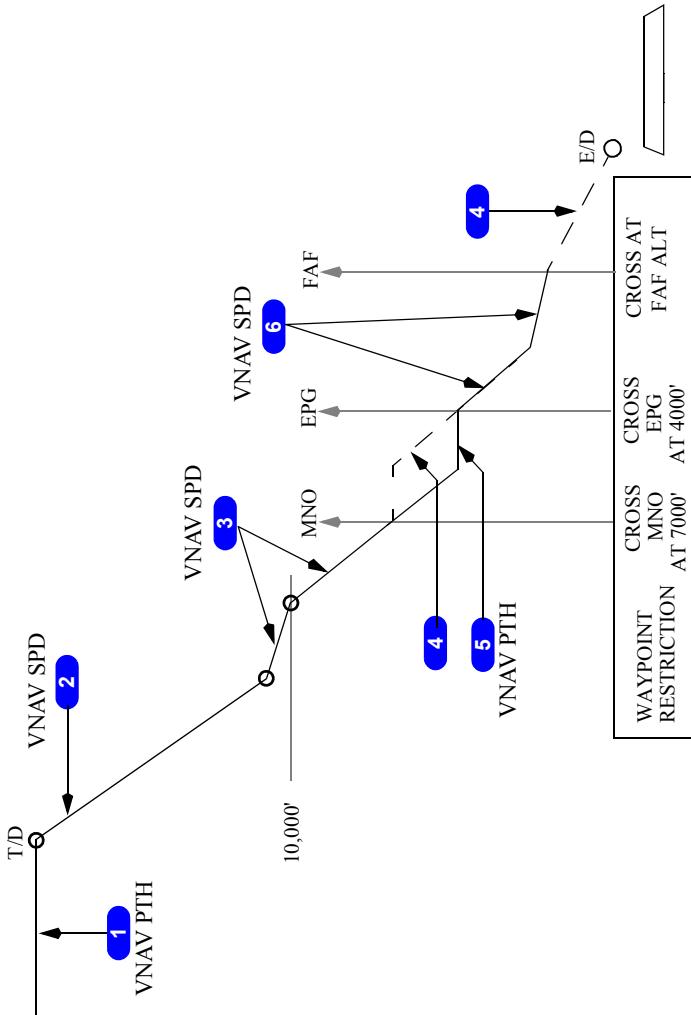
The speed descent normally begins automatically at the calculated T/D, provided the MCP altitude is reset for the descent. At the T/D, the FMC commands pitch to maintain target descent speed. LNAV does not have to be engaged in order to fly a VNAV speed descent.

A speed descent cannot automatically revert to a path descent, except with a U7 FMC installed and during a STAR, approach transition, or approach leg with a vertical angle. However, if all required parameters for a path descent are available, a path descent may be manually selected at any time by selecting the PATH prompt on the speed descent page.

The descent attempts to comply with waypoint altitude restrictions, and will not violate these restrictions. The VNAV speed descent will not, however, guarantee the airplane reaches an altitude restriction at the required point.

VNAV Cruise and Speed Descent Profile (Non-Precision Approach)

DECEL POINTS (Prior to U10)



1 Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed. The autothrottle mode is FMC SPD.

2 Descent

After top of descent, FMC is in descent mode and VNAV changes to economy descent speed and descends in VNAV SPD.

3 Speed Restriction Deceleration

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV SPD.

When at restricted speed, VNAV commands decreased pitch and descends in VNAV SPD.

4 VNAV Path

During a speed descent, VNAV may not maintain the FMC computed VNAV path. However, if E/D shows, a VNAV path is available.

5 Altitude Restrictions

VNAV conforms to altitude restrictions at MNO and EPG. After MNO VNAV continues an idle thrust descent using VNAV SPD.

Upon reaching the next altitude restriction, VNAV commands level flight using VNAV PTH. The thrust mode changes to FMC SPD.

6 Descent and Approach

After EPG, VNAV continues the idle thrust descent using VNAV SPD.

Prior to the approach, VNAV decelerates to approach speed. The FMC prompts manual flap extension.

Vertical Angle (U7 and On)

A vertical angle can be assigned to a waypoint from the navigation database. This vertical angle defines a VNAV path between the waypoint and the waypoint preceding it. This feature can be available in approaches, approach transitions, and STARs. For example, the vertical angle for the glidepath of an ILS approach would typically be 3 degrees. This angle is displayed on the ACT RTE LEGS page above the speed/altitude line for the associated waypoint. Vertical angles may be expected in any approach ending at RWXXX or MAXXX. The E/D will be RWXXX or MAXXX, and the E/D altitude will be either threshold crossing height (TCH – typically 50 feet above the touchdown zone elevation) or the altitude specified at MAXXX.

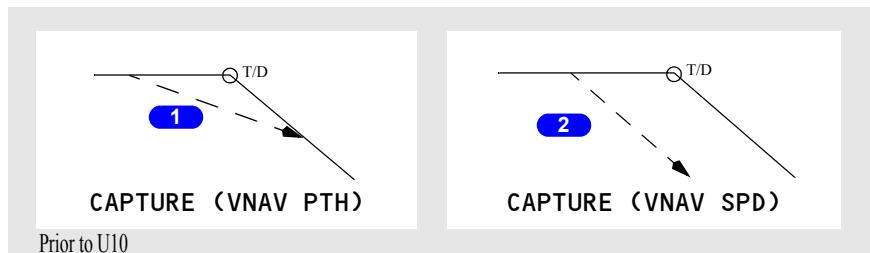
If a path (VNAV PTH) descent is active when a vertical angle leg becomes active, the path mode will remain active, but VNAV will follow the vertical angle rather than the idle thrust descent path.

If the vertical angle leg becomes active during a speed (VNAV SPD) descent, the VNAV mode will change to VNAV PTH automatically, and there will be no SPEED prompt on the descent page.

Early Descent

A descent in VNAV started before the top of descent point is an early descent. If a path descent is planned, VNAV commands a 1000 fpm descent until the idle descent path is intercepted. If a speed descent is planned, VNAV commands an idle thrust descent.

To start an early descent, use CAPTURE prompt on the DES page.



Prior to U10

1 CAPTURE (VNAV PTH)

With a VNAV path descent planned, VNAV starts an early descent at 1000 fpm and captures the idle descent path. VNAV uses FMC SPD for the autothrottle mode and VNAV PTH for the pitch mode.

2 CAPTURE (VNAV SPD)

With a VNAV speed descent planned, VNAV starts an idle thrust early descent. VNAV does not attempt to capture the VNAV descent path. VNAV uses VNAV SPD for the pitch mode and the autothrottle commands IDLE, followed by ARM.

Approach (U7 and on)

The FMC transitions to “on approach” when the airplane is within:

- 2 NM of the first approach waypoint (including approach transitions such as arcs and procedure turns), or
- 2000 feet of airport elevation, whichever occurs first.

When the FMC is “on approach”, the following features are available:

- UNABLE RNP alerting levels are higher
- if the airplane is more than 200 feet below the vertical path, VNAV commands zero vertical speed until intercepting the path.

Note: Display of a specified path angle is not limited to approaches. A path angle may be defined for a leg in a STAR and displays on the RTE LEGS page for the procedure.

The FMC transitions out of “on approach” under the following conditions:

- selecting TO/GA
- the airplane lands
- the waypoint cycles to the first waypoint of the missed approach
- executing a direct-to waypoint in the missed approach.

The following situations are generally encountered during approach operations, but are not determined by “on approach” logic:

- if a vertical angle leg (GP x.xx on RTE LEGS page) becomes active, VNAV switches to VNAV PTH without pilot action
- if on a vertical angle leg, and cross track exceeds two times the RNP value, while LNAV is not engaged, VNAV will disengage.

VNAV will remain engaged at all flap settings, allowing approaches to be flown using the vertical angle guidance. Speed for final approach can be set on the APPROACH REF page.

(U7 to U10.2A) If an ILS approach is flown in VNAV using vertical angle guidance, VNAV will disconnect when passing the GS-XXX point, but it can be reengaged. If the GS-XXX point is deleted, VNAV will remain engaged throughout the approach.

For an approach without a runway waypoint on the RTE LEGS page, the VNAV path is calculated to the MDA or a calculated altitude at the missed approach point. The calculated altitude may be below the MDA to ensure a flight path angle and normal threshold crossing height.

Note: It is the flight crew’s responsibility not to descend below the MDA until adequate visual contact is achieved.

Go-Around (U6 and On)

Below 2000 feet radio altitude, the FMC transitions to go-around logic from approach logic when any of the following events occur:

- pushing either TO/GA switch while in a descent
- executing a direct-to waypoint in the missed approach (other than the missed approach point)

- automatically while in a descent and the last waypoint of the approach cycles to the first waypoint of the missed approach.
- the airplane climbs at a vertical speed greater than 600 fpm and the flaps are retracted from a landing setting toward a flap setting of 15 or 1

Once the FMC go-around logic is established:

- the FMC transitions from active descent to active climb
- the thrust limit changes to go-around thrust
- all descent altitude constraints below the current airplane altitude are deleted and replaced with predicted altitudes
- the original destination airport (airport from which the go-around was just initiated) becomes the new origin airport allowing SID selection if a diversion to another airport is required.

Note: LNAV may be engaged when the airplane climbs above 400 feet radio altitude, but VNAV should not be engaged until after flap retraction.

If the go-around was initiated by pushing a TO/GA switch or selection of go-around thrust, the CRZ ALT will change to the highest of:

- the highest constraint in the missed approach
- 1500 feet above airport elevation
- the MCP altitude.

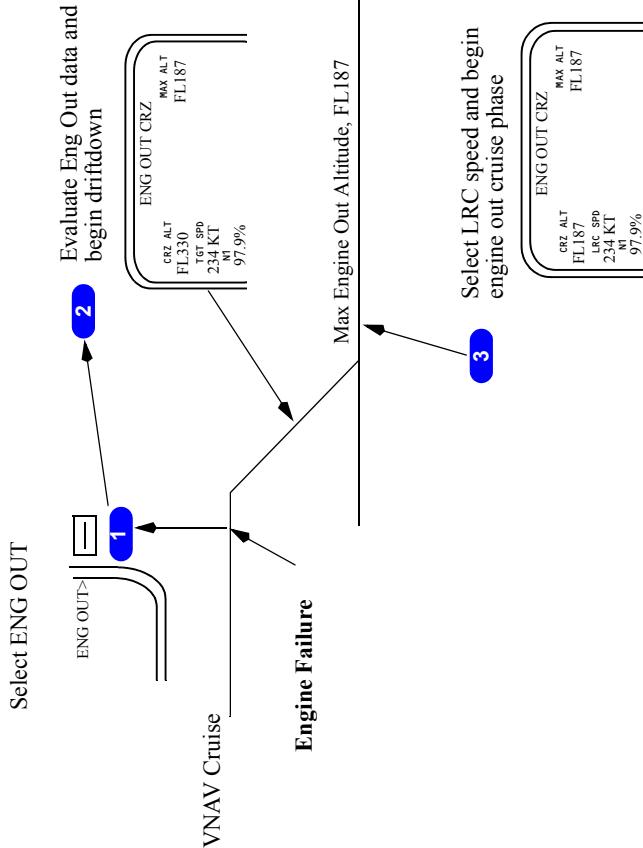
Note: If the MCP altitude is the lowest of the three, the autopilot, if engaged, will level off at the MCP altitude.

If the go-around was initiated by direct-to or waypoint sequencing, the CRZ ALT will change to the highest of:

- the highest constraint in the missed approach
- 1500 feet above airport elevation.

Refer to section NP20.xx, Go-Around Procedure and section 4.20, Go-Around for additional information.

VNAV Cruise (Engine Out Above Eng Out Max Alt)



1 Engine Out Modification

Select the ENG OUT prompt on the CRZ page. The ENG OUT page displays the appropriate engine out driftdown performance data to enable the airplane to descend to the engine out maximum altitude. Refer to FMC Cruise, section 11.42 for a complete description of the ENG OUT CRZ page.

2 Drift Down Execution

After selecting the left or right ENG OUT mode, perform the driftdown as follows:

- disconnect A/T
- set maximum continuous thrust on operating engine (N1 line)
- set MCP speed to TGT SPD
- set MCP altitude to MAX ALT or lower altitude as required
- select LVL CHG.

The airplane then descends at CON thrust and the driftdown airspeed to the MAX ALT. As the driftdown proceeds and airplane gross weight decreases, the maximum altitude may increase.

Note: The engine out cruise page provides advisory performance data for operating with one engine.

3 Engine Out Cruise

Engine out cruise operates like normal cruise with engine out cruise speeds. If range is a factor, select LRC speed. Thrust limit remains in CON.

Required Time of Arrival (RTA)

VNAV controls cruise speed to achieve a flight crew specified arrival time at a specified waypoint. After the appropriate waypoint and RTA are input to the FMC, the FMC will compute a recommended takeoff time, speeds required to comply with the RTA, and progress information for the flight. If the RTA is not achievable, the RTA UNACHIEVABLE scratchpad message is displayed.

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 automatically 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 and displayed as 800
- 1,500 feet is entered as 015 or FL015 and displayed as 1500
- 11,500 feet is entered as 115 or FL115 and displayed as FL115
- 25,000 feet is entered as 250 or FL250 and displayed 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 and displayed as 50
- 835 feet is entered as 0835 and displayed as 840
- 1,500 feet is entered as 1500 and displayed as 1500
- 8,500 feet is entered as 8500 and displayed as 8500
- 9,994 feet is entered as 9994 and displayed 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 and displayed as 50
- 835 feet is entered as 00835 and displayed as 840
- 1,500 feet is entered as 01500 and displayed as 1500
- 8,500 feet is entered as 08500 and displayed as FL085
- 9,995 feet is entered as 09995 and displayed as FL100
- 11,500 feet is entered as 11500 and displayed as FL115
- 25,000 feet is entered as 25000 and displayed as FL250.

Negative altitude entries are allowed to -1000 feet.

Airspeed Entry

Airspeeds can be entered into the FMC as calibrated airspeed or Mach number. 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 restrictions. 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.

Bearing Entry

Entry of a bearing value requires three digits. For example, key 090, not 90. A bearing entry of 360 is displayed as 000.

Plus/Minus Signs

When entering temperature or an along-track displacement distance, positive values are assumed by the FMC and + signs are not required. For negative values, key in the – sign.

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Flight Management, Navigation Flight Management Computer

Chapter 11 Section 32

FMC Databases

The FMC contains two databases:

- performance database
- navigation database.

The performance database eliminates the need for the flight crew to refer to a performance manual during flight, and provides the FMC with the information required to calculate pitch and thrust commands. All information normally required can be displayed on the CDU. The database includes:

- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds.

Maintenance personnel can refine the database by entering correction factors for drag and fuel flow.

The navigation database includes most information normally determined by referring to navigation charts. This information can be displayed on the CDU or navigation display. The database contains:

- the location of VHF navigation aids
- waypoints
- airports
- runways
- other airline selected information, such as SIDs, STARs, approaches, and company routes.

If the permanent database does not contain all of the required flight plan data, additional airports, navaids, and waypoints can be defined by the crew and stored in either a temporary or a supplemental navigation database. Use of these additional databases provides world-wide navigational capability, with the crew manually entering desired data into the FMC via various CDU pages. Information in the supplemental navigation database is stored indefinitely, requiring specific crew action for erasure; the temporary navigation database is automatically erased at flight completion.

The temporary and supplemental databases share storage capacity for forty navaids and six airports, the entries being stored in either database on a first come, first served basis. For the waypoint category, exclusive storage is reserved in the temporary database for twenty entries (including those created on the RTE or RTE LEGS pages). An additional twenty waypoints (up to a maximum of forty) can be stored in either the temporary or supplemental database on a first come, first served basis.

When any storage capacity is full, entries which are no longer required should be deleted by the crew to make space for additional new entries. Created waypoints cannot be stored in the database runway category.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the normal navigation chart revision cycle. The FMC uses the active set for navigation calculations. The contents of the navigation database are periodically updated and are transferred to the FMC before the expiration date of the current data.

Thrust Management

The autothrottle operates in response to flight crew mode control panel inputs or to automatic FMC commands. Reference thrust can be selected on the N1 LIMIT page. Automatic FMC autothrottle commands are made while VNAV is engaged. The autothrottle system:

- uses reference thrust limits calculated by the FMC
- commands the thrust levers
- commands thrust equalization through the power management control.

Thrust limits are expressed as N1 limits.

The FMC calculates a reference thrust for the following modes:

- | | |
|-------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|
| <ul style="list-style-type: none">• takeoff• derated takeoff• assumed temperature takeoff• climb | <ul style="list-style-type: none">• reduced climb• cruise• continuous• go-around. |
|-------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------|

The thrust reference mode automatically transitions for the respective phase of flight. These modes can be selected on the N1 LIMIT page. The selected thrust reference mode is displayed on the thrust mode display.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life. They are used whenever performance limits and noise abatement procedures permit.

Derate/Variable Takeoff Rating

Fixed derates can be selected on the TAKEOFF REF page 2/2. Performance data for these derates is provided in the Airplane Flight Manual (AFM).

With a derated takeoff selected, 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 while on the ground. Use the takeoff speeds supplied by the FMC or specified in Chapter PI, Performance-Inflight, for the selected derate condition.

Derate takeoff ratings can be further reduced by using an assumed temperature.

Use the takeoff speeds specified in Chapter PI, Performance–Inflight, for the selected derate or variable takeoff rating condition.

Assumed Temperature Thrust Reduction Takeoff

A takeoff thrust less than the full rated thrust may be achieved by using an assumed temperature that is higher than the actual temperature. The desired thrust level is obtained through entry of a SEL TEMP value on TAKEOFF REF page 1 or 2. Use approved sources for selecting the assumed temperature.

The maximum thrust reduction authorized is 25% 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 additional thrust is desired, the crew can manually apply full thrust.

Reduced Thrust Climb

Two fixed climb thrust reductions can be selected on the N1 LIMIT page. CLB 1 provides a climb limit reduced by 3% (approximately 10% thrust reduction). CLB 2 provides a climb limit reduced by 6% (approximately 20% thrust reduction).

The reduced climb setting gradually increases to full rated climb thrust by 15000 feet. In cruise, the thrust reference automatically changes to CRZ. The reference can be manually selected on the N1 LIMIT page.

Use of an assumed temperature reduced thrust takeoff or takeoff derate affects automatic selection of reduced climb N1.

Use of reduced climb thrust decreases engine maintenance costs, but increases total trip fuel.

Fuel Monitoring

The FMC receives fuel data from the fuel quantity summation unit. Fuel quantity values are displayed on the PERF INIT page and on PROGRESS page 1 as FUEL QTY. The FMC uses the summation unit for performance calculations.

If fuel quantity data becomes invalid, the fuel quantity will be blank on the PERF INIT page and on PROGRESS page 1. VNAV is not available.

The FMC monitors the total fuel load on board as detected by the fuel summation unit. The FMCS–CDU message INSUFFICIENT FUEL is displayed if the FMC predicts the total fuel quantity at destination to be less than 2,000 lb. (900 kg.). The USING RSV FUEL message is displayed if the fuel remaining at destination is less than the RESERVES entry on the PERF INIT page.

The CHECK FMC FUEL QUANTITY message is displayed if the FMC has detected a decrease in fuel quantity of greater than 1,500 lb. (675 kg.), and 120 seconds has elapsed since the decrease was detected. The flight crew must then manually compute the fuel quantity value to determine gross weight for the remainder of the flight.

FMC calculated fuel predictions are based on gear and flaps up during climb, cruise, and descent. Any prolonged flight with gear and/or flaps extended will increase fuel required, and will not be displayed correctly on the FMC fuel predictions pages.

Loss of FMC Electrical Power

The FMC requires continuous electrical power to operate. When the electrical power is interrupted for less than ten seconds:

- LNAV and VNAV disengage
- all entered data is retained by the FMC
- the FMC resumes normal operation when power is restored.

If power is lost for ten seconds or more on the ground, all preflight procedures and entries must be done again when power is restored.

If power is lost for more than ten seconds in flight:

- LNAV and VNAV disengage
- all entered data is retained by the FMC, and when power is restored the MOD RTE LEGS page is displayed with the advisory message SELECT ACTIVE WPT/LEG.

Before LNAV can engage, the FMC must be instructed how to return to the route. Select the desired active waypoint and proceed direct or intercept a course to the waypoint.

FMC Failure

If the FMC fails, the FMC alert light will illuminate. The FMC/CDU FAIL light will appear on both CDUs, and both CDUs will display failure modes. "VTK" will appear on both EHSIs. LNAV and VNAV will disengage. After 25 to 30 seconds, both EHSI maps will display failure information.

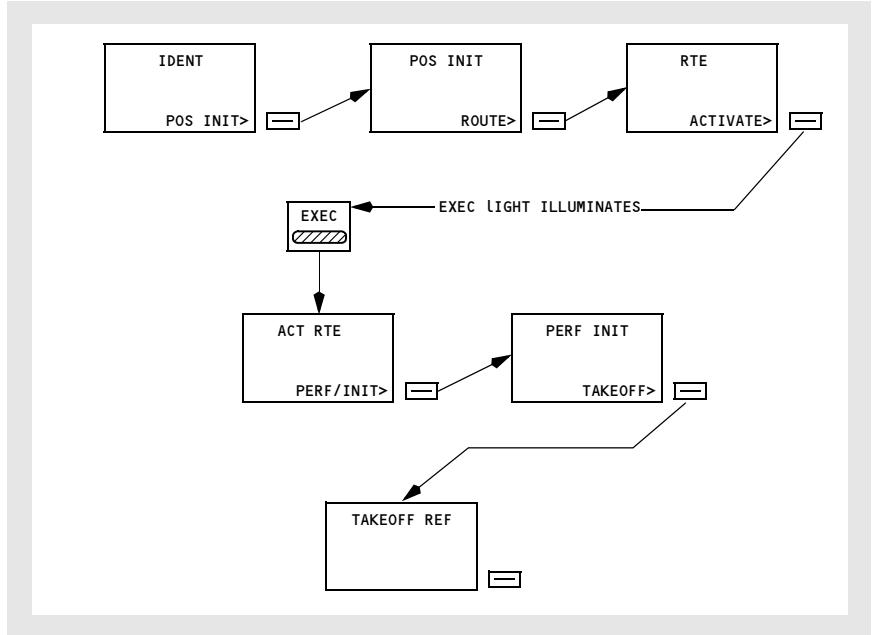
Flight Management, Navigation FMC Preflight

Chapter 11 Section 40

Introduction

Completion of the preflight requires data entry in all minimum required data locations. Completing all required and optional preflight data entries ensures the most accurate performance possible.

Preflight Page Sequence



The normal preflight sequence follows paging prompts on each CDU page.

The normal FMC power-up page is the IDENT page. Preflight flow continues in this sequence:

- Identification (IDENT) page
- Position Initialization (POS INIT) page
- Route (RTE) page
- Departures (DEP/ARR) page (no automatic prompt)
- Performance Initialization (PERF INIT) page
- Takeoff Reference (TAKEOFF REF) page.

Some of these pages are also used in flight.

The airplane inertial position is required for FMC preflight and flight instrument operation.

A route must be entered and activated. The minimum route information is origin and destination airports and a route leg.

Performance information requires the airplane weight and cruising altitude.

Page Entries and Sequence

During preflight, the prompts that appear in the lower right of the CDU page direct the crew through the minimum requirements for preflight completion. Pushing the prompt key for the next page in the flow presents new entry requirements.

Additional entries are made on pages to refine the performance and route calculations. If a required entry is missed, a prompt on the TAKEOFF page leads the crew to the preflight page that is missing data.

Supplementary Pages

Supplementary pages are sometimes required. These pages must be manually selected. Manual selection interrupts the normal automatic sequence. Discussions of each normal page include methods to display the page when the automatic sequence is interrupted.

When the route includes SIDs and STARs, they can be entered into the preflight using the DEPARTURES or ARRIVALS pages.

Route discontinuities are removed, the route is modified, and speed/altitude restrictions are entered on the RTE LEGS page. The RTE LEGS page is described in the FMC Takeoff and Climb and FMC Cruise sections of this chapter.

Waypoint, navigation, airport, and runway data is referenced on the REF NAV DATA page or the SUPP NAV DATA page. The REF NAV DATA page and SUPP NAV DATA page are described in the FMC Cruise section of this chapter.

VNAV performance is improved if the forecast winds and temperatures are entered during the preflight.

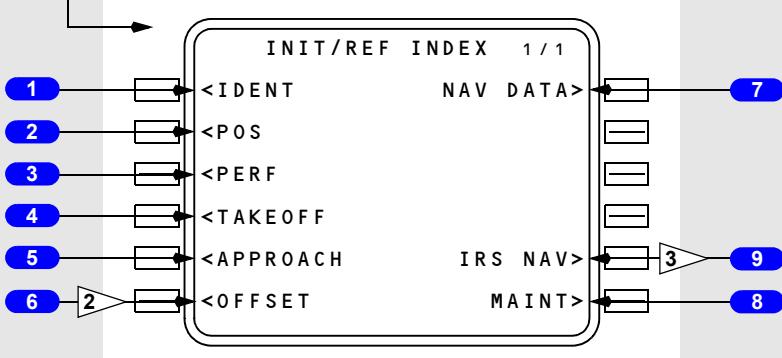
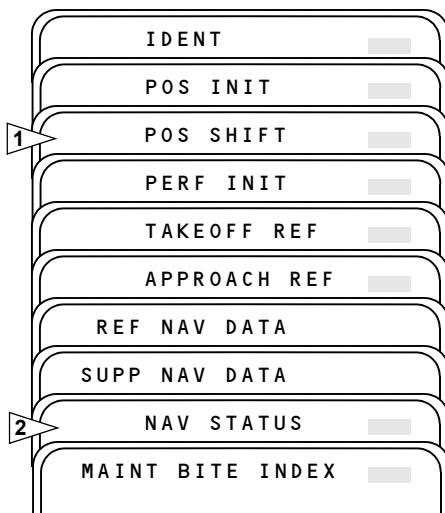
A single wind and temperature for cruise may be entered on the PERF INIT page. Wind and temperature data for specific cruise waypoints are entered on the RTE DATA page. The RTE DATA page is described in the FMC Cruise section. Wind and temperature for descent is entered on the DES FORECASTS page. The DES FORECASTS page is described in the FMC Descent section.

Initialization/Ident Pages

Note: The preflight pages are presented in the sequence used during a typical preflight.

Initialization/Reference Index Page

The INIT/REF INDEX page provides manual selection of FMC pages. It provides access to pages used during preflight and not normally used in flight.



1 ▶ U4 and on 2 ▶ U7 and on 3 ▶ Airplanes with ANS

1 Identification (IDENT)

Displays the IDENT page, the first page in the automatic preflight sequence.

2 Position (POS)

Displays the POS INIT page used for IRS initialization.

POS INIT page is also used to enter/update magnetic heading for an IRS which is in the ATT mode.

3 Performance (PERF)

Displays the PERF INIT page for initialization of data required for VNAV operations and performance predictions.

4 TAKEOFF

Displays the TAKEOFF REF page to enter takeoff reference information and V speeds.

5 APPROACH

Displays the APPROACH REF page for entry of the approach VREF speed.

6 OFFSET

Displays the LATERAL OFFSET page for initiating a lateral offset.

7 Navigation Data (NAV DATA)

Displays the REF NAV DATA page to display information about waypoints, navaids, airports, and runways. On the ground, displays the SUPP NAV DATA page if SUPP is entered in the scratchpad prior to selection.

8 Maintenance (MAINT)

For maintenance use only; displays maintenance pages which are accessible on the ground only. In the air the prompt becomes NAV STATUS which displays the status of navaids being tuned by the FMC.

9 IRS Navigation (IRS NAV)

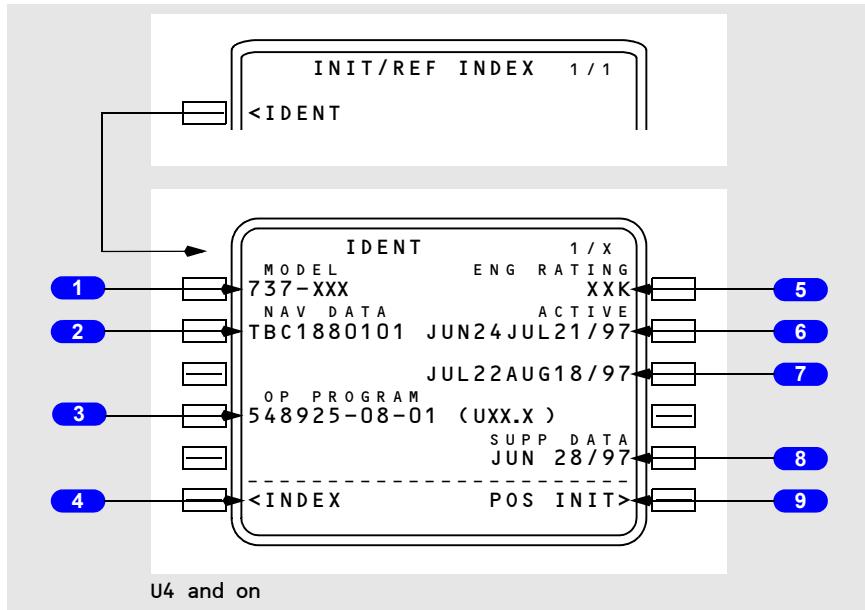
Allows selection of the appropriate ANCDU page (IRS PROGRESS or IRS LEGS).

Blank if IRS inputs to the CDU are invalid.

Identification Page

Most of the data on this page is for crew verification. The active navigation database and supplemental database accept manual entries.

The crew verifies FMC data and selects a navigation database on the IDENT page.



1 MODEL

Displays the airplane model from the FMC performance database (e.g., 737-300, 737-400 or 737-500).

2 Navigation Data (NAV DATA)

Displays the navigation database identifier.

3 Operational Program (OP PROGRAM) / (FMC Update)

Displays the Boeing software part number and FMC Update version installed.

- Update U5
- Update U7.5

4 INDEX

Push – displays the INIT/REF INDEX page.

5 Engine Rating (ENG RATING)

Displays the engine thrust stored in the FMC performance database (e.g., 23.5K, 22K, 20K or 18.5K).

6 Active Date Range (ACTIVE)

Displays the effectiveness date range for the active navigation database.

Database activation is accomplished by pushing the proper date range prompt to copy that date into the scratchpad. The scratchpad date may then be transferred to the ACTIVE database line. The previous active date moves down to the inactive date line.

The ACTIVE label appears above the active navigation database date. No label appears above the inactive navigation database date. The navigation database date can be changed only on the ground. Changing the navigation database removes all previously entered route data.

When an active database expires in flight, the expired database continues to be used until the active date is changed after landing.

7 Inactive Date Range

Displays the effectiveness date range for the inactive navigation database.

8 Supplemental Data (SUPP DATA)

Displays the effective date of the supplemental database. Blank if supplemental database is empty.

9 Position Initialization (POS INIT)

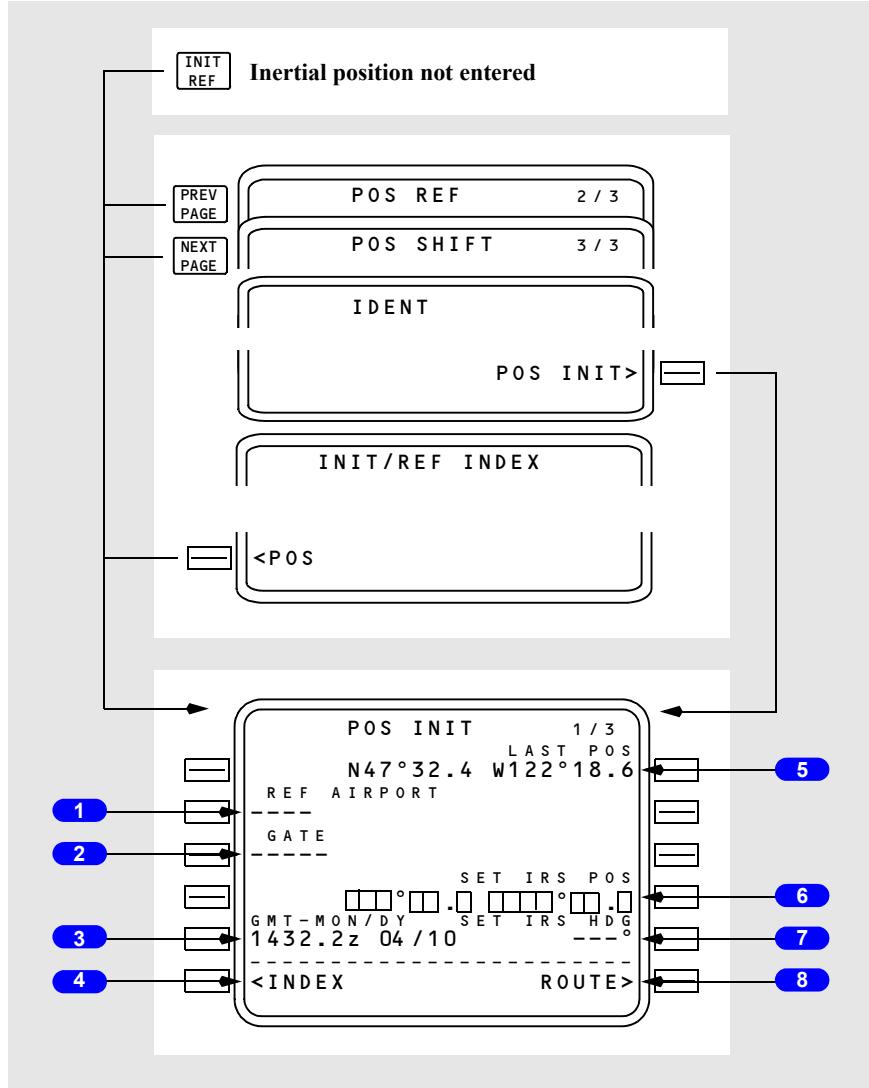
Push – displays the POS INIT page.

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Position Pages

Position Initialization Page

The POS INIT page allows airplane present position entry for IRS alignment and FMC initialization. The same page is used to enter/update the magnetic heading for an IRS which is in the ATT mode. There are three POS pages.



1 Reference Airport (REF AIRPORT)

The reference airport entry allows entry of the current airport for display of the airport latitude/longitude.

Optional entry.

Valid entries are ICAO four letter airport identifiers.

Displays the latitude and longitude of the reference airport.

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 the reference airport is entered.

Valid entry is a gate number at the reference airport.

Displays the latitude and longitude of the reference airport gate from the navigation database.

Changes to dashes when a new reference airport is entered.

Entry blanks at lift-off.

3 Greenwich Mean Time Month/Day (GMT – MON/DY)

Displays the time and date from the captain's clock.

If the captain's clock is not valid, GMT starts at 0000.0Z when the FMC is first powered. MON/DY is blank. Manually enter the correct GMT.

4 INDEX

Push – displays the INIT/REF INDEX page.

5 Last Position (LAST POS)

Displays the last FMC computed position.

6 Set IRS Position (SET IRS POS)

The set inertial position entry is required to initialize the IRS. Select the most accurate latitude/longitude for the initialization. A displayed latitude/longitude can be selected or a manual entry can be used.

If an entry is not made before the IRS finishes the initial alignment, the scratchpad message ENTER IRS POS is displayed.

Failure of the manually entered position to pass the IRS internal check displays the scratchpad message ENTER IRS POS.

Enter airplane position latitude and longitude.

If the latitude/longitude position is not within 4 NM of the origin airport, the scratchpad message VERIFY POSITION is displayed.

Box prompts are displayed when either IRS is in the ALIGN mode and IRS present position has not been entered.

Blanks when the IRS transitions from the alignment to the navigation mode.

7 Set IRS Heading (SET IRS HDG)

Enter/update magnetic heading for any IRS which is in ATT mode. Line blanks when IRS not in ATT mode.

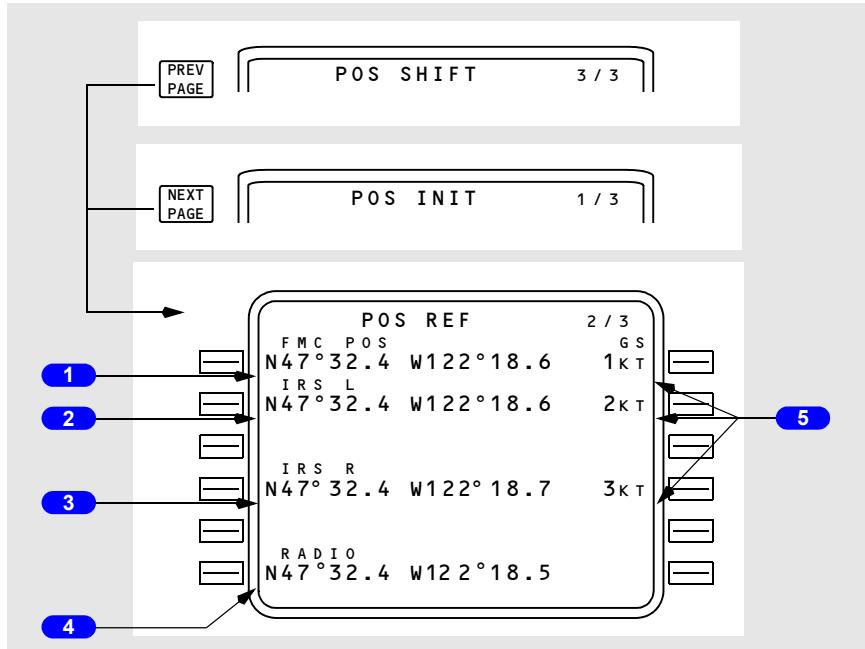
8 ROUTE

Push – displays the ROUTE page.

Position Reference Page

The POS REF page displays the airplane positions as calculated by the FMC, IRS, and radio navigation receivers.

This page displays latitude/longitude. All position displays are in actual latitude and longitude, as calculated by the respective system. Ground speed is displayed for the FMC and each IRS.



1 FMC Position (FMC POS)

Displays the FMC calculated latitude/longitude. Blank if at least one IRS is not supplying a valid present position.

2 IRS Left (IRS L)

Displays the latitude/longitude position as determined by the left IRS. Blank if IRS position is invalid.

3 IRS Right (IRS R)

Displays the latitude/longitude position as determined by the right IRS. Blank if IRS position is invalid.

4 RADIO

Displays the latitude/longitude position as determined by the navigation radios. Blank if on the ground or if radio position is invalid in flight.

5 Ground Speed (GS)

Displays the ground speed from FMC and IRS. Blank if ground speed of related system is invalid.

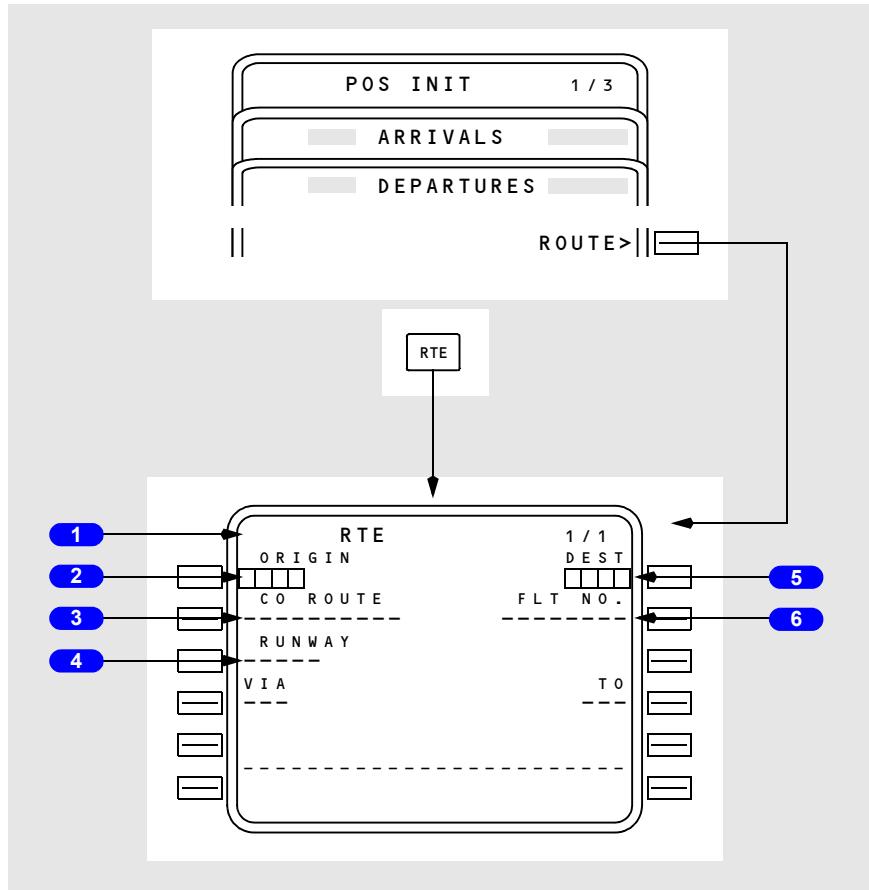
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Route/Departure Pages

Route Page

The route is entered and displayed in air traffic control format. The first RTE page displays origin and destination data and the first two route segments. Additional route segments are displayed on subsequent RTE pages.

Individual portions of the route may be manually entered by the flight crew. A pre-defined route may be loaded using the CO ROUTE line. CO ROUTE entries must correspond to a company defined route in the navigation database.



1 Page Title

The word ACT appears to the left of the title when the route has been activated and executed.

The word MOD appears to the left of the normal 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.

2 ORIGIN

Enter the ICAO airport identifier for the origin.

An entry is required for route activation.

Valid entries must be in the navigation database.

Inflight entry is inhibited for the active route. Entry of a new origin erases the previous route and can be accomplished on the active route only on the ground.

New entries on an active route display MOD in the route title.

Enables direct selection of departure and arrival procedures for the origin airport.

Automatically entered as part of a company route.

3 Company Route (CO ROUTE)

A company route can be called from the navigation database by entering the route identifier. The data provided 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 crew entered company route name. If the name is not contained in the NAV database, the scratchpad message NOT IN DATABASE is displayed.

Entry of a new company route replaces the previous route.

Inflight entry is inhibited for the active route.

4 RUNWAY

Enter the desired runway for the origin airport.

An entry is optional for activation of the route.

Entries must be in the navigation database.

New entries on an active route display MOD in the route title.

Automatically entered when part of a company route.

Can be entered from the DEPARTURES page.

Deleted upon reaching the first waypoint.

5 Destination (DEST)

Enter the ICAO airport identifier for the destination of the route.

An entry is required for route activation.

Entries must be in the navigation database.

New entries on an active route display MOD in the route title.

Enables direct selection of arrival procedures for the destination airport.

Automatically entered as part of a company route.

Entry and execution of a new destination clears any runway and runway dependent approach procedure of the previous destination. If the active leg is part of the affected procedure, then all subsequent (inactive) legs are cleared.

6 Flight Number (FLT NO.)

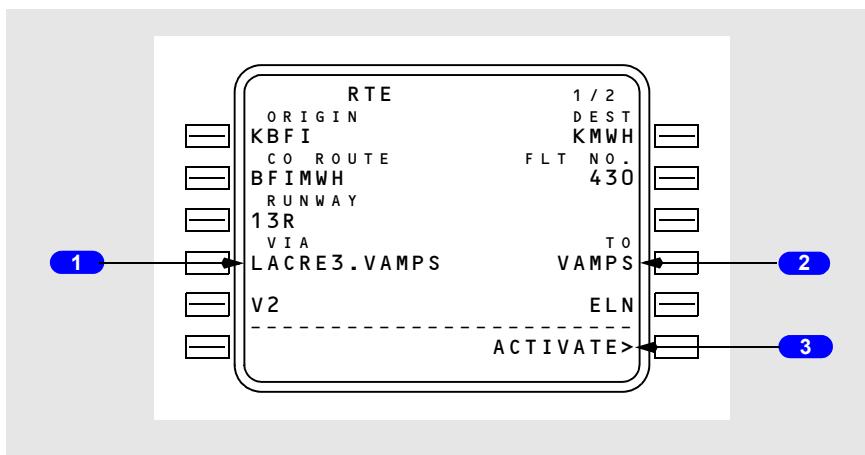
Enter the company flight number.

Entry is optional for activation of the route.

Limited to 8 characters.

Crew entered.

Flight number is included in the PROGRESS page title.

Route Page with Data Entries**1 VIA**

The VIA column displays the route segment to the waypoint or segment termination displayed 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 box prompts are displayed in the TO column if the previous TO line contains a waypoint on the airway.

Valid entries can also include procedures or DIRECT. Procedures are normally entered through selections on DEPARTURES and ARRIVALS pages. DIRECT is normally 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.

Dashed prompts change to DIRECT if the TO waypoint is entered first.

Dash prompts appear for the first VIA beyond the end of the route.

Invalid VIA entries display the scratchpad entry INVALID ENTRY.

Invalid VIA entries are:

- airways and company routes which do not contain the TO waypoint of the previous line
- airways or company routes that are not in the navigation database.

When entering airways, the beginning and ending waypoints determine if the entry 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 beginning point of the current route segment, or a route discontinuity is created between the segments.

Entry of a SID or transition automatically enters the VIA and TO data for the route segments of the SID. A SID automatically links to the next route segment when the final SID waypoint is part of the route segment.

LACRE3.VAMPS is an example of a SID selection made on the DEPARTURES page.

V2 is an example of airway entry.

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 displays DIRECT in the VIA column.

Box prompts indicate that an entry is required.

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.

Dash prompts appear on the first TO waypoint following the end of the route.

3 ACTIVATE

Pushing the ACTIVATE key arms the route for execution as the active route. When the EXEC key is pushed, the route becomes the active route and the ACTIVATE prompt is replaced with the next required preflight page prompt.

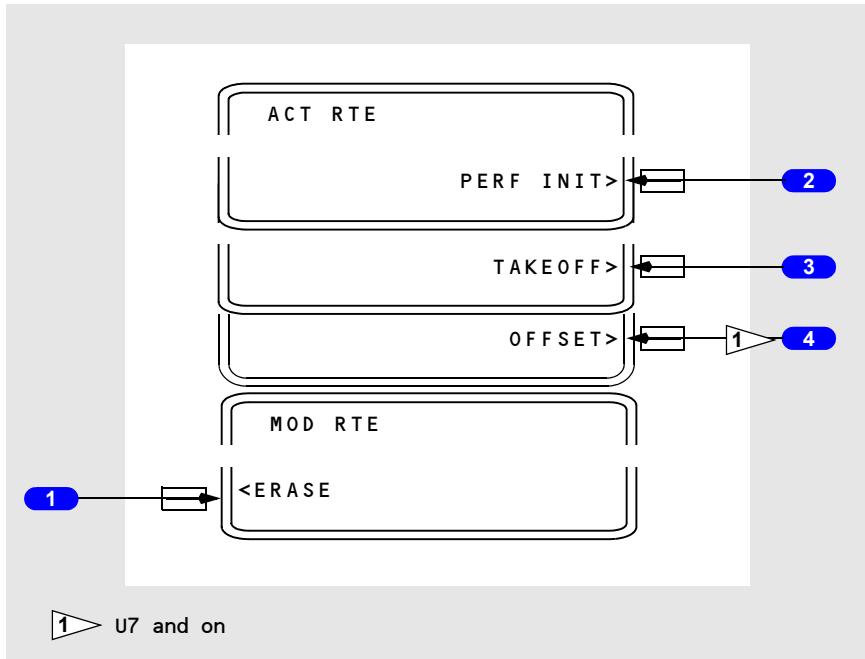
Push – prepares the selected route for execution as the active route.

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.

Additional Route Page Prompts for an Activated Route**1 ERASE**

Push – removes all pending modifications.

Displayed only during modifications.

2 Performance Initialization (PERF INIT)

Push – displays PERF INIT page.

Displayed only on the ground when required entries on the PERF INIT page are incomplete.

3 TAKEOFF

Push – displays TAKEOFF REF page.

Displayed only on the ground when all required entries on the PERF INIT page are complete.

4 OFFSET

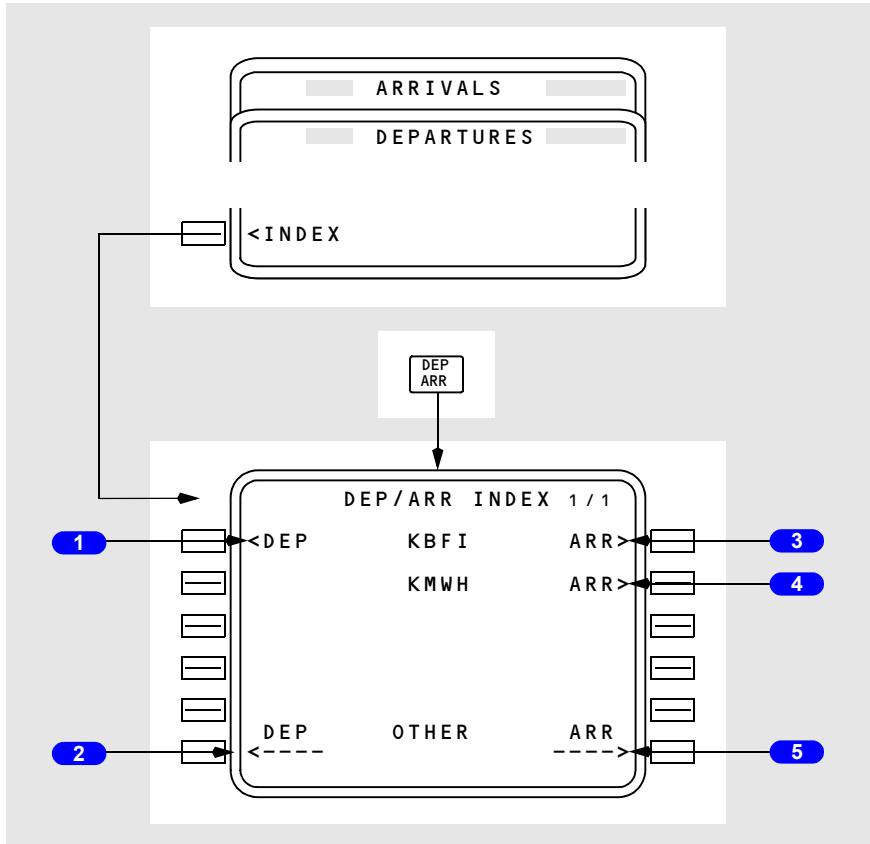
Push – displays LATERAL OFFSET page.

Displayed only in flight.

Departure/Arrival Index Page

The DEP/ARR 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 information 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) – Origin

Push – displays the departure page for the origin airport.

2 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 information about airports that are not an origin or destination. The displayed information can be viewed but cannot be selected, because the airport is not on the route.

3 Arrival (ARR) – Origin

Push – displays the arrival page for the origin airport. Origin airport arrivals selection is used during a turn-back situation.

4 Arrival (ARR) – Destination

Push – displays the arrival page for the destination airport.

