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737-300  
Flight Crew  
Operations Manual  
The Boeing Company

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# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

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# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **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.

<b>Airplane Number</b>	<b>Registry Number</b>	<b>Serial Number</b>	<b>Tab Number</b>	<b>Model Miscellaneous Data</b>
1	BN300	BN300	BN300	737-300

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## **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](mailto:FlightTraining@Boeing.com)

Telephone: (206) 662-4000

Fax: (206) 662-4743

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## **Organization**

The FCOM is organized in the following manner.

### **Volume 1**

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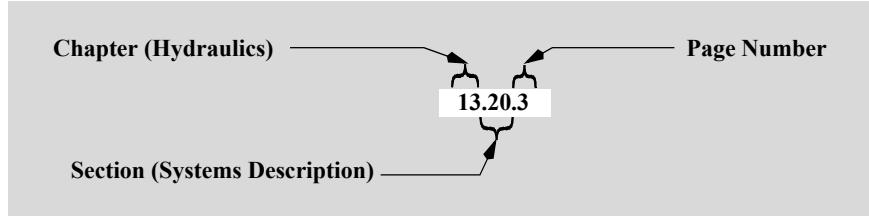
## 737 Flight Crew Operations Manual

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.

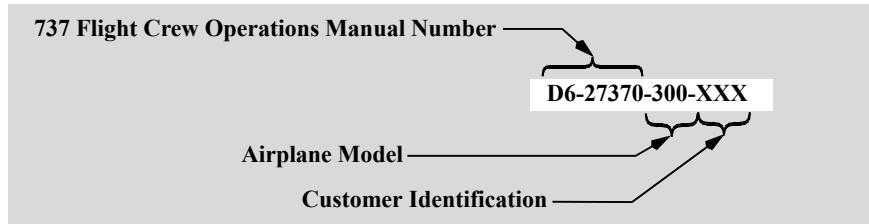
### Example Page Number



### 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.

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**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.

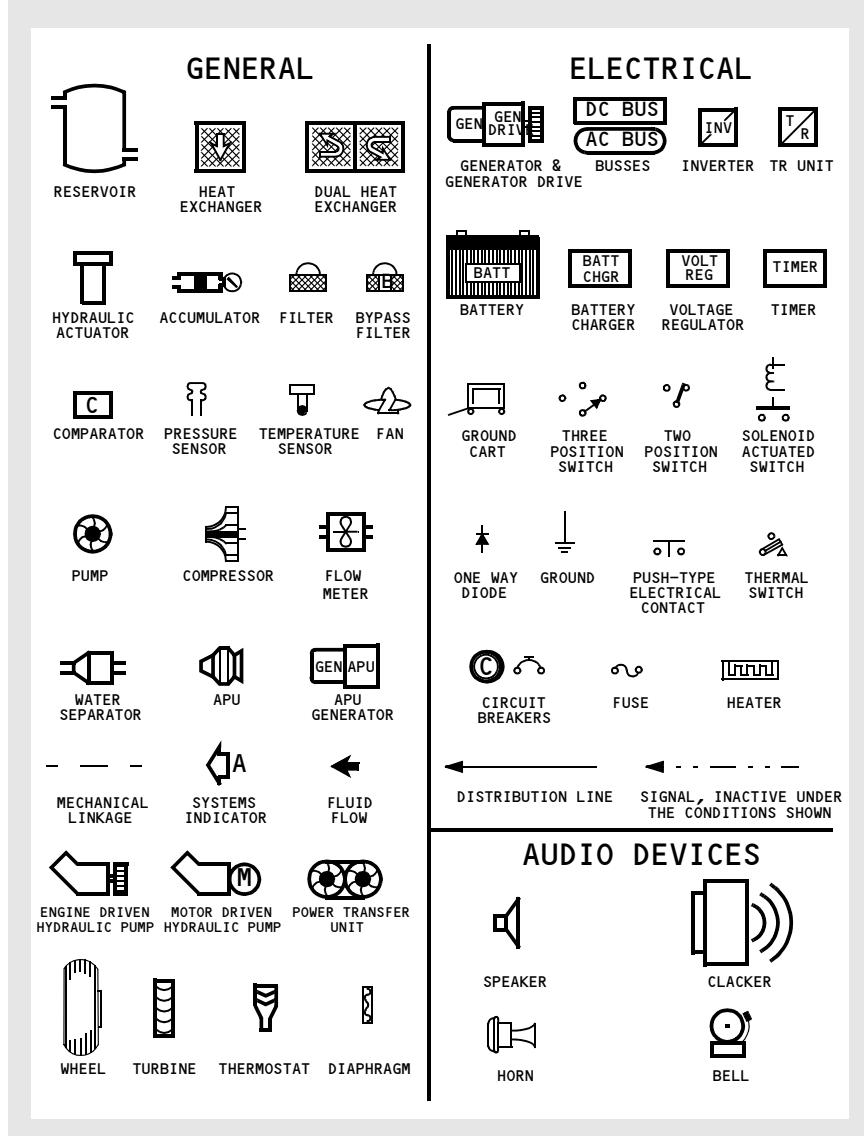
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## Flight Crew Operations Manual Configuration

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

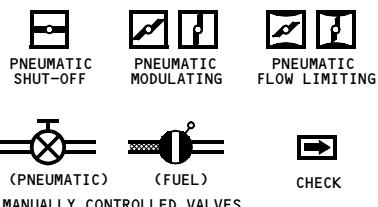
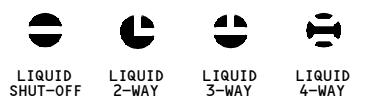
Symbols shown are those which may not be identified on schematic illustrations.



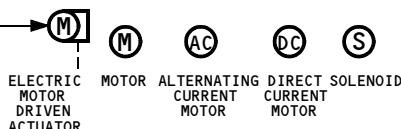
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## 737 Flight Crew Operations Manual

### VALVES



### MOTORS AND SOLENOIDS



### INDICATORS



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## 737 Flight Crew Operations Manual

### 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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## 737 Flight Crew Operations Manual

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	<b>F</b>	
CONFIG	Configuration	F	Fahrenheit
CRZ	Cruise	FCTL	Flight Control
CTL	Control	F/D or FLT DIR	Flight Director
<b>D</b>		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	<b>G</b>	
DME	Distance Measuring Equipment	GA	Go-Around
DSPL	Display	GEN	Generator
<b>E</b>		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	<b>H</b>	
		HDG	Heading

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Preface -  
Abbreviations

## 737 Flight Crew Operations Manual

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	Design Maneuvering Speed
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	Takeoff Decision Speed
T or TRU	True	V2	Takeoff Safety 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

# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **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 D6-27370-300N-TBCN.

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	October 30, 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.

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## **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.

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## **Chapter NP - Normal Procedures**

### **Section 21 - Amplified Procedures**

#### Descent Procedure

NP.21.41 - Deleted a line that was added to the Descent Procedure by error.

#### Landing Procedure - ILS

NP.21.44 - Changed "VNAV path" to "glide slope".

---

### **Chapter SP - Supplementary Procedures**

#### **Section 11 - Flight Management, Navigation**

##### **Flight Management**

SP.11.14 - 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.

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### **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.

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### **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 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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## 737 Flight Crew Operations Manual

### Preface

### V1V2 List of Effective Pages

### Chapter 0

### Section 5

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* Copyright	June 18, 2010	NP.TOC.0.1-2	December 4, 2009
0.TOC.0.1-2	December 4, 2009	* NP.11.1-4	June 18, 2010
* 0.1.1-2	June 18, 2010	NP.11.5	August 18, 2008
0.2.1	June 12, 2009	NP.11.6-7	December 5, 2008
* 0.2.2-3	June 18, 2010	NP.11.8	June 9, 2006
0.2.4	December 4, 2009	NP.21.1-25	June 12, 2009
0.2.5-6	August 18, 2008	NP.21.26-27	December 4, 2009
0.3.1-4	August 18, 2008	NP.21.28-34	June 12, 2009
Revision Record (tab)			
* 0.4.1-4	June 18, 2010	NP.21.35-38	December 4, 2009
List of Effective Pages			
* 0.5.1-8	June 18, 2010	NP.21.39	June 12, 2009
Bulletins (tab)			
* 0.6.1-2	June 18, 2010	NP.21.40	December 4, 2009
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L.TOC.0.1-2	August 18, 2008	* NP.21.41	June 18, 2010
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* SP.TOC.0.1-4	June 18, 2010	NP.21.51-54	December 4, 2009
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SP.1.8	June 9, 2006		

\* = Revised, Added, or Deleted

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* PI.14.1-4	June 18, 2010
* PI.15.1-4	June 18, 2010
* PI.16.1-12	June 18, 2010
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\* = Revised, Added, or Deleted

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**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
TBCN-1	Standby Horizon Indicator Display		06-16-1995	IE
TBCN-2	Nonselected MCP Setting Changes		06-16-1995	IE
TBCN-3	Auxiliary Power Unit (APU) Starting		06-16-1995	IE
TBCN-4	BLEED TRIP OFF Light Illuminating During A No Engine Bleed Takeoff		06-16-1995	IE
TBCN-5 R1	Runaway Stabilizer Procedure		09-20-1995	IE

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Number	Subject	Ref. No. (CS3-)	Date	Status
TBCN-11	Maneuvering Speeds for 737-100/200/300/400/500		12-03-1999	IE
TBCN-14 R1	Trailing Edge Flaps - Outboard Flap Carriage Spindle Fractures	3494	02-01-2005	IE
TBCN-16	Main Landing Gear (MLG) Actuator Beam Fracture and/or MLG Actuator Beam Arm Fracture	3517	03-22-2005	IE
TBCN-21 R1	Cabin Altitude Warning Indications and Procedures Briefing	4125	06-15-2009	IE
TBCN-22	Instrument Approach Procedures with an FMC Missed Approach Altitude Constraint Above 10,000 feet MSL	4254	04-27-2009	IE
TBCN-23	Inflight Elevator Tab Vibration	4280	06-16-2009	IE
TBCN-25	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:** TBCN-1

**Date:** June 16, 1995

**Document Effectivity:** D6-27370-300N-TBCN

**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 TBCN-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 737-34-1244. 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:

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# Flight Crew Operations Manual Bulletin for The Boeing Company

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



**737**

**Number:** TBCN-2

**Date:** June 16, 1995

**Document Effectivity:** D6-27370-300N-TBCN

**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

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## 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.

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## 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 TBCN-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 Service Bulletin 737-22A1098. If the operator does not plan to modify all the airplanes and would

**Flight Crew Operations Manual Bulletin No. TBCN-2, 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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# Flight Crew Operations Manual Bulletin for The Boeing Company

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



**737**

**Number:** TBCN-3

**Date:** June 16, 1995

**Document Effectivity:** D6-27370-300N-TBCN

**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

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## 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 TBCN-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 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: TBCN-4

Date: June 16, 1995

**Document Effectivity:** D6-27370-300N-TBCN

**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

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## 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.

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## **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 TBCN-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 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.

**Flight Crew Operations Manual Bulletin No. TBCN-4, dated June 16, 1995 (continued)**

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: TBCN-5 R1

Date: September 20, 1995

**Document Effectivity:** D6-27370-300N-TBCN

**Subject:** Runaway Stabilizer Procedure

**Reason:** This is a reissue of TBCN-5, 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

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## 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.

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## **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.

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## **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 TBCN-5 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.

**Flight Crew Operations Manual Bulletin No. TBCN-5 R1, dated September 20, 1995  
(continued)**

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

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# Flight Crew Operations Manual Bulletin for The Boeing Company

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



**737**

**Number:** TBCN-11

**Date:** December 03, 1999

**Document Effectivity:** D6-27370-300N-TBCN

**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.

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## **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))

<b>FLAP POSITION</b>	<b>UP TO 117,000 LBS (53,070 KGS)</b>
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))

<b>FLAP POSITION</b>	<b>UP TO 117,000 LBS (53,070 KGS)</b>	<b>ABOVE 117,000 LBS (53,070 KGS) UP TO 138,500 LBS (62,823 KGS)</b>	<b>ABOVE 138,500 LBS (62,823 KGS)</b>
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)

<b>FLAP POSITION</b>	<b>UP TO 117,000 LBS (53,070 KGS)</b>	<b>ABOVE 117,000 LBS (53,070 KGS) UP TO 138,500 LBS (62,823 KGS)</b>	<b>ABOVE 138,500 LBS (62,823 KGS)</b>
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 TBN-10, 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 TBN-10 "CANCELLED" (CANC) and bulletin TBCN-11 "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  
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:** TBCN-14 R1

**Date:** February 01, 2005

**Document Effectivity:** D6-27370-300N-TBCN

**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.

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## **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.

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## **Administrative Information**

This bulletin replaces bulletin TBCN-14, dated November 17, 2003. Discard bulletin TBCN-14. Revise the Bulletin Record to show TBCN-14 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 TBCN-14 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:

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:** TBCN-16

**Date:** March 22, 2005

**Document Effectivity:** D6-27370-300N-TBCN

**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

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## 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.

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## **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.

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## **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 TBCN-16 "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:

Mailing Address: Boeing Commercial Airplanes  
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Seattle, Washington 98124-2207 USA

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# Flight Crew Operations Manual Bulletin for The Boeing Company

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



**737**

**Number:** TBCN-21 R1

**Date:** June 15, 2009

**Document Effectivity:** D6-27370-300N-TBCN

**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.

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## 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 TBCN-21, dated December 12, 2008. Discard bulletin TBCN-21. Revise the Bulletin Record to show TBCN-21 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 TBCN-21 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

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# Flight Crew Operations Manual Bulletin for The Boeing Company

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



**737**

**Number:** TBCN-22

**Date:** April 27, 2009

**Document Effectivity:** D6-27370-300N-TBCN

**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 4<sup>th</sup> 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.

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## **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).

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## **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 TBCN-22 "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  
                            ATTN: 737 Manager, Flight Technical Data  
                            P. O. Box 3707, M/C 20-89  
                            Seattle, Washington 98124-2207 USA

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# Flight Crew Operations Manual Bulletin for The Boeing Company

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



**737**

**Number:** TBCN-23

**Date:** June 16, 2009

**Document Effectivity:** D6-27370-300N-TBCN

**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.

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## **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 TBCN-23 "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  
Telephone: (206) 662-4000  
Fax: (206) 662-4743

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# Flight Crew Operations Manual Bulletin for The Boeing Company

The Boeing Company  
Seattle, Washington 98124-2207



737

Number: TBCN-25

Date: July 01, 2009

**Document Effectivity:** D6-27370-300N-TBCN

**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.

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## **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 TBCN-25 "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

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

# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

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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

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## Weight Limitations

### 737-300 Airplanes

Maximum Taxi Weight	130,500 lbs (59,193 kgs)
Maximum Takeoff Weight (1)	130,000 lbs (58,967 kgs)
Maximum Landing Weight (2)	114,000 lbs (51,709 kgs)
Maximum Zero Fuel Weight	105,000 lbs (47,627 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.

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## 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.

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## 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.

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## Communications

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

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## 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

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## 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	102% 106% (1)
Maximum N2 RPM	105%
Maximum Takeoff EGT	905° C 930° C (2)
Maximum Continuous EGT	870° C 895° C (2)
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
(1) Applicable only after installation of N1 indicators displaying a red line limit of 106% RPM	
(2) Applicable only after installation of EGT indicators displaying a red line limit of 930° C and an amber arc starting at 895° C	

## Engine Ignition

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

When flight in moderate or heavy rain, hail, or sleet is encountered or anticipated, engine start switches must be set to FLT and a minimum of 45% N1 must be maintained except on short final when landing is assured.

**Note:** This restriction applies only to airplanes with a 45% N1 placard. The placard is located on the applicable pilot's panel.

## 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 data from the VOR associated with the approach displayed in the HSI VOR/ILS mode no later than final approach fix.

## **Non-AFM 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-AMF Operational Information**

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

Do not apply brakes until after touchdown.

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# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Normal Procedures**

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### Normal Procedures

### Chapter NP

#### Introduction

#### Section 11

---

### General

This chapter gives:

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

---

### Normal Procedures Philosophy and Assumptions

Normal procedures verify for each phase of flight that:

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

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

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

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

Normal procedures also assume coordination with the ground crew before:

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

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

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

---

### Configuration Check

It is the crew member's responsibility to verify correct system response. Before engine start, use 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.

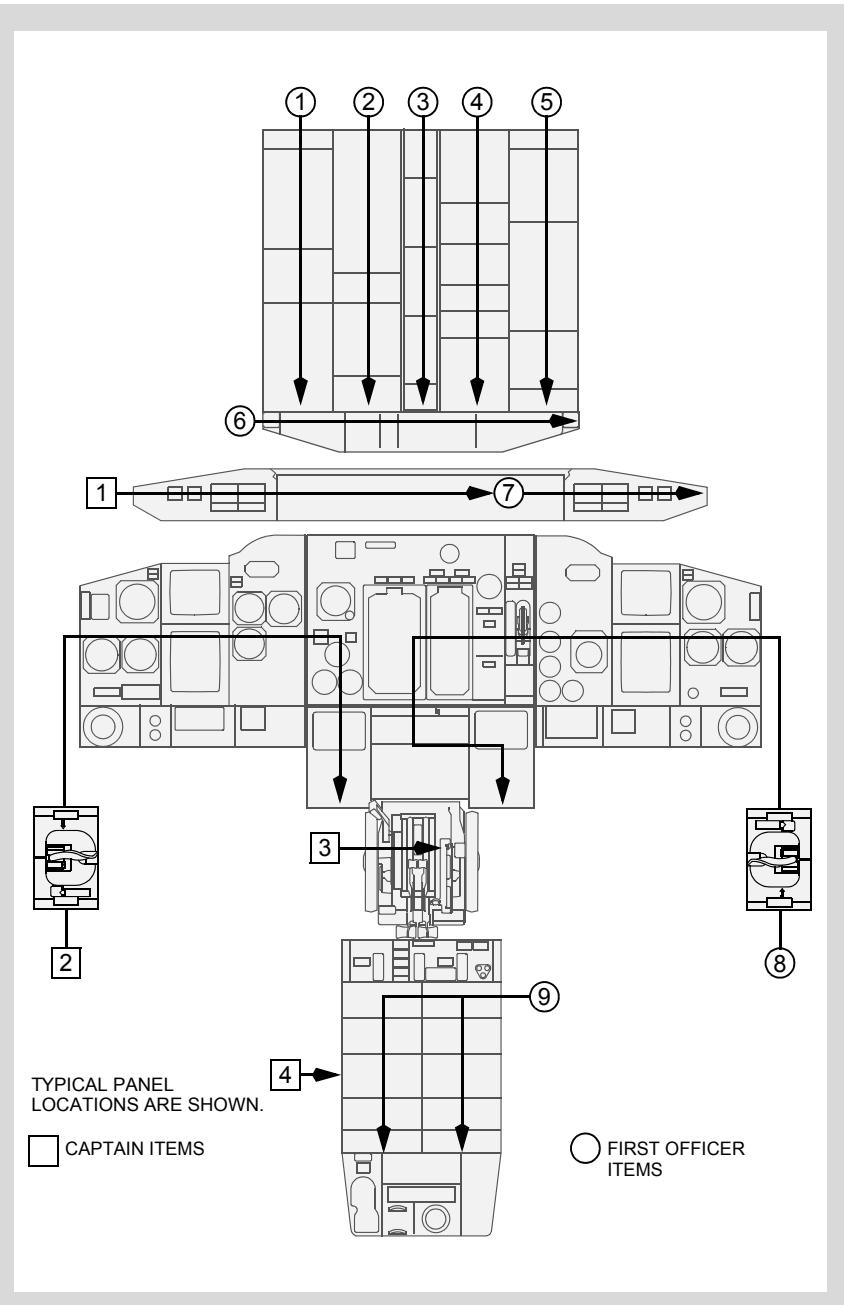
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## Scan Flow and Areas of Responsibility

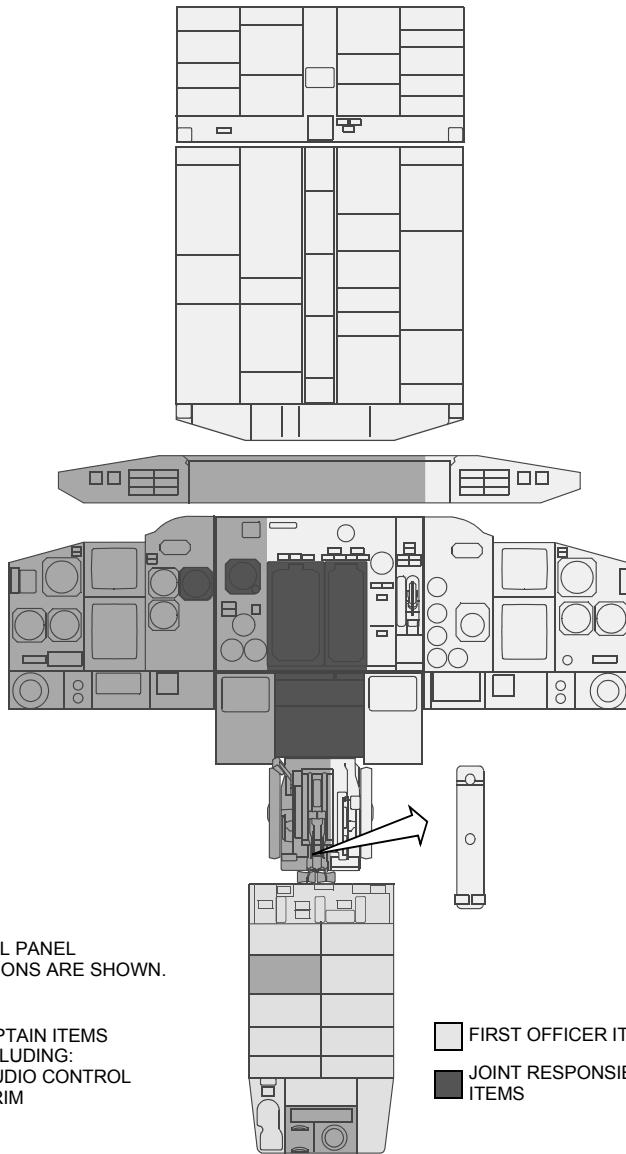
The scan flow and areas of responsibility diagrams shown below are representative and may not match the configuration of your airplane.

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.

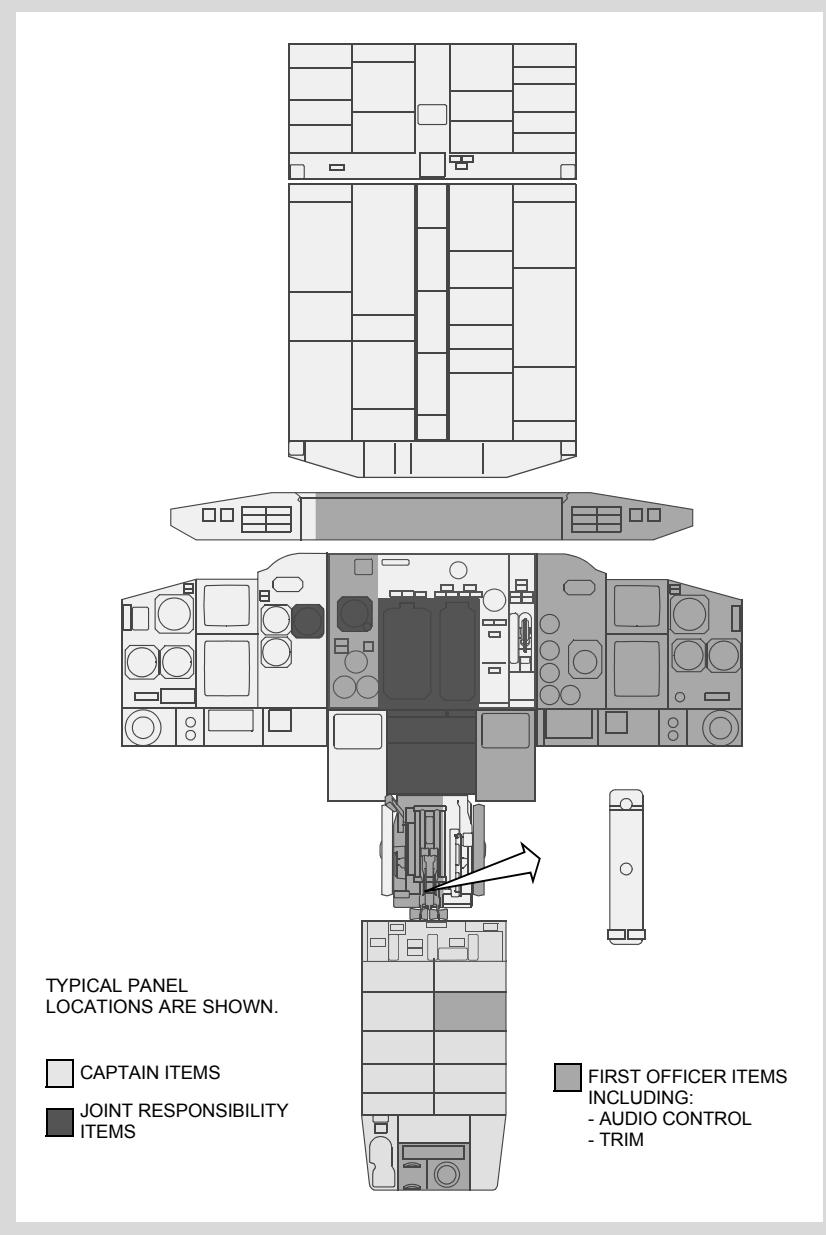
### Preflight and Postflight Scan Flow



## Areas of Responsibility - Captain as Pilot Flying or Taxiing



### Areas of Responsibility - First Officer as Pilot Flying or Taxiing



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# **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.

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.

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 dashes are shown.

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.

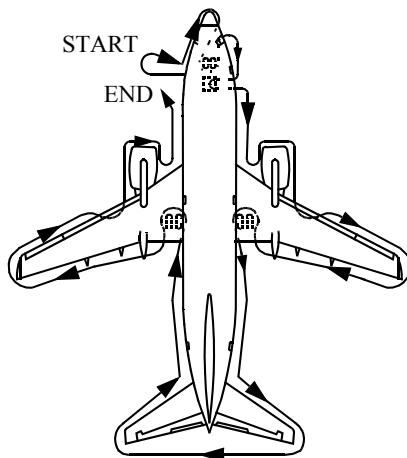
Items at each location may be checked in any sequence.

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
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

Compass transfer switch – NORMAL

Attitude 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.

Airplanes with auxiliary fuel tanks, auxiliary tank  
fuel pump switches – OFF

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

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.

---

EQUIPMENT COOLING switch ..... NORM

Verify that the OFF light is extinguished.

EMERGENCY EXIT LIGHTS switch ..... Guard closed

Verify that the NOT ARMED light is extinguished.

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.	
Temperature selectors – As needed	
Verify that the RAM DOOR FULL OPEN lights are illuminated.	
RECIRCULATION FAN switch – 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 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

HSI switch ..... As needed

Select VOR/ILS or NAV position 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%

STATIC SOURCE selector ..... NORMAL

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)

Verify that the flight mode annunciations are correct:

- autothrottle mode is blank
- pitch mode is blank
- roll mode is blank
- A/P status is A/P OFF

GROUND PROXIMITY panel ..... Check

FLAP/GEAR INHIBIT switch – Guard closed

Verify that the INOP light is extinguished.

HYDRAULIC QUANTITY indicators ..... Above RFL

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	
FUEL FLOW switch .....	Reset
REVERSER UNLOCKED lights .....	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	
Engine instruments .....	Check
Verify that the primary and secondary engine indications show existing conditions.	
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.
- 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
- Radar mode selector - OFF
- 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.

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## 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

HSI switch ..... As needed

Select VOR/ILS or NAV position 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 engage paddles – OFF

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%**

STATIC SOURCE selector ..... NORMAL

Marker beacon lights ..... Test

Marker beacon switch ..... As needed

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)

Verify that the flight mode annunciations are correct:

- autothrottle mode is blank
- pitch mode is blank
- roll mode is blank
- A/P status is A/P OFF

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

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.

Reverse thrust levers ..... Down

Forward thrust levers ..... Closed

FLAP lever ..... Set

Set the flap lever to agree with the flap position.

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

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.

If there is fuel in the auxiliary tanks:

AUXILIARY tank FUEL PUMP switches  
(for tanks with fuel) - ON

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

If a LOW PRESSURE light stays illuminated turn off the affected AUXILIARY tank 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 switch ..... ON 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"><li>• Set or verify that the engine bleeds and air conditioning packs are operating</li><li>• Set the engine start switches as needed</li><li>• Set the AUTO BRAKE select switch to OFF</li><li>• Set the landing gear lever to OFF after landing gear retraction is complete</li></ul>
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 + 15 170 190	V2 + 15 180 200	V2 + 15 190 210	5 1 UP
5	V2 + 15 190	V2 + 15 200	V2 + 15 210	1 UP
1	190	200	210	UP
Limit bank angle to 15° until reaching V2 + 15				

## 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.	
	<p>During climb, on airplanes with auxiliary fuel tanks, set both auxiliary tank fuel pump switches to OFF when both auxiliary tank fuel pump LOW PRESSURE lights illuminate.</p> <p>During climb, set both center tank fuel pump switches to OFF when both center tank fuel pump LOW PRESSURE lights illuminate.</p>
	<p>When established in a level flight attitude, on airplanes with auxiliary fuel tanks, if the auxiliary tank contains usable fuel and the auxiliary tank fuel pump switches are OFF, set both auxiliary tank fuel pump switches to ON again.</p> <p>Set both auxiliary tank fuel pump switches to OFF when both auxiliary tank fuel pump LOW PRESSURE lights illuminate.</p>

Pilot Flying	Pilot Monitoring
	<p>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.</p> <p>Set both center tank fuel pump switches to OFF when both center tank fuel pump LOW PRESSURE lights illuminate.</p>
	<p>During an ETOPS flight, additional steps must be done. See the ETOPS supplementary procedure in SP.1.</p>
	<p>Before the top of descent, modify the active route as needed for the arrival and approach.</p> <p>Verify or enter correct RNP for arrival.</p>

## 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, VREF + 15, 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/GEAR INHIBIT

switch ..... FLAP/GEAR 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"><li>• Verify that the ILS is tuned and identified</li><li>• Verify that LOC and G/S pointers are shown.</li></ul>	
Arm the APP mode. Engage the other autopilot.	
<b>WARNING: When using LNAV to intercept the localizer, LNAV might parallel the localizer without capturing it. The airplane can then descend on the glide slope with the localizer not captured.</b>	
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"><li>• "GEAR DOWN"</li><li>• "FLAPS 15"</li></ul>	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.

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<b>Pilot Flying</b>	<b>Pilot Monitoring</b>
Set the missed approach altitude on the MCP.	
Call “LANDING CHECKLIST.”	Do the LANDING checklist.
At the final approach fix or OM, verify the crossing altitude.	
Monitor the approach.	
Verify the AFDS status at 500 feet radio altitude.	

**Go-Around and Missed Approach Procedure**

Pilot Flying	Pilot Monitoring
At the same time: <ul style="list-style-type: none"><li>• push the TO/GA switch</li><li>• call "FLAPS 15".</li></ul>	Position the flap lever to 15 and monitor flap retraction.
Verify: <ul style="list-style-type: none"><li>• the rotation to go-around attitude</li><li>• that the thrust increases.</li></ul>	
	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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<b>Pilot Flying</b>	<b>Pilot Monitoring</b>
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.	
<b>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.</b>	
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 .....	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 and (on airplanes delivered prior to November, 1991) 115 V AC power available.

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.

Intentionally  
Blank

# DO NOT USE FOR FLIGHT

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 ..... 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.
- 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 indicator .....SET  
Set CAB ALT to new destination airport elevation minus 200 feet.
- LAND ALT indicator .....Reset  
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 indicator .....6000 feet  
CAB ALT indicator .....6000 feet

At initial descent or approximately 20 minutes prior to landing:

- LAND ALT indicator ..... Destination field elevation  
CAB ALT indicator .....Reset  
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 switches .....AUTO  
ISOLATION VALVE switch .....CLOSE  
Engine BLEED air switches .....OFF

---

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
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.

**Note:** During V/S mode operation with the A/T engaged, if airspeed becomes more than 5 knots below the MCP selected airspeed and is not increasing, the AFS automatically engages the LVL CHG mode.

---

## 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:** 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

# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Supplementary Procedures Communications**

### **Chapter SP Section 5**

#### **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

Intentionally  
Blank

**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 or APU LOW OIL QUANTITY light is extinguished.

Verify that the APU LOW OIL PRESSURE light is extinguished.

Verify that the APU FAULT or APU HIGH OIL TEMP 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

**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 and EGT indicators operate. The engine start switch must be held to GRD. Move the engine start lever to IDLE after 30 seconds. Release the engine start switch at 16-17% N1.

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.**

Intentionally  
Blank

# **DO NOT USE FOR FLIGHT**

737 Flight Crew Operations Manual

## **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.

Intentionally  
Blank

**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

**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

On airplanes with a FAIL light, check light illuminated.

On airplanes with a REPLY light, check light illuminated.

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

On airplanes with TCAS, 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 (Primus 90 radar)**

**CAUTION: Tests involving radiation of RF energy by the radar antenna must not be made while radar antenna is directed toward nearby large metal objects, during refueling operations or in the vicinity of trucks or containers holding flammable or explosive liquids. The antenna does not radiate while in TEST or STBY.**

Off switch ..... Push

GAIN control ..... Preset

INT switch ..... Midpoint

Antenna Tilt control ..... 15 degrees up

Range switch ..... TEST

Stab ON/OFF switch ..... ON

STBY switch ..... Push

One minute warm up time delay regardless of mode selected.

WX switch ..... Push

---

INT switch .....	Increase
	Increase the intensity of the display to the desired viewing level.
Verify the TEST pattern is displayed, that range is 100 nm with range markers labeled at 20-mile increments; preset receiver gain is indicated by 1-2-3 and color bar legend; and the scan line is present in the display.	
CYC switch .....	Push
	Verify the red 3-level band flashes on and off at 1/2 second intervals.
WX switch .....	Push
	This restores the weather mode operation.
AZIM switch .....	Push
	Verify azimuth lines are displayed at 30-degree intervals.
SEC SCAN switch .....	Push
	Verify the displayed scan width reduces to 80-degrees wide.
AZIM and SEC SCAN switches .....	Push
	To remove azimuth lines and restore 160-degree scan.
FRZ switch .....	Push
	Verify there is no scan line and that FRZ is displayed as a blinking word.
FRZ switch .....	Push
	Verify normal scan has resumed.
TGT ALRT switch .....	Push
	When the scan line is at either edge of the display, push the TGT ALRT switch. Verify the T in the red box appears. When the scan line enters the target alert sector verify the T is replaced by a flashing TGT.
TGT ALRT switch .....	Push
	Verify target alert extinguished.
MAP switch .....	Push
	Verify test pattern is displayed; note particularly the change in colors from green-yellow-red to blue-yellow-magenta.
System switches .....	As required

## IRS

### Align Light(s) Flashing

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

If CDU message “IRS MOTION” appears in the scratch pad:

Airplane ..... STOP MOTION

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 present position

Enter present position using most accurate latitude and longitude available.

**Note:** Approximately ten minutes are required for alignment.

If CDU message “IRS MOTION” does not appear in the scratch pad:

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.

On airplanes with FMC U1.0, U1.1, U1.2 or U3.0:

ISDU display selector .....PPOS

Verify both the ISDU and FMC/CDU display the same present position. Verify for both left and right IRS's

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 (U5) Intercept Course (overwrite)

RTE LEGS page ..... Select

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

(U5 and on) Observe INTC CRS prompt in line 6R.

(U5 and on) 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.

(U5 and on) 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.

**Note:** (U1) FMC can only intercept the flight plan course to the entered waypoint. The waypoint must be in the flight plan before entry will be allowed into the INTC LEG TO prompts.

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

**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.

---

## 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 PROGRESS 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.

## 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.

(U3.1 and on) 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 (U4 and on)

**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.

### 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. If the airplane is equipped with an aux tank, additional fuel can be loaded into the aux tank for greater desired fuel loading.

**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.

### Auxiliary Tank (as installed)

**Note:** Ensure all fuel pump switches are off during pressure refueling of the auxiliary tank to avoid an inadvertent transfer of fuel into the auxiliary tank.

The manual defueling and crossfeed valves must be open when pressure refueling the auxiliary tank.

### 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 fueling valve, 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

**Note:** When the aux tank fueling valve switch (as installed) is OPEN, the crossfeed valve is open, regardless of the position of the crossfeed selector.

Manual defueling valve .....Open

Center tank fueling valve switch  
(If fuel transfer into the center tank is desired) .....OPEN

---

Auxiliary tank fueling valve switch (as installed) (If fuel transfer into the aux tank is desired) .....	OPEN
Fuel transfer .....	Monitor The center and aux tank (as installed) fuel quantity indicators show an increase in fuel. The main tank indicators show a decrease in fuel.
Center and aux tank (as installed) fueling valve switches .....	CLOSE 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 0” 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:

“ERR 4” for approximately two seconds (early versions of indicators.)

All segments for two seconds

Blank for two seconds

Stored error codes (if any) for two seconds each

Indicator full scale value for up to two seconds

Actual fuel quantity.

Intentionally  
Blank

### 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.

Intentionally  
Blank

### **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.

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 levers .....Idle 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 trim .....Full 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 switch .....GRD F/O

Reduces possible pressure changes when the Engine BLEED air switches are turned OFF.

Engine BLEED air switches .....OFF F/O

Reduces the possibility of fumes entering the air conditioning system.

APU BLEED air switch .....OFF F/O

Reduces the possibility of fumes entering the air conditioning system.

After de-icing/anti-icing is completed:

APU .....As needed F/O

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 switches .....ON F/O

If the engines are running:

FLT/GRD switch .....FLT 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.

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 for airplanes without 45% N1 placard:

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).

If moderate to heavy rain, hail or sleet is encountered for airplanes with 45% N1 placard:

- ENGINE START switches ..... FLT
- Autothrottle ..... Disengage
- Minimum Engine N1 ..... 45%
- 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.

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## 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 V<sub>r</sub> speed to the performance limited gross weight rotation speed, not to exceed actual gross weight V<sub>r</sub> + 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 V<sub>r</sub>, do not attempt to accelerate to the increased V<sub>r</sub> 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**

737 Flight Crew Operations Manual

**Performance Dispatch**

**Chapter PD**

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# **DO NOT USE FOR FLIGHT**

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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)					600	TAILWIND COMPONENT (KTS)				
100	80	60	40	20		20	40	60	80	100
270	252	236	223	210		190	181	172	165	158
543	506	475	447	422		379	361	345	330	316
817	762	714	671	633		56 9	542	517	494	473
1094	1019	953	896	845		759	722	688	658	630
1372	1277	1194	1121	1057		948	902	860	821	786
1651	1535	1435	1347	1269		1137	1081	1030	984	942
1931	1795	1676	1573	1481		1326	1261	1201	1147	1097
2211	2054	1918	1799	1693		1516	1440	1372	1310	1253
2492	2314	2160	2025	1905		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.

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# 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

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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			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

## 737 Flight Crew Operations Manual

**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%.

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**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

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**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.

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**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

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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.

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## 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.

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## 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 Inflight**

**Chapter PI**

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# **DO NOT USE FOR FLIGHT**

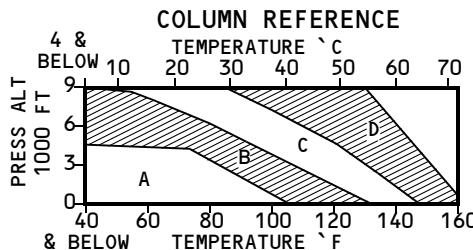
## **737 Flight Crew Operations Manual**

Performance Inflight -  
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**Performance Inflight****General****Chapter PI****Section 10****Takeoff Speeds**

WEIGHT 1000 KG	SLOPE/WIND V1 ADJUSTMENT*		
	SLOPE DN	% UP	WIND KTS TAIL HEAD
1000	-2	0	-15 0 40
65	-2	0	3 -3 0 1
55	-2	0	2 -3 0 1
45	-2	0	1 -3 0 1
35	-2	0	1 -3 0 1

\*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 V<sub>1</sub>(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).

## 737 Flight Crew Operations Manual

**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.

## 737 Flight Crew Operations Manual

**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.

## 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)		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).

## 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)			0.25 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.

## 737 Flight Crew Operations Manual

**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.

## 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
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	93.6				
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

## 737 Flight Crew Operations Manual

**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)

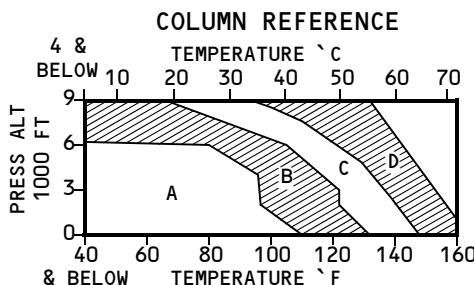
With engine bleed to packs off, increase %N1 by 1.0.

**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.

## 737 Flight Crew Operations Manual

**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<sub>R</sub>

FLAPS	WT 1000 KG	A			B			C			D		
		V <sub>1</sub>	V <sub>R</sub>	V <sub>2</sub>	V <sub>1</sub>	V <sub>R</sub>	V <sub>2</sub>	V <sub>1</sub>	V <sub>R</sub>	V <sub>2</sub>	V <sub>1</sub>	V <sub>R</sub>	V <sub>2</sub>
1	65	161	163	166	161	164	167	147 149 152 139 140 144 130 131 137 121 122 129 111 112 121			132 133 136 123 124 128 114 114 120		
	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	148 151 154 140 143 146 133 134 139 124 126 131 116 117 124			127 127 131 118 118 124 109 109 116		
	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	136 136 138 128 128 132 119 120 125 110 111 118 101 102 111			121 121 125 112 112 118 103 103 110		
	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 V<sub>1</sub>(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

## 737 Flight Crew Operations Manual

**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
5800	47.2	35.0	29.2	49.6	37.9	31.5	53.3	41.8
6200	53.9	40.5	33.9	56.1	43.4	36.3	60.0	47.3
6600	60.5	46.1	38.6	62.5	48.9	41.1	66.7	52.6
7000	67.2	51.6	43.3	69.0	54.4	46.0	73.4	58.1
7400	73.8	57.2	48.0	75.5	59.9	50.8		63.6
7800		62.9	52.7		65.4	55.7		69.1
8200			68.5	57.4		70.9	60.6	
8600			74.1	62.1			65.5	
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.

**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).

## 737 Flight Crew Operations Manual

**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.

## 737 Flight Crew Operations Manual

**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)		PRESS ALT (FT)		PRESS ALT (FT)		
S.L.	4000	8000	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 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 (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.

## 737 Flight Crew Operations Manual

**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 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).

**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.

**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		°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)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>6.5</b> 3100	<b>6.5</b> 2800	<b>6.0</b> 1800	<b>5.5</b> 1000	<b>5.5</b> 300
30000 (.73M)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>7.0</b> 3900	<b>6.5</b> 3600	<b>6.0</b> 2500	<b>5.5</b> 1700	<b>5.5</b> 1100
25000 (280 KIAS)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>7.0</b> 3700	<b>6.5</b> 3500	<b>6.0</b> 2500	<b>6.0</b> 1800	<b>6.0</b> 1300
20000 (280 KIAS)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>8.5</b> 4600	<b>8.5</b> 4300	<b>7.5</b> 3100	<b>7.0</b> 2300	<b>7.0</b> 1800
15000 (280 KIAS)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>10.5</b> 5400	<b>10.0</b> 5100	<b>9.0</b> 3800	<b>8.0</b> 2900	<b>8.0</b> 2200
10000 (280 KIAS)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>13.0</b> 6300	<b>12.0</b> 5900	<b>10.5</b> 4400	<b>9.5</b> 3400	<b>9.0</b> 2700
5000 (280 KIAS)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>15.0</b> 7100	<b>14.5</b> 6700	<b>12.0</b> 5000	<b>11.0</b> 3900	<b>10.0</b> 3100
SEA LEVEL (280 KIAS)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>17.5</b> 7900	<b>17.0</b> 7400	<b>14.0</b> 5600	<b>12.5</b> 4400	<b>11.5</b> 3500

**Cruise**

**Flaps Up, Adjust %N1 for Level Flight**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		34	38	42	46	50
30000 (.73M)	<b>PITCH ATT</b> %N1	<b>2.0</b> 79	<b>2.0</b> 79	<b>2.5</b> 80	<b>3.0</b> 81	<b>3.0</b> 82
10000 (280 KIAS)	<b>PITCH ATT</b> %N1	<b>2.0</b> 65	<b>2.0</b> 65	<b>2.5</b> 66	<b>3.0</b> 66	<b>3.0</b> 67

**Descent**

**Flaps Up, Set Idle Thrust**

PRESSURE ALTITUDE (FT) (SPEED)		WEIGHT (1000 KG)				
		34	38	42	46	50
30000 (.73M)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>-3.5</b> -4200	<b>-3.0</b> -3800	<b>-2.5</b> -3600	<b>-2.0</b> -3400	<b>-1.5</b> -3300
20000 (280 KIAS)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>-2.5</b> -2900	<b>-2.0</b> -2600	<b>-1.0</b> -2500	<b>-0.5</b> -2300	<b>0.0</b> -2200
10000 (280 KIAS)	<b>PITCH ATT</b> V/S (FT/MIN)	<b>-2.5</b> -2500	<b>-2.0</b> -2300	<b>-1.5</b> -2200	<b>-1.0</b> -2100	<b>-0.5</b> -2000

**Holding**

**Flaps Up, Adjust %N1 for Level Flight**

PRESSURE ALTITUDE (FT)		WEIGHT (1000 KG)				
		34	38	42	46	50
10000	<b>PITCH ATT</b> %N1 KIAS	<b>4.0</b> 56 210	<b>4.5</b> 57 210	<b>5.5</b> 59 210	<b>5.5</b> 61 215	<b>5.5</b> 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	<b>3.5</b>	<b>5.0</b>	<b>6.0</b>	<b>6.5</b>	<b>7.0</b>
	%N1	52	55	58	62	65
	KIAS	210	210	210	220	230
FLAPS 1 (GEAR UP)	PITCH ATT	<b>4.0</b>	<b>5.5</b>	<b>6.5</b>	<b>7.0</b>	<b>7.5</b>
	%N1	55	57	60	64	67
	KIAS	190	190	190	200	210
FLAPS 5 (GEAR UP)	PITCH ATT	<b>3.5</b>	<b>4.5</b>	<b>6.0</b>	<b>6.5</b>	<b>6.5</b>
	%N1	55	58	61	65	68
	KIAS	180	180	180	190	200
FLAPS 15 (GEAR DOWN)	PITCH ATT	<b>3.5</b>	<b>5.5</b>	<b>7.5</b>	<b>8.0</b>	<b>8.0</b>
	%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	<b>4.5</b>	<b>4.5</b>	<b>4.5</b>	<b>4.5</b>	<b>4.5</b>
	%N1	43	48	52	56	60
	KIAS	123	138	151	163	173
FLAPS 30 (VREF 30+10)	PITCH ATT	<b>2.0</b>	<b>2.0</b>	<b>2.0</b>	<b>2.5</b>	<b>2.5</b>
	%N1	48	53	58	62	65
	KIAS	116	129	141	152	162
FLAPS 40 (VREF 40+10)	PITCH ATT	<b>0.5</b>	<b>0.5</b>	<b>0.5</b>	<b>0.5</b>	<b>0.0</b>
	%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.

## 737 Flight Crew Operations Manual

**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.

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# 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	NO REV			
MAX MANUAL	2520	290/-160	50	-90 320 30	-30 50	-50	200	30	120		
MAX AUTO	3200	260/-220	70	-120 410 0	0 70	-70	320	0	10		
AUTOBRAKE 3	4430	400/-370	110	-200 680 20	-40 110	-110	450	40	60		
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		

**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)								APPROACH SPEED
		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	
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).

## 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 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).

## 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 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
GROUND	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					
45	113	92.6	93.1	93.6	93.9	93.9	94.5	94.3			
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**

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**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.

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**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

**737 Flight Crew Operations Manual**

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.

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Pitch attitude is shown in bold type for emphasis since altitude and/or vertical speed indications may also be unreliable.

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## 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.

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## 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**

## **737 Flight Crew Operations Manual**

### **Airplane General, Emergency Equipment, Doors, Windows**

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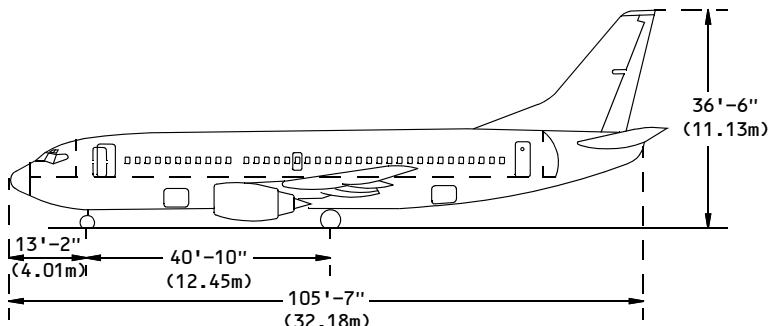
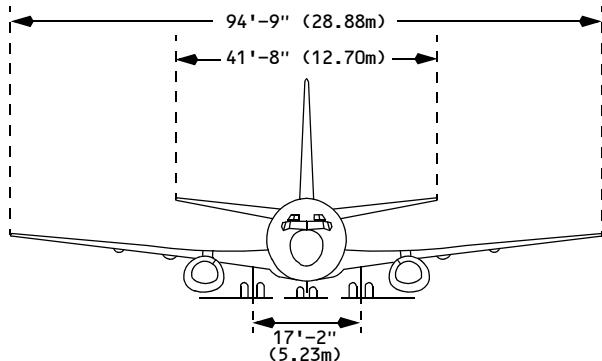
# DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

## Airplane General, Emergency Equipment, Doors, Windows Dimensions

## Chapter 1 Section 10

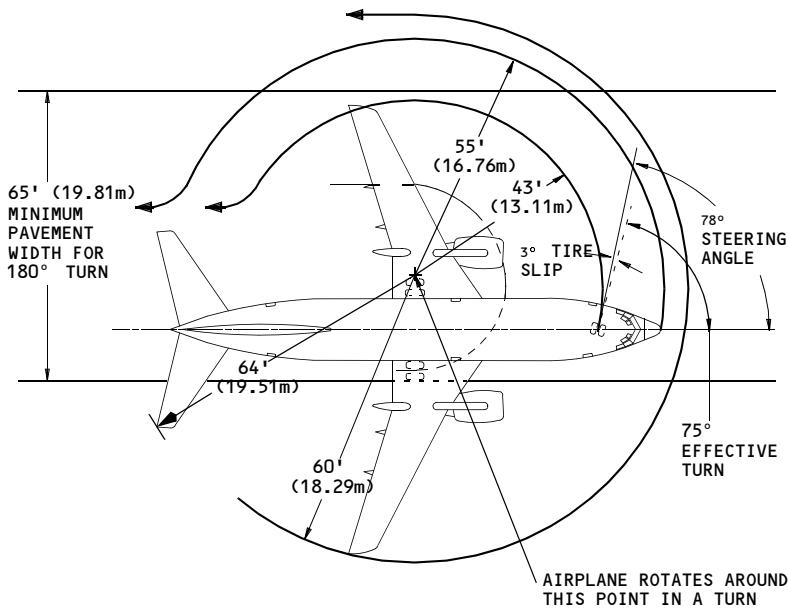
### Principal Dimensions



737-300

## 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

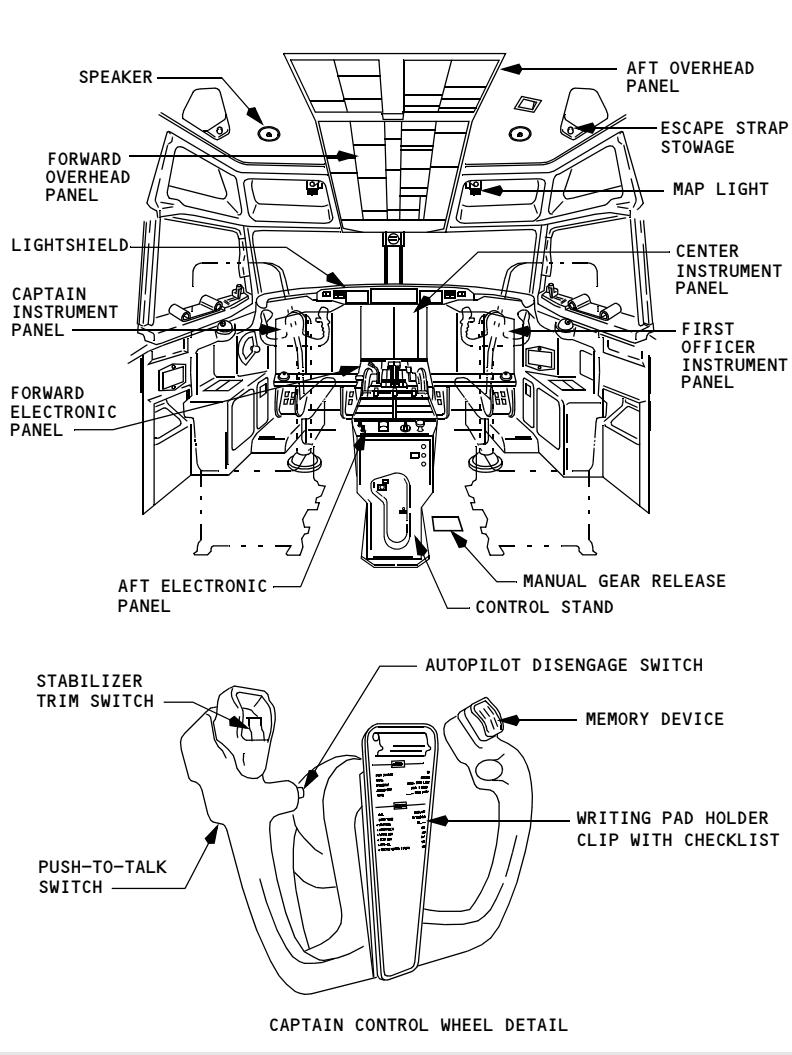
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737 Flight Crew Operations Manual

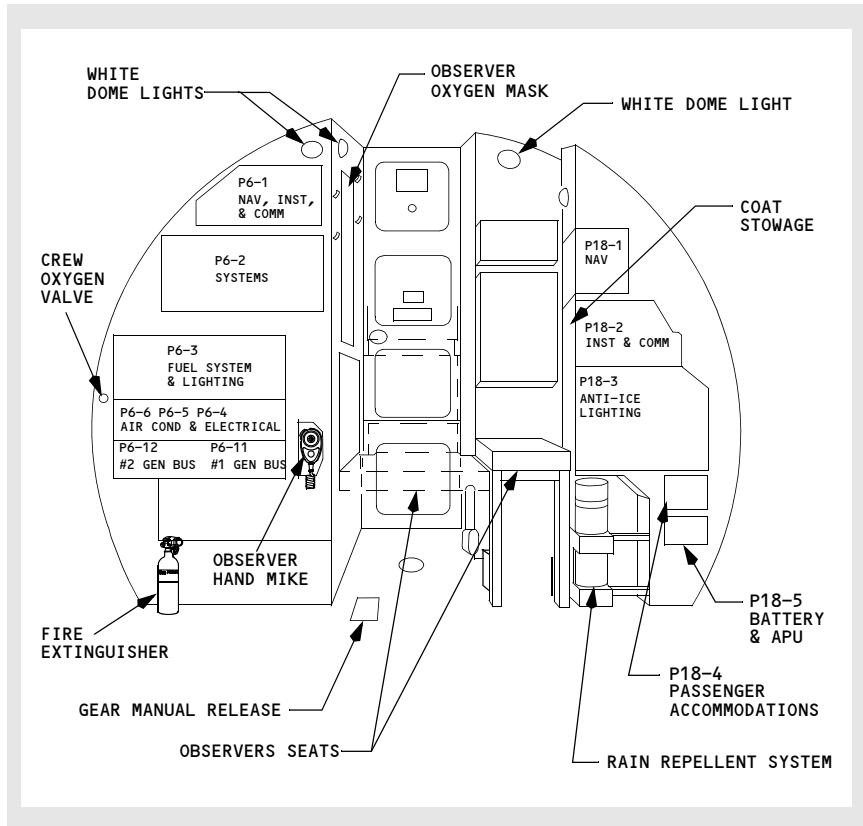
## Airplane General, Emergency Equipment, Doors, Windows Instrument Panels

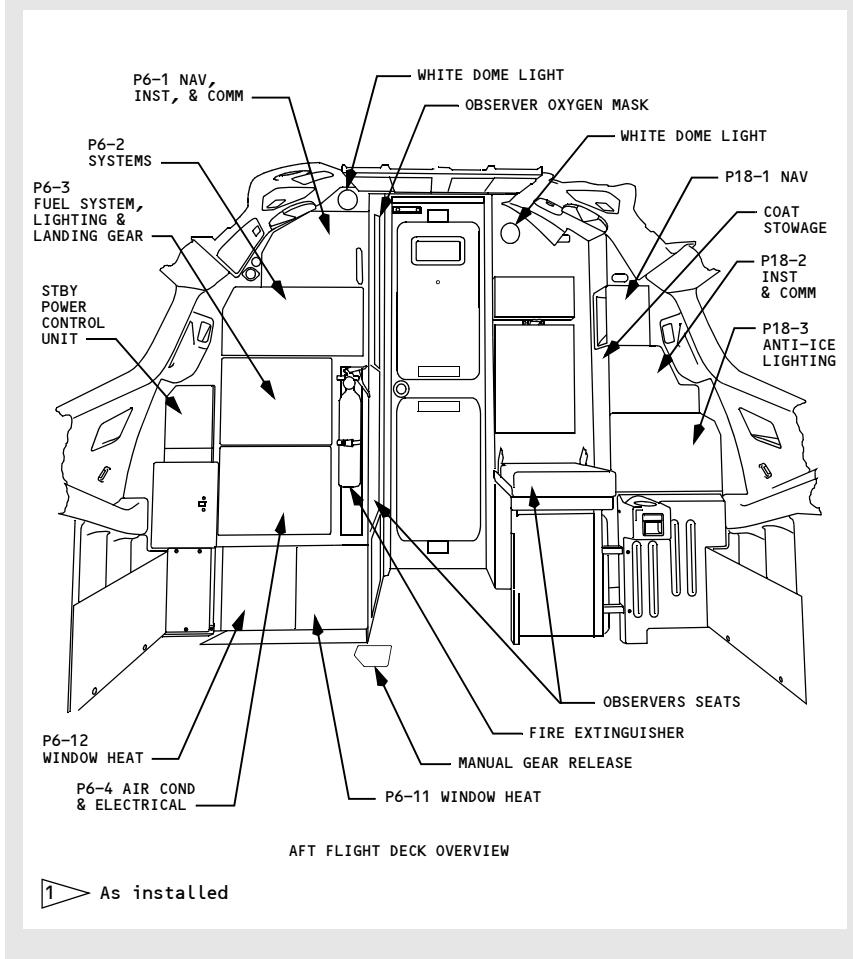
## Chapter 1 Section 20

### Panel Arrangement



## Aft Flight Deck Overview



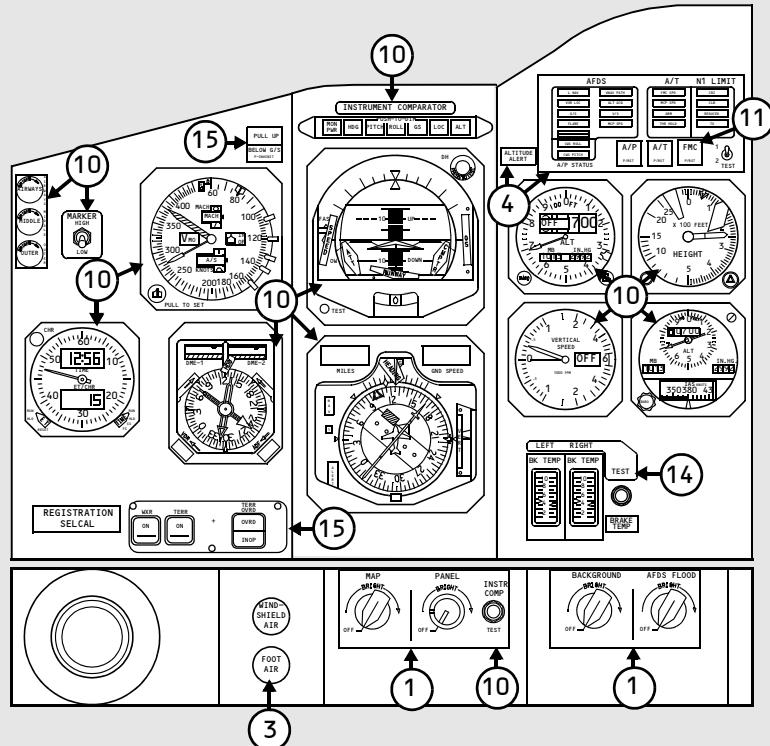


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## Instrument Panels

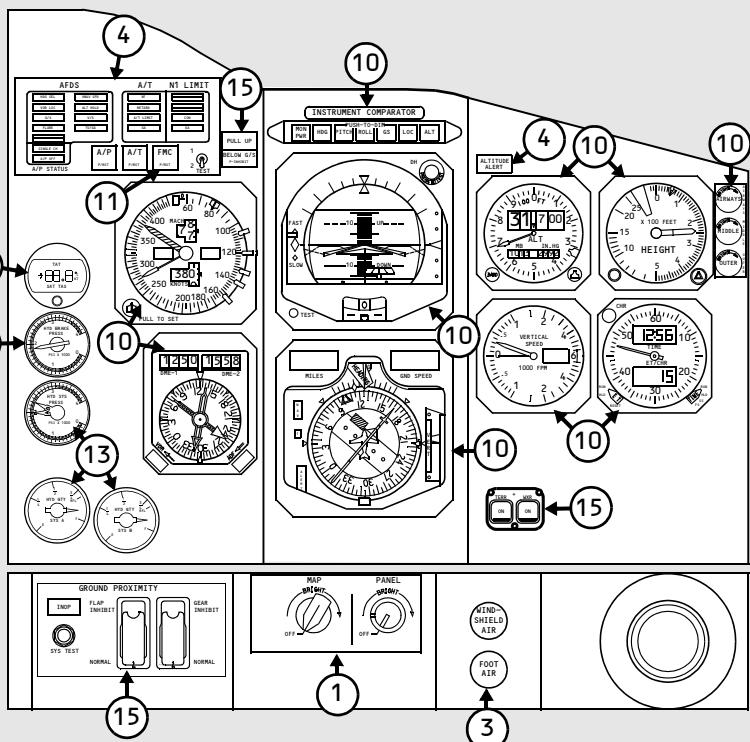
**Note:** The controls, panels and indicators shown in this chapter are representative of installed units and may not exactly reflect the details of the latest configuration. Refer to the corresponding chapter under system descriptions for current chapter information.