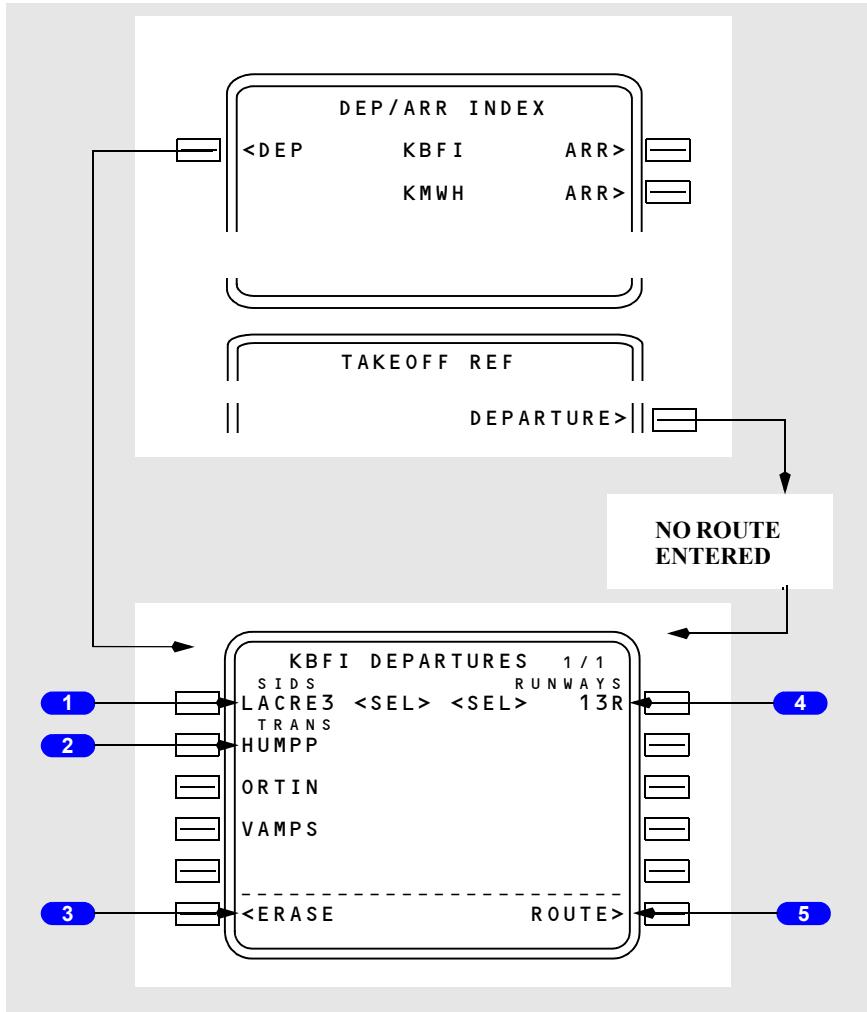
5 Arrival (ARR) – OTHER

Displays the arrival page for the airport entered into this line through the scratchpad.

ARR prompt for OTHER allows display of arrival information about airports that are not an origin or destination. The displayed information 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.



1 Standard Instrument Departures (SIDS)

Displays SIDS for the airport and runway selections.

Without the selection of a runway on the RTE page, the initial display contains all of the information for the airport runways and SIDS. As selections are made, incompatible options are removed. SID transitions are displayed after a SID is selected.

2 Transitions (TRANS)

Displays transitions compatible with the selected SID.

3 ERASE/INDEX

Erase is displayed when a route modification is pending. INDEX is displayed when no route modification is pending.

ERASE push – removes route modifications that are not executed and restores the original route.

INDEX push – displays the DEP/ARR INDEX page.

4 RUNWAYS

Displays a list of runways for the selected airport.

The runway selected on the RTE page is displayed as <SEL> or <ACT> when this page is displayed.

5 ROUTE

Push – displays the RTE page.

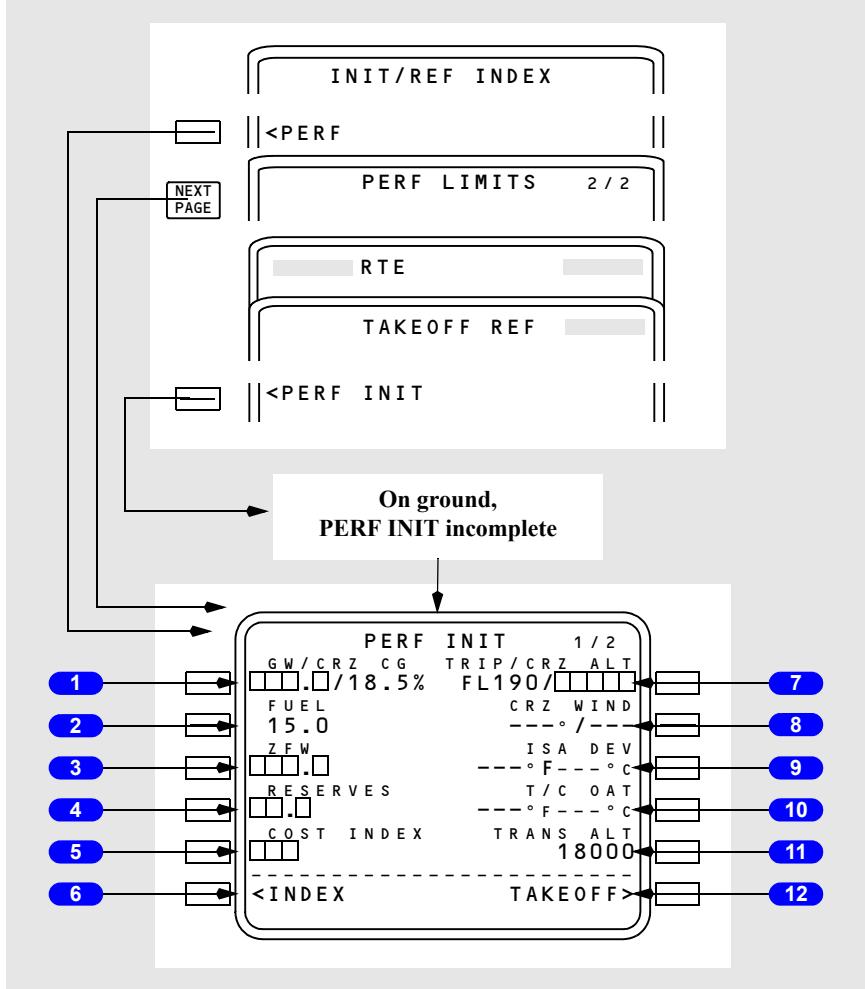
Selecting Options

Selecting an option displays <SEL> inboard of the option, and a route modification is created. When the modification is executed, the <SEL> becomes <ACT>. Leaving the page and returning displays all options and the <SEL> or <ACT> prompts.

Performance Pages

Performance Initialization Page

The PERF INIT page allows the entry of airplane and route data to initialize performance calculations. This information is required for VNAV calculations.



1 Gross Weight/Cruise Center of Gravity (GW/CRZ CG)

Airplane gross weight is required. The entry can be made by the flight crew or automatically calculated by the FMC, following entry of zero fuel weight.

Enter airplane gross weight.

Valid entries are xxx or xxx.x.

Automatically displays calculated weight when zero fuel weight is entered first.

Displays default or manually entered cruise CG. Entry of actual cruise CG may increase maximum altitude capability.

2 FUEL

Fuel on board is automatically displayed as received from the airplane fuel summation unit.

Display is blank if the FMC is not receiving the required fuel data.

3 Zero Fuel Weight (ZFW)

Airplane zero fuel weight is required. Normally the ZFW is entered from the airplane dispatch papers, and the FMC calculates the airplane gross weight.

Enter the airplane zero fuel weight.

Valid entry is xxx or xxx.x.

Calculated zero fuel weight is automatically displayed if airplane gross weight is entered first and fuel on board is valid.

4 RESERVES

Enter fuel reserves for the route.

Entry is required to complete the preflight.

Valid entry is xx or xx.x.

5 COST INDEX

The cost index is used to calculate ECON climb and cruise speeds. The value reflects the relative impacts on overall trip cost of fuel cost as compared to other direct hourly operating costs.

Enter the cost index for ECON calculations.

Entry is required to enable use of VNAV mode.

Valid entries are 0 to 200. Entry of 0 causes the ECON speed to be MAX RANGE; 200 results in a minimum time flight.

Entry of a CO ROUTE on RTE page causes any company stored value of cost index to be automatically displayed. A manual entry has priority.

6 INDEX

Push – displays the INIT/REF INDEX page.

7 Trip/Cruise Altitude (TRIP/CRZ ALT)

Trip altitude is automatically computed and displayed whenever entries have been made for the ORIGIN, DEST, GROSS WT, and COST INDEX. Otherwise, the field is blank.

Trip altitude is the predicted minimum cost altitude determined by operator constraints. Provides crew a reference for selecting a planned cruise altitude.

Cruise altitude is required.

Enter the cruise altitude for the route.

Automatically displays this cruise altitude on the CLB, CRZ, and RTE LEGS pages.

8 Cruise Wind (CRZ WIND)

Cruise wind entry provides input to optimize FMC calculations.

Enter the forecast cruise wind.

Entry is propagated onto the RTE DATA page.

If no entry is made, the FMC assumes zero wind for preflight predictions.

9 ISA Deviation (ISA DEV)

ISA deviation entry provides input to optimize FMC calculations.

Entry causes T/C OAT to be computed and displayed.

Enter ISA deviation for top of climb altitude.

If no entry is made, FMC assumes zero deviation.

10 Top of Climb Outside Air Temperature (T/C OAT)

T/C OAT entry provides input to optimize FMC calculations.

Entry causes ISA DEV to be computed and displayed.

Enter T/C OAT.

If no entry is made, FMC assumes ISA value.

11 Transition Altitude (TRANS ALT)

Displays 18,000 feet at FMC power up.

Changes automatically after selecting a departure procedure with a different transition altitude.

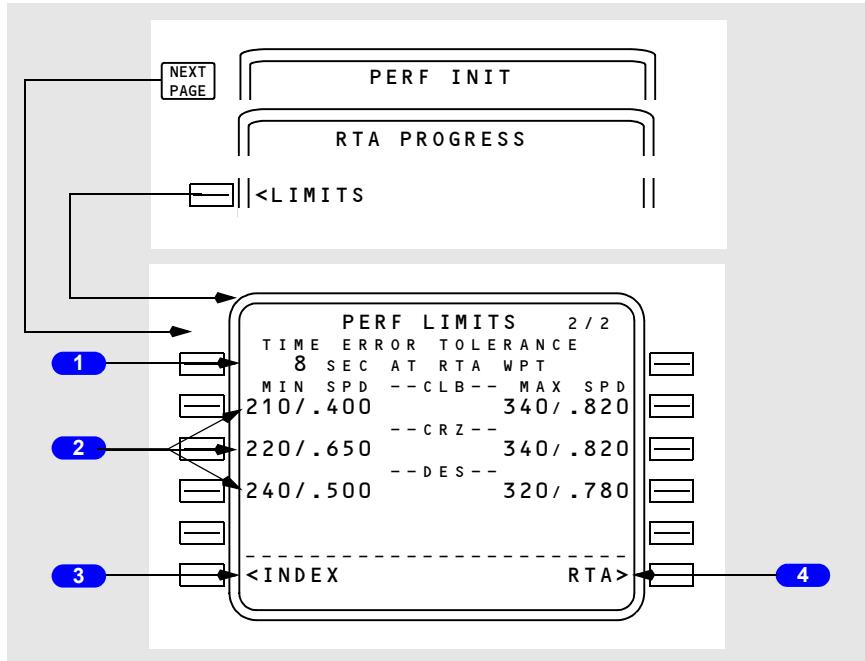
Manual entry has priority.

12 TAKEOFF

Push – displays the TAKEOFF page.

Performance Limits Page

The performance limits page allows the entry of performance limits affecting RTA and ECON calculations.

**1 TIME ERROR TOLERANCE**

Used during RTA calculations to establish a boundary on computed speeds.

Valid entry range is from 6 to 30 seconds.

Default value is 15 seconds and is displayed in small font.

2 Minimum Speed/Maximum Speed (MIN SPD/MAX SPD)

Establishes lower and upper speed limits for each phase of flight.

Default is 210/.40 for lower limit and 340/.820 for upper limit. Displayed in small font.

Either CAS or Mach can be entered.

Limits both RTA and ECON modes in flight.

3 INDEX

Push – selects INIT /REF INDEX page.

4 Required Time of Arrival (RTA)

Push – selects RTA PROGRESS page.

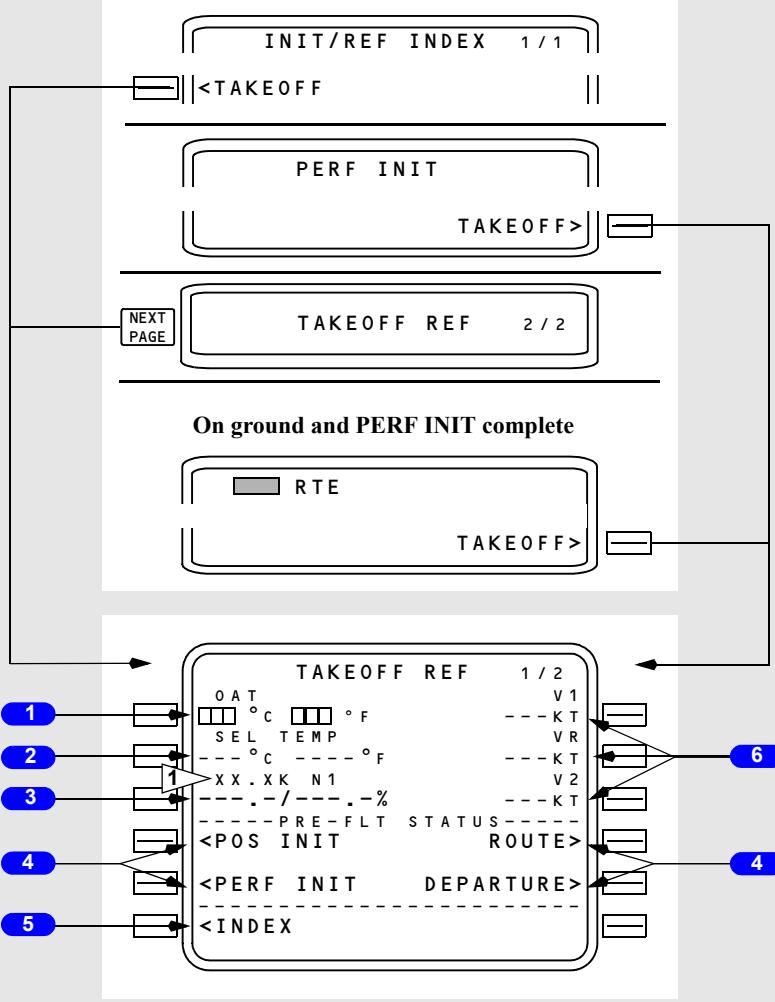
Intentionally
Blank

Takeoff Page 1

Takeoff Reference Page

The takeoff reference page allows the crew to manage takeoff performance. Temperature data is entered to allow the FMC to make takeoff N1 computations for normal or reduced thrust takeoff. V speeds are entered and verified. Preflight pages are selectively displayed to indicate preflight status whenever required entries on those pages are incomplete.

Takeoff reference page entries finish the normal preflight. V speeds should be set before completion. FMC position can be updated prior to takeoff.



1 Outside Air Temperature (OAT)

Manual entry of actual takeoff OAT is displayed in large-sized characters and is used by the FMC to calculate the takeoff N1 limits.

Entry can be made in degrees C or degrees F.

2 Selected Temperature (SEL TEMP)

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

3 Takeoff N1 (XX.XK N1/TO N1)

Displays the FMC computed N1 for takeoff.

Crew entry not allowed.

Data line title displays full rated thrust or selected takeoff derate thrust. Typical line titles display as (U5) "TO N1" (U7) "22K N1" or "20K N1".

Data line title changes to (U5) "RED TO N1" or (U7) "RED XX.XK N1" when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. If a SEL TEMP and a DERATE are both selected the data line title will change to (U5) "RED TO-1" or "RED TO-2" or (U7) "RED XX.XK N1," and the effect on thrust will be additive. The Reference N1 bugs will still display full rated or selected takeoff derate thrust N1 values.

It is possible for CLB2 thrust to be greater than the selected reduced takeoff thrust. Therefore, the thrust levers may advance when the thrust limit changes to CLB 2.

4 Preflight Status (PRE-FLT STATUS)

Selectively displayed to allow line selection of the appropriate preflight pages whenever the required entries on those pages are incomplete.

POS INIT is displayed if a valid IRS position entry disagrees with the position determined by any IRS in the ALIGN mode; otherwise blank.

PERF INIT is displayed if any required PERF INIT entries are not completed; otherwise blank.

ROUTE is displayed if a route is not active; otherwise blank.

DEPARTURE is displayed if RTE page 1 displays prompts for RUNWAY and VIA lines; otherwise blank.

Prior to completion of all required items, "PRE-FLT STATUS" appears above line 4. After completion of all required items, "PRE-FLT COMPLETE" appears.

5 INDEX

Push – displays the INIT/REF INDEX page.

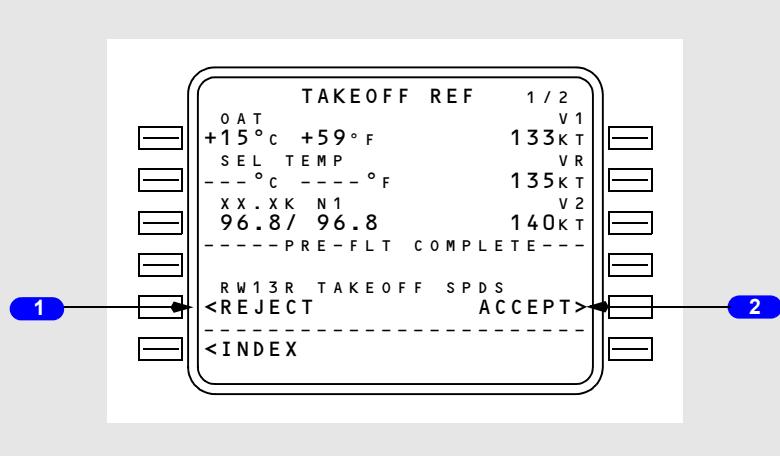
6 V Speeds

Crew calculated V speeds may be entered and displayed for reference.

Entered V1 and VR will automatically be displayed on the EFIS speed tape.

Any change of performance information results in removal of all V speeds.

Display Following Change of Performance Data (U6 and on)



1 REJECT

Displayed if takeoff speeds have been entered and gross weight or zero fuel weight has been changed.

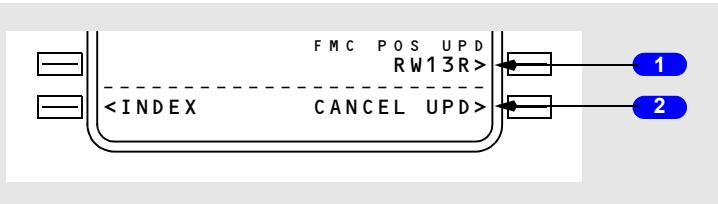
Selection causes the now small font takeoff speeds to disappear.

2 ACCEPT

Displayed if takeoff speeds have been entered and gross weight or zero fuel weight has been changed.

Selection changes the small font takeoff speeds to large font.

Runway Position Update



1 FMC Position Update (FMC POS UPDATE)

Displayed automatically on the ground when preflight complete and a departure runway is entered into the active route.

Selection illuminates the EXEC key and displays the CANCEL UPDATE prompt.

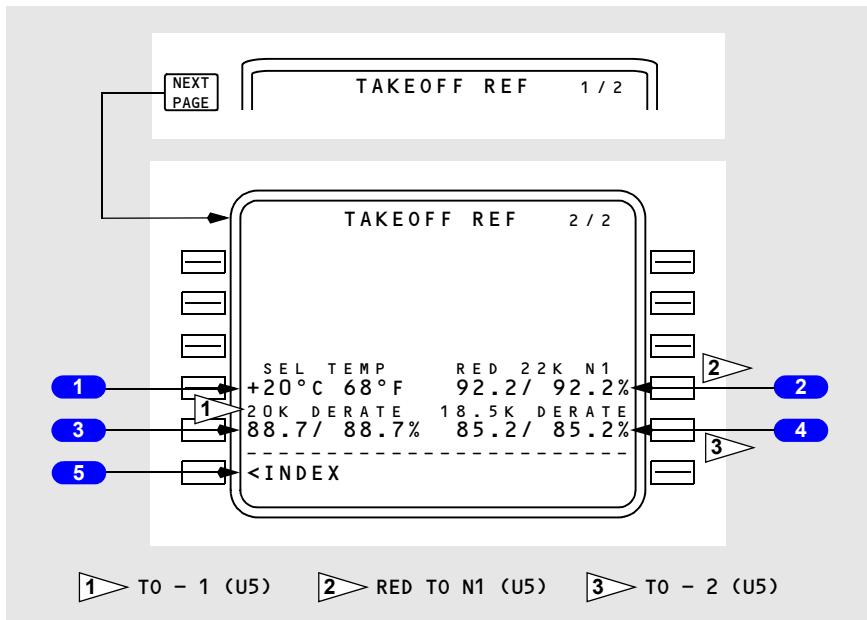
Execution updates the computed FMC position to the threshold of the departure runway.

2 CANCEL UPDATE

Displayed after line selection of the FMC POS UPDATE prompt.

Selection clears the prompt, cancels the position update armed condition, and extinguishes the execute key light.

Intentionally
Blank

Takeoff Page 2**Takeoff Reference Page 2/2****1 Selected Temperature (SEL TEMP)**

Repeats data shown on TAKEOFF REF page 1.

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

2 Takeoff N1 (XX.XX N1/TO N1)

Repeats data shown on TAKEOFF REF page 1.

Displays the FMC computed N1 for takeoff.

Crew entry not allowed.

Data line title displays full rated thrust or selected takeoff derate thrust. Typical line titles display as (U5) "TO N1" (U7) "22K N1" or "20K N1".

Data line title changes to (U5) "RED TO N1" or (U7) "RED XX.XK N1" when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. If a SEL TEMP and a DERATE are both selected, the data line title will change to (U5) "RED TO-1" or "RED TO-2" or (U7) "RED XX.XK N1," and the effect on thrust will be additive. The Reference N1 bugs will still display full rated or selected takeoff derate thrust N1 values.

It is possible for CLB2 thrust to be greater than the selected reduced takeoff thrust. Therefore, the thrust levers may advance when the thrust limit changes to CLB 2.

3 Takeoff 1 Derate (XX.XK DERATE/TO-1 DERATE)

Selects the first level of takeoff derate. For example, a 22K engine will derate to 20K.

Selection of derate replaces DERATE in the title with <SEL>.

The reference N1 bugs will display the derated N1 values.

Deletion returns takeoff thrust to full rated value for the installed engines.

Header and data fields blank if no derate capability exists.

4 Takeoff 2 Derate (XX.XK DERATE/TO-2 DERATE)

Selects the second level of takeoff derate provided one exists.

Selection of derate replaces DERATE in the title with <SEL>.

The reference N1 bugs will display the derated N1 values.

Deletion returns takeoff thrust to full rated value for the installed engines.

Header and data fields blank if no derate capability exists.

5 INDEX

Push – displays the INIT/REF INDEX page.

Flight Management, Navigation FMC Takeoff and Climb

Chapter 11 Section 41

Introduction

The FMC takeoff phase begins with the selection of takeoff/go-around (TO/GA). Preparation for this phase begins in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase automatically changes to the climb phase when climb thrust is selected. The climb phase continues to the top of climb point, where the cruise phase begins.

During these phases, the following pages are normally used:

- TAKEOFF REF page – to make last minute changes to the departure runway
- DEPARTURES page – to make last minute changes to the SID
- CLB page – to modify climb parameters and monitor airplane climb performance
- RTE LEGS page – to modify the route and monitor route progress
- PROGRESS page – to monitor the overall progress of the flight
- N1 LIMIT page – to select alternate climb thrust limits
- DEP/ARR INDEX page – to select an approach during a turn-back.

Takeoff Phase

When last minute changes are made to the departure runway and SID, the TAKEOFF REF and DEPARTURES pages must be modified to agree. The modifications are performed 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 commands acceleration to between V2+15 and V2+25 knots.

LNAV can be engaged at 400 feet and provides roll commands to fly the route leg. VNAV may be engaged after flap retraction to control the climb profile.

Climb Phase

VNAV commands acceleration to:

- 250 knots
- waypoint speed constraints, or
- the speed restriction associated with the origin airport, whichever is more restrictive.

At the climb thrust reduction point, climb thrust can be selected. Passing 10,000 feet, VNAV commands an acceleration to the economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority if slower than target 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 current commanded speed.

When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, the FMC displays the CDU scratchpad message UNABLE NEXT ALTITUDE. A different speed profile that provides a steeper climb angle must be manually selected.

If a CLB 1 or CLB 2 derate is selected, the derate is maintained for the initial part of the climb. Thrust eventually increases to maximum climb thrust at approximately 15,000 feet.

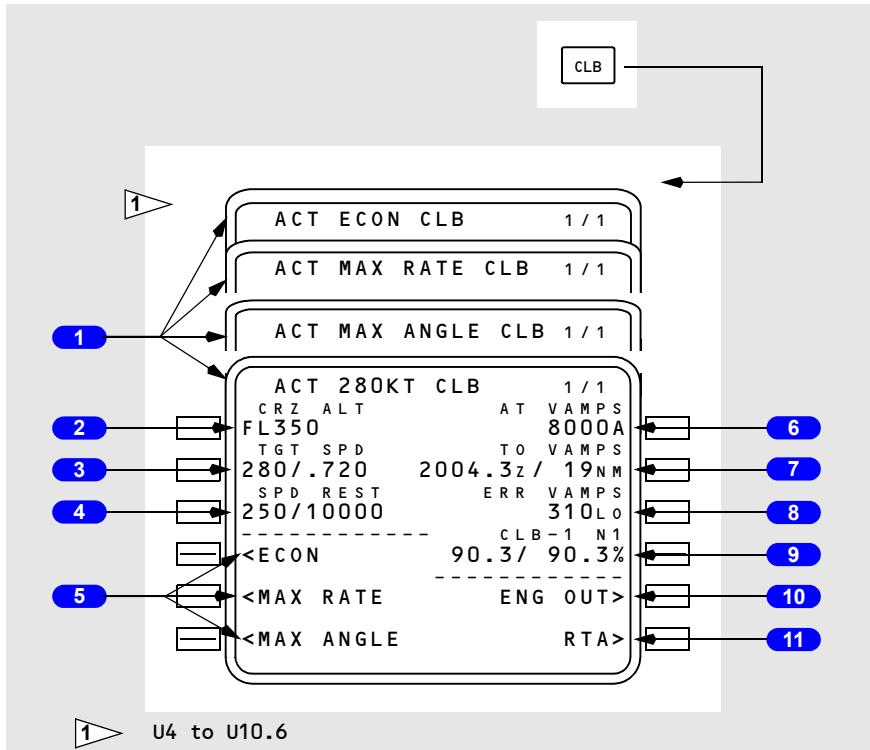
Climb Pages

Climb Page

The CLB page is used to evaluate, monitor, and modify the climb path. The data on the CLB page comes from preflight entries made on the RTE and PERF INIT pages.

The CLB page is selected by pushing the CLB function key on the ground, or during takeoff and climb.

The FMC climb mode can be economy, max rate, max angle, or fixed speed. In each of the modes, similar data is displayed on the page.



1 Page Title

The page title displays the type of climb. Normally, the title displays ECON for the economy climb mode. Other climb modes modify the title.

ECON indicates the speed is based on a cost index.

MAX RATE indicates the speed is based on the maximum altitude over the shortest period of time.

MAX ANGLE indicates the speed is based on the maximum altitude over the shortest horizontal distance.

Fixed climb speeds display XXXKT for a fixed CAS climb speed or M.XXX for a fixed Mach climb speed profile and are manually entered by the crew.

Reasons for selecting climbs other than ECON are:

- takeoff/climb acceleration segment constraints
- waypoint speed constraints
- an altitude constraint associated with a speed constraint
- a speed restriction
- a crew-entered speed.

Displays ACT when the climb phase is active.

2 Cruise Altitude (CRZ ALT)

The cruise altitude from the PERF INIT page is displayed. A new altitude can be manually entered.

3 Target Speed (TGT SPD)

Displays computed values or manually entered values for the selected mode.

Computed speed is limited to a maximum of 340 knots/M.82.

Airspeed and/or Mach may be entered using the keyboard. Title will display manually entered value.

The active controlling speed is highlighted in reverse video.

4 Speed Restriction (SPD REST)

The speed restriction line displays the speed restriction/altitude from one of the following sources:

- the navigation database value for the origin airport
- waypoint related restriction from the RTE LEGS page if restriction limits climb speed
- a default speed of 250 knots and 10,000 feet (example 250/10000)
- displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

Dashes displayed if no active speed restriction exists.

Manual crew entries or deletions may be made. HOLD or FLAPS speed may not be deleted or modified.

Note: If the FMC default speed restriction is overwritten, it will be deleted and not return after the overwrite condition passes. (e.g. the default of 250/10000 is overwritten to 230/3000, after 3000 feet is passed there will be no speed restriction and VNAV will accelerate to the unrestricted climb speed.)

The active controlling speed is highlighted in reverse video.

5 Climb Page Prompts

Push – selects various CLB pages.

Following line selection, the prompt for that page blanks.

6 AT XXXXX

The waypoint constraint line displays the next waypoint having an altitude constraint. Constraints are entered on the RTE LEGS page or by departure procedure selection. The constraints can be deleted on this page or the RTE LEGS page. The waypoint may be a HOLD AT point.

Display is blank if no restriction exists.

7 TO XXXXX

Displays ETA and distance to go to the waypoint on AT XXXXX line.

If no waypoint constraint exists, values are for CRZ ALT.

8 Error (ERR XXXXX)

Displays predicted altitude undershoot for the waypoint on AT XXXXX line.

During VNAV operation, the FMC commands a level off if an overshoot is predicted.

Display is blank, including the label, if no error exists.

9 Reduced Climb N1 (CLB – X N1)

Displays reduced climb N1 value.

Blank when reduced climb not selected.

10 Engine Out (ENG OUT)

See ENG OUT CLB page description.

11 Required Time of Arrival (RTA)

Displays the RTA PROGRESS page.

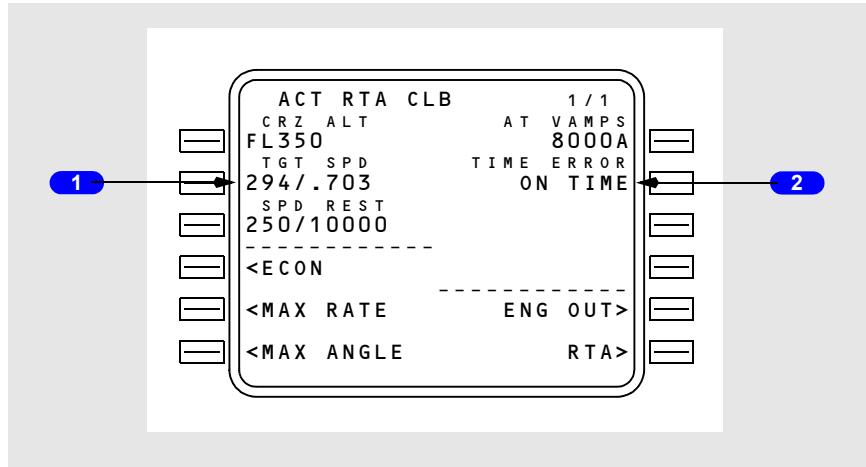
ERASE prompt replaces RTA during a page modification.

RTA Climb Page

The RTA CLB page is displayed when a required time of arrival is active.

The RTA CLB page is automatically selected by pushing the CLB function key when RTA is active.

Displays on this page are the same as other climb pages except as noted.



1 Target Speed (TGT SPD)

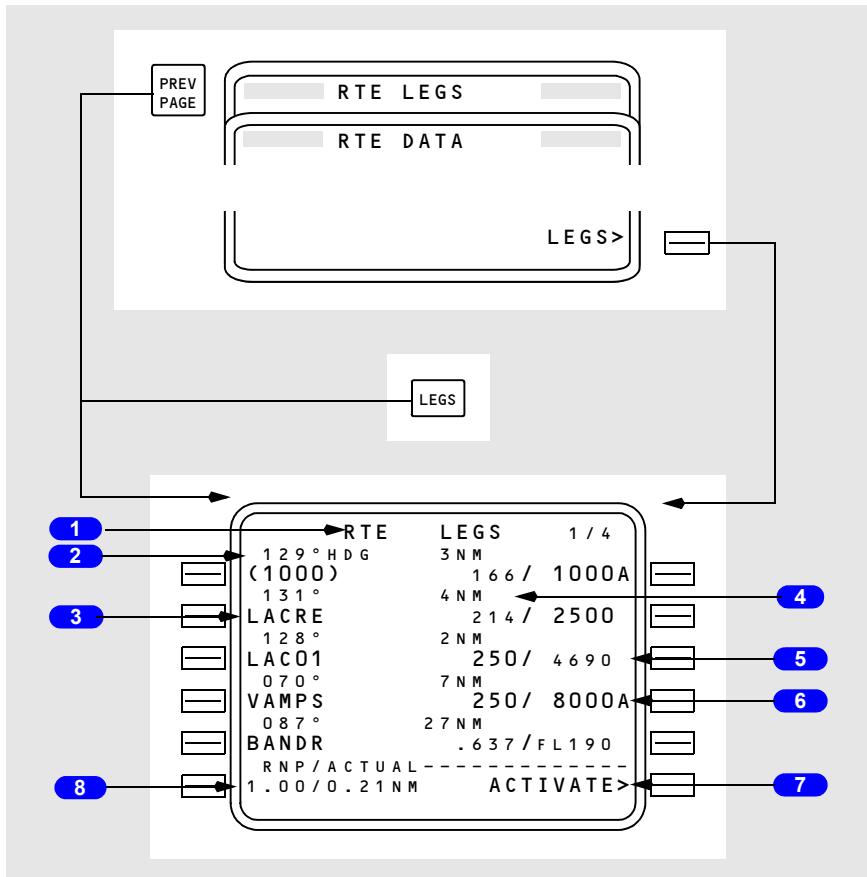
Displays the computed speed required to meet entered RTA.

When RTA is exited by waypoint sequence or deletion, this speed changes to FMC target speed.

2 TIME ERROR

Displays computed time error at RTA waypoint. Same as RTA PROGRESS page.

RTE LEGS Page



1 Page Title

An active RTE LEGS page title is displayed with ACT as part of the title. A modified page title is displayed with MOD in reverse video.

2 Leg Direction

Leg segment direction is displayed as the title of the waypoint line. Courses are displayed in magnetic (xxx°) or true (xxx° T). Computed great circle route leg directions may be different than chart values. Heading leg segments to conditional waypoints are displayed as (xxx° HDG) and track leg segments are displayed as (xxx° TRK). Directions may be displayed as special procedural instructions, such as HOLD AT or (U7.2 and on) PROC TURN.

Display is blank for an undefined course.

3 Waypoint Identifier

The current active leg is always displayed at the top of the first active RTE LEGS page.

All route waypoints are displayed. Waypoints on an airway are included on the route legs page. Waypoints appear in flight sequence.

Waypoints can be entered and moved. This includes:

- adding new waypoints
- removing existing waypoints
- resequencing existing waypoints
- linking route discontinuities.

Displays the waypoint by name or condition.

Box prompts are displayed for route discontinuities.

Dashes are displayed for the next line beyond the end of the route.

4 Distance to Waypoint

Displays the distance from the airplane or the waypoint to the next waypoint.

5 Calculated Waypoint Speed/Altitude

Displays the calculated speed or altitude at the waypoint in small font.

6 Specified Waypoint Speed/Altitude

Displays any waypoint speed or altitude constraint in large font.

Manual entry is allowed.

7 ACTIVATE, EXTENDED DATA

The ACTIVATE prompt is displayed on the RTE LEGS page when the route is not active. When the activate prompt key is pushed, the route must be executed by pushing the EXEC key.

The EXTENDED DATA prompt is used to review additional information about the route.

Push –

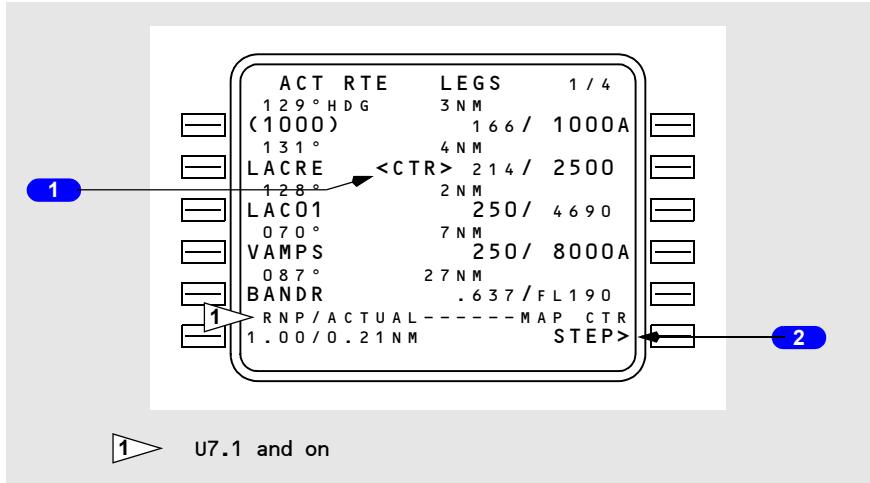
- ACTIVATE arms the execute function. Pushing the EXEC key activates the route and changes the ACTIVATE prompt to EXTENDED DATA
- EXTENDED DATA displays the RTE DATA page.

8 Required Navigational Position/Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy.

Map Center Step Display

The MAP CTR STEP prompt replaces ACTIVATE or EXTENDED DATA when the EFIS control panel mode selector is placed in the PLAN position. Pushing the prompt key advances the waypoint that is displayed in the center of the map. The <CTR> label is displayed to the right of the corresponding waypoint on the RTE LEGS page.



1 Map Center Label (<CTR>)

Identifies the waypoint around which the map display is centered.

Whenever the EFIS mode selector is positioned to PLAN, the label is automatically displayed for the first geographically fixed waypoint on the displayed page.

2 Map Center Step (MAP CTR STEP)

Displayed on a CDU when PLAN is selected on the associated EFIS control panel. Replaces the EXTENDED DATA or ACTIVATE prompt.

Push – advances the <CTR> label on the CDU to the next geographically fixed waypoint in the route and moves the respective waypoint to the center of the EHSI.

Intentionally
Blank

Progress Pages

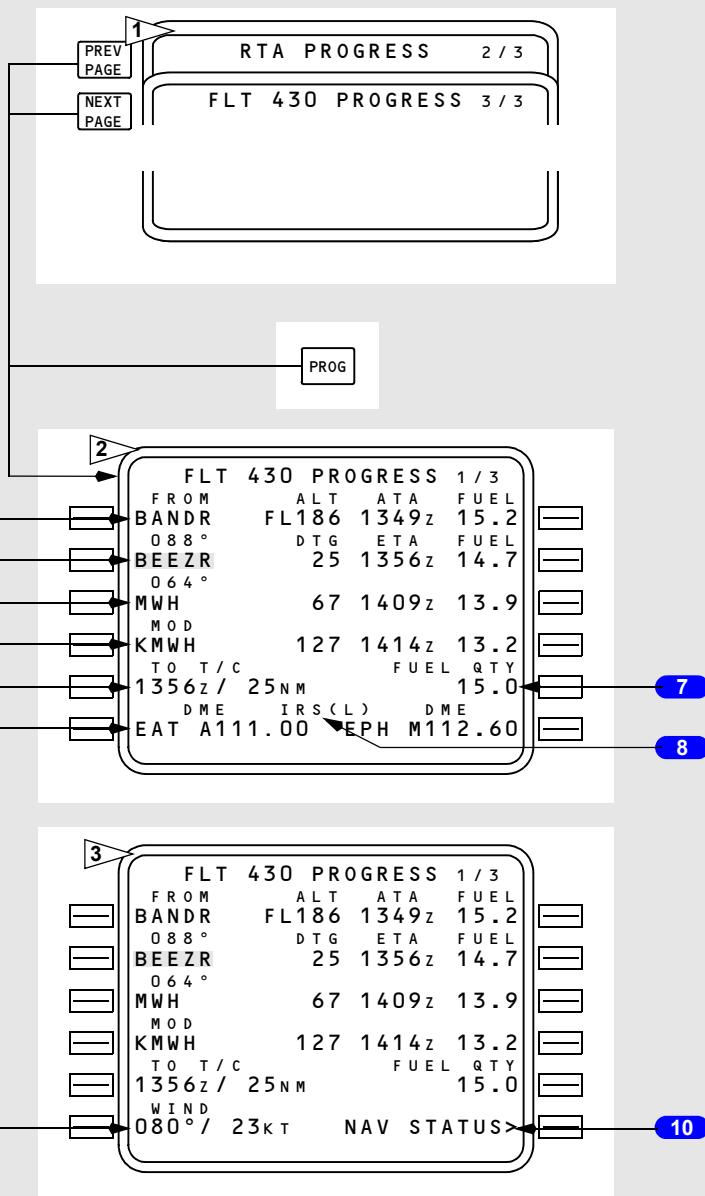
Progress Page 1

The PROGRESS page provides general flight progress information along the route of flight.

The page title displays the company flight number from the RTE page in the title.

Page one of the progress pages displays general information (such as distance-to-go, ATA, ETA, fuel remaining estimates) about the following:

- waypoints (last, active, and next)
- destination information
- altitude change points
- (U5 and on) navaid and IRS information
- (U7 and on) current wind
- fuel quantity.



1 U4 and on

2 Prior to U7

3 U7 to U10.4A

1 FROM

Displays the identifier of the last (FROM) waypoint, the altitude (ALT), the actual time of arrival (ATA), and the fuel at that waypoint.

2 Active Waypoint

Displays the identifier of the active waypoint, the flight plan course to the active waypoint, and distance-to-go (DTG) from present position to the active waypoint. Also displays the estimated time of arrival (ETA) and predicted fuel remaining at the active waypoint. The active waypoint is highlighted by reverse video.

3 Next Waypoint

Displays the identifier of the next waypoint which follows the active waypoint, the flight plan course for that leg, and flight plan distance-to-go (DTG) from present position to the next waypoint. Also displays the estimated time of arrival (ETA) and predicted fuel remaining at the next waypoint.

4 Destination

Displays the identifier of the destination airport (DEST) and flight plan distance-to-go (DTG) from present position to the destination. Also displays estimated time of arrival (ETA) and predicted fuel remaining at the destination.

When a route modification is in progress, the destination line label displays MOD. Performance predictions include the modification.

CAUTION: The displayed values on the destination line now reflect the modification (MOD) and may not be accurate for the active flight plan.

5 Altitude Change Point (TO XXXXX)

Displays ETA and distance-to-go to the following altitude change points as appropriate to phase of flight:

- TO T/C: to top of climb for the active climb
- TO STEP POINT: to the step point if a STEP TO entry is made on CRZ page
- TO T/D: to top of descent, if no STEP TO entry is made on CRZ page
- TO E/D: to the end of descent waypoint for an active path descent; blank if a path descent is not available.

6 VHF Navigation Radio Lines

Displays identifiers and frequencies of the navaids presently tuned by VHF No. 1 and VHF No. 2.

Frequency prefixes identify the tuning mode of each radio:

- A – indicates frequency tuned by the FMC auto-tune mode
- M – indicates manually tuned frequency
- P – indicates frequency auto-tuned by the FMC as required by an active procedure.

7 Fuel Quantity (FUEL QTY)

Displays the present total fuel quantity remaining as obtained from the airplane fuel summation unit.

8 IRS (X)

Displays currently selected IRS.

9 WIND

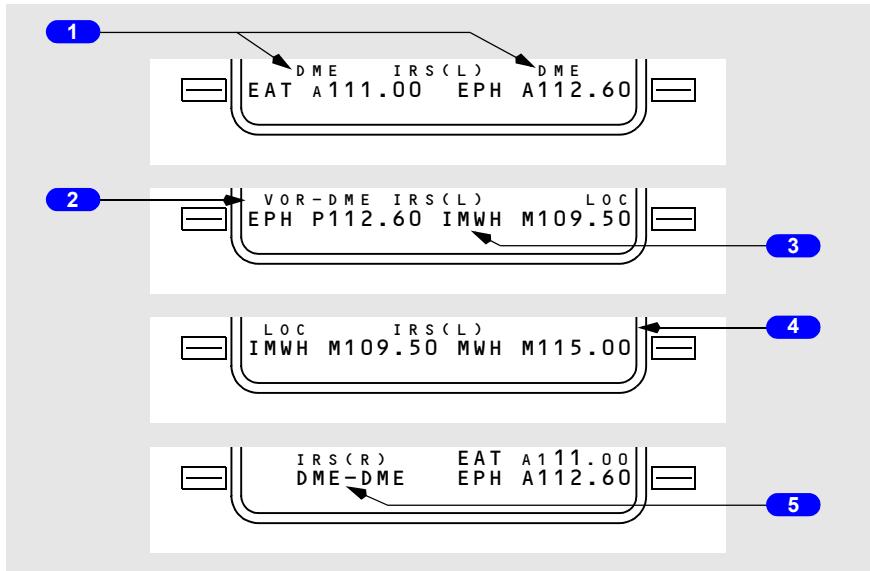
Displays current true wind direction and speed.

10 Navigation Status (NAV STATUS)

Push – displays the navigation status page.

Radio Update Modes

Displays the type of information (DME, DME-DME, VOR-DME, LOC, LOC-DME), identifiers, and frequency being used for updating the FMC position. Blank when not being used for updating.



1 DME Updating

When possible, only DME information is used from each radio to update the FMC position.

2 VOR/DME Updating

When required, both VOR and DME information is used to update the FMC position. The airplane must be 25 nm or less from the VOR/DME station.

3 LOC Updating

When required, localizer information is used to update the FMC. The ILS frequencies must be manually tuned when used as an approach aid; however, the FMC will auto-tune an ILS/DME station for use in DME updating. During an approach, the ILS localizer is used for cross-course position updating.

4 Updating Unavailable

The line title will be blank when the radio is not being used for updating.

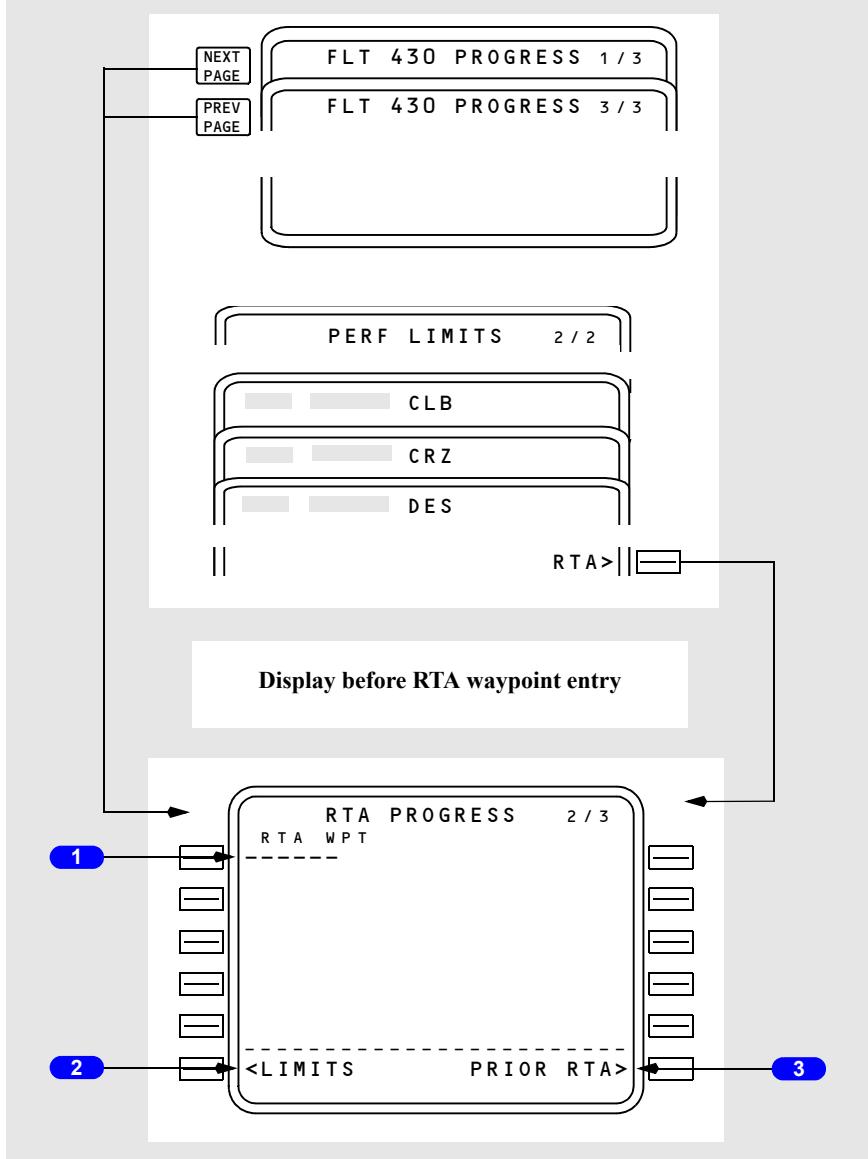
5 Agility Tuning

When required, a single radio can be automatically cyclic-tuned between two DME stations at five-second intervals. Two identifiers and frequencies are displayed for the single radio in use.

RTA Progress Page 2/3

RTA PROGRESS page is used to initiate the required time of arrival (RTA) mode.

The RTA PROGRESS page provides advisory data on flight progress in the RTA mode and advises of control times such as recommended takeoff time to meet RTA.



1 Required Time of Arrival Waypoint (RTA WPT)

Displays dashes when entry is allowed.

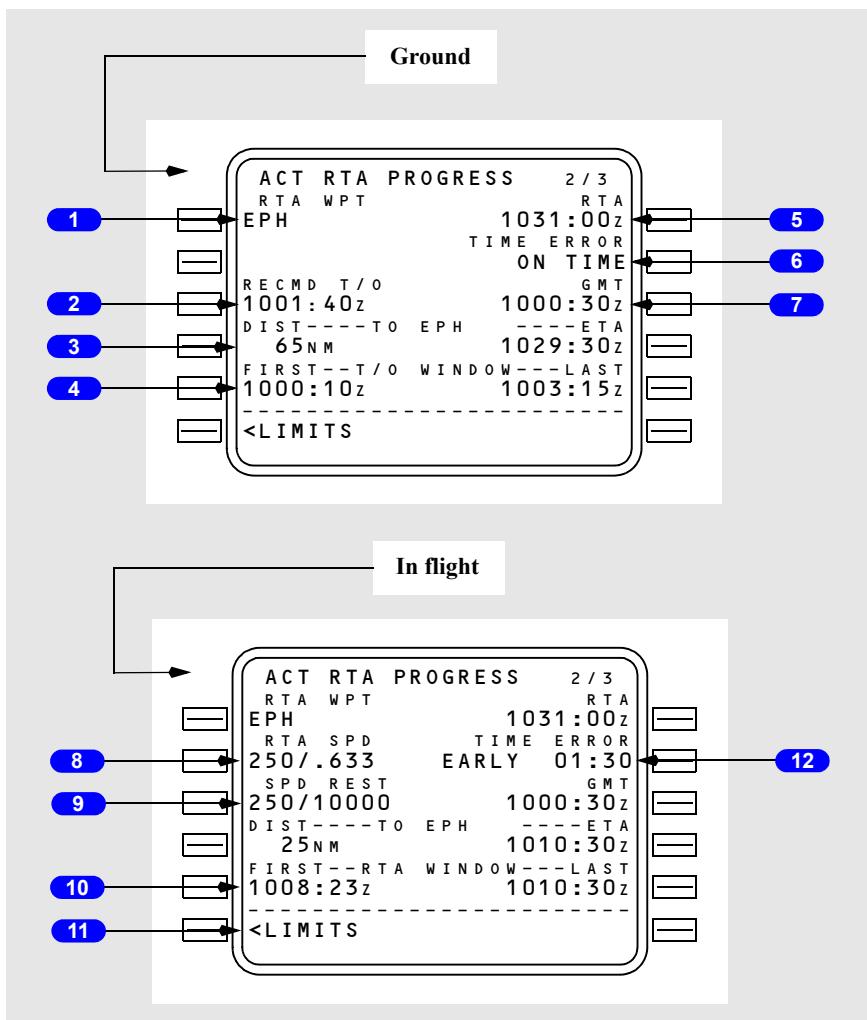
2 LIMITS

Push – displays the PERF LIMITS page.

3 Prior RTA Waypoint (PRIOR RTA)

Prompt displayed when the RTA waypoint field contains dashes and a previous RTA waypoint is still in the flight plan; otherwise blank.

Push – displays last active RTA waypoint data.

RTA Progress on Ground and In Flight**1 Required Time of Arrival Waypoint (RTA WPT)**

Waypoint entry must be in flight plan, or the CDU message NOT IN FLIGHT PLAN will be displayed.

Entering a valid waypoint will generate a MOD RTA PROGRESS page and illuminate the EXEC key.

Deletion of the RTA waypoint will create a MOD RTA PROGRESS page with all data blanked and EXEC key illuminated. Execution will exit the RTA mode.