### Captain's Instrument Panel



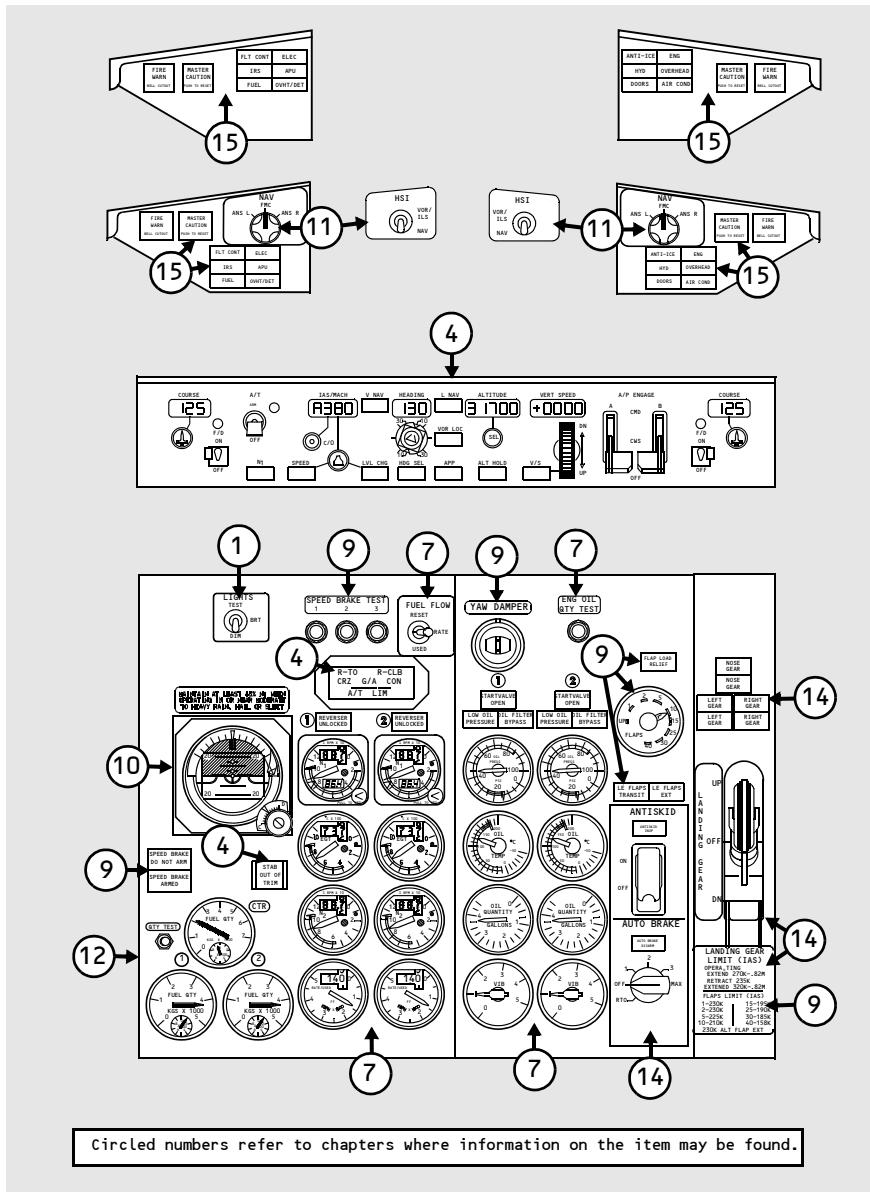
Circled numbers refer to chapters where information on the item may be found.

## First Officer's Instrument Panel



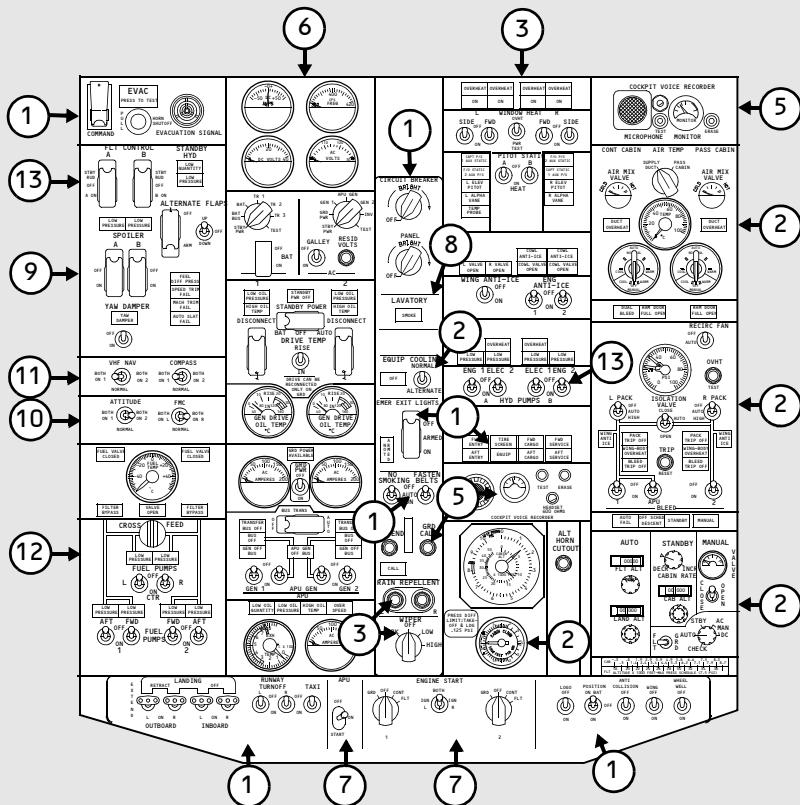
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## Center Instrument Panel and Lightshield



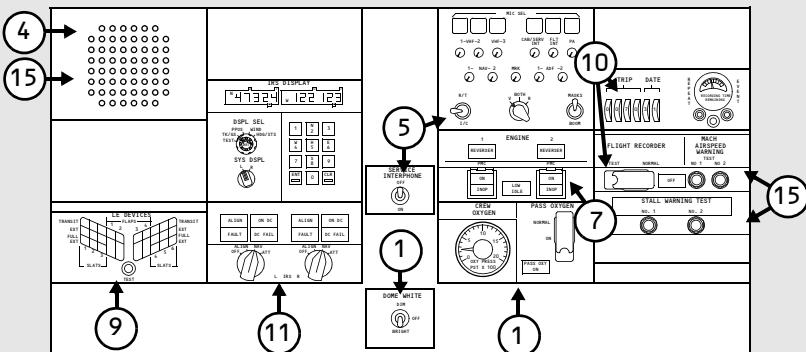
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## Forward Overhead Panel



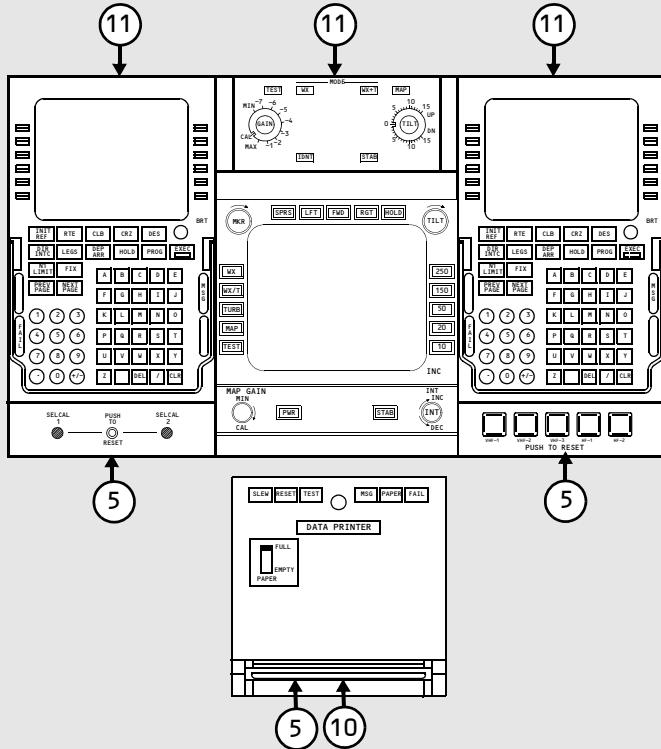
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## Aft Overhead Panel



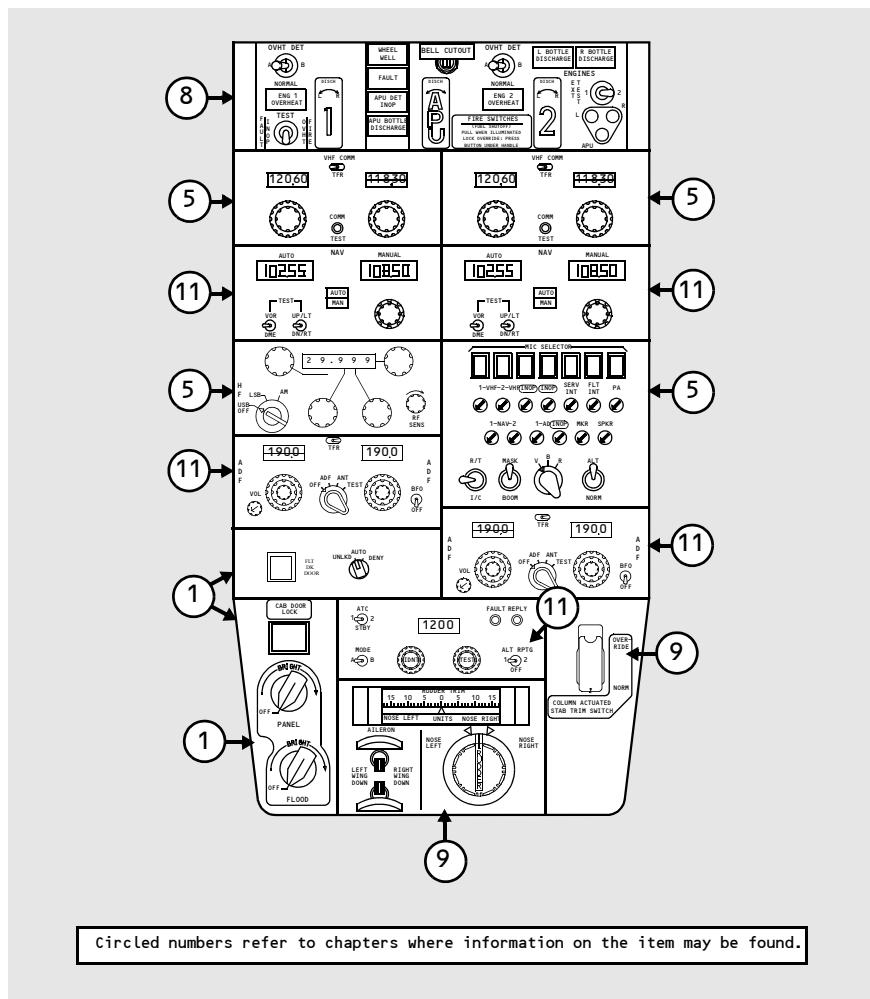
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## Forward Electronic Panel

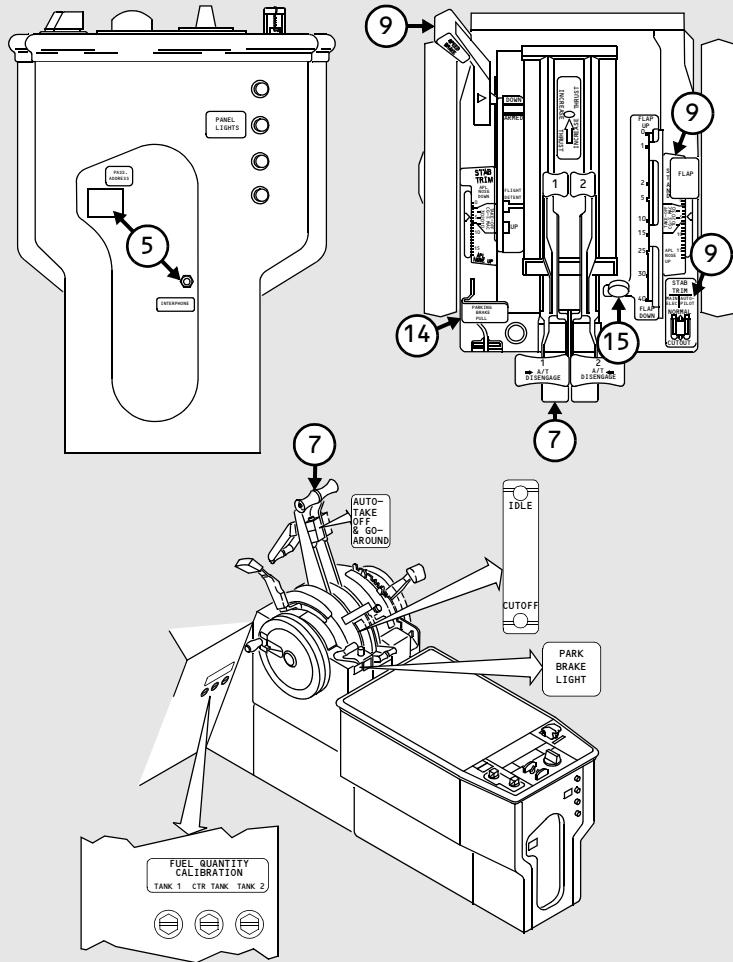


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## Aft Electronic Panel

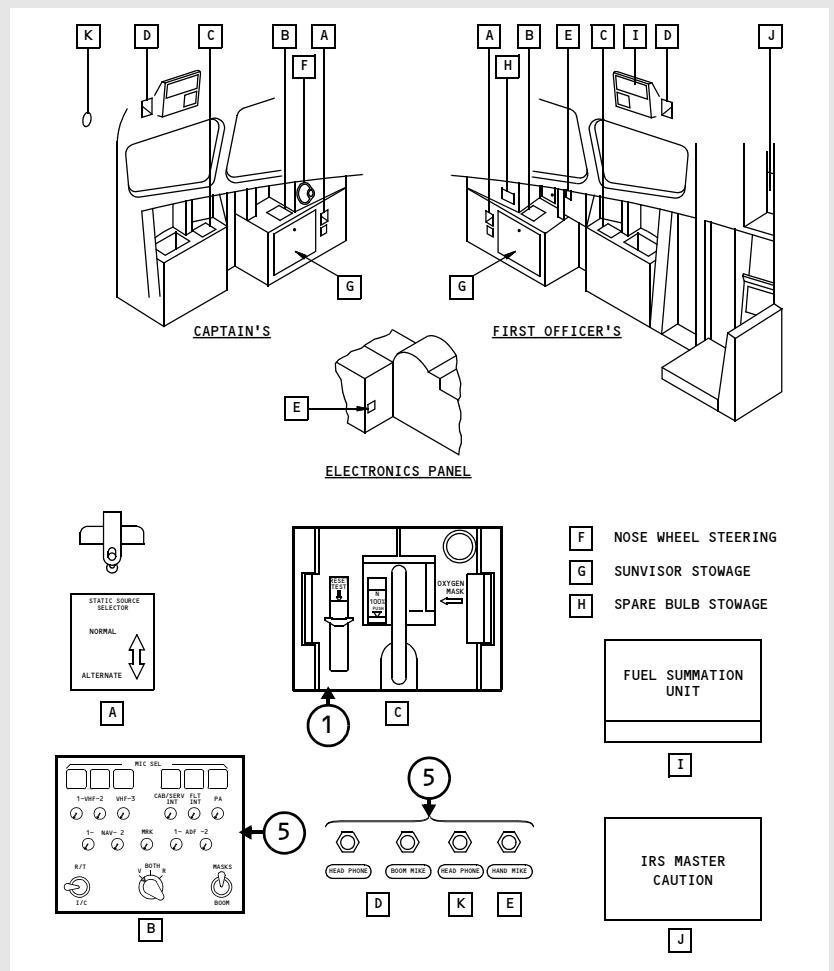


## Control Stand



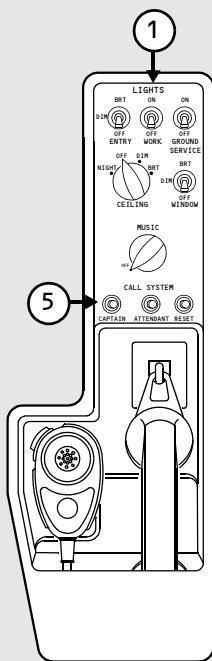
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## Auxiliary Panels

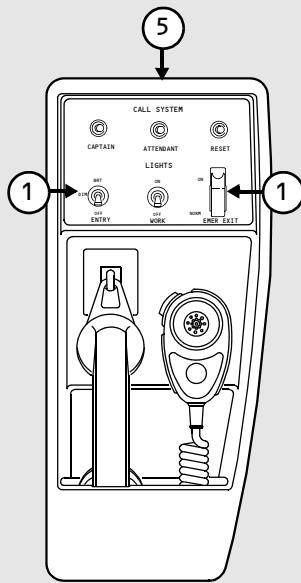


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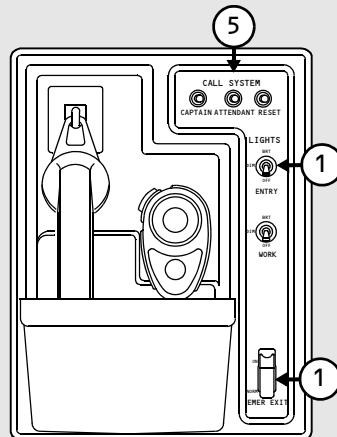
## Attendant Panels



**FORWARD ATTENDANT  
PANEL**

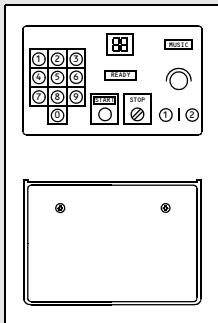


**AFT ATTENDANT PANEL**

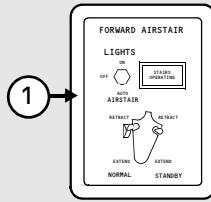


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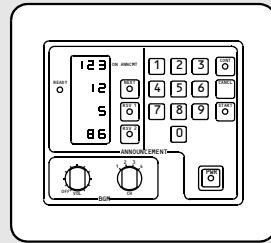
## Misc Attendant Panels



**MUSIC ANNOUNCE  
PANEL**



**FORWARD AIRSTAIR**



**PRERECORDED  
ANNOUNCEMENT PANEL**

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737 Flight Crew Operations Manual

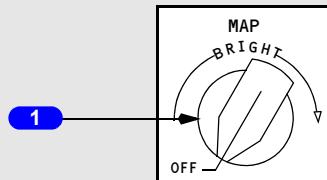
## Airplane General, Emergency Equipment, Doors, Windows Controls and Indicators

## Chapter 1

### Section 30

#### Flight Deck Lighting

##### Map Light Controls

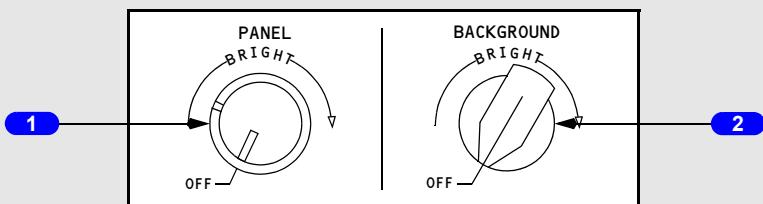


CAPTAIN'S / FIRST OFFICER'S PANEL

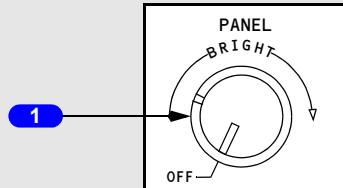
##### 1 MAP Light Control

Rotate – adjusts brightness of Captain/First Officer map lights.

#### Panel and Background Lighting



CAPTAIN'S PANEL



FIRST OFFICER'S PANEL

## 1 PANEL Light Control

Rotate –

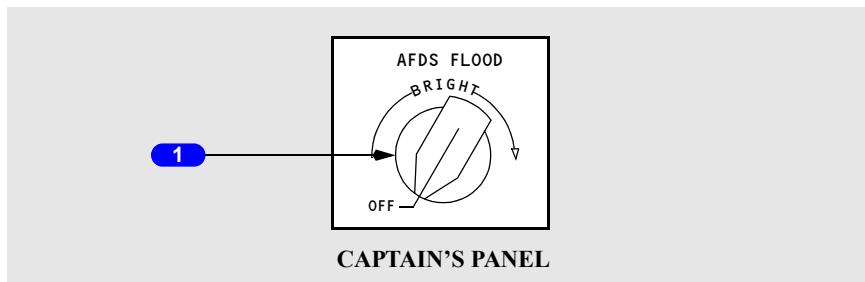
- Regulates the intensity of the integral instrument lights in the Captain's or First Officer's instrument panel and center instrument panel
- Outer knob controls the integral instrument lights
- Inner knob controls the HSI digital indicator lights.

## 2 BACKGROUND Light Control

Rotate –

- Controls fluorescent lighting brightness for Captain's panel, First Officer's panel, and center panel.

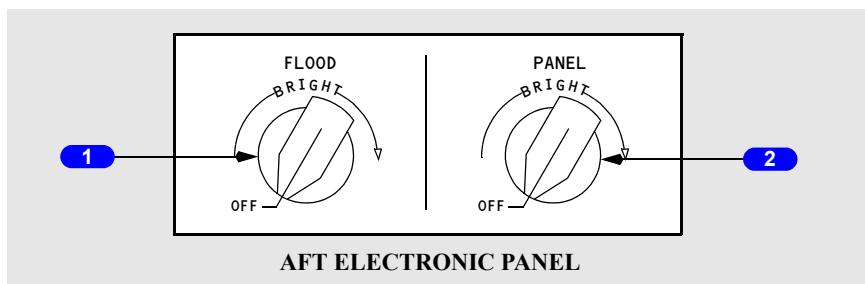
## AFDS Flood Light Control



## 1 AFDS FLOOD Light Control

Rotate – controls brightness of lighting directed at AFDS panel.

## Flood and Aft Electronic Panel Lights Controls



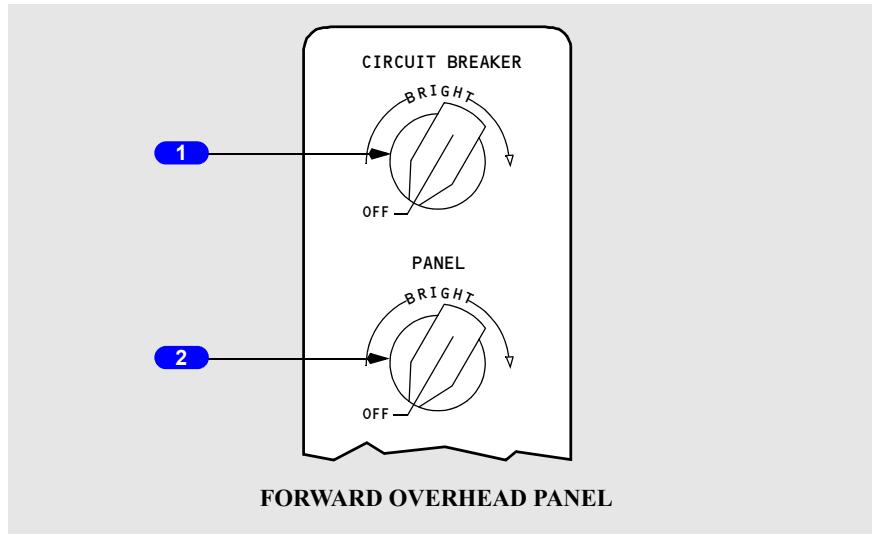
## 1 FLOOD Light Control

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



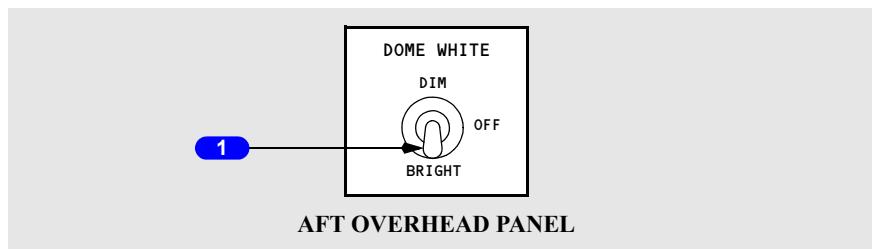
## 1 CIRCUIT BREAKER Light Control

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



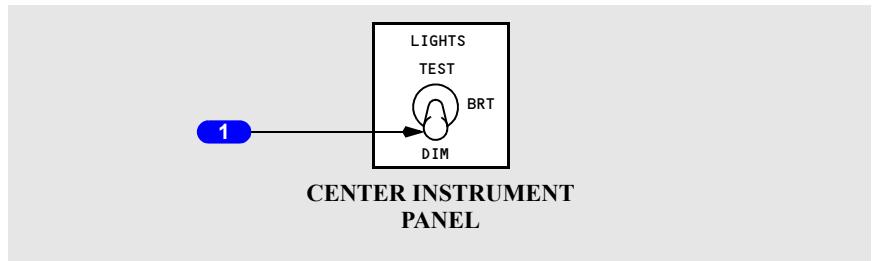
## 1 DOME Light Control

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

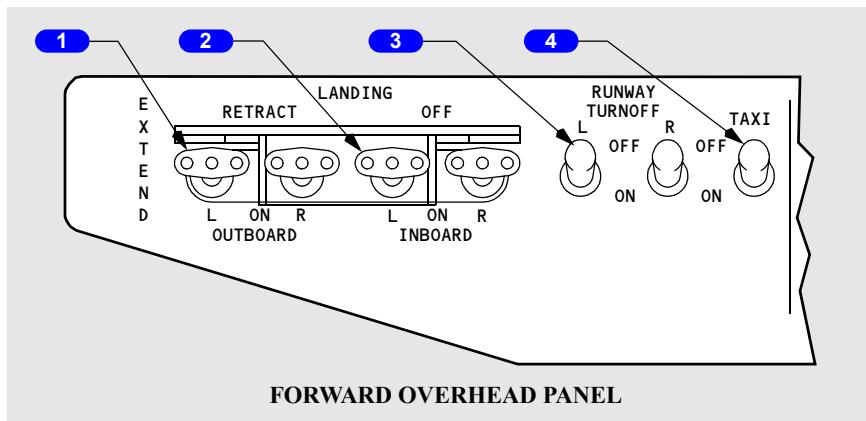
TEST – illuminates all system lights on forward and aft overhead panels, and some lights on Captain's and First Officer's instrument panels to full brightness.

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.

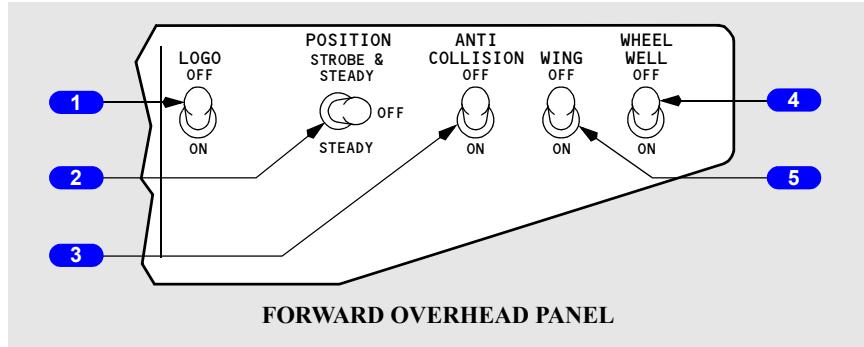
ON – runway turnoff lights are illuminated.

## 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.

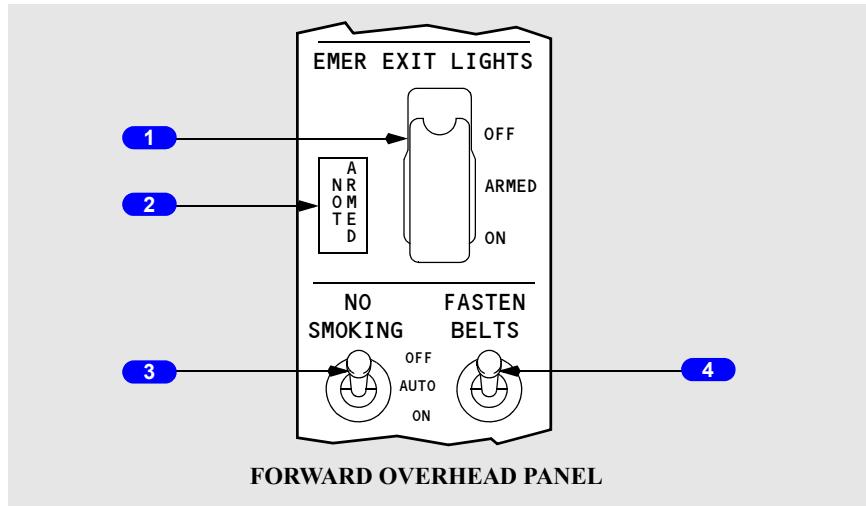
### **5 WING Illumination Switch**

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.

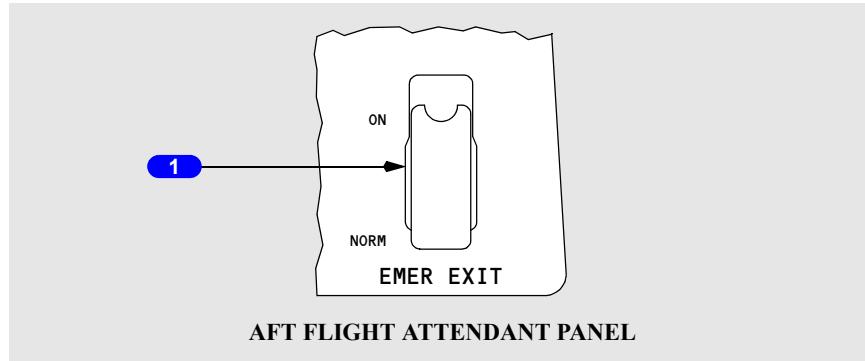
**4 SEAT BELTS Lights Switch**

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**



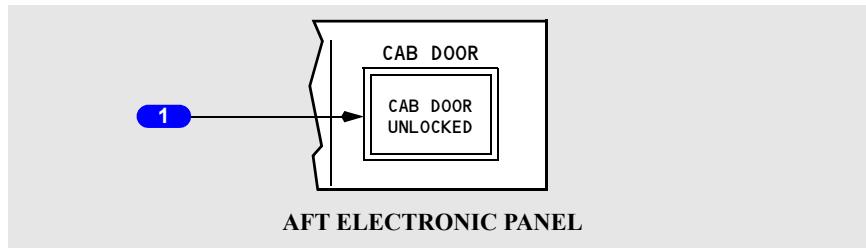
**1 Passenger Cabin Emergency Exit Lights Switch (guarded, red)**

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)

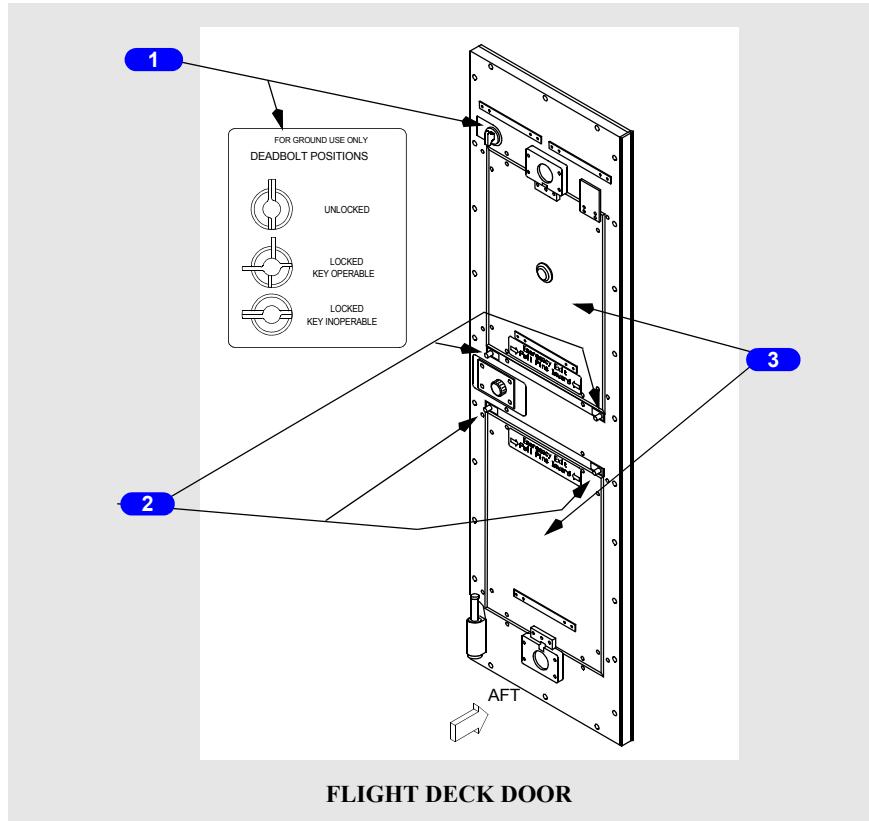


#### 1 Cabin Door (CAB DOOR) Lock Switch

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

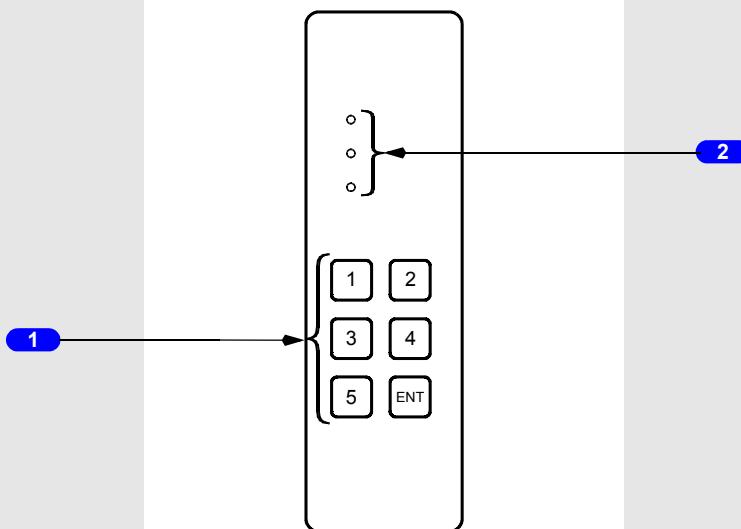
### 2 Release Pins

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.

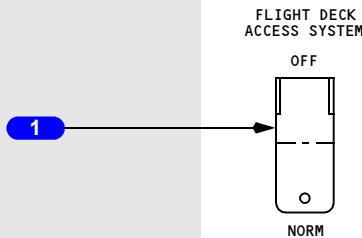
### 2 Access Lights

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



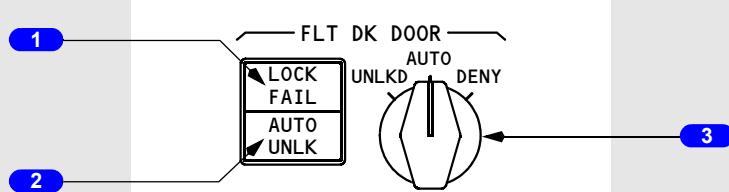
**FLIGHT DECK SIDE DOOR POST**

### 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.

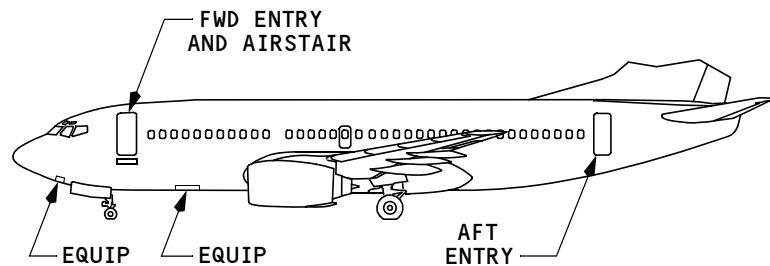
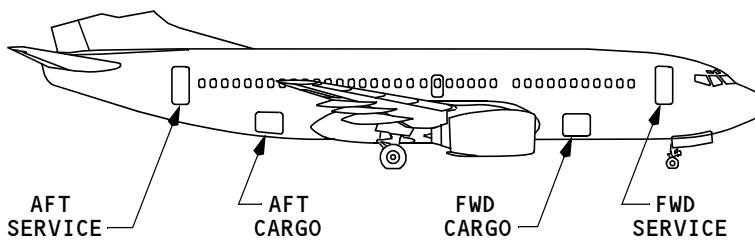
DENY - rejects keypad entry request and prevents further emergency access code entry for a time period.

### Exterior Door Announcer Lights

1



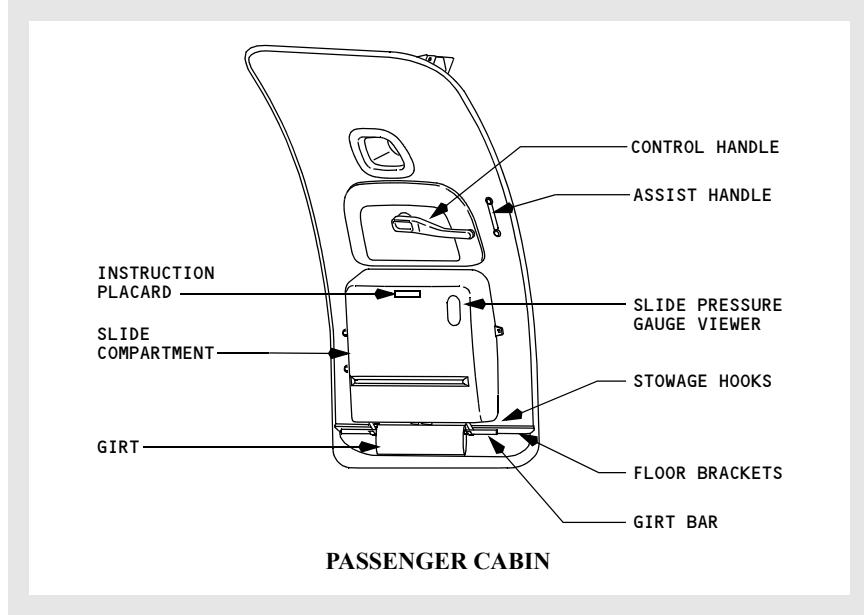
FORWARD OVERHEAD PANEL



### 1 Interior Door Annunciations

Illuminated (amber) – related door is unlocked.

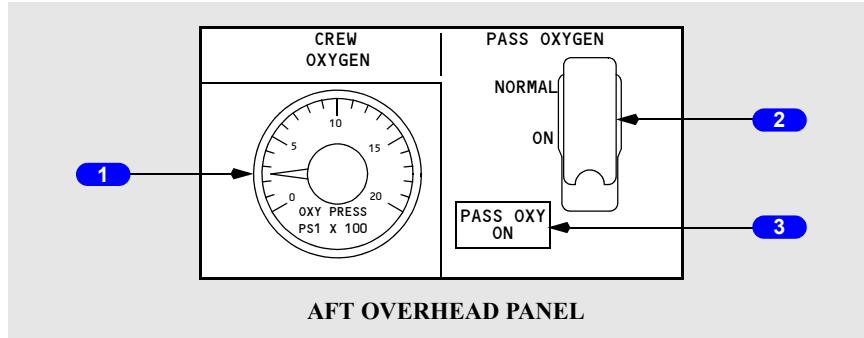
## Passenger Entry/Galley Service Doors



**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.

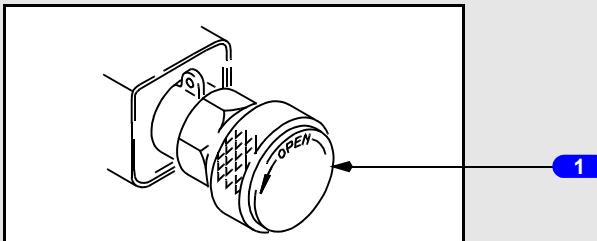
## **2 Passenger Oxygen (PASS OXYGEN) Switch**

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.



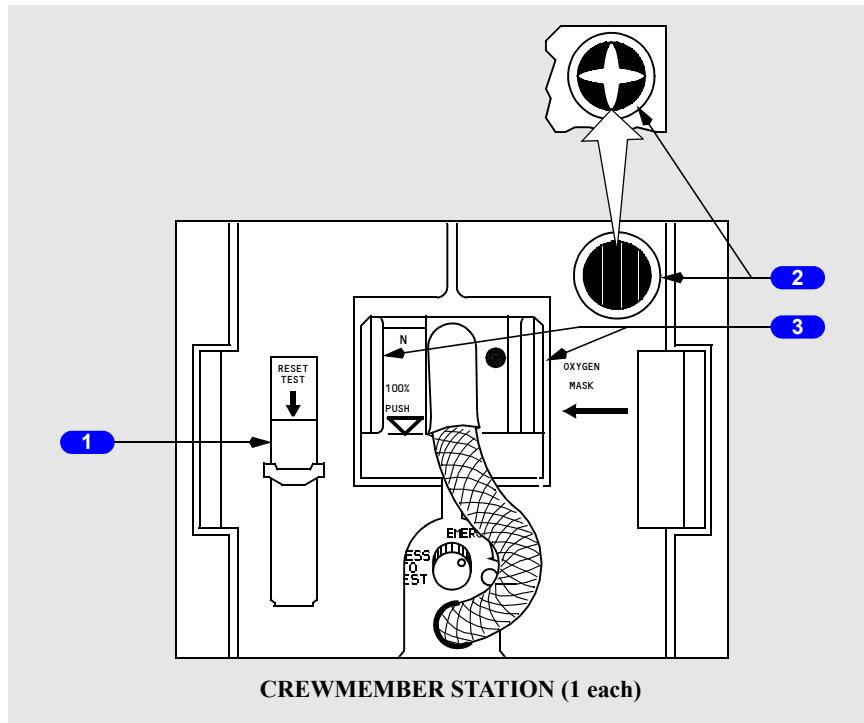
**RIGHT FLIGHT DECK BULKHEAD  
BEHIND FIRST OFFICER'S SEAT**

## **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

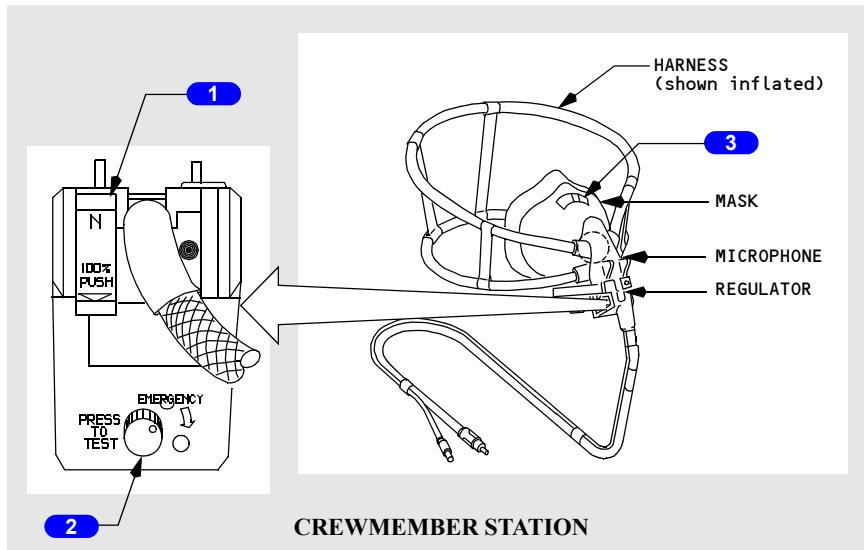
Indicates a yellow cross when oxygen is flowing.

### 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.

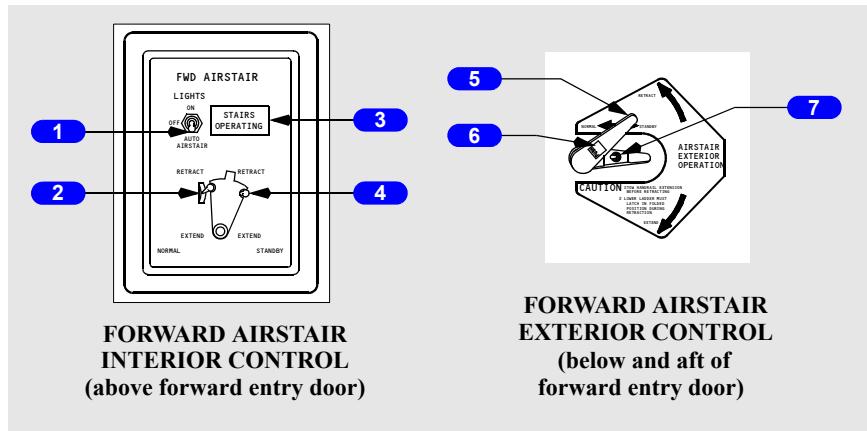
### 3 Smoke Vent Valve Selector

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.

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**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.

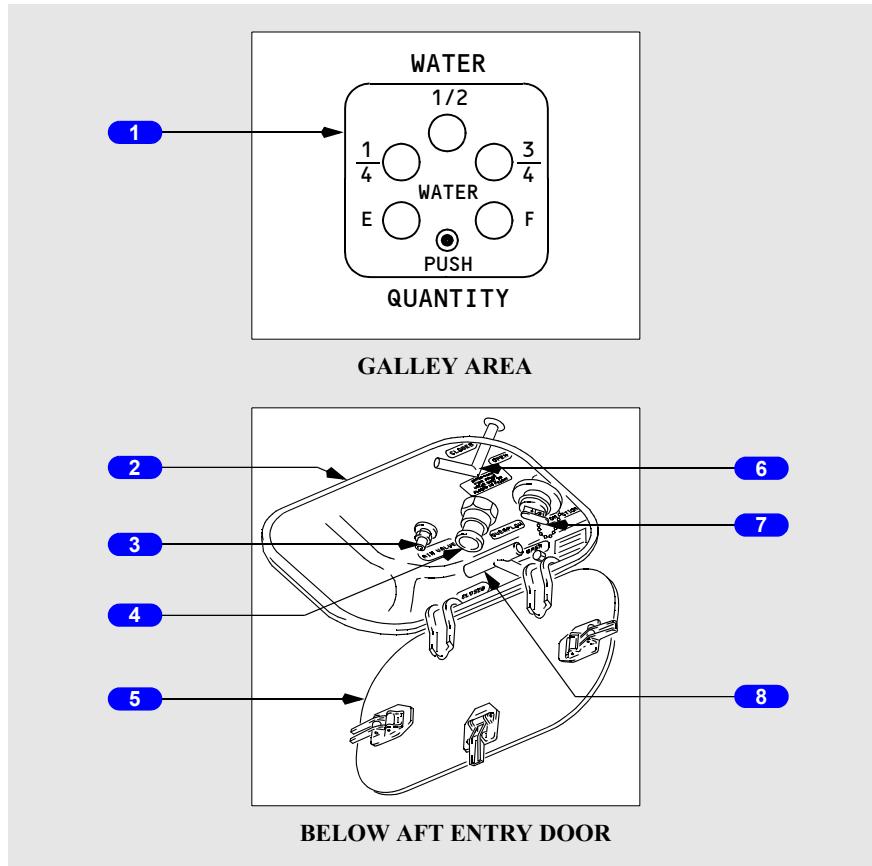
**7 NORMAL/STANDBY Switch**

(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

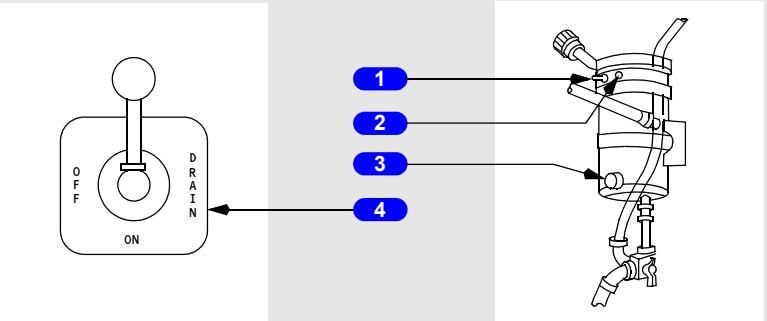
Used to fill tank.

## 8 Tank Drain Valve Handle

Open – drains water from tank.

Closed – normal position.

## Lavatory Controls



### 1 Water Heater Switch

On – activates the water heater.

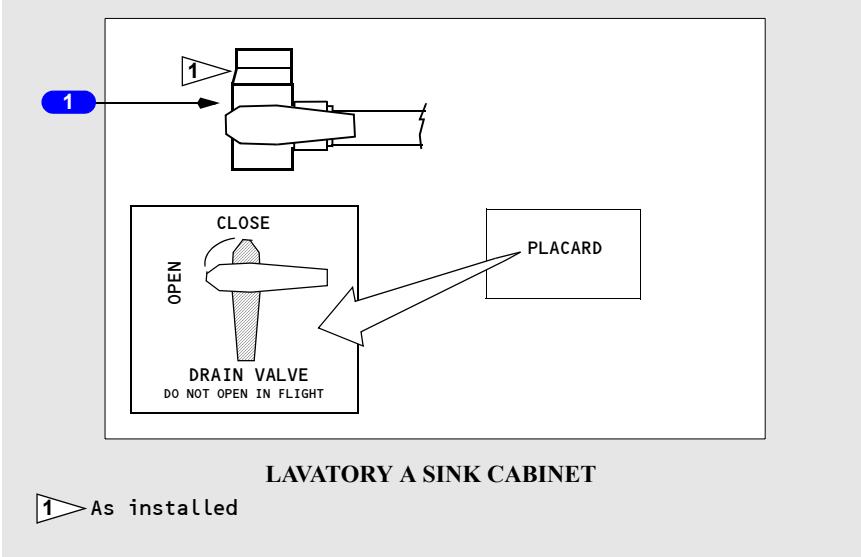
### 2 Water Heater Light

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.

Intentionally  
Blank

### **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.

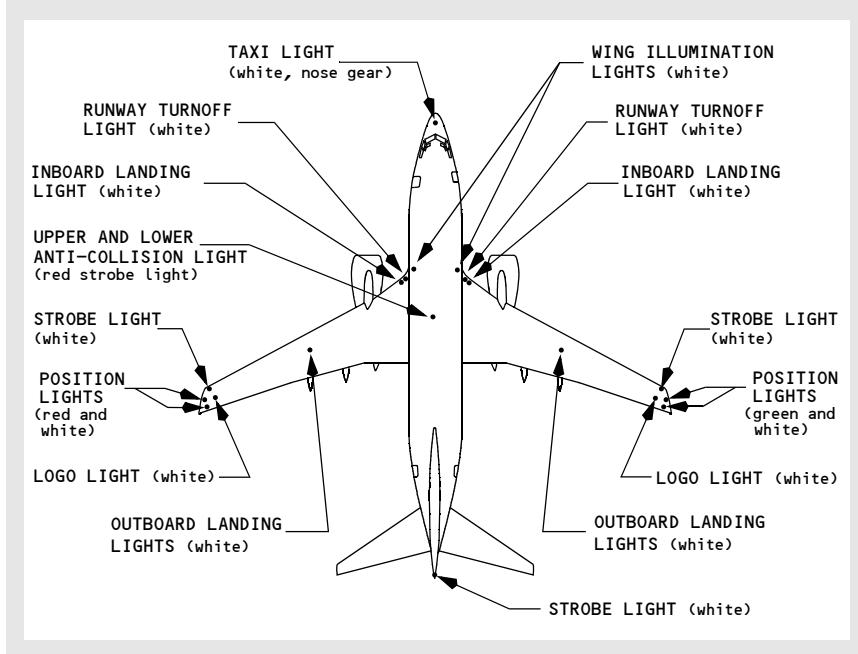
## Wing Illumination Lights

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.