Deletion of the RTA waypoint does not remove the waypoint from the flight plan.
The RTA waypoint automatically clears, and the FMC exits the RTA mode after sequencing the RTA waypoint out of the flight plan.

2 Recommended Takeoff Time (RECMD T/O)

Displays the recommended takeoff time to meet the planned RTA.

Time is based on entered cost index.

3 Distance To RTA Waypoint (DIST --- TO XXXX)

Displays the distance (DIST) to the RTA waypoint.

Displays estimated time of arrival (ETA) to the RTA waypoint based on:

- immediate takeoff
- MIN/MAX speeds on PERF LIMITS page
- entered forecast winds.

4 Takeoff Window (FIRST -- T/O WINDOW --- LAST)

Displays earliest (FIRST) and latest (LAST) takeoff times to meet the planned RTA.

Times are based on MIN/MAX speeds on the PERF LIMITS page.

5 Required Time of Arrival (RTA)

After RTA waypoint entry, initially displays current ETA based on the active flight plan and performance parameters at the time of waypoint entry.

Desired RTA may be entered by overwriting displayed data.

Entry must be in one of the following forms:

- XXXXXX (hr/min/sec)
- XXXX (hr/min)
- XXXX.X (hr/min/tenths of min).

6 TIME ERROR

Displays the most recent time error in minutes and seconds up to a maximum of 59:59 minutes.

Displays ON TIME if GMT is within current T/O WINDOW

Displays EARLY or LATE as appropriate if GMT is not within current T/O WINDOW.

7 Greenwich Mean Time (GMT)

Displays the actual GMT.

8 Required Time of Arrival Speed (RTA SPD)

Displays the target speed required to meet the planned RTA.

Same as speed displayed on RTA CLB, CRZ, or DES page.

Limited by MIN/MAX speeds on the PERF LIMITS page and any entered speed restriction.

During cruise, displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

9 Speed Restriction (SPD REST)

Displays the current speed restriction affecting RTA progress.

During cruise, displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

10 Arrival Time Window (FIRST -- RTA WINDOW --- LAST)

Displays earliest (FIRST) and latest (LAST) achievable arrival times at the RTA waypoint.

Times based on MIN/MAX speeds on PERF LIMITS page, existing winds, and entered forecast winds.

11 LIMITS

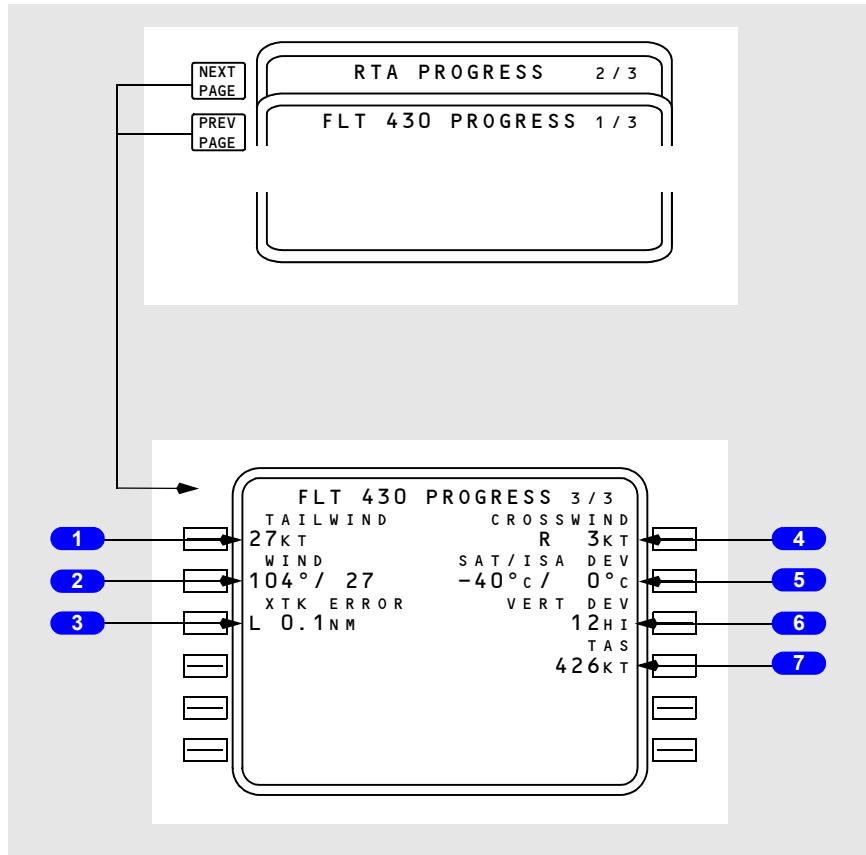
Push – displays PERF LIMITS page.

12 TIME ERROR

Displays the difference between the ETA and the RTA plus the TIME ERROR TOLERANCE on the PERF LIMITS page.

Progress Page 3

The last progress page displays wind, track, path, temperature, and speed data.



1 HEADWIND/TAILWIND

Displays the present headwind or tailwind component.

2 WIND

Displays the present true wind direction/speed.

3 Cross track Error (XTK ERROR)

Displays present cross-track error (left or right) from the lateral guidance path.

Blank if error is greater than 99.9 nm.

4 CROSSWIND

Displays present crosswind component (left or right).

5 Static Air Temperature/ISA Deviation (SAT/ISA DEV)

Displays present SAT and the equivalent ISA deviation.

6 Vertical Deviation (VERT DEV)

Displays present computed deviation (HI or LO) from the FMC vertical path.

Blank if descent is not active or path is not available.

7 True Airspeed (TAS)

Displays present TAS.

Intentionally
Blank

Limit Page

N1 Limit Page

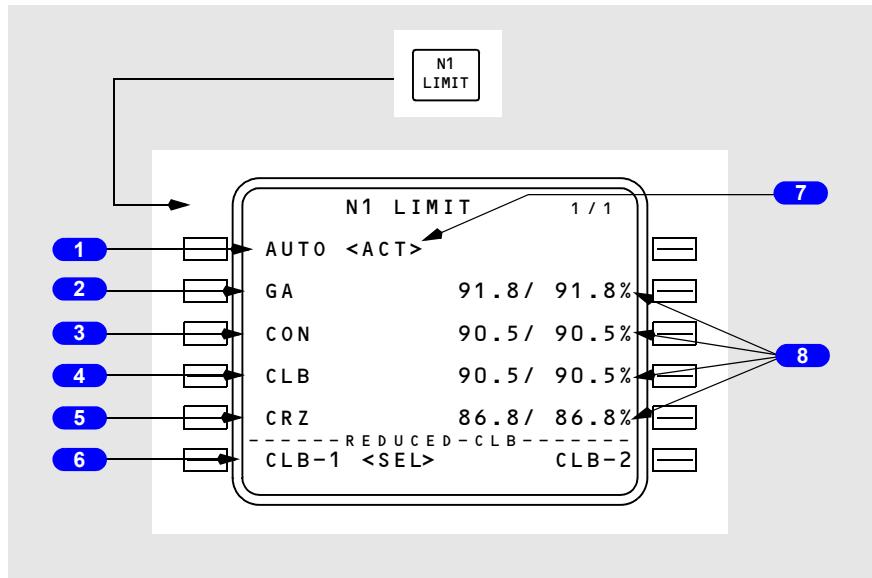
The N1 LIMIT page provides thrust limit and reduced climb thrust selection.

Normally, N1 limits are automatically specified. Pilot selection of other limits is allowed.

Pilot selection of a reduced climb mode does not change the automatic selection for other phases of flight.

A pilot selected mode is automatically replaced by AUTO selection when the autopilot changes to the next vertical mode.

The active thrust limit is used by the autothrottle and is displayed on the thrust mode display.



1 Automatic (AUTO)

Push – selects the automatic computation of N1 limits for all phases of flight.

2 Go-Around (GA)

Push – selects the go-around thrust limit.

3 Continuous (CON)

Push – selects the maximum continuous thrust limit.

4 Climb (CLB)

Push – changes the thrust mode from AUTO to the active climb thrust, i.e. CLB, CLB-1, or CLB-2.

5 Cruise (CRZ)

Push – selects the cruise thrust limit.

6 Reduced Climb (REDUCED-CLB)

Push – selects either of two reduced climb thrust modes.

CLB-1 provides a climb limit reduced by 3% N1 (approximately 10% thrust).

CLB-2 provides a climb limit reduced by 6% N1 (approximately 20% thrust).

The reduced climb N1 value is displayed on the CLB pages.

If either mode is <SEL>, deletion allows return to full rated climb thrust.

Any reduced climb selection is automatically deleted above 15,000 feet.

Note: If a reduced thrust takeoff has been specified on the TAKEOFF REF page, then either CLB-1 or CLB-2 may be automatically specified if required to avoid a climb N1 value greater than the RED-TO N1.

7 Active Status Label (<ACT>)

Identifies the active N1 thrust limit.

8 N1

Displays the N1 for individual thrust limits based on present conditions and bleed air configuration.

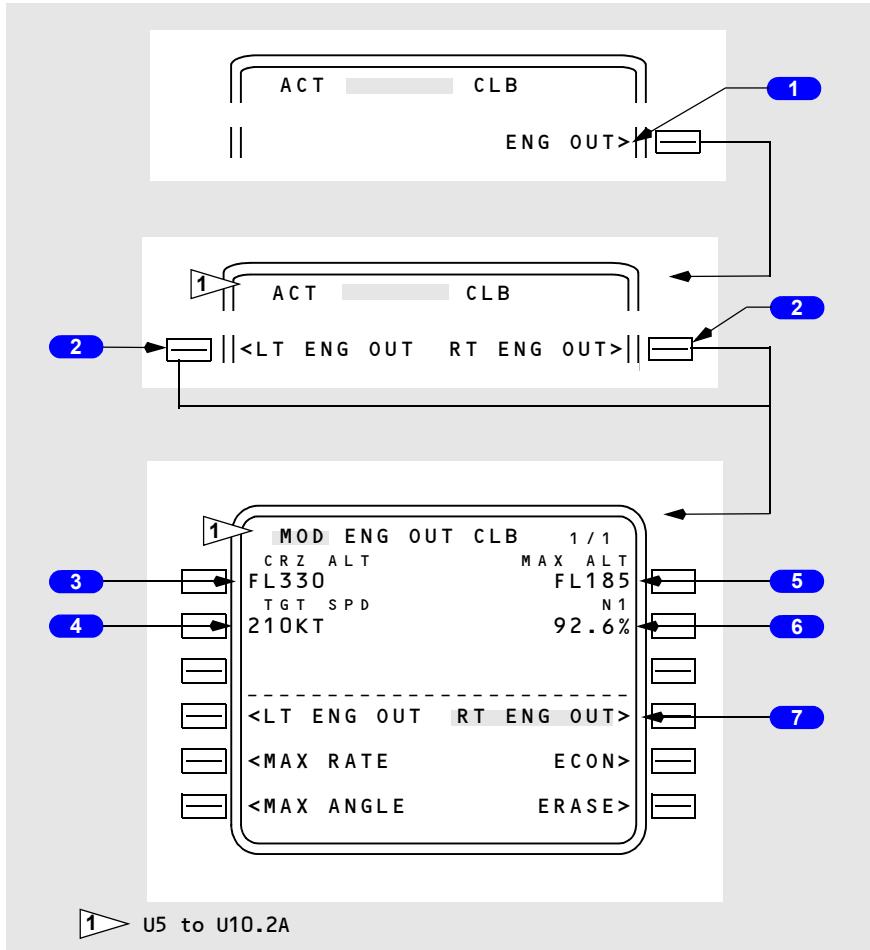
If CLB-1 or CLB-2 is selected, the N1% for CLB and the N1 cursors still display values for full rated climb.

Engine Out Climb

Engine out climb advisory data is available on the CLB page. Engine out data is also available with both engines operating. The engine out climb phase automatically transitions to the engine out cruise phase when reaching the cruise altitude.

Engine Out Climb Page

Displays advisory information for an engine inoperative condition.



1 Engine Out (ENG OUT)

Push – permits access to ENG OUT CLB page.

2 Left/Right Engine Out (LT ENG OUT / RT ENG OUT)

Displayed after selection of ENG OUT prompt.

(Prior to U10.3) Selection of left or right engine changes display to MOD ENG OUT CLB page.

After viewing engine out data, select ERASE to return to the active climb mode.

3 Cruise Altitude (CRZ ALT)

Displays the current active cruise altitude. Value is forwarded from either the PERF INIT or another CLB page. Manual entry is allowed.

4 Target Speed (TGT SPD)

Displays the minimum drag engine out climb speed.

5 Maximum Altitude (MAX ALT)

Displays the maximum altitude at which a company specified rate of climb can be achieved using one engine at maximum continuous thrust (default climb rate is 100 fpm).

After page selection, the FMC accounts for wing and engine anti-ice, air conditioning, and the engine bleed of the operating engine.

6 N1

Displays N1 for maximum continuous thrust.

(Prior to U7.5) If the page is executed, this becomes the active N1 limit. N1 is computed using actual bleed conditions.

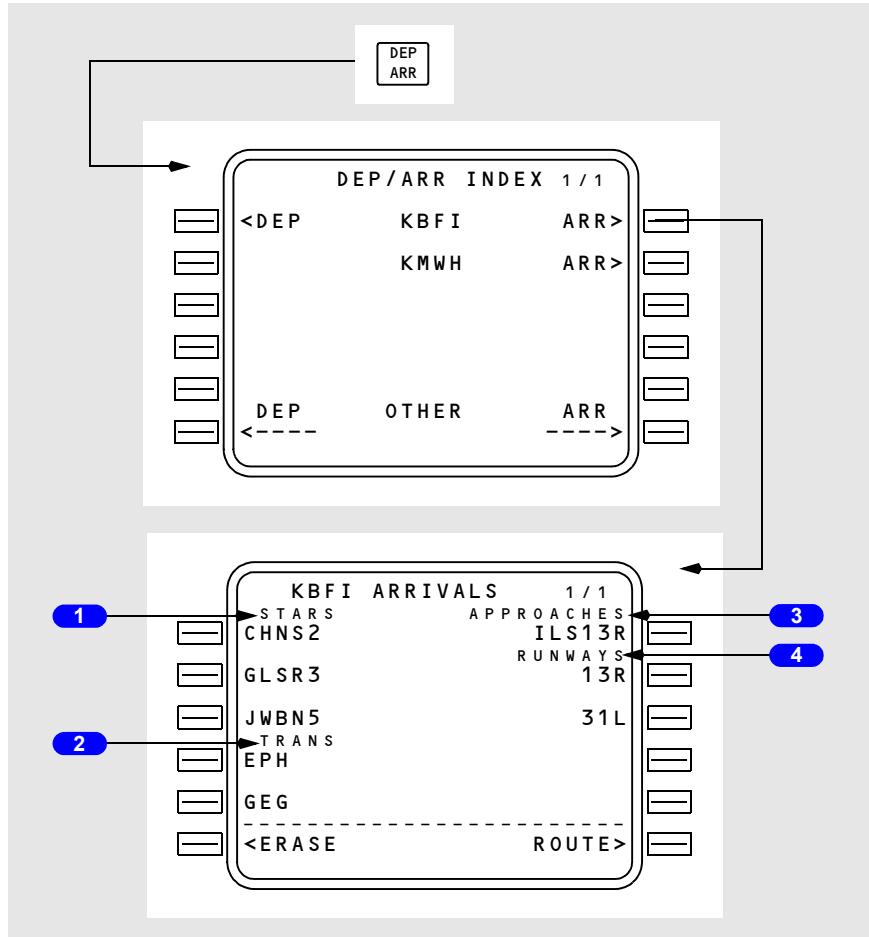
7 Left/Right Engine Out (LT ENG OUT / RT ENG OUT)

The selected engine out is highlighted in reverse video.

Air Turnback

Arrivals Page

During a turn-back situation, the crew requires quick access to the arrivals information for the origin airport. The DEP/ARR INDEX and ARRIVALS pages provide access without changing the destination on the RTE page.



1 Standard Terminal Arrivals Routes (STARS)

Displays STARS for the origin airport.

2 Transitions (TRANS)

Displays all transitions associated with the selected STAR for the origin airport.

3 APPROACHES

Displays approaches for the origin airport.

4 RUNWAYS

Displays runways for the origin airport.

Flight Management, Navigation FMC Cruise

Chapter 11 Section 42

Introduction

The cruise phase automatically begins when the top of climb is reached.

During cruise, the primary FMC pages are:

- RTE LEGS
- PROGRESS
- CRZ

The RTE LEGS pages are used to manage route restrictions and modify the route. The PROGRESS pages display flight progress information. RTA requirements are also specified on the PROGRESS pages. The CRZ pages display VNAV related information. Other pages include:

- POS REF page – verifies the FMC position (refer to Section 40 of this chapter)
- POS SHIFT page – permits selection of preferred position from a list of references
- RTE DATA page – displays progress data for each waypoint on the RTE LEGS page. Displays wind data for cruise waypoints
- REF NAV DATA page – displays information about waypoints, navaids, airports, or runways
- (U7.1 and on) LATERAL OFFSET page – permits selection of a route offset
- FIX INFO page – displays information about waypoints, and can be used to create new waypoints and fixes
- SELECT DESIRED WPT page – permits selection of the desired waypoint from a list of duplicate named waypoints.
- (U7 and on) NAV STATUS page – displays information about available navigation aids.

The only cruise mode automatic page changes are the transition from climb to cruise at the top of climb point and from cruise to descent at the top of descent point.

LNAV Modifications

This section presents the normal techniques for modifying the route. The modifications include:

- adding and deleting waypoints
- resequencing waypoints
- linking discontinuities
- intercepting a course.

RTE LEGS Page Modifications

When modifications are made to the RTE LEGS page, several automatic prompt or identifying features assist in managing and executing the modifications, such as:

- ERASE
- INTC CRS.

Adding Waypoints

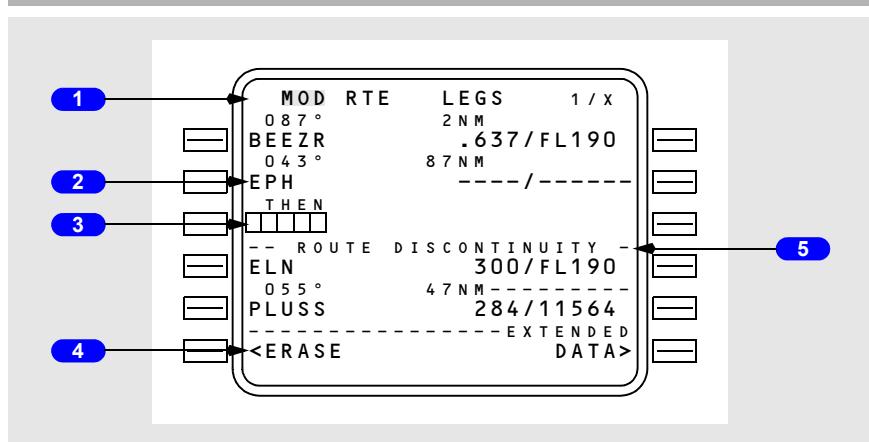
A waypoint can be added to the route whenever necessary.

The new waypoint must first be placed into the CDU scratchpad. Existing waypoints can be copied from a RTE LEGS page into the scratchpad by pushing the line select key adjacent to the desired waypoint.

The new waypoint is then inserted into the route at the desired sequence point by pushing the line select key adjacent to the desired location for the new waypoint. Using the NEXT PAGE/PREV PAGE function keys to select the desired location does not alter the CDU scratchpad. The new entry automatically links to the preceding waypoint via a direct route. Placing the new waypoint into the active waypoint line is a special case and is discussed under Intercept Course in this section.

All new waypoints, except downpath waypoints, cause a route discontinuity between the new waypoint and the following waypoint.

Note: If the FMC NAV database contains a HOLD pattern at the FAF, executing a database approach with a procedure turn and then executing a HOLD at the same FAF, using any inbound course, may cause a discontinuity between the FAF and the procedure turn. If the discontinuity is removed, LNAV guidance is available to fly the approach from the published holding pattern. LNAV guidance is not available to fly the published procedure turn.



1 Page Title

When the page is modified, MOD appears in front of the title in reverse video. This means the route is now altered. The MOD title also shows that the modifications are not yet executed and can be removed using the ERASE prompt.

2 Modified Waypoint

EPH waypoint is entered into the route between BEEZR and ELN. This modification creates a route discontinuity.

3 Route Discontinuity

Box prompts indicates a break in the route structure and the ability to link the route by entering a route waypoint into the discontinuity box prompts.

4 ERASE

The ERASE prompt is displayed when the first modification is entered. The prompt remains on the page until the modifications are erased or executed. Selecting ERASE removes all modifications and restores all active data.

5 ROUTE DISCONTINUITY

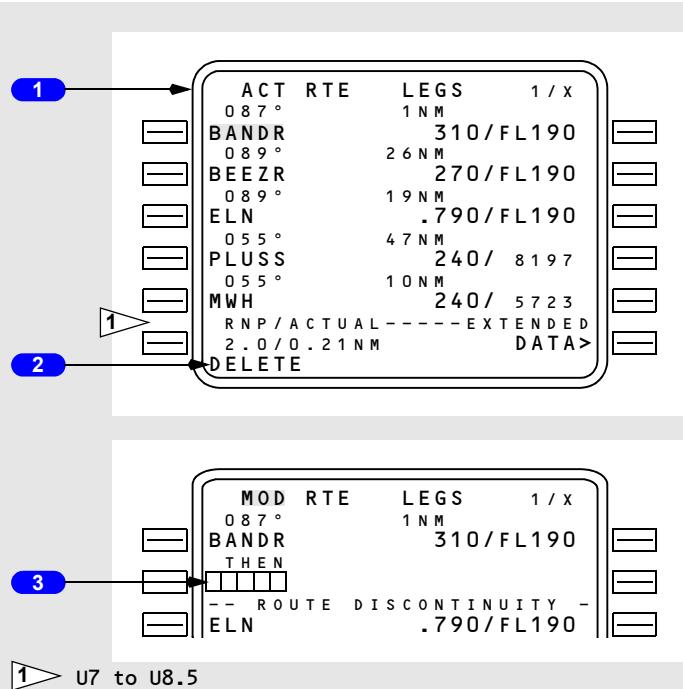
Indicates that the route is not continuous. Distance to destination on the PROGRESS page is not correct.

Deleting Waypoints

Waypoints can be removed from the RTE LEGS page. There are two normal methods to remove a waypoint:

- delete the waypoint using the DEL function key (not possible for the active waypoint and conditional waypoints)
- resequence the route by moving a down-route waypoint up in the sequence and automatically removing all waypoints that are between.

During the deletion process, all of the route prior to the deletion point remains unchanged. Removing a waypoint using the DEL function key causes a route discontinuity to replace the deleted waypoint.



1 Active Route Legs (ACT RTE LEGS)

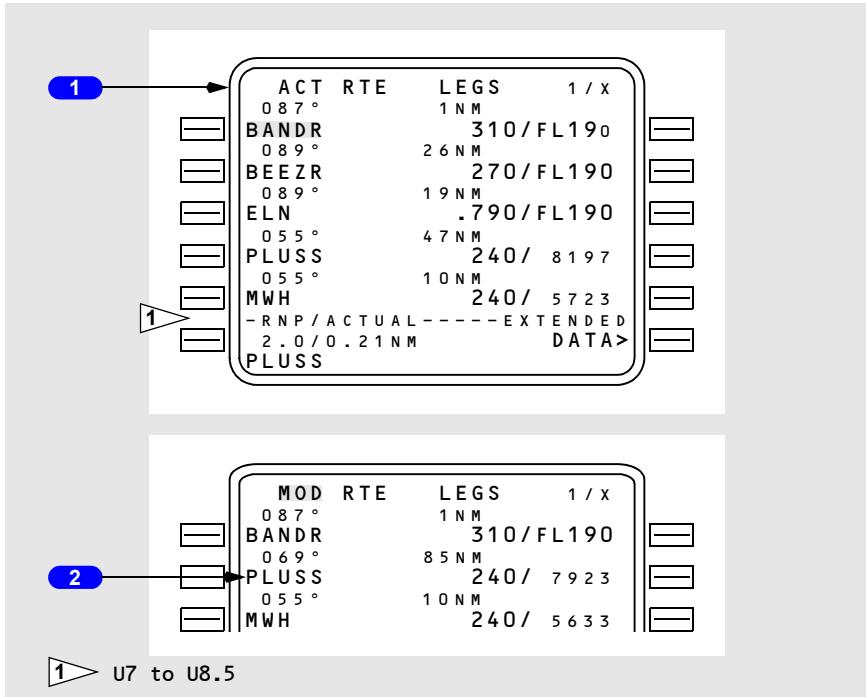
The existing route shows BANDR followed by BEEZR and ELN.

2 DELETE Entry

Push the DEL key to arm the delete function. DELETE is displayed in the scratchpad.

3 Delete BEEZR

With DELETE displayed in the scratchpad, push the line select key left of BEEZR to delete the waypoint. Box prompts replace BEEZR, and a route discontinuity follows the box prompts.

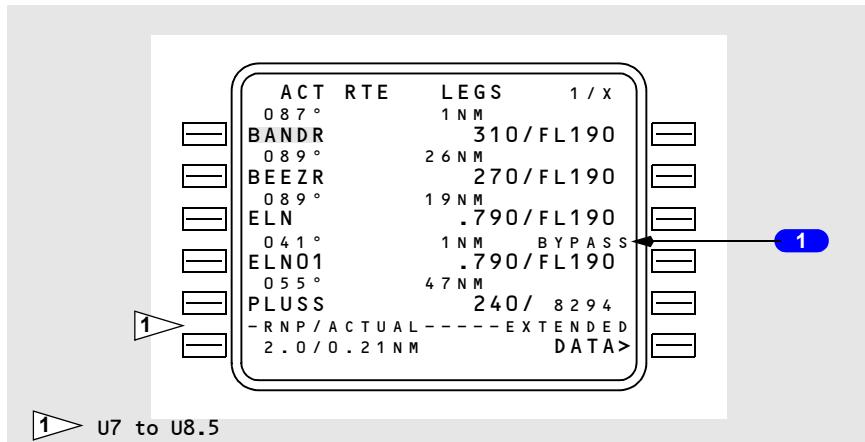
Resequencing Waypoints**1 Active Route**

The existing route shows BANDR followed by BEEZR, ELN then PLUSS. The airplane is cleared BANDR direct PLUSS. The PLUSS waypoint is copied into the scratchpad.

2 Resequence PLUSS

PLUSS is entered after BANDR. BEEZR and ELN are automatically removed, and the route remains continuous.

Leg Bypass



1 Bypass Notification

A waypoint (ELN01) has been entered into the route which is very close to another route waypoint (ELN). It is impossible for the airplane to turn and capture the leg between ELN and ELN01, so a bypass is noted.

Turn construction is based upon FMC criteria which assume that LNAV is engaged. Normal turn construction may not be possible under certain combinations of airspeed, short leg length, and a significant change in leg direction. If normal turn construction cannot provide a continuous path, the FMC bypasses the affected leg and uses alternative turn construction to intercept the leg to the subsequent waypoint. When the bypass is for the active waypoint, the waypoint remains active until the airplane passes abeam.

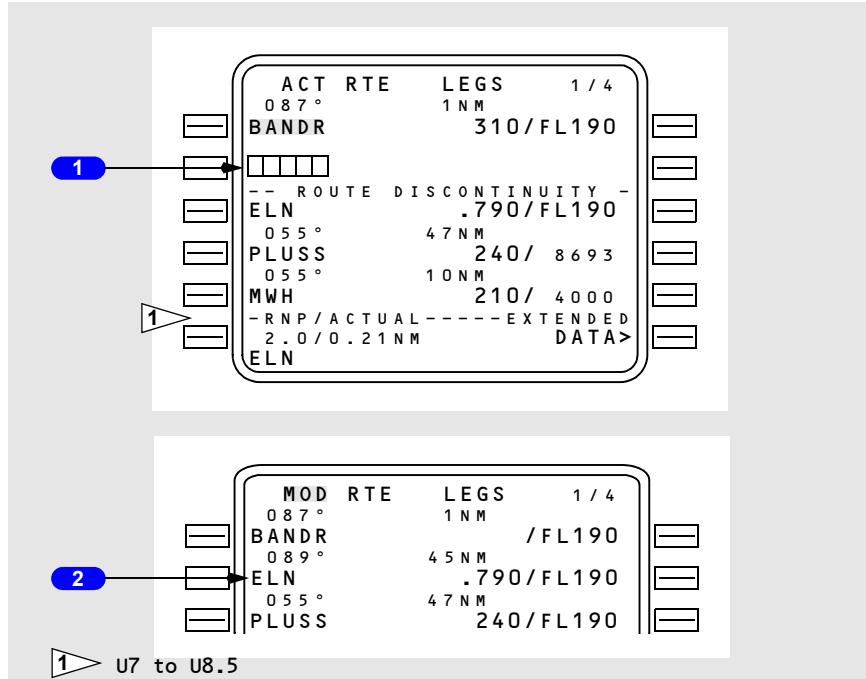
Any mandatory altitude-crossing restriction for the bypass waypoint is still observed if VNAV is engaged, based on passing abeam the waypoint.

If a double bypass condition occurs (bypass of two consecutive legs), a route discontinuity will be inserted.

Removing Discontinuities

A discontinuity exists when the FMC is unable to determine the route leg following a waypoint. Discontinuities are removed by linking the route segment following the discontinuity to the route segment preceding the discontinuity.

The next desired waypoint from the subsequent route is copied into the CDU scratchpad and entered into the discontinuity box prompts, just as when adding a waypoint.



1 ROUTE DISCONTINUITY

The active route shows a discontinuity. The airplane must fly direct from BANDR to ELN. The ELN waypoint is copied into the scratchpad in preparation to remove the discontinuity. Any waypoint from the route can be copied into the scratchpad to remove the discontinuity.

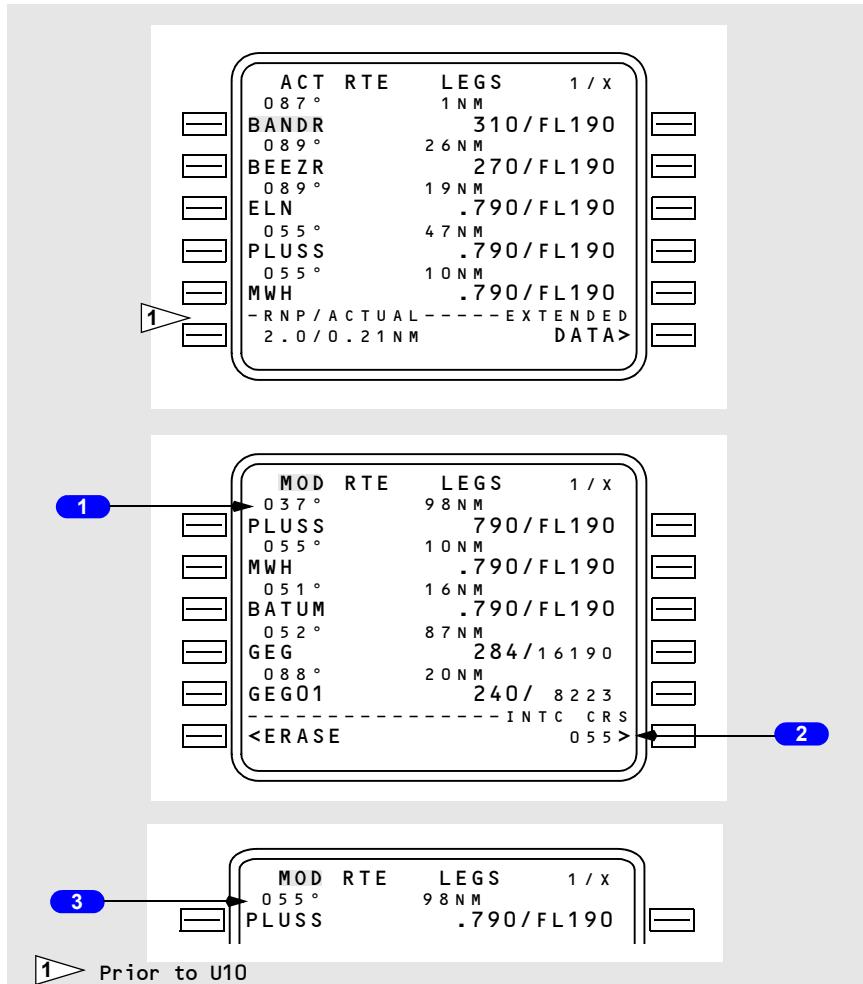
2 Continuous Route

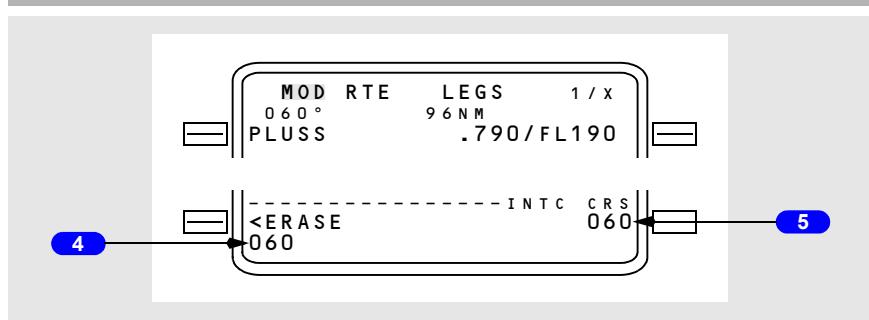
ELN is copied into the box prompts to remove the discontinuity.

Entering a waypoint which does not already exist on the route moves the discontinuity one waypoint farther down the route.

Direct To or Intercept Course

To fly direct to a waypoint or intercept a course to a waypoint, enter the waypoint name on the active waypoint line, the first line on the MOD RTE LEGS 1/X page. This example shows the result with PLUSS entered into the active waypoint line. A new entry onto this waypoint line displays INTC CRS in the lower right.





1 Direct Course

Direct course from airplane present position to entered waypoint.

Execute to proceed direct to active waypoint.

2 Intercept Course (INTC CRS)

Displayed whenever the active waypoint name is modified.

Displays flight plan leg direction to entered waypoint in small font. Displays dashes if entered waypoint was not in the flight plan.

Valid input is any course from 000 through 360. May be changed until executed. Entered or selected value displays in large font.

Push – puts displayed course into active waypoint leg direction. Enables intercept course function.

3 Leg Direction

Displays the course inbound to the active waypoint after selecting the course displayed in the INTC CRS line.

4 Crew Desired Intercept Course

The crew can select any inbound course to the active waypoint by first entering the course into the scratchpad.

5 Intercept Course (INTC CRS) – Change

Enter the inbound intercept course to the modified waypoint in the scratchpad.

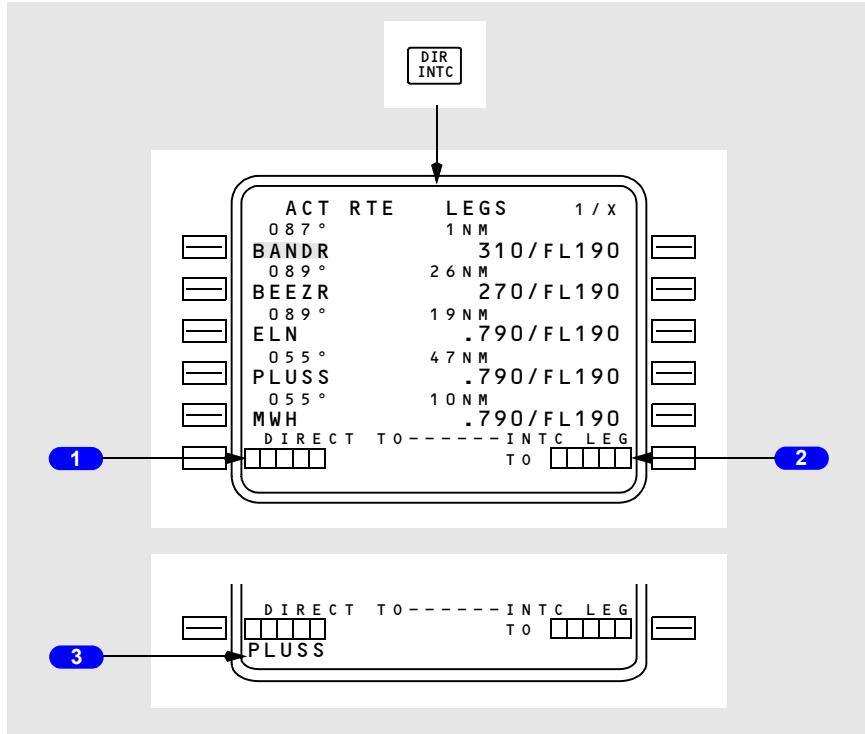
Select the INTC CRS line to change the leg direction.

The example shows 060° intercept course to PLUSS entered in the INTC CRS line.

Direct To/Intercept Leg To

Proceeding direct to a waypoint or intercepting a course to a waypoint may be accomplished by using the direct intercept (DIR INTC) mode select key. Pushing the DIR INTC key adds box prompt options to the bottom of the ACT RTE LEGS page.

Using line select or manual entry, the desired waypoint is entered into the scratchpad. The waypoint is then moved into the appropriate boxes.



1 DIRECT TO Boxes

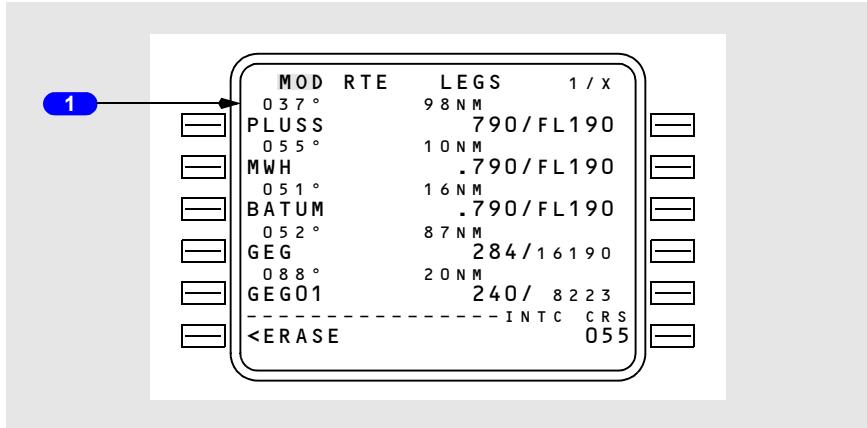
Entering the desired waypoint in these boxes makes that waypoint the active waypoint and establishes a course direct to the waypoint.

2 Intercept Leg To (INTC LEG TO) Boxes

Entering the desired waypoint in these boxes makes that waypoint the active waypoint and allows an intercept course to be specified to the waypoint.

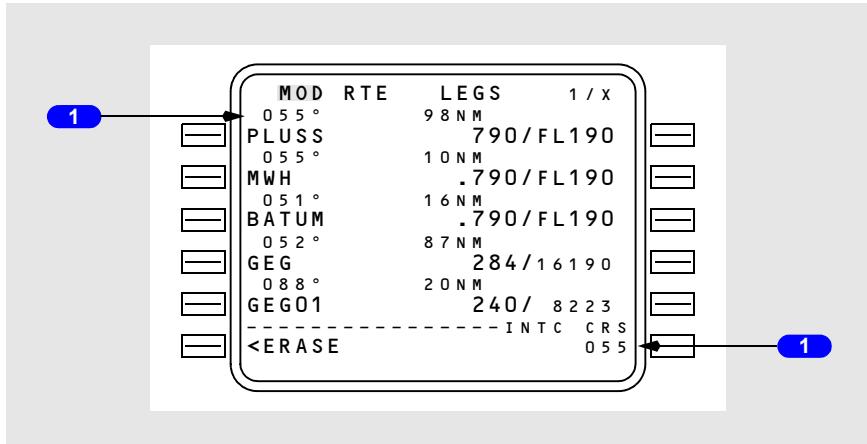
3 Scratchpad Entry

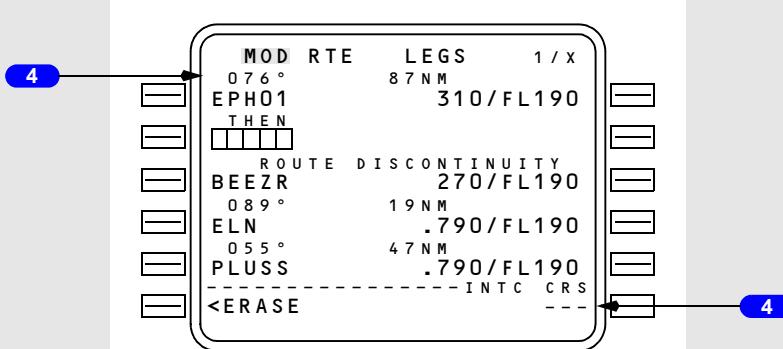
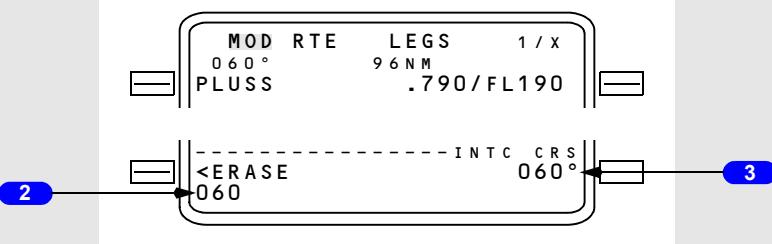
The desired waypoint is entered in the scratchpad, then line selected to the appropriate boxes.

Direct To**1 Direct Course**

Direct course from airplane position to entered waypoint.

Execute to proceed direct to active waypoint.

Intercept Leg To



1 Intercept Course (INTC CRS)

A waypoint already in the route has an existing inbound course. When the waypoint is inserted into the INTC LEG TO box prompts, the waypoint becomes the modified active waypoint. The existing inbound course is displayed above the waypoint and on the INTC CRS line in small font. Execution changes the MOD page to ACT.

After completing the desired modifications, the crew must ensure that LNAV is engaged to fly the intercept course. In order to engage LNAV, the airplane must be on an intercept heading to the course.

2 Crew Desired Intercept Course

The crew can select any inbound course to the active waypoint by first entering the course into the scratchpad.

3 Crew Selected Intercept Course

After entering a course into the scratchpad, selecting the INTC CRS line transfers the new course to the INTC CRS line and to the active waypoint.

After completing the desired modifications, the crew must ensure that LNAV is engaged to fly the intercept course. In order to engage LNAV, the airplane must be on an intercept heading to the course.

4 Intercept Course (INTC CRS)

A waypoint not already in the route is inserted into the INTC LEG TO box prompts. It becomes the modified active waypoint, and the direct inbound course is displayed above the waypoint. Dashes are displayed on the INTC CRS line in small font.

Pilot entry of a course into the dashes replaces the direct course to the modified active waypoint. Manual entries are displayed in large font.

After completing the desired modifications, the crew must ensure that LNAV is engaged to fly the intercept course. In order to engage LNAV, the airplane must be on an intercept heading to the course.

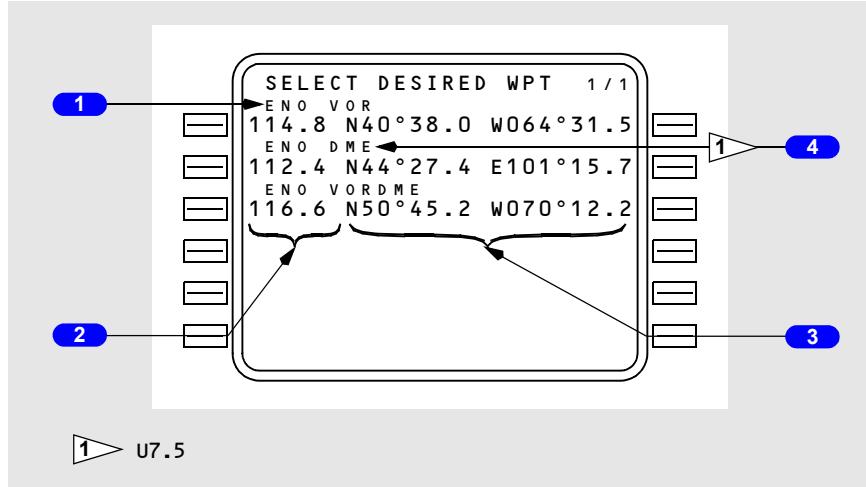
Intentionally
Blank

Desired Waypoint/Offset Pages

Select Desired Waypoint Page

When a waypoint identifier is not unique (other database waypoints have the same name), a selection of which latitude/longitude to use must be made before that waypoint can be used in the route.

The SELECT DESIRED WPT page is automatically displayed when the FMC encounters more than one identifier for the same waypoint name after a waypoint entry.



1 Identifier

Displays the identifier for the duplicate named waypoints. Select the proper waypoint by pushing the appropriate left or right line select key. This page is automatically removed after a waypoint is selected.

2 Frequency

Displays the frequency of the navaid.

Blank if the waypoint is not a navaid.

3 Latitude/Longitude

The latitude/longitude is displayed for each duplicate name.

4 Type

Shows type of navaid.

Blank if the waypoint is not a navaid.

Lateral Offset (U7 and On)

A lateral offset may be specified up to 99.9 nautical miles left or right of course. The OFFSET prompt is displayed on the INIT/REF INDEX page and in flight on the RTE page. Selection displays the MOD LATERAL OFFSET (or ACT LATERAL OFFSET page if an offset already exists).

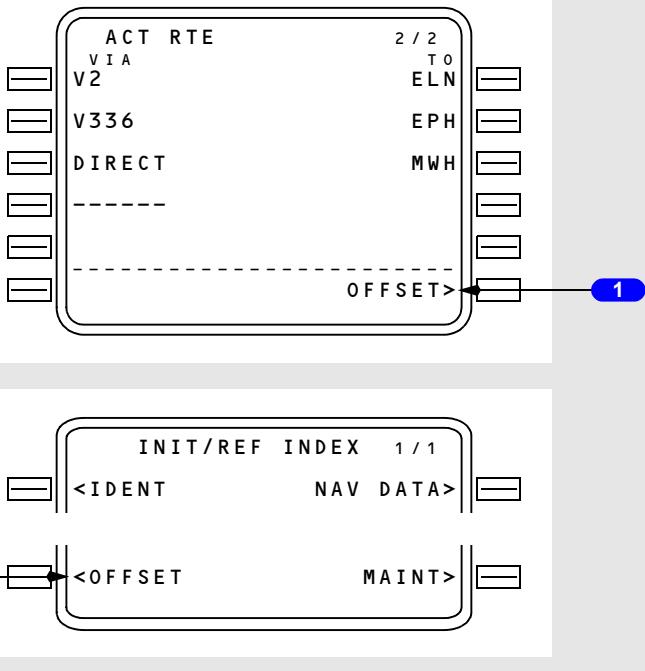
Some legs are invalid for offset. These include:

- end of flight plan waypoint
- discontinuity
- beginning of approach transition
- approach procedure
- DME arc
- heading leg
- holding pattern (except PPOS)
- certain legs containing flyover waypoints
- course change greater than 135 degrees
- preplanned termination waypoint.

DO NOT USE FOR FLIGHT

Flight Management, Navigation - FMC Cruise

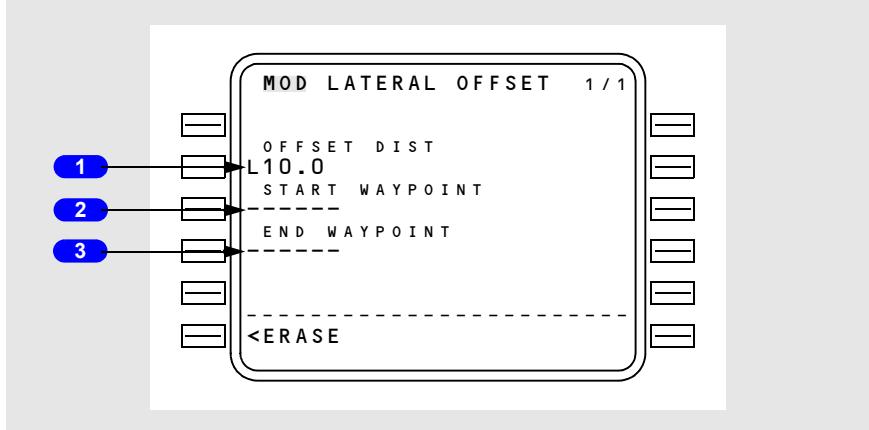
737 Flight Crew Operations Manual



1 OFFSET

Selection displays the lateral offset page.

Lateral Offset Page



1 Offset Distance (OFFSET DIST)

Enter the desired lateral offset direction (left or right) and distance. In the example, the 10.0 nm offset left of course could be entered L10.0, L10, 10.0L, or 10L.

Entry results in display of start and end waypoint fields.

2 START WAYPOINT

The waypoint at which the offset is to begin may be entered (up to 6 characters).

Dashes are displayed if current leg is valid for offset. Box prompts are displayed if current leg is invalid for offset.

Offset will begin at first valid offset leg after the start waypoint.

Deletion of the start waypoint (or no entry) will result in offset beginning at first valid offset leg in the flight plan.

3 END WAYPOINT

The waypoint at which the offset is to end may be entered (up to 6 characters).

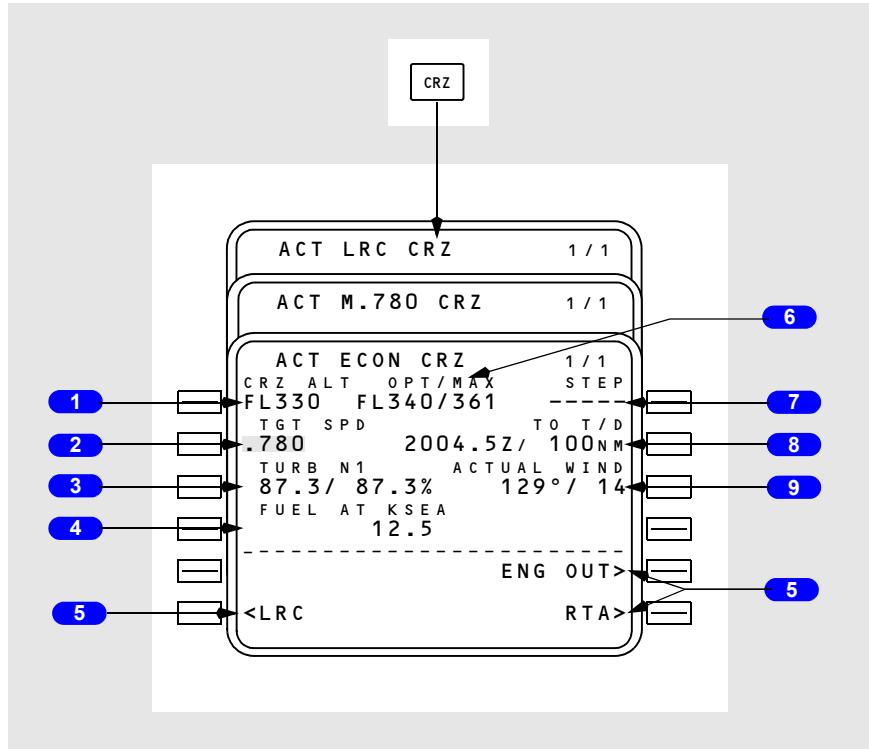
Offset will propagate through the flight plan until the end waypoint is encountered.

Deletion of the end waypoint (or no entry) will result in offset continuing until an invalid offset leg is encountered.

VNAV Modifications

Three primary cruise modes are available – economy cruise (ECON CRZ), long range cruise (LRC CRZ), and cruise with a manually selected speed. Access to the various cruise pages is obtained by pressing the CRZ mode select key.

Cruise Page



1 Cruise Altitude (CRZ ALT)

Displays present cruise altitude in flight level or feet x 100. Value may be entered via the keyboard or propagated from the PERF INIT, CLB, CRZ CLB, or CRZ DES pages.

During active cruise, entry of a new value propagates to all other pages which display cruise altitude and causes the MOD CRZ CLB or MOD CRZ DES page to appear.

2 Target Speed (TGT SPD)

Displays the computed or manually entered value for target airspeed or Mach. Computed speed is limited to a maximum of 340 knots or M .82.

The value is reverse highlighted on an active CRZ page.

3 Turbulence N1 (TURB N1)

Displays proper N1 for turbulence penetration.

Value is for reference only. It is not commanded to the autothrottle.

4 Fuel at Destination (FUEL AT XXXX)

Displays the predicted fuel remaining at destination.

The value assumes continued flight per the displayed cruise and planned descent modes along the active route.

If a step to altitude is entered on line 1R, the computation assumes that the step will occur at the step point. After passing the step climb point, the predicted fuel weight is based on an immediate step climb from current position.

5 Cruise page Prompts

Allow line selection of various CRZ pages.

The RTA prompt is replaced with ERASE when a MOD page is displayed.

6 Optimum/Maximum Altitude (OPT/MAX)

OPT – displays the computed optimum altitude for the displayed cruise mode. The value is not constrained by minimum cruise time criteria (as is the TRIP ALT on the PERF INIT page).

MAX – displays the maximum possible altitude based on the selected target speed and the specified maneuver margin.

Values are advisory only. They are provided for crew reference.

7 STEP Altitude

This line may be used to enter a possible step climb or descent altitude for crew evaluation.

The line will be blank when within 100 nm of top of descent or when RTA mode is active.

8 To Top of Descent (TO T/D)

Displays time of arrival at and distance to top of descent point.

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The data is always displayed when the distance is less than 100 nm. If the distance is more than 100 nm, the data will be displayed only if a step altitude has not been entered. The distance is blank if it is greater than 999 nm.

9 ACTUAL WIND/Estimated Wind (EST WIND)

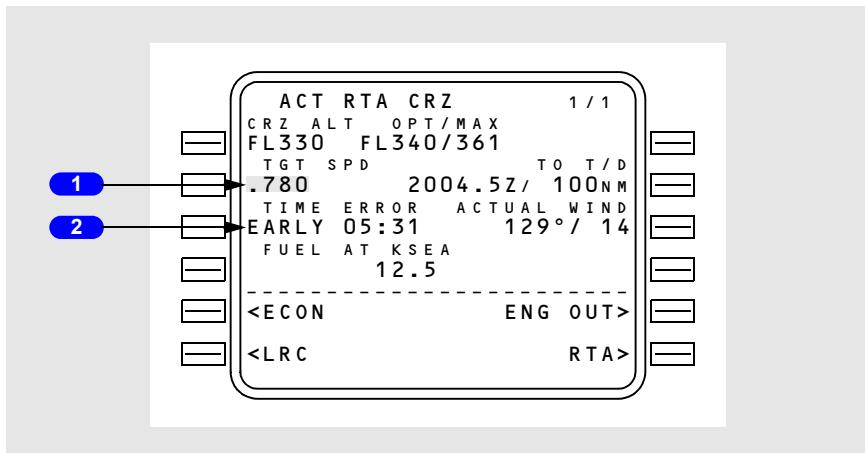
Displays computed or manually entered true wind for present altitude.

A manual entry has priority. The data line title then changes ACTUAL WIND to estimated wind (EST WIND).

The displayed value is used as the assumed true wind at the step to altitude for making wind/altitude trade computations.

RTA Cruise

If an RTA waypoint has been specified, the CRZ page will reflect the RTA data.

**1 Target Speed (TGT SPD)**

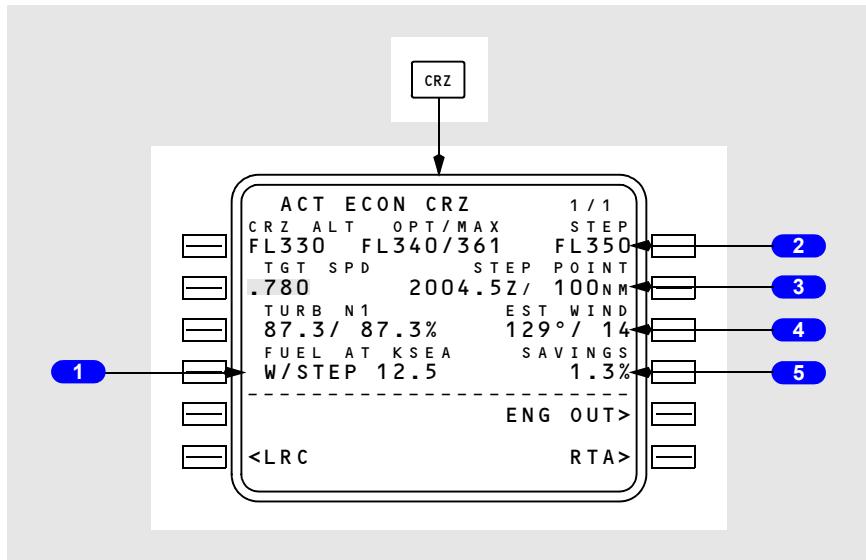
Displays the computed speed required to meet the RTA.

When RTA mode is exited by waypoint sequence or by deletion, this speed changes to FMC target speed on a manual speed CRZ page, and the scratchpad message SELECT MODE AFTER RTA is displayed.

2 Time Error

Displays the computed time error at the RTA waypoint.

Same as time error on RTA PROGRESS page.

Cruise with Step Climb**1 Fuel at Destination with Step Climb Altitude (FUEL AT XXXX)**

The computation assumes the step climb will occur at the STEP POINT, and the value is prefixed by W/STEP.

2 Step Altitude (STEP)

Used to enter step climb or step descent altitudes for crew evaluation.

Blank when within 100 nm of top of descent or when RTA mode is active.

3 STEP POINT

Displays the computed ETA at, and distance to, the first possible step climb point based on gross weight.

If already past the STEP POINT, the data line changes to NOW as long as savings are positive.

Blank if no entry on STEP line.

4 ACTUAL WIND/Estimated Wind (EST WIND)

Used as the assumed true wind at the STEP altitude for making wind–altitude trade computations.

5 SAVINGS/PENALTY

Displays the predicted cost savings or penalty associated with flying the displayed speed/altitude step climb or descent profile, as compared to flying the current cruise speed schedule and maintaining present altitude to top of descent.

Blank if no step data entered.

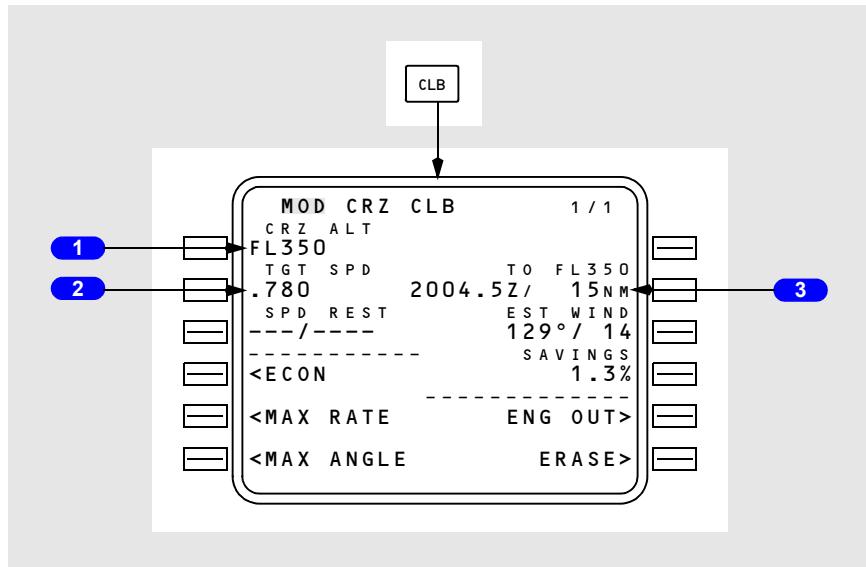
Cruise Climb

The CRZ CLB page displays data for a cruise climb to a new cruise altitude.

MOD CRZ CLB is automatically displayed during cruise if a higher cruise altitude is entered on the CRZ page.

During VNAV operation, execution initiates a climb at climb thrust and cruise target speed to the new altitude.

The VNAV climb mode is active until reaching the selected altitude. The mode then automatically changes back to cruise.

**1 Cruise Altitude (CRZ ALT)**

Initially displays the CRZ ALT entered on the CRZ page.

Manual entry may be made.

2 Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude.

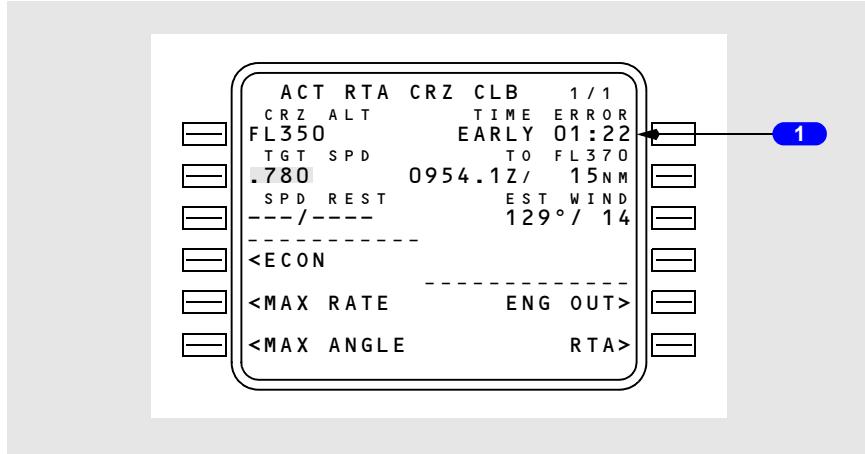
Manual entry may be made.

3 TO FLXXX

Displays ETA at, and distance to, the displayed cruise altitude.

RTA Cruise Climb

The RTA CRZ CLB page displays the same data as the CRZ CLB page except for the TIME ERROR line.



1 TIME ERROR

Displays the computed time error at the RTA waypoint.

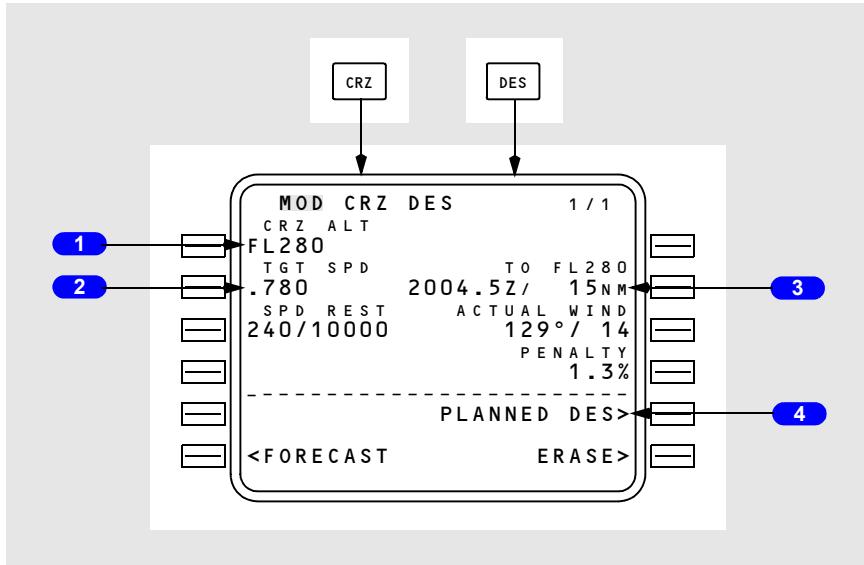
Same as time error on RTA PROGRESS page.

Cruise Descent

The CRZ DES page displays data for a cruise descent to a new altitude.

MOD CRZ DES is automatically displayed during cruise if a lower cruise altitude is entered on the CRZ page.

During VNAV operation, execution initiates a descent at 1,000 feet per minute and cruise target speed to the new altitude.



1 Cruise Altitude (CRZ ALT)

Initially displays the CRZ ALT entered on the CRZ page.

Manual entry may be made.

2 Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude.

Manual entry may be made.

3 TO FLXXX

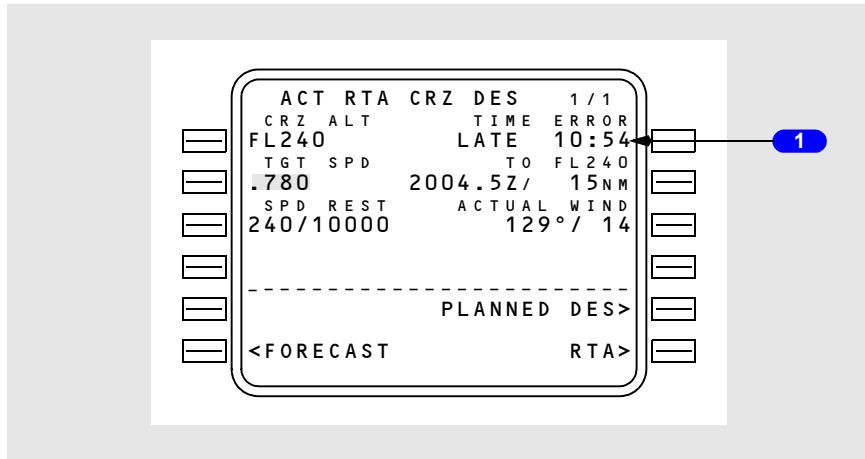
Displays ETA at, and distance to, the displayed cruise altitude.

4 Planned Descent (PLANNED DES)

Shows the planned DES page and allows access to the planned standard descent mode.

RTA Cruise Descent

The RTA CRZ DES page displays the same data as the CRZ DES page except for the TIME ERROR line.



1 TIME ERROR

Displays the computed time error at the RTA waypoint.

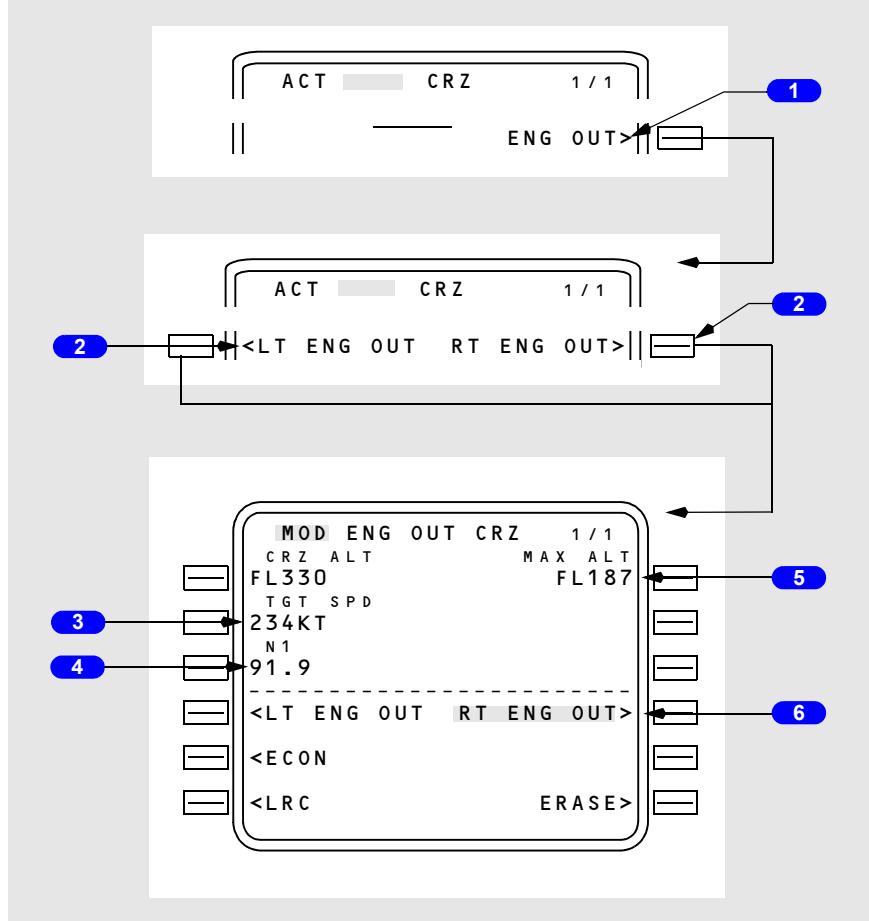
Same as time error on RTA PROGRESS page.

Engine Out Cruise

The engine out cruise page may be accessed by selecting the ENG OUT prompt on the CRZ page. The page displays advisory information for a one engine inoperative condition. Engine out data is also available with both engines operating.

The FMC accounts for current gross weight and actual bleed conditions.

(Prior to U7.5/U8.5) When activated, all subsequent performance predictions are blanked and VNAV cannot be engaged.



1 Engine Out (ENG OUT)

Permits access to ENG OUT CRZ page.

2 Left/Right Engine Out (LT ENG OUT/RT ENG OUT)

Selection changes display to MOD ENG OUT CRZ page. The MOD ENG OUT CRZ page is information only.

(U7.5/8.5 and on) The execute light does not illuminate and the page can not be executed.

(Prior to U10) After viewing page data, select ERASE to return to the active CRZ page.

3 Target Speed (TGT SPD)

Displays the optimum speed based on minimum drag.

4 N1

Displays N1 for maximum continuous thrust.

If the page is executed, this becomes the active N1 limit.

(Prior to U7.5/8.5) If the page is executed, this becomes the active N1 limit.
N1 is computed using actual bleed conditions.

5 Maximum Altitude (MAX ALT)

Displays the computed maximum altitude at which a company-specified rate of climb can be achieved, using one engine at maximum continuous thrust. Default climb rate is 100 feet per minute.

6 Left/Right Engine Out (LT ENG OUT / RT ENG OUT)

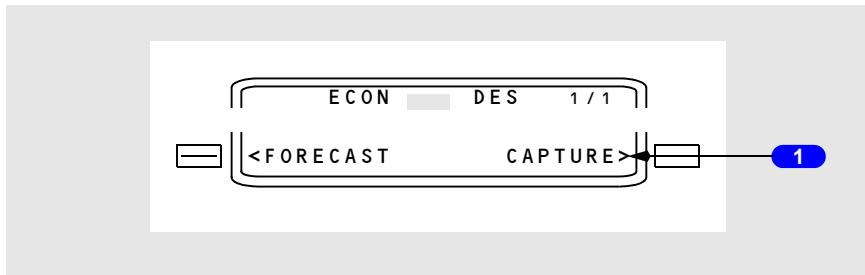
Selected engine out is shown in reverse highlighting.

Early Descent

Early descents are initiated from the DES page. Once an early descent is executed, VNAV transitions to the descent mode, and cruise features are no longer available.

For a VNAV path descent the CAPTURE prompt will not be displayed until a descent path is established. Once executed, the autothrottle adjusts thrust to maintain 1,000 feet per minute until intercepting the descent path.

For a VNAV speed descent, the autothrottle retards to idle, and pitch maintains target speed.



1 CAPTURE

Selecting the PATH DES page before reaching the top of descent displays the PATH DES page with the prompt CAPTURE on the bottom right of the page. Selecting and executing the CAPTURE prompt initiates a VNAV descent of 1000 feet per minute at ECON speed. Upon reaching the planned descent path, VNAV transitions to maintain the planned descent path.

Selecting the SPD DES page and executing the CAPTURE prompt initiates a VNAV descent at idle thrust and target speed.

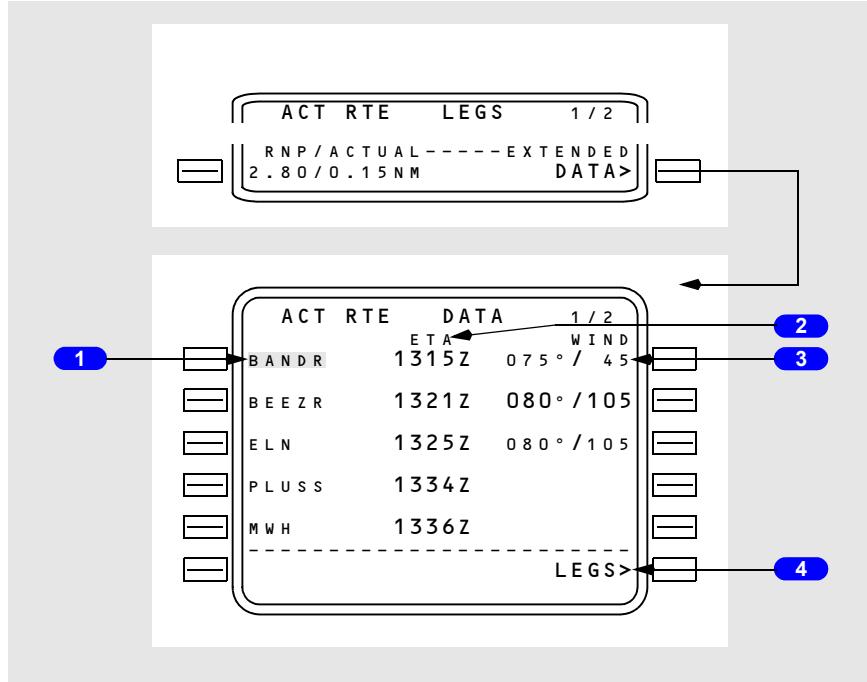
Intentionally
Blank

Route and Waypoint Data

Route Data (RTE DATA) Page

The RTE DATA page displays ETAs for each waypoint on the RTE LEGS page. This page also displays forecast wind data for cruise waypoints.

One page displays data for five waypoints.



1 Waypoint

Displays the same waypoint identifier as on the corresponding RTE LEGS page. The active waypoint is highlighted in reverse video.

2 Estimated Time of Arrival (ETA)

Displays estimated time of arrival to displayed waypoint.

3 WIND

Used for entry and/or display of the true wind at the cruise waypoint identified on the same line.

Entry may be via the keyboard or propagated from the CRZ WIND entry on the PERF INIT page.

The CRZ WIND value (075°/45 is depicted) propagates to all cruise waypoints (BANDR to ELN is the depicted cruise segment).

If no CRZ WIND entry was made, the FMC assumes 000°/000.

A keyboard entry has priority and propagates to all down path cruise waypoints (an entry of 080°/105 at BREEZR is depicted). The entry must be executed.

Any entries propagated from the CRZ WIND entry are displayed in small font. Keyboard entries are displayed in large font.

Crew entries of forecast winds (or default 000°/000) are automatically biased with the actual wind computed by the FMC when within 100 NM of a cruise waypoint and within 2,000 feet of a cruise altitude. (U4 and on) Biased values are not displayed.

Blank for non-cruise waypoints (PLUSS and MWH are depicted). Entry is inhibited.

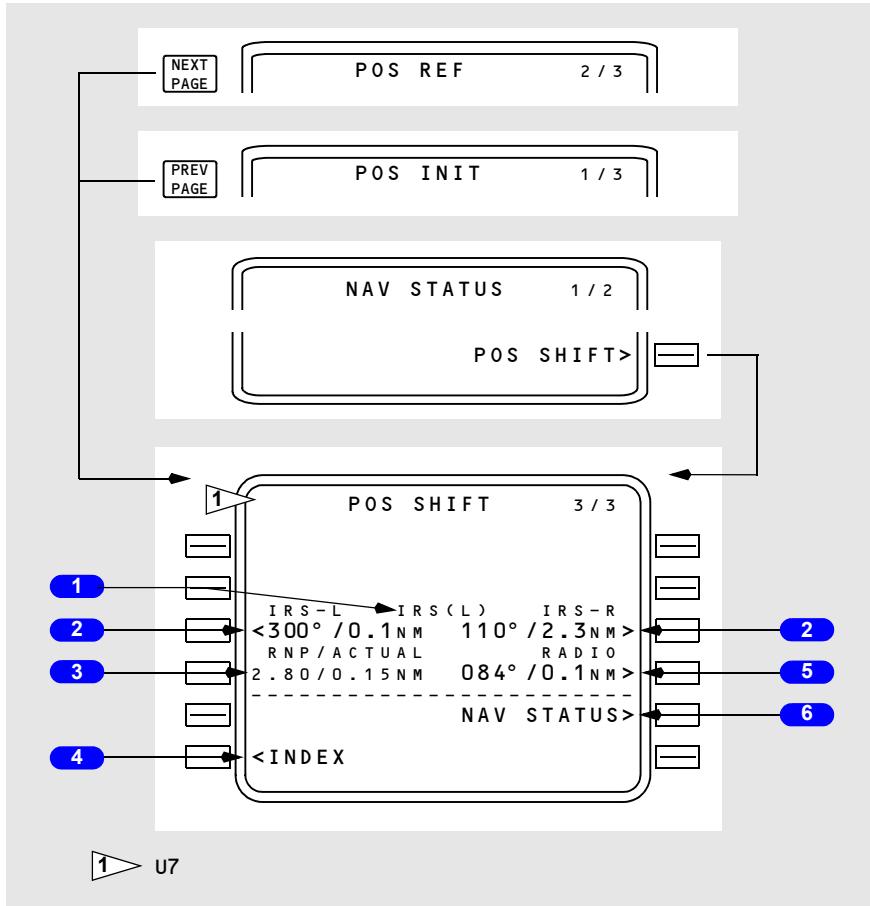
4 LEGS

Selection displays the RTE LEGS page.

Position Shift Page

On the POS SHIFT page, each prompt indicates the bearing and distance of the indicated system relative to the FMC position. FMC position is displayed on line 1R of the POS REF page. The entries with parentheses in the center of the page show the active position references.

Data fields are blank when on the ground.



1 IRS (X)

Displays currently selected IRS.

2 IRS Left/IRS Right (IRS-L/IRS-R)

Displays the left and right IRS positions relative to FMC position using current Mag/True reference. Blank if IRS position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

3 Required Navigation Performance/Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy.

4 INDEX

Push – displays the INIT/REF INDEX page.

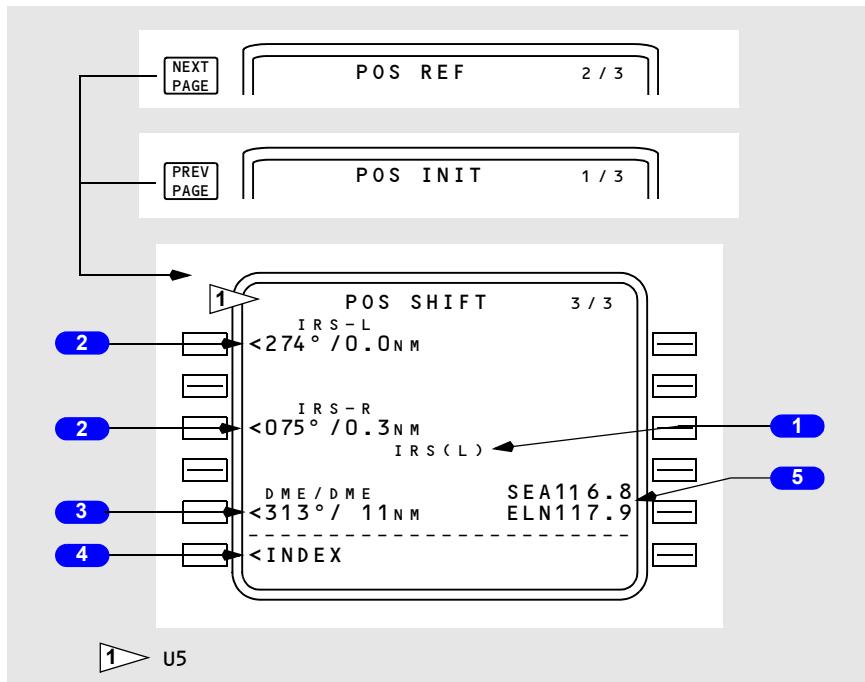
5 RADIO Position

Displays the radio position relative to FMC position using current Mag/True reference. Blank if radio position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

6 Navigation Status (NAV STATUS)

Push – displays the NAV STATUS page.



1 IRS (X)

Displays currently selected IRS.

2 IRS Left/IRS Right (IRS-L/IRS-R)

Displays the left and right IRS positions relative to FMC position using current Mag/True reference. Blank if IRS position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

3 DME/DME

Displays the radio position relative to FMC position using current Mag/True reference. Blank if radio position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

4 INDEX

Push – displays the INIT/REF INDEX page.

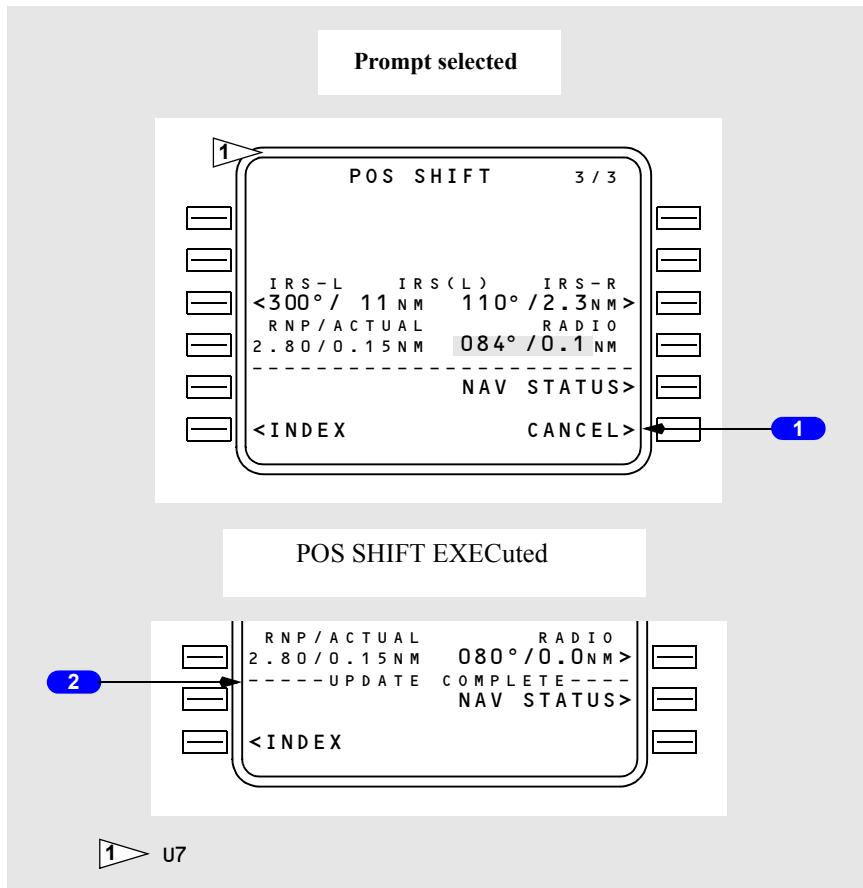
5 Radio Identifiers

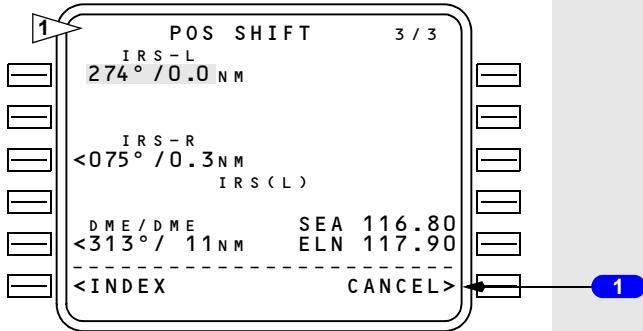
Displays navaid identifiers and frequencies being used for position updating. Blank if radio position is invalid.

Inflight Position Update

FMC position update is accomplished on the POS SHIFT page in flight. Selecting a prompt stops the updating of the relative position. The bearing and distance is highlighted, the EXEC key will illuminate, and a CANCEL prompt is displayed in line 6R.

When the position shift is executed, UPDATE COMPLETE is displayed.



Prompt selected**1****POS SHIFT EXECuted****2****U5****1 CANCEL**

Displayed when a line selection is made for position update. Selection prior to execution cancels the line selection.

2 UPDATE COMPLETE

Displayed after a position shift has been selected and executed.

Intentionally
Blank

Navigation Data

Reference Navigation Data (REF NAV DATA) Page

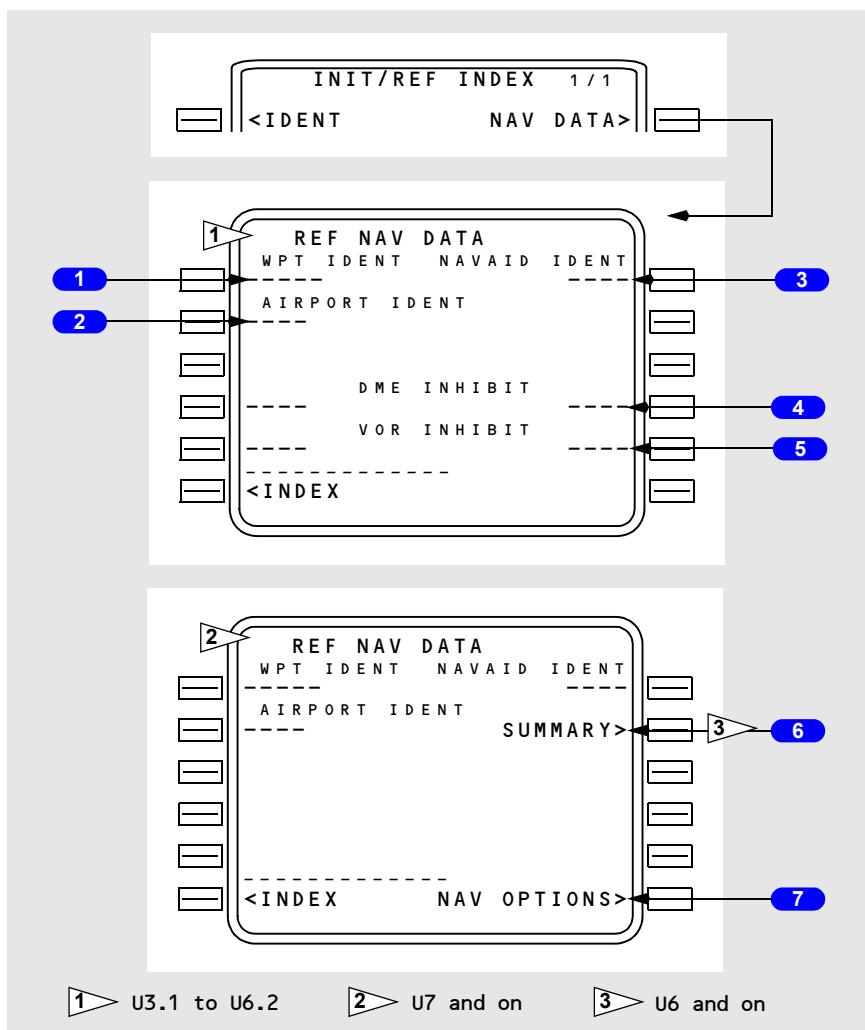
The REF NAV DATA page provides information about waypoints, navaids, airports, and runways. Entering the appropriate identifier initiates the display.

Entering SUPP in the scratch pad prior to selecting NAV DATA results in display of the supplemental navigation data (SUPP NAV DATA) page.

If the entered identifier is already stored in the permanent, supplemental, or temporary database, then relevant data propagates to the subsequent REF NAV DATA display.

If the entered identifier is not stored in any database, the subsequent REF NAV DATA display contains box prompts. Following entry of the required information, the new data may be stored in the temporary database by executing (except for runway data). Data may be subsequently deleted from the temporary database by deleting the individual identifier, if the identifier is not presently being displayed on another page (e.g., RTE LEGS, PROGRESS, etc.).

All data stored in the temporary database is cleared at flight completion.



1 Waypoint Identifier (WPT IDENT)

Displays dashes initially.

Any waypoint, navaid or runway can be entered.

Format for runway entry is "RWnna" where "nn" is a one or two digit numeric (with or without leading zeros) and "a" is an optional character L, R, or C.

In order to access runway data, an airport must be identified.

2 Airport Identifier (AIRPORT IDENT)

Displays dashes initially.

Displays box prompts if runway is entered into 1L prior to airport entry.

An invalid airport/runway pair will result in “NOT IN DATA BASE” displayed in the scratchpad.

3 Navigation Aid Identifier (NAVAID IDENT)

Displays dashes initially.

Valid entries are up to 4 alphanumeric characters.

If the navaid is not contained in the databases, box prompts will appear in related data fields needing entry.

4 DME INHIBIT

Entry of a DME identifier inhibits use of DME information for FMC position updating.

Any associated VOR can still be used for FMC position updating out to 25NM from the station.

5 VOR INHIBIT

Entry of a VOR identifier inhibits use of VOR bearing information for FMC position updating.

Any associated DME can still be used for FMC position updating.

6 SUMMARY

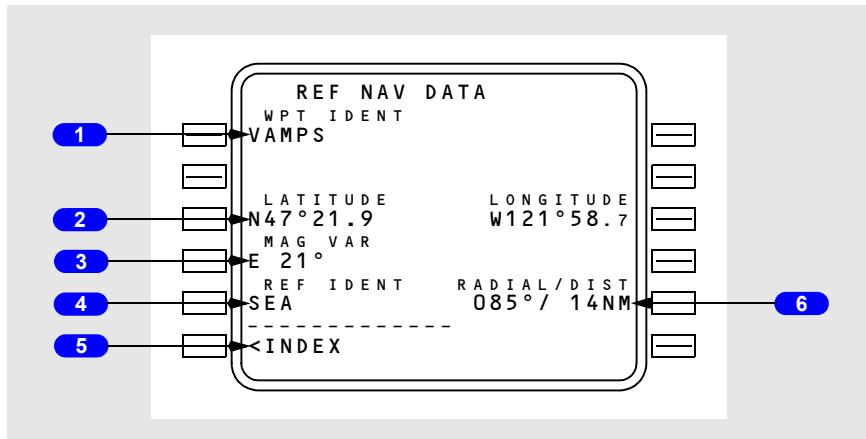
Selection displays NAV SUMMARY pages.

Blank if supplemental and temporary databases are empty.

7 Navigation Options (NAV OPTIONS)

Selection displays NAV OPTIONS page.

Waypoint Data Display



1 Waypoint Identifier (WPT IDENT)

Displays or permits entry of the desired waypoint (5 characters maximum). Following entry, the associated data lines are displayed.

2 LATITUDE/LONGITUDE

Displays or permits entry of waypoint latitude and longitude. Entry on the REF IDENT and RADIAL/DIST lines cause latitude and longitude to be computed and displayed.

3 Magnetic Variation (MAG VAR)

Displays or permits entry of waypoint magnetic variation. Data is automatically computed based on latitude and longitude.

Manual entry has priority.

4 Reference Identifier (REF IDENT)

Together with RADIAL/DIST, displays or permits entry of reference point for a created waypoint.

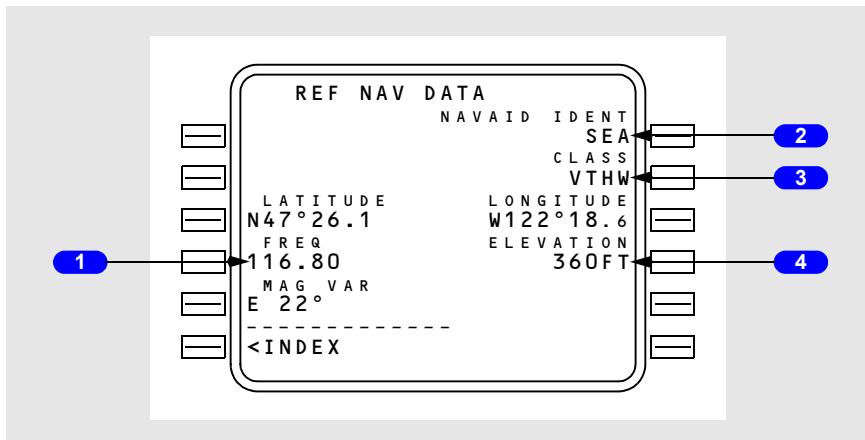
5 INDEX

Selection displays INIT/REF INDEX page.

6 Radial/Distance (RADIAL/DIST)

Together with REF IDENT, displays or permits entry of bearing and distance for a created waypoint.

Navigation Aid Data Display



1 Frequency (FREQ)

Displays or permits entry of the frequency of the entered navaid.

2 Navigation Aid Identifier (NAVAID IDENT)

Displays or permits entry of navaid identifier (5 characters maximum). Following entry, the associated data lines are displayed.

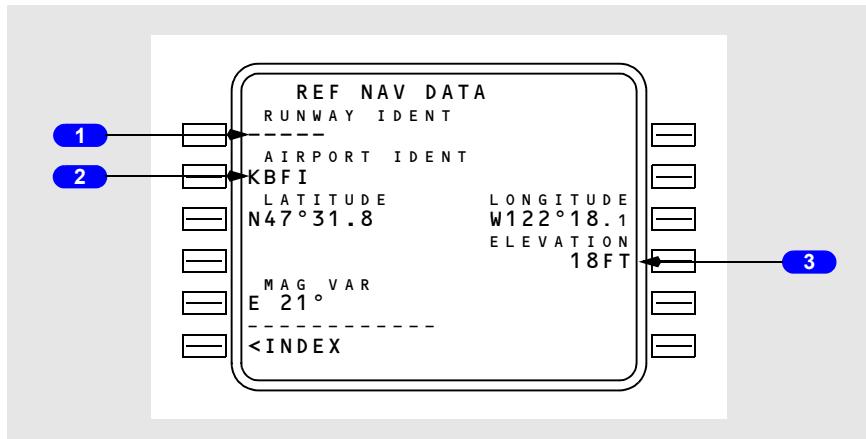
3 Classification (CLASS)

Displays or permits entry of the classification of the entered navaid.

4 ELEVATION

Displays or permits entry of the elevation (feet above MSL) of the entered navaid.

Airport Data Display



1 Runway Identifier (RUNWAY IDENT)

Permits entry of runway identifier.

2 Airport Identifier (AIRPORT IDENT)

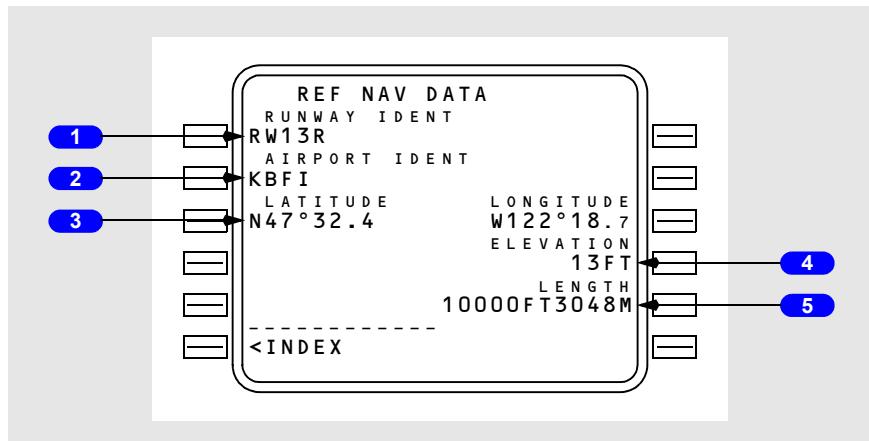
Displays airport identifier.

3 ELEVATION

Displays or permits entry of the elevation (feet above MSL) of the entered airport.

Runway Data Display

A runway identifier may be entered on the airport data display page or as a waypoint on the REF NAV DATA page. On the airport data display page, entry may be in the form of 13R or RW13R. Single digit entries are possible, with or without leading zeros. If the waypoint method is used, entry must be in the form RW13R, and the proper airport identifier must be entered on the runway data display page. Runways must be stored in the permanent navigation database.



1 Runway Identifier (RUNWAY IDENT)

Displays runway identifier.

2 Airport Identifier (AIRPORT IDENT)

Displays airport identifier.

3 LATITUDE/LONGITUDE

Displays latitude and longitude of entered runway.

4 ELEVATION

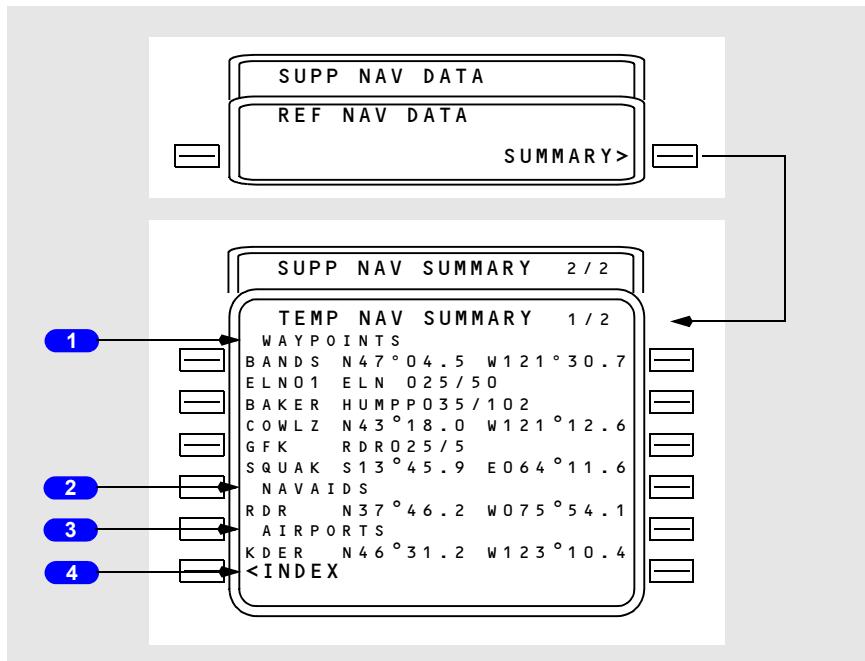
Displays elevation (feet above MSL) of the entered runway.

5 Runway Length (LENGTH)

Displays length of entered runway in feet and meters.

Navigation Summary (U6 and On)

The NAV SUMMARY pages show the contents of the temporary and supplemental navigation databases. Contents of the temporary navigation database show first, followed by contents of the supplemental navigation database.



1 WAYPOINTS

Shows waypoints stored in the related database.

Waypoints show in defining format.

2 Navigation Aids (NAVAIDS)

Shows navaids stored in related database.

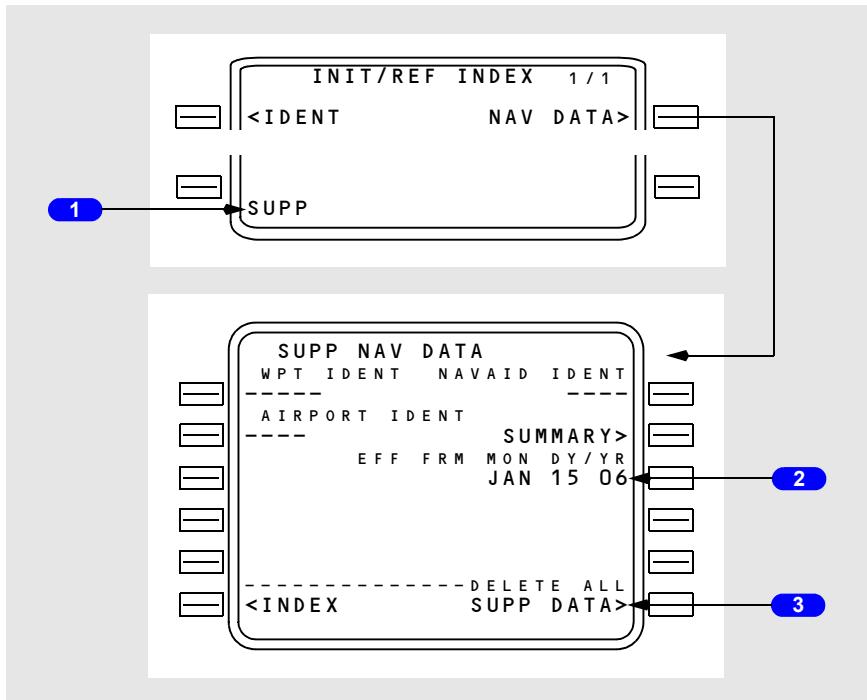
3 AIRPORTS

Shows airports stored in related database.

4 INDEX

Push – Shows page (REF NAV DATA or SUPP NAV DATA) used to access NAV SUMMARY pages.

Supplemental Nav Data



1 Supplemental Scratchpad Entry (SUPP)

The supplemental navigation database is accessed by entering SUPP in the scratchpad while on the INIT/REF INDEX page, then selecting the NAV DATA prompt. Access is only available on the ground.

2 Effectivity Date (EFF FRM MON DY/YR)

Allows entry of month, day, and year that the supplemental database becomes valid. The date will be displayed on the IDENT page after entry. Box prompts are displayed if an effectivity date is not entered.

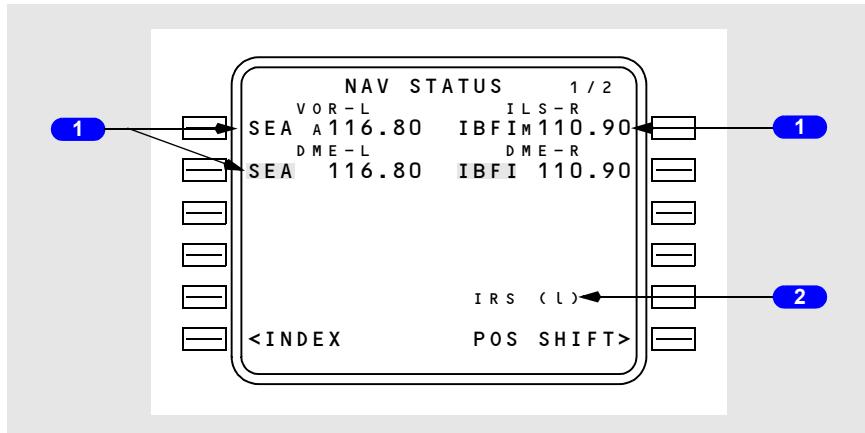
3 Delete All Supplemental Data (DELETE ALL SUPP DATA)

Data may be deleted from the supplemental database by two methods. Deletion may be accomplished one item at a time on the display pages, or the entire database may be deleted by selecting this prompt. The prompt is only available before entry of an origin airport.

Navigation Status Display (U7 and On)

The NAV STATUS page displays the current status of the navaids being tuned.

Access to the NAV STATUS display is from the NAV STATUS prompt on the POS SHIFT page, the PROGRESS page 1/3, and (in flight) the INIT/REF INDEX page or from the NAV OPTIONS page, NEXT or PREV PAGE.



1 VOR/ILS and DME Lines

Lines 1L and 1R display VOR or ILS identifier and frequency tuned on the corresponding VHF NAV control panel.

Lines 2L – 2R through 4L – 4R display up to five DME identifiers and frequencies tuned by the corresponding DME receiver.

Data is displayed in large font with the identifier highlighted if that facility is being used for navigation.

Data is displayed in large font with the identifier not highlighted if that facility is being received but not used for navigation.

Data is displayed in small font if that facility is being tuned but not received.

If the navaid has failed, FAIL will be displayed in small font.

If there is no corresponding identifier for the displayed frequency, then the identifier field will be blank and only the frequency will be displayed.

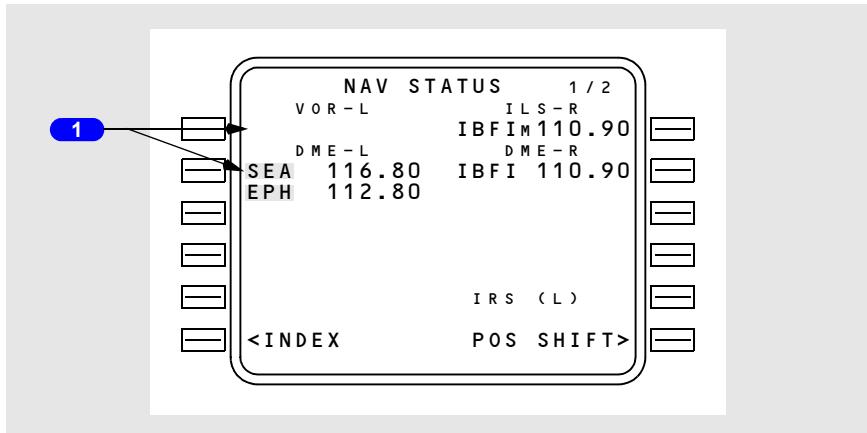
On lines 1L or 1R, for VOR/ILS displays, the mode of tuning will be shown:

- M – Manual
- P – Procedural
- A – Automatic.

On lines 2L – 2R through 4L – 4R, if no DME information is received then the identifier and frequency field is blank.