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## 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:

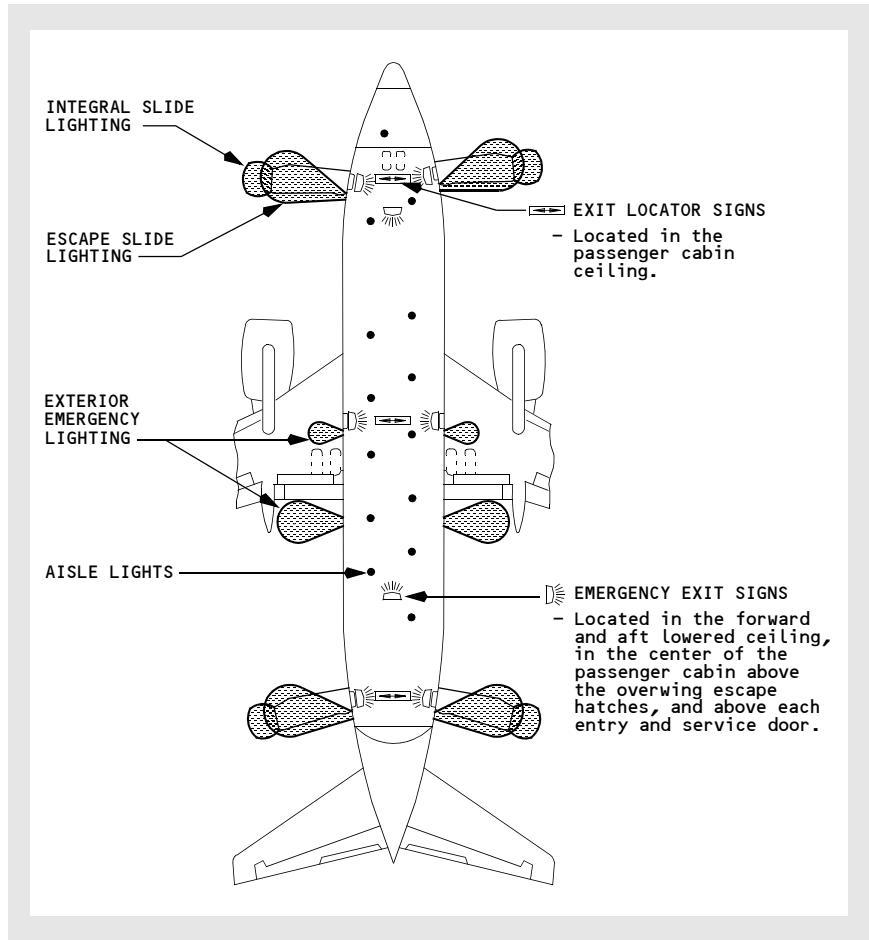
- in the lower inboard corner of stowage bins to illuminate the aisle
- over the entry/service and overwing emergency hatches to indicate the door and hatch exits
- in the ceiling to locate the exits and provide general illumination in the area of the exits.

Self-illuminating exit locator signs are installed at the forward, middle, and aft end of the passenger cabin.

## 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.

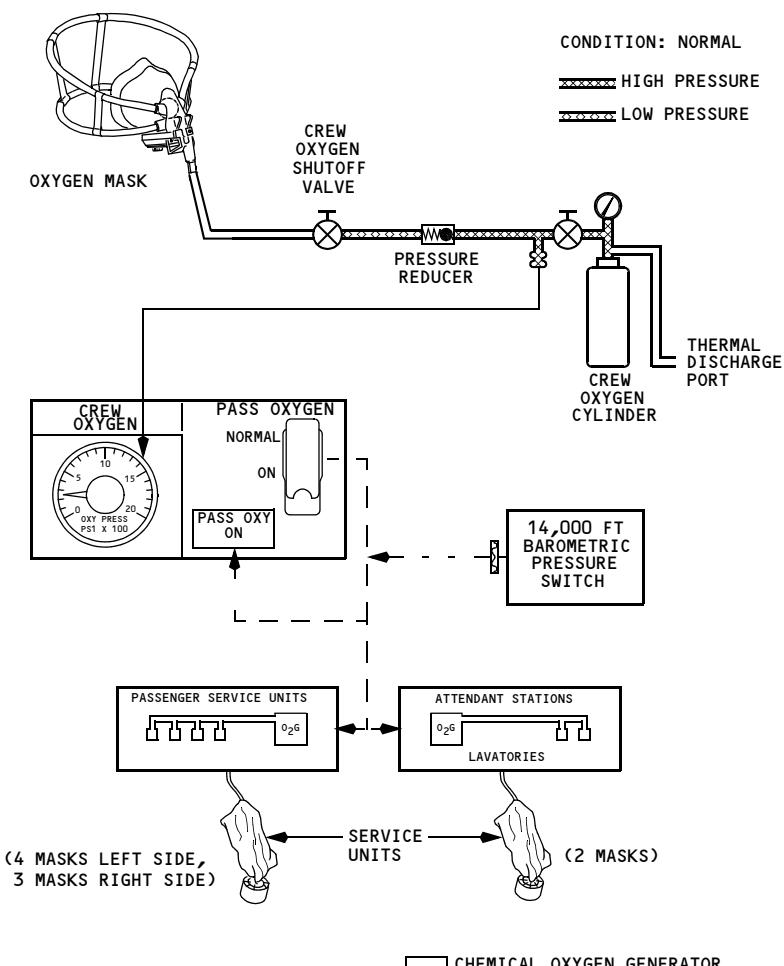
## Emergency Exit Lighting



## 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 pilots'.

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.

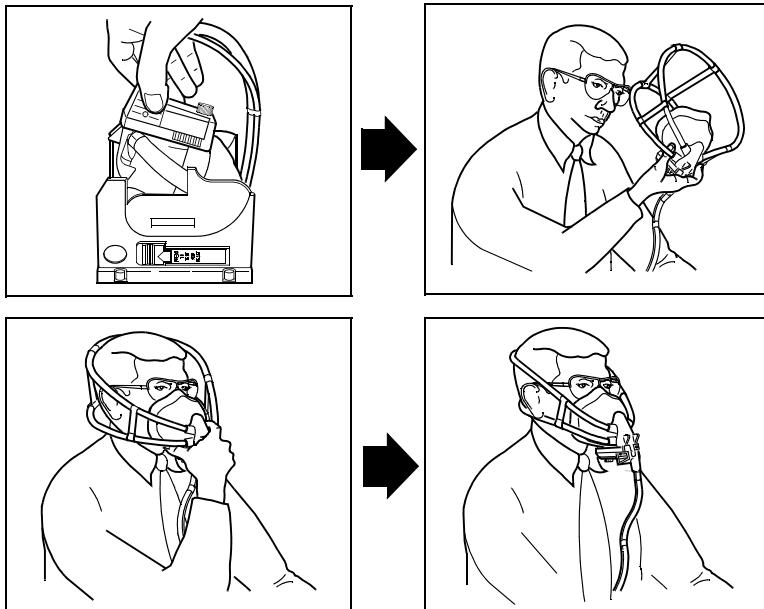
### **Flight Crew Oxygen Mask Usage**

#### **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

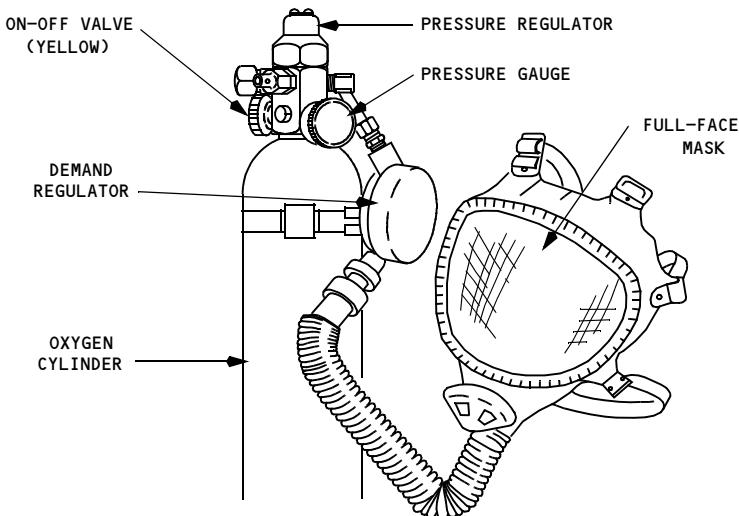
The flight crew portable oxygen unit is a completely self-contained oxygen system, offering both demand and constant flow capabilities. It consists of a portable oxygen cylinder, a pressure regulator (constant flow), an on-off valve, a pressure gauge to show oxygen supply, a demand regulator, and a sling-type 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<br>(DEMAND FLOW)<br>USE FULL FACE<br>MASK                    | 1. TURN YELLOW KNOB OPEN<br>2. ATTACH FULL FACE MASK TO LARGE<br>OUTLET.<br>3. APPLY MASK TO FACE (TIGHTEN<br>LOWER STRAPS FIRST) |
| FOR SUPPLEMENTAL<br>OXYGEN<br>(CONSTANT FLOW)<br>USE REBREATHER<br>TYPE MASK | 1. TURN YELLOW KNOB OPEN<br>2. ATTACH MASK HOSE TO SMALL<br>CONSTANT FLOW OUTLET<br>3. APPLY REBREATHER TYPE MASK<br>TO FACE      |

## Passenger Oxygen System

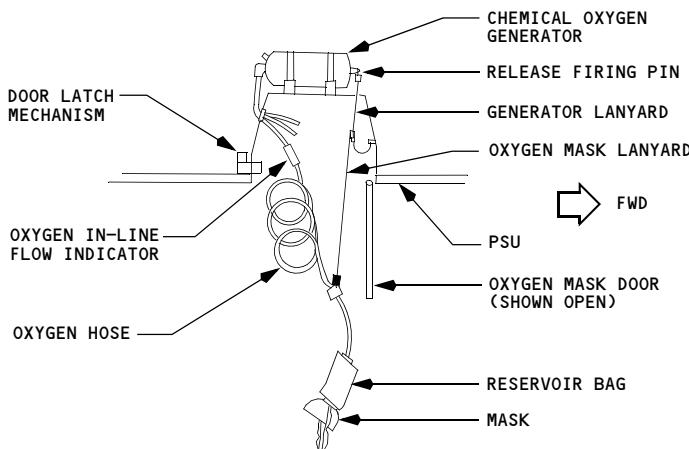
The passenger oxygen system is supplied by individual chemical oxygen generators located at each Passenger Service Unit (PSU). Three or four continuous flow masks are connected to each generator. A generator with two masks is located above each attendant station and in each lavatory.

**DO NOT USE FOR FLIGHT**

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.

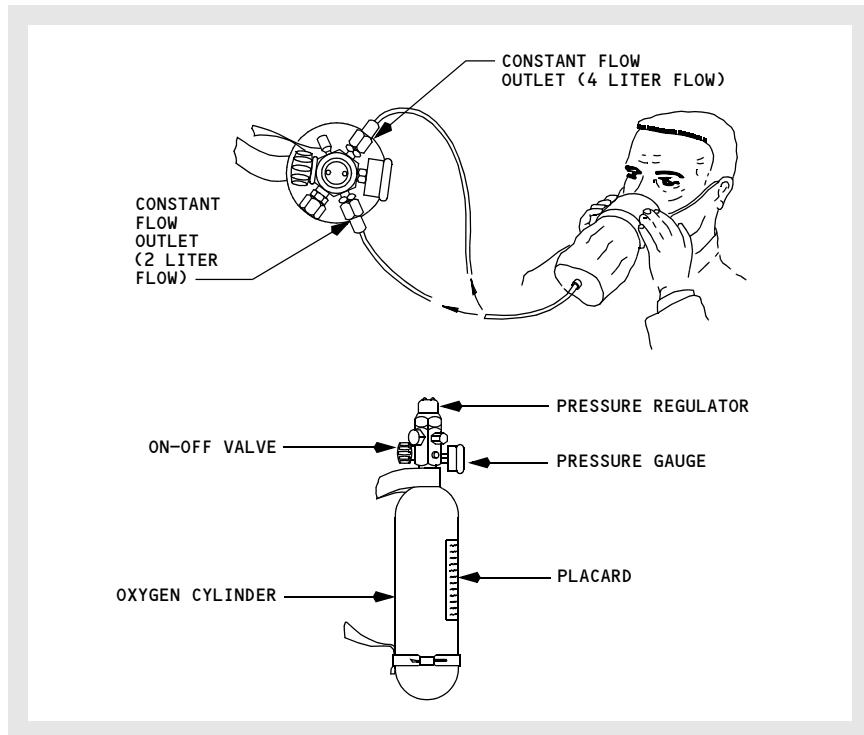
**WARNING:** Do not use passenger oxygen with cabin altitude below 14,000 feet when smoke or an abnormal heat source is present. The use of passenger oxygen does not prevent the passengers from inhaling smoke. Air inhaled is a mixture of oxygen and cabin air.

## 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

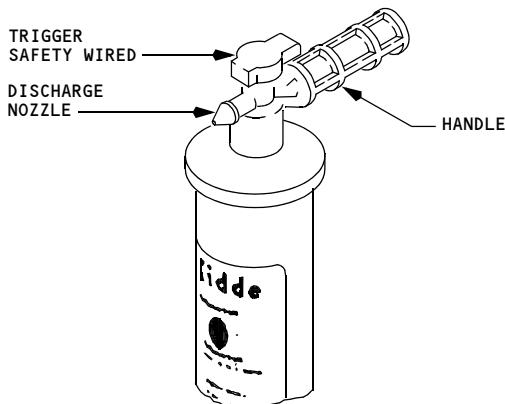
Water fire extinguishers contain a solution of water mixed with antifreeze. The container is pressurized by a CO<sub>2</sub> cartridge when the extinguisher handle is rotated fully clockwise. The extinguisher should be used on fabric, paper or wood fires only.

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



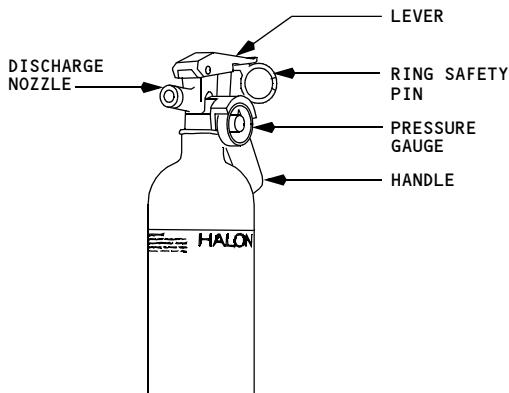
## Halon (BCF) Fire Extinguishers

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 There are three common classes of fire:	EXTINGUISHER TYPE
CLASS <b>A</b> COMBUSTIBLE - paper, wood, fabric, rubber, MATERIALS certain plastics, etc., where quenching by water is effective.	TYPE <b>A</b> Water ( $H_2O$ ) saturates material and prevents rekindling.
CLASS <b>B</b> FLAMMABLE LIQUIDS - gasoline, oils, greases, solvents, paints, burning liquids, cooking fats, etc., where smothering action is required.	TYPE <b>B</b> BCF (Halon 1211)
CLASS <b>C</b> 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. <b>NOTE:</b> Whenever possible, electrical equipment should be de-energized before attacking a class C fire.	TYPE <b>C</b> BCF (Halon 1211)

**WARNING:** THE WRONG EXTINGUISHER ON A FIRE COULD DO MORE HARM THAN GOOD. FOR EXAMPLE, **B** OR **C** 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.

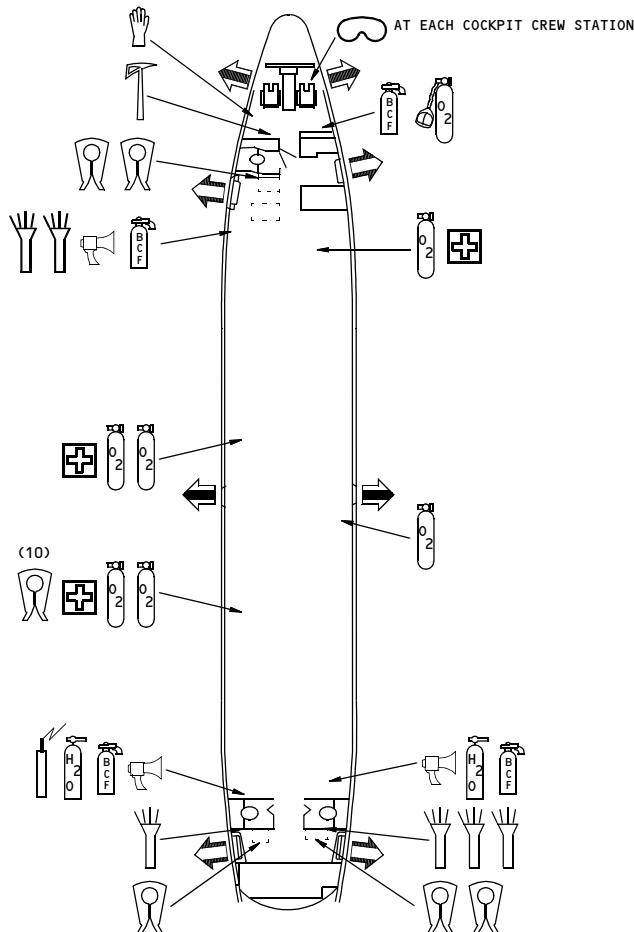
**WARNING:** If a fire extinguisher is to be discharged in the flight deck, then all crewmembers are to wear oxygen masks and use 100% oxygen with emergency selected.

## Emergency Equipment Symbols



NOTE: Some symbols do not apply to all configurations.

## Emergency Equipment Locations



## 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.

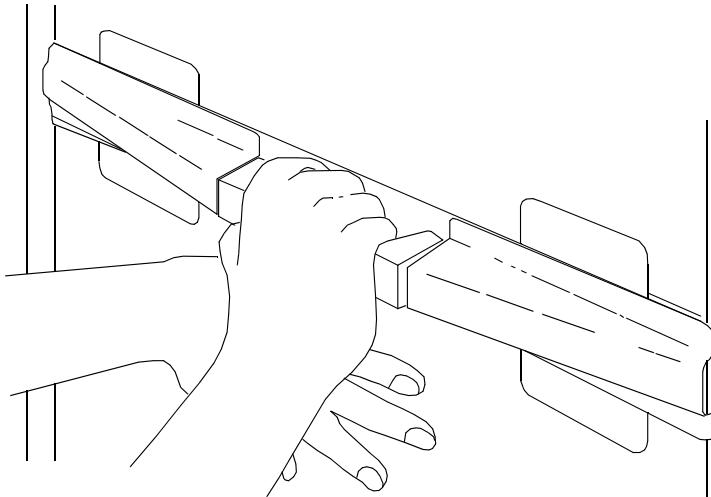
The flight deck number two windows, one on the left and one on the right, can be opened by the flight crew.

### Cabin Door (as installed)

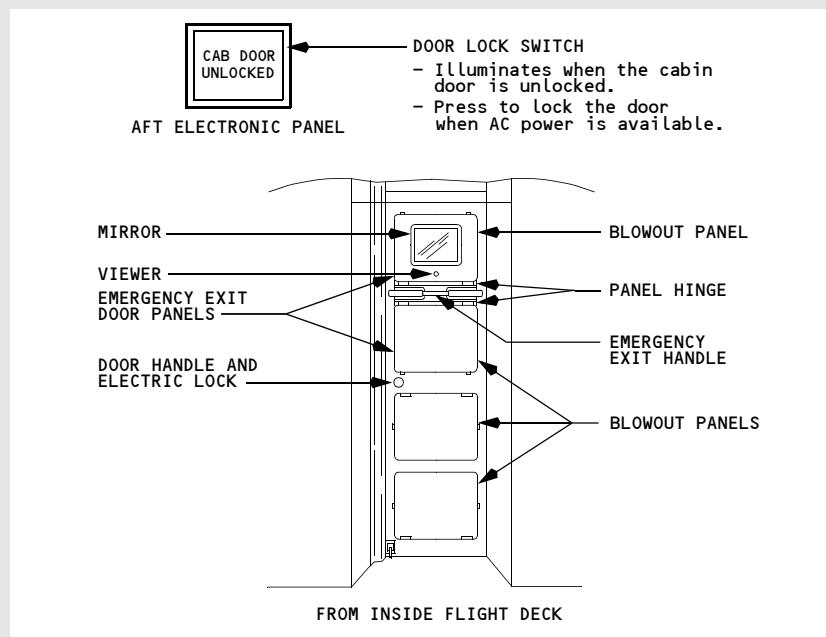
An electrical and keyed lock permits the door to be opened, closed, and locked from either side. With 115 volt AC power available, the door may be electrically locked or unlocked by pressing the door lock switch on the control stand; entrance from the passenger cabin requires a key when the door is electrically 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.

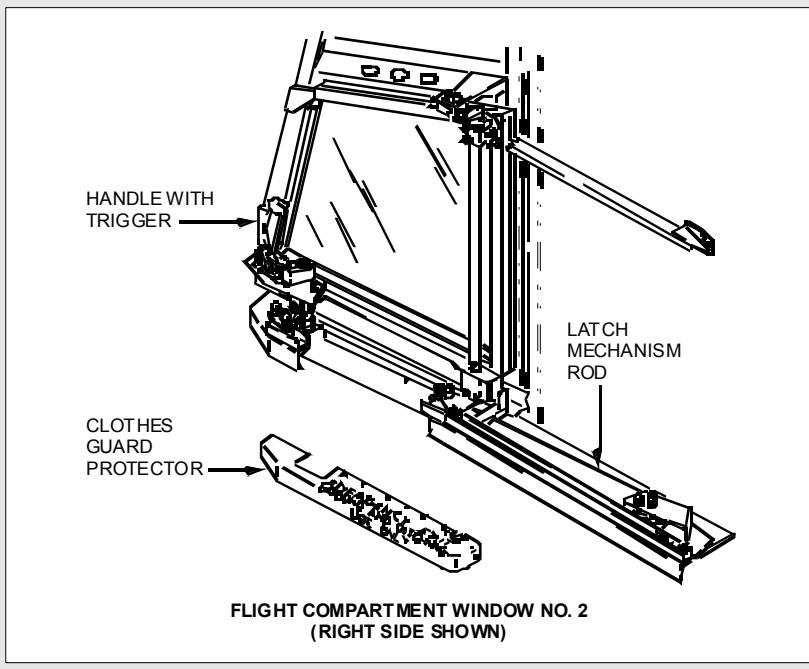
By pressing "1" then "ENT" keys on the emergency access panel, the flight deck chime will sound (if programmed).

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.

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## **Emergency Escape**

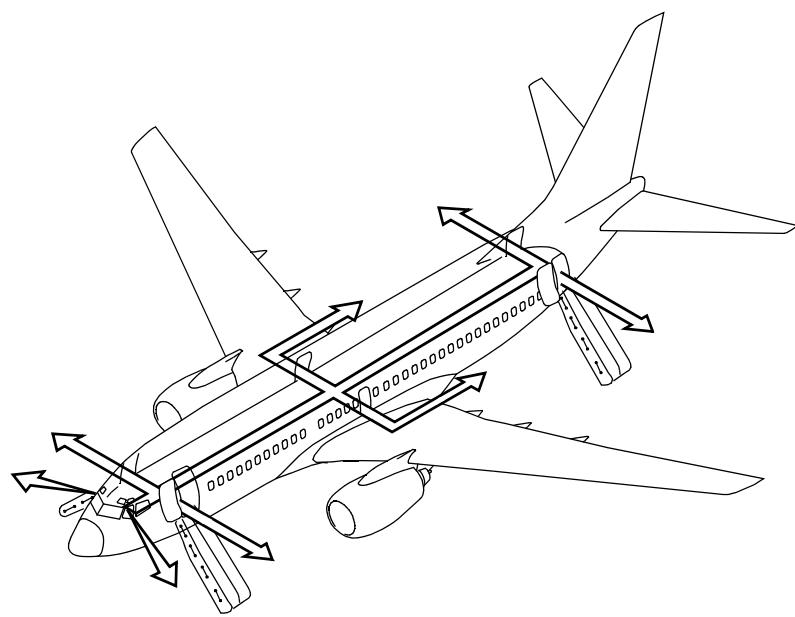
Emergency escape information included in this chapter includes:

- 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. Flight deck crew members may evacuate the airplane through two sliding flight deck windows.

## Emergency Evacuation Routes



## 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.

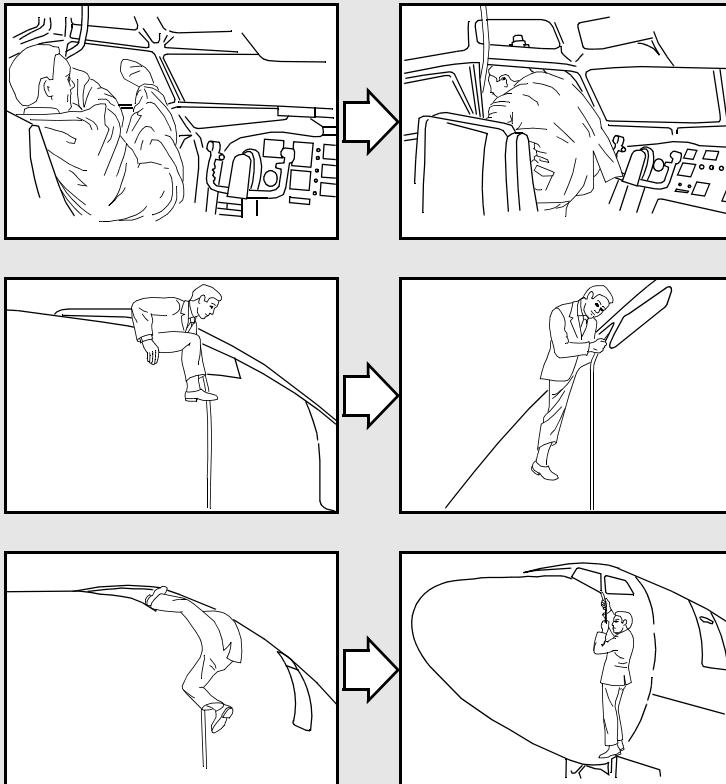
### Flight Deck Number Two Windows

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.

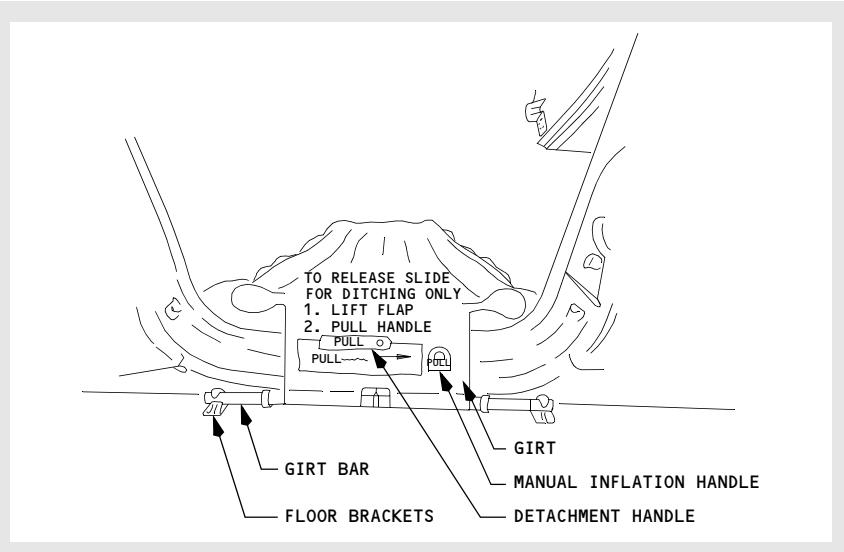
### Flight Deck Escape Straps

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.

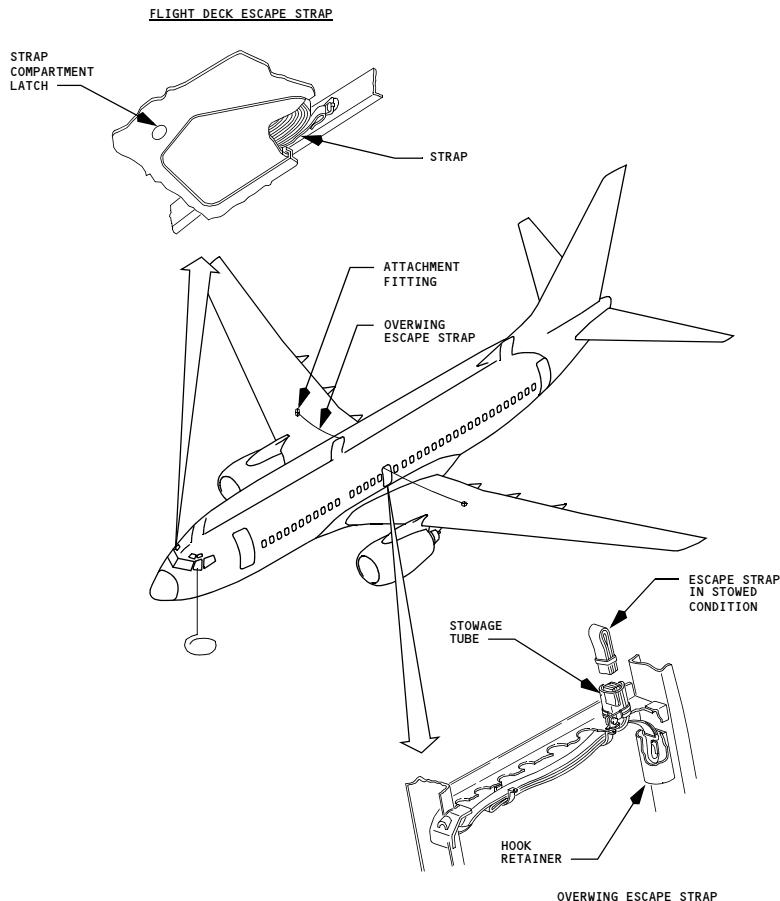
### Escape Slide Detachment Handle



## 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.

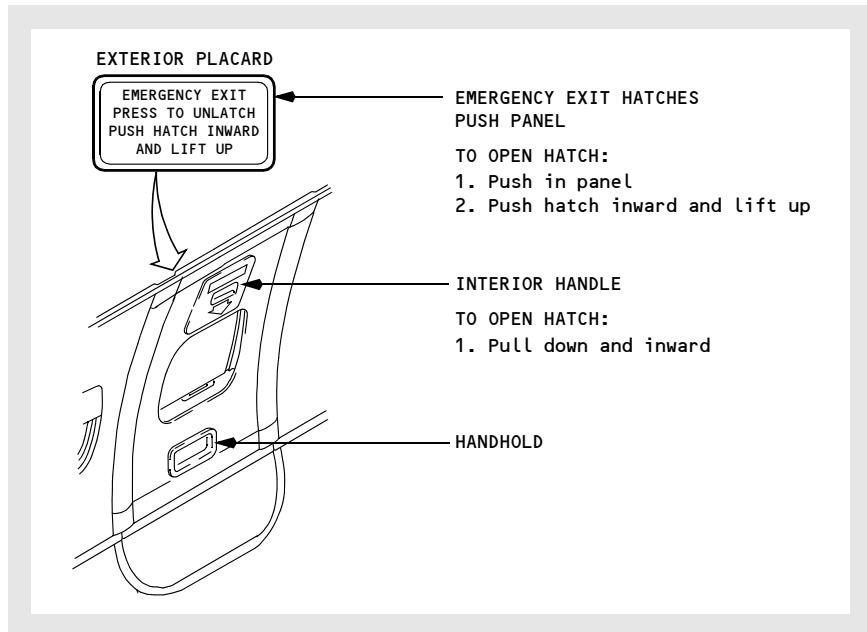
## Overwing Escape Straps



## 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



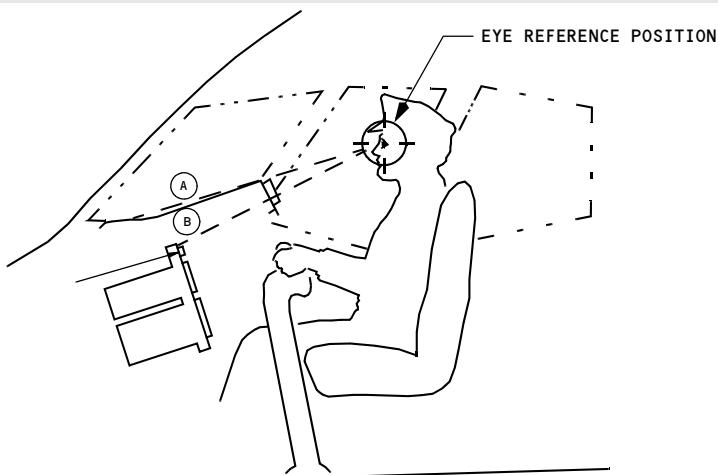
**WARNING:** Do not remove hatches in flight in preparation for passenger evacuation. For emergency evacuation on the ground or in water, remove hatch and place so as not to obstruct egress. The hatch may be thrown out onto the wing, placed on the seat arm rests, or placed in any other suitable location 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 topmost FMA annunciators (B)

## 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 above the aft service door. When the "PUSH" button on the indicator is pressed, lights illuminate to show the water level.

The system is pressurized by bleed air when the left engine or the APU is running.

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.

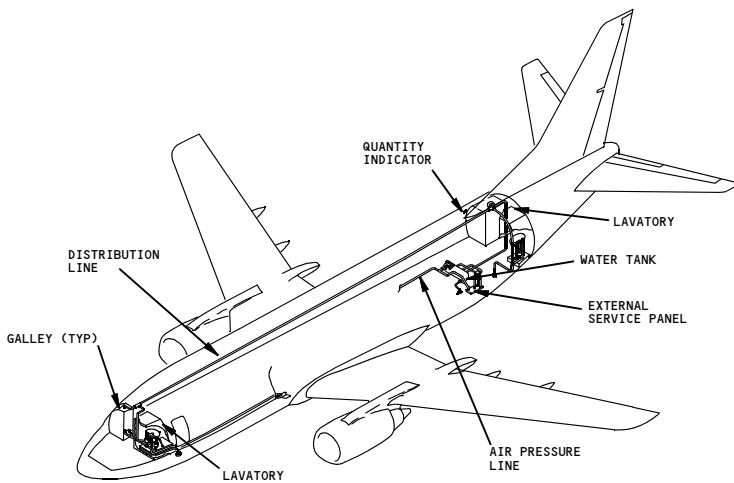
### Hot Water

Hot and cold water is available in all 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 are 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.

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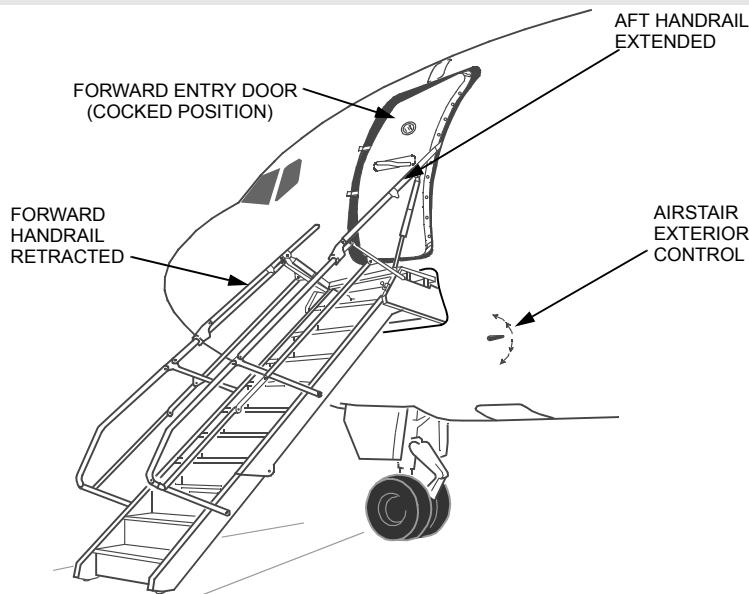
## Interior Control

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. For airplanes delivered prior to November 1991, standby operation requires both AC and DC. 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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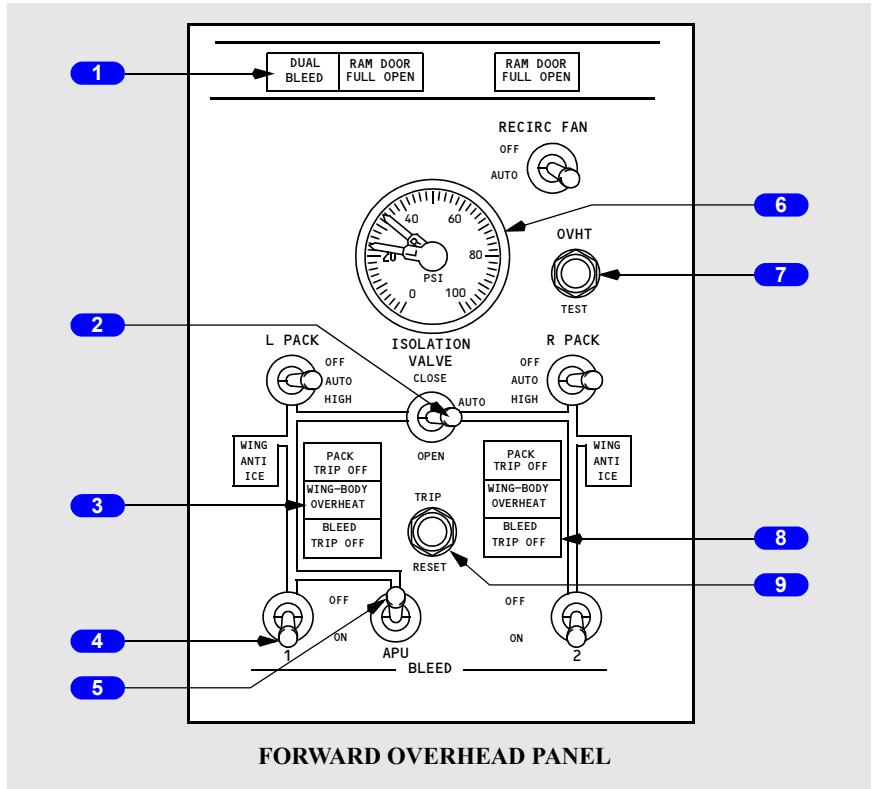
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## Bleed Air Controls and Indicators



### 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

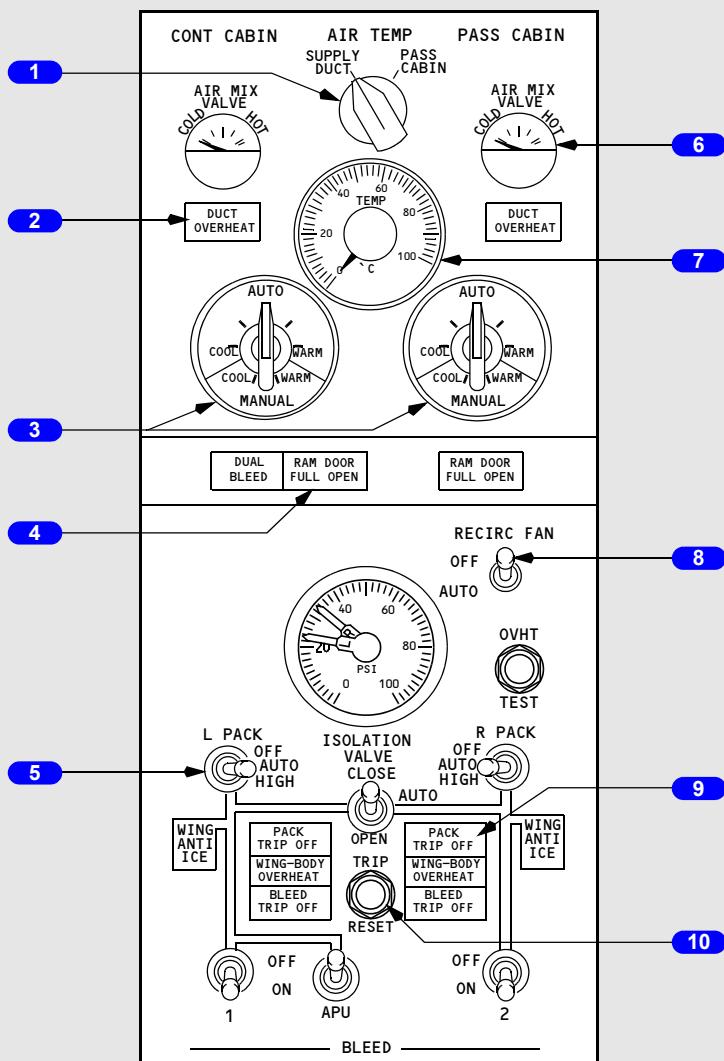
- related engine bleed air valve closes automatically
- requires reset.

### 9 TRIP RESET Switch

PUSH (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights
- lights remain illuminated until reset.

## Air Conditioning Controls and Indicators



**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) –

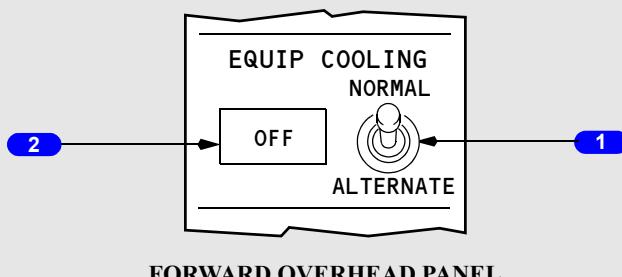
- indicates pack temperature has exceeded limits
- related pack valve automatically closes and mix valves drive full cold
- requires reset.

## 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.

## Equipment Cooling Panel



FORWARD OVERHEAD PANEL

## 1 Equipment (EQUIP) COOLING Switch

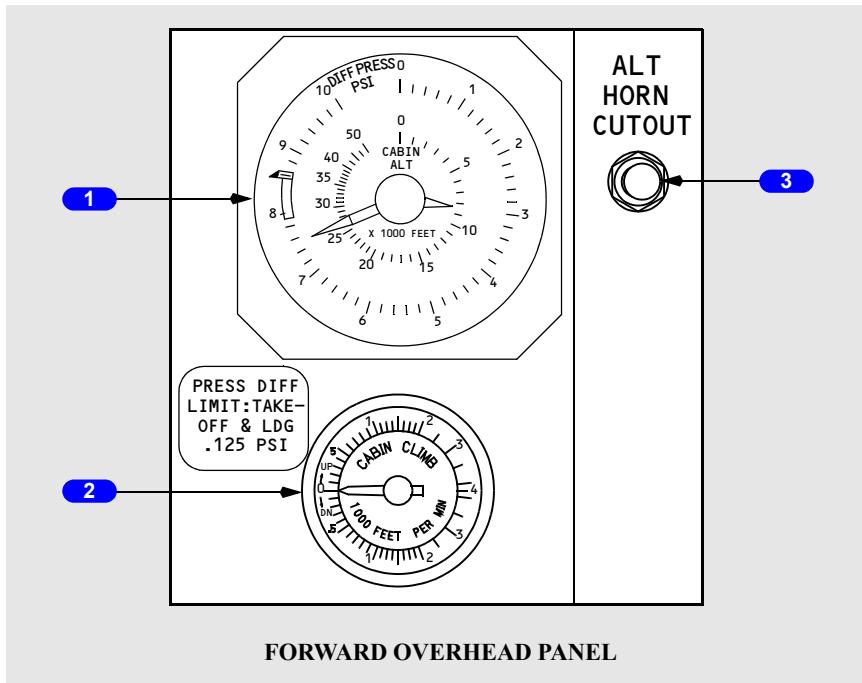
NORMAL – normal cooling supply fan activated.

ALTERNATE – alternate cooling supply fan activated.

## 2 Equipment Cooling OFF Light

Illuminated (amber) – no airflow from selected cooling 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

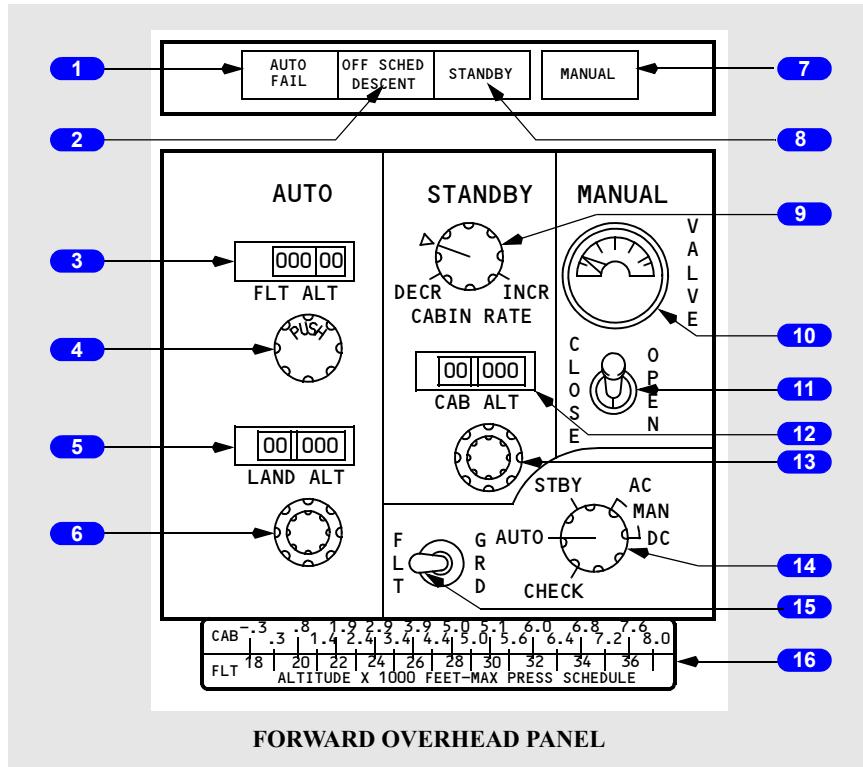
Indicates cabin rate of climb or descent in feet per minute.

### 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.

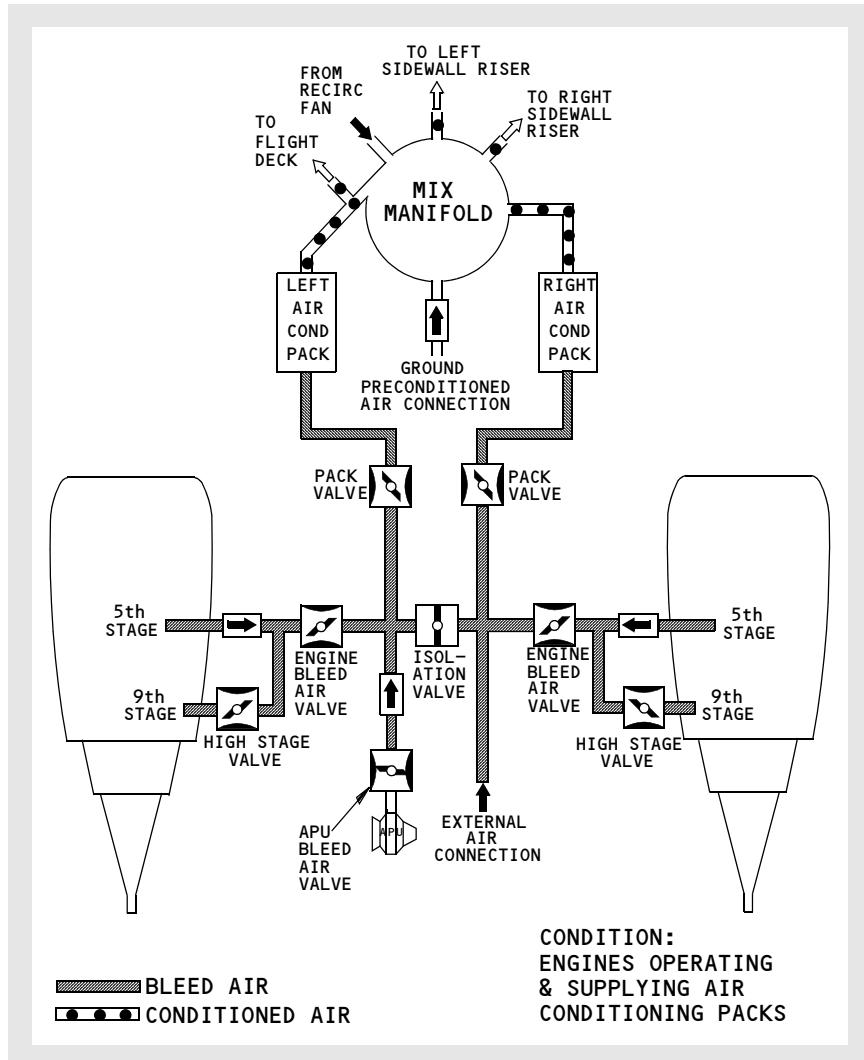
GRD –

- 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



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## **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

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

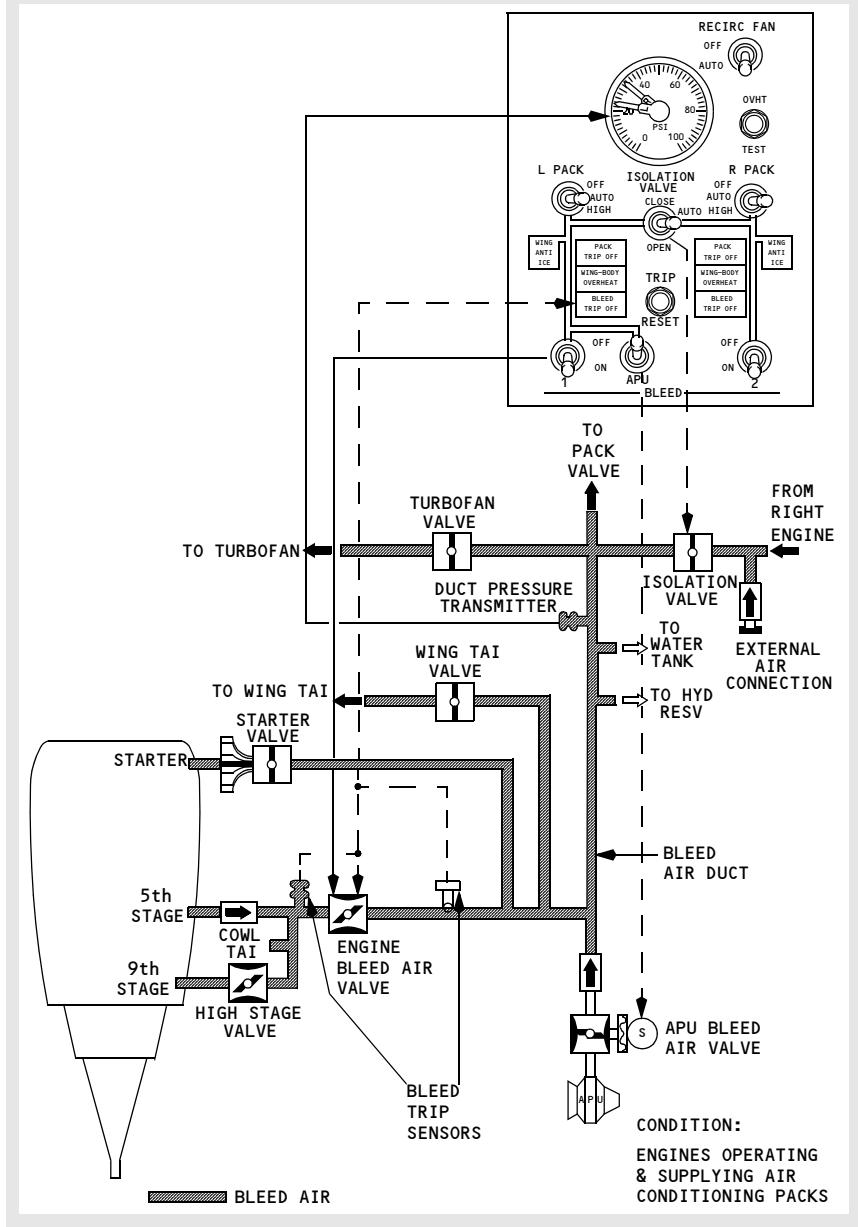
The APU bleed air valve permits APU bleed air to flow to the bleed air duct. The valve closes automatically when the APU is shut down. The APU bleed air valve is DC controlled and pressure operated.

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.

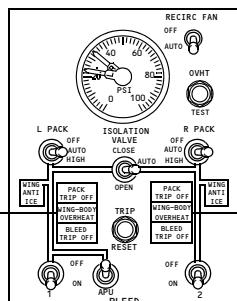
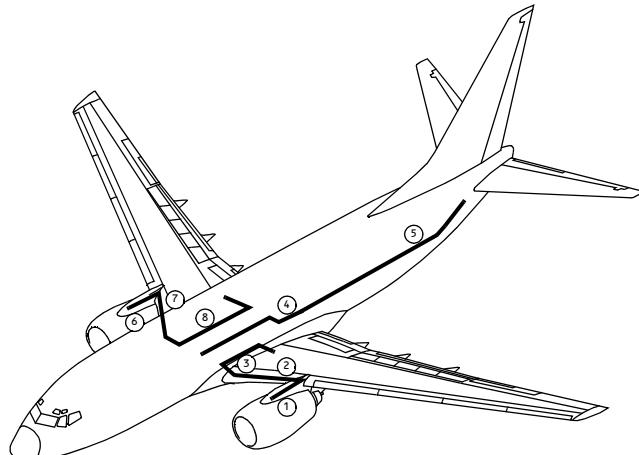
## Bleed Air System Schematic



## 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



**LEFT LIGHT**  
Sensors located:  

- (1) Left engine strut.
- (2) Left inboard wing leading edge.
- (3) Left-hand air conditioning bay.
- (4) Keel beam.
- (5) Bleed duct from APU.

FORWARD OVERHEAD PANEL

**RIGHT LIGHT**  
Sensors located:  

- (6) Right engine strut.
- (7) Right inboard wing leading edge.
- (8) Right-hand air conditioning bay.

### **Air Systems**

#### **Air Conditioning System Description**

### **Chapter 2**

#### **Section 30**

---

## **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.

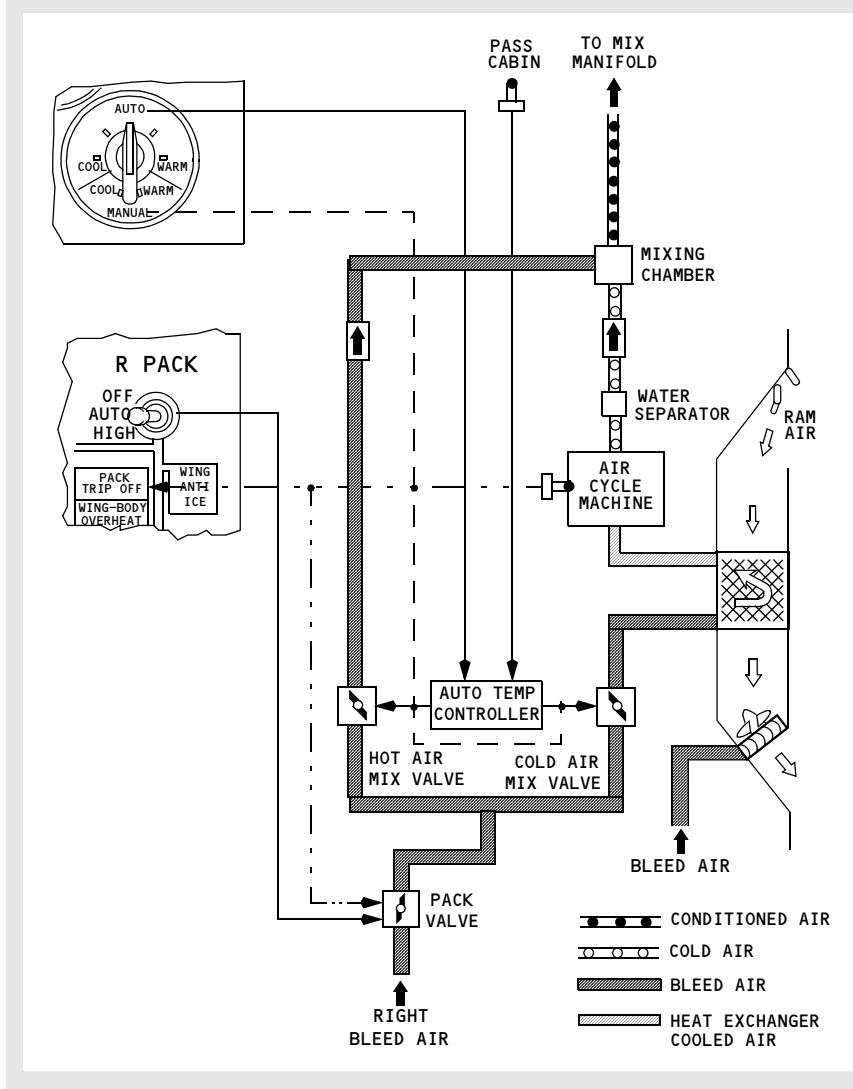
## Air Mix Valves

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 duct, a normal fan and an alternate fan. The duct collects and discards warm air from the 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 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.

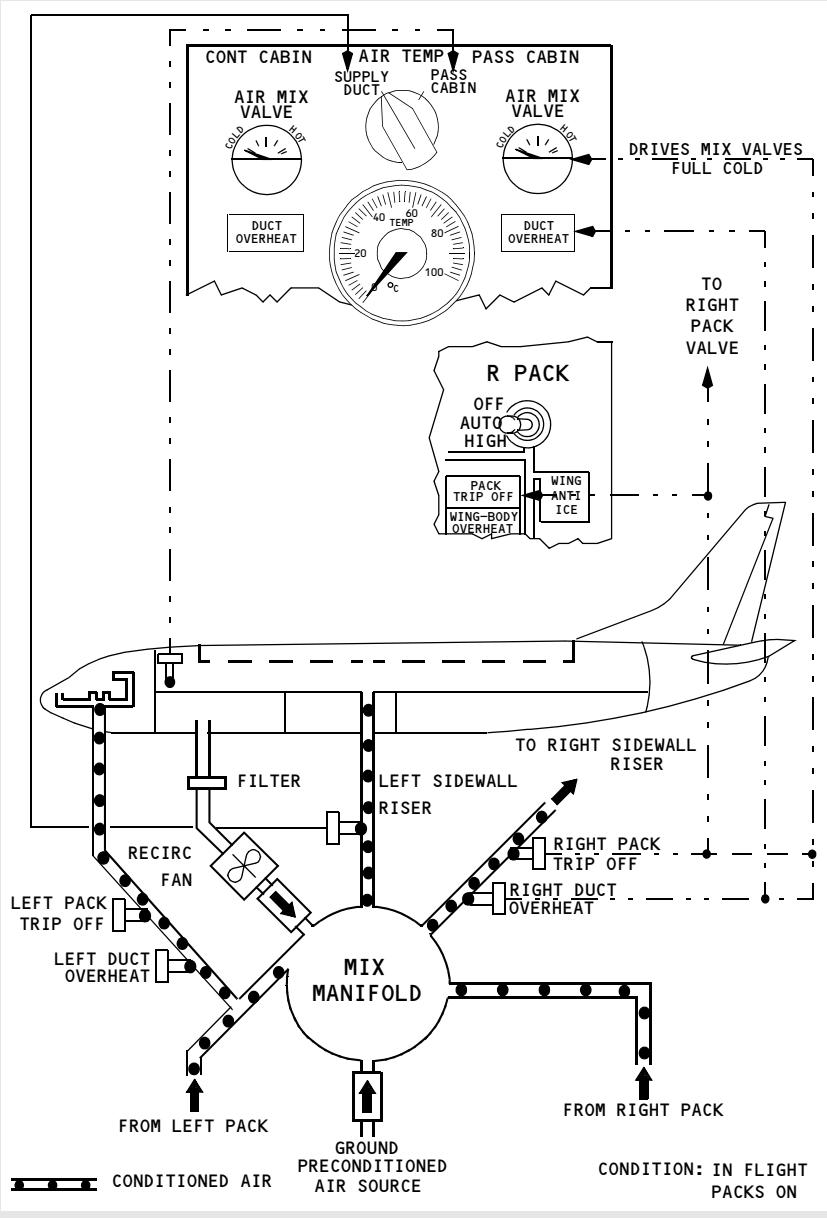
## **Forward Cargo Compartment**

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.

## Air Conditioning Distribution Schematic



## **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**

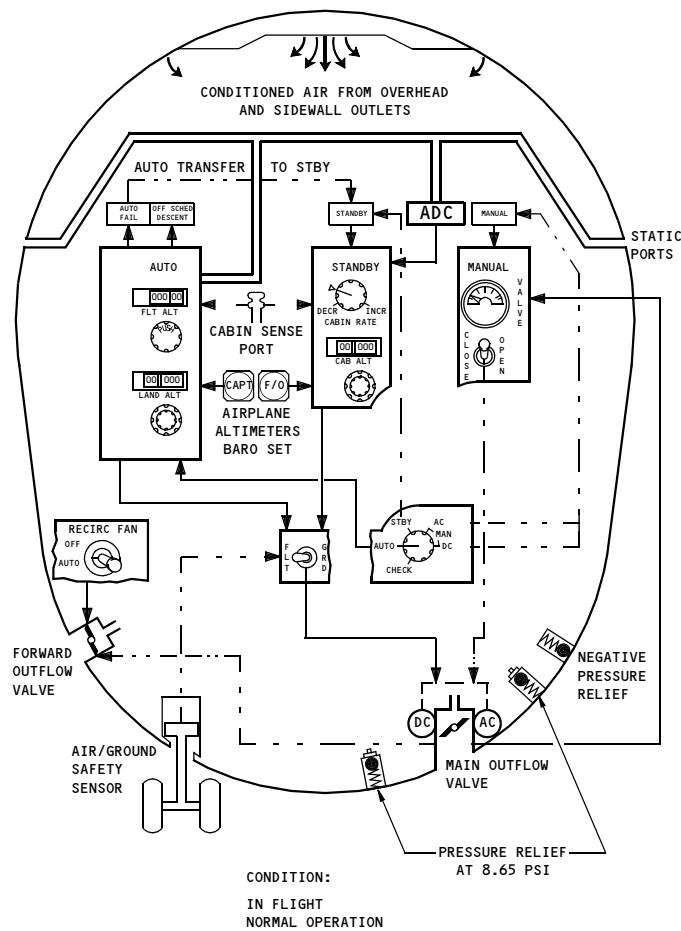
Cabin altitude is normally rate-controlled by the cabin pressure controller up to a cabin altitude of 8,000 feet at the airplane maximum certified ceiling of 37,000 feet. The cabin pressure controller controls cabin altitude in the following modes:

- 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.

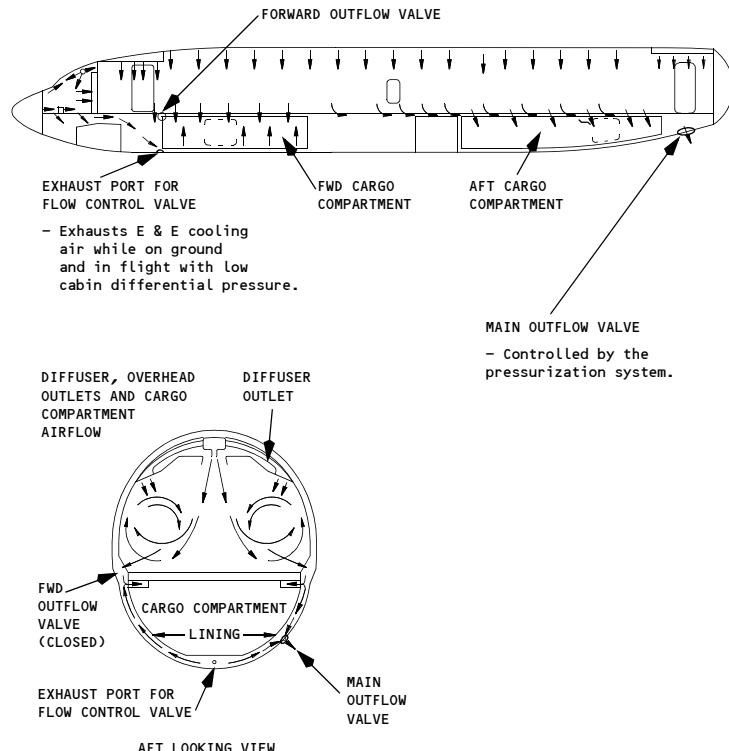
When the flow control valve closes, air is directed around the forward cargo compartment liner for inflight heating.

## 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 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



## 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.

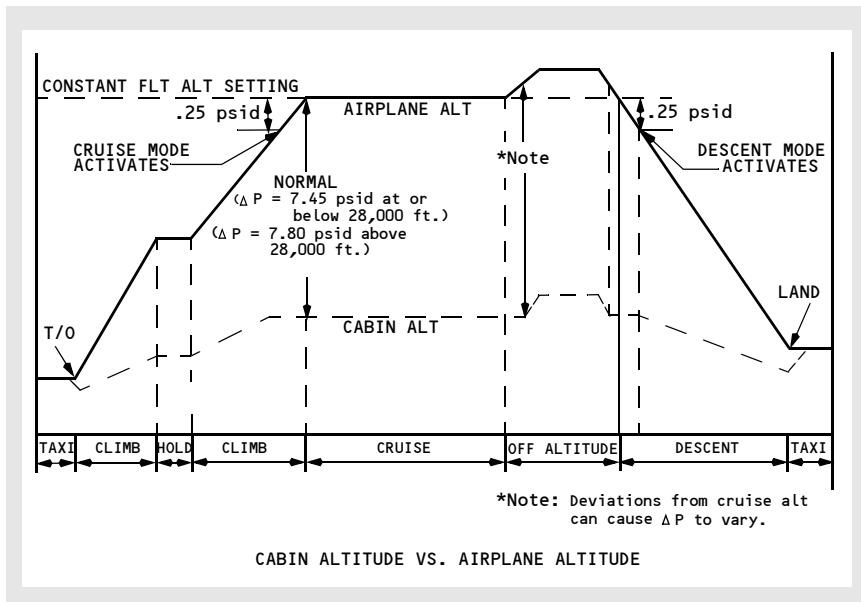
Taxiing in, the controller drives the main outflow valve slowly to full open when the FLT/GRD switch is positioned to GRD, thereby depressurizing the cabin. Having the main outflow valve full open also prevents the equipment cooling fan from depressurizing the airplane to a negative pressure.

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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# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Anti-Ice, Rain**

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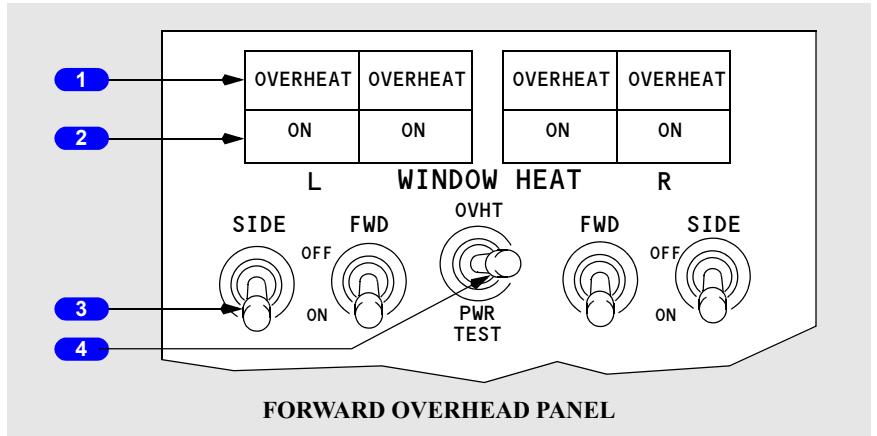
# DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

## 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.

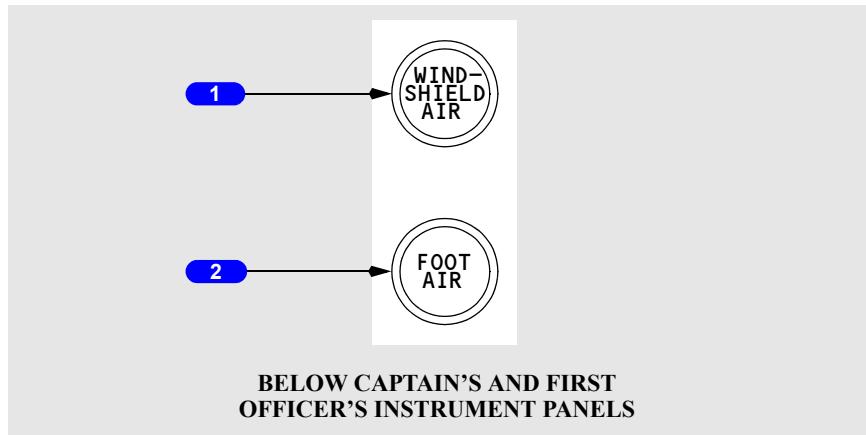
#### 4 WINDOW HEAT Test Switch (spring-loaded to neutral)

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



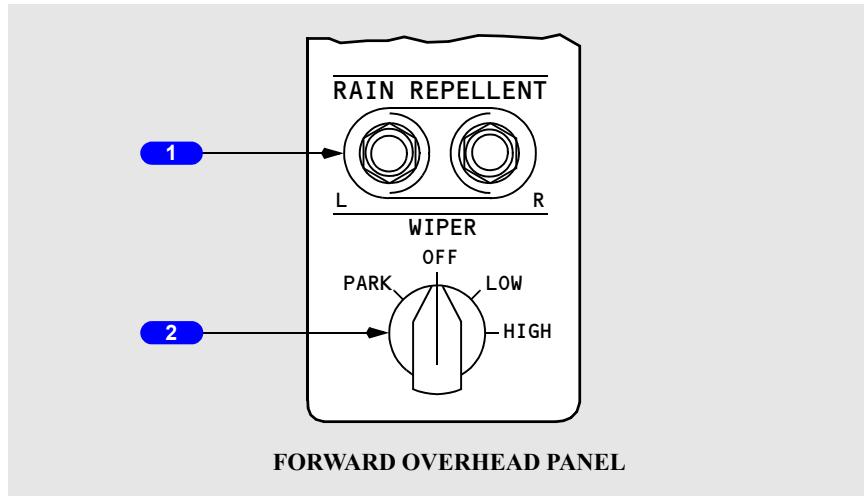
### **1 WINDSHIELD AIR Controls**

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**

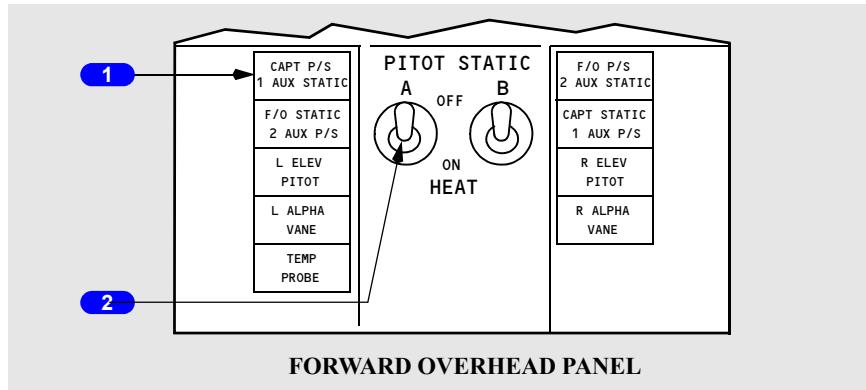
PARK – turns off wiper motors and stows wiper blades.

OFF – turns off wiper motors.

LOW – low speed operation.

HIGH – high speed operation.

## Pitot Static Heat Panel



### 1 Pitot Static Lights

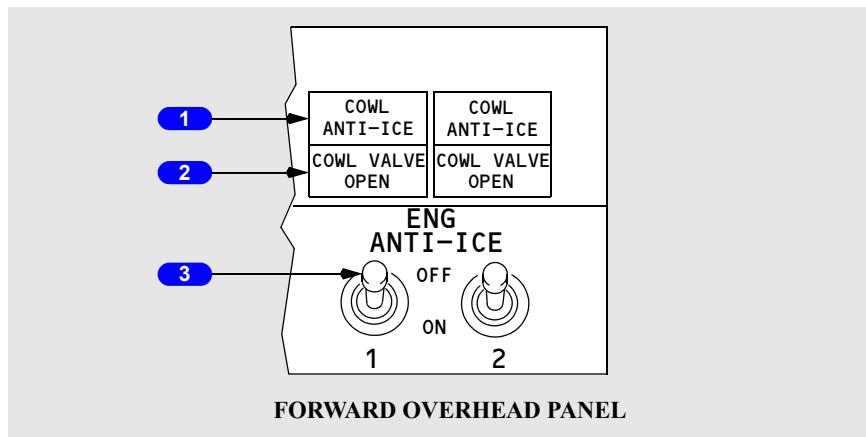
Illuminated (amber) – related probe not heated.

### 2 PITOT STATIC Switches

ON – power is supplied to heat related system.

OFF – power off.

## 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).

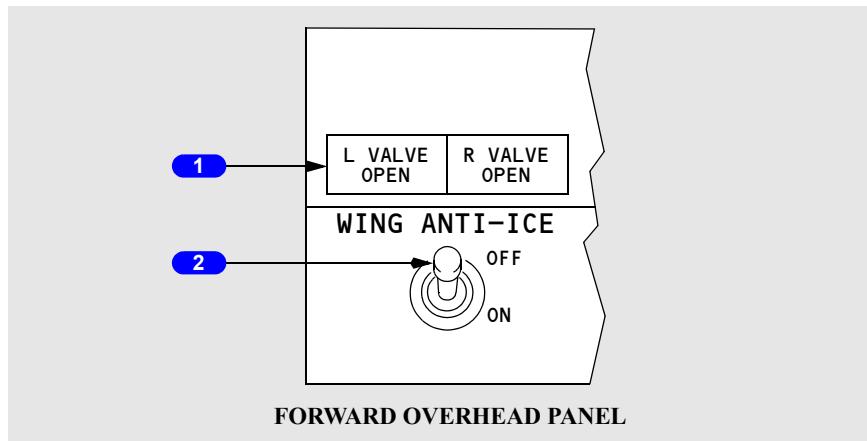
Extinguished – related cowl anti–ice valve is closed (switch OFF).

### 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

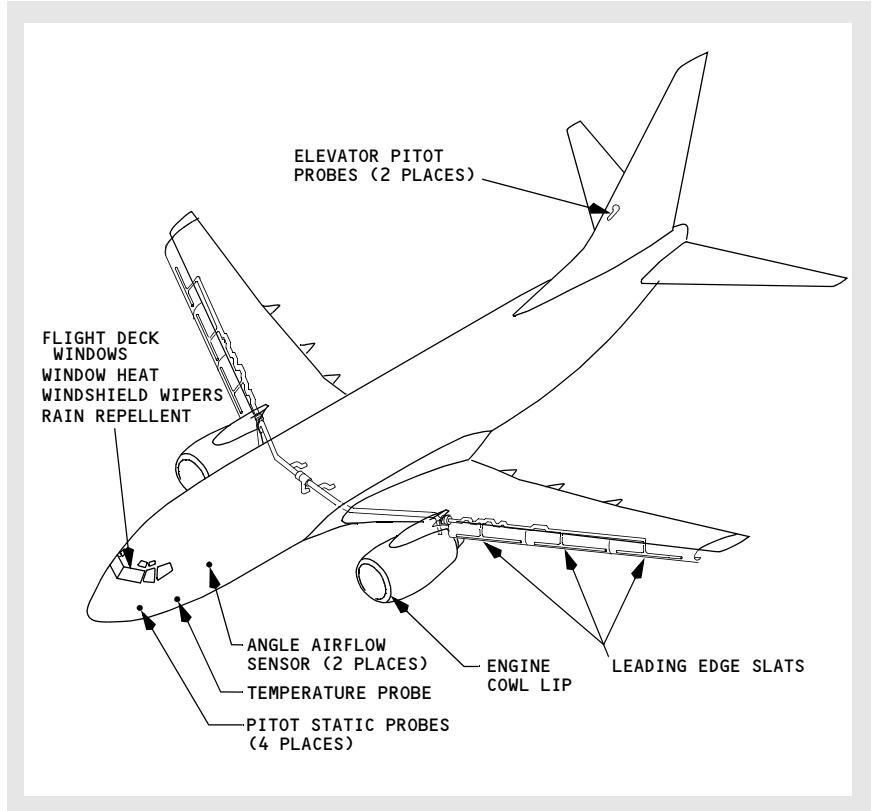
#### Introduction

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



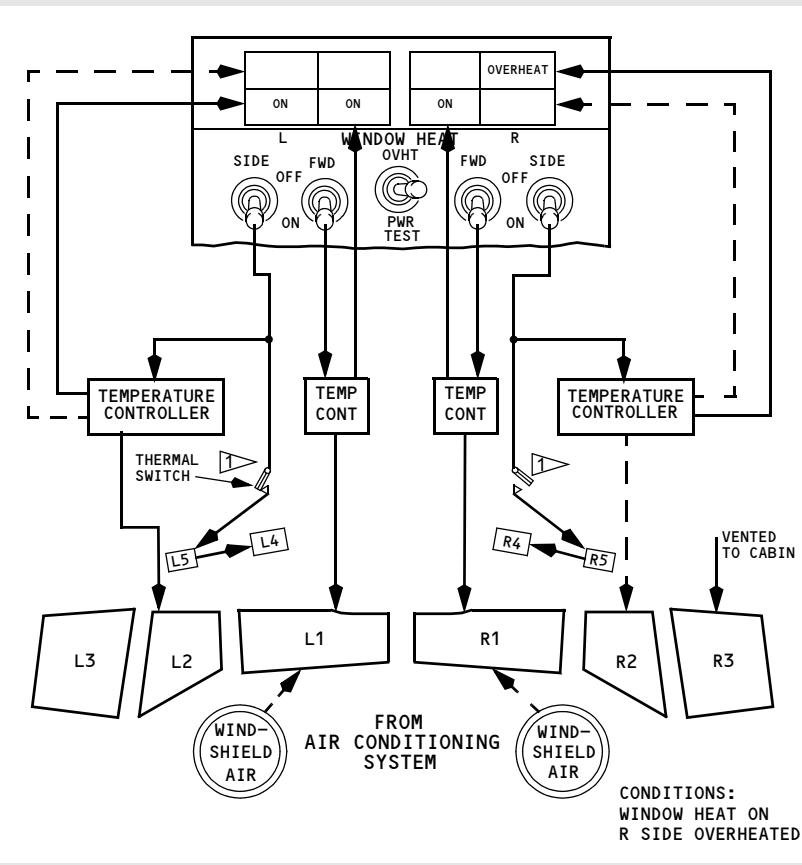
## Flight Deck Window Heat

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.

**Flight Deck Window Heat Schematic**

As installed

**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.

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## 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.

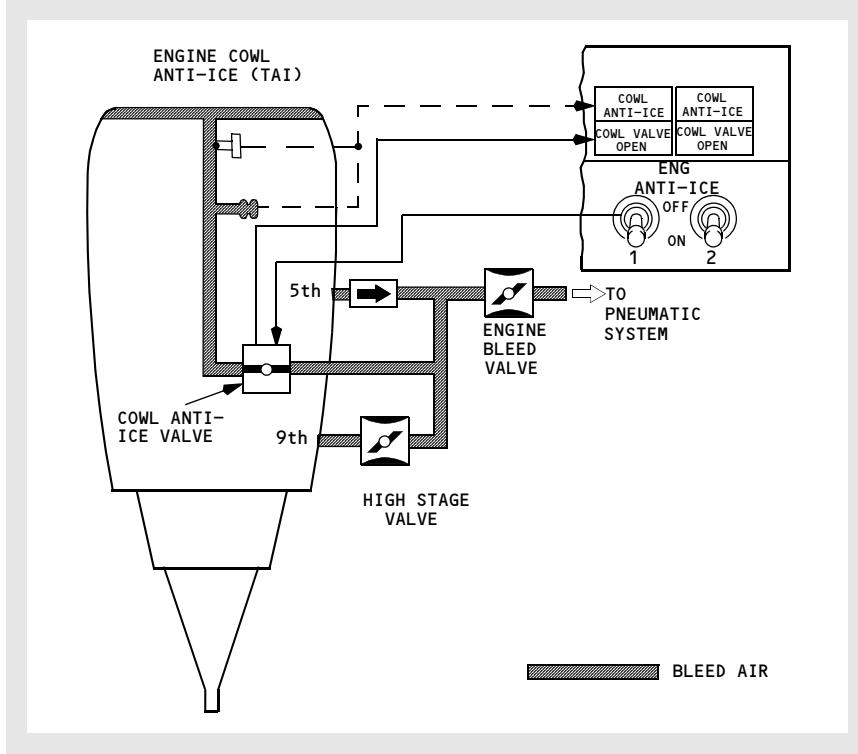
### Engine Anti-Ice System Operation

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.

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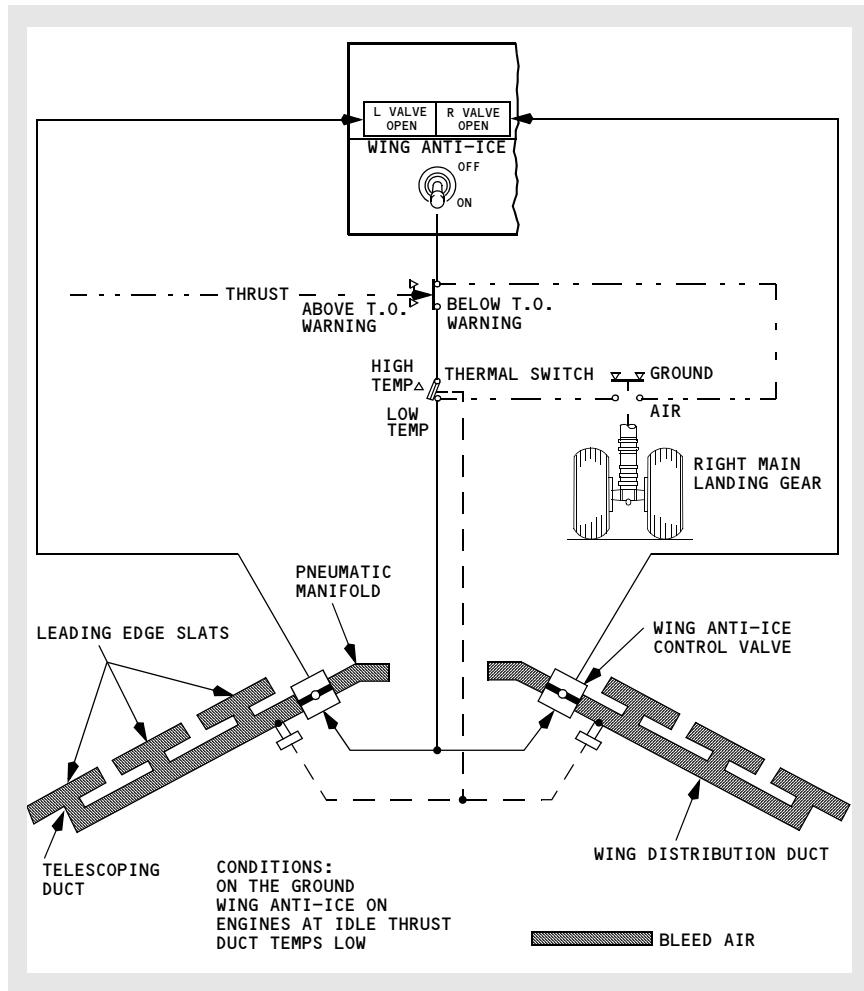
Both valves close if either engine thrust is above the takeoff warning setting or either temperature sensor senses a duct overtemperature. The valves automatically reopen if thrust on both engines is reduced and both temperature sensors are cool.

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



Intentionally  
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# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Automatic Flight**

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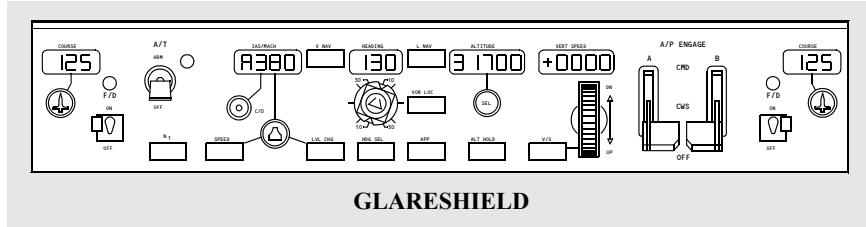
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### Automatic Flight Controls and Indicators

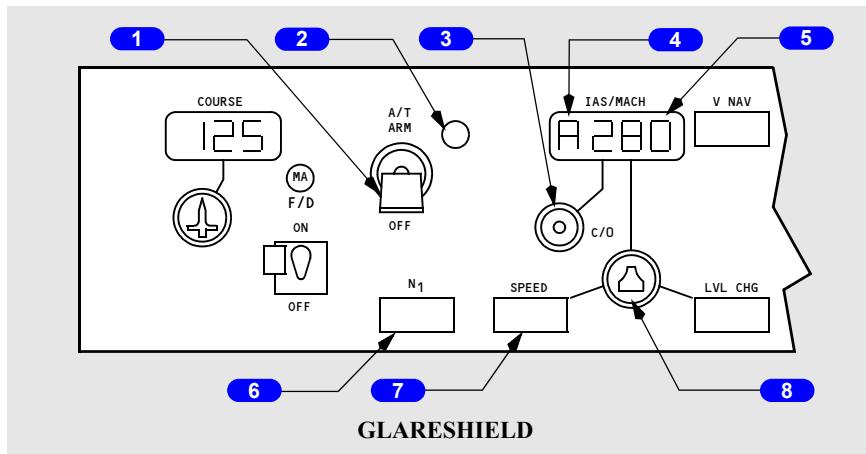
### Chapter 4 Section 10

#### 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:

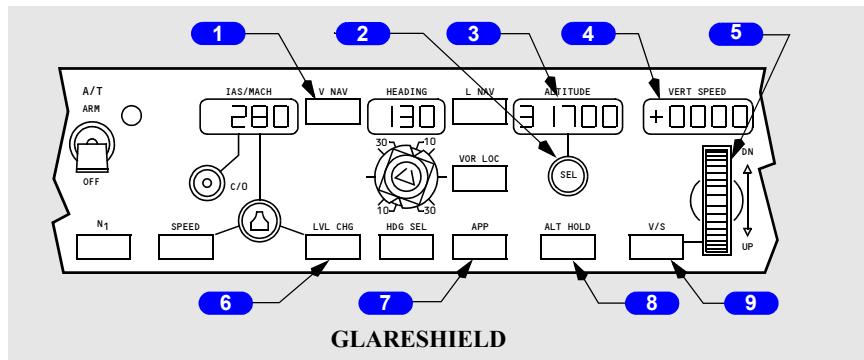
- ALT ACQ engages
- ALT HOLD engages
- V/S engages
- G/S capture occurs.

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
- LNAV is disengaged without localizer capture (prior to FMC U5.0)
- Transition of glideslope intercept waypoint
- flaps extended beyond 15

## **2 Altitude Selector (SEL)**

Rotate –

- with unmodified selector pushed in, sets altitude in ALTITUDE display in 100 foot increments
- with unmodified selector pulled out, sets altitude in ALTITUDE display in 1,000 foot increments
- with modified selector, 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
- unmodified selector displays 10,000 ft when power first applied
- modified selector 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.

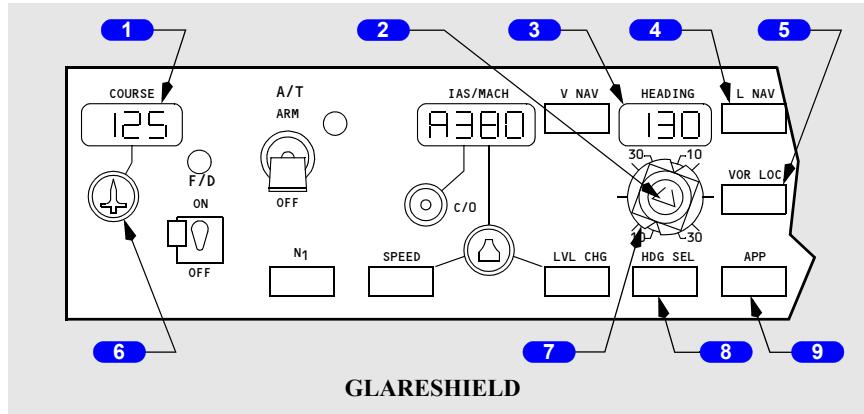
V/S mode automatically engages if ALT ACQ mode is engaged and a new MCP altitude is selected which is more than 100 feet different from previously selected altitude

- 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 or glideslope can be captured first
- 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:

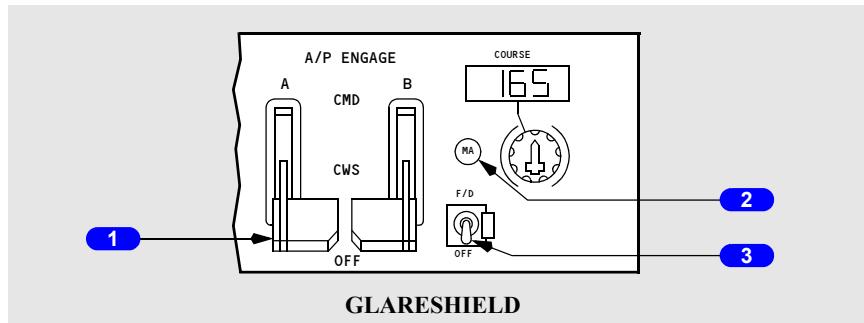
- pushing a TO/GA switch
- disengaging autopilot(s) and turning off both F/D switches
- retuning the VHF NAV receiver.
- during a single autopilot approach, overriding pitch or roll into CWS.

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 Paddle:

CMD –

- engages related A/P
- enables all command modes
- displays CMD in A/P status display
- selecting a second A/P in CMD disengages the first A/P, unless in APP mode.
- enables CWS operation
- CWS engages if:
  - pitch or roll mode not selected
  - pitch or roll mode deselected

- pitch or roll mode manually overridden with control column force.

**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.

- CWS engaged displays:
  - CWS P and/or CWS R in A/P status display
  - blank in pitch and/or roll mode FMA
- when approaching a selected altitude in CWS P, the pitch mode engages in ALT ACQ and ALT HOLD when reaching selected altitude
- when approaching a selected radio course in CWS R with VOR/LOC or approach mode armed, VOR/LOC engages when course is intercepted
- if pitch is manually overridden while in ALT HOLD and control force is released within 250 feet of selected altitude, A/P pitch mode engages in ALT ACQ and return to selected altitude in ALT HOLD mode.

**Note:** During F/D only operation while pitch or roll commands are more than 1/2 scale from center, selecting CMD A or B engages the A/P in CWS for pitch and/or roll and the related F/D bar(s) retract.

CWS –

- engages A/P
- engages pitch and roll modes in CWS. Other pitch and roll modes not enabled
- displays CWS P and CWS R in A/P status display
- CMD not displayed in A/P status display
- F/Ds, if ON, display guidance commands and FD annunciations in A/P status display. A/P does not follow commands while in CWS
- A/P pitch and roll controlled by pilot with control wheel pressure
- when control pressure released, A/P holds existing attitude. If aileron pressure released with 6 degrees or less bank, the A/P rolls wings level and holds existing heading. Heading hold feature inhibited:
  - below 1500 feet RA with gear down
  - after LOC capture in APP mode
  - after VOR capture with TAS 250 kts or less.

## **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

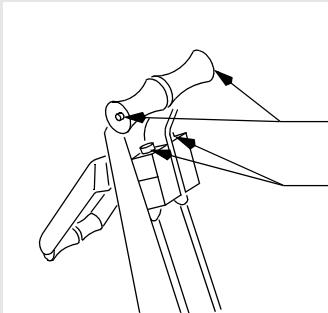
Left F/D switch activates command bars on Captain's ADI. Right F/D switch activates command bars on First Officer's ADI.

ON –

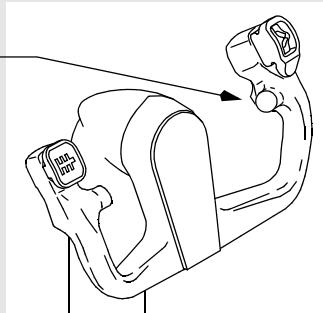
- enables command bar display on related pilot's ADI
- command bars are displayed if command pitch and/or roll modes are engaged
- displays FD in A/P status display if A/P is OFF or engaged in CWS
- on ground, arms pitch and roll modes for engagement in TO/GA and WINGS LEVEL when TO/GA switch is pushed
- 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.

## Autopilot / Autothrottle Controls



CONTROL STAND



CONTROL WHEELS

### 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

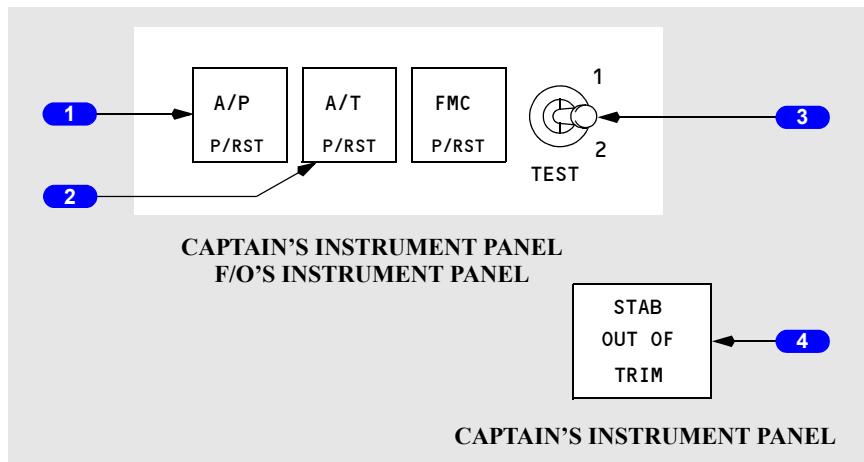
Push –

- 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) –

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) –

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

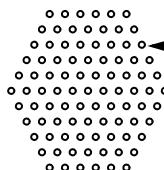
Operates only with autopilot engaged. Remains extinguished with autopilot not engaged.

Illuminated (amber) – autopilot not trimming stabilizer properly.

## Altitude Alert



ABOVE EACH PILOT'S  
ALTIMETER



AFT OVERHEAD PANEL

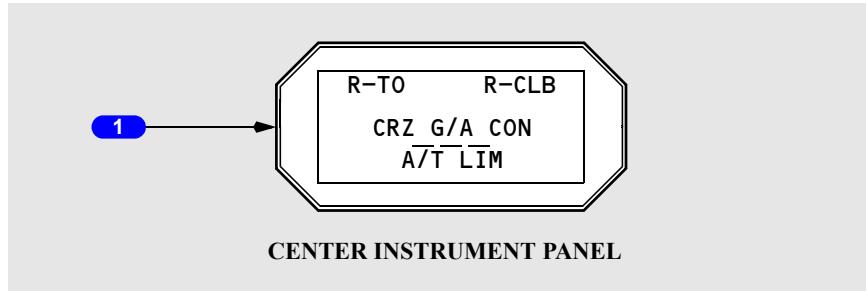
### 1 ALTITUDE ALERT Light

Illuminated (amber) – airplane is approaching or departing selected altitude.

## 2 Speaker

Transmits alert tone when airplane approaches or departs selected altitude.

## Thrust Mode Annunciator Panel



## 1 Thrust Mode Annunciator Panel

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.

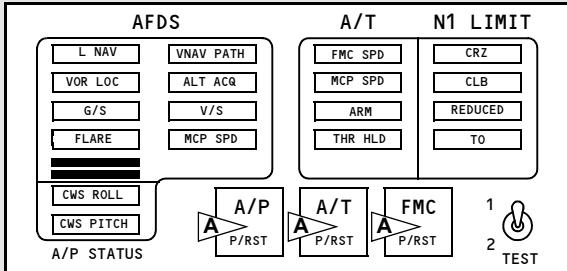
N1 limit reference is normally calculated by the FMC.

Thrust mode display/Thrust mode annunciator panel annunciations are:

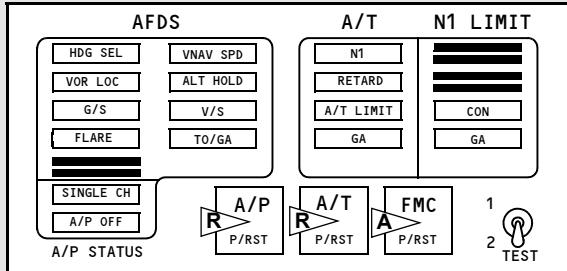
- R – Reduced. Can appear with TO or CLB
- TO – Takeoff
- CLB – Climb
- CRZ – Cruise
- G/A – Go-around
- CON – Continuous
- —— FMC not computing thrust limit.
- A/T LIM – Autothrottle limit. Indicates A/T computer is calculating a degraded N1 limit for the affected engine or engines.

### Flight Mode Annunciator Panels

#### Test Displays



TEST 1



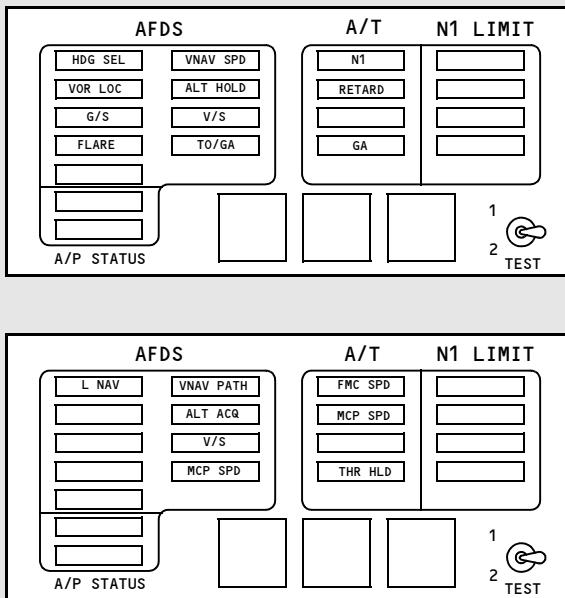
TEST 2

#### CAPTAIN'S INSTRUMENT PANEL FIRST OFFICER'S INSTRUMENT PANEL

Illuminated steady amber

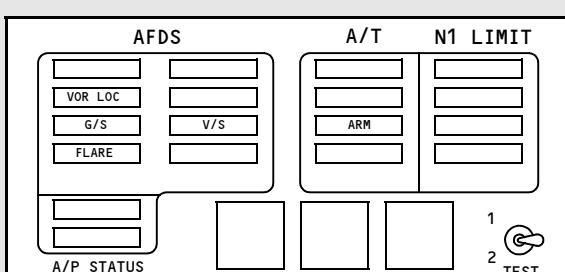
Illuminated steady red

## Engaged Mode Annunciations



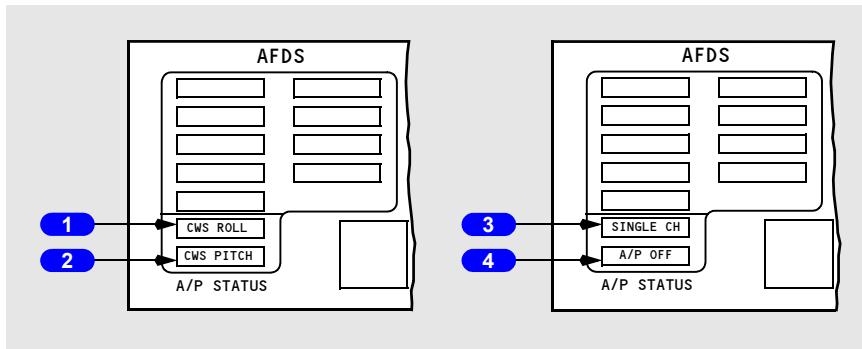
Black letters on a green background

## Armed Mode Annunciations



White letters on a black background

## Autopilot Status Annunciations



### 1 CWS ROLL

(black on amber) – indicates roll axis in CWS mode.

### 2 CWS PITCH

(black on amber) – indicates pitch axis in CWS mode.

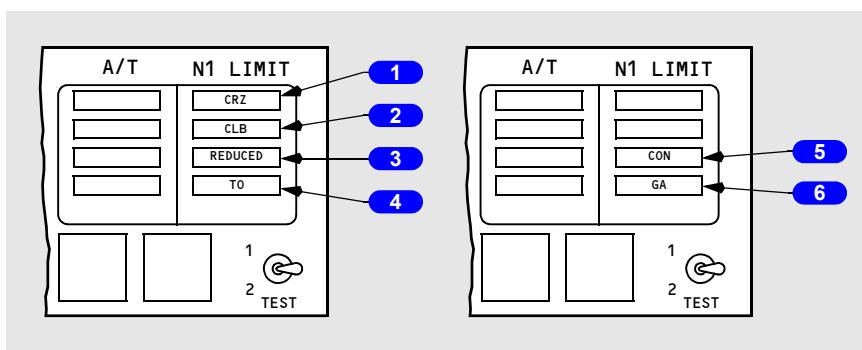
### 3 Single Channel (SINGLE CH)

(black on amber) – annunciated in APP mode at LOC capture.

### 4 Autopilot Off (A/P OFF)

(black on white) – indicates that neither autopilot is engaged and at least one flight director is on.

## FMC N1 Limit Annunciations



### 1 Cruise (CRZ)

(white on black) – indicates cruise mode is engaged.

**2 Climb (CLB)**

(white on black) – indicates climb mode is engaged.

**3 REDUCED**

(white on black) – indicates reduced takeoff or reduced climb mode is engaged.

**4 Takeoff (TO)**

(white on black) – indicates takeoff mode is engaged.

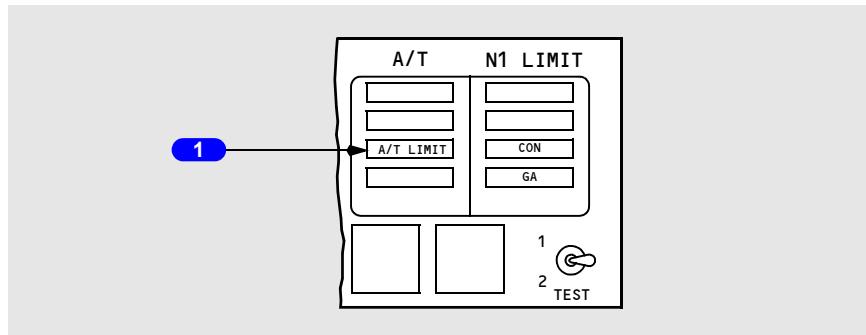
**5 Continuous (CON)**

(white on black) – indicates maximum continuous thrust mode is engaged.

**6 Go Around (GA)**

(white on black) – indicates go around mode is engaged.

**Degraded A/T Annunciation**



**1 A/T LIMIT**

(black on white) – indicates degraded autothrottle operation due to loss of FMC or N1 signals. Appears with active autothrottle mode.

### **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 annunciator panels on each pilot's instrument panel.

#### **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
- 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.

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## AFDS Status Annunciation

The following AFDS status annunciations are displayed in the A/P status display located on the flight mode annunciator panel:

- CWS PITCH (pitch mode engaged in CWS)
- CWS ROLL (roll mode engaged in CWS).

## AFDS Flight Mode Annunciations

The flight mode annunciations are displayed on the flight mode annunciator panel.

The modes are in these categories:

- autothrottle
- pitch
- roll
- autopilot status

Engaged or captured modes are shown in black letters on a green background.

Armed modes are shown in white letters on a black background.

### Autothrottle Modes

- N1 – The autothrottle maintains thrust at the selected N1 limit displayed on the thrust mode annunciator
- 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 annunciator
- 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 annunciator
- 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

- 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

### Engage Paddle in CWS

Pressing a CWS engage switch engages the A/P pitch and roll axes in the CWS mode and displays CWS PITCH and CWS ROLL 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 Engage Paddle in CMD

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 PITCH is annunciated on the FMAs while this mode is engaged. Command pitch modes can then be selected.

When approaching a selected altitude in CWS PITCH with a CMD engage switch selected, CWS PITCH 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 PITCH. If control force is released within 250 feet of the selected altitude, CWS PITCH 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 PITCH.

### **Roll CWS with Engage Paddle in CMD**

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 ROLL is annunciated on the FMAs while this mode is engaged.

CWS ROLL 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 ROLL 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.

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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.

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## 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

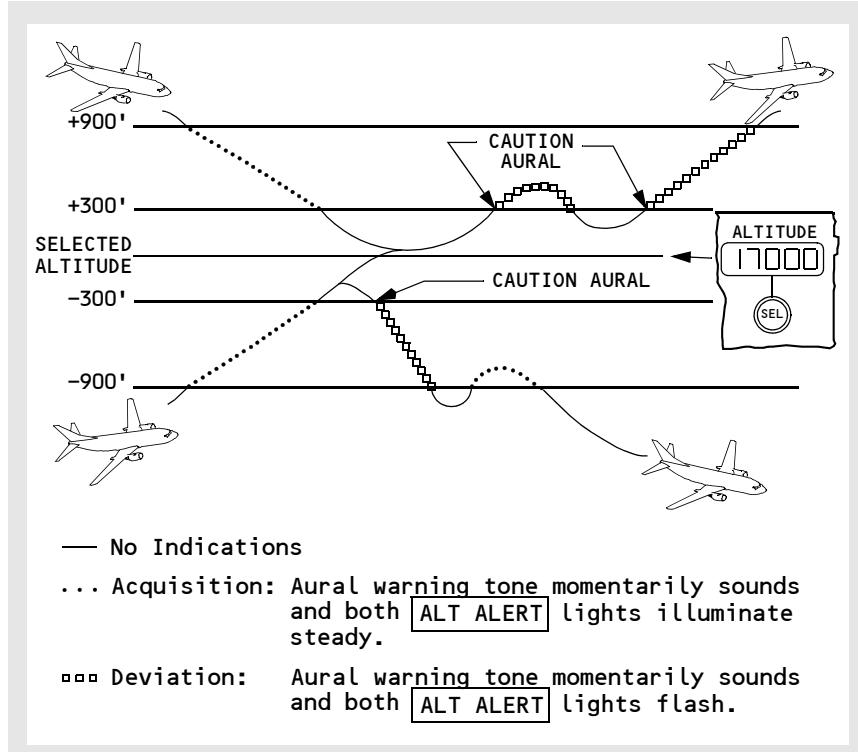
When approaching within 900 feet of selected altitude both ALTITUDE ALERT lights illuminate steady, and a momentary tone sounds. When at 300 feet from selected altitude, both ALTITUDE ALERT lights extinguish.

### 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.

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 64 knots, the A/T mode annunciates THR HLD.

At lift-off:

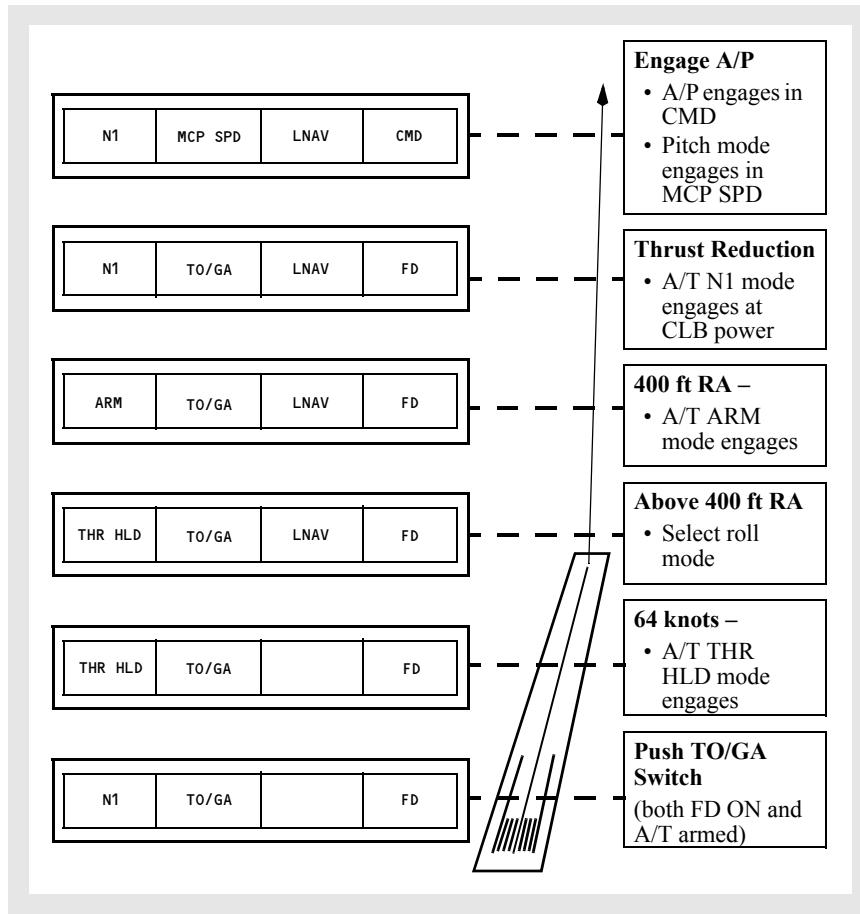
- the pitch command continues at 15 degrees until sufficient climb rate is acquired. Pitch then commands MCP speed (normally V2) plus 20 knots.
- if an engine failure occurs during takeoff, the pitch command target speed is:
  - V2, if airspeed is below V2
  - existing speed, if airspeed is between V2 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. Either localizer or glide slope can be captured first.

### 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, SINGLE CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

### Glide Slope Capture

Either the LOC or G/S can be captured first. 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
- FLARE armed is annunciated
- the SINGLE 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. Either the LOC or G/S can be captured first.

### 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, SINGLE CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

## Glide Slope Capture

Either the LOC or G/S can be captured first. 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).

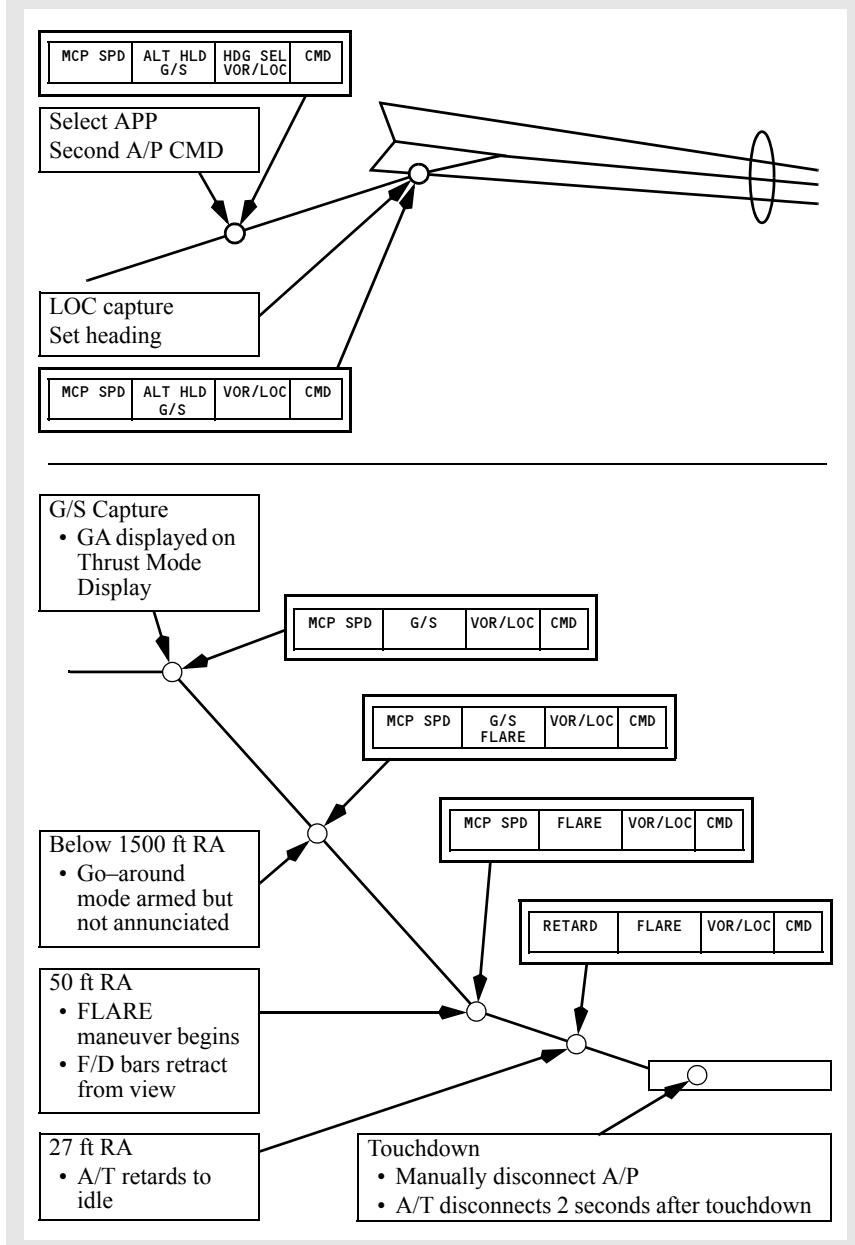
After VOR/LOC and G/S are both captured, the APP mode can be exited by:

- pressing a TO/GA switch
- retuning a VHF NAV receiver
- overriding pitch or roll into CWS.

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 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:

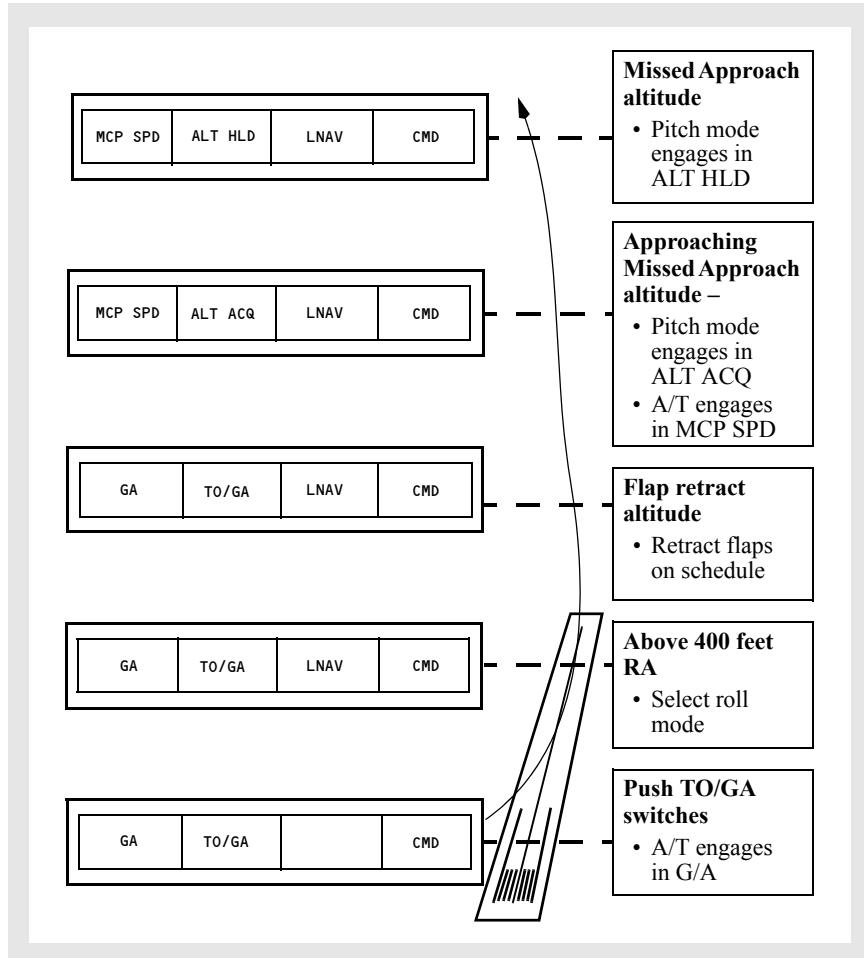
- F/D roll commands hold current ground track. The Roll Engaged Mode annunciation on the FMA is blank
- Pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- The F/D target speed is displayed on IAS/Mach display
- The F/D target speed is displayed on the airspeed 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
- Performance limit 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.

## Performance Limit Reversion

This function occurs only while operating in the V/S mode when the selected vertical speed and airspeed combination exceeds the thrust capability to maintain the selected airspeed. If airspeed becomes more than 5 knots below the MCP selected airspeed and is not increasing, the AFS reverts to LVL CHG, and the underspeed limiting symbol appears in the MCP IAS/MACH Display.

---

The underspeed limiting symbol remains displayed until a different speed or a different pitch mode is selected.

Performance limit reversion can occur with the A/T OFF and the autopilot ON.