2 IRS Status Display

Displays the IRS currently selected for use in navigation. "L" or "R" indicates left or right IRS is being used in the FMC position calculation.

Non-Scanning DME in Agility Tuning Mode**1 Agile Tuning**

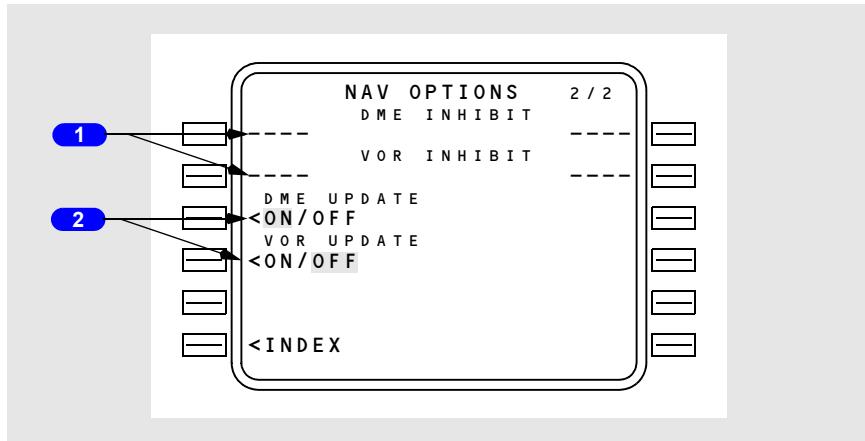
During agility tuning, the corresponding VOR or ILS field (1L or 1R) blanks.

The identifiers and frequencies being used for the navigation solution are displayed simultaneously on Lines 2L or 2R.

Navigation Options (U7 and On)

When a navigation facility or internal system is invalid, the invalid data must be inhibited to prevent incorrect position calculations. When the aircrew is aware that unreliable navaids exist (either by NOTAM, ATC, etc.) they should manually exclude these navaids from the FMC navigation solution. This will prevent the possibility of incorrect position calculations and maximize the reliability of the system.

Access to the NAV OPTIONS page is from the NAV OPTIONS prompt on the REF NAV DATA page or by selecting NEXT or PREV PAGE on the NAV STATUS page.



1 DME/VOR INHIBIT

Enter the identifier of up to two VOR, VOR/DME, VORTAC, or DME stations that must not be used for FMC position updates.

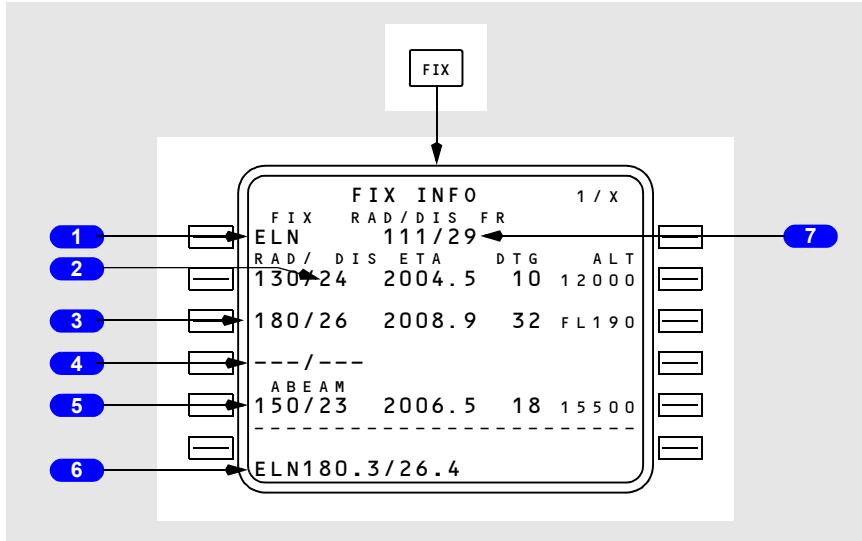
Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

2 DME/VOR UPDATE

Fix Information Page

Two identical FIX INFO pages are used to identify waypoint fixes for display on the EFIS map. If desired, fix information can be copied into the RTE page. Access is via the FIX key.



1 FIX Name

Enter the desired fix.

Valid entries are airports, navaids, and waypoints from the navigation database. The selected fix is displayed on the EFIS map and highlighted by a green circle.

2 Distance Entry (DIS)

Enter a distance from the fix. Distances from the fix are displayed on the EFIS map as a dashed green circle around the fix.

When the distance intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed for that intersection.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

Valid entries are xxx.x:

- distance only entries must start with a /
- leading zeros can be omitted for distance
- decimal values can be omitted.

ETA – displays the estimated time of arrival to the intersection point.

DTG – displays the distance to go to the intersection point.

ALT – displays the predicted altitude at the intersection point.

3 Radial Entry (RAD)

Enter a radial from the fix. Radials are displayed on the EFIS map as green dashed lines from the fix.

When the radial intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

Valid entries are xxx.

4 Radial/Distance Entry (RAD/DIS)

Enter a radial, distance, or both radial and distance from the fix. A radial and distance from the fix is displayed on the EFIS map by both radial and distance, but ETA and ALT fields will be blank.

5 ABEAM

Displays the abeam point and calculates the ETA, DTG, and ALT information.

The fix abeam point ahead of the airplane is displayed by a radial line from the waypoint ending at the nearest perpendicular route leg intersection.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

6 Route Intersection Point Copied

Pushing the line select key for one of the RAD/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 Radial/Distance From Fix (RAD/DIS FR)

Displays the radial and distance from the fix to the airplane. This information is continually updated as the airplane position changes.

**Flight Management, Navigation
FMC Descent and Approach****Chapter 11
Section 43****Introduction**

The descent phase begins at the top of descent point and continues to the end of descent point. Planning for the descent phase begins during cruise.

The approach phase begins at the end of descent point and continues to touchdown or go-around. When a go-around is accomplished, the FMC enters the cruise phase.

The only automatic page change provided in the descent/approach modes is the transition from cruise to descent at the top of descent.

Early Descent

Early descent may be commenced prior to reaching the top of descent by using the CAPTURE prompt.

Descent

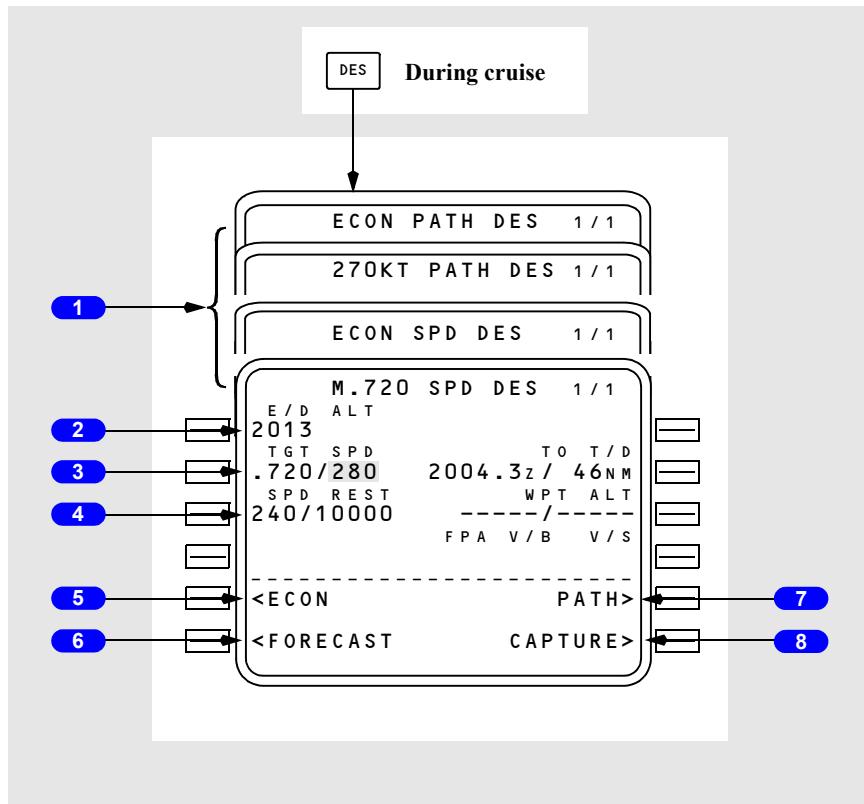
During descent, LNAV progress is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

The DES FORECASTS page is also available to enter forecast wind data to aid in descent planning.

Descent Page (During Cruise)

The descent page is used to monitor, revise, or select the descent path. Descent modes are economy (ECON) path or speed and manual path or speed. The default VNAV descent mode is ECON PATH.

The page title reflects the VNAV descent mode. The path mode controls descent to fly a vertical path which complies with altitude and speed restrictions in the flight plan. The speed mode controls descent at a fixed speed and complies with altitude and speed restrictions in the flight plan.



1 Page Title

The page title identifies the selected mode. When a manual speed is selected, the title includes XXXKT for fixed CAS or M.XXX for fixed Mach selections.

Displays ACT when the descent phase is active.

2 End of Descent Point (E/D ALT)

Displays the end of descent altitude.

- for a PATH DES page, displays the altitude restriction for the E/D waypoint; blank if path descent not available
- for a SPD DES page, displays 1,000 feet above destination airport or, the lowest “at” altitude constraint, whichever is lower.
- (U7 and On) If an approach is selected which ends at RWXXX, the E/D altitude will be threshold crossing height (TCH), 50 feet above the runway.

(U10.5A and earlier) The end of descent altitude is the last of the following not preceded by a lateral discontinuity:

- (U10.5A and earlier) glideslope intercept point or FAF for approaches other than ILS or GLS
- (U10.5A and earlier) the “at” altitude constraint including the runway threshold altitude
- (U10.2A and earlier) threshold crossing height for the runway if the vertical angle is not zero.

3 Target Speed (TGT SPD)

Displays the command speed maintained by VNAV while descending to waypoints, constraints, or speed restrictions:

- on ECON PATH or ECON SPD DES pages, displays the computed values for target Mach and airspeed. Speeds are performance limited.
- manual entries may be made and cause the manual PATH or manual SPD DES page for that value to display (M.720 SPD DES is depicted)
- the active controlling speed is highlighted in reverse video
- blank for any PATH DES page if a path descent is not available.

4 Speed Restriction (SPD REST)

Displays the most restrictive of the following speeds:

- destination airport speed minus 10 knots
- waypoint speed restriction if greater than minimum flaps up maneuvering speed
- minimum flaps up maneuvering speed
- selected Vref + wind correction for landing flap setting
- whenever flaps are extended, the appropriate flap speed shall be displayed as XXX/FLAPS. This shall supersede any other speed restriction
- displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

Dash prompts displayed when there is no active speed restriction.

Manual crew entries or deletions may be made. HOLD or FLAPS speed may not be deleted or modified.

5 Economy (ECON)

Displayed on the manual DES pages.

Push – selects the corresponding ECON SPD or ECON PATH DES page.

6 Descent Forecasts (FORECAST)

Push – selects the DES FORECASTS page.

7 PATH

Displayed on the SPD DES pages if a path descent is available.

Push – selects the corresponding PATH DES page.

8 CAPTURE

Displayed on the standard DES pages whenever descent is not ACT or MOD.

Blank for any PATH DES page if a path descent is not available.

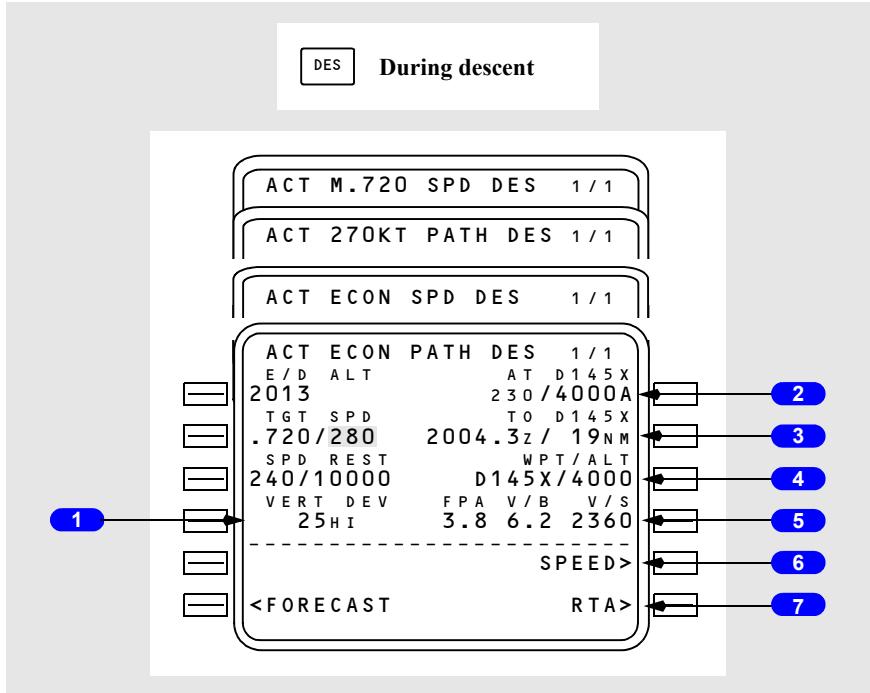
Push – arms the CAPTURE function and illuminates the EXEC light.

Execution allows early initiation of PATH descent at 1000 fpm until intercepting the computed path.

Execution allows early initiation of a SPD descent.

Descent Page (During Descent)

Display when any descent mode is active after beginning of descent.



1 Vertical Deviation (VERT DEV)

Displays present deviation (feet HI or LO) from the computed vertical path.

The deviation is always in relation to the path descent profile, regardless of which page is active (PATH DES or SPD DES).

Blank if a path is not available.

2 Altitude Restriction (AT XXXXX)

Displays the next waypoint constraint from the RTE LEGS page.

The constraint is speed/altitude. If an airspeed restriction exists at the waypoint, it will be displayed in large font; otherwise the predicted speed will be displayed in small font.

Can be deleted on this page.

The display is blank when no constraint exists, or for any PATH DES page if a path descent is not available.

3 To Waypoint (TO XXXXX)

Displays computed ETA and distance to go to T/D when not in an active descent mode.

If an early descent is in progress (initiated using CAPTURE prompt), ETA and distance to go to original T/D is displayed until passing the T/D.

If a descent mode is active, displays ETA and distance to go to the first of the following points:

- the waypoint in the AT XXXXX line
- an intermediate T/D (TO T/D – XXXXX, where XXXXX is the altitude).

The display is blank if a path descent is not available, or if the AT XXXXX line is blank and no T/D information is displayed.

4 Waypoint/Altitude (WPT/ALT)

Displays the waypoint and altitude that serves as the basis for the vertical bearing (V/B) display on line 4R.

Normally displays the same waypoint/altitude restriction that is displayed on the AT XXXXX line.

May be overwritten by pilot entry.

Dash prompts are displayed if there is no entry.

5 Vertical Path Parameters (FPA V/B V/S)

Displays the following parameters related to the present vertical path:

- FPA – actual flight path angle based on present ground speed and vertical speed (that is, the present vertical bearing being flown)
- V/B – vertical bearing direct from present position on the WPT/ALT line (that is, the flight path angle required if flying direct to the waypoint and altitude on the WPT/ALT line)
- V/S – the required vertical speed (in fpm, based on present ground speed) to fly the displayed V/B.

Blank if no entry on the WPT/ALT line.

6 SPEED

Displayed on PATH DES pages.

Push – selects the related SPD DES page.

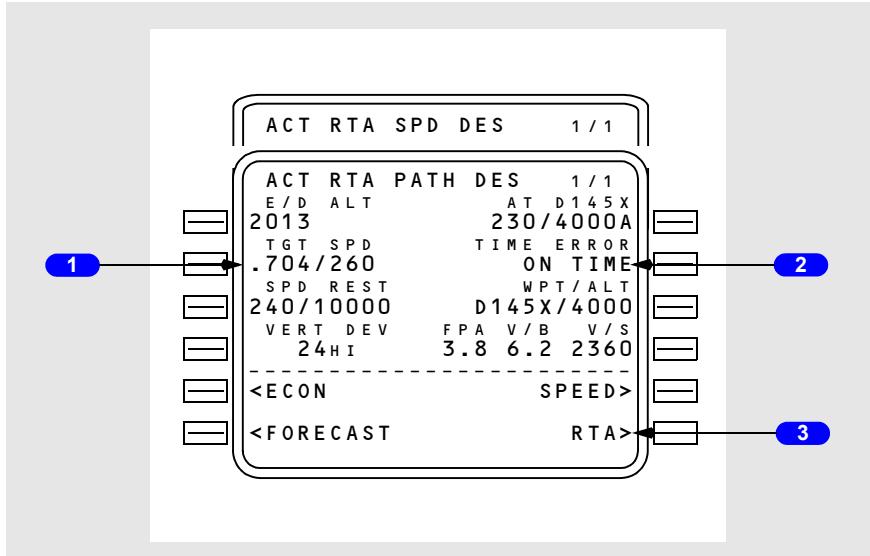
7 RTA

Displayed when CAPTURE or ERASE prompt is not displayed.

Push – selects the RTA PROGRESS page.

RTA Descent Page

RTA Descent pages are displayed when an RTA mode is active. Displays are the same as on other descent pages except as noted.



1 Target Speed (TGT SPD)

Displays computed RTA target speed.

Changes to FMC target speed if the RTA mode is exited.

2 TIME ERROR

Displays computed time error at the RTA waypoint.

Same as time error line on RTA PROGRESS page.

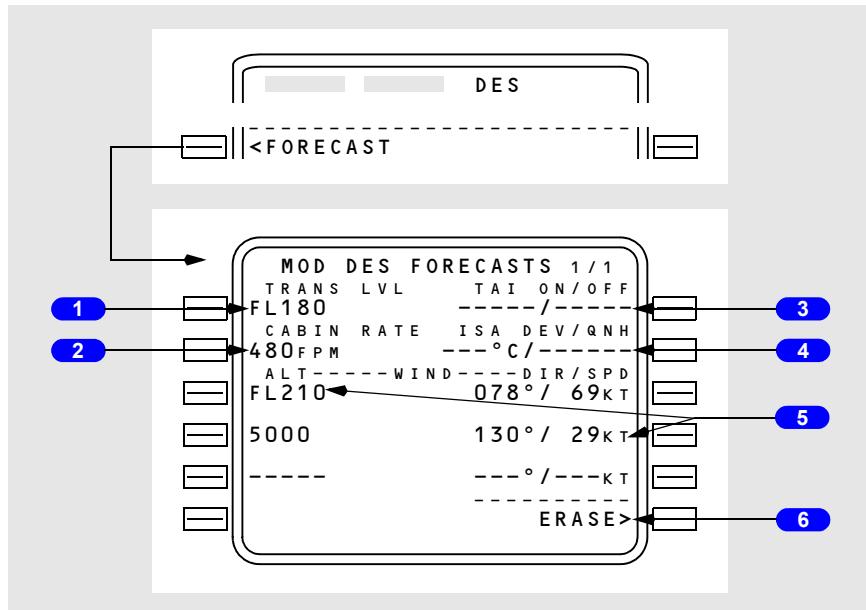
3 RTA

Push – selects the RTA PROGRESS page.

Descent Forecast Page

The descent forecast page is used for pre-descent planning to enter forecast data for more precise descent path calculation.

The primary entries are wind direction and speed for up to three descent altitudes, and the altitude that anti-icing is turned on and off.



1 Transition Level (TRANS LVL)

Normally displays FL180 as the assumed descent transition level.

Changes automatically if an arrival procedure having a different stored value is entered.

Manual entry has priority.

2 CABIN RATE

Displays the predicted cabin rate of descent required by the flight plan descent profile.

3 Thermal Anti-Ice On/Off (TAI ON/OFF)

Enter the altitudes in flight level or feet at which anti-ice is expected to be turned on and off.

FMC computations assume minimum thrust at high idle at all times in flight.

4 ISA Deviation and QNH (DEV/QNH)

Enter the average ISA deviation for descent in °C (+/-XX°C) or °F (+/-XX°F)

Enter the destination QNH altimeter setting (IN, HG or MB). Do not enter a QFE altimeter setting.

5 Descent Wind (ALT ----- WIND ----- DIR/SPD)

Allows entry of altitude and wind direction/speed for up to three forecast wind values.

Entries may be made in any altitude sequence and will be automatically ordered by altitude from highest to lowest.

6 ERASE

Push – deletes modification and returns page to previously displayed descent page.

Engine Out Descent

There are no specific engine out pages for descent. Use the normal descent planning features and pages.

Approach

During approach, LNAV and VNAV guidance normally transitions to the approach guidance provided by navigation radios. The FMC continues to calculate and display present position and can provide 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:

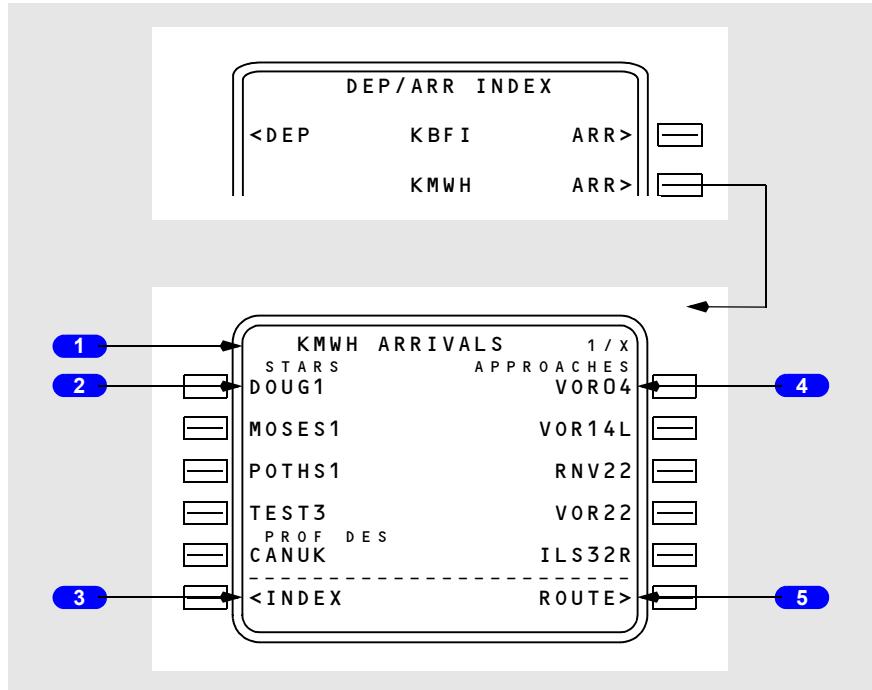
- APPROACH REF page – to select the approach VREF
- ARRIVALS page – to select the desired arrival and approach procedures
- HOLD page – to manage holding patterns.

Holding is described in this section but it can be used during any phase of flight.

Arrivals Page – IFR Approaches

The arrivals page allows selection of an approach, standard terminal arrival route (STAR), and arrival transitions to the destination airport. This page can also be used to view information about a selected airport that is not the destination. Procedures for the origin and destination airport can be selected for entry into the flight plan.

The approaches, STARS, profile descents, and transitions are displayed and selected on this page.



1 Page Title

The destination airport identifier is displayed in the title.

Airports with more than 5 runways or STARs produce multiple arrivals pages.

2 Standard Terminal Arrival Routes (STARS)

Upon initial selection, an alphabetical listing of all STARS and profile descents is displayed.

STARS are displayed first in a list under the STAR label. Profile descents are listed after the STARS under the PROF DES label.

Selection of the desired STAR deletes all other STARs and non-applicable approaches/runways, and displays a listing of any arrival transitions applicable to that STAR.

The selection of an approach or runway deletes all STARs not related to that approach/runway.

3 INDEX

Push – displays the DEP/ARR INDEX page.

4 Approaches and Runways (APPROACHES/RUNWAYS)

Upon initial page display, an alphabetical listing of all approaches for the airport, followed by a numerical listing of all runways, is displayed.

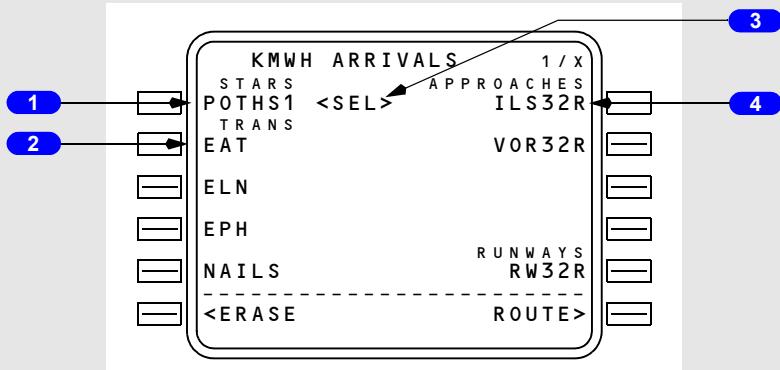
Selection of the desired approach or runway deletes all other approaches/runways.

5 ROUTE

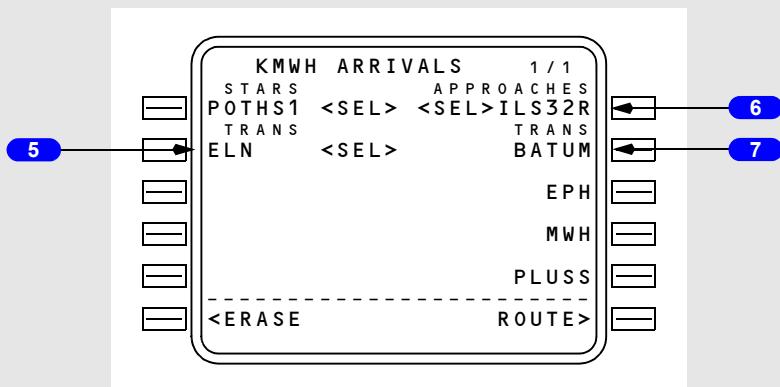
Push – displays the RTE page.

Arrivals Page during approach selection

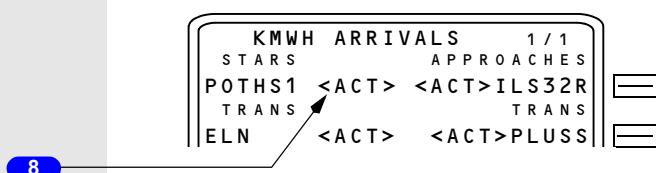
Display after STAR selected



Display after STAR Transition and Approach/Runway selected



Display after executing



1 STARS

Displays the selected STAR.

2 Arrival Transitions (TRANS)

Displays all arrival transitions related to the selected STAR.

3 Selected Status Label (<SEL>)

Identifies arrival/approach procedures or a runway which has been selected for entry into the route, but not executed.

All <SEL> entries propagate to the MOD RTE and MOD RTE LEGS pages for subsequent execution.

4 Approaches and Runways (APPROACHES/RUNWAYS)

Displays all approaches related to the selected STAR, followed by all related runways (unless the desired approach/runway was selected on the initial display).

5 Arrival Transition (TRANS)

Displays the selected arrival transition.

6 APPROACHES

Displays selected approach/runway.

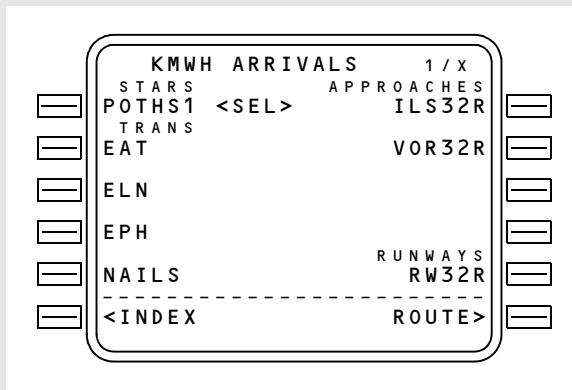
7 Approach Transition (TRANS)

Displays all approach transitions related to the selected approach.

8 Active Status Labels (<ACT>)

Following execution of the selected entries, the arrival/approach procedures and runway are identified as active.

Note: For an existing active route, the execute key illuminates upon STAR or approach/runway selection. Following selections, the ERASE prompt is available. Selections should be executed on the RTE or RTE LEGS pages after linking any route discontinuities.

Arrivals Page – Runway Extension Fix**Initial display****Display after runway 32R selected****Display after runway 32R extension inserted****Display after execution**

1 Runway Extension (RWY EXT)

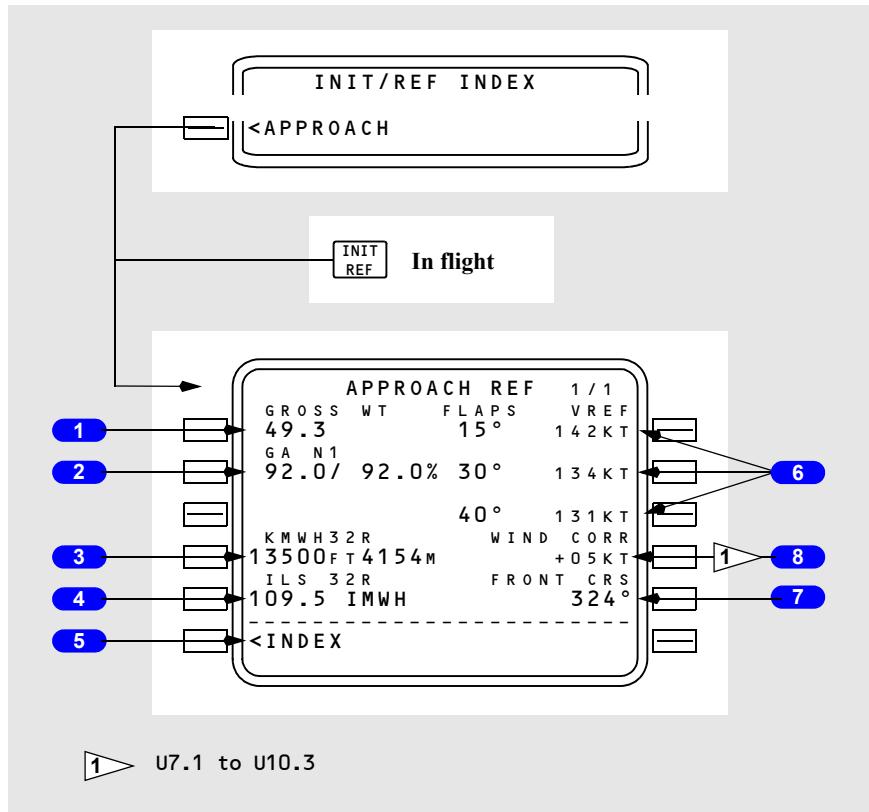
Permits entry of runway extension waypoint following selection of desired runway.

Desired extension distance is entered in scratch pad, then inserted on RWY EXT line. This creates a waypoint on the extended runway centerline at the specified distance from the threshold. Permissible entries are between 1 and 25 NM in increments of .1 NM.

Waypoint is identified on the RTE and RTE LEGS pages as RXYYY, where YYY is the runway designation.

Approach Reference Page

The approach reference page displays approach planning information and approach reference speed (VREF) selection. The displayed data is for the DEST airport and the arrival/approach entered into the FMC flight plan.



1 Airplane Gross Weight (GROSS WT)

Normally displays the FMC calculated airplane gross weight.

A manual entry of gross weight is allowed.

Displays box prompts when gross weight is not available from the FMC.

Valid entry is XXX.X.

Leaving and returning to this page replaces a manually entered weight with FMC computed gross weight.

2 Go-around N1 (GA N1)

Displays the computed N1 go-around limit, based on present pressure altitude, temperature, and bleed configuration.

3 Runway Length

Displays the length of the referenced runway in feet and meters.

Blank if no runway has been entered and executed.

4 ILS Approach

Displays the runway number and associated ILS frequency/identifier for the ILS, LOC, or back course approach in the active flight plan.

Blank if no approach has been executed.

5 INDEX

Push – selects the INIT/REF INDEX page.

6 Vref (FLAPS --- VREF)

Displays landing Vref for three flap settings as computed by the FMC. Displayed in small size characters.

Double line selection of a displayed Vref, or manual entry of another value, causes Vref to be displayed on the airspeed display. CDU display changes to large size characters.

Speeds are based on displayed gross weights.

(U7 and on) Double line selection provides Vref to be used by VNAV in combination with wind correction.

Vref, once selected, will not be updated. To obtain an updated speed, the current speed must be deleted or a different Vref selected or entered.

7 Front Course (FRONT CRS)

Displays front course for the approach displayed on ILS approach line.

Blank if no ILS approach is selected.

8 Wind Correction (WIND CORR)

Displays current wind correction for approach. Default is +05 knots.

Manual input of desired wind correction may be made up to +20 knots.

Holding

HOLD Page

The hold page is used to enter a holding pattern into the route.

When the flight plan does not have a holding pattern, push the HOLD function key to show the LEGS page with the HOLD AT line.

Two versions of the hold page are possible:

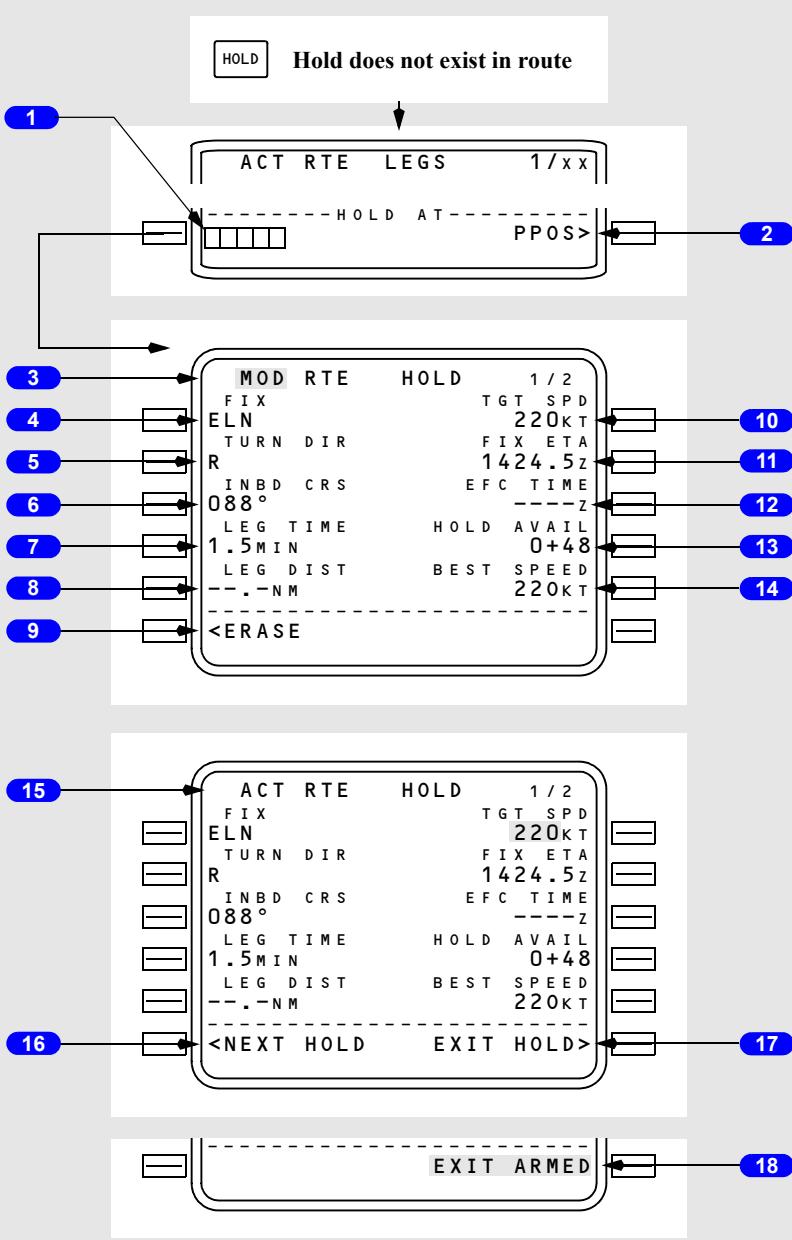
- an airway or procedure holding pattern (from the navigation database)
- a flight crew-entered holding pattern.

The holding page shows actual or default data about the holding pattern.

Entries make route modifications, which can be erased or executed.

Active holding patterns are magenta on the navigation display.

Pushing the HOLD key when a holding pattern already exists in the route displays the hold page for the next hold. Holding parameters can be monitored and changed on this page. Performance predictions assume the hold will be in level flight. New holding patterns are added using the NEXT HOLD prompt. Exit from the holding pattern must be manually initiated.



1 HOLD AT

When the HOLD function key is pushed and no holding pattern exists in the route, the LEGS page shows prompts to enter the holding fix. Enter the holding fix to show the RTE HOLD page.

Displays a prompt to enter the holding fix, a route waypoint, or present position. A waypoint is entered as the holding fix.

2 HOLD AT Present Position (PPOS)

Selects the airplane present position as the holding fix.

3 Modified Route Hold Status

MOD indicates that the holding fix has not been executed.

Execution changes the page title to RTE HOLD (ACT RTE HOLD if holding at PPOS).

4 FIX

Displays waypoint identifier of the holding fix.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

If PPOS was selected on the HOLD AT page, then the FMC assigns PPOS as the fix identifier.

5 Turn Direction (TURN DIR)

Displays holding pattern turn direction.

Entry is propagated either automatically from the database, or from a manual entry.

Valid entry is L or R. Manual entry has priority.

If no entry is made, the FMC assumes right (R) turns.

6 Inbound Course (INBD CRS)

Displays holding pattern inbound course.

Entry is propagated either automatically from the database, or from a manual entry.

Valid entry is XXX. Manual entry has priority.

If no entry is made, the FMC assumes the course to be the same as the preceding leg to the fix.

7 LEG TIME

Displays holding pattern leg time.

Valid entry is X.X. Manual entry has priority.

If no entry is made, the FMC assumes the standard times of 1.0 minute at or below 14,000 feet, and 1.5 minutes above 14,000 feet.

If a LEG DIST is manually entered, then dashes will be displayed.

8 Leg Distance (LEG DIST)

Dash prompts are normally displayed.

Entry may be propagated either automatically from the database, or made by manual entry.

Manual entry has priority.

Overrides LEG TIME.

9 ERASE

Displayed only while modification is in progress.

Push – deletes modification and returns to ACT RTE HOLD page, if one exists; otherwise returns to the ACT RTE LEGS page.

10 Target Speed (TGT SPD)

Used for entry and/or display of the holding pattern target airspeed.

If no entry is made, the best speed value is displayed.

Manual entry has priority.

Target speed is propagated to the CLB, CRZ, or DES page three minutes prior to reaching the fix.

Speed is highlighted in reverse video when the RTE HOLD is active.

11 Fix Estimated Time of Arrival (FIX ETA)

Displays computed time for next passage over holding fix.

12 Expect Further Clearance Time (EFC TIME)

Entry of the EFC time will help optimize FMC performance computations.

Computation of destination fuel assumes that departure from the holding fix will occur at this time.

13 Hold Available (HOLD AVAIL)

Displays available holding time in hours + minutes remaining if destination is to be reached with planned fuel reserves as entered on PERF INIT page.

14 BEST SPEED

Displays computed best holding speed based on present altitude and conditions.

Note: May exceed maximum speed permitted by regulatory agency.

15 Active Route Hold Status

ACT indicates that the airplane has entered the holding pattern.

16 NEXT HOLD

Displayed when the route contains less than five holding patterns and there is no route modification in progress.

Push – displays (RTE LEGS) HOLD AT page and prompts for new holding fix entry.

17 EXIT HOLD

Displayed on the holding page when in the holding pattern.

Used when preparing to depart holding pattern.

Push – changes prompt to EXIT ARMED and illuminates execute key.

The EXIT prompt is not available until the next crossing of the holding fix, if the holding pattern is modified while being flown.

18 EXIT ARMED

Displayed on the holding page when in the holding pattern and after line selection of EXIT HOLD prompt.

Execution activates LNAV flight back to the holding fix via a shortened holding pattern, departure from holding pattern, and continued flight along the active route. ACT RTE LEGS page 1/XX appears after holding exited.

Highlighted in reverse video after execution.

RTE LEGS HOLD AT (Fix in Route)

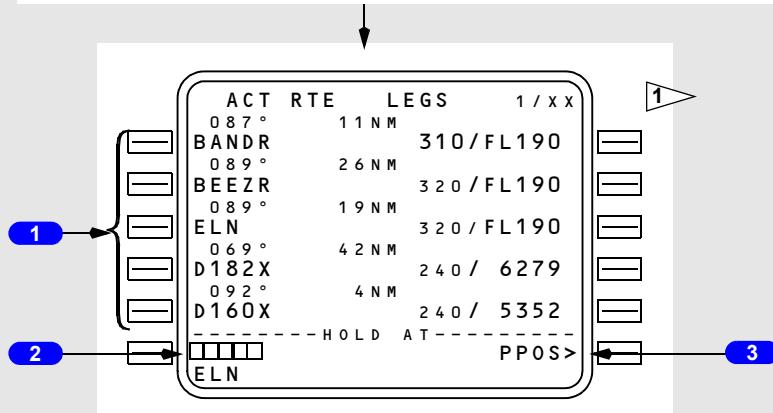
Used to enter proposed fix for racetrack holding pattern at either present position or any waypoint.

A maximum of five holding patterns may exist at one time.

With U7 FMC, two holding patterns may exist at the same waypoint if one is in the route and the other is in the missed approach.

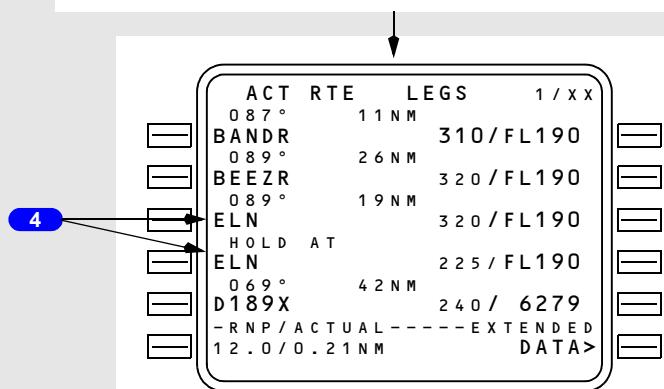
HOLD

Proposed holding fix in current route; no holding pattern currently exists in route



HOLD

After executing route hold at downtrack waypoint



U7 to U8.4

1 Data Lines

Display same data as the corresponding RTE LEGS page.

2 HOLD AT

Used to enter any waypoint identifier, which then defines a holding fix.

Entry may be via keyboard, or by transfer of any downpath waypoint which is in the existing route (the example depicts ELN line selected into the scratch pad).

Following line selection of the desired waypoint into the box prompts, the MOD RTE HOLD page appears and the execute key illuminates.

3 Present Position (PPOS)

Push – selects holding fix at present position. The MOD RTE HOLD page appears and the execute key illuminates (“present” is at the time of execution of the MOD RTE HOLD page).

Displayed only in flight.

Default parameters are a standard holding pattern on the inbound leg.

4 Hold at Waypoints (HOLD AT)

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

Displayed on the RTE LEGS page in the proper route sequence after executing the related MOD RTE HOLD page.

RTE LEGS HOLD AT (Fix not in Route)

HOLD

Display after off-route waypoint selected

ACT	RTE	LEGS	1 / XX
0 8 7 °		1 1 N M	
BANDR		3 1 0 / FL 1 9 0	
0 8 9 °		2 6 N M	
BEEZR		3 2 0 / FL 1 9 0	
0 8 9 °		1 9 N M	
ELN		3 2 0 / FL 1 9 0	
0 6 9 °		4 2 N M	
D182X		2 4 0 / 6 2 7 9	
0 9 2 °		4 N M	
D160X		2 4 0 / 5 3 5 2	
- RNP / ACTUAL ----- EXTENDED DATA >			
1 2 . 0 / 0 . 2 1 N M			
HOLD AT PLUSS			

1



After line selecting the desired LEGS page sequence and executing the off route hold

ACT	RTE	LEGS	1 / XX
0 6 7 °		9 6 N M	
PLUSS		3 1 0 / FL 1 9 0	
HOLD AT		2 2 0 / FL 1 9 0	
PLUSS			
THEN			
- - ROUTE DISCONTINUITY -			
BANDR		3 2 0 / FL 1 9 0	
0 8 9 °		2 6 N M	
BEEZR		3 2 0 / FL 1 9 0	
- RNP / ACTUAL ----- EXTENDED DATA >			
1 2 . 0 / 0 . 2 1 N M			

2

3

1 ▶ U7 to U8.5

1 Hold at Waypoint (HOLD AT XXXX)

Displayed in the scratch pad whenever the entry in the HOLD AT line is not a waypoint in the existing route (the example above depicts entry of PLUSS).

Route position of the holding fix is defined by line selecting to the desired LEGS page sequence.

Following line selection to the desired LEGS page sequence, the MOD RTE HOLD page appears and the execute key illuminates.

2 Hold at Waypoints (HOLD AT)

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

Displayed on the RTE LEGS page in the proper route sequence after executing the related MOD RTE HOLD page.

3 ROUTE DISCONTINUITY

The entered route must always form a continuous path of linked legs.

The example depicts a HOLD AT entry where the entry was not a downpath waypoint.

The FMC computes a direct course to the off-route holding fix.

The HOLD AT waypoint becomes a termination identifier which is not part of the existing route. The resulting route discontinuity is identified by box prompts, requiring entries to define the route after PLUSS.

Intentionally
Blank

Flight Management, Navigation Alternate Navigation System (ANS)

Chapter 11 Section 50

Introduction

This section provides a detailed description of the alternate navigation system (ANS). Information in this section is limited to that which is unique to the ANS; information which is common with the flight management computer system (FMCS) is not repeated.

General

The ANS is an IRS-based system which provides lateral navigation capability independent of the FMCS. The ANS with the control display units (ANCDU) can be operated in parallel with the FMCS, providing an independent crosscheck of FMC/CDU operation. In the event of FMC failure, the ANS provides a backup mode of operation which is immediately available for use.

As does the FMCS, the ANS performs computations related to lateral navigation; it also provides LNAV commands which can be coupled to the AFDS for integrated operation with the flight management system.

System Components

The ANS consists of two separate systems; ANS-Left and ANS-Right. Each system is independent of the other, consisting of its own ANCDU and “on-side” IRS.

During FMC/CDU operation, all memory and computing capability are contained within the FMC. The same information is available for display on either CDU.

During ANCDU operation, each CDU uses its own internal memory and computing capability. Since each ANCDU performs its own computations based on inputs from its own IRS, the information available for display on each CDU is independent of that displayed on the other CDU.

Each pilot has a navigation mode selector, which is used to specify the source (FMC, ANS-L, or ANS-R) of the navigation information being provided to the related EFIS symbol generator and flight director.

If the associated flight control computer (FCC A or FCC B) is the master, then the related navigation mode selector is also the master and determines the source of LNAV commands provided to the autopilot.

Memory

In contrast to the FMC, the ANCDU has neither a performance database nor a permanent nav database. Thus, there is no stored information from which the desired waypoints can be extracted by use of their identifiers. All waypoints in the ANCDU flight plan must be defined in terms of latitude and longitude. The ANCDU has a limited memory which can store up to 20 waypoints. The ANCDU flight plan is then assembled from this memory. Waypoints can be entered into the ANCDU flight plan either during preflight or while in flight. Navaids and airports can also be entered as "waypoints," as well as certain procedural waypoints (only those defined by latitude and longitude).

If the crew has not entered an ANCDU flight plan, the ANCDU memory automatically stores the active FMC flight plan. This makes a flight plan available for the ANCDU in the event of FMC failure. All waypoints in the ANCDU memory and flight plan are automatically erased at flight completion.

Operation

Overview

When the FMC is operable, the CDUs are used in the normal manner during preflight to activate an FMC flight plan. With the FMC/CDU preflight complete, the IRS LEGS page may be used to crossload (copy) the FMC flight plan into the ANCDU. If executed, the ANCDU flight plan becomes identical to the FMC flight plan (except that the ANCDU bypasses any undefined procedural legs contained in the FMC flight plan). If desired, the flight plan may be modified prior to execution. Additionally, the entire ANCDU flight plan may be entered manually. When entering flight plans into both ANCDUs, note that each flight plan (whether identical or not), must be entered and executed individually.

ANCDU operation requires valid inputs from the related IRS navigation mode for present position, ground speed, track, and wind. Based on the flight plan and IRS inputs, the ANCDU computes and displays courses to fly, leg lengths, estimated time en route, and crosstrack deviation. Associated roll commands are available to the AFDS.

With the FMC operable, the ANCDU can be used to monitor FMCS operation. Note that a CDU can be switched between FMC/CDU and ANCDU page displays as desired, since source selection of control and guidance commands is determined separately by the navigation mode selector.

If the FMC flight plan was crossloaded into the ANCDU, only the first 20 waypoints appear in the initial ANCDU flight plan. However, as the flight progresses, downpath FMC waypoints are automatically added to the ANCDU memory, becoming available for subsequent crossloading into the ANCDU flight plan. Anytime the FMC flight plan is modified, the ANCDU memory is automatically updated with applicable changes.

If the FMC should fail, the IRS PROGRESS page is automatically displayed, and ANCDU LNAV operation is immediately available via the navigation mode selector. If an ANCDU flight plan had not been previously executed, the IRS LEGS page is automatically displayed. The most recent FMC flight plan is stored in the ANCDU memory and can be activated if desired, or a new flight plan may be manually entered. Additional crew entries may be required as the flight progresses, due to the ANCDU limit of 20 waypoints.

Lateral Navigation

All computations and commands from the ANCDU are based on a direct great-circle course between waypoints. Complete departure or arrival/approach procedures cannot be manually entered or crossloaded from the FMC. This is because the ANCDU does not accept “undefined” waypoints/legs, that is, no fixed heading or course legs, and no conditional waypoints. The ANCDU automatically constructs a great-circle course to bypass such legs. However, individual legs of a procedure, if they are great-circle courses, can be manually entered or crossloaded.

Computed courses are referenced to magnetic north for the active leg. Downpath legs are displayed as true courses, because the IRS can provide magnetic variation only for present position.

Vertical Navigation

The ANCDU does not perform computations related to vertical navigation and does not provide VNAV or autothrottle commands. However, an operable FMC can provide thrust limits to the autothrottle during ANCDU LNAV operation. Autothrottle commands are provided by MCP speed and mode selection.

Radio Tuning

The ANCDU cannot tune the VHF navigation radios and does not use radio information for position updating.

Electrical Power

Both ANCDUs are powered via transfer bus No. 1. Response to power loss is the same as for the FMC/CDU, except that the MOD IRS LEGS page is displayed in flight following a power interruption of ten seconds or more.

System Downmoding

The ANS may fail due to either the loss of IRS navigation mode inputs or ANCDU malfunction. If an IRS fails, the IRS transfer switch cannot transfer navigation inputs from the other IRS. If continual self-tests detect a failure, the CDU display is blanked, and LNAV disengages.

CDU Messages

There are only four messages associated specifically with ANS operation, all related to CDU entries. See section 11.60.

Waypoints

All waypoints in the ANCDU flight plan must be defined in terms of latitude and longitude.

Waypoint Identifiers

When an FMC flight plan is crossloaded, the ANCDU flight plan maintains the same waypoint identifiers used by the FMC. The associated latitude/longitude of those waypoints is also automatically crossloaded from the FMC.

If manually entering waypoints on the IRS LEGS or IRS WPT DATA pages, the waypoint identifier is limited to a maximum of 6 alpha/numeric characters.