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# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Communications**

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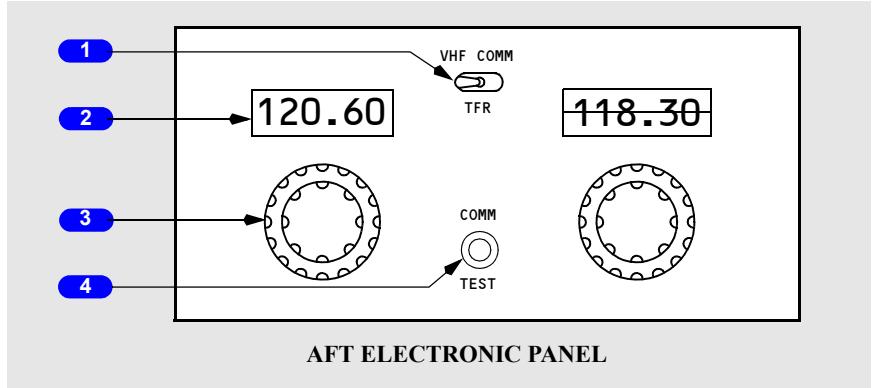
### Communications

#### Controls and Indicators

### Chapter 5

#### Section 10

## VHF Communication Panel



### 1 VHF Communications Transfer (TFR) Switch

Selects which frequency as active for the transceiver.

### 2 Frequency Indicator

Indicates selected frequency.

- A shutter covers inactive frequency.

### 3 Frequency Selector

Rotate – selects frequency in related indicator:

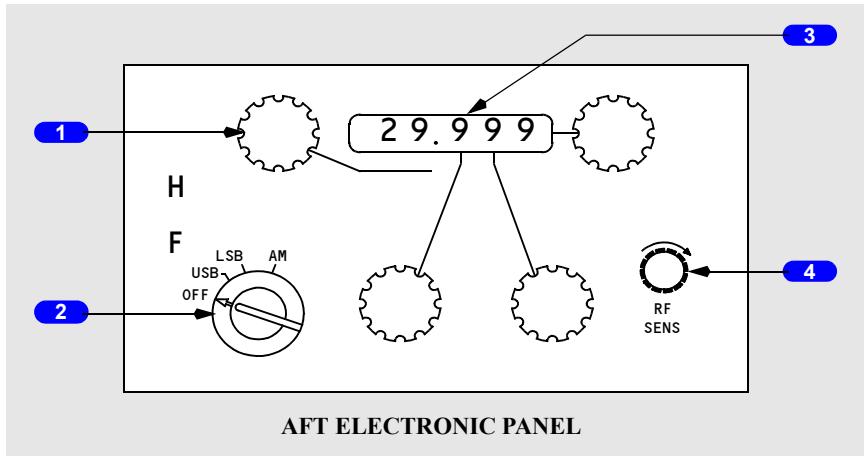
- outer selector changes three left digits
- inner selector changes two right digits.

### 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.

## 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.

LSB (Lower Sideband) – transmits and receives on lower 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.

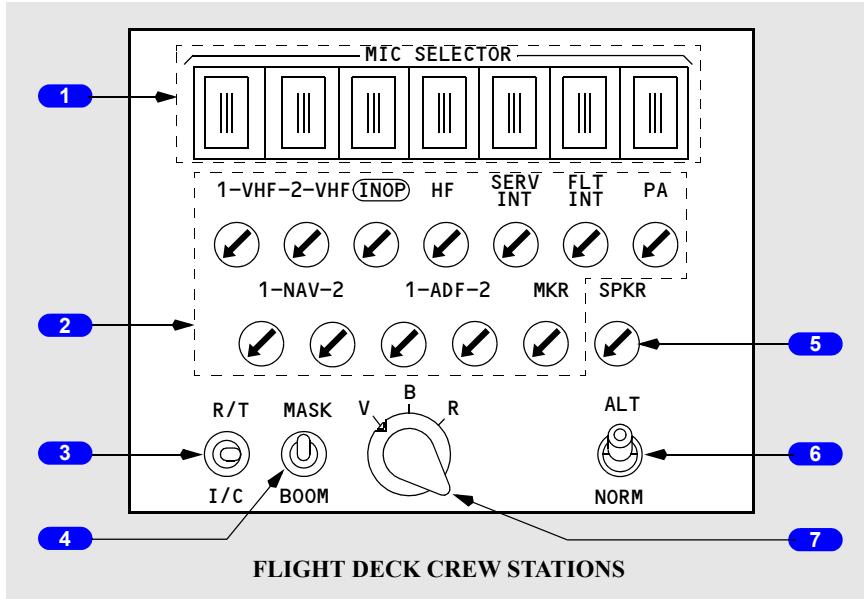
### 4 RF/HF Sensitivity Control

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.

## 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.

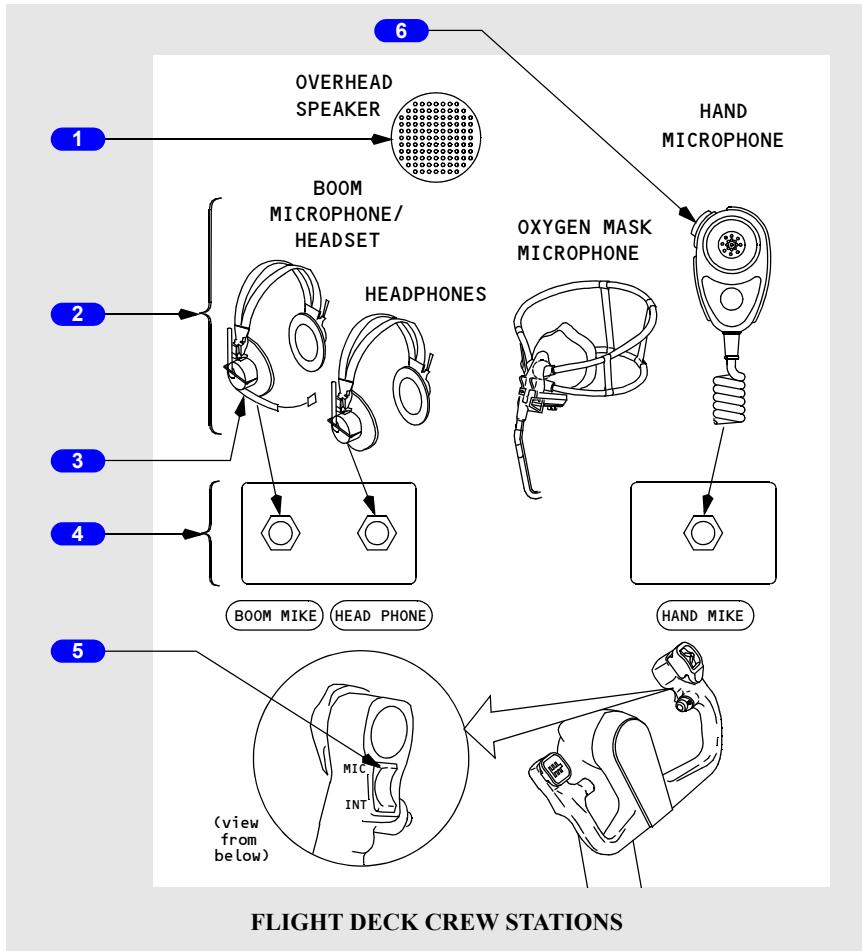
**7 Filter Switch**

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

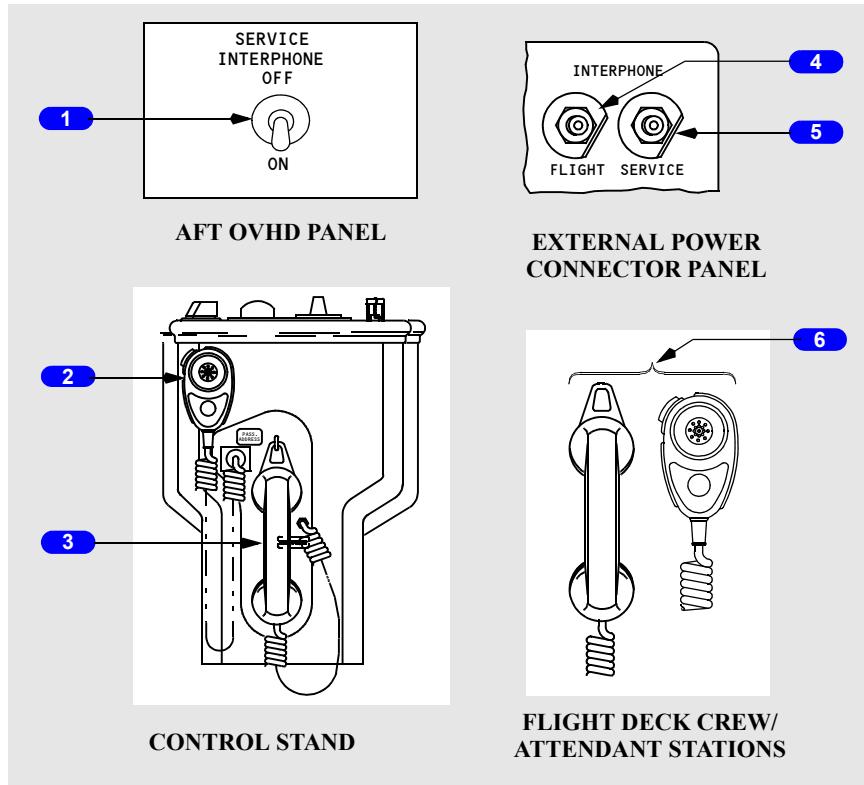
Push – keys hand microphone for transmission, as selected by ASP transmission selector.

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Communications -  
Controls and Indicators

## 737 Flight Crew Operations Manual

### 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 Passenger Address (PASS ADDRESS) Hand Microphone

- used to make PA announcements
- bypasses ASP.

### 3 Service INTERPHONE Handset

- used to communicate with flight attendant stations
- With SERVICE INTERPHONE switch ON, also used to communicate with any external jack location
- bypasses ASPs.

### 4 FLIGHT INTERPHONE Jack

Connects ground crew to Flight Interphone system.

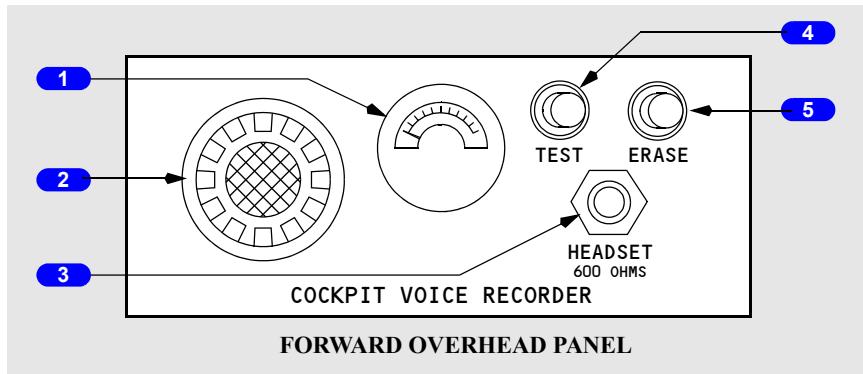
### 5 SERVICE INTERPHONE Jack

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 TEST Switch

Push –

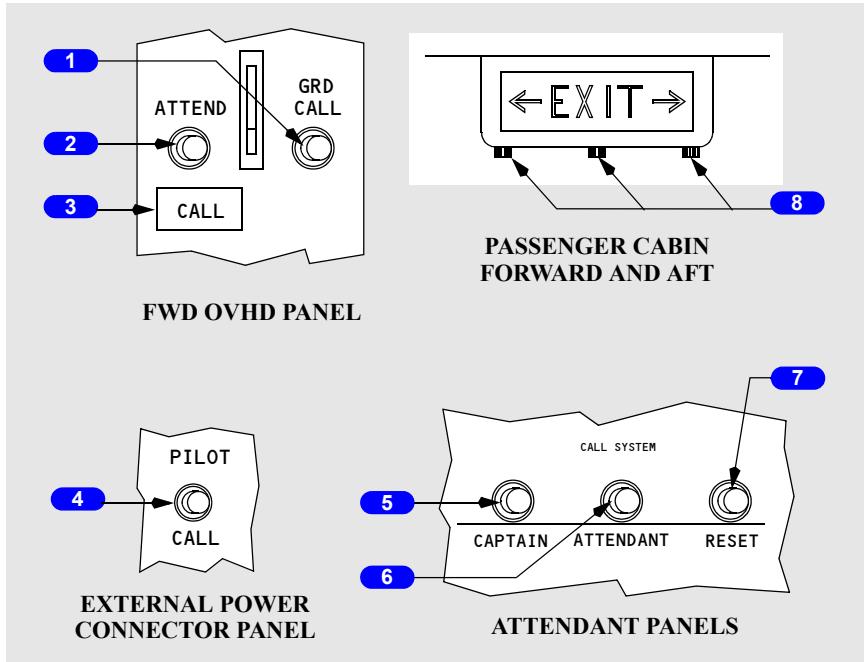
- after a slight delay, monitor indicator rises into green band
- a tone may be heard through a headset plugged into HEADSET jack.

### 5 ERASE Switch

Push (2 seconds) –

- all four channels are erased
- monitor indicator momentarily deflects
- operates only when airplane is on ground and parking brake is set.

## 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**

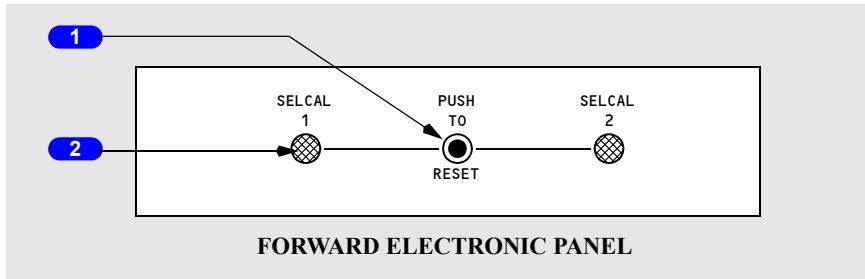
Push – extinguishes both pink master call lights.

**8 Master Call Light**

Illuminated –

- amber – a lavatory call switch is activated
- 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-1
- SELCAL 2 light illuminates for a call on VHF-2 or HF-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) (as installed)

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 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-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 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.

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# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Electrical**

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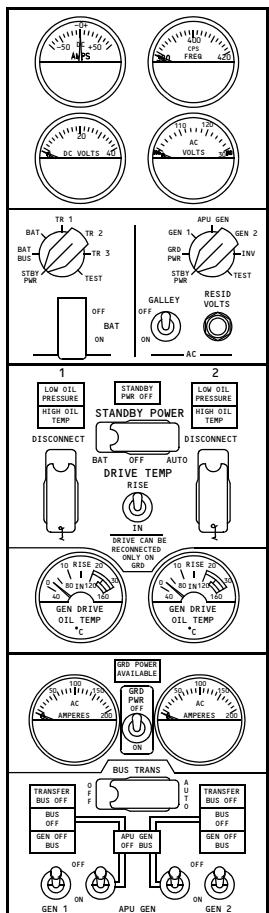
# DO NOT USE FOR FLIGHT

## 737 Flight Crew Operations Manual

### Electrical Controls and Indicators

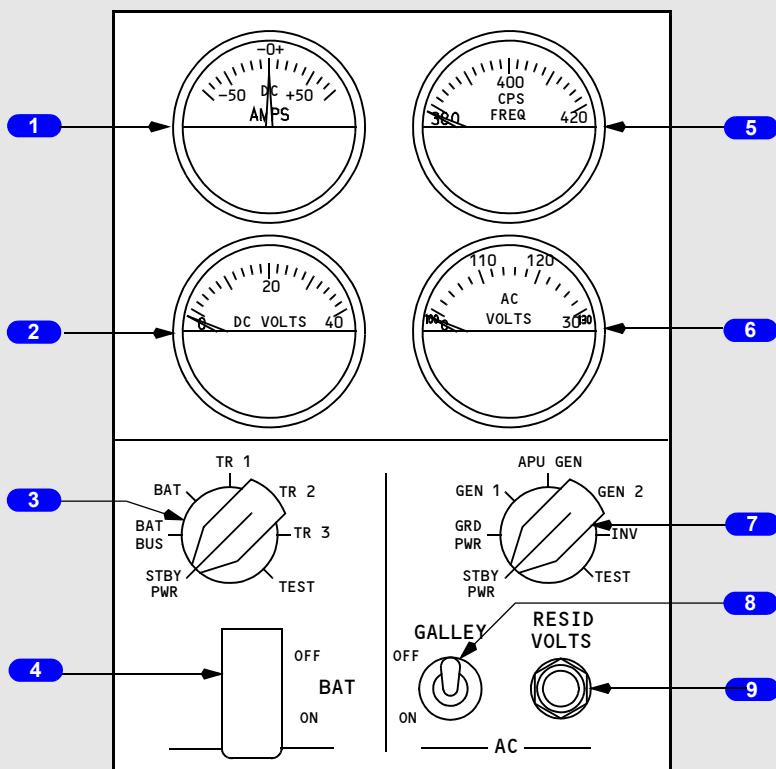
### Chapter 6 Section 10

#### 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.

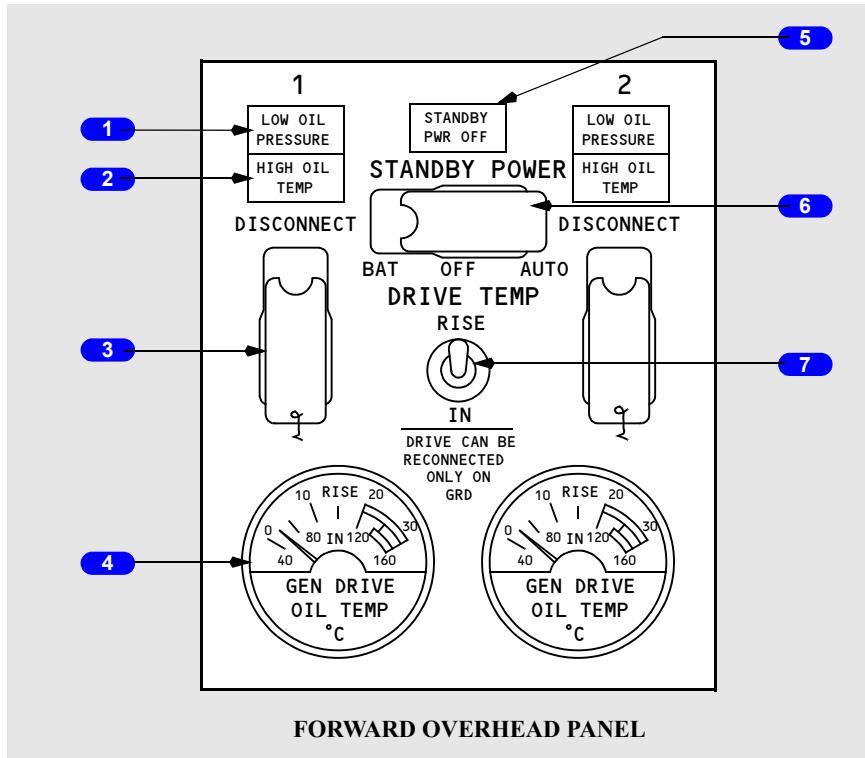
ON – electrical power is supplied to galleys when both AC generator busses are powered.

### 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) –

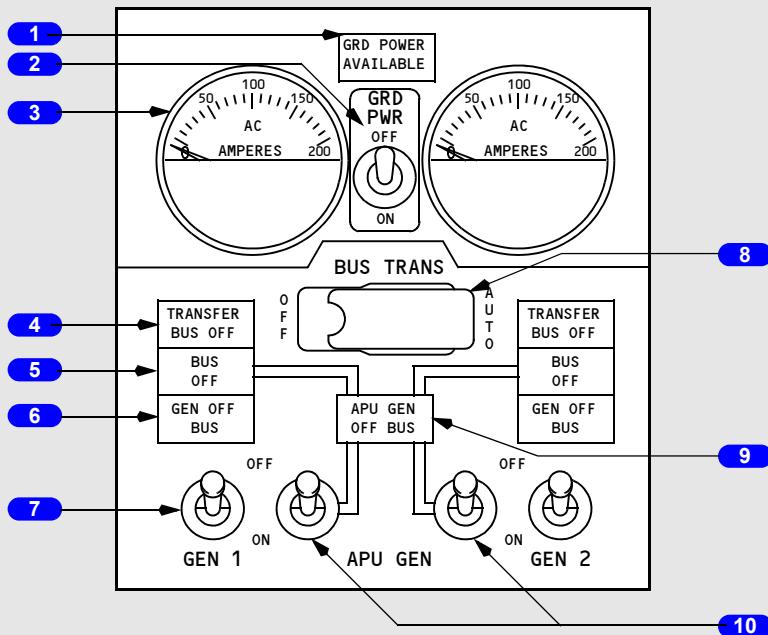
- STANDBY PWR OFF light illuminates
- AC standby bus, static inverter, and DC standby bus are not powered.

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

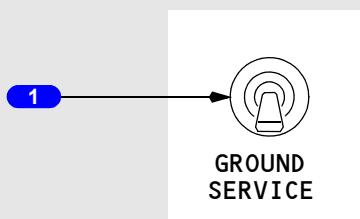
Three position switch, spring-loaded to center position.

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.

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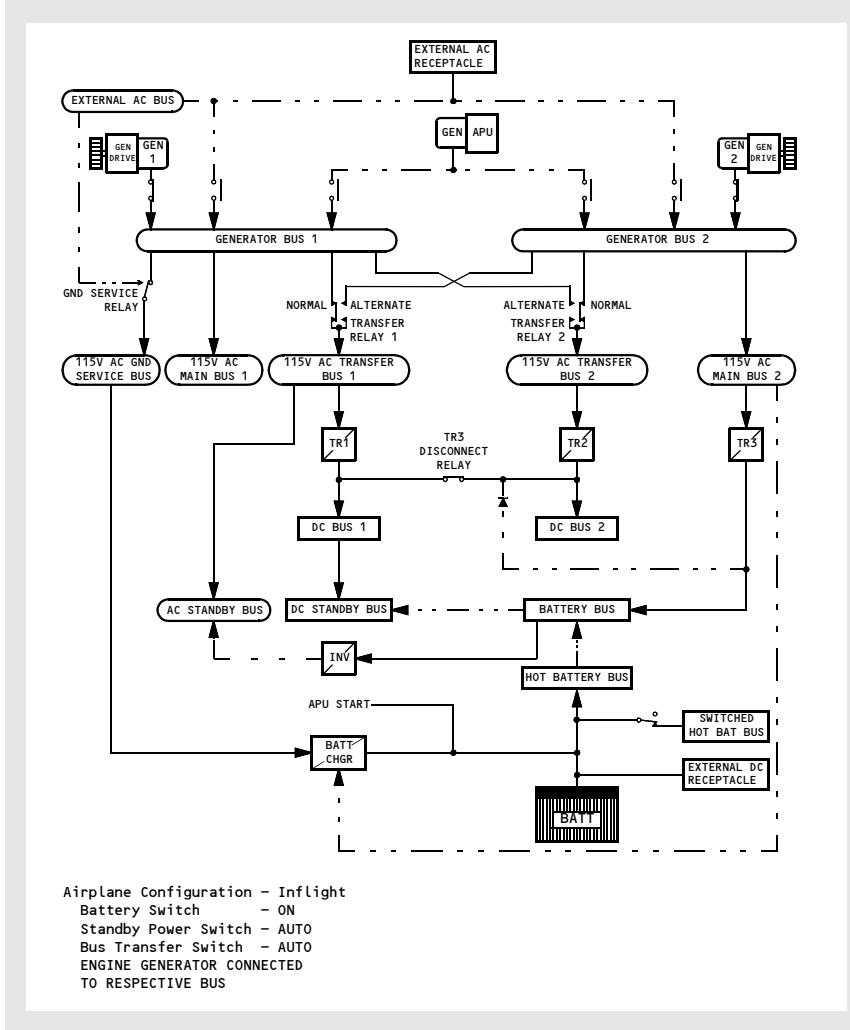
## External Ground Power

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**

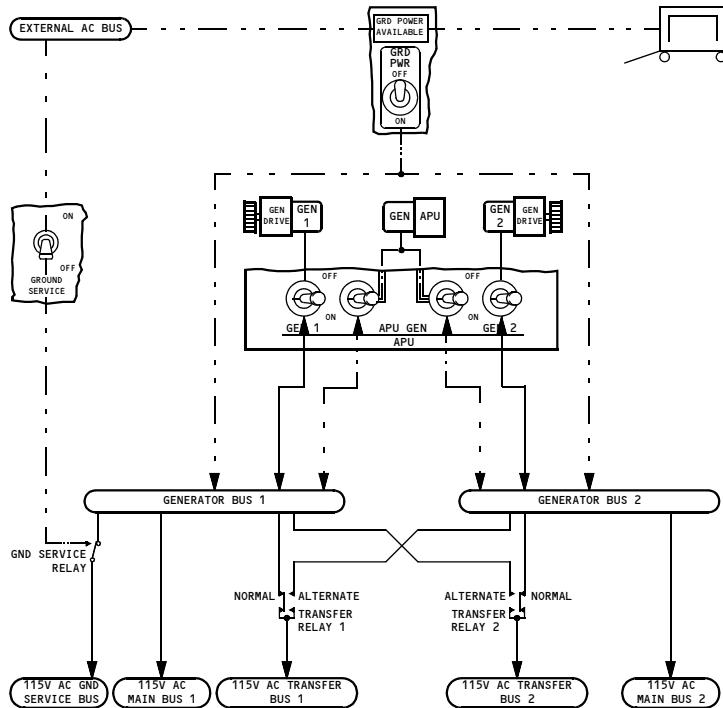
The generator busses supply the heavy electrical loads including supplying power to the transfer and main busses. The transfer busses carry the essential electrical loads, and the main busses carry the non-essential loads.

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.

## 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.

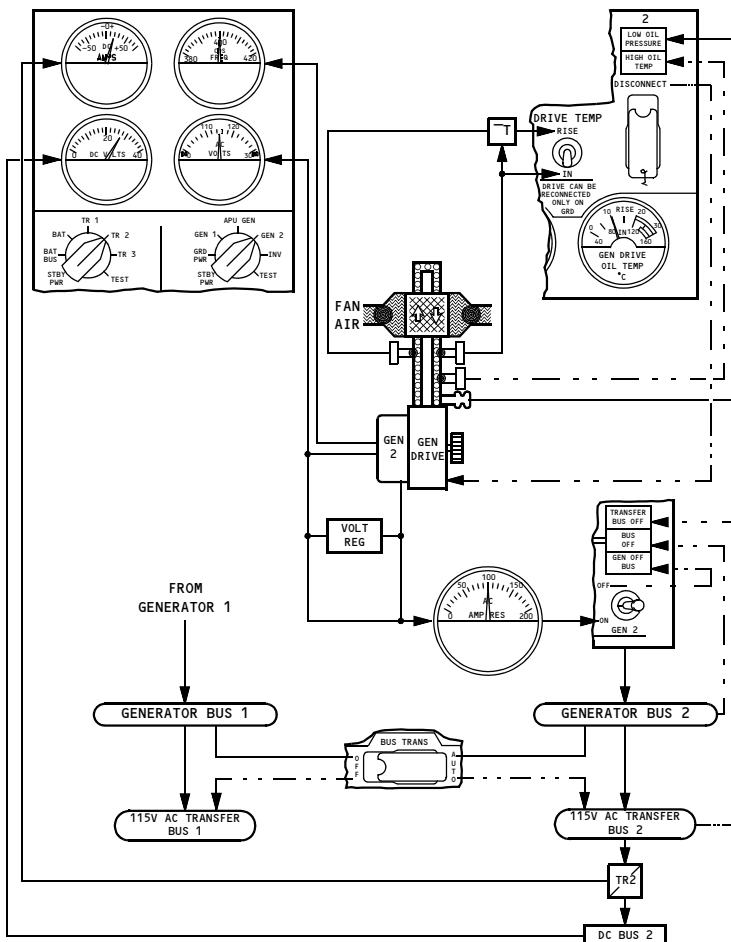
The TEST position is used by maintenance and connects the voltage and frequency meter to the power systems test module for selection of additional reading points.

## **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

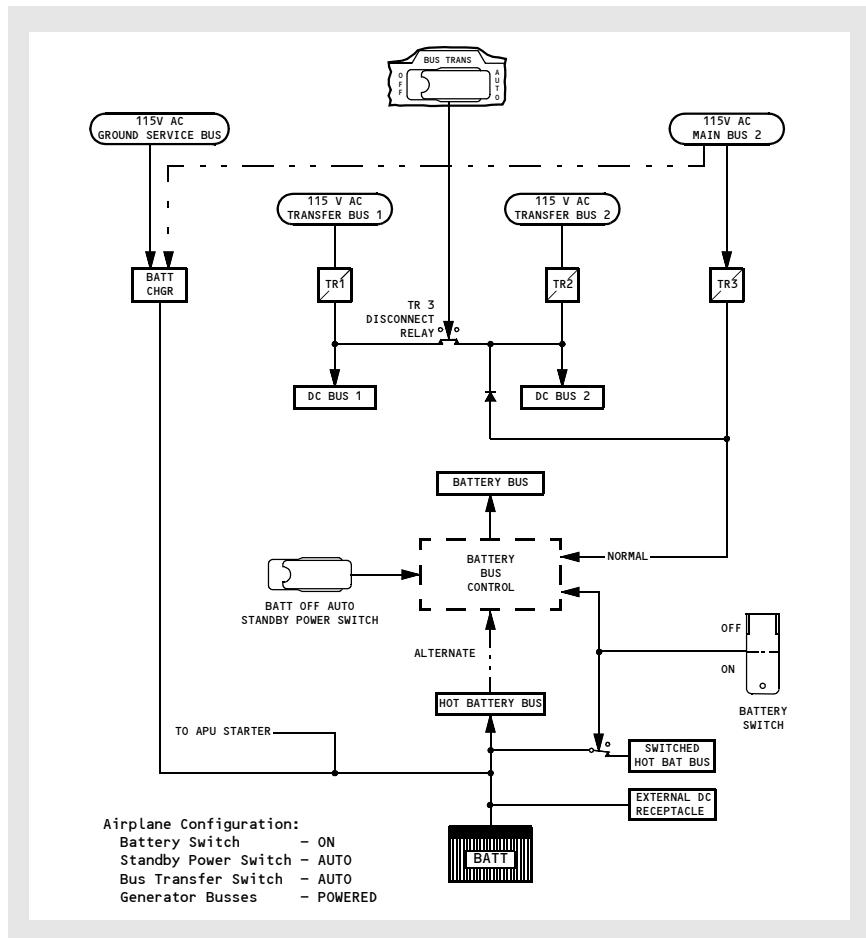
The purpose of the battery charger is to restore and maintain the battery at full electrical power. The battery charger is powered through AC ground service bus with provisions for automatic switching to main bus 2 when the ground service bus is unpowered.

## 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.

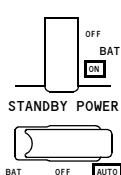
On the ground, with the loss of all AC power, the AC and DC standby busses are unpowered with the standby power switch in AUTO. The air/ground safety sensor inhibits the transfer to battery power to prevent discharging the battery. If the standby power switch is positioned to BAT, the air/ground safety 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

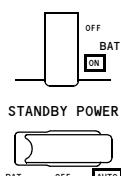
TRANSFER BUS NO. 1



DC BUS NO. 1

DC STANDBY BUS

AC STANDBY BUS



Airplane configuration - Inflight  
Battery Switch - ON  
Standby Power Switch - AUTO  
GENERATOR BUSSES NOT POWERED

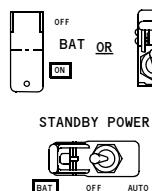
DC STANDBY BUS

BATTERY BUS

AC STANDBY BUS



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



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 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)
- standby bus volts indication

## Flight Instruments

- clocks (hot battery bus)
- standby airspeed/altitude indicator
- standby horizon indicator

- standby magnetic compass
- captain's ADI
- captain's HSI

## **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
- air/ground relay
- landing gear indicator lights

## **Navigation**

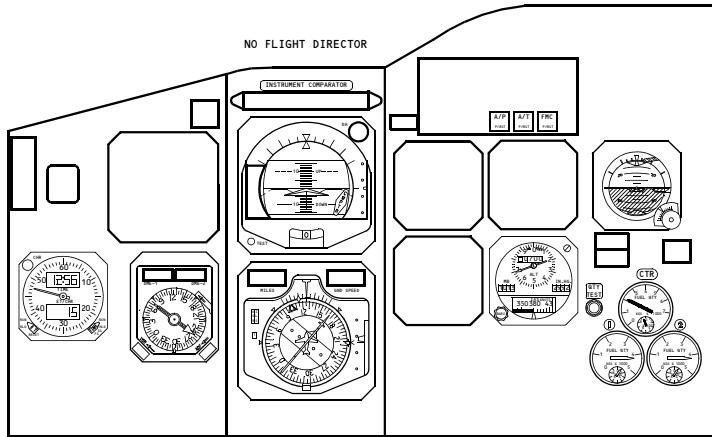
- ADF No. 1
- captain's RDMI
- left IRS - AC
- left & right IRS - DC (switched hot battery bus)
- VHF NAV No. 1

## **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.

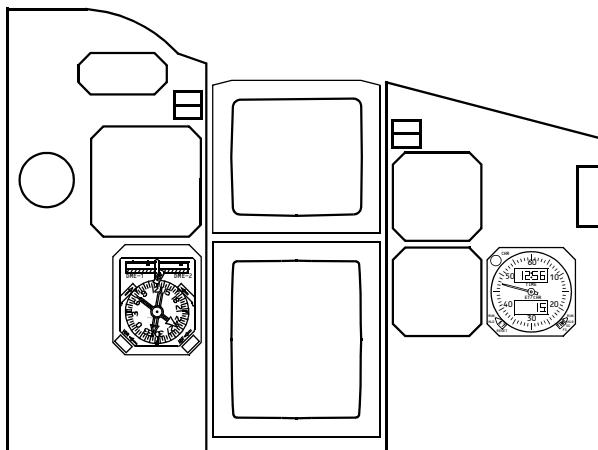
**CAUTION:** AS SOON AS THE AIRPLANE LANDS, THE STANDBY POWER SWITCH SHOULD BE POSITIONED TO "BAT" TO ENERGIZE THE ABOVE ELECTRONICS AND FOR VHF-1 COMMUNICATIONS.

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 – In Flight  
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
Aux tank aft fuel pump (as installed)	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

**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
Aux tank forward fuel pump	LOW PRESSURE light
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
Recirculation fan	Inoperative
Engine vibration amplifier	Inoperative

# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Engines, APU**

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# DO NOT USE FOR FLIGHT

737 Flight Crew Operations Manual

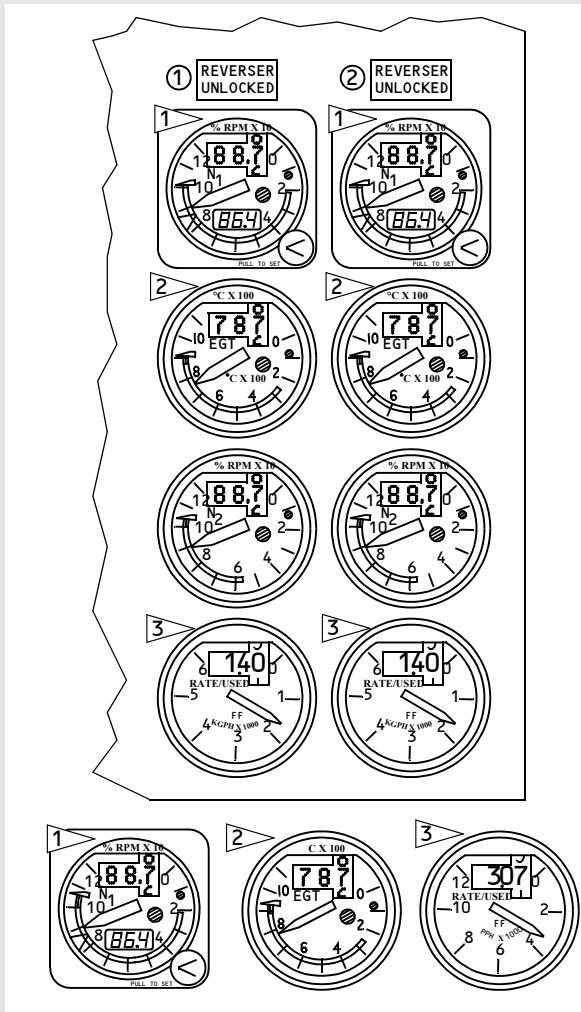
## Engines, APU

### Controls and Indicators

## Chapter 7

### Section 10

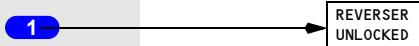
#### Conventional Engine Instruments Primary Panel



# As installed

#### CENTER INSTRUMENT PANEL

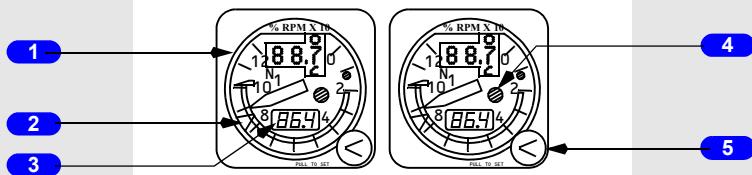
## Reverser Unlocked Light



### 1 REVERSER UNLOCKED Light

Illuminated (amber) – Indicates the thrust reverser is unlocked.

## N1 Indications



### 1 N1 RPM Indicator

Displays N1 % RPM.

### 2 N1 Cursor

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.

### 3 N1 Manual Set Indication

Set by N1 manual set knob.

Blank when manual set knob is pushed in.

### 4 Warning Light

Illuminated (red) –

- indicates the N1 limit has been reached or exceeded
- remains illuminated until N1 is reduced below the limit.

### 5 N1 Manual Set Knob

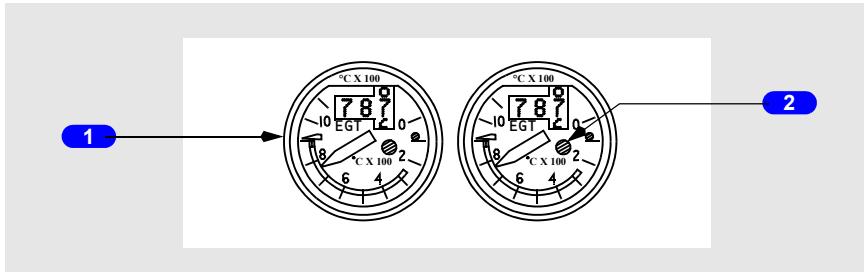
Push in –

- N1 cursor 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 N1 cursor to the corresponding location.

## EGT Indications



### 1 Exhaust Gas Temperature (EGT) Indication

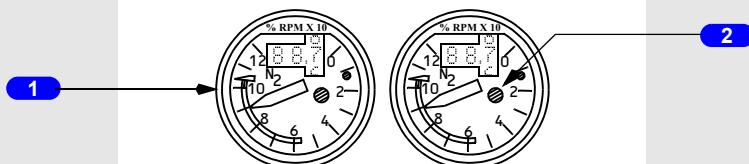
Displays engine EGT in degrees C.

### 2 Warning Light

Illuminated (red) –

- indicates the EGT limit has been reached or exceeded
- remains illuminated until EGT is reduced below the limit.

## N2 Indications



### 1 N2 Indicator

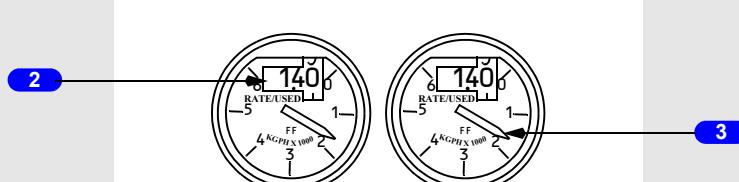
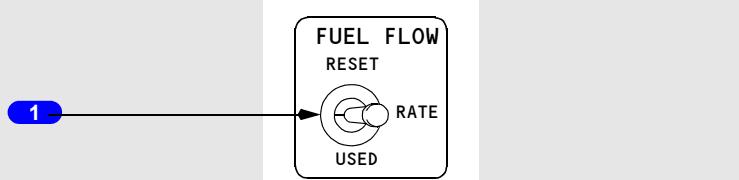
Displays N2 % RPM.

### 2 Warning Light

Illuminated (red) –

- indicates the N2 limit has been reached or exceeded
- remains illuminated until N2 is reduced below the limit.

## Fuel Flow/Fuel Used Indications



### 1 Fuel Flow Switch (spring-loaded to RATE position)

RESET –resets the fuel used display on both fuel flow indicators to zero.

---

RATE – the digital display on both fuel flow indicators shows rate of fuel consumption.

USED – the digital display on both fuel flow indicators shows total fuel consumed since last reset.

### 2 Fuel Flow (RATE/USED) Digital Display

With the fuel flow switch in the RATE position, indicates rate of fuel flow in pounds/kilograms per hour X 1000.

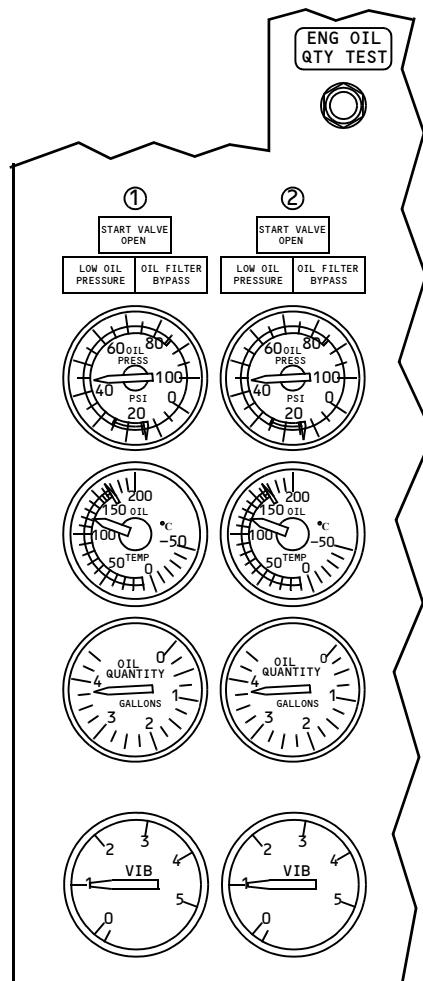
With the fuel flow switch held in the USED position, indicates the amount of fuel used in pounds/kilograms since last reset.

With the fuel flow switch held in the RESET position, the fuel USED display returns to zero

### 3 Fuel Flow Pointer

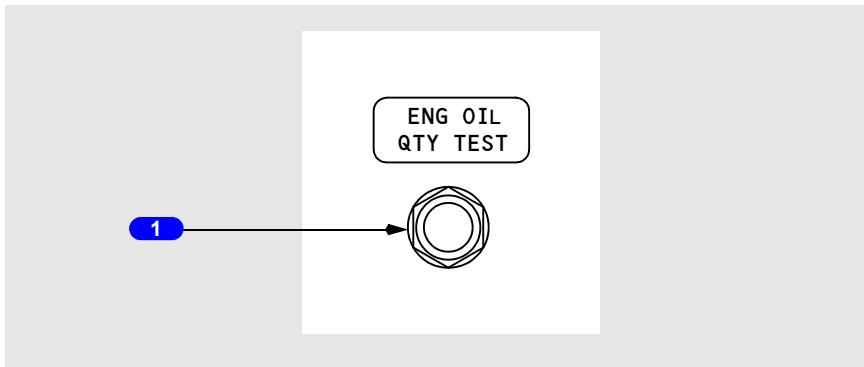
Indicates rate of fuel flow in pounds/kilograms per hour at all times.

## Conventional Engine Instruments Secondary Panel



CENTER INSTRUMENT PANEL

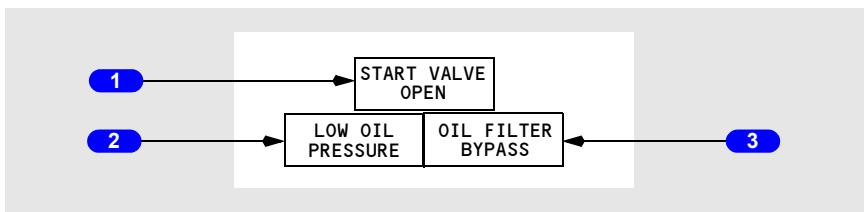
## Engine Oil Quantity Test Switch



### 1 Engine Oil Quantity Test (ENG OIL QTY TEST) Switch

Push – oil quantity indicators move toward zero.

## Caution Lights



### 1 START VALVE OPEN Light

Illuminated (amber) – related engine start valve is open and air is being supplied to the starter.

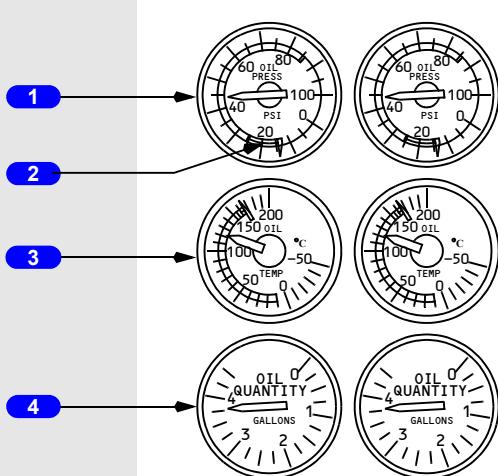
### 2 LOW OIL PRESSURE Light

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.

## Engine Oil Indications



### 1 Oil Pressure (OIL PRESS) Indicator

Displays engine oil pressure in psi.

### 2 Low Oil Pressure Yellow Band

With takeoff thrust set, indicates minimum oil pressure limit.

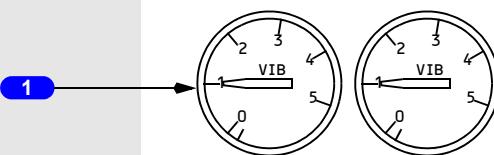
### 3 Oil Temperature (OIL TEMP) Indicator

Displays engine oil temperature in degrees C.

### 4 Oil Quantity (OIL QTY) Indicator

Displays engine oil quantity in gallons.

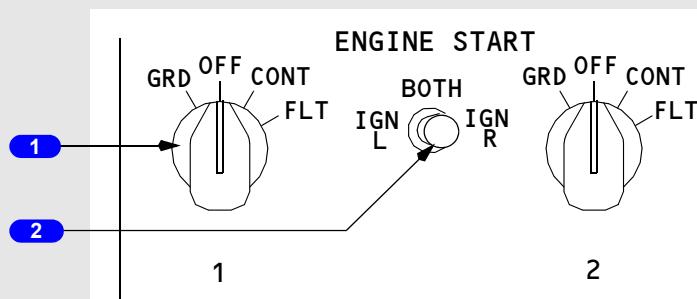
## Engine Vibration Indications



### 1 Airborne Vibration (VIB) Monitor

Indicates engine vibration level.

## Engine Start Switches



FORWARD OVERHEAD PANEL

### 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.

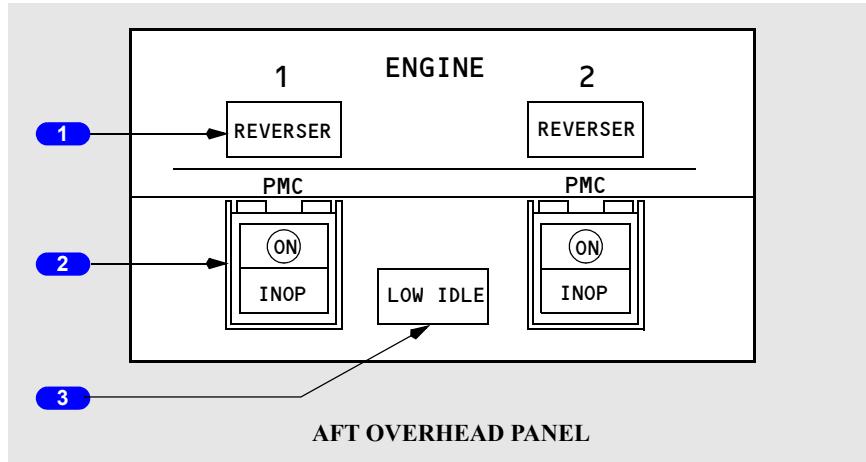
## 2 Ignition Select Switch

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.

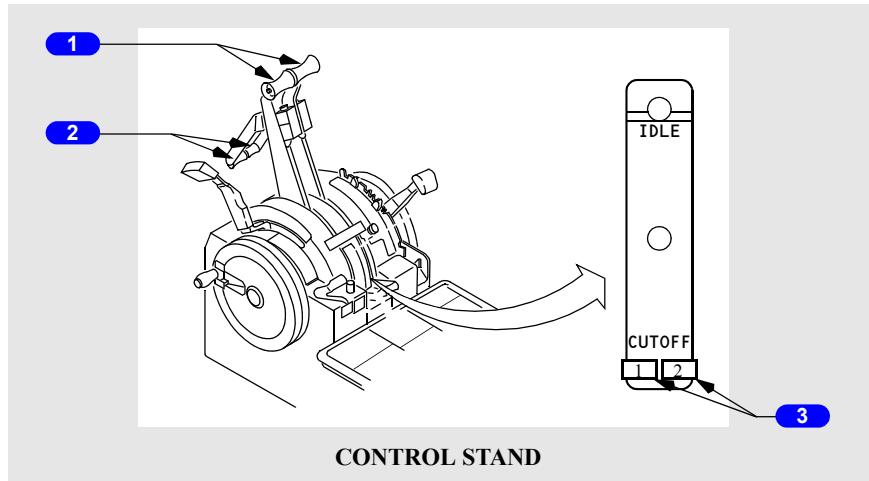
## 3 LOW IDLE Light

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
- for airplanes that have the autothrottles connected to the FLT position of the engine start switch circuit, an engine start switch is in FLT and one or both engines are operating below 45% in flight above 500 feet radio altitude.

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

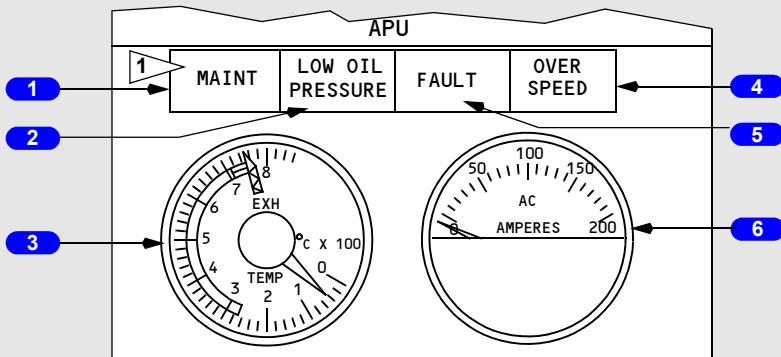
IDLE –

- 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.

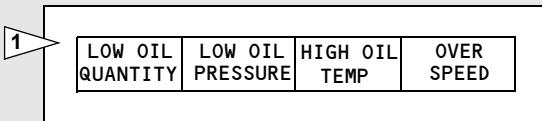
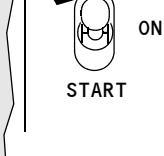
## APU



GARRETT GTCP 85-129

APU

7



1 As Installed

### FORWARD OVERHEAD PANEL

#### 1 APU Maintenance (MAINT)/LOW OIL QUANTITY Light

MAINT Illuminated (blue) – APU maintenance problem exists:

- APU may be operated.
- light is disarmed when APU switch is OFF.

LOW OIL QUANTITY Illuminated (blue) –

- APU oil quantity is insufficient for extended operation.
- 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)
- light is disarmed when APU switch is OFF.

## **3 APU Exhaust Gas Temperature (EGT) Indicator**

Displays APU EGT

## **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 a normal APU shutdown
- APU start is aborted prior to reaching governed speed (light will extinguish following a normal start)
- light is disarmed when APU switch is OFF.

## **5 APU FAULT/HIGH OIL TEMPERATURE Light**

FAULT Illuminated (amber) –

- a malfunction exists causing APU to initiate an automatic shutdown
- light is disarmed when APU switch is OFF.
- Additional restarts may be attempted.

HIGH OIL TEMP Illuminated (amber) –

- APU oil temperature is excessive, causing APU to initiate an automatic shutdown.
- 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 – normal position when APU is running.

# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

**Engines, APU -  
Controls and Indicators**

---

START (momentary) – positioning APU switch from OFF to START and releasing it to ON initiates an automatic start sequence.

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. 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 ranges and limits indicated by green and yellow bands and red radials. When the round red warning light on the indicator is illuminated it indicates the limit for the related engine parameter has been reached or exceeded. The red warning light remains illuminated until the engine parameter is reduced below the limit.

---

Oil pressure, oil temperature, and oil quantity 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 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.

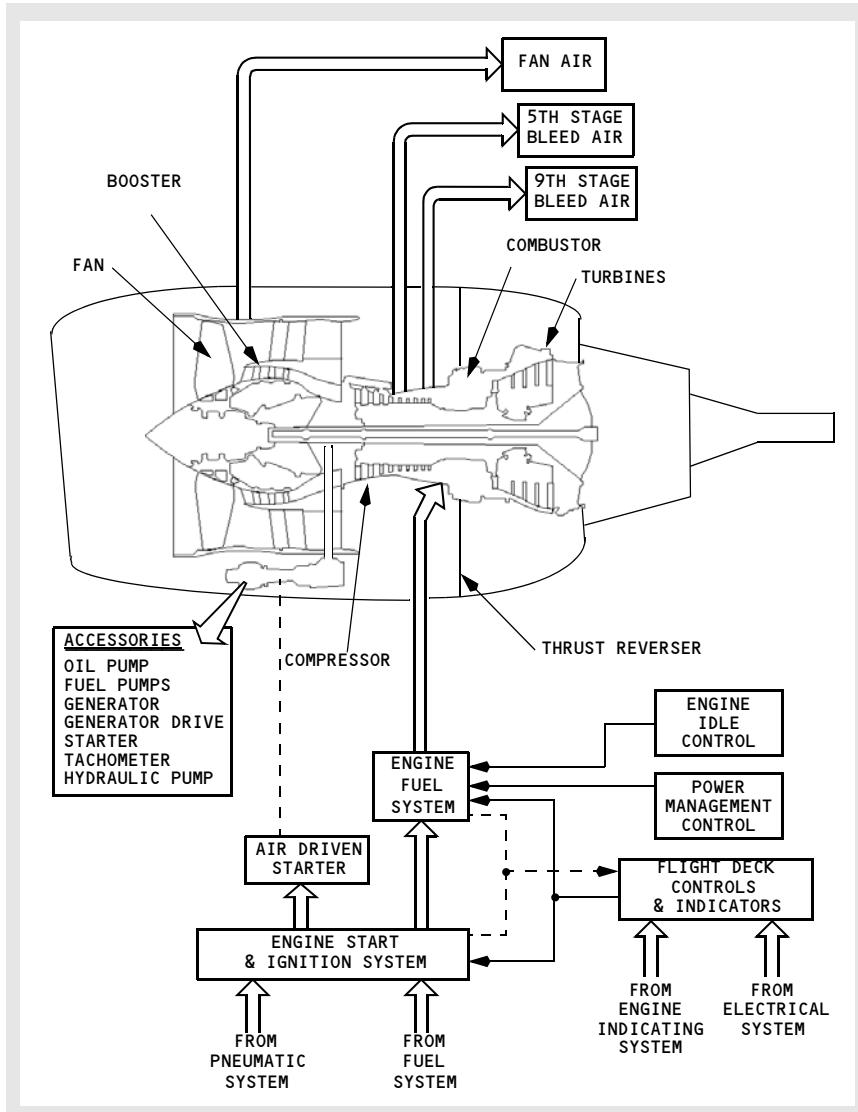
The minimum engine speed for all flight phases is high idle, which varies with flight conditions. As temperature and airspeed decrease, high idle speed also decreases. The average high idle setting is approximately 32% N1.

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.

## Minimum Engine Speed Control

On airplanes that have the autothrottles connected to the FLT position of the engine start switch circuit, in flight above 500 feet radio altitude, anytime one or both engine start switch(es) are placed to FLT, the autothrottle, if armed, maintains a minimum engine speed of 45% N1. This increases engine tolerance to water ingestion.

## 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

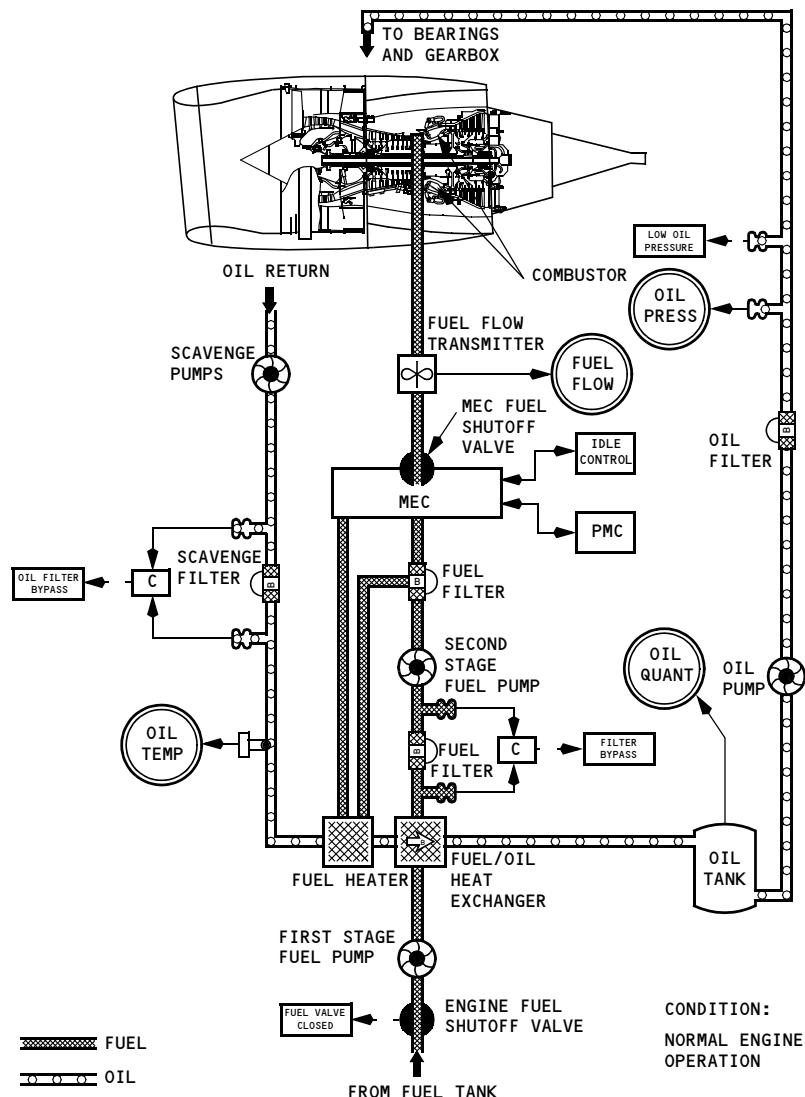
Oil from the individual engine tank is circulated under pressure through the engine to lubricate the engine bearings and accessory gearbox. Oil quantity is displayed on the oil quantity indicator, located on the center instrument panel.