Manually entered waypoints are keyed into the scratch pad as any of the following:

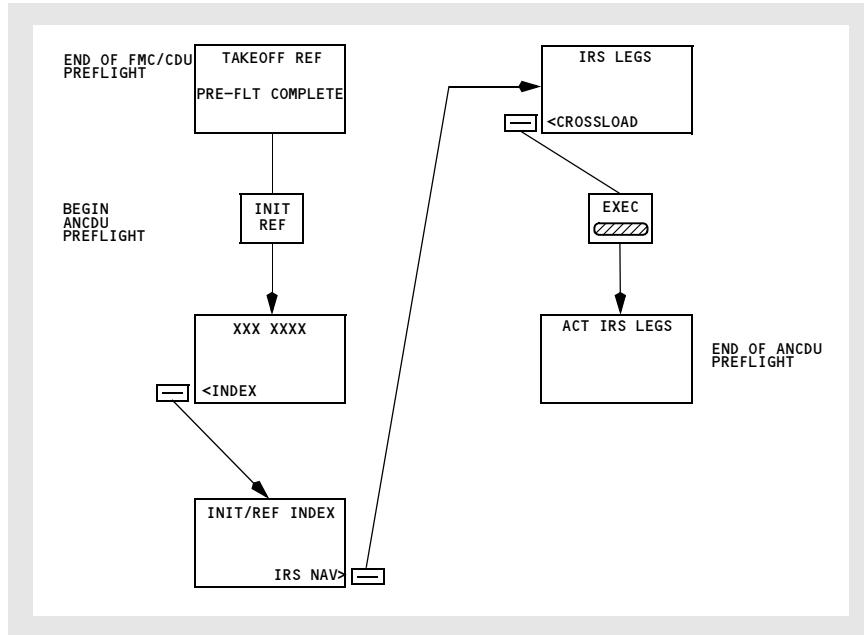
- an identifier which already exists in the ANCDU flight plan (e.g., SEA, KBFI, ELN01, or WPT03).
- a crew-assigned identifier and associated latitude/longitude (e.g., SIMONE/N4802.2W12241.3).
- latitude/longitude (e.g., S3618.5E14136.9). Upon entry, the ANCDU assigns a sequential identifier number such as WPT04, etc.

Preflight

Introduction

Preflight entry of an ANCDU flight plan is accomplished after entry of the FMC/CDU flight plan is complete. The following diagram depicts crossloading of the FMC flight plan into the ANCDU.

Preflight Page Sequence



Page Displays

Introduction

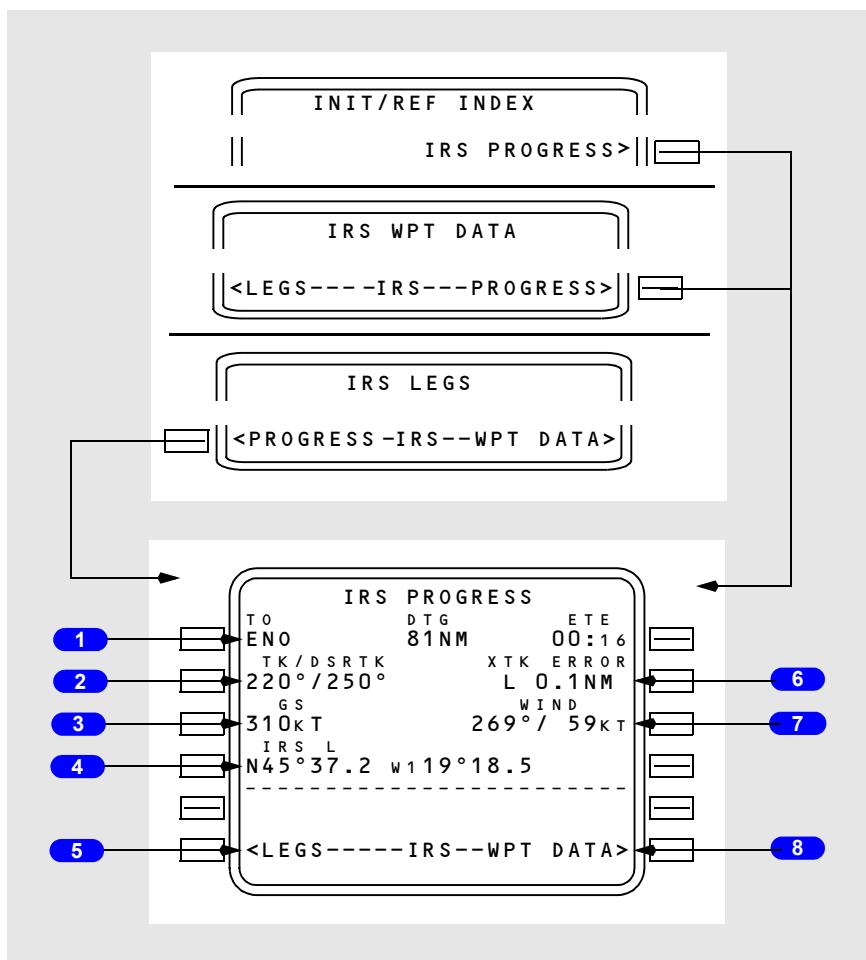
This section provides detailed descriptions and examples of the three page displays which are unique to the ANCDU mode of operation. These page displays are only intended to provide a general description of overall system capability; they are not intended to reflect valid navigational data.

IRS Progress

The IRS PROGRESS page is an advisory page which displays current dynamic data concerning progress along the active ANCDU flight plan route. No entries are permitted.

Page access is as shown. The page is also automatically displayed upon FMC failure when IRS inputs are valid and an active ANCDU flight plan exists.

IRS Progress Page



1 Active (TO) Waypoint Line

Displays:

- identifier of the active waypoint (highlighted in reverse video)
- distance to go (DTG) from present position to the active waypoint
- estimated time en route (ETE) to the active waypoint.

2 Track/Desired Track (TK/DSRTK)

Displays present IRS magnetic track/desired magnetic track (i.e., the flight plan great-circle course).

3 Groundspeed (GS)

Displays current IRS ground speed in knots.

4 IRS Present Position

Displays latitude and longitude of IRS present position.

Data is from the “on-side” IRS (L or R).

All displays on this ANCDU are based on inputs from this IRS.

5 IRS LEGS

Allows selection of IRS LEGS page 1.

6 Cross-Track Error (XTK ERROR)

Displays present deviation (NM left or right) from the DSRTK flight plan course.

7 WIND

Displays present IRS true wind direction and speed in knots.

8 IRS Waypoint Data (WPT DATA)

Allows line selection of IRS WPT DATA page 1.

IRS Legs

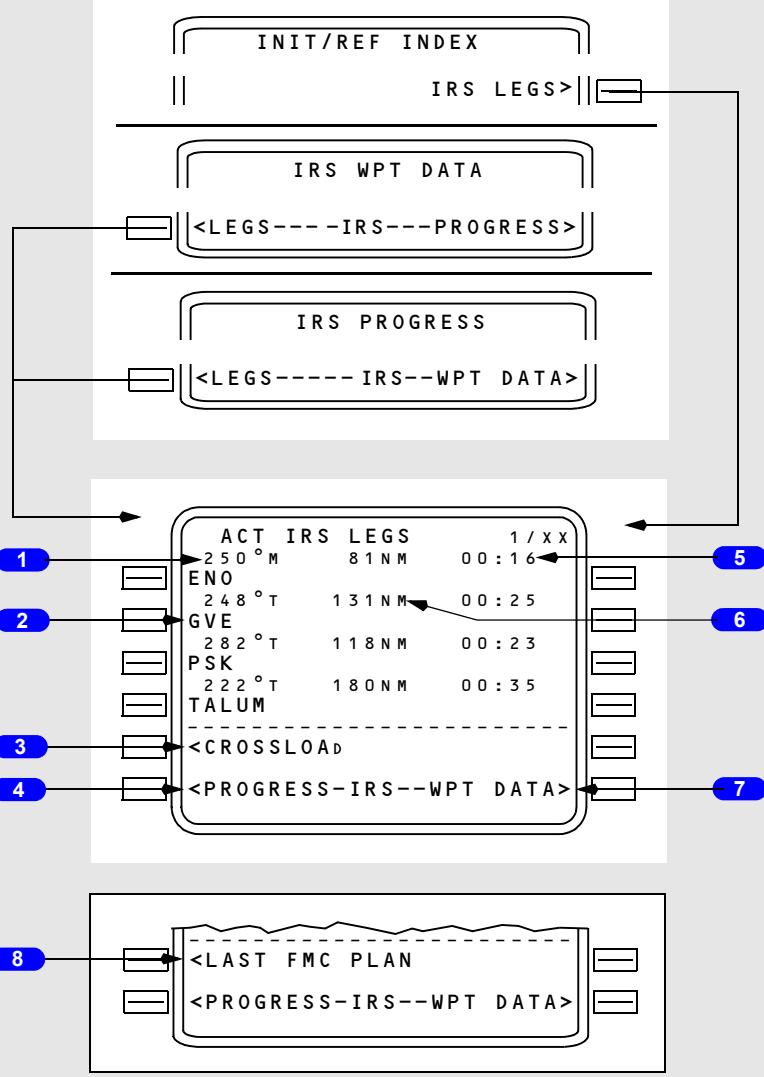
The IRS LEGS page displays details of the ANCDU flight plan (20 waypoints maximum). It has no required entries.

The page allows review of the crossloaded FMC flight plan, or it may be used to enter or modify a unique ANCDU flight plan.

The flight plan is cleared at flight completion.

Page access is as shown. The page is also displayed automatically upon FMC failure when IRS inputs are valid and an active ANCDU flight plan does not exist.

IRS Legs Page



1 Leg Direction

Applies to the leg going to the waypoint identified on the line below.

Displays the IRS computed great-circle course. For the active waypoint, the displayed course is the present magnetic course to be flown. For all downpath waypoints, displayed course is the initial true course for that leg.

2 Waypoint Identifier (lines 1L–4L)

Used for entry and/or display of any valid waypoint identifier.

Entry may be made via the keyboard or propagated from either the RTE LEGS page or IRS WPT DATA page.

Entries are propagated to the IRS WPT DATA pages.

The active waypoint identifier is highlighted in reverse video. It cannot be deleted, but it can be overwritten.

3 Crossload

Used to crossload (copy) the FMC flight plan into the ANCDU.

If there is no flight plan in the ANCDU, initial lines selection displays the FMC flight plan which is proposed to be stored in the ANCDU.

If an ANCDU flight plan already exists, line selection changes the page title to MOD.

Line selection “arms” the execution function, and the EXEC light illuminates. Subsequent execution activates the ANCDU flight plan (page title change to ACT).

Upon FMC failure, the CROSSLOAD prompt is replaced by the LAST FMC PLAN prompt.

4 IRS Progress

Allows selection of the IRS PROGRESS page.

5 Estimated Time En route

Applies to the leg going to the waypoint identified on the line below. Displayed only when ground speed exceeds 210 knots.

For the active waypoint, displays time-to-go to the active waypoint.

For all downpath waypoints, displays estimated time en route for that leg.

6 Leg Length

Applies to the leg going to the waypoint identified on the line below.

For the active waypoint, displays computed distance-to-go from present position to the waypoint.

For all downpath waypoints, displays flight plan leg length.

Blank if distance-to-go is greater than 9,999 NM.

Displayed values are in tenths of miles if the leg length is less than 10 NM.

7 IRS Waypoint Data

Allows selection of the corresponding IRS WPT DATA page.

8 Last FMC Plan

Displayed upon FMC failure.

Line selection displays the FMC flight plan which existed at the time of FMC failure. The EXEC key illuminates.

Subsequent execution activates the ANCDU flight plan.

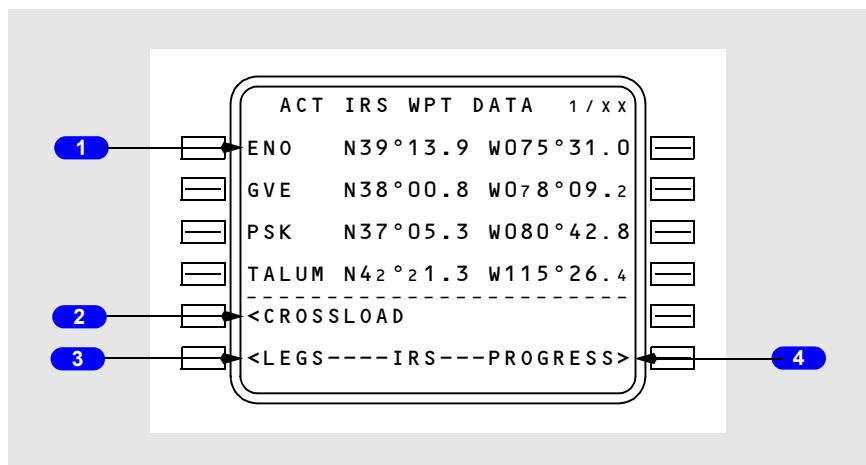
IRS Waypoint Data

The IRS WPT DATA page displays latitude and longitude for each waypoint in the ANCDU flight plan (20 waypoints maximum). It has no required entries.

The page can be used to enter or modify the ANCDU flight plan.

Page access is from IRS PROGRESS page or IRS LEGS page.

IRS Waypoint Data Page



1 Waypoint Line (lines 1L–4L)

Used for entry and/or display of any valid waypoint identifier and the associated latitude and longitude.

Entry may be via the keyboard or propagated from either the RTE LEGS page or the IRS LEGS page.

Entries are propagated to the IRS LEGS pages.

The active waypoint cannot be deleted, but it can be overwritten.

2 Crossload

Functions the same as on IRS LEGS page.

3 IRS Legs

Allows selection of the IRS LEGS page.

4 IRS Progress

Allows selection of the IRS PROGRESS page.

Intentionally
Blank

Introduction

FMC messages tell the flight crew when system operation is degraded or if there are data input errors.

FMC messages show in the CDU scratchpad. The messages are categorized as:

- alerting messages
- entry error messages
- advisory messages
- ANCDU advisory messages

The FMC messages are shown according to their level of importance. Alerting messages are most important, followed by entry error messages. Advisory messages are least important. If multiple messages exist, a less important message replaces another message in the scratchpad when the CLR key is pushed or the condition is corrected.

The amber FMC alert light on each pilot's instrument panel illuminates when there is an FMC alerting message. All FMC messages illuminate the CDU message (MSG) light. Clear the message or correct the condition to cancel the message.

The following tables are general lists; some messages may not apply to all FMC configurations.

FMC Alerting Messages

These messages relate to operationally significant conditions which affect FMC operation.

FMC alerting messages:

- are shown in the CDU scratchpad
- cause the amber FMC alert light on each pilot's instrument panel to illuminate
- illuminate message lights (MSG) on both CDUs.

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
CHECK FLIGHT PLAN	The FMC has found and corrected an error in the nav database.	Check the flight plan and correct if necessary.
CHECK ALT TGT	U10.5 and later: VNAV disengages while airplane is between MCP and FMC altitudes or VNAV button pressed while airplane is between MCP and FMC altitudes.	Clear the message.
CRZ ALT CHANGED TO XXXXX	U10.4 and later: During a missed approach a STAR or approach has been selected that conflicts with the cruise altitude.	Clear the message.
CYCLE IRS OFF-NAV	IRS is unable to complete alignment under current conditions.	Cycle IRS mode selector to "OFF" and back to "NAV".
DATA BASE INVALID	The automatic validity test of the permanent navigation database has failed.	Advise maintenance personnel to check the FMC and reload the database, as required. If desired, consider the use of the temporary nav database.

DO NOT USE FOR FLIGHTFlight Management, Navigation -
FMC/CDU Messages

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ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
DISCO INSRTD AFTR XXXXX (waypoint identifier)	A ROUTE DISCONTINUITY has been inserted into the flight plan due to undefined termination of a downpath leg or a double or triple waypoint BYPASS.	Select the RTE or RTE LEGS pages and modify the waypoints for a continuous route.
DISCONTINUITY	Passing the last waypoint in the route prior to a ROUTE DISCONTINUITY (LNAV disengages) or pressing LNAV while in a discontinuity.	Select the RTE LEGS page. Enter the desired active waypoint into the box prompts. Correct any ROUTE DISCONTINUITY and EXECute. Reengage LNAV.
DRAG REQ AFTER XXXX	U10.7 and later: A waypoint speed constraint greater than 10 knots above the predicted speed exists at waypoint XXXXX.	Modify flight plan as required. Clear the message.
DUAL FMC OP RESTORED	Dual FMC operation has been successfully restored. (Dual FMC as installed)	Clear message and set FMC source select switch to NORMAL.
END OF OFFSET	Two minutes prior to passing offset leg termination.	Confirm ATC clearance.
END OF ROUTE	LNAV engaged and passing the last waypoint in the route (LNAV disengages).	Select the RTE LEGS page. Enter the desired active waypoint into the dash prompts and EXECute. Reengage LNAV.
ENG OUT SID MOD	U10.3 and later (As installed): An engine-out SID has been automatically inserted into the flight plan as a modification.	Clear the message.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
ENTER IRS POSITION	IRS in the alignment mode needs present position to complete alignment. Previous present position entry was not received back from the IRS.	Enter IRS present position into the scratch pad and line select 4R on the POS INIT page of the CDU. If present position was previously entered, overwrite displayed data. If necessary, enter present position directly into the IRS control /display unit.
FMC APP MODE UNAVAIL-QFE	U10.5 and later: An approach that utilizes FMC generated glidepath is in the flight plan (active or inactive) but QFE is selected on the FMC.	Select QNH as the landing altimeter reference on the APPROACH REF page. Clear the message
FMC APP/TUNE DISAGREE	U10.5 and later: An approach that utilizes FMC generated glidepath is in the active flight plan but an approach navaid (ILS/GLS) has been tuned with G/S ON.	Confirm the tuned frequency and approach selected in the FMC are both consistent with the actual approach intended to be flown. Resolve tuning or approach selection inconsistency. Clear the message.
FMC DISAGREE	U10.6 and later: During approach or on the ground, monitored parameters required for dual FMC operation are in disagreement. (Dual FMC as installed).	Monitor FMCs closely. Both FMCs remain online. Limit approaches to single FMC only. If desired, revert to SINGLE FMC OPERATION in this section.
FMC POS/RW DISAGREE	U10.7 and later: Position information is contradictory.	Refer to FMC Navigation Check supplementary procedure.
GPS-L INVALID (airplanes with single GPS)	U10.7 and later: FMC is no longer receiving valid information from the GPS system.	Refer to FMC Navigation Check supplementary procedure.

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ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
GPS-L INVALID GPS-R INVALID (airplanes with dual GPS)	U10.7 and later: FMC is no longer receiving valid information from the GPS system.	Clear the message. If both GPS-L INVALID and GPS-R INVALID messages show, refer to FMC Navigation Check supplementary procedure.
INSUFFICIENT FUEL	A change in conditions or flight plan route causes predicted fuel at destination to be 900 kilograms/2000 lbs or less. May be the result of a fuel quantity indicator inoperative.	Modify the route plan or cruising altitude, or divert for additional fuel. Use manual computations of fuel quantity remaining to determine gross weight.
IRS MOTION	IRS has automatically restarted the alignment due to detection of excessive motion.	Clear message and attempt to reduce airplane movement, if practicable.
IRS NAV ONLY	The FMC has downmoded to the IRS-only mode of navigation or (U7.1 – U10.2A) navigation accuracy is not sufficient for present phase of flight.	Refer to FMC Navigation Check supplementary procedure.
IRS POS/ORIGIN DISAGREE	U10.7 and later: Position information is contradictory.	Refer to FMC Navigation Check supplementary procedure.
LNAV BANK ANGLE LIMITED	U10.2 and later: 5 minutes prior to an LNAV guided course change that may exceed airway/route boundary due to LNAV performance limited bank angle.	Review the LNAV course change. If course change exceeds airway/route boundary, consider flight plan change.
MAX ALT FLXXX (flight level value)	Altitude intervention (as installed) attempt to raise cruise altitude when MCP altitude is above maximum altitude.	Reset MCP altitude.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
MISSED CAPTURE	Proper localizer capture maneuver was performed, but the AFDS did not capture.	Clear the message.
MODEL/ENG DATA INVALID	A valid performance database is not available.	Contact maintenance personnel.
NAV DATA OUT OF DATE	Effectivity dates of nav database do not agree with date input from clock.	Check the IDENT page and reverse the dates for ACTIVE NAV DATA if required.
NAV INVALID-TUNE XXXXX (navaid identifier)	FMC is unable to auto-tune or receive the navaid for a RNAV or VOR approach procedure.	Cross-check radios and manually tune the desired navaid.
OVERSPEED DISCONNECT	U10.1 and earlier: During path descent and below the speed restriction altitude, VNAV disengages when airspeed exceeds FMC speed restriction by more than 15 knots. U10.2 and later: During path descent and above or below the speed restriction altitude, VNAV disengages when airspeed exceeds FMC speed restriction by more than 15 knots.	Manually reduce speed and reengage VNAV.
PARTIAL ROUTE LOADED	U10.3 and later: A route is loaded which references data not contained in the database.	Clear the message.
PATH DES NOT AVAILABLE	Within 5 NM of advisory top-of-descent, a path descent is planned, and a computed path is not available.	EXECute a SPD DES if desired, or construct an adequate path (must include an “at” altitude restriction for the E/D waypoint and not have a ROUTE DISCONTINUITY).

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ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
PERF DEFAULTS INVALID	Validity check of performance defaults database has failed.	Contact maintenance personnel.
PROGRAM PIN MISCOMPARE	Dual FMC as installed: Primary FMC has detected a discrepancy between its program pin configuration and that of the secondary FMC.	Contact maintenance personnel.
RESET MCP ALT	U10.5 and earlier: During the FMC cruise phase, when within 5 NM of the top-of-descent point without selecting a lower altitude on the AFDS MCP. U10.5A and later: During the FMC cruise phase with VNAV engaged, when within 5 NM of the top-of-descent point without selecting a lower altitude on the AFDS MCP.	Select lower MCP altitude values as clearances permit.
RTA UNACHIEVABLE	The RTA is not in the computed RTA window under current parameters.	Enter an achievable RTA or discontinue the RTA mode of navigation. Adjust parameters to meet the RTA.
RW/APP CRS ERROR	U10.4 and later: During approach, MCP selected course does not match front course for the approach in the active flight plan.	Clear the message and select correct MCP course.
RW/APP TUNE DISAGREE	U10.4 and later: During approach, manual tuned approach frequency or channel does not match active flight plan.	Clear the message and select correct approach frequency.
SCANNING DME FAIL	Inputs from frequency scanning DME radio(s) have failed.	Clear the message and check position. Radio updating of FMC position is not available.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
SELECT MODE AFTER RTA	RTA mode has been discontinued due to sequencing of RTA waypoint or RTA waypoint has been removed from the flight plan.	Select desired navigation mode. (ECON, manual speed, etc.)
SINGLE FMC OPERATION	The primary FMC has determined that the secondary FMC is not available. (Dual FMC as installed)	If FMC source selector switch is in Normal Position, move to "BOTH ON L." No action required if FMC source selector switch is already on "BOTH ON L" or "BOTH ON R."
SINGLE IRS NAV	Navigation environment is OCEANIC and one IRS is invalid.	NONE
SW OPTIONS INVALID	The validity check of the software options database has failed.	Contact maintenance personnel.
TAKEOFF SPEEDS DELETED	U10.1 and later: New performance data is entered after the V speeds have been entered on the TAKEOFF REF page, or a takeoff thrust selection change is entered after the V speeds have been entered. or U10.0: Runway is changed after the V speeds have been entered.	Select new V speeds.
THRUST REQUIRED	U10.5 and later: Airplane is in an underspeed condition.	Clear the message. Increase airspeed to within 15 knots of speed target.

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ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
UNABLE HOLD AIRSPACE	U10.2 and later: LNAV guided holding pattern may exceed allowable hold airspace due to LNAV performance limited bank angle.	Review the holding pattern. If holding pattern exceeds allowable holding airspace, consider flight plan change.
UNABLE NEXT ALTITUDE	Prior to U5: Due to undershoot, the next climb constraint cannot be achieved (VNAV engaged). U5 and later: Unable to meet the next flight plan altitude constraint in a VNAV SPD climb or descent. The message appears only with VNAV engaged.	Clear the message and review the prediction. For undershoot condition during climb, consider selection of MAX RATE CLB or MAX ANGLE CLB, or a different N1 limit as appropriate.
UNABLE YYY KTS AT XXXXX	U10.7 and later: Next waypoint speed restriction (speed YYY, at waypoint XXXXX) cannot be met.	Modify flight plan as required. Clear the message.
UNABLE REQD NAV PERF – RNP (U7.1 and later)	U7.1 to U10.2A: FMC actual navigation performance is not sufficient for the current special RNP (crew entered or leg specified). U10.3 and later: FMC actual navigation performance is not sufficient for the displayed RNP.	During approach: Refer to UNABLE REQD NAV PERF - RNP non-normal checklist in the QRH. During other phases of flight: Refer to FMC Navigation Check supplementary procedure in SP.11.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
VERIFY GW AND FUEL	Fuel data becomes invalid, PERF INIT fuel value is replaced with dashes. FMC uses last valid fuel quantity for performance predictions until manual entry is made. Shows if 30 minutes have elapsed since last manual entry. Does not show in descent with Vref selected.	Enter fuel weight on PERF INIT page 1/2. Periodic update of fuel weight is required to keep gross weight value current.
VERIFY OFFSET	A flight plan change has resulted in a conflict in reference to an offset start or end waypoint.	Confirm ATC clearance and make appropriate adjustments to RTE.
VERIFY POSITION	Position information is contradictory. Inhibited during approach.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: FMC-FMC	U10.7 and later: Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: FMC-GPS	U10.7 and later: Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: FMC-RADIO	U10.7 and later: Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: IRS-FMC	U10.7 and later: Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: IRS-IRS	U10.7 and later: Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.
VERIFY POS: IRS-RADIO	U10.7 and later: Position information is contradictory.	Refer to FMC Navigation Check Supplementary Procedure.

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ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
VERIFY RNP	U7.3, U7.4, U7.5, U8.3 – U10.2A: Underlying RNP value is less than manually entered value or a GPS approach has been selected and the default RNP is active (no crew entered or leg specified RNP active). U7.1, U7.2, U8.0, U8.1, or U10.3 and later: Underlying RNP value is less than manually entered value.	Enter appropriate RNP.
VERIFY TAKEOFF SPEEDS	A PERF INIT change has been made after takeoff speeds were specified.	Enter new takeoff speeds.
VNAV DISCONNECT	The criteria for VNAV engagement is not satisfied (VNAV disengages). U10.4 and later: On approach, with VNAV engaged, the FCC has switched to LVL CHG.	Manually control the vertical path.

FMC Entry Error Messages

These messages relate to incorrect scratch pad entries. FMC entry error messages:

- are shown in the CDU scratchpad
- illuminate the message light (MSG) of the CDU where the entry error was made
- temporarily overwrite data in the scratchpad.

Use the CLR key or key in new data to remove the message. If the CLR key is used to remove the message, the data previously entered is once again displayed. If new data is keyed in over the message, the message and the data previously entered are removed.

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
ALT CONSTRAINT XXXXX (waypoint identifier)	A flight plan modification has caused an altitude conflict with a waypoint that has an altitude constraint.	Clear the message and revise the entry.
DATA BASE FULL	Entry attempted into a supplemental or temporary navigation database category which is full.	Go to the NAV DATA pages and delete unneeded waypoints, navaids, or airports from the appropriate database and re-attempt entry.
DUPLICATE FLIGHT PLAN ID	U10.3 and later: The entry attempted is a duplicate of an existing supplemental flight plan name.	Clear the message and select a unique flight plan name.
INVALID DELETE	DEL key operation was attempted for a data line to which it was not applicable.	Clear the message and select the proper line after the DEL key is pressed.
INVALID ENTRY	Attempted data entry has incorrect format, range, etc. for the selected data line. Entered RTA waypoint is not in the flight plan.	Clear the message and scratch pad entry, and repeat the entry with the correct data.
INVALID QUAD	U10.2 and later: Attempted HOLD page QUAD entry has incorrect format or range.	Clear the message and revise the QUAD entry.

DO NOT USE FOR FLIGHTFlight Management, Navigation -
FMC/CDU Messages

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ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
NO OFFSET AT LEG XXXXX (waypoint)	Attempted entry of a lateral offset start or end waypoint XXXXXX that is not offsetable (lateral offset as installed).	Clear the message and amend the route.
NOT IN DATA BASE	FMC does not contain the required data for the entered identifier.	Clear the message and check data entry, or enter the required information into the supplemental or temporary navigation database via the NAV DATA pages.
NOT IN FLIGHT PLAN	RTA waypoint or lateral offset (as installed) start/end waypoint entry is not in active flight plan.	Clear the message and amend the entry.
ROUTE FULL	Entry of more than maximum allowed number of waypoints or holding patterns attempted.	Clear the message and review existing and desired waypoints and holding patterns for possible deletion.
SUPP RTE DATA BASE FULL	U10.3 and later: Attempted save of the 11th supplemental flight plan.	Clear the message, delete unneeded supplemental flight plans and re-attempt entry.

FMC Advisory Messages

These messages relate to FMC status. FMC advisory messages:

- are shown in the CDU scratchpad
- illuminate message lights (MSG) on both CDUs.

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
ABOVE MAX CERT ALT	The airplane is above its maximum certified altitude.	Descend to an altitude below the maximum certified altitude.
APPRCH VREF NOT SELECTED	Airplane has transitioned into approach environment and Vref has not been selected on APPROACH REF page.	Select Vref on APPROACH REF page.
ARR N/A FOR RUNWAY	Runway or approach does not match the selected arrival procedure.	Go to the ARRIVALS page and modify selection.
BUFFET ALERT	Current conditions result in a maneuver margin less than specified.	Bring the airplane back within the operating envelope.
CHECK FMC FUEL QUANTITY	The FMC has detected an unexpected drop in the fuel quantity.	Check the fuel system gauges for correctness.
DES PATH UNACHIEVABLE	When in path descent and above the path, the FMC predictions show the profile restrictions at the next waypoint cannot be achieved (LNAV remains engaged).	Modify the restrictions.
DRAG REQUIRED	Airspeed is 10 kts or more above FMC target speed or within 5 kts of Vmo/Vmmo.	Use speedbrakes, trim or reduced thrust, as required, to bring the airplane within 5 kts of FMC target speed.
FMC APP MODE UNAVAIL-GP	U10.5 and later: The approach selected in the FMC does not have a specified glidepath angle for final approach. The FMC approach mode cannot be used for this approach.	Select an alternate approach. Clear the message.
INVALID OFFSET	Desired offset does not meet FMC offset criteria.	Clear the message and amend the entry.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
KEY/FUNCTION INOP	A mode key is pressed for which an FMC function has not been implemented or has not been enabled. (FANS MCDU only)	Clear the message and select another CDU page for display.
LOC CAP ACTIVE	The airplane is approaching its turn onto the localizer course and will maintain an intercept heading.	Clear the message manually, or wait for the AFDS to signal reset status to the FMC.
LOC CAP CANCELLED	Flight plan modifications or the airplane condition did not facilitate localizer capture.	Clear the message manually, or wait for the AFDS to reset to LOC CAP ACTIVE.
MAX ALT FLXXX (flight level value)	Altitude entry on any page is above the maximum altitude for current selected performance margins.	Clear the message or amend the data entry.
MAX MACH .XXX/MIN MACH .XXX OR MAX CAS .XXX/MIN CAS .XXX	FMC target speed is greater than the maximum or less than the minimum buffet speed for the entered cruise or step climb altitude.	Change the target speed to within the message limits or enter a lower altitude.
MCP APP DISARM REQD	U10.4 and U10.4A: A change in the expected vertical approach control from glideslope (G/S) to FMC generated glidepath (G/P) is required.	Clear the message. Change the active flight plan approach to one that utilizes FMC generated glidepath. Insure G/S is turned off. Re-arm approach mode if required.
NO DES PATH AFTER XXXXX (waypoint)	FMC is unable to construct a PATH DES that satisfies all altitude restrictions after XXXXX.	Modify speed or altitude restrictions on the RTE LEGS pages.
NOT ON INTERCEPT HEADING	Airplane is not within the LNAV capture criteria for the active leg (LNAV disengages).	Manually place the airplane on an intercept heading and reengage LNAV.
OFFSET DELETED	The entered start waypoint has been deleted from the flight plan. (As installed)	Clear the message and amend the route.

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ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
OFST ENDS ABEAM XXXXXX	An invalid offset leg exists between the end waypoint (XXXXXX) and the start of offset or no end waypoint exists.	Clear the message and amend the route.
PERF DEFAULTS DELETED	Performance database has been automatically deleted due to conflict with performance database limits.	Contact maintenance personnel.
PROGRAM PIN ERROR	FMC connector wiring is incorrect.	System unusable; advise maintenance personnel. The CLR key will not clear the message.
PROGRAM PIN NOT IN DB	FMC connector wiring or performance database is incorrect.	Contact maintenance personnel.
RESET MCP ALT	Normal FMC operation would require flying away from the MCP altitude.	Select a MCP altitude value in the proper direction (higher for climb, lower for descent).
RESET MCP APP MODE	U10.5 and later: A change in the expected approach is made with an FCC approach mode armed or engaged.	Clear and rearm FCC approach mode. Clear the message.
RUNWAY N/A FOR SID	The selected runway is not applicable to the selected departure procedure.	Clear the message and check selections on the DEPARTURES page. Modify as required.
SELECT ACTIVE WPT/LEG	Power-up restart or insertion of a different flight plan while airborne.	EXECute a direct-to or leg intercept to tell the FMC which leg of the route is active.
STEEP DESCENT AFTER XXXXXX	An excessive vertical discontinuity exists after point XXXXXX.	Check routing.
TAI ON ABOVE 10°C	Airplane is operating with anti-icing with TAT above +10°C.	Clear the message and check the use of anti-icing for engines and/or wings.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
UNABLE CRZ ALT	FMC predicts that no cruise time is possible at the entered CRZ ALT.	Clear the message and review the CRZ ALT selection.
UNABLE MACH .XXX	The entered cruise mach is unattainable based on present gross weight.	Select a smaller mach number or wait until gross weight is reduced sufficiently.
UNABLE TO OFFSET	A valid offset cannot be constructed due to geometric limitations.	Clear the message and amend the route.
USING RSV FUEL	Predicted fuel remaining at DEST is less than the RESERVES entry on the PERF INIT page. May be the result of an inoperative fuel quantity indicator.	Clear the message and change routing if required. Use manual computations of fuel quantity remaining to determine gross weight.
VERIFY RNP VALUE	U7.3 and later: When entering an RNP the underlying RNP value is smaller than the manually entered value or the ANP is greater than the manually entered RNP.	Change or delete the manually entered RNP.
V SPEEDS UNAVAILABLE	FMC cannot compute V speeds (as installed) due to unreasonable inputs on the RTE, PERF INIT, or TAKEOFF REF pages.	Correct inputs that affect V speed computation.
XXXX (airport identifier)	A REF AIRPORT is entered on the POS INIT page and no entry of ORIGIN yet appears on RTE page 1.	Enter the airport identifier on the ORIGIN data line.
XXXXX (MCP altitude value)	With the CRZ page displayed, resetting the AFDS MCP altitude to a value different from the CRZ ALT causes the value to appear in the scratch pad.	Enter the MCP altitude value on the appropriate target altitude data line.

ANCDU Messages

These messages relate to incorrect scratch pad entries or to flight plan status and are unique to ANCDU operation.

ANCDU Entry Error Messages

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
INVALID ENTRY	Invalid format or range for selected data field.	Clear message and reenter the data correctly.
ROUTE FULL	Attempted entry of more than 20 waypoints.	Clear message. Review flight plan for possible deletions or wait until less than 20 waypoints remain in flight plan.
WAYPOINT NOT DEFINED	Entered waypoint identifier does not have a known position.	Reenter waypoint with a valid latitude and longitude.
WPT PREVIOUSLY DEFINED	Attempted entry of an existing waypoint identifier using a position different from existing waypoint position.	Delete previous waypoint identifier and reenter or rename new waypoint identifier.

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Fuel

Chapter 12

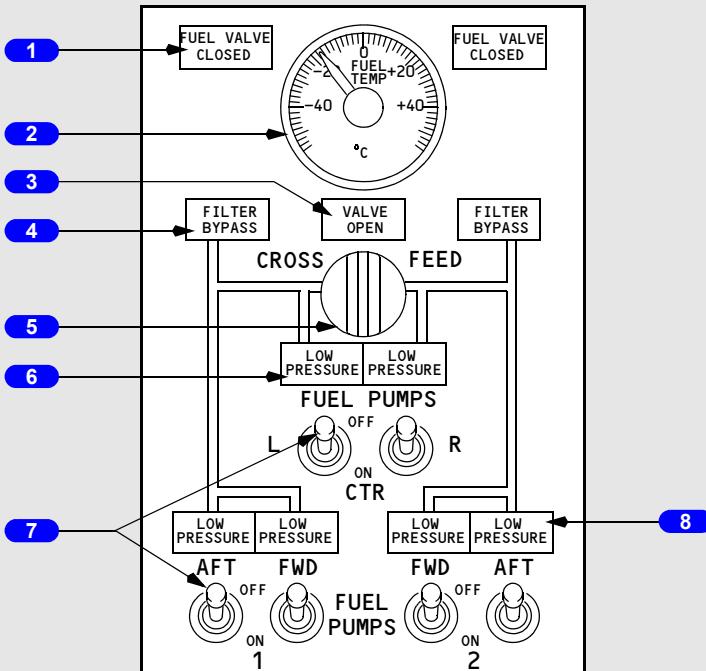
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Fuel Control Panel



FORWARD OVERHEAD PANEL

1 FUEL VALVE CLOSED Light

Extinguished – related engine fuel shutoff valve is open.

Illuminated (blue) –

- bright – related fuel shutoff valve is in transit, or valve position and engine start lever or engine fire switch disagree.
- dim – related fuel shutoff valve is closed.

2 Fuel Temperature (FUEL TEMP) Indicator

Indicates fuel temperature in No. 1 tank.

3 Crossfeed VALVE OPEN Light

Extinguished – crossfeed valve is closed.

Illuminated (blue) –

- bright – crossfeed valve is in transit, or valve position and CROSSFEED selector disagree.
- dim – crossfeed valve is open.

4 FILTER BYPASS Light

Extinguished – fuel filter operating normally.

Illuminated (amber) – impending fuel filter bypass due to a contaminated filter.

5 CROSSFEED Selector

Controls fuel crossfeed valve.

Closed – isolates engine No. 1 and No. 2 fuel feed lines.

Open – connects engine No. 1 and No. 2 fuel feed lines.

6 Center Tank Fuel Pump LOW PRESSURE Light

Illuminated (amber) – fuel pump output pressure is low and FUEL PUMP switch is ON.

Note: With both Center (CTR) tank FUEL PUMP switches ON, illumination of both LOW PRESSURE lights illuminates MASTER CAUTION and FUEL system annunciator lights. Illumination of one LOW PRESSURE light illuminates MASTER CAUTION and FUEL system annunciator lights on MASTER CAUTION light recall.

Note: With one CTR tank FUEL PUMP switch OFF, illumination of opposite CTR tank LOW PRESSURE light illuminates the MASTER CAUTION and FUEL system annunciator lights.

Extinguished – fuel pump output pressure is normal, or FUEL PUMP switch is OFF.

7 FUEL PUMP Switch

ON – activates fuel pump.

OFF – deactivates fuel pump.

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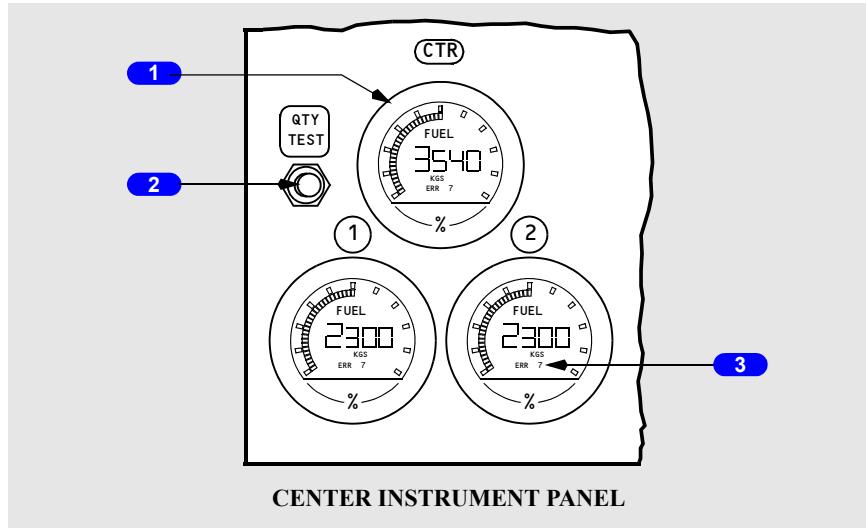
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8 Main Tank Fuel Pump LOW PRESSURE Light

Illuminated (amber) – fuel pump output pressure is low, or FUEL PUMP switch is OFF.

Note: Two LOW PRESSURE lights illuminated in same tank illuminates MASTER CAUTION and FUEL system annunciator lights. One LOW PRESSURE light causes MASTER CAUTION and FUEL system annunciator lights to illuminate on MASTER CAUTION light recall.

Extinguished – fuel pump output pressure is normal.

Fuel Quantity Indications**1 Fuel Quantity Indicator**

- indicates usable fuel in the related tank
- standby AC power is required.

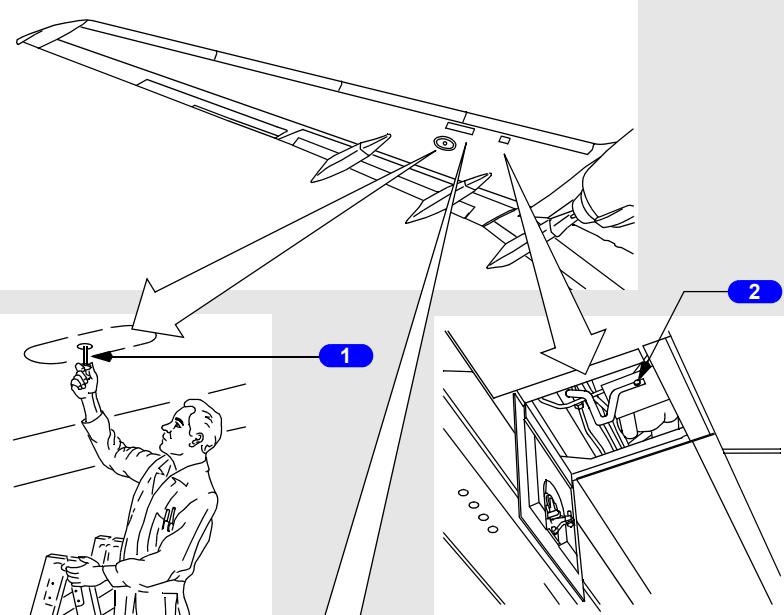
2 Fuel Quantity Test (QTY TEST) Switch

Indicator test is described in Supplementary Procedures.

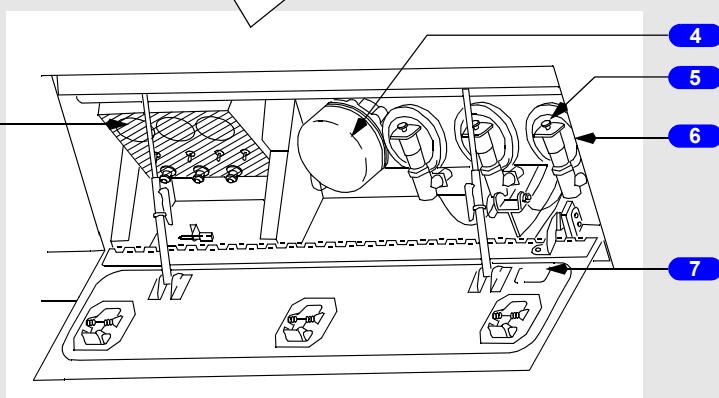
3 Error (ERR) Indicator

- ERR appears with associated error codes whenever a malfunction occurs
- used for maintenance purposes only.

Fueling / Defueling / Measurement



(multiple wing locations)



RIGHT WING LEADING EDGE

1 Fuel Measuring Stick

Allows comparison of fuel quantity or weight as determined from measuring stick reading and fuel weight indicated by fuel quantity indicators.

- five fuel measuring sticks are installed in each main tank
- reading is obtained by withdrawing the flexible floatstick scale from the tank until the scale “sticks” or “hangs.”
- floatstick indication is read from the floatstick scale level with the lower wing skin and corrected for airplane attitude via conversion/correction tables

2 Manual Defueling Valve

Open – interconnects engine feed system and fueling station for:

- defueling
- ground transfer of fuel.

Closed – isolates engine feed system from fueling station.

3 TEST GAUGES & FUELING Panel

4 Fueling Receptacle

Hose connection receptacle for single point underwing fueling.

5 Solenoid Override

Mechanically opens solenoid operated valve. Fuel valve opens if fuel pressure is available.

6 Fueling Valves

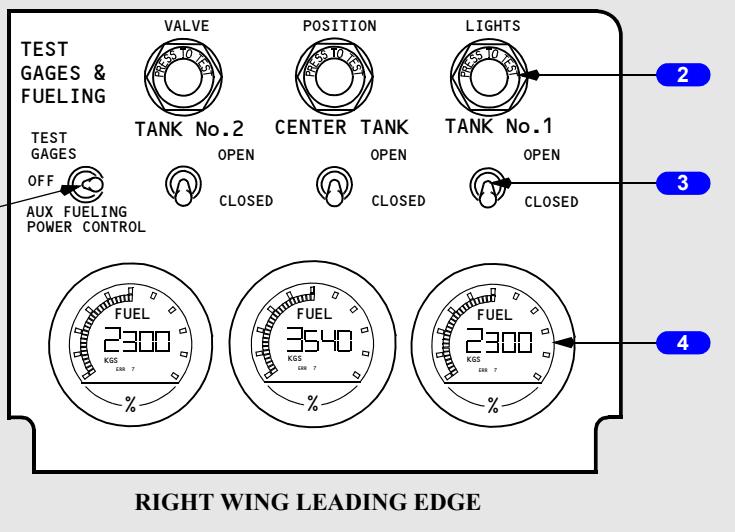
With battery switch ON, fuel pressure opens valve, if energized.

7 Fueling Power Control Switch

Door closed – proximity sensor deactivates power to fueling system.

Door open – the fueling system is powered and panel lights illuminate.

Test Gauges & Fueling Panel



RIGHT WING LEADING EDGE

1 TEST GAUGES & FUELING Switch

(spring-loaded to OFF position)

TEST GAUGES – checks operation of fuel quantity indicators.

AUX FUELING POWER CONTROL – energizes the fueling system if the fueling power control switch fails to activate the system when the door is open.

2 Fueling VALVE POSITION LIGHTS

Extinguished –

- fueling valve switch is OPEN and related tank is full
- fueling valve switch is CLOSED.

Illuminated (blue) – fueling valve switch is OPEN and related tank is not full.

3 Fueling Valve Switches

OPEN – energizes fueling valve in related tank.

CLOSED – de-energizes fueling valve in related tank.

4 FUEL Quantity Indicators

Indicates total usable fuel tank quantity in related tank.

Introduction

The fuel system supplies fuel to the engines and the APU. Fuel is contained in three tanks located within the wings and wing center section.

Refer to Engine and APU chapter for a description of the engine and APU fuel systems.

Fuel Feed

Both engines are normally pressure fed from the center tank until the center tank quantity decreases to near zero. The engines are normally then pressure fed from their respective main tanks. Check valves are located throughout the fuel system to ensure the proper direction of fuel flow and to prevent transfer of fuel between tanks.

Fuel Pumps

Each fuel tank uses two AC powered fuel pumps which are fuel cooled and lubricated. Center tank check valves open at a lower pressure than do the main tank check valves. This ensures that center tank fuel is used before main tank fuel, even though all fuel pumps are operating. Individual pressure sensors monitor the output pressure of each pump.

Note: Fuel pump LOW PRESSURE lights may flicker when tank quantity is low and the airplane is in a climb, descent, or on the ground with a nose-down attitude.

Note: Center tank fuel pump LOW PRESSURE lights may flicker when tank quantity is low and the airplane is in cruise. One pump may indicate low pressure sooner than the other due to aircraft attitude and/or slight variation between pump inlet position. Low pressure indication may occur after center tank quantity reads zero. Low pressure light flickering can continue for as long as 5 minutes before the Fuel System Annunciator light and the Master Caution lights are illuminated for the associated center tank pump.

Suction Feed

When main tank fuel pump pressure is low, each engine can draw fuel from its corresponding main tank through a suction feed line that bypasses the pumps. As the airplane climbs, dissolved air is released from the fuel in the tank due to the decrease in air pressure. This air may collect in the suction feed line and restrict fuel flow. At high altitude, thrust deterioration or engine flameout may occur as a result of the fuel flow reduction.

The dissolved air in the fuel tank will eventually deplete after reaching cruise altitude. The depletion time is dependent upon airplane altitude, fuel temperature, and type of fuel. Once the dissolved air is depleted, the engine may be capable of suction feed operation at cruise power.

The main tank bypass valves may also be used for suction defueling.

Fuel Crossfeed

The engine fuel manifolds are interconnected by use of the crossfeed valve. The valve is DC motor operated from the battery bus.

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 will result in a progressive fuel imbalance.

Fuel Shutoff Valves

Fuel shutoff valves are located at the engine-mounting wing stations. The valves are DC motor operated from the hot battery bus. They close whenever the respective engine fire switch is pulled or engine start lever is placed to CUTOFF.

Center Tank Scavenge Jet Pump

When both center tank fuel pump switches are turned OFF, the fuel scavenge shutoff valve opens. This allows fuel pressure from the main tank No. 1 forward pump to operate the center tank scavenge jet pump, which transfers the remaining center tank fuel to main tank No. 1. After 20 minutes, the fuel scavenge shutoff valve automatically closes.

Fuel Vent System

The purpose of the fuel vent system is to prevent damage to the wings due to excessive buildup of positive or negative pressures inside the fuel tanks and to provide ram air pressure within the tanks. The tanks are vented into surge tanks which vent through a single opening at each wing tip.

Fuel Temperature

The FUEL TEMP indicator located on the fuel control panel displays fuel temperature. A sensor in main tank No. 1 allows monitoring of fuel temperature. The temperature indicating system uses AC electrical power.

APU Fuel Feed

When AC fuel pumps are operating, fuel for the APU is supplied from the left side of the fuel manifold. If the AC fuel pumps are not operating, fuel is suction fed from main tank No. 1.

Fueling/Defueling/Ground Transfer

Rapid fueling and defueling is accomplished at the single-point pressure fueling station in the right wing. The fueling station is also used for the ground transfer of fuel between tanks.

Standard overwing fueling receptacles for main tanks No. 1 and No. 2 are provided for gravity fueling. In the absence of underwing pressure fueling facilities, center tank servicing can only be accomplished through the ground tank to tank fuel transferring operation.

The manual defueling valve, located outboard of engine No. 2, interconnects the engine feed system and the fueling station. It is opened for defueling and tank to tank transfer operations.

A shutoff system is used during fueling to automatically close the fueling valve in each fuel tank when the tank is full.

Fuel Quantity Indication

The fuel quantity indication system calculates the useable fuel quantity in each tank. The fuel quantity in each tank is displayed on the center instrument panel and on the fueling station panel.

Fuel Tank Location and Capacities (Usable Fuel)

Main tanks No. 1 and No. 2 are integral with the wing structure. The center tank lies between the wing roots within the fuselage area and extends out into the wing structure.

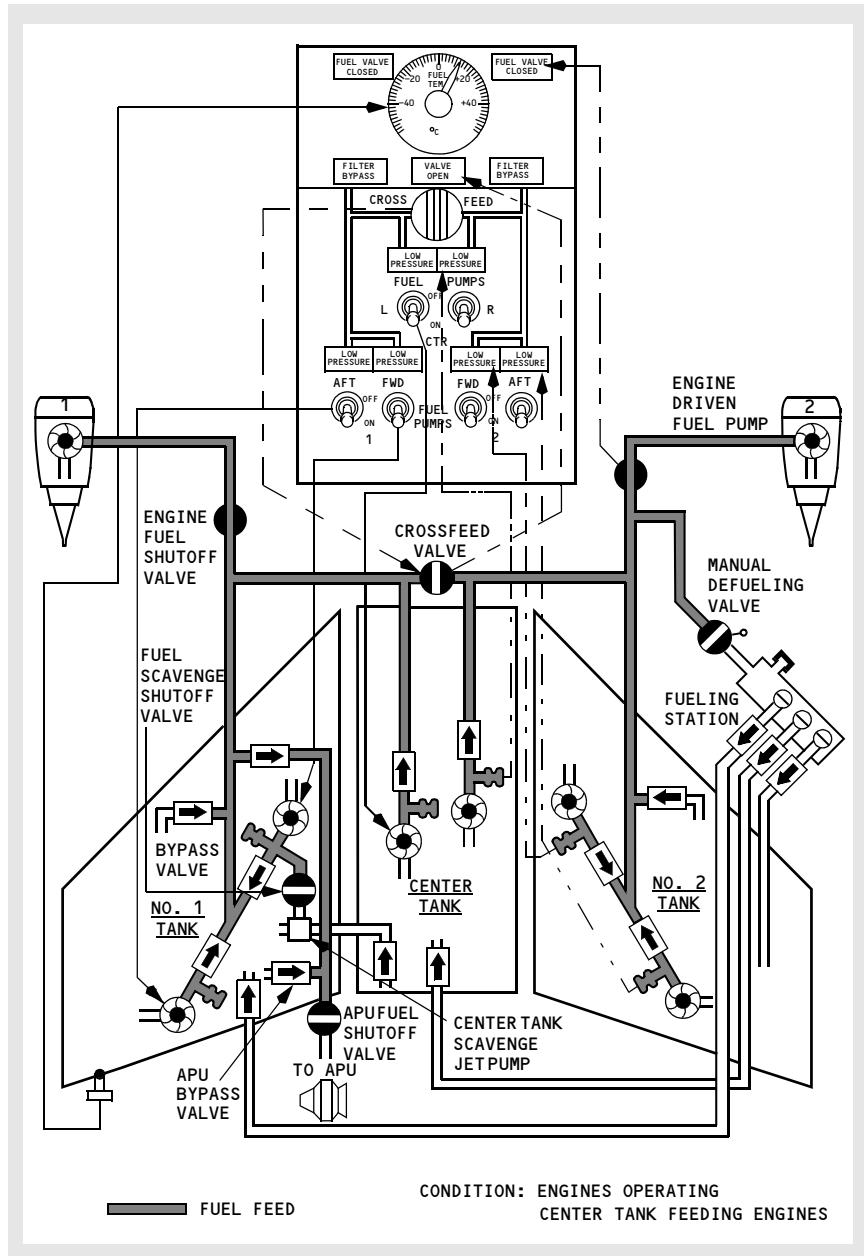
These figures represent approximate amounts of usable fuel. The appropriate weight and balance control and loading manual gives exact figures for all conditions.

TANK	GALLONS	POUNDS*
NO. 1	1,499	10,043
NO. 2	1,499	10,043
CENTER	2,313	15,497
TOTAL	5,311	35,583

* Usable fuel at level attitude, fuel density = 6.7 pounds per US gallon

TANK	LITERS	KILOGRAMS*
NO. 1	5,674	4,555
NO. 2	5,674	4,555
CENTER	8,755	7,029
TOTAL	20,103	16,139

* Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter

Fuel Schematic

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737 Flight Crew Operations Manual

Hydraulics

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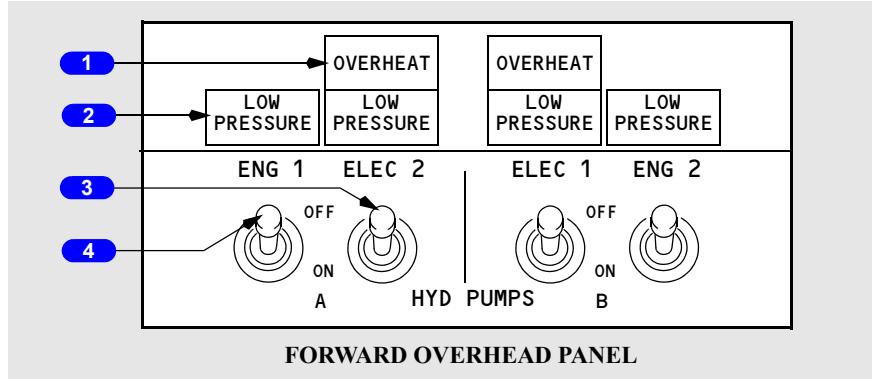
Hydraulics

Controls and Indicators

Chapter 13

Section 10

Hydraulic Panel



FORWARD OVERHEAD PANEL

1 Electric Hydraulic Pump OVERHEAT Lights

Illuminated (amber) – associated electric motor–driven pump has overheated.

2 Hydraulic Pump LOW PRESSURE Lights

Illuminated (amber) – output pressure of associated pump is low

Note: When an engine fire switch is pulled, the associated engine-driven pump low pressure light is deactivated.

3 ELECTRIC HYDRAULIC PUMPS Switches

ON – provides power to associated electric motor–driven pump.

OFF – electrical power removed from pump.

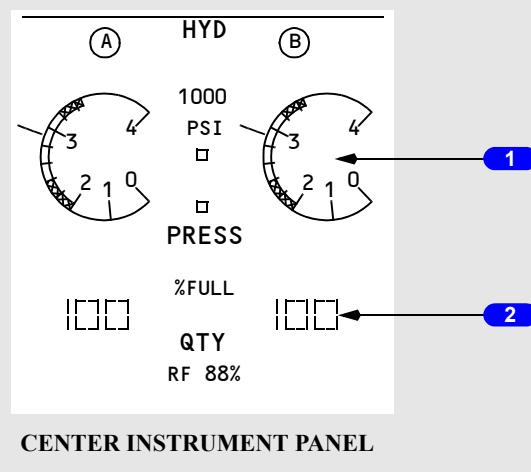
4 ENGINE HYDRAULIC PUMPS Switches

ON – de–energizes blocking valve in pump to allow pump pressure to enter system.

Note: Should remain ON at shutdown to prolong solenoid life.

OFF – energizes blocking valve to block pump output.

Hydraulic Indications



1 HYDRAULIC System PRESSURE Indications

Indicates system pressure:

- Normal pressure (green) – 3000 psi
- Maximum pressure (red) – 3500 psi.

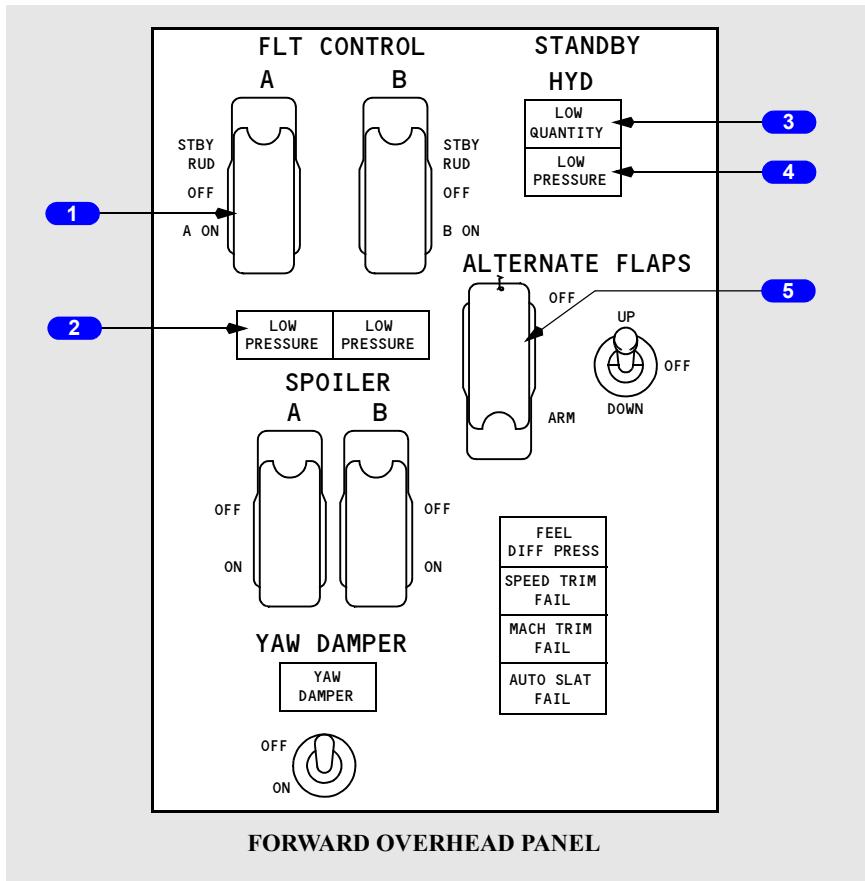
Note: When both pumps for a system are OFF, respective pointer reads zero.

2 HYDRAULIC System QUANTITY Indications

Indicates digital percentage of hydraulic quantity (green).

Note: Refill condition of 88% is valid only when airplane is on the ground.

Flight Control Panel (before Rudder System Enhancement Program (RSEP) modification)



1 FLIGHT CONTROL Switches

STBY RUD – activates standby pump and opens standby rudder shutoff valve to pressurize standby rudder power control unit.

OFF – closes flight control shutoff valve isolating ailerons, elevators and rudder from associated hydraulic system pressure.

ON (guarded position) – normal operating position.

2 Flight Control LOW PRESSURE Lights

Illuminated (amber) –

- indicates low hydraulic system (A or B) pressure to ailerons, elevator and rudder
- deactivated when associated FLT CONTROL switch is positioned to STBY RUD and standby rudder shutoff valve opens
- the A system light indicates A system pressure is low when the rudder pressure reducer is commanding normal system pressure.

Note: The A system light will remain illuminated for approximately five seconds after A hydraulic system is activated.

3 STANDBY HYDRAULIC LOW QUANTITY Light

Illuminated (amber) –

- indicates low quantity in standby hydraulic reservoir
- always armed.

4 STANDBY HYDRAULIC LOW PRESSURE Light

Illuminated (amber) –

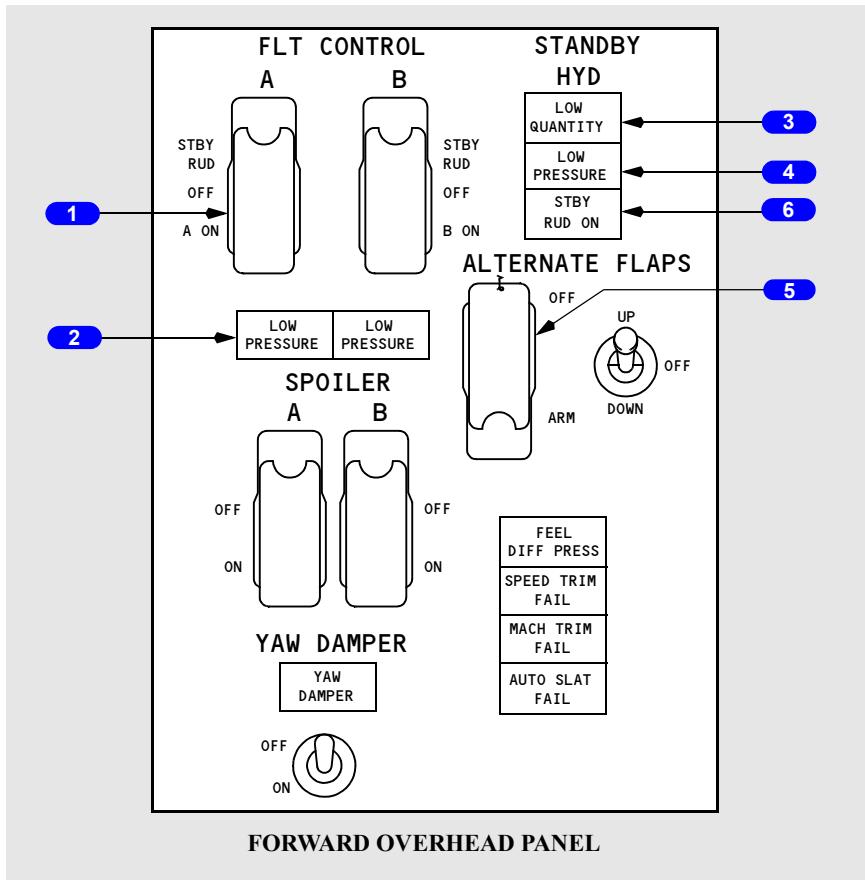
- indicates output pressure of standby pump is low
- armed only when standby pump operation has been selected or automatic standby function is activated.

5 ALTERNATE FLAPS Master Switch

OFF (guarded position) – normal operating position.

ARM – closes trailing edge flap bypass valve, activates standby pump, and arms ALTERNATE FLAPS position switch.

Flight Control Panel (after Rudder System Enhancement Program (RSEP) modification)



1 FLIGHT CONTROL Switches

STBY RUD – activates standby pump, opens standby rudder shutoff valve to pressurize standby rudder power control unit, and illuminates amber STBY RUD ON light.

OFF – closes flight control shutoff valve isolating ailerons, elevators and rudder from associated hydraulic system pressure.

ON (guarded position) – normal operating position.

2 Flight Control LOW PRESSURE Lights

Illuminated (amber) –

- indicates low hydraulic system (A or B) pressure to ailerons, elevator and rudder
- deactivated when associated FLT CONTROL switch is positioned to STBY RUD and standby rudder shutoff valve opens
- the A system light indicates A system pressure is low when full RPR pressure is commanded.

Note: The A system light will remain illuminated for approximately five seconds after A hydraulic system is activated.

3 STANDBY HYDRAULIC LOW QUANTITY Light

Illuminated (amber) –

- indicates low quantity in standby hydraulic reservoir
- always armed.

4 STANDBY HYDRAULIC LOW PRESSURE Light

Illuminated (amber) –

- indicates output pressure of standby pump is low
- armed only when standby pump operation has been selected or automatic standby function is activated.

5 ALTERNATE FLAPS Master Switch

OFF (guarded position) – normal operating position.

ARM – closes trailing edge flap bypass valve, activates standby pump, and arms ALTERNATE FLAPS position switch.

6 STBY RUD ON Light

Illuminated (amber) - indicates the standby hydraulic system is commanded on to pressurize the standby rudder power control unit.

Hydraulics System Description

Chapter 13 Section 20

Introduction

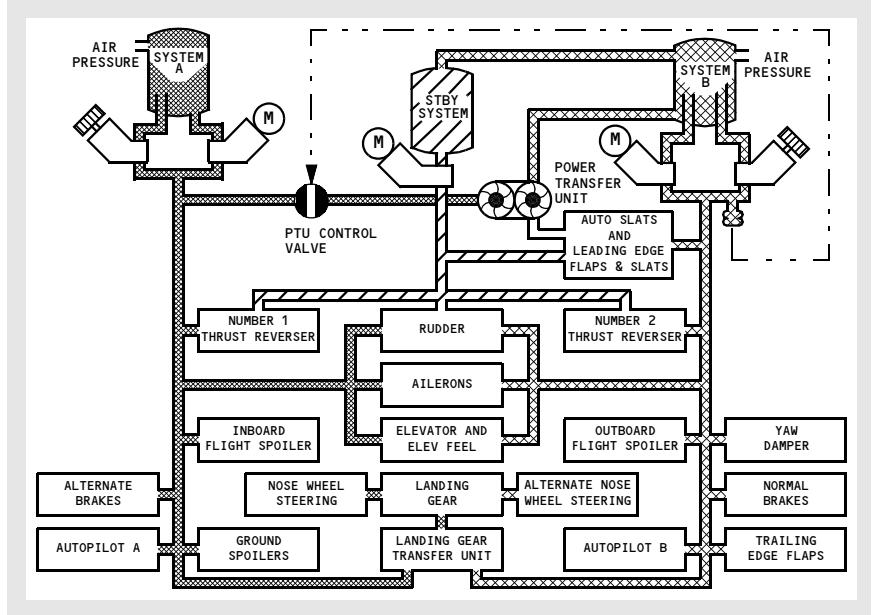
The airplane has three hydraulic systems: A, B and standby. The standby system is used if system A and/or B pressure is lost. The hydraulic systems power the following airplane systems:

- flight controls
- leading edge flaps and slats
- trailing edge flaps
- landing gear
- wheel brakes
- nose wheel steering
- thrust reversers
- autopilots

Either A or B hydraulic system can power all flight controls with no decrease in airplane controllability.

Each hydraulic system has a fluid reservoir located in the main wheel well area. System A and B reservoirs are pressurized by bleed air. The standby system reservoir is connected to the system B reservoir for pressurization and servicing. Pressurization of all reservoirs ensures positive fluid flow to all hydraulic pumps.

Hydraulic Power Distribution Schematic



A and B Hydraulic Systems

Components powered by hydraulic systems A and B are:

System A

- ailerons
- rudder
- elevator and elevator feel
- flight spoilers (one on each wing)
- ground spoilers
- alternate brakes
- No. 1 thrust reverser
- autopilot A
- normal nose wheel steering
- landing gear
- power transfer unit (PTU)

System B

- ailerons
- rudder
- elevator and elevator feel
- flight spoilers (one on each wing)
- leading edge flaps and slats
- normal brakes
- No. 2 thrust reverser
- autopilot B
- alternate nose wheel steering
- landing gear transfer unit
- autoslats
- yaw damper
- trailing edge flaps

A and B Hydraulic System Pumps

Both A and B hydraulic systems have an engine–driven pump and an AC electric motor–driven pump. The system A engine–driven pump is powered by the No. 1 engine and the system B engine–driven pump is powered by the No. 2 engine. An engine–driven hydraulic pump supplies approximately four times the fluid volume of the related electric motor–driven hydraulic pump.

The ENG 1 (system A) or ENG 2 (system B) pump ON/OFF switch controls the engine–driven pump output pressure. Positioning the switch to OFF isolates fluid flow from the system components. However, the engine–driven pump continues to rotate as long as the engine is operating. Pulling the engine fire switch shuts off the fluid flow to the engine–driven pump and deactivates the related LOW PRESSURE light.

The ELEC 2 (system A) or ELEC 1 (system B) pump ON/OFF switch controls the related electric motor–driven pump. If an overheat is detected in either system, the related OVERHEAT light illuminates.

Note: Loss of the system A, engine–driven hydraulic pump and a heavy demand on system A may result in an intermittent LOW PRESSURE light for the remaining electric hydraulic pump. The system A flight controls LOW PRESSURE light, Master Caution light, and the FLT CONT and HYD system annunciation lights also illuminate.

Hydraulic fluid used for cooling and lubrication of the pumps passes through a heat exchanger before returning to the reservoir. The heat exchanger for system A is located in main fuel tank No. 1 and for system B is in main fuel tank No. 2.

CAUTION: Minimum fuel for ground operation of electric pumps is 760 Kgs (1675 Lbs) in the related main tank.

Pressure switches, located in the engine-driven and electric motor-driven pump output lines, send signals to illuminate the related LOW PRESSURE light if pump output pressure is low. A check valve, located in each output line, isolates the related pump from the system. The related system pressure transmitter sends the combined pressure of the engine-driven and electric motor-driven pumps to the related hydraulic system pressure indication.

System A Hydraulic Leak

If a leak develops in the engine-driven pump or its related lines, a standpipe in the reservoir prevents a total system fluid loss. With fluid level at the top of the standpipe, the reservoir quantity displayed indicates approximately 22% full. System A hydraulic pressure is maintained by the electric motor-driven pump.

If a leak develops in the electric motor-driven pump or its related lines, or components common to both the engine and electric motor-driven pumps, the quantity in the reservoir steadily decreases to zero and all system pressure is lost.

System B Hydraulic Leak

The system B reservoir has two standpipes. One standpipe supplies fluid to the engine-driven pump and the other to the electric motor-driven pump. If a leak develops in the engine-driven pump or its associated lines, the system B quantity decreases until it indicates approximately 40% full. System pressure is maintained by the electric motor-driven pump. If a leak develops in the electric motor-driven pump or its associated lines, system B pressure is lost. However, fluid remaining in the system B reservoir is sufficient for power transfer unit operation.

A leak in system B does not affect the operation of the standby hydraulic system.

Power Transfer Unit

The purpose of the PTU is to supply the additional volume of hydraulic fluid needed to operate the autoslats and leading edge flaps and slats at the normal rate when system B engine-driven hydraulic pump volume is lost. The PTU uses system A pressure to power a hydraulic motor-driven pump, which pressurizes system B hydraulic fluid. The PTU operates automatically when all of the following conditions exist:

- airborne
- system B engine-driven pump hydraulic pressure drops below limits
- flaps are less than 15 but not up.

Landing Gear Transfer Unit

The purpose of the landing gear transfer unit is to supply the pressurized hydraulic fluid needed to raise the landing gear at the normal rate when system A is lost due to No. 1 engine RPM loss. The system B engine-driven pump supplies the pressurized hydraulic fluid needed to operate the landing gear transfer unit when all of the following conditions exist:

- airborne
- No. 1 engine RPM drops below a limit value
- LANDING GEAR lever is positioned UP
- either main landing gear is not up and locked.

Standby Hydraulic System

The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. The standby system can be activated manually or automatically. It uses a single electric motor-driven pump to power:

- thrust reversers
- rudder
- leading edge flaps and slats (extend only).

Manual Operation

Positioning either FLT CONTROL switch to STBY RUD:

- activates the standby electric motor-driven pump
- shuts off the related hydraulic system pressure to ailerons, elevators and rudder by closing the flight control shutoff valve
- opens the standby rudder shutoff valve
- deactivates the related flight control LOW PRESSURE light when the standby rudder shutoff valve opens
- allows the standby system to power the rudder and thrust reversers.
- (after RSEP modification) illuminates the STBY RUD ON, Master Caution, and Flight Controls (FLT CONT) lights.

Positioning the ALTERNATE FLAPS master switch to ARM, (see the Flight Controls chapter for a more complete explanation):

- activates the standby electric motor-driven pump
- closes the trailing edge flap bypass valve
- arms the ALTERNATE FLAPS position switch
- allows the standby system to power the leading edge flaps and slats and thrust reversers.

Automatic Operation

Automatic operation is initiated when the following conditions exist:

- loss of system A or B, or rudder pressure reducer system fails in low pressure mode, and
- flaps extended, and
- airborne, or wheel speed greater than 60 kts, and
- FLT CONTROL switch A or B Hydraulic System ON

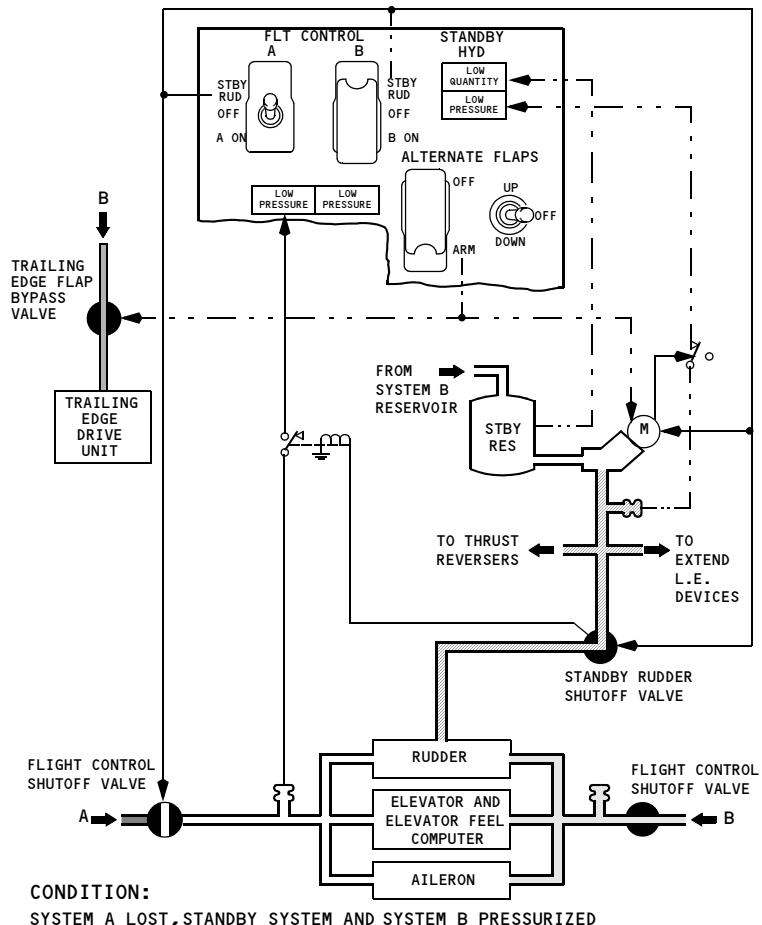
OR (after RSEP modification)

- The main PCU Force Fight Monitor (FFM) trips.

Automatic operation:

- opens the standby rudder shutoff valve
- activates the standby electric motor-driven pump
- allows the standby system to power the rudder and thrust reversers.
- (after RSEP modification) illuminates the STBY RUD ON, Master Caution, and Flight Controls (FLT CONT) lights.

Standby Hydraulic System Schematic

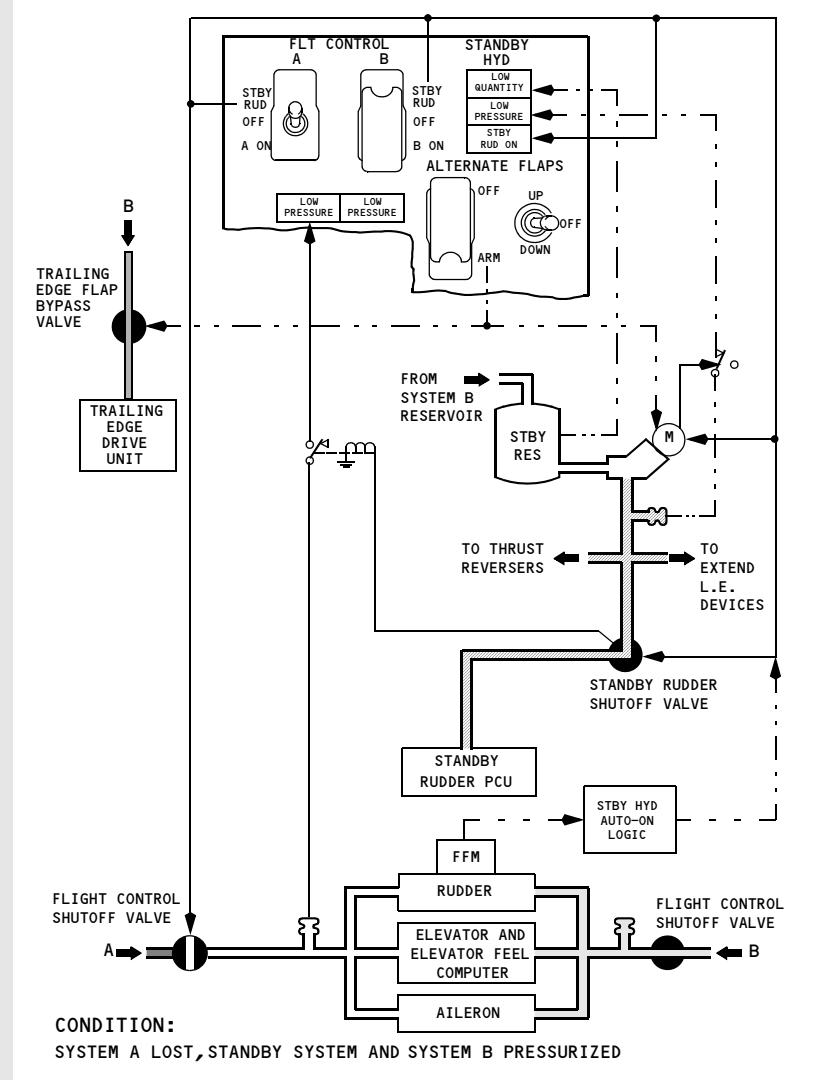


(before RSEP modification)

DO NOT USE FOR FLIGHT

Hydraulics -
System Description

737 Flight Crew Operations Manual



(after RSEP modification)

Standby Hydraulic System Leak

If a leak occurs in the standby system, the standby reservoir quantity decreases to zero. The LOW QUANTITY light illuminates when the standby reservoir is approximately half empty. System B continues to operate normally, however, the system B reservoir fluid level indication decreases and stabilizes at approximately 64% full.

Variations in Hydraulic Quantity Indications

During normal operations, variations in hydraulic quantity indications occur when:

- the system becomes pressurized after engine start
- raising or lowering the landing gear or leading edge devices
- cold soaking occurs during long periods of cruise.

These variations have little effect on systems operation.

If the hydraulic system is not properly pressurized, foaming can occur at higher altitudes. Foaming can be recognized by pressure fluctuations and the blinking of the related LOW PRESSURE lights. The MASTER CAUTION and HYD annunciator lights may also illuminate momentarily.

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Landing Gear

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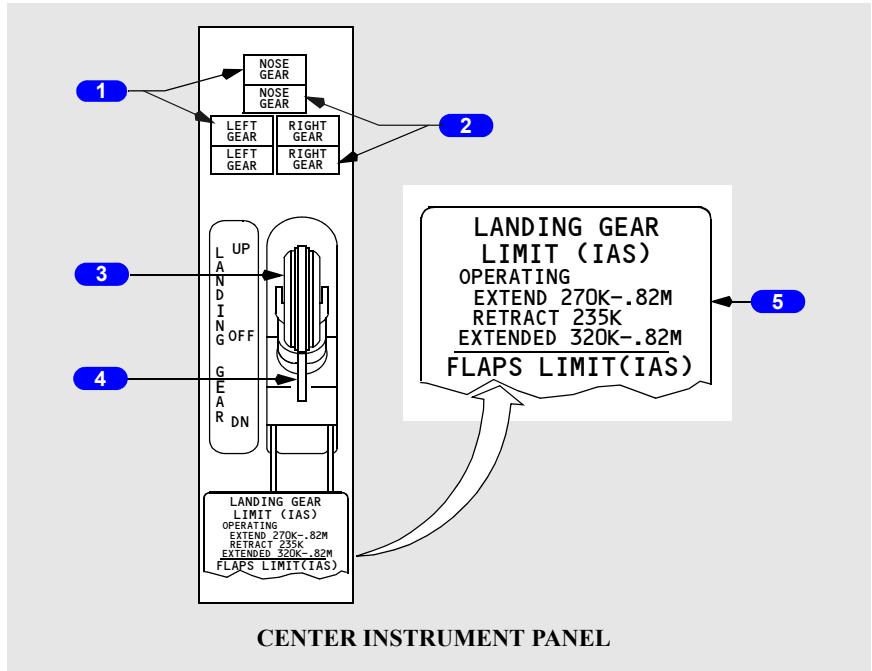
Landing Gear

Controls and Indicators

Chapter 14

Section 10

Landing Gear Panel



1 Landing Gear Indicator Lights (top)

Illuminated (red) –

- landing gear is not down and locked (with either or both forward thrust levers retarded to idle)
- related landing gear is in disagreement with LANDING GEAR lever position (in transit or unsafe)

Extinguished –

- landing gear is up and locked with landing gear lever UP or OFF
- landing gear is down and locked with landing gear lever DN.

2 Landing Gear Indicator Lights (bottom)

Illuminated (green) – related gear down and locked.

Note: Landing gear warning horn is deactivated with all gear down and locked.

Extinguished – landing gear is not down and locked.

3 LANDING GEAR Lever

UP – landing gear retract

OFF – hydraulic pressure is removed from landing gear system

DN – landing gear extend.

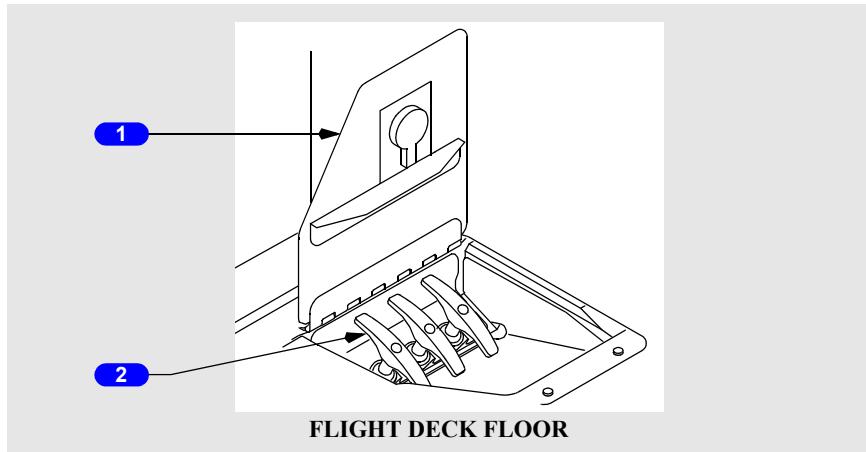
4 Override Trigger

Allows LANDING GEAR lever to be raised, bypassing lever lock.

5 LANDING GEAR LIMIT Speed Placard

Indicates maximum speed while operating landing gear and after gear extension.

Manual Gear Extension

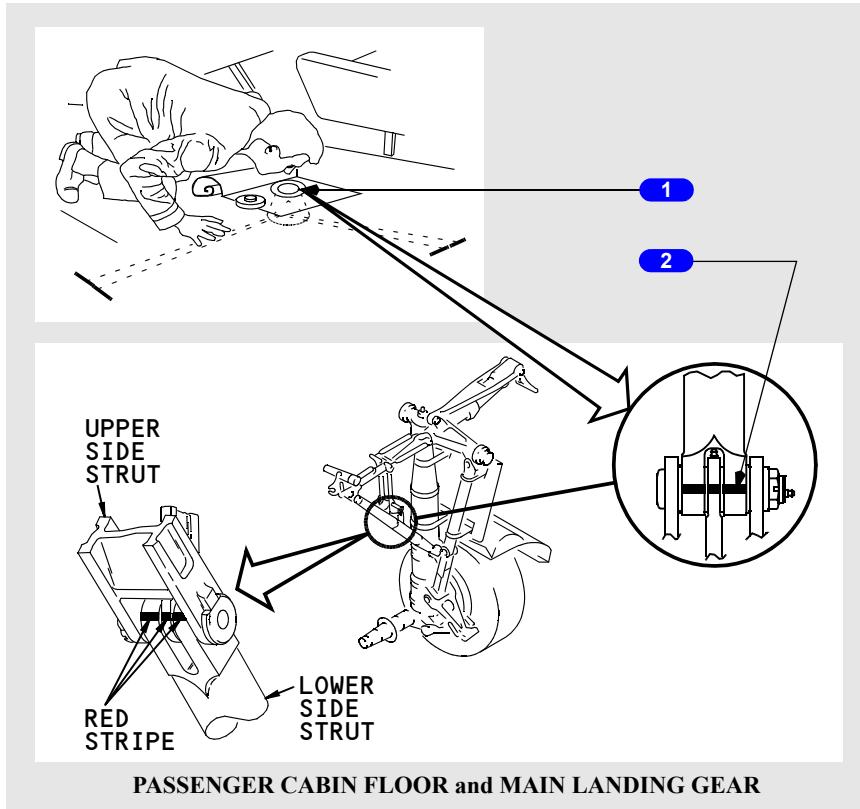


1 Manual Extension Access Door

2 Manual Gear Extension Handles

Right main, nose, left main– With LANDING GEAR lever in the OFF position, each landing gear uplock is released when related handle is pulled to its limit, approximately 18 inches (45 cm) for the main gear, approximately 8 inches (20 cm) for the nose gear.

Main Gear Viewer



1 Viewer Access

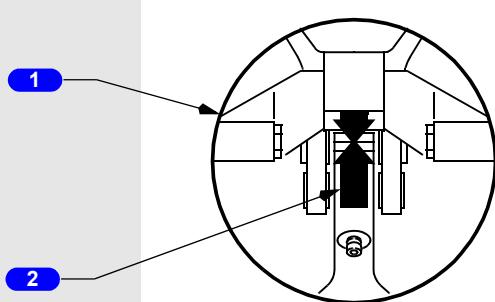
Opposite the 3rd window behind the aft overwing exit and one foot left of center. Pull up the carpet identified by a metal button to sight through viewer. Before leaving the cockpit, position the WHEEL WELL light switch ON.

Note: In some installations the viewer may be under an aisle seat.

2 Paint Stripes (red)

Indication that the landing gear is down and locked is provided by observing the alignment of red paint stripes, located on the down lock and the side struts.

Nose Gear Viewer



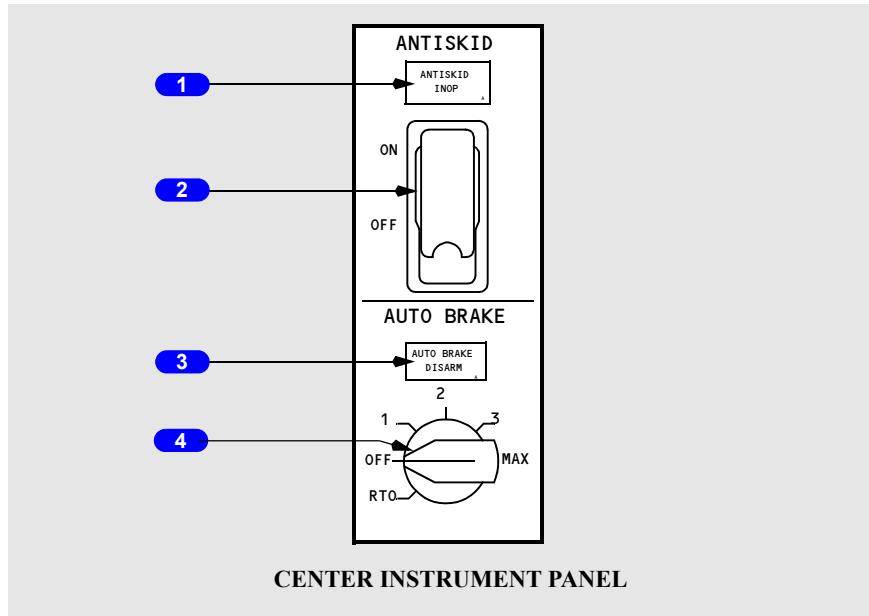
1 Viewer Access –

Cover plate for the nose landing gear viewer is located on the floor just inside the cockpit door. The WHEEL WELL light switch must be ON.

2 Arrow head (red) –

Indication that the nose gear is down and locked is provided by observing the two red arrow heads on the down lock strut are in contact.

Autobrake and Antiskid Controls



1 Antiskid Inoperative (ANTISKID INOP) Light

Illuminated (amber) – a system fault is detected by antiskid monitoring system, or switch is off

Extinguished – antiskid system operating normally.

2 ANTISKID Control Switch

ON – guarded position

OFF – turns off antiskid system, illuminates ANTISKID INOP light and illuminates AUTO BRAKE DISARM light if the system is armed.

3 AUTO BRAKE DISARM Light

Illuminated (amber) –

- SPEED BRAKE lever moved to DOWN detent during RTO or landing
- manual brakes applied during RTO or landing
- thrust lever(s) advanced during RTO or landing
 - except during first 3 seconds after touchdown for landing
- landing made with RTO selected
- RTO mode selected on ground
 - illuminates for one to two seconds then extinguishes

- a malfunction exists in automatic braking system
- the pilot has turned off the antiskid

Extinguished –

- AUTO BRAKE select switch set to OFF
- autobrake armed.

4 AUTO BRAKE Select Switch

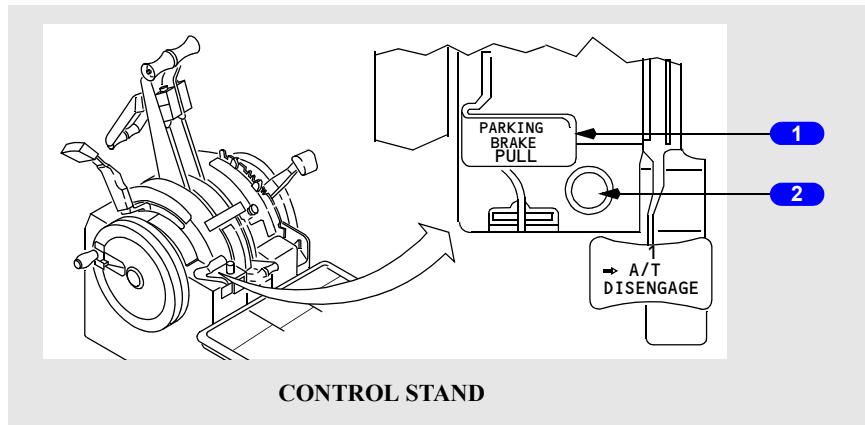
OFF – autobrake system deactivated

1, 2, 3, or MAX –

- selects desired deceleration rate for landing
- switch must be pulled out to select MAX deceleration

RTO – automatically applies maximum brake pressure when thrust levers are retarded to idle at or above 90 knots.

Parking Brake



1 PARKING BRAKE Lever

Forward – parking brake is released

Aft – sets parking brakes when either Captain's or First Officer's brake pedals are fully depressed.

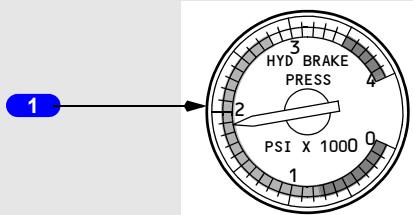
2 Parking Brake Warning Light

Note: Parking brake repeater light located on the external power receptacle panel.

Illuminated (red) – parking brake is set (lights operate from battery power)

Extinguished – parking brake is released.

Hydraulic Brake Pressure Indicator



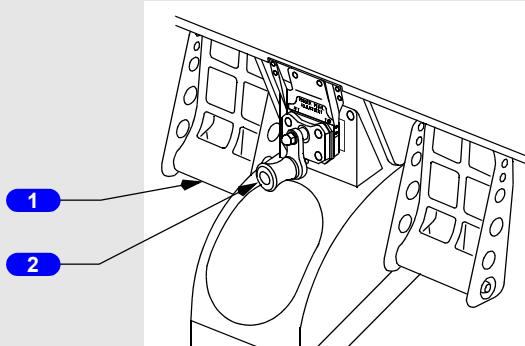
FIRST OFFICER'S INSTRUMENT PANEL

1 Hydraulic (HYD) BRAKE Pressure (PRESS) Indicator

Indicates brake accumulator pressure:

- normal pressure – 3000 psi
- maximum pressure – 3500 psi
- normal precharge – 1000 psi.

Rudder/Brake Pedals



CREW STATION

1 Rudder/Brake Pedals

Push full pedal – turns nose wheel up to 7 degrees in either direction

Push top of pedal only – activates wheel brakes

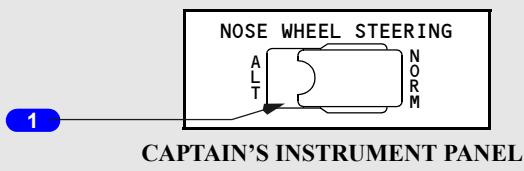
Refer to Chapter 9 Flight Controls for rudder description.

2 RUDDER PEDAL ADJUSTMENT Crank

AFT (counter-clockwise) – adjusts rudder pedals aft

FWD (clockwise) – adjusts rudder pedals forward.

Nose Wheel Steering Switch

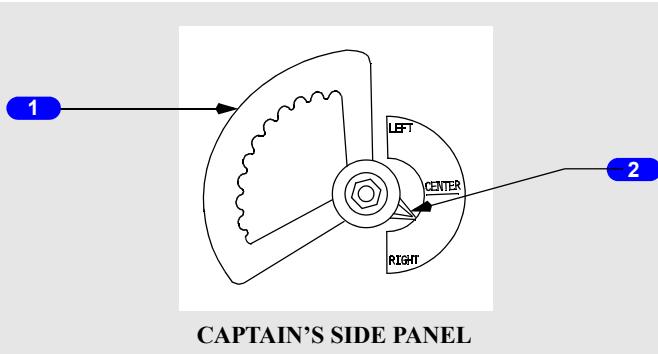


1 NOSE WHEEL STEERING Switch

ALT – hydraulic system B provides power for nose wheel steering

NORM – hydraulic system A provides power for nose wheel steering.

Nose Wheel Steering Wheel



1 Nose Wheel Steering Wheel

Rotate –

- turns nose wheel up to 78 degrees in either direction
- overrides rudder pedal steering.

2 Nose Wheel Steering Indicator

LEFT – indicates nose wheel steering displacement left of center position

CENTER – normal straight ahead position

RIGHT – indicates nose wheel steering displacement right of center position.

Landing Gear System Description

Chapter 14 Section 20

Introduction

The airplane has two main landing gear and a single nose gear. Each main gear is a conventional two-wheel landing gear. The nose gear is a conventional steerable two-wheel unit.

Hydraulic power for retraction, extension, and nose wheel steering is normally supplied by hydraulic system A. A manual landing gear extension system and an alternate source of hydraulic power for nose wheel steering are also provided.

The normal brake system is powered by hydraulic system B. The alternate brake system is powered by hydraulic system A. Antiskid protection is provided on both brake systems, but the autobrake system is available only with the normal brake system.

Landing Gear Operation

The landing gear are normally controlled by the LANDING GEAR lever. On the ground, a landing gear lever lock prevents the LANDING GEAR lever from moving to the up position. An override trigger in the lever may be used to bypass the landing gear lever lock. In flight, the air/ground system energizes a solenoid which opens the lever lock.

Landing Gear Retraction

When the LANDING GEAR lever is moved to UP, the landing gear begins to retract. During retraction, the brakes automatically stop rotation of the main gear wheels. After retraction, the main gear are held in place by mechanical uplocks. Rubber seals and oversized hubcaps complete the fairing of the outboard wheels.

Note: Manual brake application during flight may cause brake pedal vibration until pedal force is released.

The nose wheels retract forward into the wheel well and nose wheel rotation is stopped by snubbers. The nose gear is held in place by an overcenter lock and enclosed by doors which are mechanically linked to the nose gear.

Hydraulic system B pressure is available for raising the landing gear through the landing gear transfer valve. Hydraulic system B supplies the volume of hydraulic fluid required to raise the landing gear at the normal rate when all of the following conditions exist:

- airborne
- No. 1 engine RPM drops below a limit value

- LANDING GEAR lever is positioned UP
- either main landing gear is not up and locked.

Hydraulic pressure is removed from the landing gear system with the LANDING GEAR lever in the OFF position.

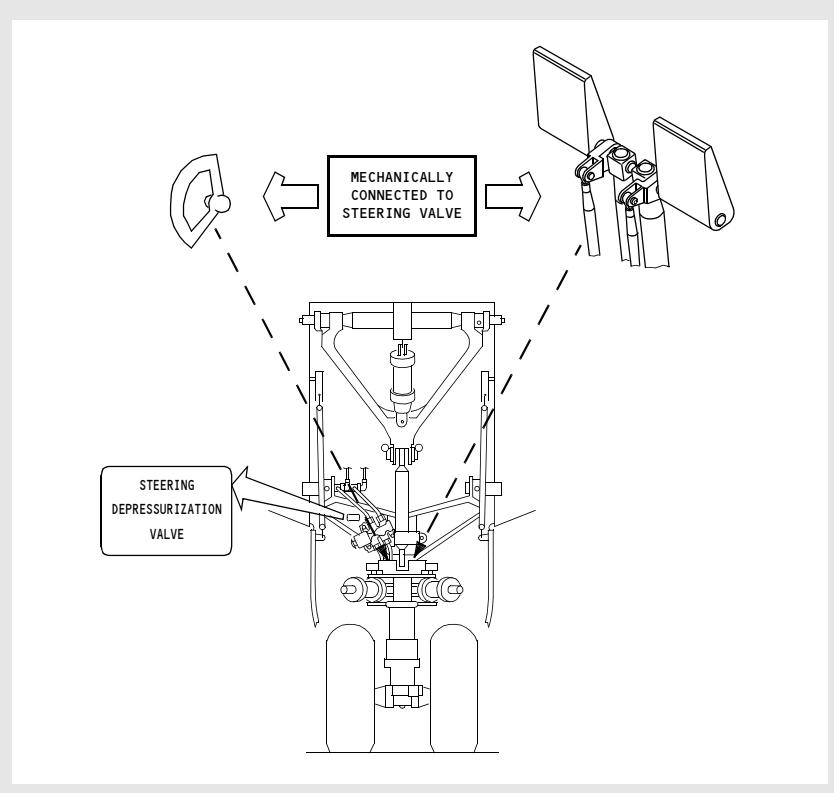
Landing Gear Extension

When the LANDING GEAR lever is moved to DN, hydraulic system A pressure is used to release the uplocks. The landing gear extends by hydraulic pressure, gravity and air loads. Overcenter mechanical and hydraulic locks hold the gear at full extension. The nose wheel doors stay open when the gear is down.

Landing Gear Manual Extension

If hydraulic system A pressure is lost, the manual extension system provides another means of landing gear extension. Manual gear releases on the flight deck are used to release uplocks that allow the gear to free-fall to the down and locked position. The forces that pull the gear down are gravity and air loads.

Nose Wheel Steering



NOSE WHEEL STEERING

Nose wheel steering is available when the nose gear is in the down position and compressed by weight of the airplane. Positioning the landing gear control lever to down makes system A hydraulic pressure available to the steering metering valve. Alternate nose wheel steering can be activated to provide system B pressure to the nose wheels when the NOSE WHEEL STEERING switch is placed to ALT, normal quantity is in the system B reservoir, and the airplane is on the ground. In the event of a hydraulic leak downstream of the Landing Gear Transfer Unit, resulting in a loss of hydraulic system B fluid in the reservoir, a sensor closes the Landing Gear Transfer Valve and alternate steering will be lost.

Primary steering is controlled through the nose wheel steering wheel. Limited steering control is available through the rudder pedals. A pointer on the nose steering wheel assembly shows nose wheel steering position relative to the neutral setting. Rudder pedal steering is deactivated as the nose gear strut extends.

A lockout pin may be installed in the towing lever to depressurize nose wheel steering. This allows airplane pushback or towing without depressurizing the hydraulic systems.

Brake System

Each main gear wheel has a multi-disc hydraulic powered brake. The brake pedals provide independent control of the left and right brakes. The nose wheels have no brakes. The brake system includes:

- normal brake system
- alternate brake system
- brake accumulator
- antiskid protection
- autobrake system
- parking brake

Normal Brake System

The normal brake system is powered by hydraulic system B.

Alternate Brake System

The alternate brake system is powered by hydraulic system A. If hydraulic system B is low or fails, hydraulic system A automatically supplies pressure to the alternate brake system.

Brake Accumulator

The brake accumulator is pressurized by hydraulic system B. If both normal and alternate brake system pressure is lost, trapped hydraulic pressure in the brake accumulator can still provide several braking applications or parking brake application.

Antiskid Protection

Antiskid protection is provided in the normal and alternate brake systems. The ANTISKID control switch controls power to the antiskid controller.

The normal brake hydraulic system provides each main gear wheel with individual antiskid protection. When the system detects a skid, the associated antiskid valve reduces brake pressure until skidding stops. The alternate brake hydraulic system works similar to the normal system. However, antiskid protection is applied to main gear wheel pairs instead of individual wheels.

The normal and alternate brake systems provide skid and hydroplane protection. Locked wheel and touchdown protection is available only with the normal braking system.

Antiskid protection is available even with loss of both hydraulic systems.

Autobrake System

The autobrake system uses hydraulic system B pressure to provide maximum deceleration for rejected takeoff and automatic braking at preselected deceleration rates immediately after touchdown. The system operates only when the normal brake system is functioning. Antiskid system protection is provided during autobrake operation.

Rejected Takeoff (RTO)

The RTO mode can be selected only when on the ground. Upon selection, the AUTO BRAKE DISARM light illuminates for one to two seconds and then extinguishes, indicating that an automatic self-test has been successfully accomplished.

To arm the RTO mode prior to takeoff the following conditions must exist:

- airplane on the ground
- antiskid and autobrake systems operational
- AUTO BRAKE select switch positioned to RTO
- wheel speed less than 60 knots
- forward thrust levers positioned to IDLE.

The RTO mode is activated when wheel speed reaches 60 knots. If the takeoff is rejected while wheel speed is between 60 and 90 knots, the AUTO BRAKE DISARM light illuminates, autobraking is not initiated. If the takeoff is rejected after reaching a wheel speed of 90 knots, maximum braking is applied automatically when the forward thrust levers are retarded to IDLE. Braking force is the equivalent of full manual braking.

The RTO mode is automatically disarmed when the right main gear strut extends. The AUTO BRAKE DISARM light does not illuminate. The selector switch must be manually positioned to OFF. If a landing is made with RTO selected, no automatic braking action occurs and the AUTO BRAKE DISARM light illuminates two minutes after touchdown. To reset, position the selector to OFF.

Landing

When a landing autobrake selection is made, the system performs a turn-on-self-test. If the turn-on-self-test is not successful, the AUTO BRAKE DISARM light illuminates and the autobrake system does not arm.