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 scavenge pumps. From the scavenge pumps the oil passes through a scavenge filter. If the filter becomes saturated with contaminants, oil automatically bypasses the filter. Prior to the oil bypassing the scavenge 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.

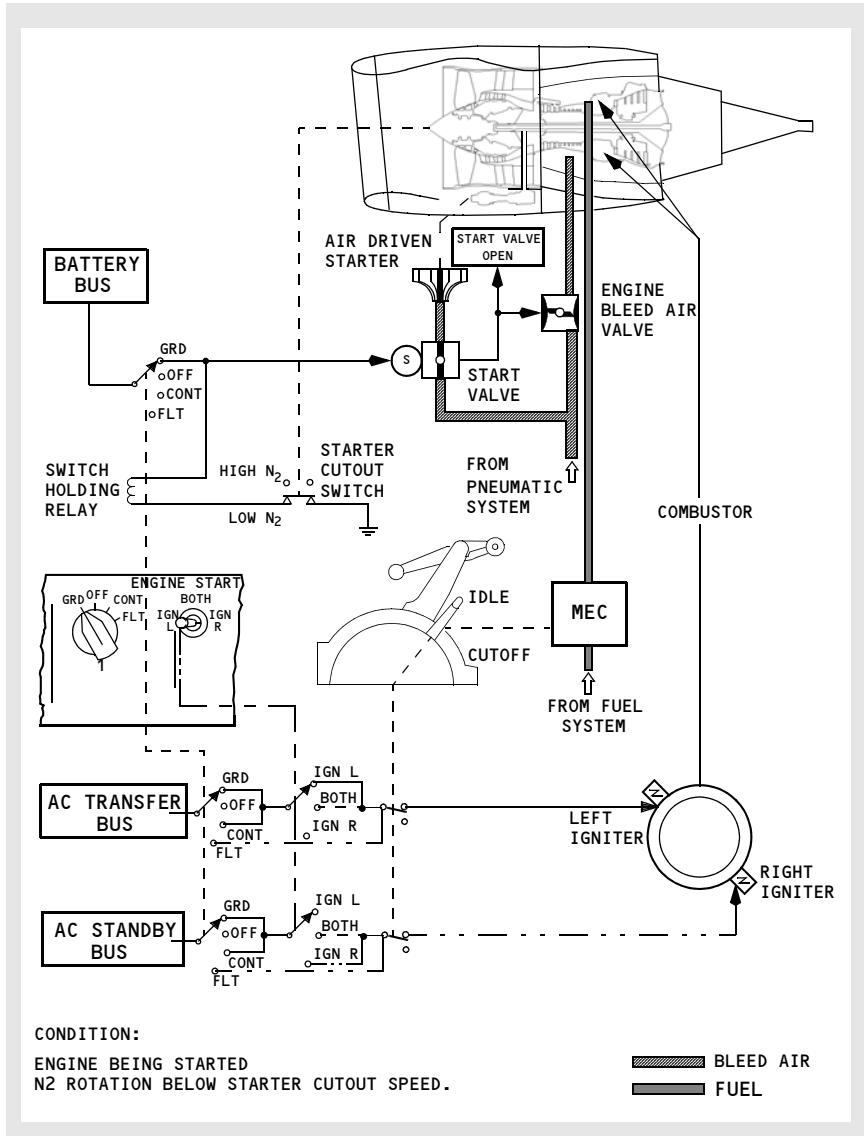
## Engine Ignition System

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



**CONDITION:**

ENGINE BEING STARTED  
N2 ROTATION BELOW STARTER CUTOUT SPEED.

 BLEED AIR  
 FUEL

## 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.

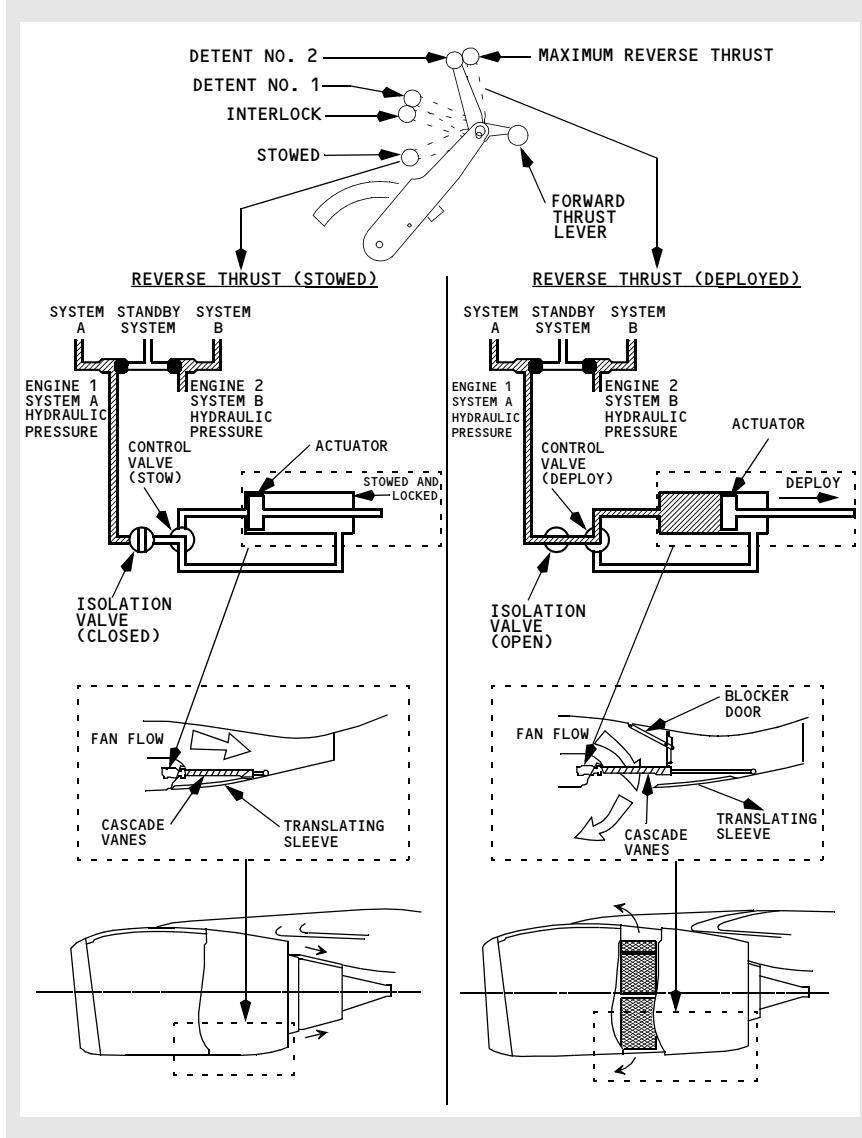
When reverse thrust is selected, the isolation valve opens, and the thrust reverser control valve moves to the deploy position, allowing hydraulic pressure to unlock and deploy the reverser system. An interlock mechanism restricts movement of the reverse thrust lever until the reverser sleeves have approached 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**

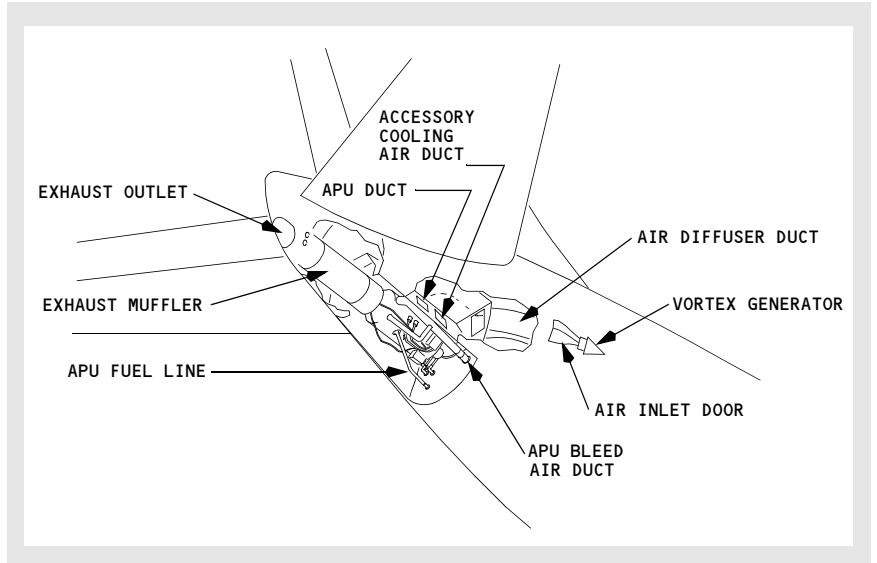
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## Introduction

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**

Operate the APU for one full minute with no bleed air load prior to shutdown. This cooling period is recommended to extend the turbine wheel life of the APU.

Moving the APU switch to OFF shuts down the APU, trips the APU generator, and closes the APU bleed air valve. 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 over temperature, the bleed air valve will close rapidly, but the APU will continue to run without initiating an automatic shutdown.

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# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Fire Protection**

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**DO NOT USE FOR FLIGHT**  
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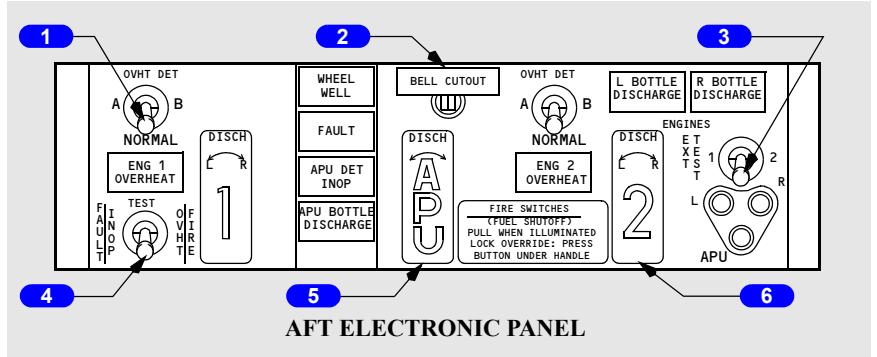
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### Fire Protection Controls and Indicators

### 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.

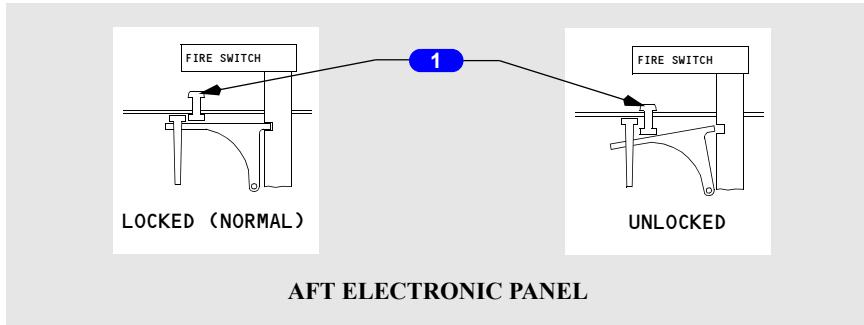
In – normal position, mechanically locked if no fire signal.

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

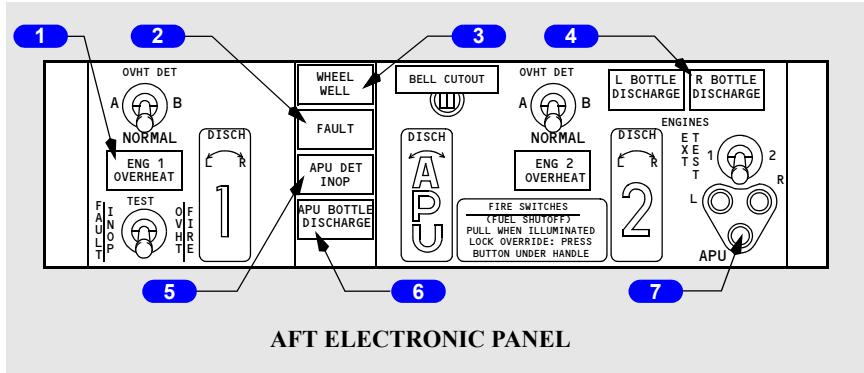


AFT ELECTRONIC PANEL

### 1 Fire Switch Override

Push – unlocks fire switch.

## Overheat/Fire Protection Panel Lights



AFT ELECTRONIC PANEL

### 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.

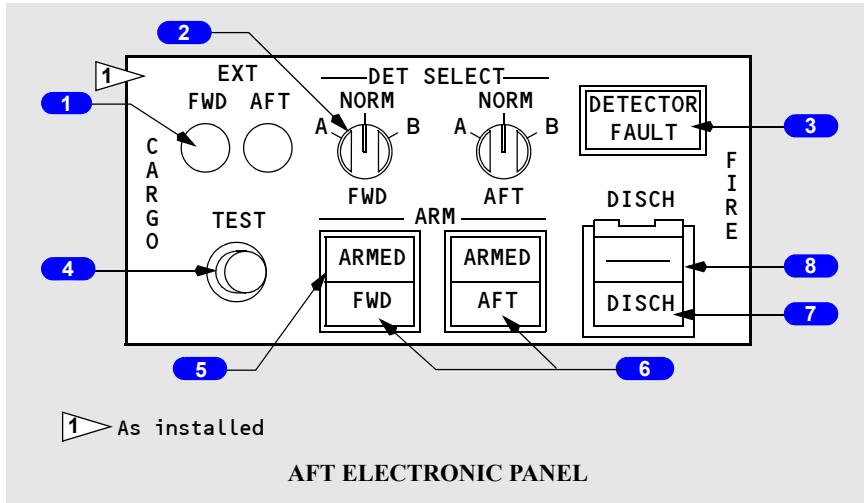
**6 APU BOTTLE DISCHARGE Light**

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)

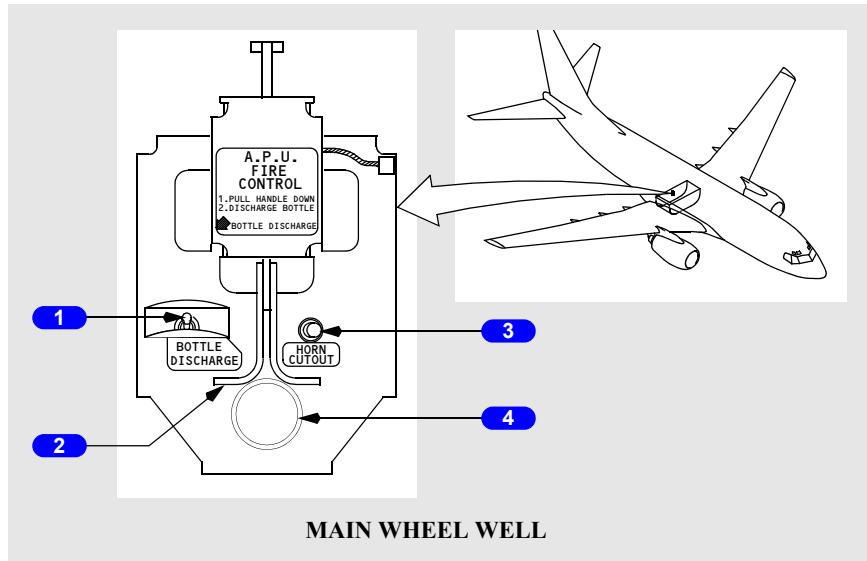
- fire warning bell sounds
- if on ground, remote APU fire warning horn sounds.

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

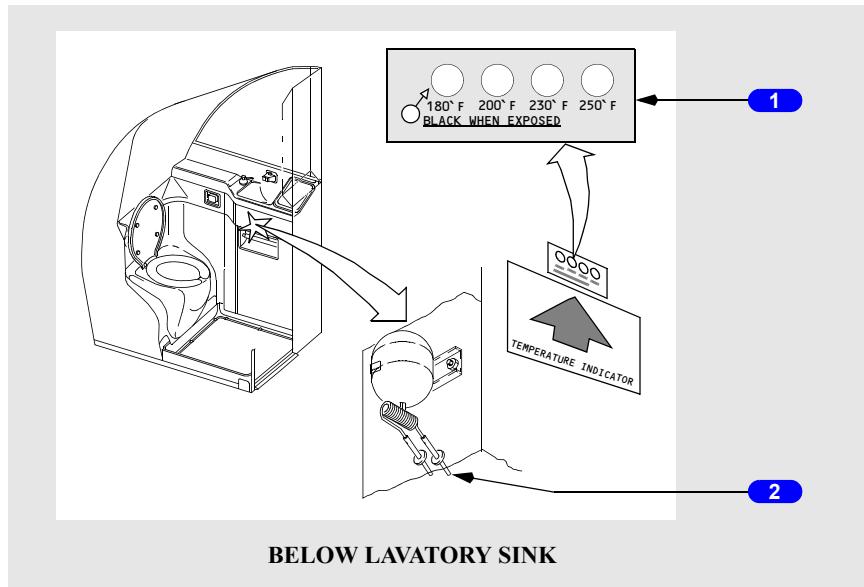
Illuminated (red flashing) – indicates fire in APU.

**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 Fire Extinguisher



#### 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.

### **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.

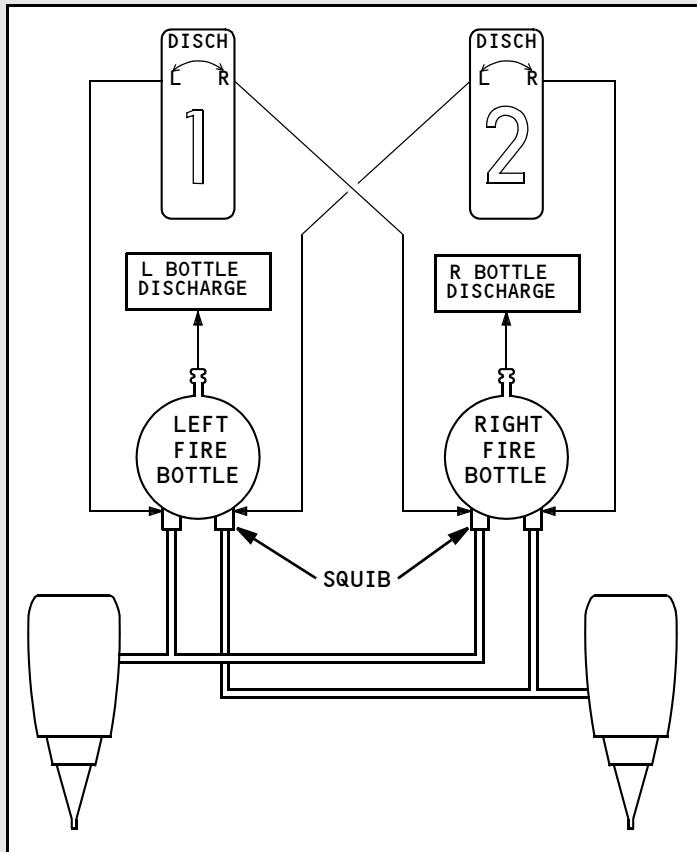
Pulling the engine fire switch up:

- 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

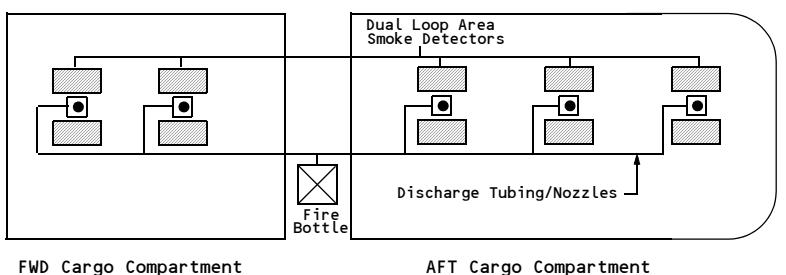
The indications of a cargo compartment fire are:

- 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

There is no flight deck indication. 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.

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## **737 Flight Crew Operations Manual**

### **Flight Controls**

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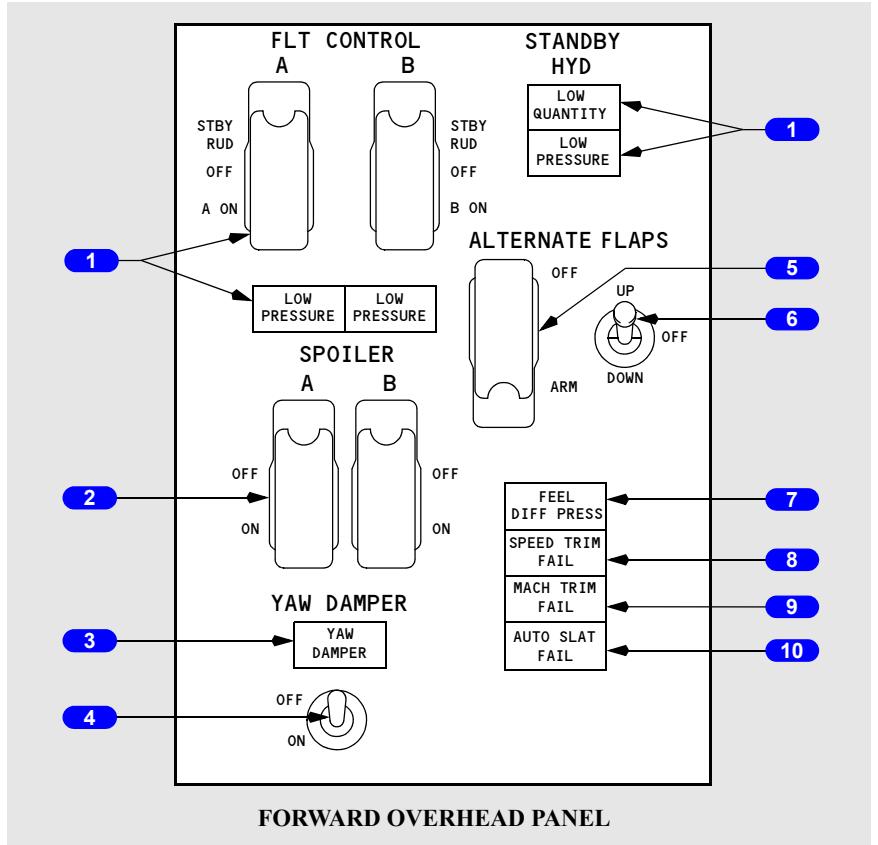
### Flight Controls

#### 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) –

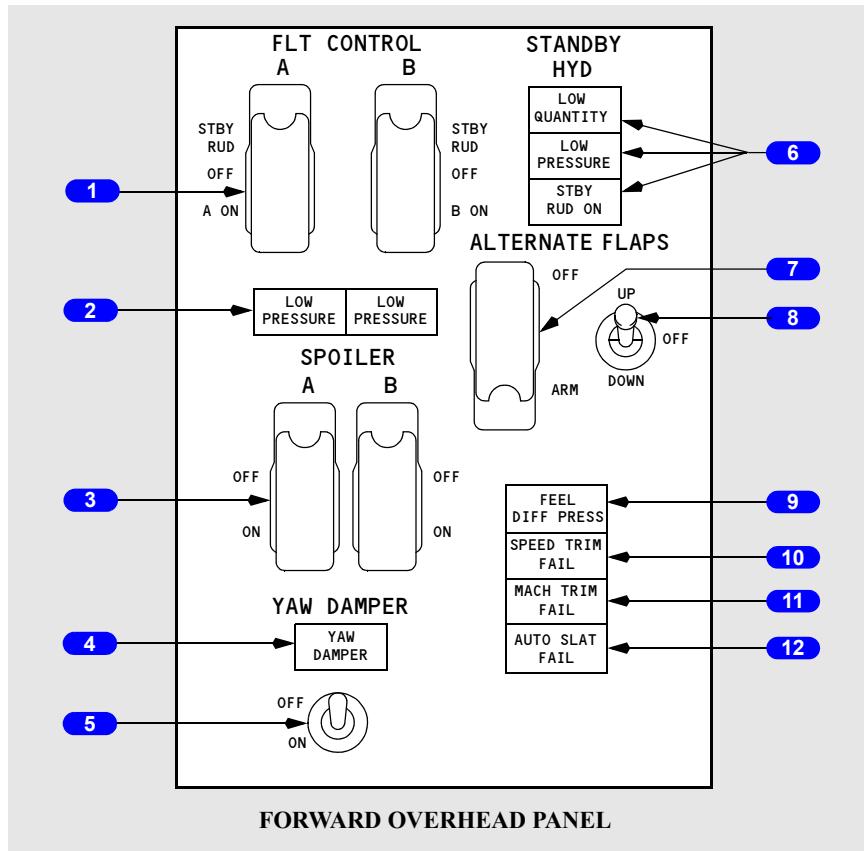
- indicates failure of the Mach trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

## 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.

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**11 MACH TRIM Failure (FAIL) Light**

Illuminated (amber) –

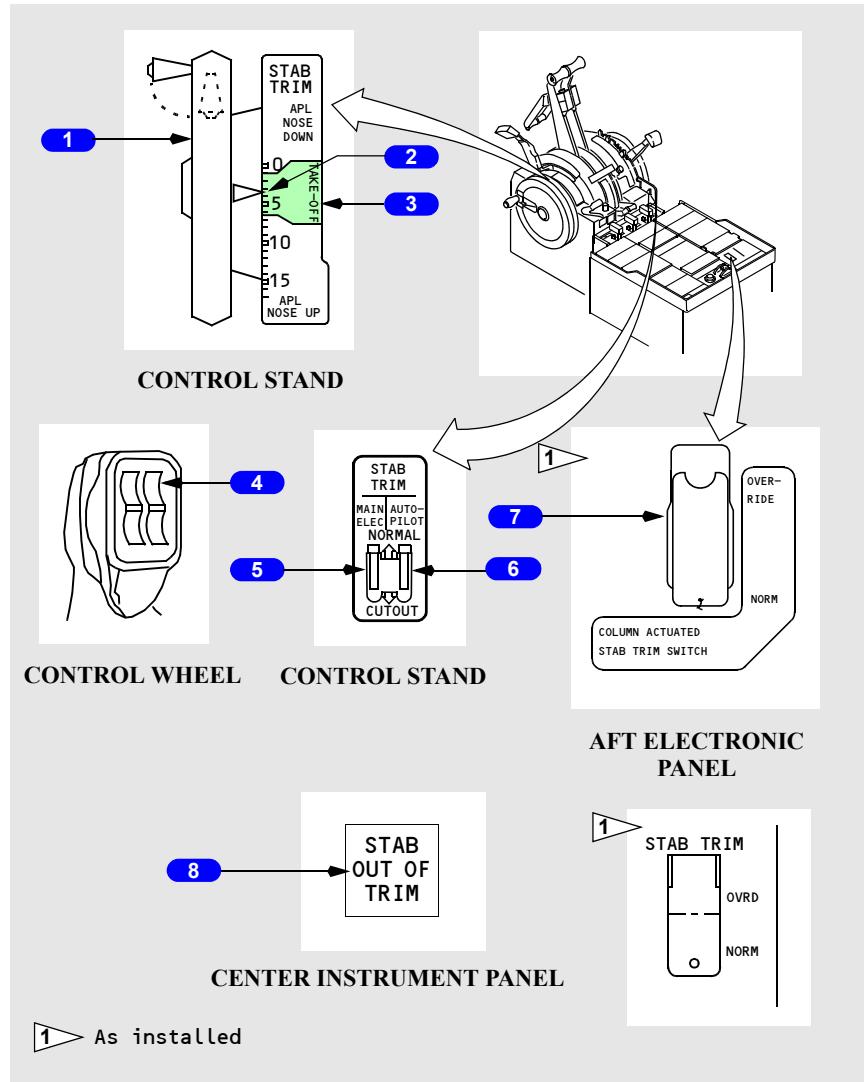
- indicates failure of the Mach trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

**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**

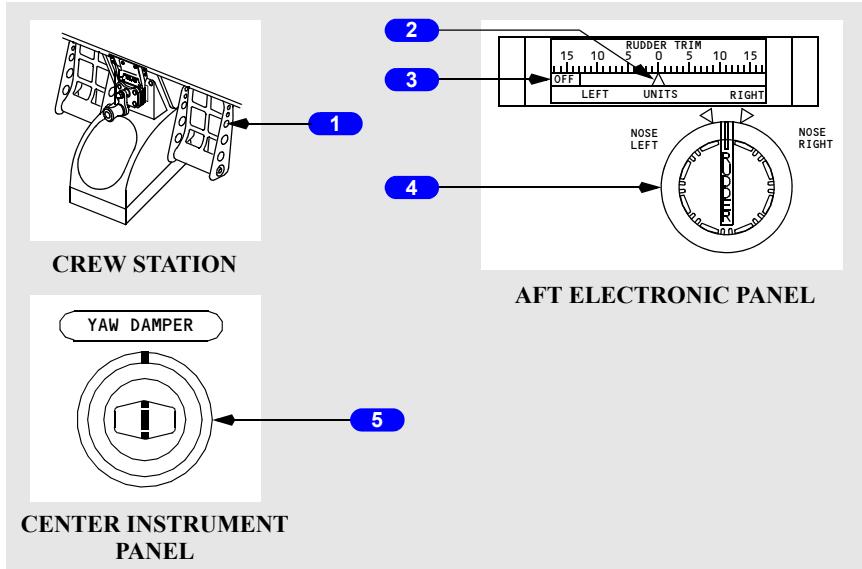
OVERRIDE – bypasses the control column actuated stabilizer trim cutout switches to restore power to the stabilizer trim switches

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.

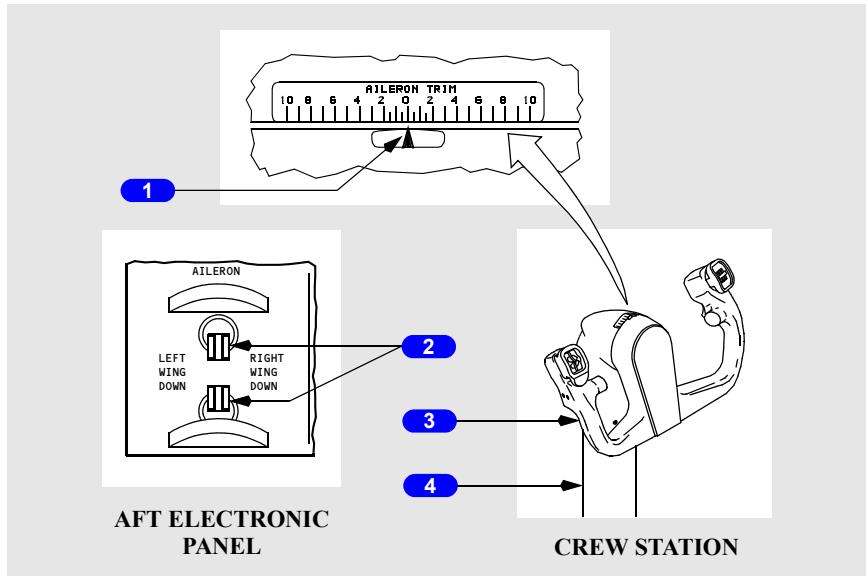
### 4 Rudder Trim Control (spring-loaded to neutral)

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

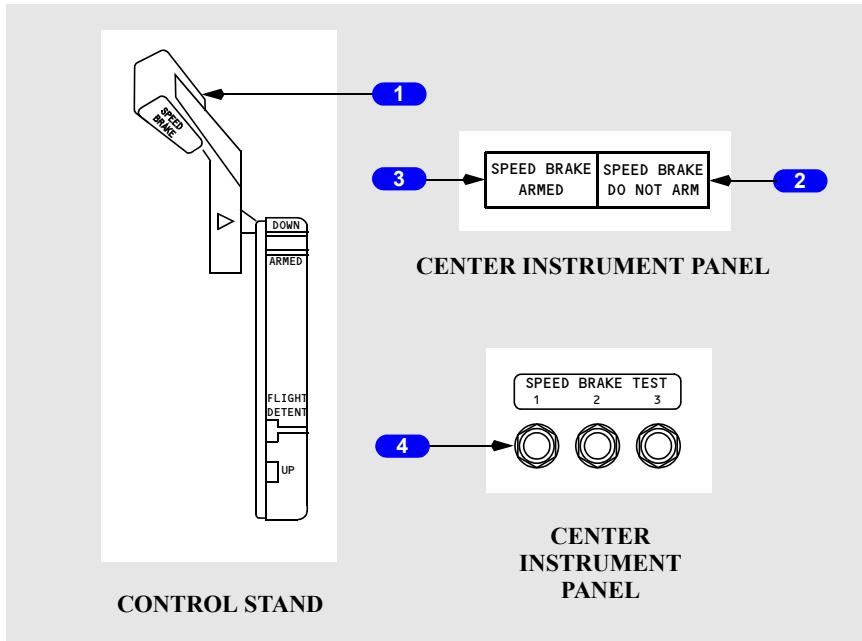
Rotate – operates ailerons and flight spoilers in desired direction.

### 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.

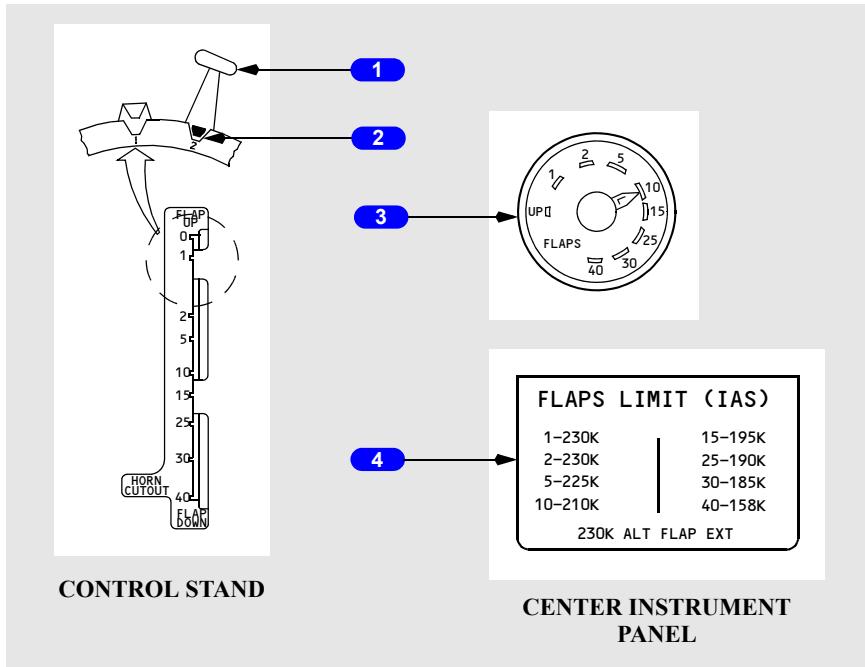
Illuminated (green) – indicates valid automatic speed brake system inputs.

#### **4 SPEED BRAKE Test Switches**

Used for maintenance purposes only.

Tests fault detection circuits of the automatic speed brake system.

## 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:

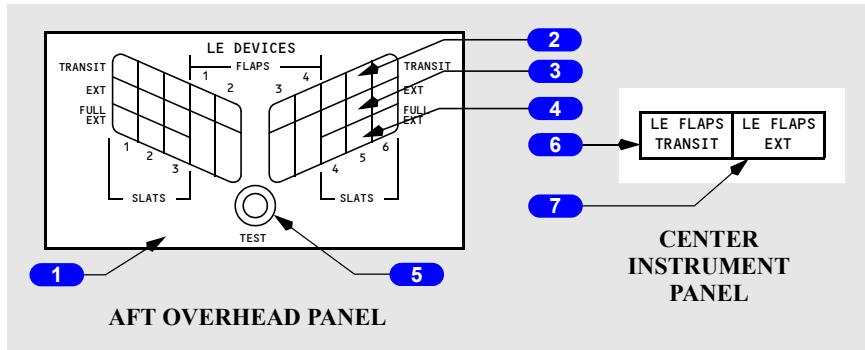
- position 1 – to check flap position for one engine inoperative go-around
- position 15 – to check flap position for normal go-around.

### 3 Flap Position Indicator

- indicates position of left and right trailing edge flaps
- provides trailing edge flaps asymmetry protection.

### 4 FLAPS LIMIT Placard

## 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).

Intentionally  
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### 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:

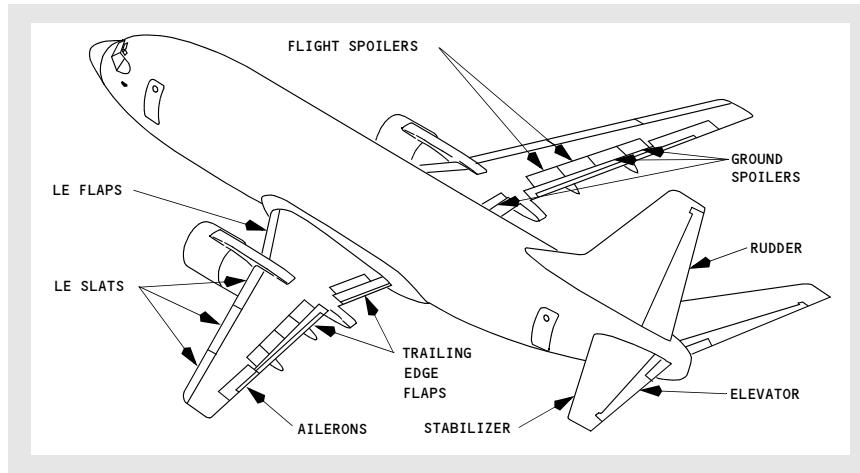
- two ailerons
- four flight spoilers.

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.

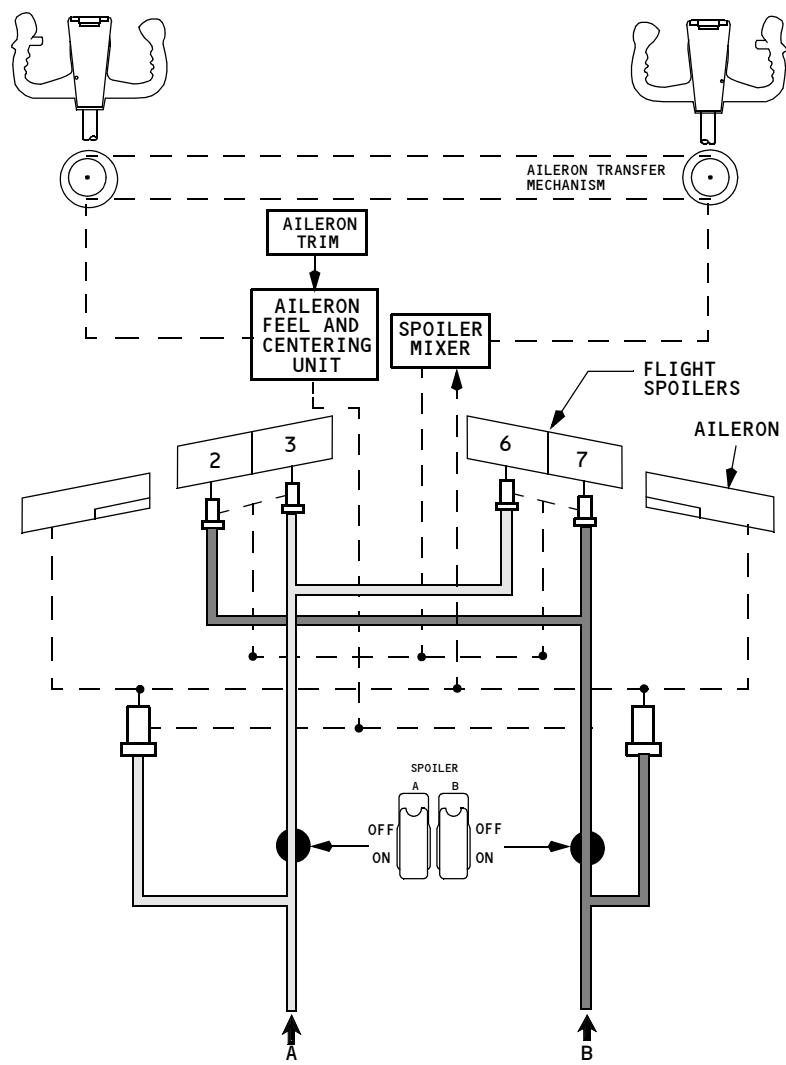
## Flight Spoilers

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.

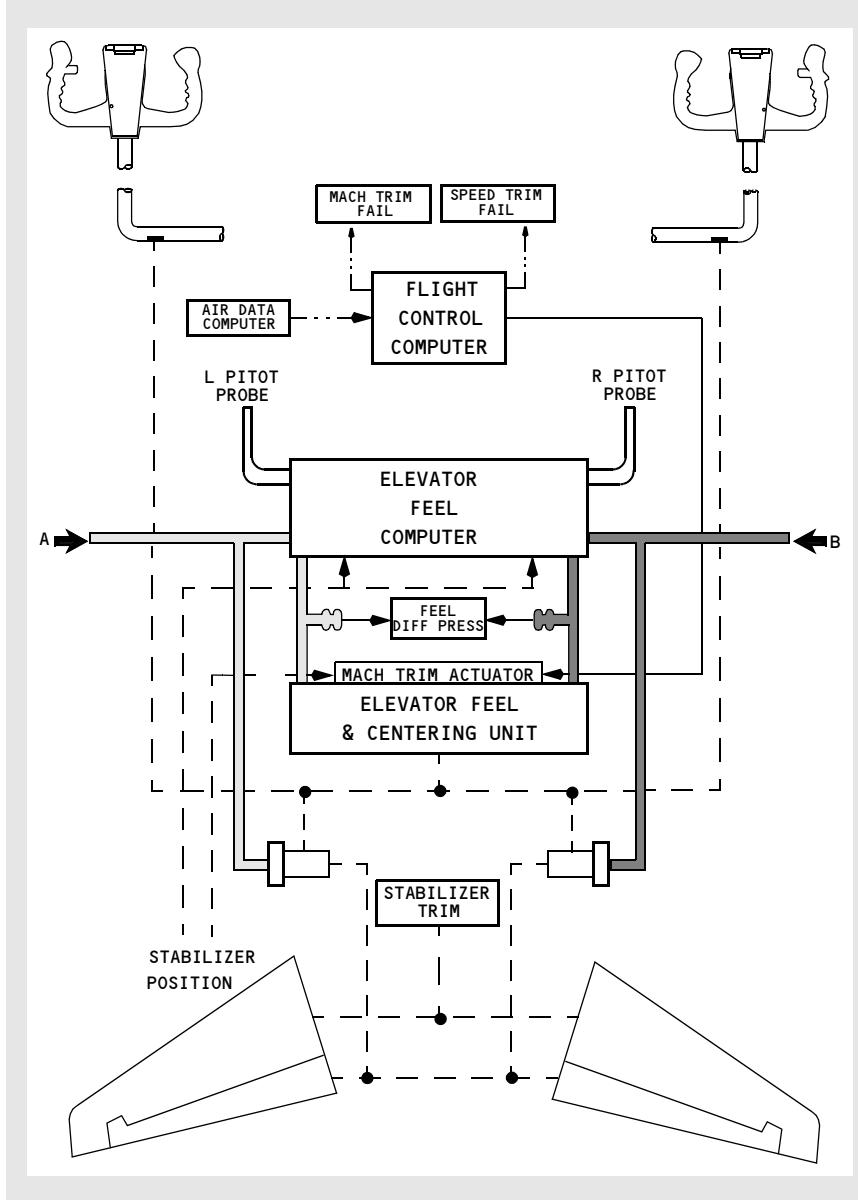
### Elevator Feel System

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
  - 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
- 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

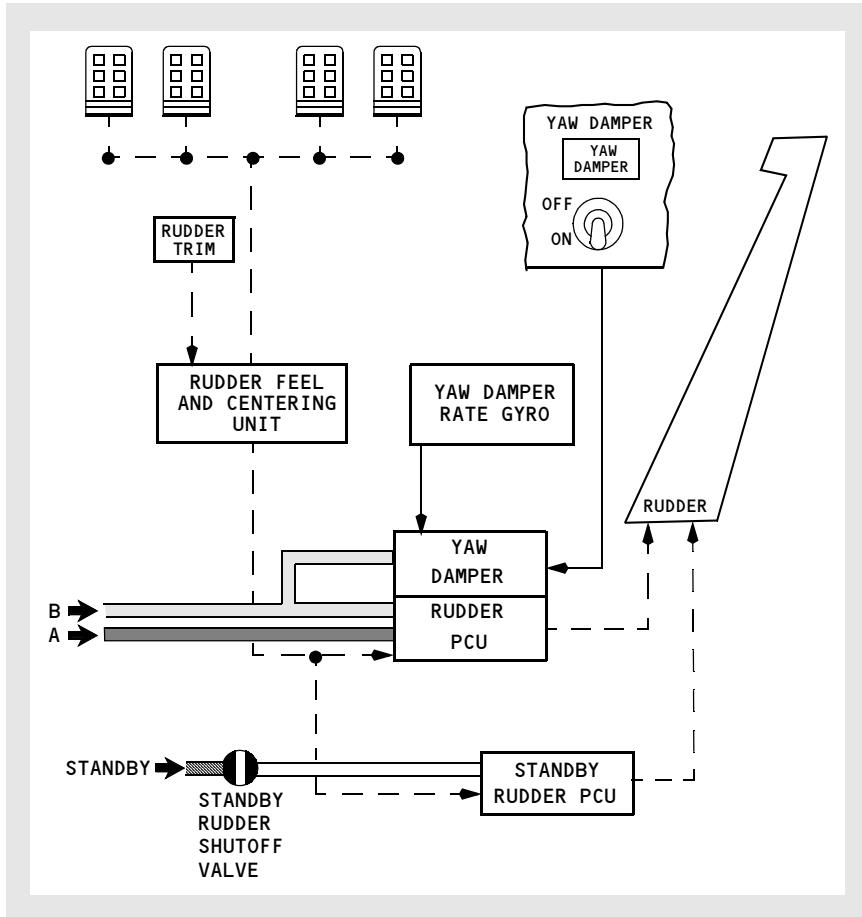
The RUDDER trim control, located on the aft electronic panel, electrically repositions the rudder feel and centering unit which adjusts the rudder neutral position. The rudder pedals are displaced proportionately. The rudder trim indicator displays the rudder trim position in units.

### 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

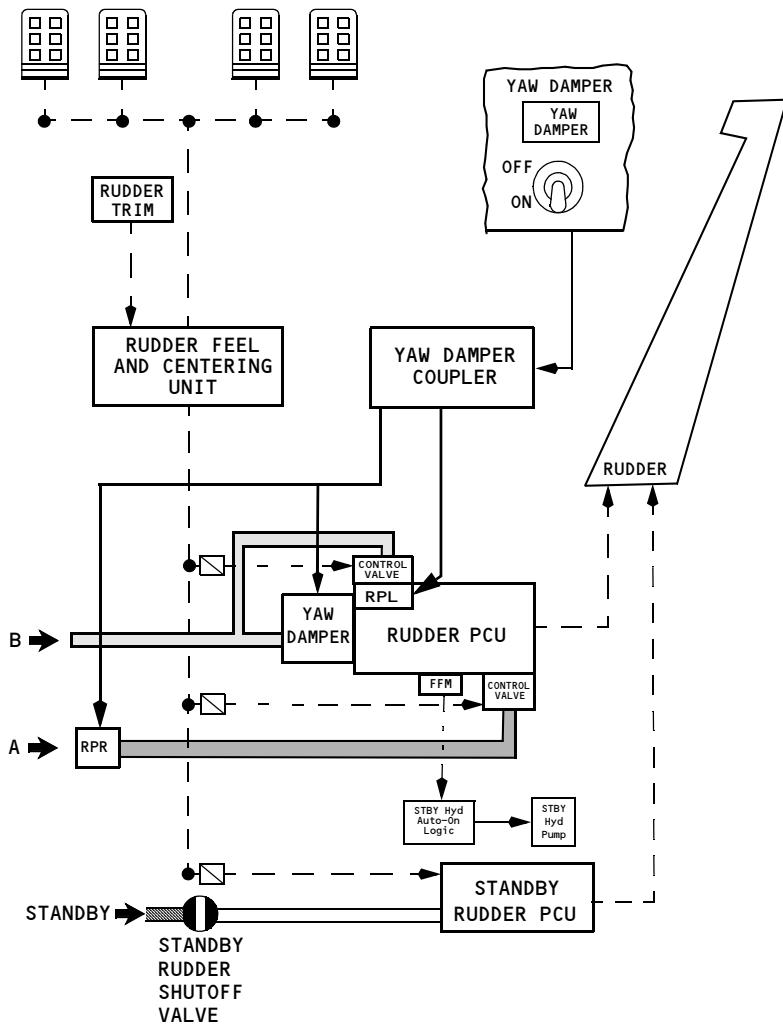
The RUDDER trim control, located on the aft electronic panel, electrically repositions the rudder feel and centering unit which adjusts the rudder neutral position. The rudder pedals are displaced proportionately. The rudder trim indicator displays the rudder trim position in units.

## **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

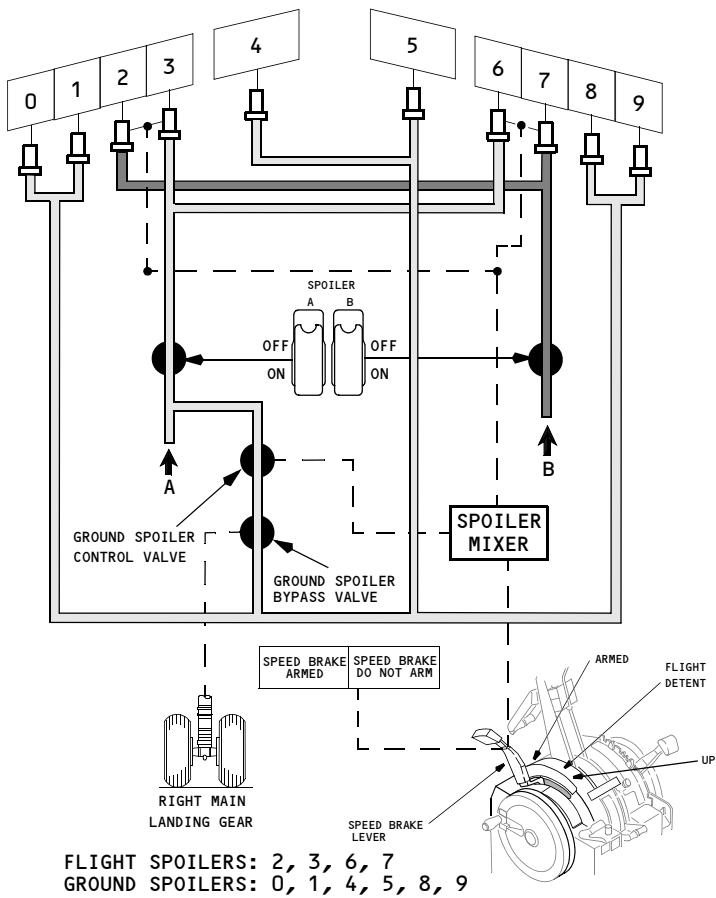
If a wheel spin-up signal is not detected, when the air/ground system senses ground mode, the SPEED BRAKE lever moves to the UP position, and all spoiler panels deploy automatically.

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.

## 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.

When the flaps are set at 40 the TE flaps:

- retract to 30 if airspeed exceeds 158 knots
- re-extend when airspeed is reduced to 153 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

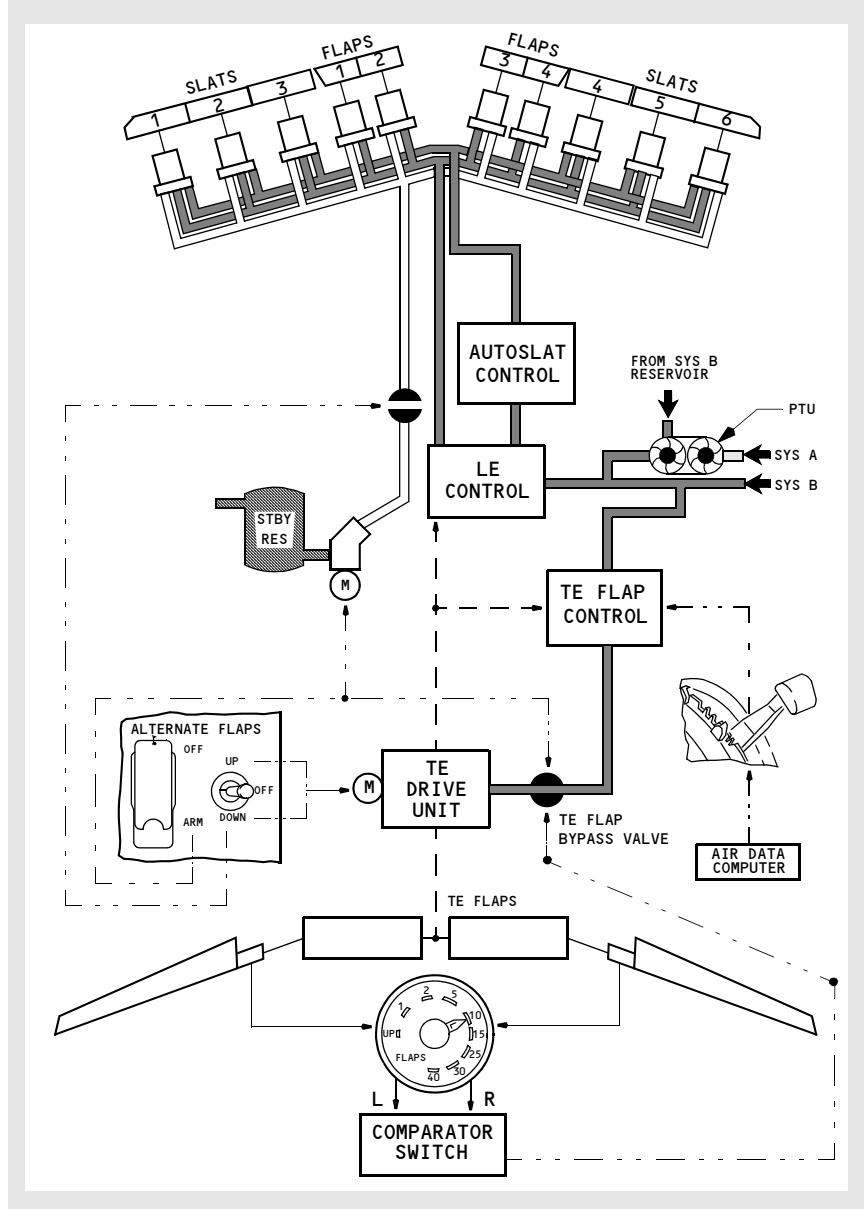
In the event that hydraulic system B fails, an alternate method of extending the LE devices, and extending and retracting the TE flaps is provided.

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**

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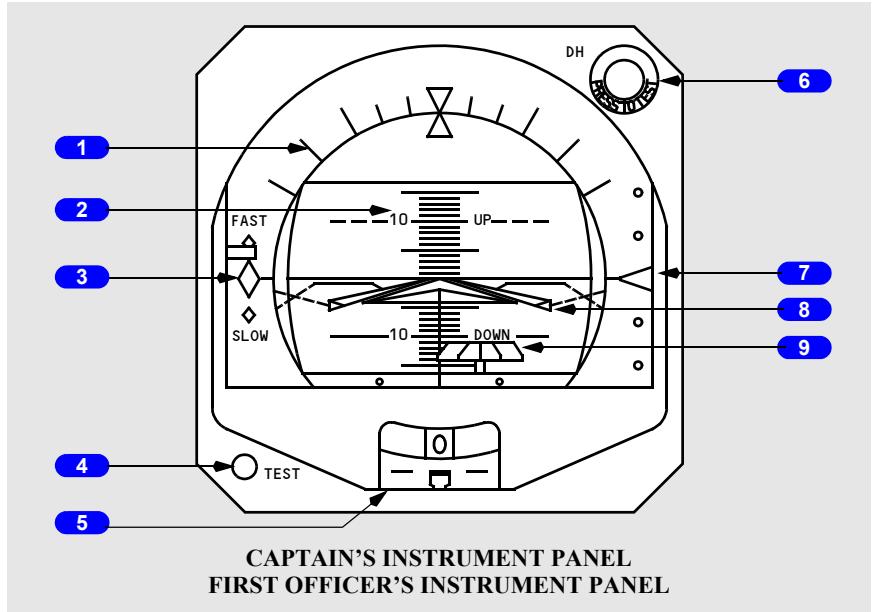
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#### Conventional Flight Instruments

##### Attitude Director Indicator (ADI)



##### 1 Bank Indicator and Scale

- index indicates roll angle against calibrated scale
- scale has minor markings at 10 degrees and 20 degrees and major markings at 30 degrees, 45 degrees, and 60 degrees.

##### 2 Attitude Display

- tape moves relative to symbolic airplane, displaying pitch and roll signals from the IRS
- pitch up or down scaled in 1 degree increments to 25 degrees, then every 5 degrees to 80 degrees.

##### 3 FAST-SLOW Pointer and Scale

Driven by autothrottle. (See automatic flight, chapter 4)

Small diamond represents 5 knots fast or slow

Pointer at FAST or SLOW represents 10 knots fast or slow.

---

#### 4 TEST Switch

Push –

- displays 20 degrees roll to right and 10 degrees pitch up from present attitude
- ATT flag will be in view.

#### 5 Rate of turn Indicator

- displays rate of turn from the IRS.
- one mark right or left is equal to 3 degrees per second.

#### 6 Decision Height (DH) Light

The radio altimeter altitude pointer is at or below the altitude selected with the decision height cursor control.

#### 7 Glideslope Pointer and Deviation Scale

- pointer indicates glideslope position
- scale indicates deviation
- glideslope flag covers the display when the signal is not valid
- pointer is out of view when a VOR frequency is tuned.

#### 8 Flight Director Command Bars

(yellow) – (Refer to Chapter 4, Automatic Flight.)

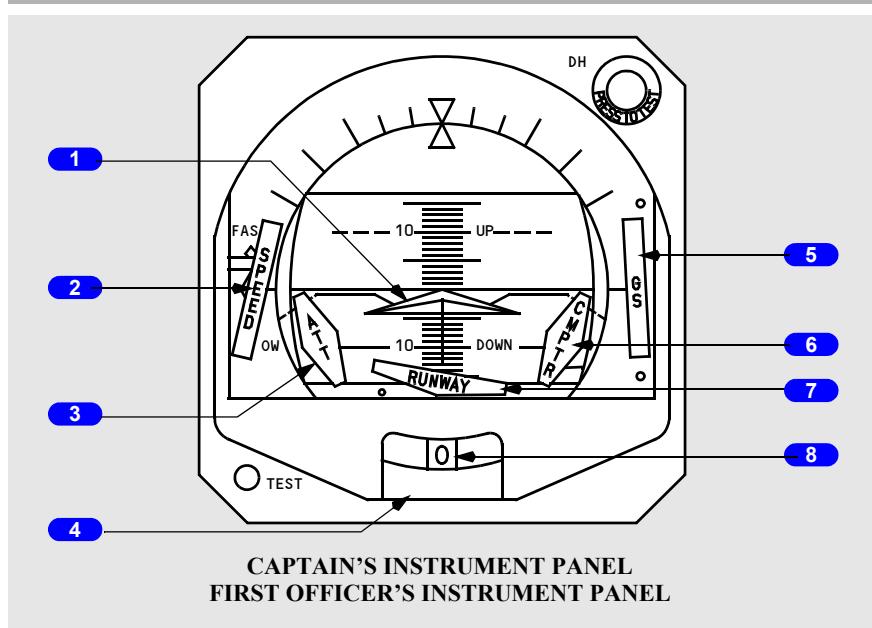
- displays computed pitch and/or roll commands

Biased out of view –

- flight director switch is position OFF
- the required signal inputs are unreliable.

#### 9 Runway Symbol/Localizer Pointer and Deviation Scale

- runway rises toward symbolic airplane for last 200 feet of radio altitude during localizer or ILS approach if the radio altimeter is valid
- pointer indicates localizer position
- scale indicates localizer deviations of one dot or less (one dot is one degree displacement)
- runway flag covers the display when the localizer frequency is tuned and the localizer signal is not valid.



### 1 Symbolic Airplane

(orange) – represents airplane attitude relative to the horizon.

### 2 Speed Flag

In view – Autothrottle system is inoperative.

### 3 Attitude Warning Flag

In view –

- display is unreliable (some failures cause indications of 90 degrees left bank)
- instrument power failure
- IRS failure
- ADI TEST switch is pushed.

### 4 Turn Indicator Shield

In view (covers rate of turn indicator) – invalid or no signal from the IRS.

## 5 Glide Slope Warning Flag

In view –

- glide slope information is unreliable with ILS frequency tuned.
- parallels the VERT warning flag on the HSI when the HSI switch is in VOR/ILS.

## 6 Computer Warning Flag

In view –

- indicates the flight director system is inoperative.
- electrical power loss
- causes flight director command bars to retract.

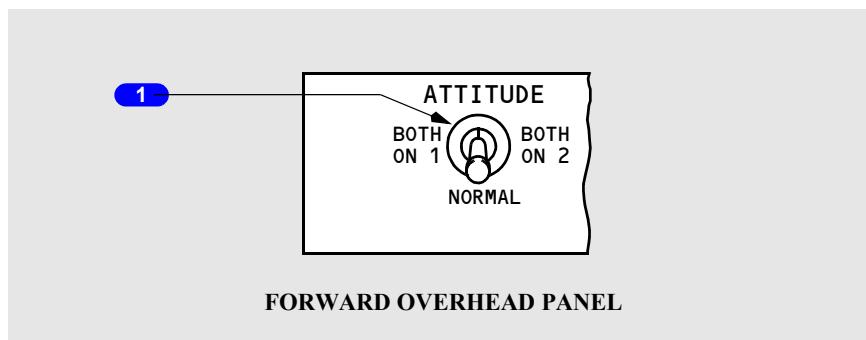
## 7 Runway Flag

In view – a localizer frequency is tuned and the localizer signal is not valid.

## 8 Slip/Skid Indicator and Rate of Turn Indicator

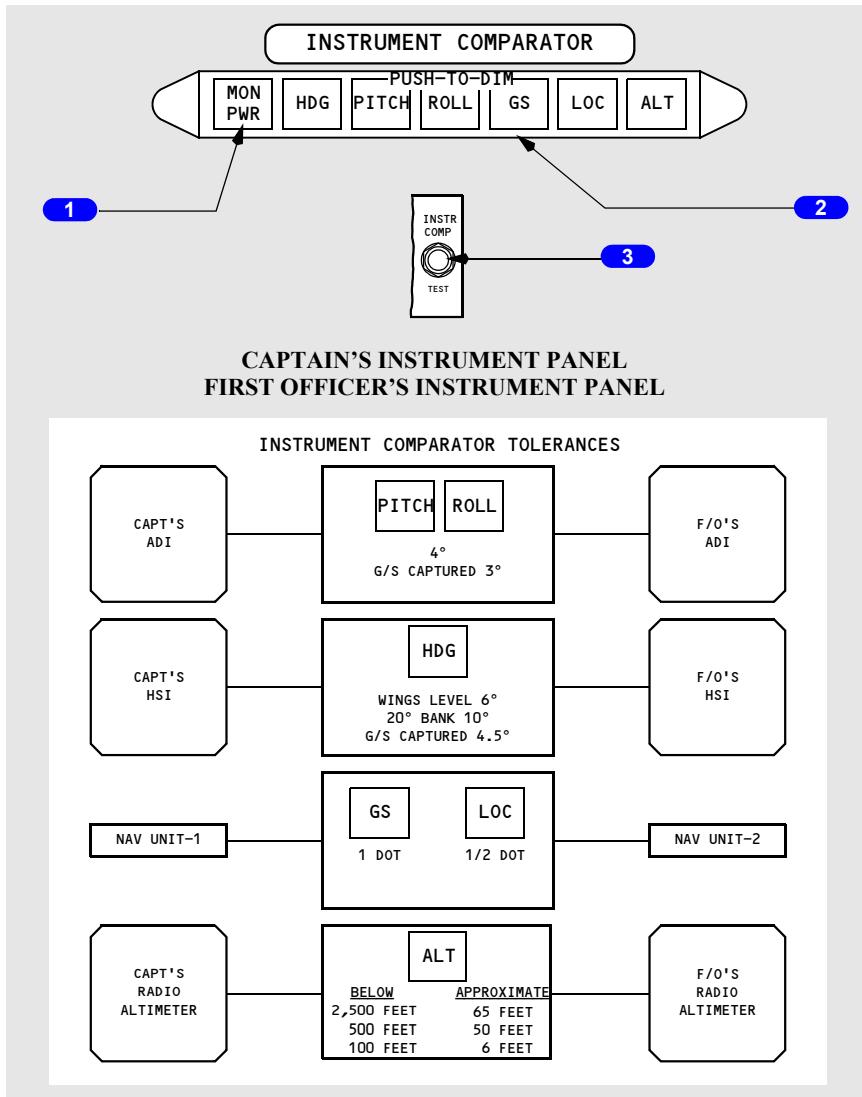
Ball monitors slip or skid for coordinated flight.

## Attitude Transfer Switch



## 1 Attitude Transfer Switch

- BOTH ON 1 – attitude references come from IRS No. 1 (left)
- BOTH ON 2 – attitude references come from IRS No. 2 (right)
- NORMAL – attitude references come from related IRS.

**Instrument Comparator****1 Monitor Power Light**

Illuminated (amber) – 115 volt power loss to comparator unit.

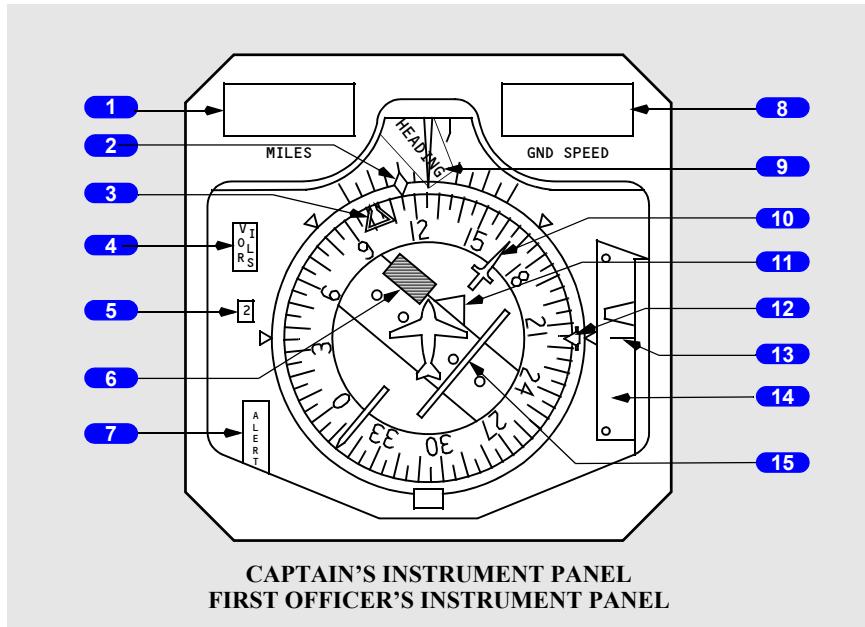
**2 Instrument Comparator Lights**

Illuminated (amber) – instruments being compared have exceeded established tolerances.

### 3 Instrument Comparator Test Switch

Push – illuminates all instrument comparator lights, except MON PWR.

## Horizontal Situation Indicator (HSI)



### 1 Miles Window

- With HSI switch in NAV mode, FMC distance is displayed in miles to the next waypoint.
- blank – indicates power failure
- dashes – indicates no computed data is available.

### 2 Drift Angle Pointer

- displays left or right drift as sensed by the IRS
- pointer moves to and remains at the bottom of the HSI when drift angle input from the IRS is not valid
- HSI switch in VOR/ILS – left or right drift displayed on the outer scale is provided by the IRS
- HSI switch in NAV – left or right drift displayed on the outer scale is provided by the IRS and FMC.

**3 Heading Marker**

Displays the heading set by the heading selector on the AFDS Mode Control Panel.

**4 Nav Data Source Indicator**

Display reads –

- VOR-ILS – the VOR or ILS is supplying course deviation information
- NAV – the FMC is supplying course deviation information.

**5 Navigation Source Indicator**

Displays the source of navigation signal as VHF NAV 1, or 2, or FMC 1.

**6 Navigation Failure Flag**

- HSI switch in VOR/ILS –
  - VHF navigation signal is not being received
- HSI switch in NAV –
  - FMC failure to provide navigation signal to the HSI.

**7 Alert Annunciator**

- (amber) – signal generated by FMC
- illuminates ten seconds before course change

**8 Ground Speed Indicator Window**

Displays ground speed information from the IRS.

**9 Heading Failure Flag**

In view – the selected compass is invalid or the HSI has lost power.

**10 Course Pointer**

- HSI switch in VOR/ILS –  
Reflects the course set by the course selector on the AFDS mode control panel.
- HSI switch in NAV –  
The pointer is set automatically by the FMC.

**11 VOR Operation Annunciators**

TO/FROM ambiguity used in VOR mode

## 12 Waypoint Bearing Pointer

HSI switch in NAV –

- indicates relative bearing of the next fixed waypoint in the active route

HSI switch in VOR/ILS –

- pointer at the 090 relative position.

## 13 Vertical Deviation Pointer and Scale

HSI switch in VOR/ILS –

- indicates displacement above or below glide slope
- pointer in view when localizer frequency is tuned and HSI is powered.

HSI switch in NAV –

- path deviation from FMC
- 1 dot = 400 feet above or below the vertical path.

## 14 Vertical Failure Flag

HSI switch in VOR/ILS –

- In view –
  - ILS frequency tuned and has an invalid glide slope signal.
- Out of view –
  - VOR frequency tuned
  - ILS frequency tuned and a valid glide slope signal exists.

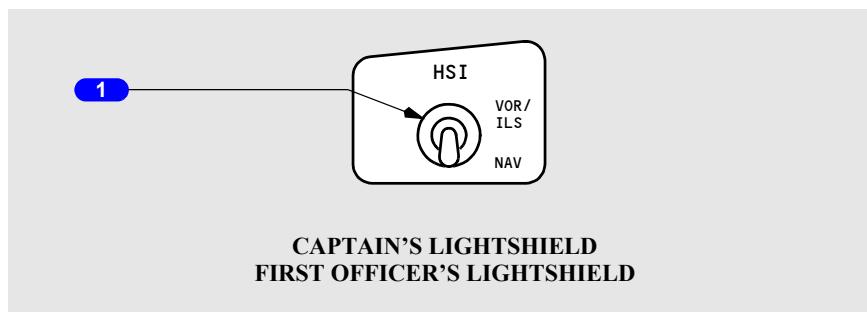
HSI switch in NAV –

- FMC failure to provide path deviation signal.

## 15 Course Deviation Bar

- VOR: 1 dot = 5 degrees.
- LOC: 1 dot = 1 degree.
- NAV: 1 dot = 2 nautical miles cross track deviation.

### HSI Switch



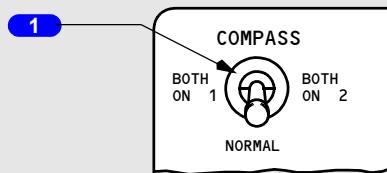
**1 HSI Switch**

VOR/ILS –

- The HSI is in the VOR/ILS mode
- the HSI course pointer reflects the course set by the course selector on the AFDS mode control panel
- VHF navigation frequencies must be tuned manually

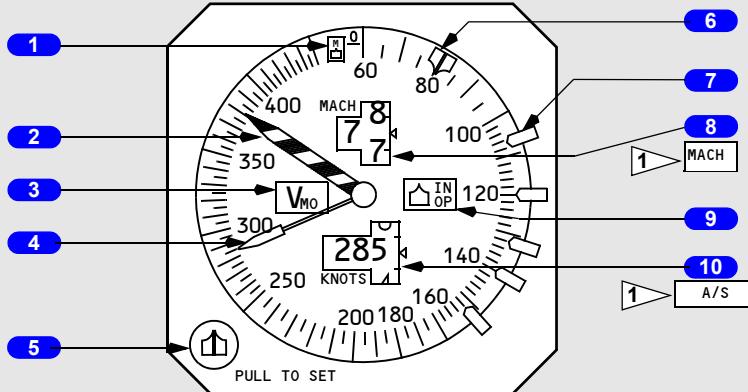
NAV –

- the HSI is in the NAV mode
- the HSI course pointer is automatically positioned by the FMC
- VHF navigation frequencies are selected automatically but may be manually selected if the auto/manual switch has been switched to the manual mode.

**Compass Transfer Switch****FORWARD OVERHEAD PANEL****1 Compass Transfer Switch**

Enables selection of opposite compass system in the event of a compass system failure.

## Mach/Airspeed Indicator



1 ▶ Warning Flags

### CAPTAIN'S INSTRUMENT PANEL FIRST OFFICER'S INSTRUMENT PANEL

#### 1 Airspeed Cursor Mode Annuciator

- 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**

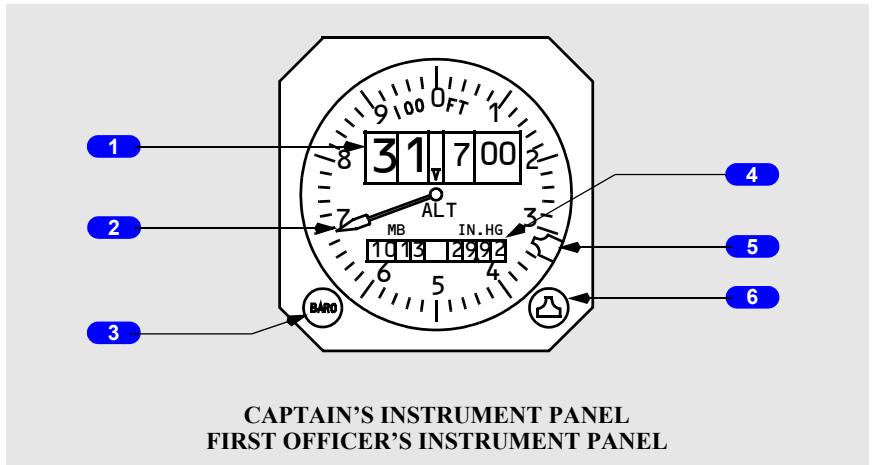
- shows Mach number, from .40 to .99 Mach, in digital form
- masked below .40 Mach
- digits are covered by a warning flag when the display is unreliable.

**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.

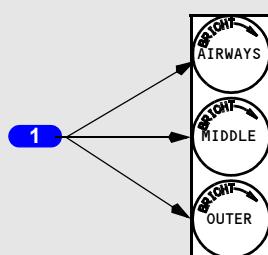
## 5 Reference Altitude Marker

Manually positioned to the desired reference altitude using the reference altitude marker control.

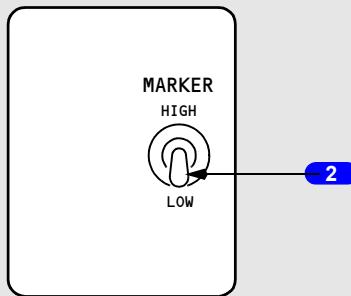
## 6 Reference Altitude Marker Control

Used to manually set the reference altitude marker.

## Marker Beacon



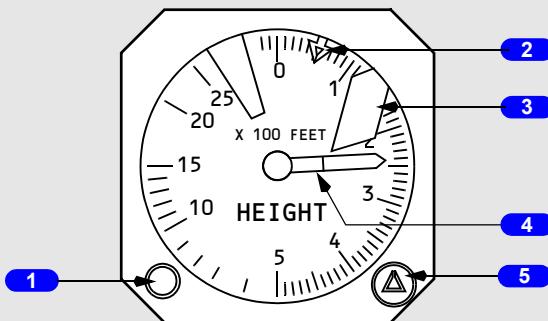
CAPTAIN'S INSTRUMENT PANEL  
FIRST OFFICER'S INSTRUMENT PANEL

**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 Altimeter****CAPTAIN'S INSTRUMENT PANEL  
FIRST OFFICER'S INSTRUMENT PANEL**

---

## 1 Radio Altimeter Test Switch

Push –

- altitude pointer drives to 40 feet
- warning flag in view
- the decision height light illuminates if the altitude pointer drives to a position at or below the altitude indicated by the DH cursor.

## 2 Decision Height (DH) Cursor

### 3 Warning Flag

In view –

- power failure
- loss of return signal below 2500 feet
- incorrect altitude tracking
- radio altimeter test switch pushed.

### 4 Altitude Pointer

Power off –

- pointer moves to the top of the scale under the mask

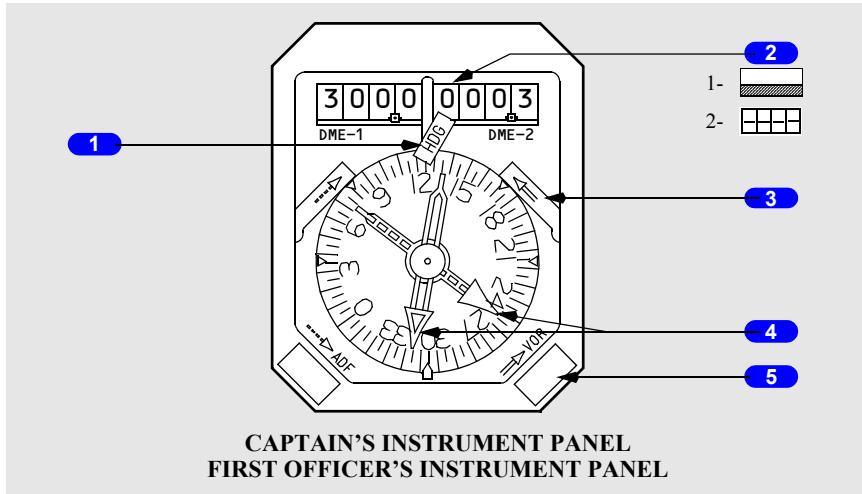
Power on –

- up to 2500 feet –
  - pointer reads true altitude above ground level
- above 2500 feet –
  - pointer is behind the mask

## 5 Decision Height (DH) Cursor Control

Rotate – sets the DH cursor.

## Radio Distance Magnetic Indicator



CAPTAIN'S INSTRUMENT PANEL  
FIRST OFFICER'S INSTRUMENT PANEL

### 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

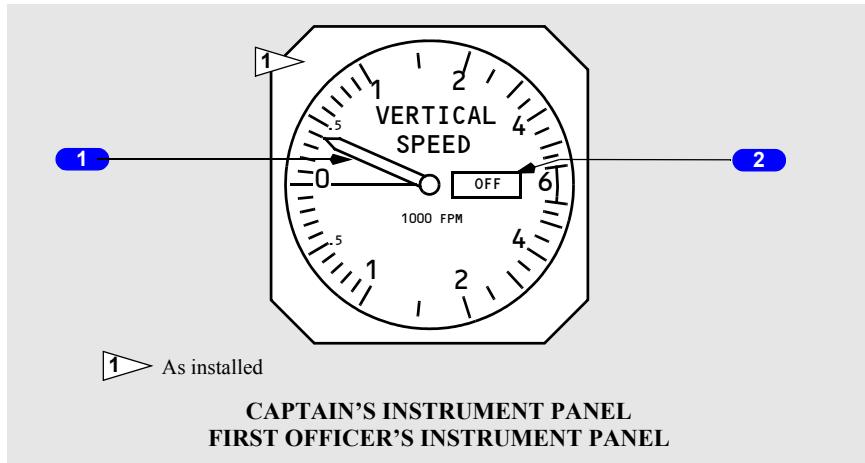
#### 4 Bearing Pointers

- 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



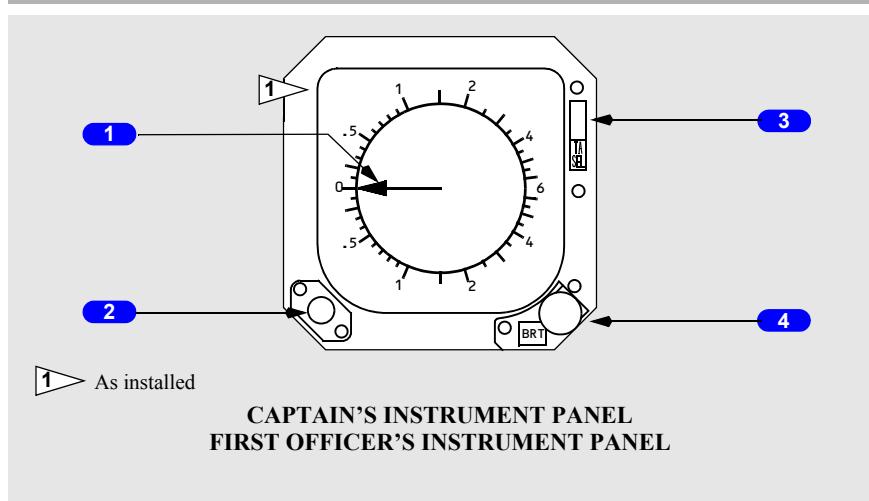
#### 1 Vertical Speed Pointer

- depicts rate of climb or descent from 0 to 6,000 feet per minute

#### 2 OFF Flag

In view –

- respective VSI and/or ADC has failed

**1 Vertical Speed Pointer**

- depicts rate of climb or descent from 0 to 6,000 feet per minute

**2 Light Sensor**

Automatically adjusts display contrast for ambient light conditions.

**3 TA Select Push-button**

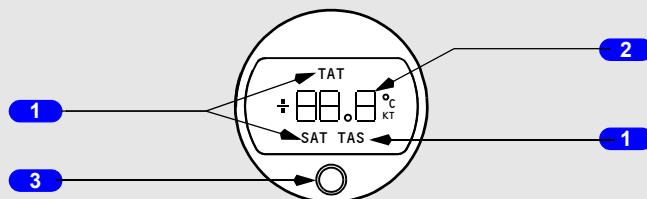
Push – changes display between modes:

- full-time mode – traffic information is displayed full-time.
- popup mode – traffic information is displayed only when a TA or RA is generated. Display remains for the duration of the alert.

**4 Brightness Control**

Rotate – adjusts brightness of the VSI display.

## Air Temperature



FIRST OFFICER'S INSTRUMENT PANEL

### 1 TAT/SAT/TAS Annunciators

Illuminated – identifies the type of data being displayed on the digital display.

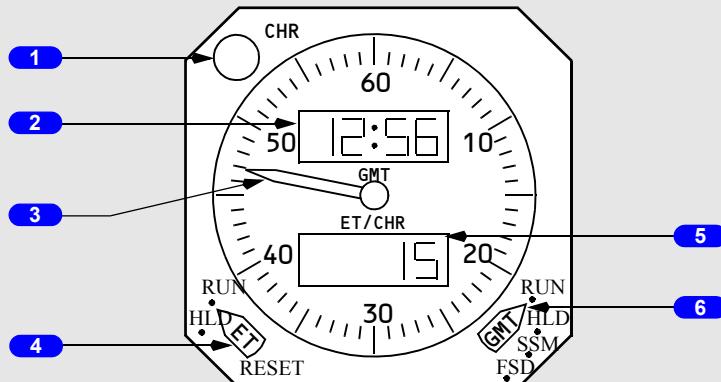
### 2 Digital Display

Displays TAT (deg C), SAT (deg C), or TAS (knots) indications in digital form.

### 3 Selector Push Button

Push – sequences the display from TAT, to SAT, to TAS.

## Clock



CAPTAIN'S INSTRUMENT PANEL  
FIRST OFFICER'S INSTRUMENT PANEL

**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 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.

**6 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

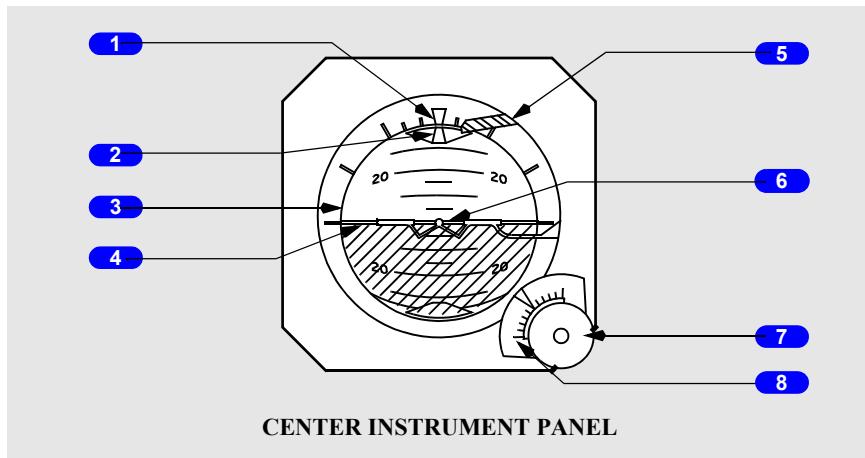
HLD Y (hold, year) –

- 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 Angle Scale

Scale marks are at 0, 10, 20, 30 and 60 degrees.

#### 2 Bank Angle Indicator

Indicates airplane bank angle.

#### 3 Horizon Ball and Pitch Angle Scale

Provides indication of airplane pitch angle (up to 90°).

#### 4 Horizon Bar

#### 5 Warning Flag

In view – loss of power or attitude is unreliable.

#### 6 Airplane Symbol

#### 7 Pitch Trim and Caging Control

IN – rotate to adjust airplane symbol pitch presentation.

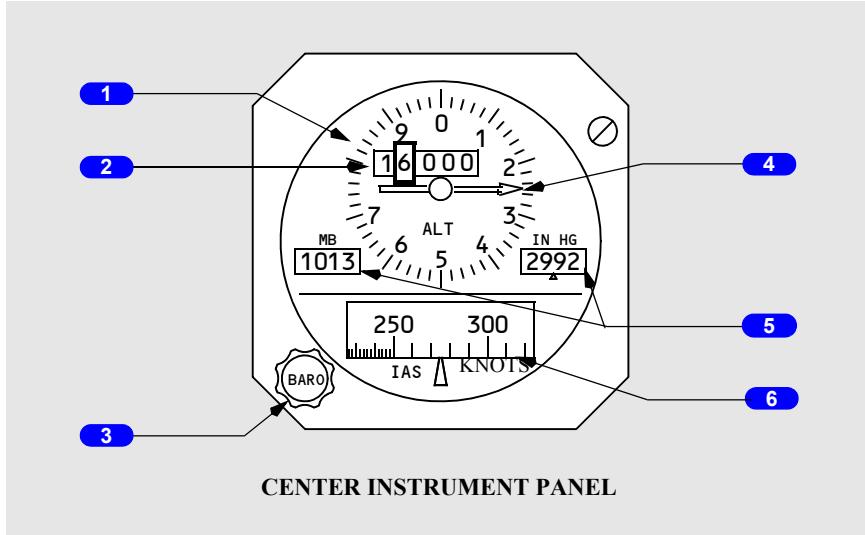
Pull – provides fast erection (caging) of gyro.

Release – control retracts.

**8 Pitch Trim Scale**

Provides reference for adjusting airplane symbol pitch presentation.

- C – climb
- D – dive.

**Standby Altimeter/Airspeed Indicator****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.

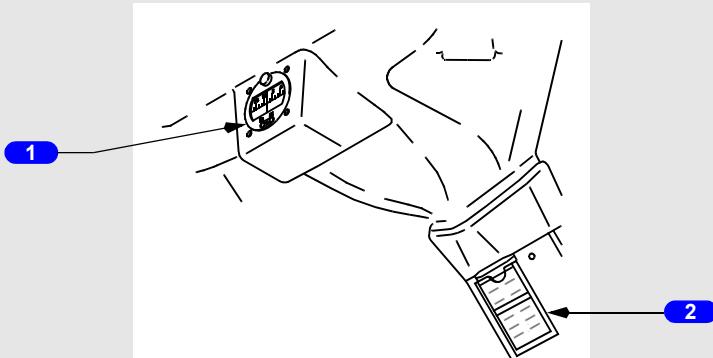
## 5 Barometric Setting Windows

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

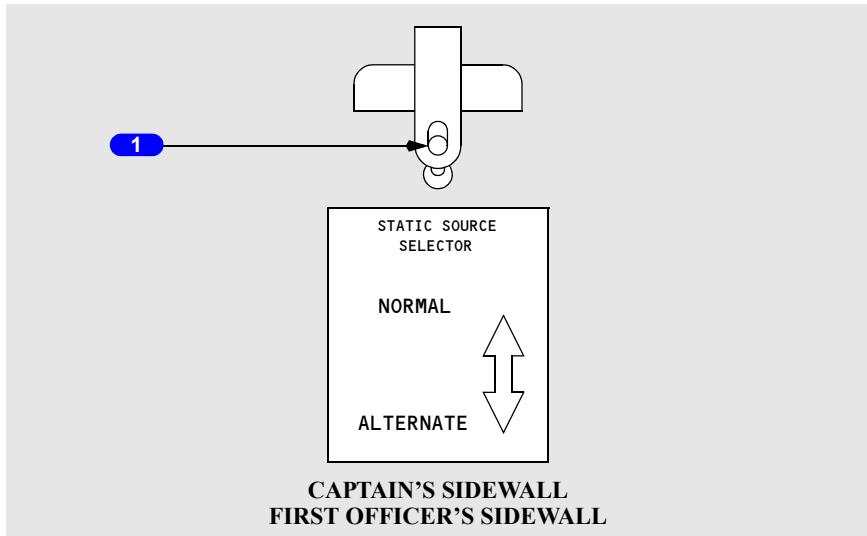
Displays magnetic heading.

The magnetic compass may be folded out of view for an unobstructed view through the windshield.

### 2 Standby Magnetic Compass Correction Card

Provides appropriate heading corrections.

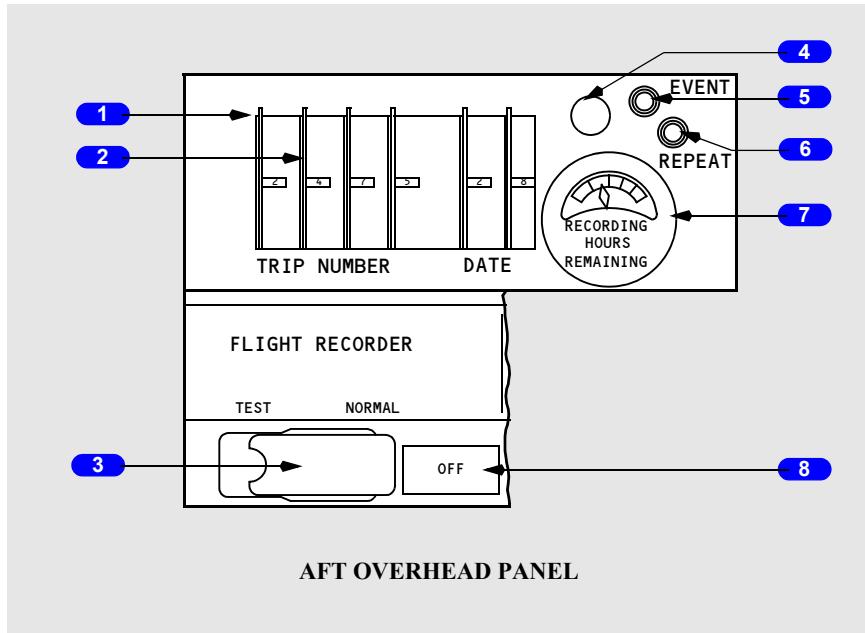
## Static Source Selector



### 1 Static Source Selector Switch

- NORMAL (guarded position) – primary pitot-static system is providing static inputs to respective pilot's system
- ALTERNATE – alternate static system is providing static inputs to respective pilot's system.

## Flight Recorder



### 1 Trip and Date Encoder

### 2 Trip and Date Selectors

Rotate – sets trip number and date.

### 3 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.

### 4 Trip and Date Light

Illuminated (amber) – trip and date information is being recorded. The 15 minute transcribing cycle does not interfere with the recording of other information.

**5 Event Switch**

Push and Hold Momentarily – transcribes a mark on the tape to identify the time of an event. Do not use until after the trip and date light is extinguished.

**6 Repeat Switch**

Push – initiates or repeats transcribing of the trip and date information.

**7 Recording Time Remaining Indicator**

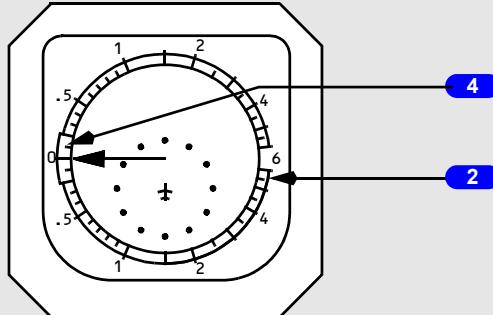
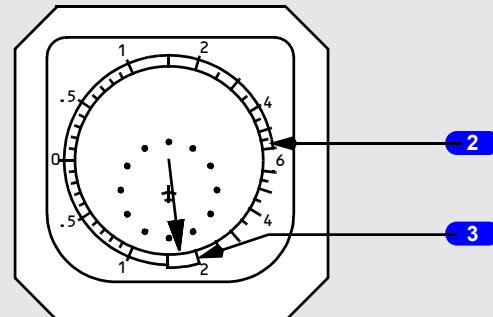
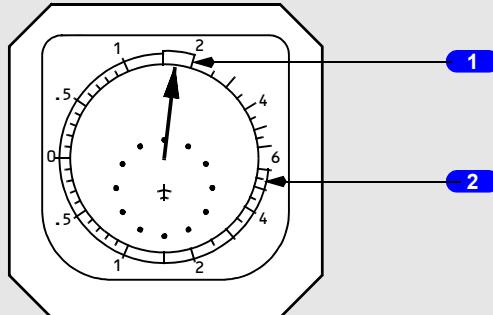
- not used
- should always read above zero.

**8 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.

## TCAS (As installed)

### TCAS Resolution Advisory Commands



**CAPTAIN'S INSTRUMENT PANEL  
FIRST OFFICER'S INSTRUMENT PANEL**

- 1 RA Pitch Command (green) (UP Advisory)**

Indicates vertical speed range to ensure traffic separation.

**2 Command Arc (red)**

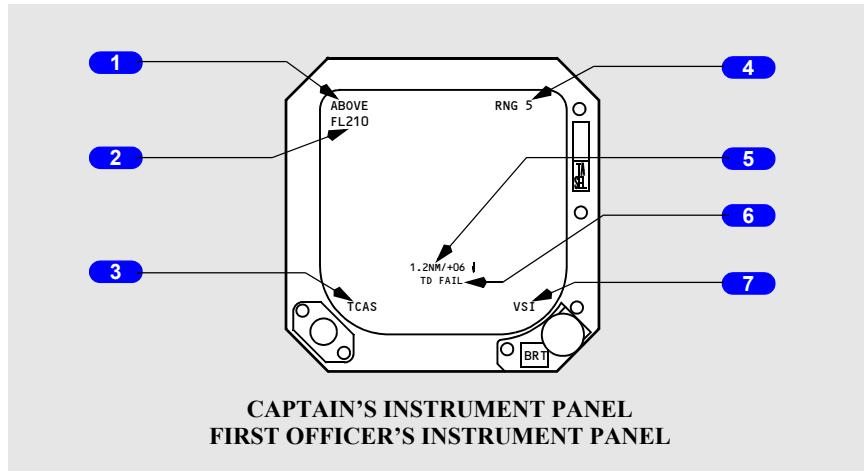
Indicates vertical speed range to avoid.

**3 RA Pitch Command (green) (DOWN Advisory)**

Indicates vertical speed range to ensure traffic separation.

**4 RA Pitch Command (green) (LEVEL Advisory)**

Indicates vertical speed range to ensure traffic separation.

**TCAS VSI Messages****1 ABOVE/NORM/BELOW Annunciation**

Shows the position of the TAU envelope switch on the transponder control panel

- ABOVE (blue) – vertical display range for other traffic is biased above the airplane
- BELOW (blue) – vertical display range for other traffic is biased below the airplane
- Blank – NORM is selected on the transponder control panel. Vertical display range for other traffic is equal above and below the airplane.

**2 Ownship Altitude Readout (blue))**

Shows FL followed by the first three numbers of the airplane's altitude if the FL switch is selected on the transponder control panel.

---

### 3 TCAS Mode Display

Indicates current TCAS mode/system status

- TCAS (amber) – TCAS system has failed
- TA ONLY (blue) – TCAS TA only mode is selected
- TCAS STBY (blue) – TCAS standby mode is selected
- TEST (amber) – TCAS is in test mode.

### 4 TCAS Range

Displays TCAS range in nautical miles.

### 5 NO BEARING Messages

Displayed when no bearing information is available for traffic (distance, altitude, trend arrow).

### 6 Fault Annunciations

TD FAIL (amber) – failure in the operation of the traffic display.

RA FAIL (amber) – RA information is not available.

### 7 VSI Flag (amber)

Indicates that vertical speed is unreliable.

**TCAS Symbology**

SYMBOL	NAME	REMARKS
	RA traffic symbol (R)	Displayed during TCAS Resolution Advisory when traffic selected on the VSI or Weather Radar Indicator.
	RA off-scale traffic symbol (A)	Displayed when traffic selected on the VSI or Weather Radar Indicator and traffic is not within the display range.
	TA traffic symbol (A)	Displayed during TCAS Traffic Advisory when traffic selected on the VSI or Weather Radar Indicator.
	TA off-scale traffic symbol (A)	Displayed when traffic selected on the VSI or Weather Radar Indicator and traffic is not within the display range.
	Proximate traffic symbol (W)	Displayed when traffic selected on the VSI or Weather Radar Indicator and traffic is within 1200 feet vertical and 6 miles horizontal from present position.
	Other traffic symbol (W/outlined)	Displayed when traffic selected on the VSI or Weather Radar Indicator and traffic is greater than 1200 feet vertical or 6 miles horizontal from present position.
+ 05 - 05	Relative altitude (R,A,W)	With traffic selected on the VSI or Weather Radar Indicator, displays relative traffic altitude in hundreds of feet.
	Vertical motion arrow (R,A,W)	Displayed when traffic vertical speed is greater than 500 feet per minute and traffic selected on the VSI or Weather Radar Indicator.
6.8NM/-11 3.6NM/+04	No bearing data (Red for RA; Amber for TA)	Displayed when no bearing information is available. Displays distance and altitude and trend arrow.

Intentionally  
Blank

### **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. An alternate static system is also available and may be selected from the flight deck.

#### **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.

An alternate static system provides each pilot with a standby source of static pressure that may be selected with the related static source selector. The alternate static system cannot be connected to the auxiliary systems. There is no alternate pitot system.

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.

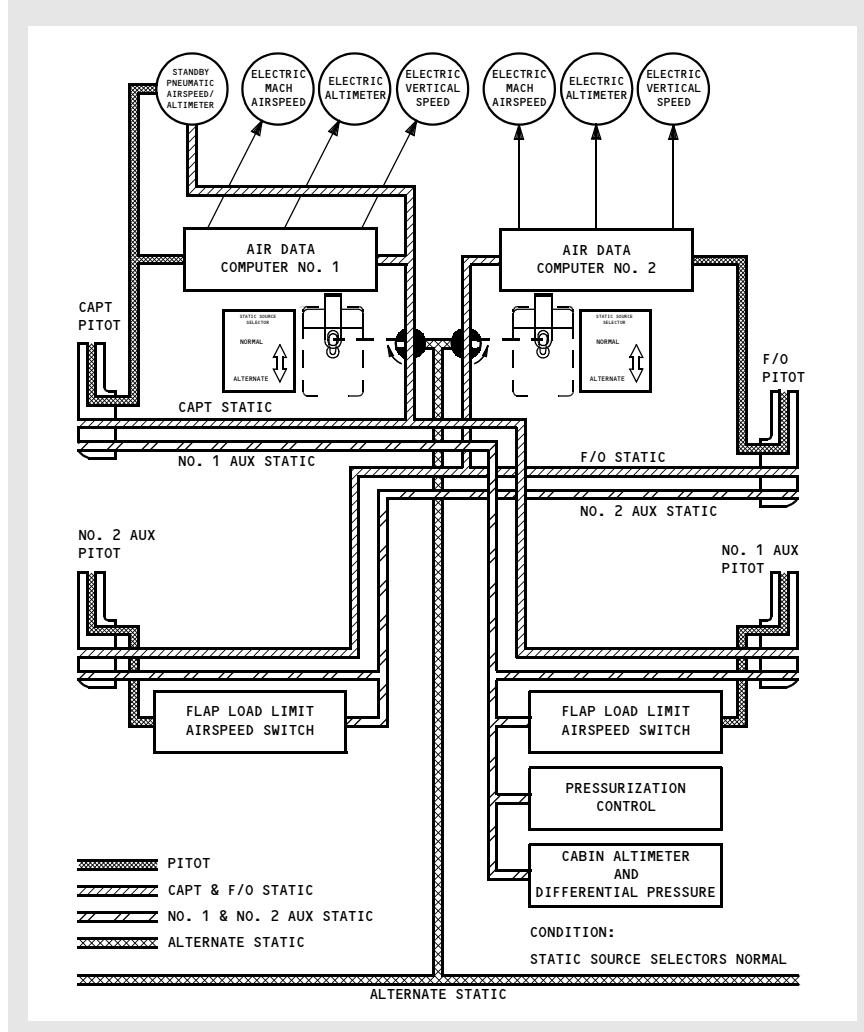
A blocked or frozen pitot and/or static system may affect the following primary airplane system

- 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

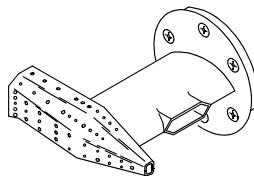
## Air Data Computers

Two air data computers (ADCs) are installed. Each ADC receives pitot and static pressure inputs from the respective pilot's P/S system, or from the alternate static system, if selected. 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 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/true airspeed indicator. Total air temperature derived data from ADC No. 2 is used by the right IRS, the FMC, autothrottle, and FCC "B."



**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, the TAT indication is approximately OAT if pitot heat is OFF. 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 and on the SAT indicator, 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

### Attitude Director Indicator

An attitude director indicator (ADI), on each pilot's panel, displays a view of the pitch and roll attitude of the airplane. The attitude display is shown on a colored tape with pitch and roll reference provided by vertical gyros.

Computed steering commands from the flight director computers are presented on the ADIs by command bars. These commands are viewed with respect to a fixed symbolic airplane.

When the ATT warning flag is in view, use the ATTITUDE switch to transfer the associated systems to the alternate vertical gyro. When the GS or LOC flag is in view, use the VHF NAV switch to transfer to the good VHF navigation receiver.

The RUNWAY flag will appear for loss of the localizer signal. The runway symbol moves left or right to indicate deviation from localizer center line. At 200 feet radio altitude the runway symbol will rise toward the symbolic airplane as the airplane approaches the runway. Loss of the radio altimeter will cause the runway to fail to indicate radio altitude. The localizer function will not be impaired.

Altimeters cannot be switched. Loss of localizer can be recovered with the VHF NAV switch.

The CMPTR flag monitors the flight director system. Switching is not installed for this problem.

### Instrument Comparator

An instrument warning system is installed which provides comparison of the captain and first officer compass headings, pitch and roll attitude indications, localizer and glide slope deviation outputs from the No. 1 and No. 2 VHF navigation unit and the two radio altimeter output signals.

### 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.

## Radio Altimeter

Two low range radio altimeters and two indicators provide indication of airplane height above the ground up to 2500 feet absolute altitude. A radio altimeter indicator is located on each pilot instrument panel.

When the captain's radio altimeter is inoperative –

- all modes of the GPWS are inoperative
- autopilot channel "A" should not be used for approach
- autothrottle automatic retard during landing flare is inoperative.

When the first officer's radio altimeter is inoperative –

- autopilot channel "B" should not be used for approach.

## Vertical Speed Indicators

Two vertical speed indicators display instantaneous vertical speed derived from the respective air data computer and inertial reference system.

On airplanes with TCAS VSI installed, the display can also show air traffic information detected by the TCAS system, and provides resolution advisory (RA) Pitch Commands (refer to Chapter 10-10; TCAS section, and Chapter 15, Warning Systems, for further information).

## 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.

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## 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.

# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Flight Management, Navigation**

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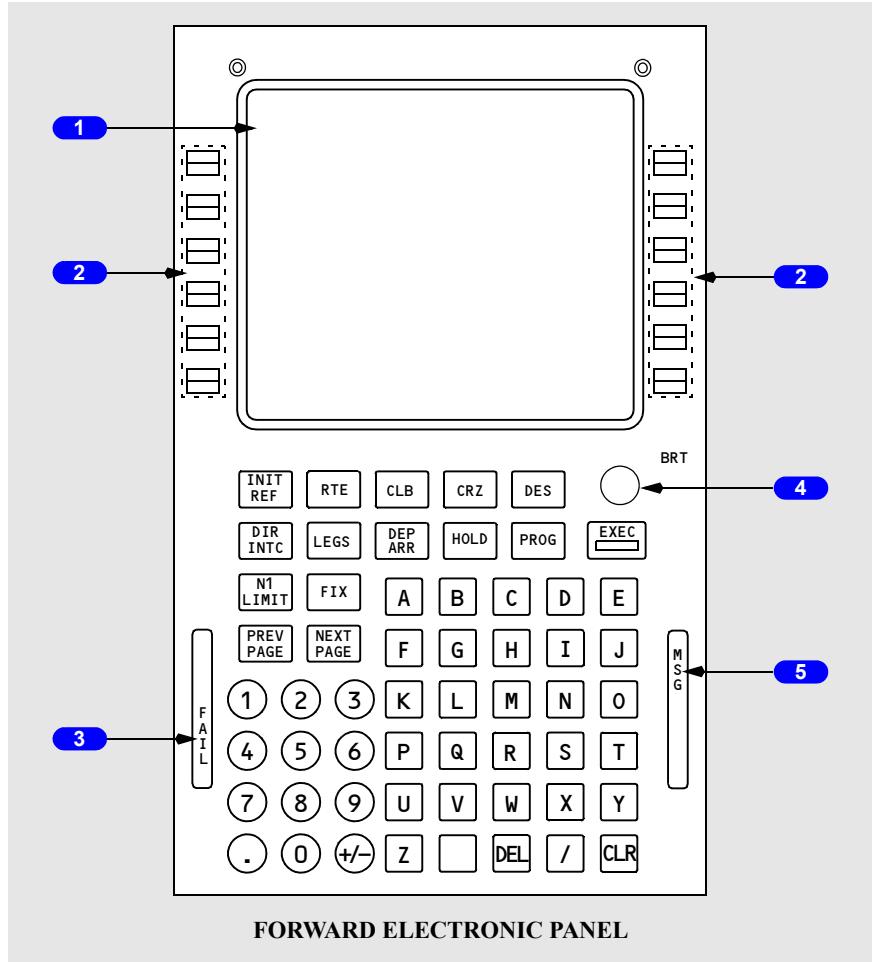
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#### Flight Management System

##### 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.

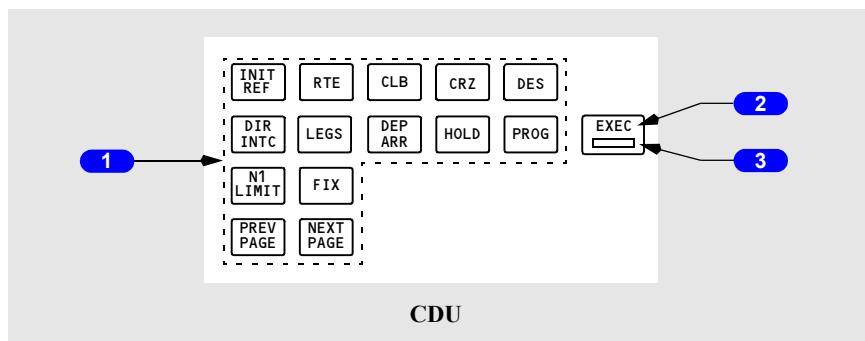
## 4 Brightness Control

Rotate – controls display brightness.

## 5 Message (MSG) Light

Illuminated (white) – scratchpad message is shown.

## 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

- 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 waypoints using preset bearing and distance from selected fix
- PREV PAGE – shows previous page of related pages (for example, LEGS pages)
- NEXT PAGE – shows next page of related pages.

## 2 Execute (EXEC) Key

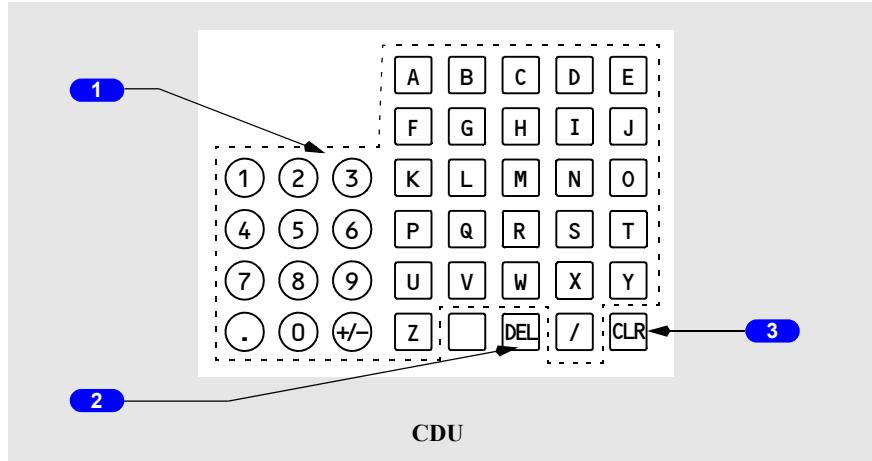
Push –

- 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.

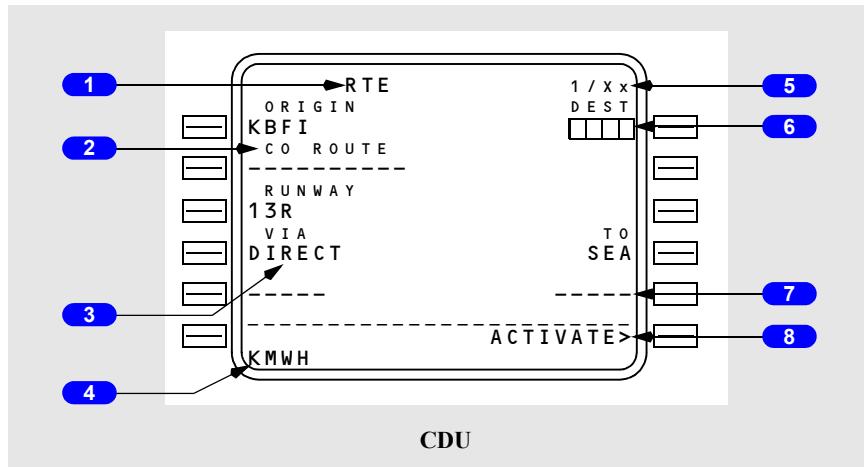
## 3 Clear (CLR) Key

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**

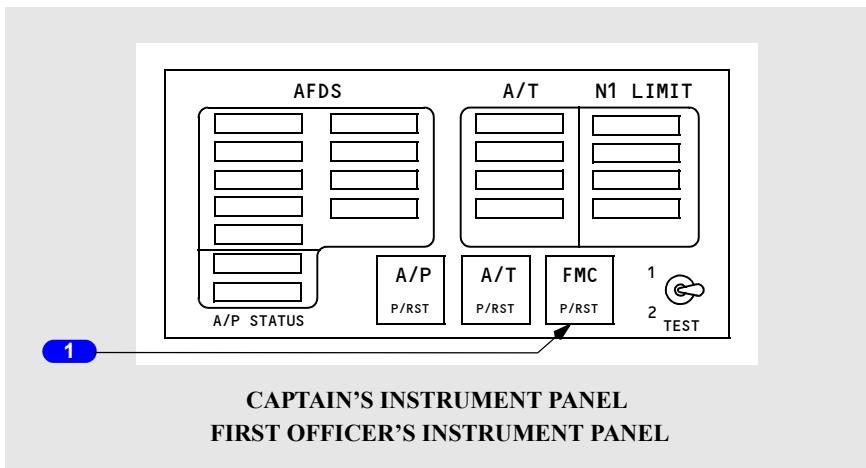
Data input is mandatory.

**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.

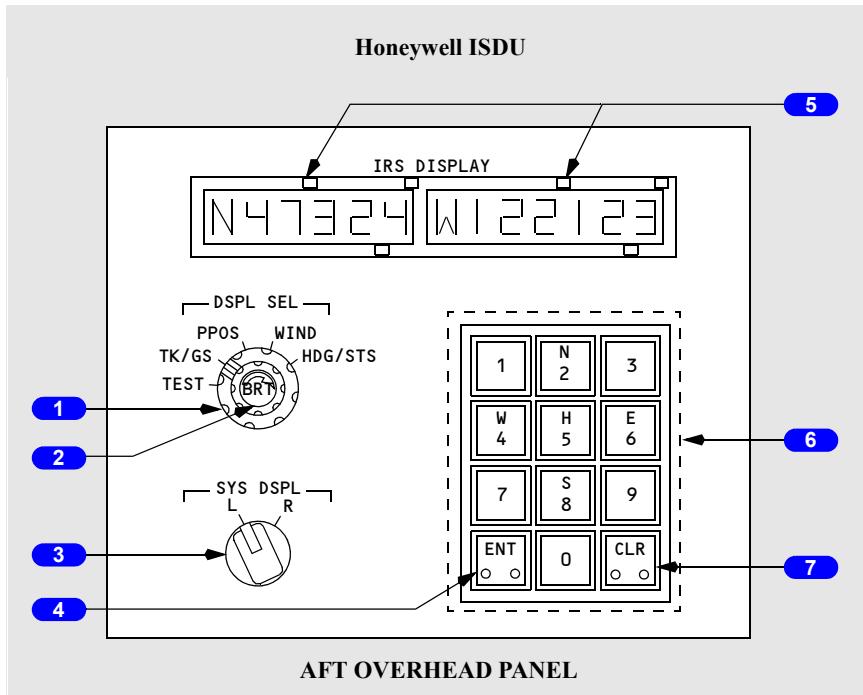
**FMC Alert Light**

**1 FMC Alert Light**

Illuminated (amber) –

- the FAIL light on the CDU, or both CDUs (as installed) is illuminated, or
- an alerting message exists for the CDU, or both CDUs (as installed), or
- test switch is in position 1 or 2.

Push – both pilots' FMC alert lights extinguish.