Four levels of deceleration can be selected for landing. However, on dry runways, the maximum autobrake deceleration rate in the landing mode is less than that produced by full pedal braking.

After landing, autobrake application begins when:

- both forward thrust levers are retarded to IDLE, and
- the main wheels spin-up.

To maintain the selected landing deceleration rate, autobrake pressure is reduced as other controls, such as thrust reversers and spoilers, contribute to total deceleration. The autobrake system brings the airplane to a complete stop unless the braking is terminated by the pilot.

Autobrake – Disarm

The pilots may disarm the autobrake system by moving the selector switch to the OFF position. This action does not cause the AUTO BRAKE DISARM light to illuminate. After braking has started, any of the following pilot actions disarm the system immediately and illuminate the AUTO BRAKE DISARM light:

- moving the SPEED BRAKE lever to the down detent
- advancing the forward thrust lever(s) after touchdown, or
- applying manual brakes.

Parking Brake

The parking brake can be set with either A or B hydraulic systems pressurized. If A and B hydraulic systems are not pressurized, parking brake pressure is maintained by the brake accumulator. Accumulator pressure is shown on the HYDRAULIC BRAKE PRESSURE indicator.

The parking brake is set by depressing both brake pedals fully, while simultaneously pulling the PARKING BRAKE lever up. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

The parking brake is released by depressing the pedals until the PARKING BRAKE lever releases. A fault in the parking brake system may cause the ANTISKID INOP light to illuminate.

The takeoff configuration warning horn sounds if either forward thrust lever is advanced for takeoff with the parking brake set.

Air/Ground System

Inflight and ground operation of various airplane systems are controlled by the air/ground system.

The system receives air/ground logic signals from sensors located on the right main gear and the nose gear. These signals are used to configure the airplane systems to the appropriate air or ground status.

Air/Ground System Logic Table

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
Drain Mast Heaters	115 volt AC operation.	28 volt AC operation.	1
Pack Valves	With one pack operating regulates to high flow with flaps up.	With one pack operating, regulates to high flow only when pack is operating from the APU and both engine bleed switches are OFF.	2
Pressurization (CPCS)	Allows programmed pressurization in the standby and automatic modes.	Allows pressurization as determined by the FLT/GRD switch.	2
Ram Air	Turbofans operate only when air conditioning packs operate and flaps are not up.	Turbofans operate whenever air conditioning packs operate. Deflectors are extended.	2
Wing Anti-ice (Ground Operating System)	Control valves open when switch is ON. Thrust setting and duct temperature logic is bypassed.	With switch ON, valves cycle open and closed. Switch trips to OFF at lift-off.	3
Autothrottle	Enables go-around below 2000 ft radio altitude.	Disengaged 2 seconds after landing. Takeoff mode enabled.	4
TO/GA switch	Flight director engages go-around mode.	Flight director engages takeoff mode.	4
ACARS	Sends out signal on strut extension for takeoff signal.	Sends out signal on strut compression for landing signal.	5
Voice Recorder	Prevents tape erasure.	Allows tape erasure when parking brake is set.	5
Standby Power	Standby busses automatically transferred to battery and inverter power when standby power switch is in AUTO	BAT position must be selected for transfer of standby busses	6
APU Control	APU operation possible with battery switch OFF.	APU shutdown if battery switch is positioned OFF.	7

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
APU Generator	May be connected to only one generator bus.	May be connected to two generator buses.	7
Engine Idle Control	Idle control and indication system is armed.	Maintains high idle until 4 seconds after landing.	7
Thrust Reverser	Thrust reverse disabled by gear sensors and radio altimeter.	Thrust reverse enabled.	7
APU Fire Horn	Wheel well horn disabled.	Wheel well horn enabled.	8
Speed Brake Lever Actuator	Can be armed to raise ground spoilers for landing.	Activates SPEED BRAKE lever on landing if armed. Rejected take-off feature available. Drives to DOWN when thrust lever advanced.	9
Auto Slat	System enabled with flaps 1, 2, or 5 selected. PTU available if system B pressure is lost.	System disabled.	9
Flight Recorder	Operates when transfer bus No. 1 is powered	Operates when transfer bus No. 1 is powered and either engine is operating.	10
FMC	Position updated from DME or VOR/DME.	Does not update.	11
Standby Hydraulic	Pump automatic operation with flaps extended and A or B pressure lost.	Wheel speed must be greater than 60 knots for automatic operation.	13
Antiskid	Releases normal brakes for touchdown protection.	Allows normal antiskid braking after wheel spin-up.	14
Autobrake	Allows selection of landing mode.	RTO mode available.	14
Landing Gear Lever Lock	Lever Lock solenoid released.	Lever Lock solenoid latched.	14
Landing Gear Transfer Unit	Enabled.	Disabled.	14
Stall Warning	Enabled.	Disabled.	15
Takeoff Warning	Disabled.	Enabled.	15

DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

Warning Systems

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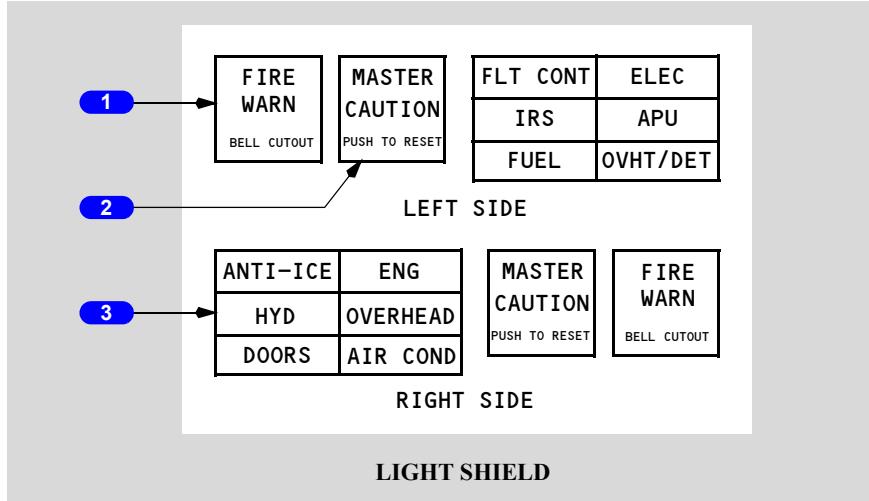
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Fire Warning and Master Caution System



1 FIRE WARN Lights

Illuminated (red) – indicates a fire warning (or system test) in engine, cargo, APU or main gear wheel well

- fire warning bell sounds
- if on ground, remote APU fire warning horn sounds.

Push – extinguishes both master FIRE WARN lights

- silences fire warning bell
- silences remote APU fire warning horn
- resets system for additional warnings.

Note: Pushing fire warning bell cutout switch on overheat/fire protection panel results in same actions.

2 MASTER CAUTION Lights

Illuminated (amber) – a system annunciation light has illuminated.

Push – extinguishes both MASTER CAUTION lights

- system annunciation light(s) extinguish
- resets system for additional master caution conditions.

3 System Annunciator Panel

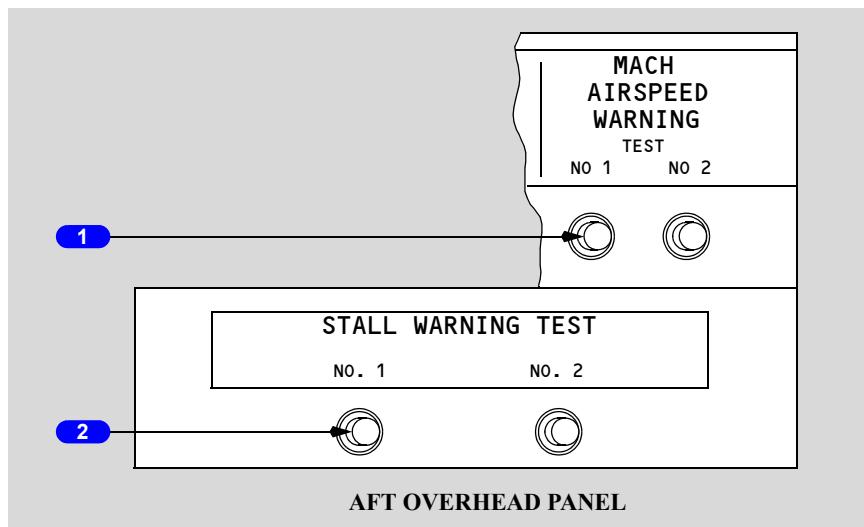
Illuminated (amber) – an amber light, relating to illuminated system annunciator, has illuminated on forward overhead, aft overhead or overheat/fire protection panel.

To extinguish – push either MASTER CAUTION light.

To recall – push and release either System Annunciator Panel

- if a master caution condition exists, appropriate system annunciator(s) and MASTER CAUTION lights illuminate
- a single fault in certain redundant systems, or some simple faults, cause the system annunciator light to illuminate during a recall. The system annunciator light will extinguish when the MASTER CAUTION light is pushed

Mach/Airspeed Warning and Stall Warning Test Switches



1 MACH AIRSPEED WARNING TEST Switches

Push – tests respective Mach/Airspeed warning system:

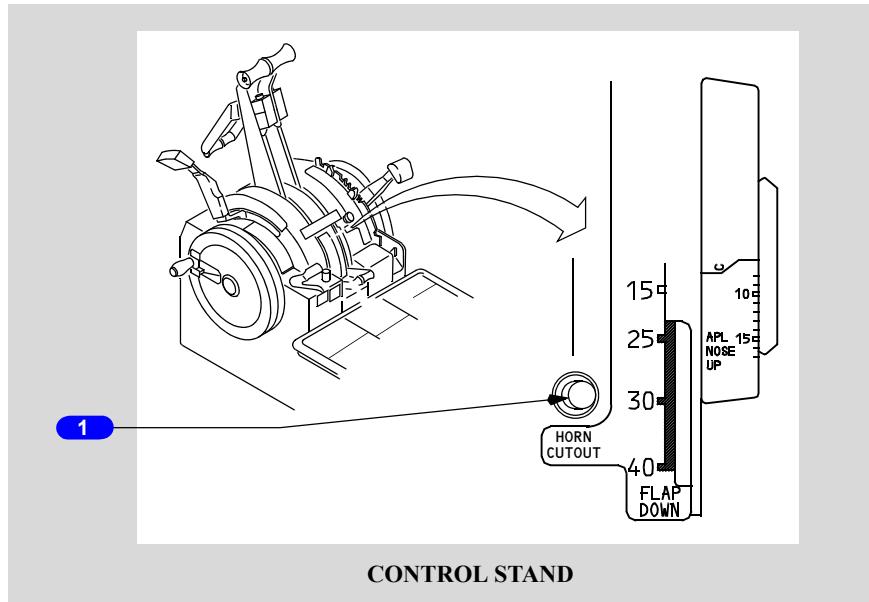
- clacker sounds

2 STALL WARNING TEST Switches

Push – on ground with 115 volt AC power available: each test switch tests its respective stall management computer. Vibrations are

- felt on both columns
- inhibited while airborne.

Landing Gear Warning Cutout Switch



1 Landing Gear Warning Cutout Switch

Push – silences landing gear configuration warning aural indication:

- at flaps 1 through 10
- at flaps 15, when either forward thrust lever is between idle and approximately 10 degrees and opposite forward thrust lever is greater than approximately 30 degrees.

Note: Cutout switch cannot silence aural indication if flaps are greater than 15.

Takeoff Configuration and Cabin Altitude Warning Lights



1 Cabin Altitude Warning Light

Illuminated (red) –

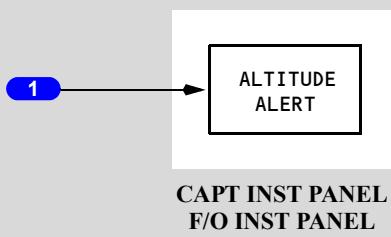
- illuminates at 10,000 feet if the cabin has not been pressurized
- illuminates during flight when loss of cabin pressure occurs
- activation is simultaneous with aural warning intermittent horn for CABIN ALTITUDE alert.

2 Takeoff Configuration Warning Light

Illuminated (red) –

- activates on the ground as the throttles are advanced if the airplane is not configured correctly for takeoff
- activation is simultaneous with aural warning intermittent horn for TAKEOFF CONFIGURATION alert.

Altitude Alert



1 ALTITUDE ALERT Annunciation

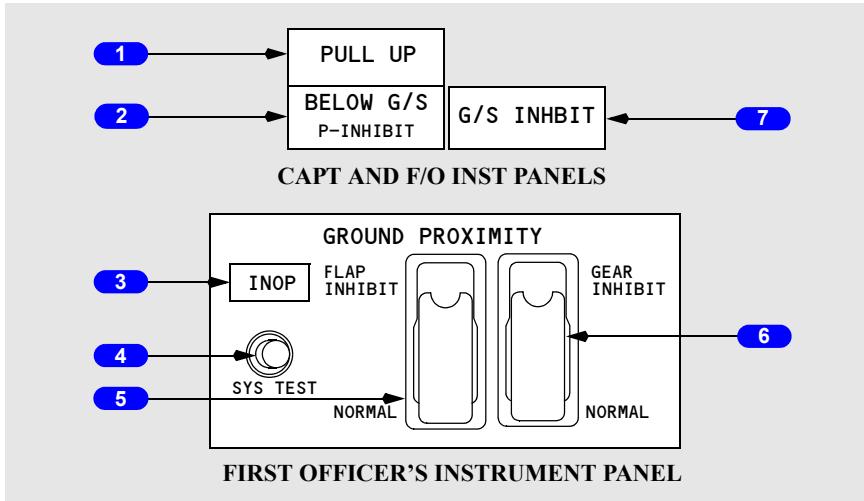
One on each pilot's primary display above altimeter

Illuminated (amber) –

- steady – acquisition alert:
 - within 900 feet from MCP-selected altitude, ALT ALERT annunciation shows
 - momentary tone also sounds
 - within 300 feet from MCP-selected altitude, ALT ALERT annunciation no longer shows
- flashing – deviation alert:
 - deviation more than 300 feet from MCP-selected altitude, ALT ALERT annunciation flashes
 - momentary tone also sounds
 - flashing continues until:
 - altitude deviation less than 300 feet, or

- altitude deviation more than 900 feet, or
- new MCP altitude selected.

GPWS Controls and Indicators



1 PULL UP WARNING LIGHT

Illuminated (red) – indicates one or more of the following exist:

- excessive descent rate
- excessive terrain closure rate
- altitude loss after takeoff or go-around
- unsafe terrain clearance when not in the landing configuration

2 BELOW Glide Slope (G/S) Alert Light

Illuminated (amber) – airplane is more than 1.3 dots below glide slope.

Push – inhibits or cancels below glide slope alerting if pushed while in alerting area.

3 GPWS Inoperative (INOP) Light

Illuminated (amber) – GPWS computer malfunction or power loss

- invalid inputs are being received from radio altimeter, ADC, ILS receiver, IRS, FMC, stall warning system, or EFIS control panel.

Note: Some or all GPWS alerts are not available. GPWS alerts which occur are valid.

4 Ground Proximity System (SYS TEST) Switch

Push –

- momentarily on ground, or above 1,000 feet radio altitude in flight:
 - illuminates BELOW G/S, PULL UP, and INOP lights; displays the EADI WINDSHEAR message; and causes “GLIDESLOPE”, “WHOOOP, WHOOOP, PULL UP”, and “WINDSHEAR” aural to sound
- at least 10 seconds, on ground – above indications always occur first, followed by any additional aural, as installed
- system test is inhibited from lift-off to 1000 feet radio altitude.

5 GROUND PROXIMITY Flap Inhibit Switch

FLAP INHIBIT – inhibits or cancels warnings/alerts caused by flaps not in 30 or 40 position.

NORMAL (guarded position) – flap position logic is provided for GPWS.

6 GROUND PROXIMITY Gear Inhibit Switch

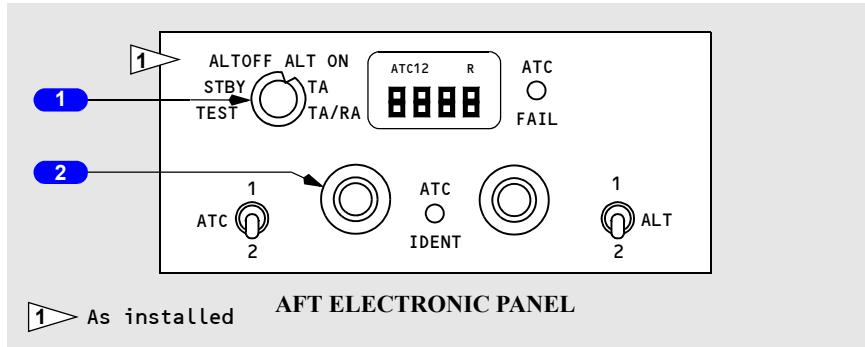
GEAR INHIBIT – inhibits or cancels warnings/alerts caused by landing gear not down.

NORMAL (guarded position) – landing gear position logic is provided for GPWS.

7 GLIDESLOPE INHIBIT light

Illuminated (white) – below glideslope deviation alert has been manually inhibited by pressing the BELOW G/S light.

Transponder Panel (TCAS)



1 Transponder Switch

TEST – the ATC FAIL light illuminates to indicate the selected transponder is operational.

STBY – disables transponder modes.

Note: Transponder modes are enabled only when the airplane is airborne, except for mode S, which operates continuously when the transponder mode selector is out of STBY.

ALT OFF – transponder operates without altitude reporting.

ALT ON – transponder operates with altitude reporting.

TA – enables display of traffic advisory TCAS targets.

TA/RA – enables display of traffic advisory and resolution advisory TCAS targets.

2 Air Traffic Control (ATC) Code Selector

Rotate – sets transponder code.

Intentionally
Blank

Warning Systems System Description

Chapter 15 Section 20

Introduction

Aural, tactile and visual warning signals alert the flight crew to conditions requiring action or caution in the operation of the airplane. The character of the signals varies, depending upon the degree of urgency or types of hazards involved. Aural, tactile, and visual signals are used singularly or in combination to simultaneously provide both warnings and information regarding the nature of the condition.

Mach/airspeed warnings, landing gear warnings, takeoff configuration warnings, windshear warnings, and ground proximity warnings are discussed in this section. Cabin altitude warning is discussed in this section and in the Air Systems chapter, and autopilot and autothrottle disconnect warnings are discussed in the Automatic Flight chapter. The conditions which excite the fire warning bell are discussed in the Fire Protection chapter.

Conditions which require the immediate attention of the flight crew are indicated by red warning lights located in the area of the pilots' primary field of vision. These lights indicate APU, cargo, engine, or wheel well fires; autopilot, autothrottle disconnects; and landing gear unsafe conditions.

Conditions which require the timely attention of the flight crew are indicated by amber caution lights.

Blue lights inform the flight crew of electrical power availability, valve position, equipment status, and flight attendant or ground communications. Blue lights are for information and do not require immediate flight crew attention. Some system blue lights indicate a transitional state by illuminating bright as valves or components reposition, then returning to a dim blue when the required configuration is reached.

Green lights indicate a fully extended configuration, e.g., landing gear and leading edge devices.

For specific information regarding red, amber, blue, and green lights refer to the appropriate systems chapters.

Stall warning is provided by a control column shaker on each control column.

Various aural signals call attention to warnings and cautions. An aural warning for airspeed limits is given by a clacker, the autopilot disconnect by a warning tone, takeoff configuration and cabin altitude by an intermittent horn, and landing gear positions by a steady horn. The fire warning is given by a fire warning bell.

Ground proximity warnings and alerts--as well as windshear warnings and alerts--are given by voice warnings.

Generally, aural silence when the associated non-normal condition no longer exists.

Master Fire Warning Lights

Two master FIRE WARN lights illuminate when any fire warning condition occurs. The lights remain illuminated as long as the condition exists. Pushing either master FIRE WARN light or fire warning bell cutout switch extinguishes both lights, silences the fire warning bell and resets the system for future warnings. Further information appears in the Fire Protection chapter.

Master Caution Lights

Two MASTER CAUTION lights illuminate when any caution occurs outside the normal field of vision of the flight crew. The lights remain illuminated as long as the caution condition exists, or until the crew resets the system. Pushing either MASTER CAUTION light extinguishes both lights and resets the master caution system for further cautions. Pushing either annunciator light panel recalls all existing fault annunciations.

A single fault in certain redundant systems--or some simple faults--do not illuminate the MASTER CAUTION or system annunciator lights. These faults, however, are stored in the master caution system. Pushing the system annunciator recalls the single fault on the system annunciator panel.

When MASTER CAUTION recall is pressed, all twelve system lights should illuminate while the press-to-test feature is held. If a system annunciator light does not illuminate, refer to the dispatch deviation procedures guide (DDPG).

System Annunciator Lights

Two system annunciator light panels are located on the glare shield. The annunciator light panels include only those systems located on the forward overhead, aft overhead, and fire control panels. If a caution condition exists, the appropriate system annunciator(s) and MASTER CAUTION lights illuminate.

Left Side - System Annunciators and Related Amber Lights

FLT CONT	LEFT SIDE LIGHT SHIELD		ELEC
LOW QUANTITY			LOW OIL PRESSURE
LOW PRESSURE			HIGH OIL TEMP
FEEL DIFF PRESS			STANDBY PWR OFF
SPEED TRIM FAIL			TRANSFER BUS OFF
MACH TRIM FAIL	FLT CONT	ELEC	BUS OFF
AUTO SLAT FAIL	IRS	APU	
YAW DAMPER	FUEL	OVHT/DET	
STBY RUD ON			
IRS			APU
FAULT			LOW OIL PRESSURE
ON DC			FAULT
DC FAIL			OVERSPEED
FUEL			OVHT/DET
LOW PRESSURE			ENGINE 1 OVERHEAT
FILTER BYPASS			ENGINE 2 OVERHEAT
			APU DET INOP

Right Side - System Annunciators and Related Amber Lights

ANTI-ICE			ENG
WINDOW OVERHEAT			REVERSER PMC-INOP LOW IDLE
PITOT HEAT			
COWL ANTI-ICE			
HYD			OVERHEAD
OVERHEAT	ANTI-ICE	ENG	EQUIP COOLING-OFF
LOW PRESSURE	HYD	OVERHEAD	EMER EXIT LIGHTS-NOT ARMED
	DOORS	AIR COND	FLIGHT RECORDER-OFF
	RIGHT SIDE LIGHT SHIELD		PASS OXY-ON
DOORS			LAVATORY SMOKE (as installed)
FWD/AFT ENTRY			AIR COND
EQUIP			DUAL BLEED
FWD/AFT CARGO			WING-BODY OVERHEAT
FWD/AFT SERVICE			BLEED TRIP OFF
AIRSTAIR			AUTO FAIL
			OFF SCHED DESCENT
			PACK TRIP OFF (737-300/500)
			DUCT OVERHEAT (737-300/500)
			ZONE TEMP (737-400)
			PACK (737-400)

Warning Systems

Intermittent Cabin Altitude/Configuration Warning

The Cabin Altitude Warning Horn activates when cabin altitude exceeds 10,000 feet. An intermittent warning horn is heard. The Cabin Altitude Warning Horn may be silenced by momentarily pressing the ALT HORN CUTOUT switch on the Cabin Altitude Panel.

The takeoff configuration warning is armed when the airplane is on the ground and either or both forward thrust levers are advanced for takeoff. An intermittent warning horn sounds if:

- trailing edge flaps are not in the flaps 5 through 15 takeoff range, or
- leading edge devices are not configured for takeoff, or
- the SPEED BRAKE lever is not in the DOWN position, or
- the parking brake is set, or
- the stabilizer trim is not set in the takeoff range.

The warning indication is cancelled when the configuration error is corrected.

WARNING: The Cabin Altitude and Takeoff Configuration Warnings use the same intermittent tone when activated.

The Takeoff Configuration warning and the Cabin Altitude warning use the same intermittent horn for crew awareness. Flight crews should be aware, especially if departing high altitude airports, that this can provide confusion. Flight crews can misinterpret the Cabin Altitude warning for the Takeoff Configuration warning and may improperly respond.

On some airplanes two warning lights have been installed, T/O CONFIG and CABIN ALTITUDE, to assist in distinguishing between the aural warnings.

Landing Gear Configuration Warnings

Visual indications and aural warnings of landing gear position are provided by the landing gear indicator lights and landing gear warning horn.

Visual Indications

The landing gear indication lights are activated by signals from each gear, the LANDING GEAR lever, and the forward thrust lever position as follows:

Green light illuminated – landing gear is down and locked.

Red light illuminated –

- landing gear is in disagreement with LANDING GEAR lever position (in transit or unsafe).
- landing gear is not down and locked--with either or both forward thrust levers retarded to idle.

All lights extinguished – landing gear is up and locked with the LANDING GEAR lever UP or OFF.

Aural Indications

A steady warning horn is provided to alert the flight crew whenever the airplane is in a landing configuration and any gear is not down and locked. The landing gear warning horn is activated by forward thrust lever and flap position as follows:

Flaps 1 through 10 –

- either or both forward thrust levers between idle and approximately 10 degrees thrust lever angle: the landing gear warning horn can be silenced (reset) with the landing gear warning HORN CUTOUT switch.

Flaps 15 –

- either forward thrust lever between idle and approximately 10 degrees and the opposite thrust lever greater than approximately 30 degrees: the landing gear warning horn can be silenced with the landing gear warning HORN CUTOUT switch.
- both forward thrust levers set below approximately 30 degrees: the landing gear warning horn cannot be silenced with the landing gear warning HORN CUTOUT switch.

Flaps greater than 15 –

- regardless of forward thrust lever position, the landing gear warning horn cannot be silenced with the landing gear warning HORN CUTOUT switch.

The warning indication is cancelled when the configuration error is corrected.

Mach/Airspeed Warning System

Two independent Mach/airspeed warning systems provide a distinct aural warning, a clacker, any time the maximum operating airspeed of Vmo/Mmo is exceeded. The warning clackers can be silenced only by reducing airspeed below Vmo/Mmo.

The systems operate from a mechanism internal to each pilot's Mach/airspeed indicator. Test switches allow a system operation check at any time.

The airspeed indicator displays red warning bands indicating maximum and minimum airspeeds. Amber bands indicate maximum and minimum maneuvering airspeeds.

Stall Warning System

Natural stall warning (buffet) usually occurs at a speed prior to stall. In some configurations the margin between stall and natural stall warning is less than desired. Therefore, an artificial stall warning device, a stick shaker, is used to provide the required warning.

The stall warning “stick shaker” consists of two eccentric weight motors, one on each control column. They are designed to alert the pilots before a stall develops. The warning is given by vibrating both control columns. The system is armed in flight at all times. The system is deactivated on the ground.

Two independent, identical computers determine when stall warning is required based upon:

- wing configurations
- air/ground sensing
- thrust
- angle of attack
- Air Data Computer outputs.

The stall warning computers provide outputs for all stall warnings to include stick shaker, signals to the pitch limit indicator and airspeed displays, as well as the GPWS windshear detection and alert.

Two test switches are installed in the aft overhead panel. Pushing either of these initiates a self-test of the respective stall warning channel. The No.1 activates the Captain stick shaker, and the No. 2 activates the F/O stick shaker. Either stick shaker vibrates both columns through column interconnects.

Altitude Alerting System

Altitude alerting references the altitude selected on the MCP. Alerting occurs when approaching or departing the selected altitude. Altitude alerting is inhibited when wing flaps are extended to 25 or greater, or while G/S is captured.

Alerting consists of a momentary tone and illumination of an ALTITUDE ALERT light located on the captain’s and first officer’s instrument panels.

Acquisition Alerting

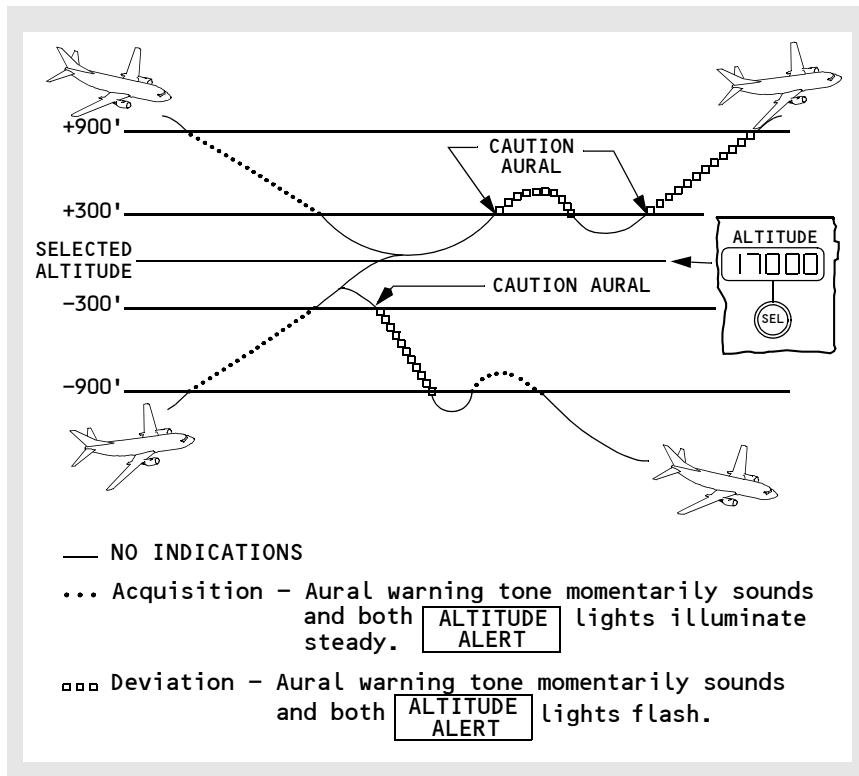
When approaching within 900 feet of selected altitude both ALTITUDE ALERT lights illuminate steady and a momentary tone sounds. When at 300 feet from selected altitude, both ALTITUDE ALERT lights extinguish.

Deviation Alerting

Upon deviating from the selected altitude by more than 300 feet, a momentary tone sounds and the ALTITUDE ALERT lights flash. Flashing continues until:

- altitude deviation becomes less than 300 feet
- altitude deviation becomes more than 900 feet
- a new altitude is selected.

Altitude Alert Profile



Enhanced Ground Proximity Warning System (EGPWS)

The EGPWS provides alerts for potentially hazardous flight conditions involving imminent impact with the ground.

In addition to providing the protection of GPWS, the EGPWS monitors terrain proximity using an internal world wide terrain data base. Proximate terrain data show on the navigation display. If there is a potential terrain conflict, alerts are provided based on estimated time to impact. These alerts are “look-ahead terrain alerts.”

The EGPWS provides alerts based on radio altitude and combinations of barometric altitude, airspeed, glide slope deviation, and airplane configuration. The alerts are for:

- excessive descent rate
- excessive terrain closure rate
- altitude loss after takeoff or go-around
- unsafe terrain clearance when not in the landing configuration
- excessive deviation below an ILS glide slope

These alerts are “radio altitude based alerts.”

Ground proximity alerts are accompanied by voice aural alerts and the PULL UP annunciation on the attitude indicators or, for deviation below glide slope alert, the BELOW G/S light.

Note: Terrain ahead of the airplane may exceed available climb performance. A ground proximity alert does not guarantee terrain clearance.

Look-ahead terrain alerts and radio altitude based alerts are prioritized based on the level of hazard and the required flight crew reaction time. Look-ahead terrain alerts and radio altitude based alerts are inhibited by an actual windshear warning (airplane in windshear).

Look-Ahead Terrain Alerting

The EGPWS terrain data base contains detailed terrain data near major airports, and data in lesser detail for areas between airports. Terrain within 2,000 feet of airplane barometric altitude shows on the navigation display. The terrain display is not designed to be an independent navigation aid.

The terrain display is generated from the data base contained in the EGPWS computer and correlated to GPS position from either an aircraft installed GPS receiver or an internal GPS receiver contained in the EGPWS computer. It is significant for the crew to be aware that the EGPWS internal GPS is not used for navigation of the aircraft.

Terrain and weather radar cannot show together on a display. If one pilot selects terrain and the other pilot selects weather radar, each display updates on alternating sweeps. All other displays (TCAS, LNAV routing, etc.) can show with terrain data.

Look-ahead terrain alerts are based on the airplane's position, barometric altitude, vertical flight path, and ground speed.

Look Ahead Terrain Alerts

AURAL ALERT	VISUAL ALERT	DESCRIPTION
TERRAIN PULL UP	PULL UP on both attitude indicators Red TERRAIN message on navigation display (all modes) Solid red terrain on navigation display	20 to 30 seconds from projected impact with terrain shown solid red on the navigation display (in expanded MAP, center MAP, expanded VOR, or expanded APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.
CAUTION TERRAIN	Amber TERRAIN message on navigation display (all modes) Solid amber terrain on navigation displays	40 to 60 seconds from projected impact with terrain shown solid amber on the navigation display (in expanded MAP, center MAP, expanded VOR, or expanded APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.
TOO LOW, TERRAIN	PULL UP on both attitude indicators	Descent below unsafe radio altitude while too far from any airport in the terrain database. Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.

Radio Altitude Based Alerts

The following list(s) identifies the various alerts available. Two or more alerts may be activated simultaneously and may override a lower priority message even if it is already in progress. Visual and audio indications may vary and are dependent on aircraft type and options selected at installation.

AURAL ALERT	VISUAL ALERT	DESCRIPTION
PULL UP	PULL UP on both attitude indicators	<p>Follows SINK RATE alert if descent rate becomes severe.</p> <p>Follows radio altitude based TERRAIN alert if excessive terrain closure rate continues and landing gear and/or flaps are not in landing configuration.</p>
TERRAIN	PULL UP on both attitude indicators	Excessive terrain closure rate.
DON'T SINK	PULL UP on both attitude indicators	Excessive altitude loss after takeoff or go-around.
GLIDE SLOPE	BELOW G/S P-INHIBIT lights	<p>Deviation below glide slope. Volume and repetition rate increase as deviation increases.</p> <p>Pushing the ground proximity BELOW G/S P-INHIBIT light cancels or inhibits the alert below 1,000 feet RA.</p>
SINK RATE	PULL UP on both attitude indicators	Excessive descent rate.
TOO LOW, FLAPS	PULL UP on both attitude indicators	<p>Unsafe terrain clearance at low airspeed with flaps not in a normal landing position.</p> <p>Pushing the ground proximity flap override switch to FLAP INHIBIT inhibits the alert.</p>
TOO LOW, GEAR	PULL UP on both attitude indicators	<p>Unsafe terrain clearance at low airspeed with landing gear not down.</p> <p>Pushing the ground proximity gear override switch to GEAR INHIBIT inhibits the alert.</p>
TOO LOW, TERRAIN	PULL UP on both attitude indicators	Unsafe terrain clearance at high airspeed with either landing gear not down or flaps not in landing position. Follows DON'T SINK if another descent is initiated after initial alert, before climbing to the altitude where the initial descent began.

Peaks Display Mode

As an enhancement to the current “standard” EGPWS terrain display, the Peaks Mode terrain display allows terrain below the aircraft to be viewed on the EGPWS terrain display during the cruise portion of flight. At altitudes safely above all terrain for the display range chosen the terrain is displayed independent of aircraft altitude emphasizing the highest and lowest elevations to provide increased situational awareness. This increased awareness can be particularly valuable to the flight crew in the event of an unplanned descent or off-route deviation and for the purpose of previewing terrain prior to descent.

The standard EGPWS terrain display uses colors and shading patterns corresponding to the vertical placement between terrain elevation and the current altitude of the aircraft. Terrain more than 2000 feet below the aircraft is not displayed and the terrain display is typically blank during the enroute portion of flight. The Peaks Mode Display adds additional density patterns and level thresholds based on terrain elevations relative to the range and distribution of terrain in the display area. The Peaks Mode display is thus a “merged” display applicable to all phases of flight.

With the new Peaks Mode display, two elevation numbers indicating the highest and lowest terrain currently being displayed are overlaid on the display. The elevation numbers indicate terrain in hundreds of feet above sea level (MSL). The terrain elevation numbers are displayed with the “highest” terrain number on top, and the “lowest” terrain number beneath it. The “highest” terrain number is shown in the same color as the highest terrain color pattern on the display, and the “lowest” terrain number is shown in the color of the lowest terrain color pattern shown on the display. A single elevation number is displayed when the screen is all black or blue as a result of flying over water or relatively flat terrain where there is no appreciable difference in terrain elevations. The elevation numbers on the display are an additional indication that the terrain display is selected.

The background color dot patterns and terrain elevation threshold values are shown in the table below. (Bold/Italics indicate new functionality in Peaks Mode display).

DO NOT USE FOR FLIGHT

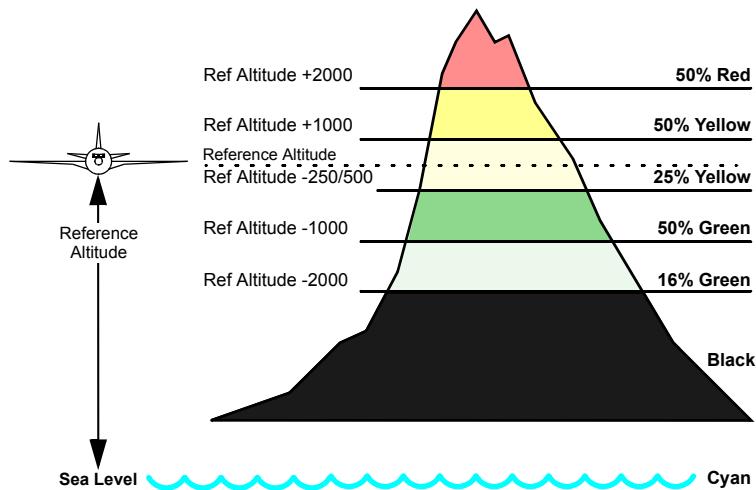
737 Flight Crew Operations Manual

Warning Systems -
System Description

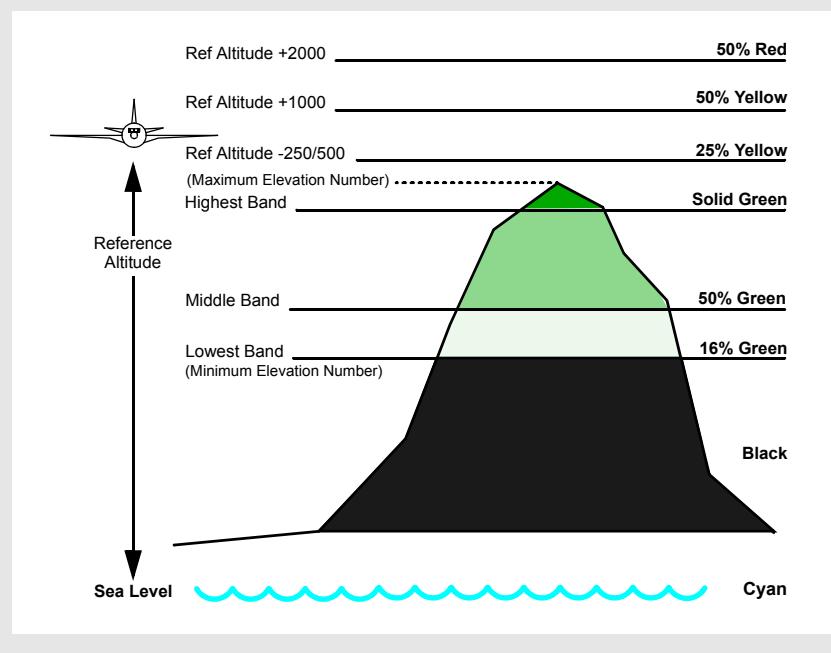
Color	Terrain Elevation
Solid Red	Terrain Threat Area - Warning.
Solid Yellow	Terrain Threat Area - Caution.
50% Red Dots	Terrain that is more than 2000 feet above aircraft altitude.
50% Yellow Dots	Terrain that is between 1000 and 2000 feet above aircraft altitude.
25% Yellow Dots	Terrain that is 500 (250 with gear down) feet below to 1000 feet above aircraft altitude.
Solid Green	Shown only when no Red or Yellow terrain areas are within range on the display. Highest terrain not within 500 (250 with gear down) feet of aircraft altitude.
50% Green Dots	Terrain that is 500 (250 with gear down) feet below to 1000 below aircraft altitude. OR Terrain that is the middle elevation band when there are no Red or Yellow terrain areas within range on the display.
16% Green Dots	Terrain that is 1000 to 2000 feet below aircraft altitude. OR Terrain that is the lower elevation band when there are no Red or Yellow terrain areas within range on the display.
Black	No significant terrain.
16% Cyan	Terrain Elevation equal to 0 feet MSL (Optional requires compatible display)
Magenta Dots	Unknown terrain.

The Peaks Mode display adds a new solid green level to indicate the highest, non-threatening terrain. The existing lower density green display patterns now indicate mid and upper terrain in the display area as well as terrain that is within 2000 feet below the aircraft. The red yellow dot patterns are unchanged and continue to indicate terrain that is near or above the current altitude of the aircraft. Solid yellow and red colors are unchanged and continue to indicate alert and warning areas relative to the flight path of the aircraft. Terrain identified as water (0 Ft. MSL) may optionally be displayed as cyan color dot patterns if the aircraft display hardware supports the color cyan. The Peaks Mode display is prioritized such that higher level colors and densities override lower color and densities for maximum situational awareness of the most significant terrain relative to the altitude and flight path of the aircraft.

Peaks Mode display is enabled via a Program Pin during aircraft installation of EGPWS. Customers may choose from the current “standard” terrain display, or the “Peaks Mode” display. Pilot selection between “standard” and ‘Peaks Mode’ is not available. Configurable display options, including the water display option, are defined within the EGPWS computer.



Peaks Mode Terrain Display - Aircraft at Low Relative Altitude



Peaks Mode Terrain Display - Aircraft at High Relative Altitude

Cautions and Warnings

EGPWS provides the following alerts:

- Look-ahead terrain caution
- Look-ahead terrain warning
- Look-ahead obstacle caution
- Look-ahead obstacle warning
- Terrain clearance floor caution.

“TERRAIN AHEAD,” “CAUTION TERRAIN,” and “CAUTION OBSTACLE” aural warnings are triggered approximately 60 seconds from impact. Additionally, the amber GPWS light is illuminated and the appropriate section of the TAD on the EHSI will be colored solid yellow. If the terrain display function is not selected, the display will automatically appear.

“TERRAIN, TERRAIN, PULL UP,” or “OBSTACLE, OBSTACLE, PULL UP” aural warnings are triggered approximately 30 seconds from impact. Additionally, the red PULL UP light is illuminated and the appropriate section of the TAD on the EHSI will be colored solid red. If the terrain display function is not selected, the display will automatically appear.

Terrain Clearance Floor

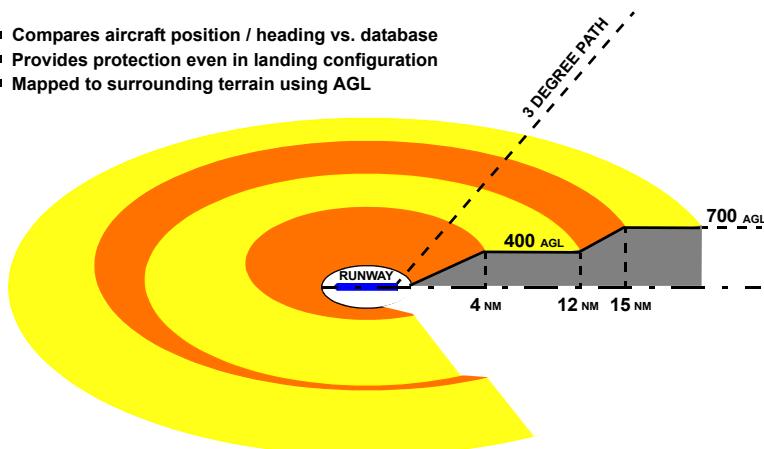
The Terrain Clearance Floor (TCF) function, enabled with Terrain Alerting and Display (TAD), enhances the Basic GPWS Modes by alerting the pilot of descent below a defined "Terrain Clearance Floor" regardless of the aircraft configuration.

The TCF alert is a function of the aircraft's Radio Altitude and distance (calculated from Latitude/longitude position) relative to the center of the nearest runway in the data base.

The TCF envelope is defined for all runways as illustrated below and extends to infinity, or until it meets the envelope of another runway. The envelope bias factor varies as a function of position accuracy.

For additional information, refer to the specific manufacturer's operation and maintenance manuals.

- Compares aircraft position / heading vs. database
- Provides protection even in landing configuration
- Mapped to surrounding terrain using AGL



Terrain Clearance Floor

Obstacle Alerts

Aural Alert	Visual Alert	Description
OBSTACLE OBSTACLE PULL UP	PULL UP on both attitude indicators Red OBSTACLE message on EHSI (all modes) Solid red terrain on EHSI	20 to 30 seconds from projected impact with terrain shown solid red on the EHSI (in MAP, MAP CTR, VOR, or APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.
CAUTION OBSTACLE	Amber OBSTACLE message on EHSI (all modes) Solid amber terrain on EHSI	40 to 60 seconds from projected impact with terrain shown solid amber on the EHSI (in MAP, MAP CTR, VOR, or APP modes only). Moving the ground proximity terrain inhibit switch to TERRAIN INHIBIT inhibits the alert.

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 advisory and traffic displays of the other airplanes to the flight crew. Neither advisory, guidance, nor traffic display is provided for other airplanes which do not have operating transponders. TCAS operation is independent of ground-based air traffic control.

To provide advisories, TCAS identifies a three dimensional airspace around the airplane where a high likelihood of traffic conflict exists. The dimensions of this airspace are based upon the closure rate with conflicting traffic.

TCAS equipment interrogates the transponders of other airplanes to determine their range, bearing, and altitude. A traffic advisory (TA) is generated when the other airplane is approximately 40 seconds from the point of closest approach. If the other airplane continues to close, a resolution advisory (RA) is generated when the other airplane is approximately 25 seconds from the point of closest approach. The RA provides aural warning and guidance as well as maneuver guidance to maintain or increase separation from the traffic.

Non-transponder equipped airplanes are invisible to TCAS. RAs can be generated if the other airplane has a mode C transponder. Coordinated RAs require both airplanes to have TCAS.

Advisories and Displays

Annunciations associated with TCAS and the traffic displays are discussed further in Chapter 10.

TAs are indicated by the aural “TRAFFIC, TRAFFIC” which sounds once and is then reset until the next TA occurs. The TRAFFIC message appears on the EHSI. The TA symbol appears at the proper range and relative bearing of the other airplane. Altitude and vertical motion are included with the symbol if the other airplane is using transponder mode S or C.

RAs are indicated by one or more aural listed in the RA aural table. The TRAFFIC message and RA symbol which depicts the traffic’s relative bearing, range, altitude, and vertical motion are on the EHSI similar to the TA symbol.

Additional symbols are proximate traffic and other traffic. Proximate traffic is within six miles and 1200 feet vertically, but is not expected to cause a TA or RA alert. Other traffic is beyond the six mile and 1200 feet vertical criteria. Traffic symbols are revised as the TCAS system constantly reevaluates the motion of other airplanes.

If the range selected does not permit the display of a TA or RA an OFFSCALE message appears on the EHSI.

TA or RA traffic detected by TCAS which do not provide a bearing generate a no-bearing text block beneath the TRAFFIC text on the EHSI. The text block contains distance, altitude, and vertical motion information.

Vertical motion information is indicated by an arrow depicting a climb or descent if a change of greater than 500 feet per minute is detected.

Inhibits (Without TCAS change 7.0 update)

INCREASE DESCENT RAs are inhibited below 1,450 feet radio altitude.

DESCEND RAs are inhibited below 1,200 feet radio altitude during climbs, and 1,000 feet radio altitude during descents.

All RAs and TCAS voice annunciations are inhibited below 1,100 feet radio altitude during climbs, and 900 feet radio altitude during descents.

All TCAS alerts are inhibited by GPWS and windshear warnings.

Inhibits (With TCAS change 7.0 update)

INCREASE DESCENT RAs are inhibited below 1,450 feet radio altitude.

DESCEND RAs are inhibited below 1,200 feet radio altitude during climbs, and 1,000 feet radio altitude during descents.

All RAs are inhibited below 1,100 feet radio altitude during climbs, and 900 feet radio altitude during descents.

All TCAS voice annunciations are inhibited below 600 feet while climbing, and 400 feet while descending.

All TCAS alerts are inhibited by GPWS and windshear warnings.

Mode Control

The TCAS operating mode is controlled from the transponder panel. TCAS is normally operated in the TA/RA mode. However, sometimes it is necessary to operate in the TA ONLY mode to prevent undesired RAs. For example, TA ONLY may be selected when intentionally operating near other airplanes such as might be found in VFR conditions at a busy airport, or on parallel approach.

TCAS equipped transponders communicate between airplanes to provide appropriate coordinated avoidance maneuvers. When performance is limited, such as with an inoperative engine, select TA ONLY to prevent receiving RAs beyond the airplane's capabilities, and to prevent communicating to other airplanes an ability to perform an RA maneuver.

Resolution Advisory Aural

The following table identifies the possible callouts associated with RAs and the vertical restrictions or maneuver recommended in each case.

AURAL ALERTS	VERTICAL RESTRICTIONS/MANEUVER
MONITOR VERTICAL SPEED, MONITOR VERTICAL SPEED	Present pitch attitude is outside the RA pitch command area. Keep pitch attitude away from red area.
CLIMB, CLIMB, CLIMB	Climb at the displayed pitch
DESCEND, DESCEND, DESCEND	Descend at the displayed pitch
REDUCE CLIMB, REDUCE CLIMB	Reduce climb rate
REDUCE DESCENT, REDUCE DESCENT	Reduce descent rate
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	Climb at displayed pitch. Airplane climbs through traffic's altitude.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	Descend at displayed pitch. Airplane descends through traffic's altitude.
INCREASE CLIMB, INCREASE CLIMB	Increase climb rate from initial pitch attitude.
INCREASE DESCENT, INCREASE DESCENT	Increase descent rate from initial pitch attitude.
CLIMB – CLIMB NOW, CLIMB – CLIMB NOW	Reversal maneuver from initial descent RA.
DESCEND – DESCEND NOW, DESCEND – DESCEND NOW	Reversal maneuver from initial climb RA.
CLEAR OF CONFLICT	RA encounter terminated. Maneuver guidance no longer displayed.

Resolution Advisory Aural (TCAS Version 7)

The following table identifies the possible callouts associated with RAs and the vertical restrictions or maneuver recommended in each case.

AURAL ALERTS	VERTICAL RESTRICTIONS/MANEUVER
MONITOR VERTICAL SPEED	Present pitch attitude is outside the TCAS vertical guidance command. Keep pitch attitude away from red area.
MAINTAIN VERTICAL SPEED, MAINTAIN	
MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN	
CLIMB, CLIMB	Climb at the displayed pitch
DESCEND, DESCEND	Descend at the displayed pitch
ADJUST VERTICAL SPEED, ADJUST	Reduce climb or descent rate
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	Climb at displayed pitch. Airplane climbs through traffic's altitude.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	Descend at displayed pitch. Airplane descends through traffic's altitude.
INCREASE CLIMB, INCREASE CLIMB	Increase climb rate from initial pitch attitude.
INCREASE DESCENT, INCREASE DESCENT	Increase descent rate from initial pitch attitude.
CLIMB – CLIMB NOW, CLIMB – CLIMB NOW	Reversal maneuver from initial descent RA.
DESCEND – DESCEND NOW, DESCEND – DESCEND NOW	Reversal maneuver from initial climb RA.
CLEAR OF CONFLICT	RA encounter terminated. Maneuver guidance no longer displayed.

Tail Skid (737-400)

The tail skid assembly consists of a cartridge assembly, tail skid, fairing (skirt) and shoe. The fairing provides an enclosure for the actual tail skid structure. The shoe is fitted to the bottom of the fairing.

The cartridge assembly consists of a crushable honeycomb material. When the tail skid strikes the runway the skid moves upward and the honeycomb material crushes. The tail skid is serviceable when the cartridge warning decal shows both green and red. The green disappears gradually as the cartridge is crushed. When the warning decal is all red, the cartridge must be replaced.

The shoe is what contacts the runway in the event of an over rotation. The shoe surface displays "wear dimples" which serve as a reference for shoe replacement.

Tail Skid Detail