**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

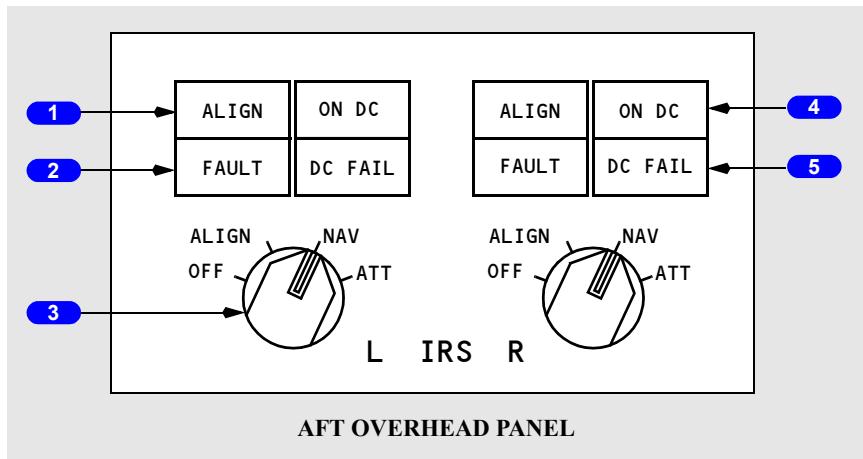
- pushing an alpha key arms the keyboard for numeric entries.
- numeric keys:
  - permit manual entry of present position when ALIGN light is illuminated
  - permit manual entry of magnetic heading when either mode selector is in ATT.

## 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:
  - airplane movement
  - 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.

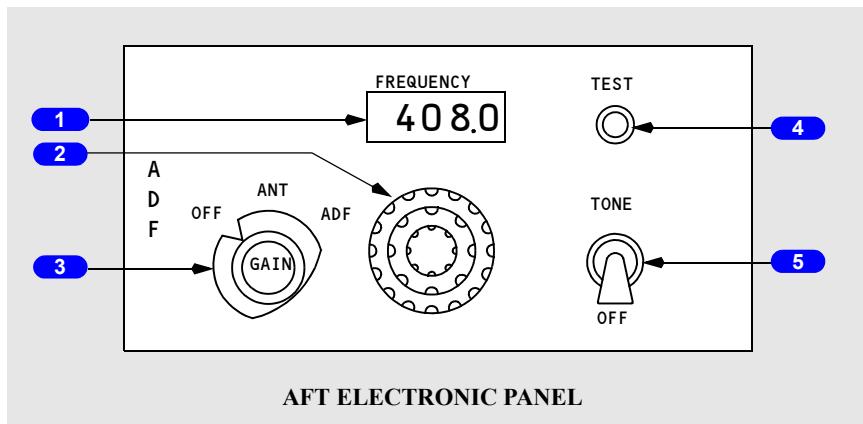
#### 5 DC FAIL Light

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.

### 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 selected receiver.

ANT – receiver sends only station audio.

ADF – receiver sends bearing and station audio.

GAIN – adjusts receiver gain.

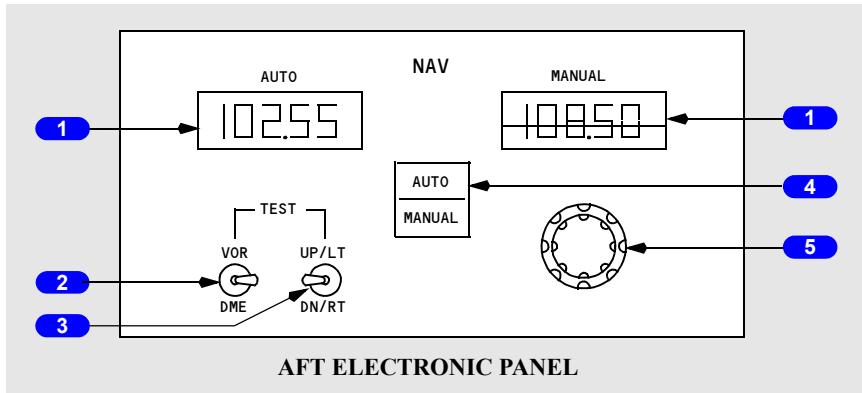
**4 TEST Switch**

Push – ADF bearing pointer indicates 45 degrees left of lubber line.

**5 TONE Switch**

TONE – adds tone to receiver audio.

OFF – 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**

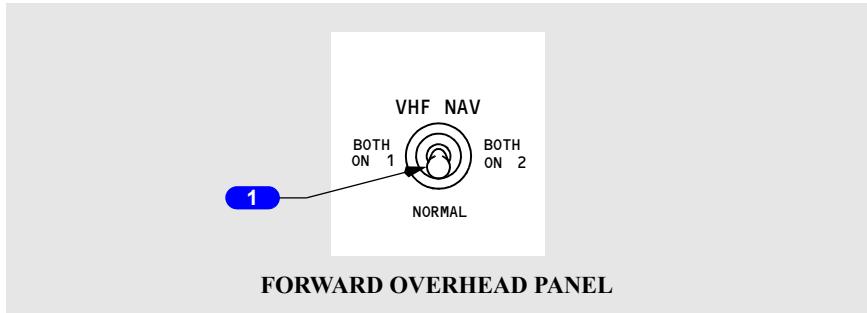
AUTO (illuminates white) – tuning automatically accomplished by the FMC. The HSI switch must be in the NAV position.

MANUAL (illuminates white) – tuning accomplished manually by rotating the frequency selector.

## **5 Frequency Selector**

Rotate – manually selects the desired frequency.

## VHF NAV Transfer Switch



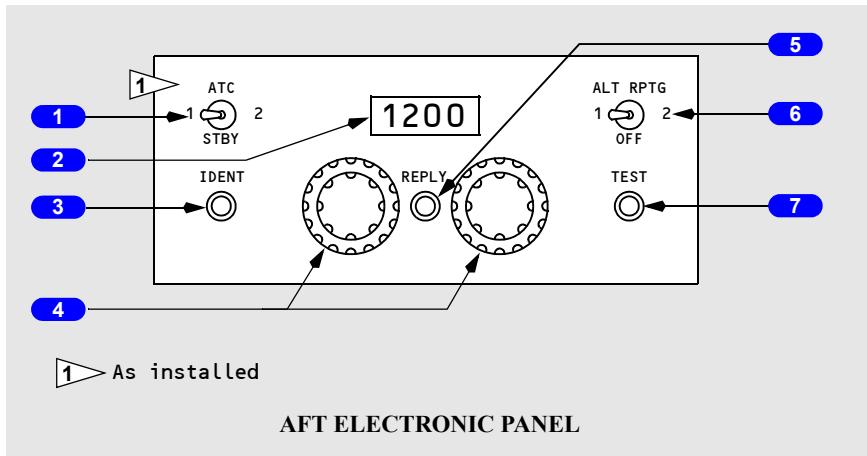
### 1 VHF NAV Transfer Switch

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



### 1 Transponder Air Traffic Control (ATC) Switch

1 – selects transponder No. 1.

STBY – does not transmit.

2 – selects transponder No. 2.

### 2 Air Traffic Control (ATC) Code Indicator

Shows transponder code.

**3 Identification (IDENT) Switch**

Push – transmits an identification signal.

**4 Air Traffic Control (ATC) Code Selectors**

Rotate – sets transponder code in transponder.

**5 Reply Light**

Illuminated (green) –

- transponder replying to ground interrogation
- test in progress.

**6 Altitude Reporting (ALT RPTG) Switch**

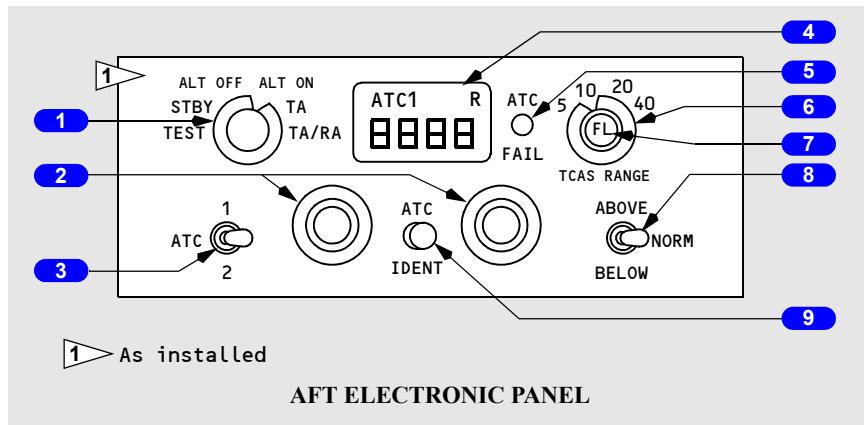
1 – enables altitude reporting from air data computer No. 1.

OFF – transponder operates without altitude reporting.

2 – enables altitude reporting from air data computer No. 2.

**7 Test Switch**

Push – with the transponder air traffic control (ATC) switch in position 1 or 2, the reply light illuminates to indicate the selected transponder is operational.

**1 Transponder Mode Selector**

TEST – starts ATC transponder functional test.

STBY – does not transmit.

**Note:** On airplanes with TCAS, mode S 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. Inoperative on some airplanes.

TA/RA – enables display of traffic advisory and resolution advisory TCAS targets. Inoperative on some airplanes.

Refer to Chapter 15, Warning Systems.

## **2 Air Traffic Control (ATC) Code Selector**

Rotate – sets transponder code in transponder.

## **3 Transponder (ATC) Switch**

1 – selects transponder No. 1.

2 – selects transponder No. 2.

## **4 Air Traffic Control (ATC) Code Indicator**

Shows transponder code.

Shows operating transponder (1 or 2).

Shows response indicator (R).

## **5 Transponder (ATC) FAIL Light**

Illuminated – indicates transponder malfunction.

## **6 TCAS RANGE Switch**

Selects range for TCAS display.

## **7 Absolute Altitude (FL) Display Selector**

Push – displays relative altitudes of TCAS targets for 15 seconds.

## **8 TAU Envelope Switch**

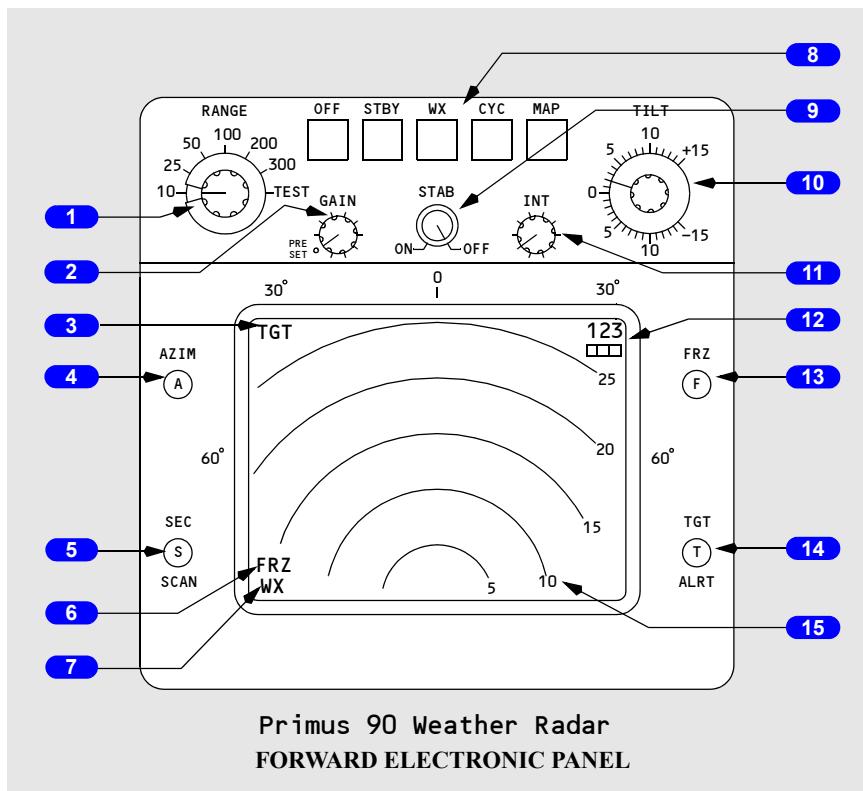
ABOVE – sets TCAS display at upper elevation limit.

NORM – sets TCAS display for normal limit.

BELOW – sets TCAS display at lower elevation limit.

## **9 Identification (IDENT) Switch**

Push – transmits an identification signal.

**Weather Radar Panel****1 RANGE/TEST Selector**

Rotate – selects one of six nautical mile ranges or TEST mode.

TEST mode provides special test pattern in which all colors are displayed.

In TEST mode, range selection is automatically 100 NM, gain is set to preset level, and transmitter energy is switched into the dummy load.

**2 GAIN Control**

Used to adjust sensitivity of receiver, primarily to resolve nearby strong target signals (usually while ground mapping).

Sensitivity increases as the control is rotated clockwise.

Full counterclockwise rotation to the detent position sets gain at preset level.

When the control is not in PRESET, VAR is displayed in the sub-mode field.

**3 Target (TGT) Field**

Letter T in red rectangle – function is selected and no target alert condition exists.  
TGT (blinking) – a contourable signal is within 60 to 150 NM and 10 degrees about the centerline.

**4 Azimuth (AZIM) Switch**

Push – azimuth strobe lines are displayed at 30 degree intervals.

**5 Sector Scan (SEC SCAN) Switch**

Push – selects 80 degree wide display.

When system is turned on, the 160 degree scan is operative.

**6 MODE Sub Field**

ANT (blinking) – antenna is not sweeping because of antenna failure.

FRZ (blinking) – freeze mode is activated. Blanked if STBY, WAIT, or PUSH conditions exist.

VAR – gain control is not in the detented preset position. VAR is overridden by FRZ if freeze mode is activated. VAR is blanked if cyclic mode is selected.

**7 Mode Field**

Displays selected mode: STBY, WX, CYC, MAP, or TEST.

PUSH – displayed if “all-buttons-out” condition exists with power on.

WAIT – displayed if indicator is synchronizing with antenna, e.g., immediately after turn-on or after STBY mode is selected.

TEST – displayed if range switch is in TEST position.

**8 MODE Selector Switches**

Push –

STBY (standby mode) –

- warm-up power applied
- one minute time delay, regardless of mode selected
- antenna scan stops, tilt remains active, and memory is erased
- STBY is displayed.

WX (weather mode) –

- normal mode of operation for weather detection
- WX is displayed.

---

CYC (cyclical mode) –

- displayed strong targets flash on and off at one-half second intervals
- gain is automatically set to preset level
- CYC is displayed.

MAP –

- enables ground mapping
- preset or variable gain may be selected
- MAP is displayed.

## **9 Antenna Stabilization (STAB) Switch**

ON – activates the stabilization function. Vertical gyro maintains antenna sweep at selected tilt angle relative to earth's horizon.

## **10 Antenna Tilt Control (TILT)**

Rotate – directs antenna beam 0 to 15 degrees above or below the horizontal plane of the airplane to obtain a better presentation of weather or terrain.

## **11 Intensity Control (INT)**

Regulates intensity (brightness) of the display. The display remains distinguishable over the range of control.

## **12 Auxiliary Field**

1 2 3 and the color bar legend are displayed in the weather and map modes.

- weather mode: color bar is green, yellow, and red
- map mode: color bar is blue, yellow, and magenta.

## **13 Freeze (FRZ) Switch**

Push – stops updating display.

FRZ flashes on and off at one second intervals in the submode field.

## **14 Target Alert (TGT ALRT) Switch**

Activates the target alert mode when radar gain is calibrated, i.e., in WX with gain control in PRESET or in CYC or TEST.

Target alert is deactivated automatically if MAP is selected or VAR gain is used, but is reactivated automatically when operating controls are restored to valid alert setting.

When activated, the letter T in a red rectangle is displayed in the target field.

If a contourable target is within the defined zone of 60 to 150 NM and 10 degrees about the center line, the target alert label flashes on and off at one second intervals in the target field.

## **15 Range Mark Identifiers**

Five range marks are displayed.

Range and azimuth marks are displayed in blue for WX and green for MAP.

Intentionally  
Blank

### **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 and two control display units (CDUs). The primary displays are the CDUs, attitude director indicator (ADI), horizontal situation indicator (HSI), 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. 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 attitude transfer switch.

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## 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, (on some airplanes) 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  $73^{\circ}$  north and  $60^{\circ}$  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, no heading information will be provided to the flight instruments.

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, then parked, position the mode selector OFF and accomplish realignment.

### **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)

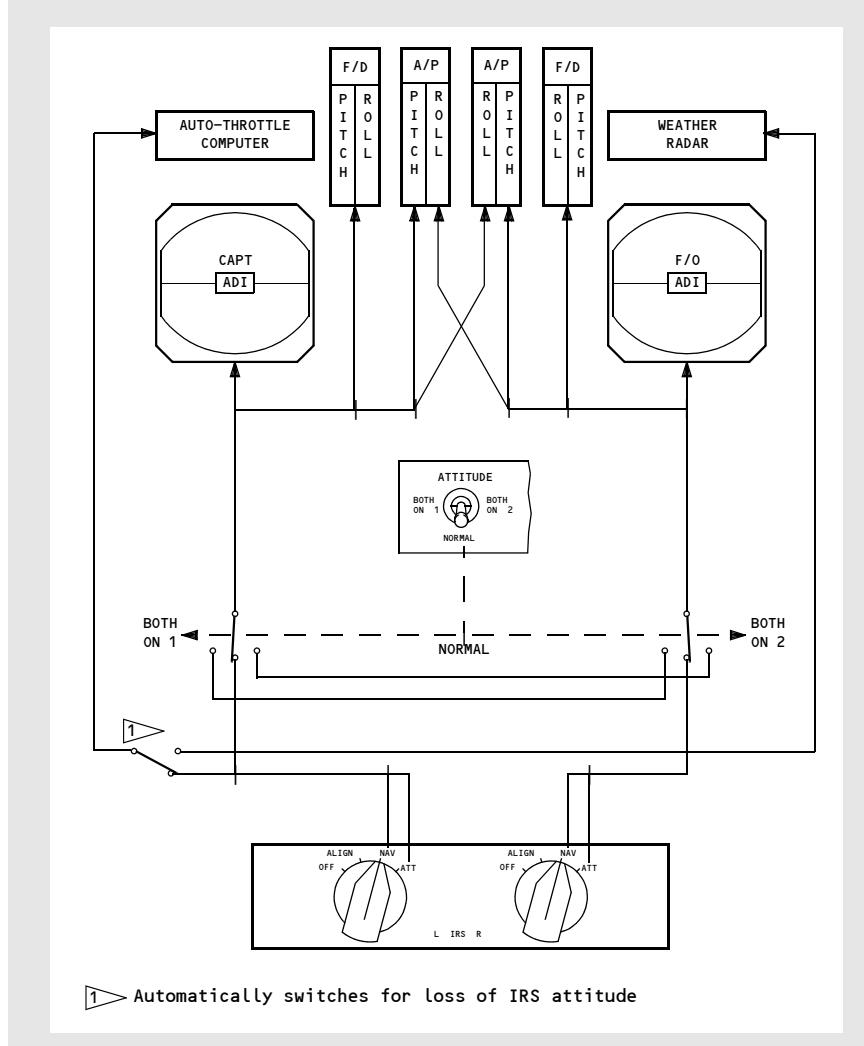
The MSU is located on the aft overhead panel and is used to select the operating mode for each IRS. Indicator lights on the MSU show status of each IRS.

## Attitude Systems

Two attitude systems are installed. The IRSs provide the attitude references when the IRS modes selectors are in the NAV or ATT position.

Should either IRS fail, the attitude transfer switch is used to switch all associated systems to the functioning IRS.

## Attitude System Schematic



## Compass Systems

Two compass systems are installed. The IRSs provide a true north compass reference and magnetic variation for any position between latitude 73° north and 60° south.

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## NAV Mode

When an IRS is operating in the NAV mode, the IRS calculates the position of the airplane, then applies the local variation to the true north reference and produces "magnetic" referenced compass cards.

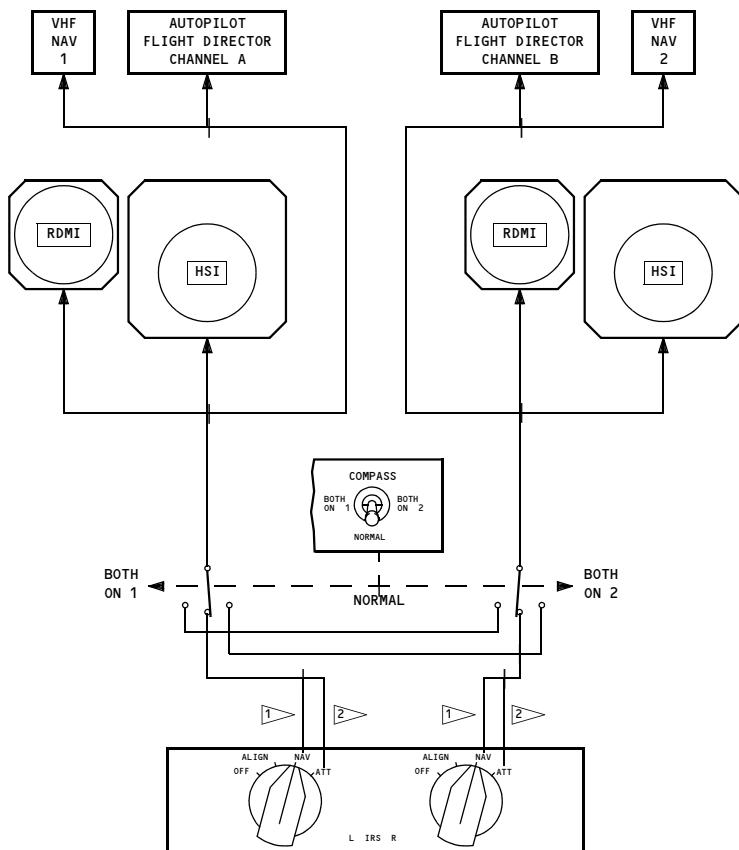
## ATT Mode

When an IRS is operating in the ATT mode, the associated compass cards will display heading flags. The COMPASS switch should be used to place all compass cards onto the good compass system.

When an IRS is operating in the ATT mode, compass headings can be entered into the IRS with the IRS keyboard. This action will retract the heading flags from view and provide a directional gyro (DG) type heading reference.

The DG type heading reference precesses (drifts). Therefore, new compass headings must be entered manually into the IRS whenever compass card indications are unacceptable.

## Compass System Schematic



1> IRS computes local variation, compass displays magnetic heading.

2> Magnetic Heading must be entered into the IRS by the pilot.

## 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 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, 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 RDMIs 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 ADIs and HSIs.

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 RDMIs. VOR–DME radio updating is available in the automatic or manual modes if a valid, in-range, VOR–DME station is selected. The HSI 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.

## Instrument Transfer Switching

### VERTICAL GYRO TRANSFER

VERTICAL GYRO  CAPT ON AUX F/O ON AUX NORMAL	EQUIPMENT/INPUT					
	CAPT ADI	F/O ADI	AUTO-PILOT	WEATHER RADAR	NO. 1 FD	NO. 2 FD
NORMAL	VG-1	VG-2	VG-1	VG-1	VG-1	VG-2
CAPT ON AUX	AUX VG	VG-2	AUX VG	AUX VG	AUX VG	VG-2
F/O ON AUX	VG-1	AUX VG	VG-1	VG-1	VG-1	AUX VG

### VHF NAVIGATION TRANSFER

VHF NAV  CAPT ON AUX F/O ON AUX NORMAL	EQUIPMENT/INPUT								
	CAPT HSI	F/O HSI	RMI'S		CAPT ADI	F/O ADI	AUTO-PILOT	NO. 1 FD	NO. 2 FD
NORMAL	NAV-1	NAV-2	NAV-1	NAV-2	NAV-1	NAV-2	NAV-1	NAV-1	NAV-2
CAPT ON AUX	AUX NAV	NAV-2	AUX NAV	NAV-2	AUX NAV	NAV-2	AUX NAV	AUX NAV	NAV-2
F/O ON AUX	NAV-1	AUX NAV	NAV-1	AUX NAV	NAV-1	AUX NAV	NAV-1	NAV-1	AUX NAV

### COMPASS TRANSFER

COMPASS  BOTH ON 1 BOTH ON 2 NORMAL	EQUIPMENT/INPUT					
	CAPT RMI	F/O RMI	CAPT HSI	F/O HSI	AUTO-PILOT	FLIGHT RECORDER
NORMAL	COMP-1	COMP-2	COMP-2	COMP-1	COMP-1	COMP-2
BOTH ON 1	COMP-1	COMP-1	COMP-1	COMP-1	COMP-1	COMP-1
BOTH ON 2	COMP-2	COMP-2	COMP-2	COMP-2	COMP-2	COMP-2

**NOTE:** When compass system is switched to BOTH ON 1  
(or BOTH ON 2) the switched RMI must be  
synchronized with the good compass RMI.

## 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.

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The Primus 90 radar system does not include turbulence detection.

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 Primus 90 radar system does not include a ground clutter reduction feature.

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### **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, and fuel monitoring. Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). Command markers (bugs) on the airspeed and N1 indicators 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, and holding patterns.

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. (U4 and on) 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. Route information are sent to HSIs. The HSI switch is used to select the desired information for HSI display. The HSI switch is used to select the desired information for the HSI 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.

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.

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## 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.

### 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 (U4 and on)
- cruise wind
- reduced takeoff and climb 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.

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## **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 careted (< or >) line to remind the flight crew to enter or validate information.

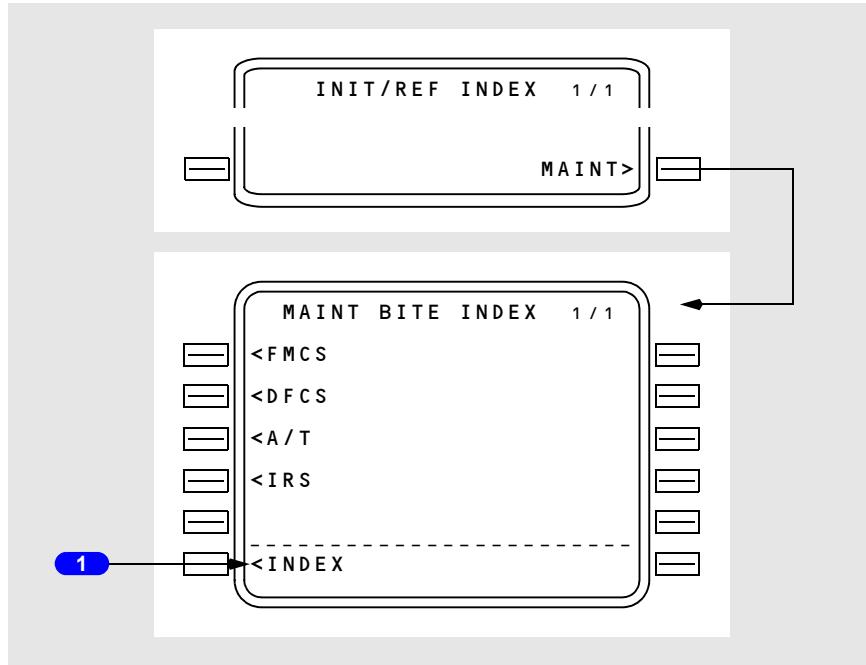
Select – pushing a key to obtain the desired information or action, or to copy selected data to the scratchpad.

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.

(U3 and on) On the ground prior to takeoff with FMC position update, the FMC position update to the takeoff runway threshold position can be done on the TAKEOFF REF page. On airplanes with TO/GA update, automatic FMC position update to the takeoff runway threshold position, displayed on the TAKEOFF REF page, occurs during takeoff when the TO/GA switch is pushed. In this case, when making an intersection takeoff, the intersection displacement distance from the runway threshold must be entered on the TAKEOFF REF page. On airplanes with RWY REMAIN the runway remaining distance must be entered 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.

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 radio(s) 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 (U3 and on) or 40 NM (U1).

**Note:** With both navigation radios in AUTO tuning, if a U1 or U3 series FMC determines that a navigation radio is unreliable for position updating, both VHF navigation control panels will display dashes in the automatic frequency indicators. This creates the appearance that both radios are agility tuning. However, the FMC is not using both radios for position updating. It deselects the unreliable radio and uses the good radio for agility tuning. U4 and later FMCs operate in the same manner, but 108.0 is displayed in the automatic frequency indicator.

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. VOR/DME position updating is less accurate due to inherent VOR bearing errors, especially when tuning manually. With a U3 or later FMC, 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.

**Note:** If the flight crew observes this indication, and an extended period of IRS NAV ONLY flight follows, the FMC should be carefully monitored.

## 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.

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
- N75° W170° becomes 75N70
- N50° E020° becomes 5020E
- N06° E110° becomes 06E10
- S52° W075° becomes 5275W
- S07° W120° becomes 07W20
- S50° E020° becomes 5020S
- S06° E110° becomes 06S10.

### Procedure Arc Fix Waypoint Names

Unnamed terminal area fixes along a DME arc procedure – 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.

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## 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
- FA – VFR final approach fix
- CF – final approach course fix
- FF – final approach fix
- IF – initial approach fix
- OM – outer marker
- MM – middle marker
- IM – inner marker
- BM – back course marker
- MD – minimum descent altitude
- A – (+ an alpha) step down fix
- RW – runway threshold
- MA – missed approach point other than RW
- TD – touchdown point inboard of RW.

Examples: OM25L, MM09, IM23, RW04, RW18L.

For airports with more than one approach to the same runway, the two letter prefix may change to allow different identifiers for the same waypoint. The first letter identifies the type of fix and the second letter identifies the type approach as follows:

- C( ) – final approach course fix
- F( ) – final approach fix
- P( ) – missed approach point
- I( ) – initial approach fix
- D( ) – minimum descent altitude
- T( ) – touch down point
- R( ) – runway centerline intercept
- ( )I – ILS
- ( )L – localizer only
- ( )B – backcourse ILS
- ( )D – VOR/DME
- ( )V – VOR only
- ( )S – VOR with DME points
- ( )N – NDB
- ( )Q – NDB with DME points
- ( )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:

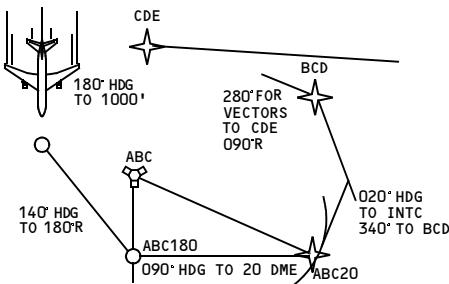
- passing through an altitude
- flying a heading to a radial or DME distance
- intercepting a course
- heading vector to a course or fix.

Altitude and course intercept conditional waypoints are displayed on the CDU inside (parentheses) marks. The following diagram depicts conditional waypoints.

**EXAMPLE:**

RTE LEGS  
180° HDG  
(1000)  
140° HDG  
(ABC180)  
90° HDG  
(ABC-20)  
20° HDG  
(INTC)  
340°  
BCD  
280° HDG  
(VECTOR)  
270°  
CDE

**MEANING:**



**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 (U3 and On)

---

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.

---

## 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.

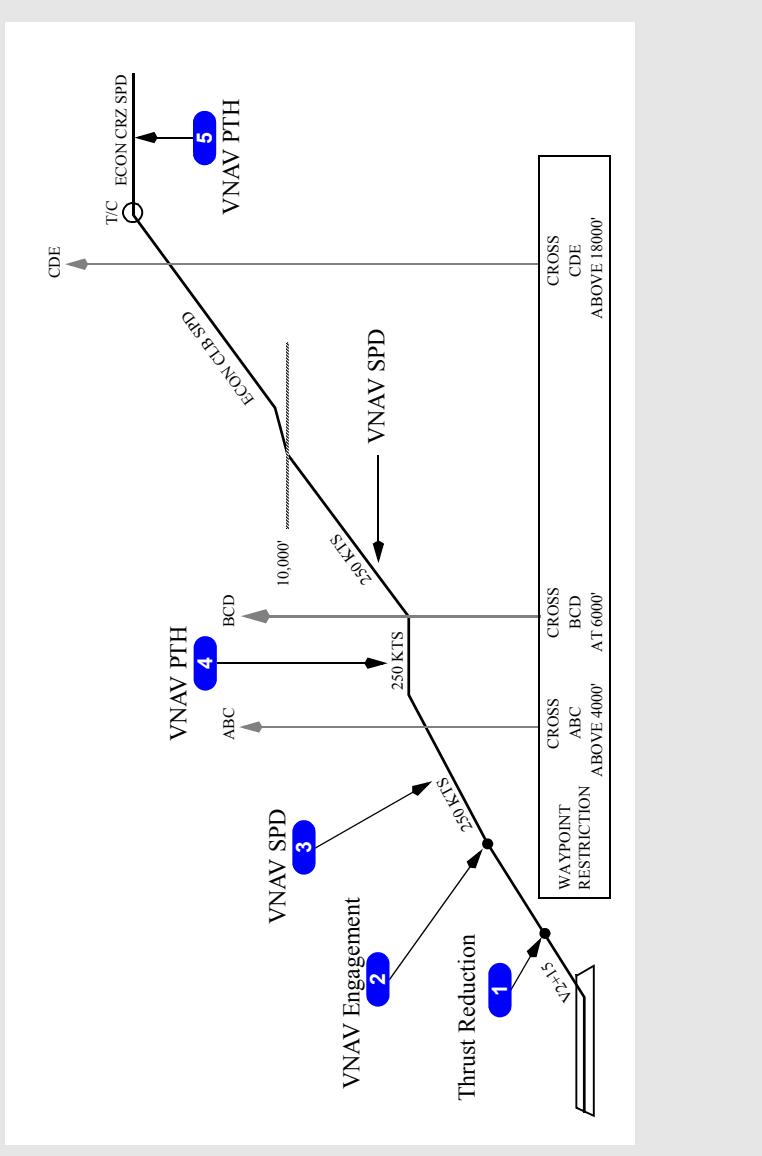
At or above altitude restrictions are entered with a suffix letter A (example: 220A).

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. 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.

## 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.

## 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.

### End of Descent (E/D) (Prior to UPDATE 7.0)

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 the lowest point with an “at” altitude restriction. 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.

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.

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.

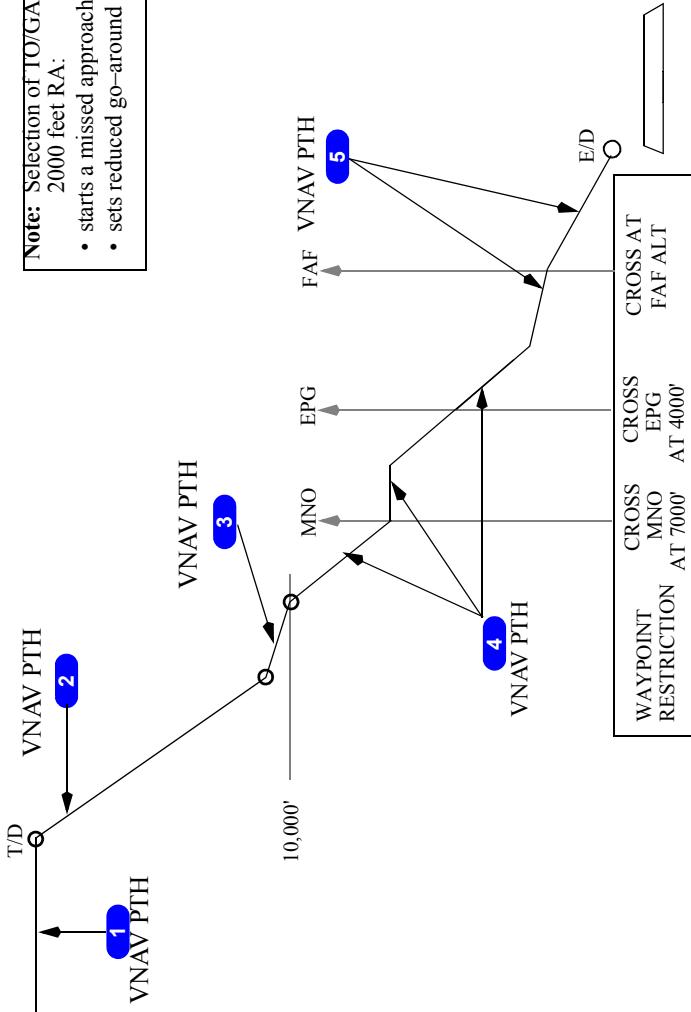
The CDU message DRAG REQUIRED is displayed if an unexpected tailwind results in a significant increase in airspeed to maintain path. The CDU message DES PATH UNACHIEVABLE is displayed if the FMC determines that the planned descent profile cannot be accomplished. VNAV disengages if a limit speed will be exceeded.

To initiate a path descent LNAV must be engaged. If LNAV is disengaged during a path descent, VNAV will (U4 and earlier) disengage or (U5 to U7) change to a speed descent.

**VNAV Cruise and Path Descent Profile (Non-Precision Approach)**

DECEL POINTS (U10 prior)

**Note:** Selection of TO/GA below 2000 feet RA:  
• starts a missed approach  
• sets reduced go-around thrust.



## 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.

### 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.

(Prior to U5) The descent must be initiated manually by resetting the MCP altitude, selecting the CAPTURE prompt on the descent page, and executing.

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.

(U5 and on) 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.

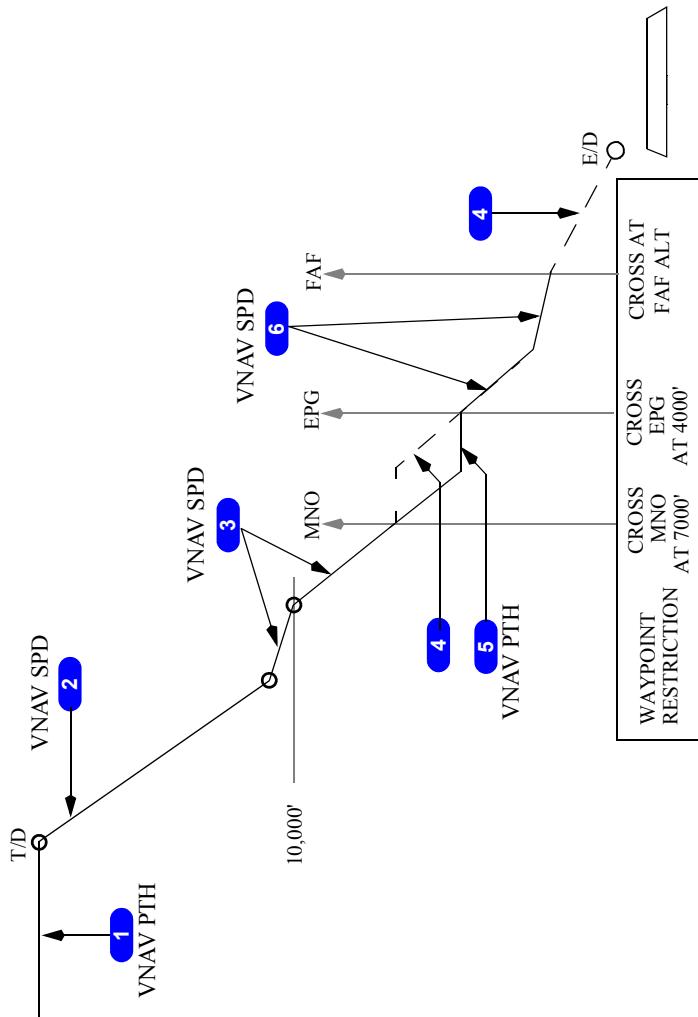
A speed descent cannot automatically revert to a path descent. However, if all required parameters for a path descent are available, a path descent may be manually selected at any time by selecting the PATH prompt on the speed descent page.

---

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

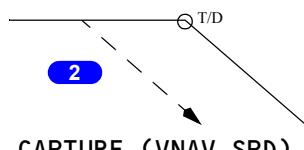
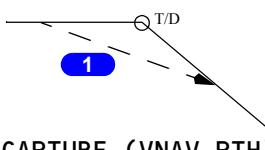
After EPG, VNAV continues the idle thrust descent using VNAV SPD.

Prior to the approach, VNAV decelerates to approach speed. The FMC prompts manual flap extension.

## 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

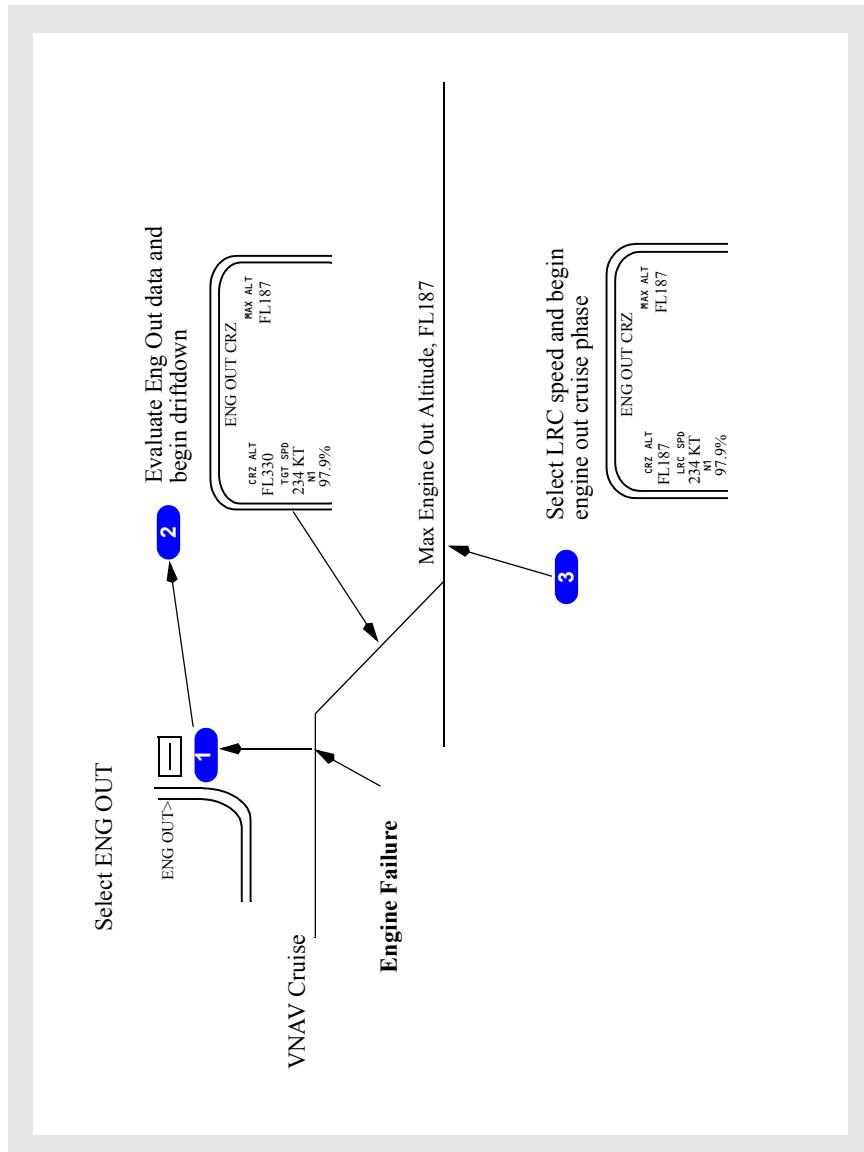
### 1 CAPTURE (VNAV PTH)

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.

## 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 ENG OUT CRZ page, and (U5 and on) 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) (U4 and on)

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.

With FMC prior to U5, when entering the first value of a pair, the slash must be entered before transferring to the data line. When entering only the second value, the slash is optional. 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.

### **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 (U3 and on) 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 U1 FMC has no supplemental database. The temporary database has storage capacity for twenty waypoints, twenty navaids, and three airports.

---

(U3 and on) 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"><li>• takeoff</li><li>• derated takeoff (U4 and on)</li><li>• assumed temperature takeoff</li><li>• climb</li></ul> | <ul style="list-style-type: none"><li>• reduced climb</li><li>• cruise</li><li>• continuous</li><li>• go-around.</li></ul> |
|---|--|

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 (U4 and On)

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

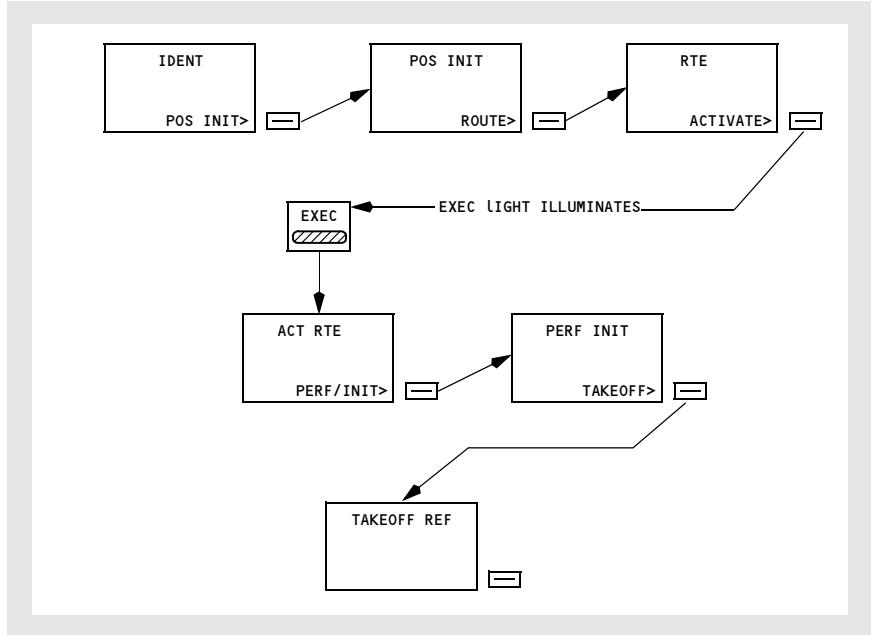
If the FMC fails, the FMC alert light will illuminate. The FMC/CDU FAIL light will appear on the CDUs, and the CDUs will display failure modes. LNAV and VNAV will disengage.

Intentionally  
Blank

#### 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.

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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 (U3 and on) 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.

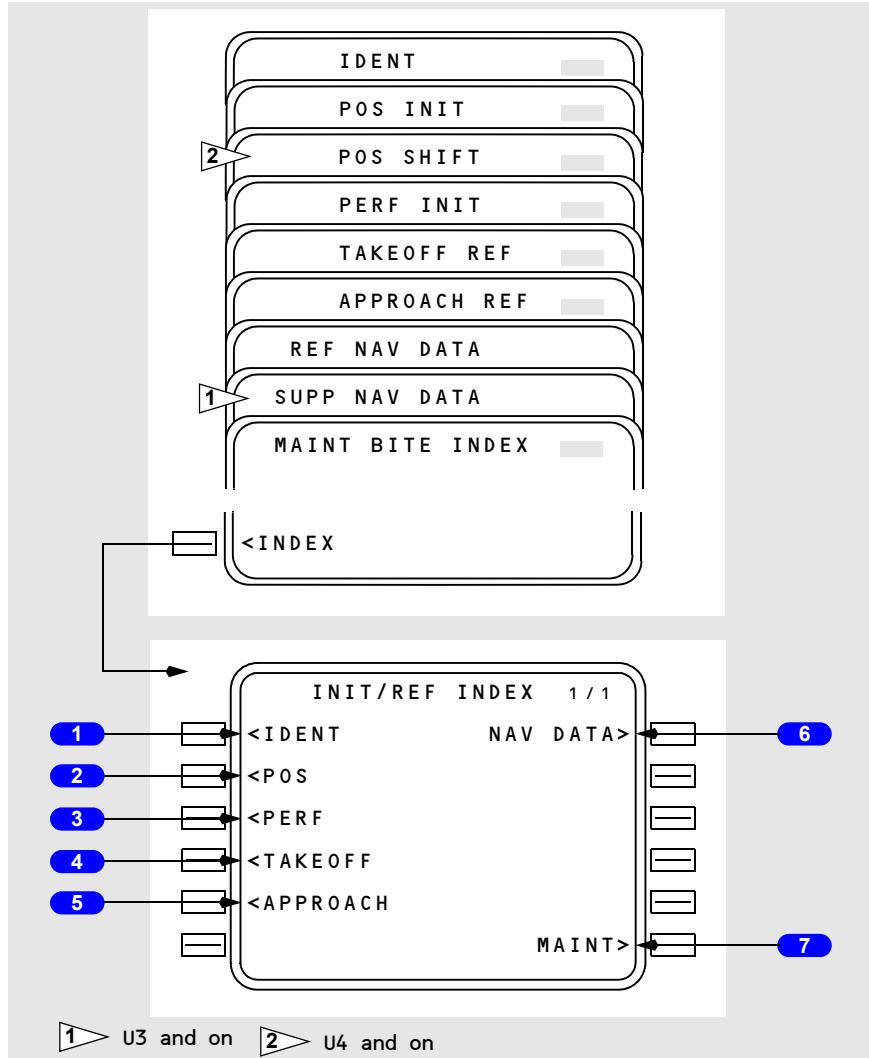
A single wind and temperature for cruise may be entered on the PERF INIT page. Wind and temperature data for specific cruise waypoints are entered on the RTE DATA page. The RTE DATA page is described in the FMC Cruise section. Wind and temperature for descent is entered on the DES FORECASTS page. The 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 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 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.

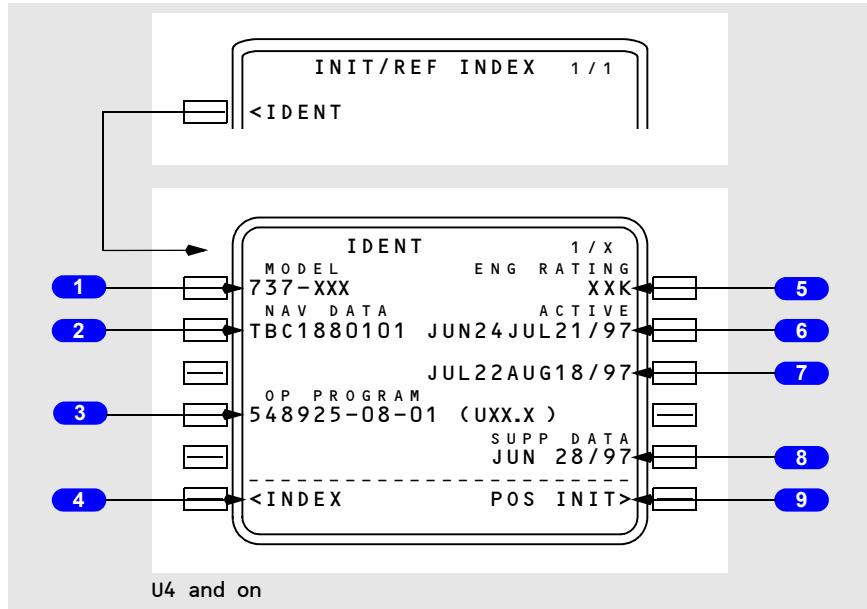
## 7 Maintenance (MAINT)

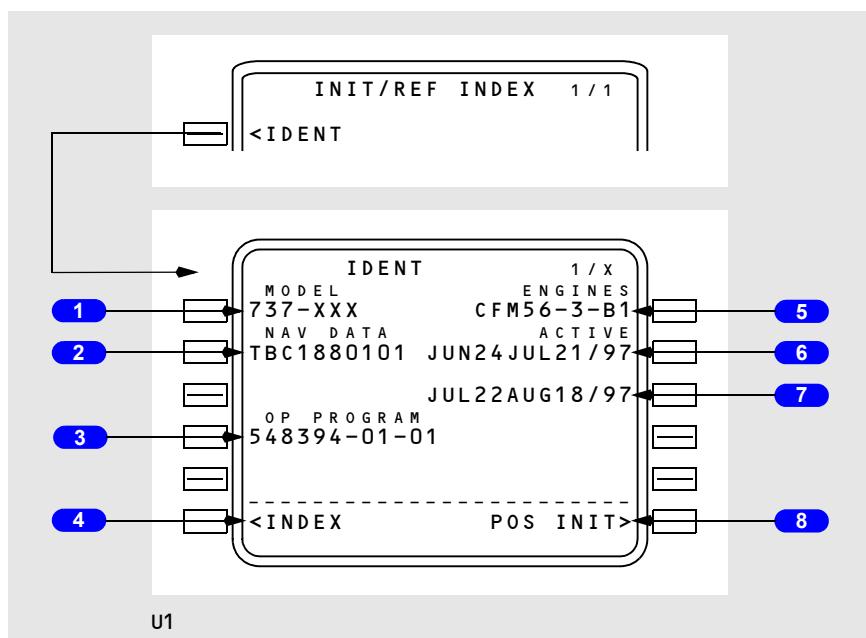
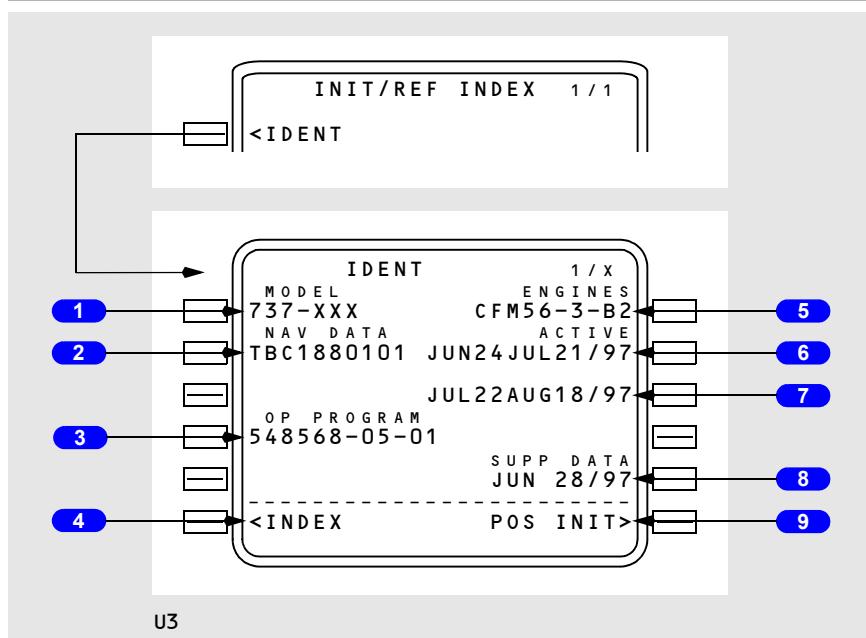
For maintenance use only; displays maintenance pages which are accessible on the ground only. In the air the prompt becomes NAV STATUS which displays the status of navaids being tuned by the FMC.

## 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) - U1 to U3**

Displays the Boeing software part number only for Updates U1 to U3.

**3 Operational Program (OP PROGRAM) / (FMC Update)**

Displays the Boeing software part number and FMC Update version installed.

- Update U4
- Update U5

**4 INDEX**

Push – displays the INIT/REF INDEX page.

**5 Engine Rating (ENG RATING) / Engine Model (ENGINES)**

(U1 to U3) Displays the engine model number. (U4 and on) Displays the engine thrust stored in the FMC performance database. A typical line may read (U1 to U3) “ENGINES – CFM56–3B–1” (U4 and on) “ENG RATING – 23.5K, 22K, 20K or 18.5K.”

**6 Active Date Range (ACTIVE)**

Displays the effectivity 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 Position Initialization (POS INIT) / SUPP DATA**

(U1) Push – displays the POS INIT page. (U3 and on) Displays the effective date of the supplemental database. Blank if supplemental database is empty.

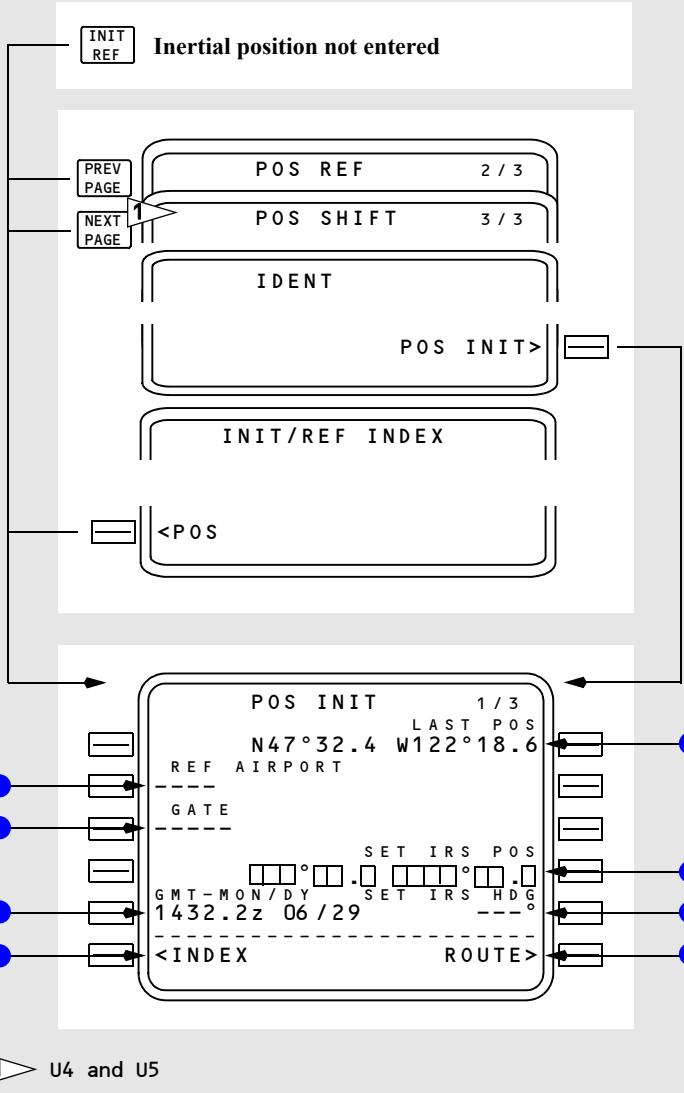
**9 Position Initialization (POS INIT)**

Push – displays the POS INIT page.

## 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 (U1/U3) two or (U4 and on) 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.

(U3 and on) Removes previous GATE entry.

Entry blanks at lift-off.

## **2 GATE (U3 and on)**

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 (U3 and on) 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. (U3 and on) MON/DY is blank. (U1) MON/DY are not displayed.

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.

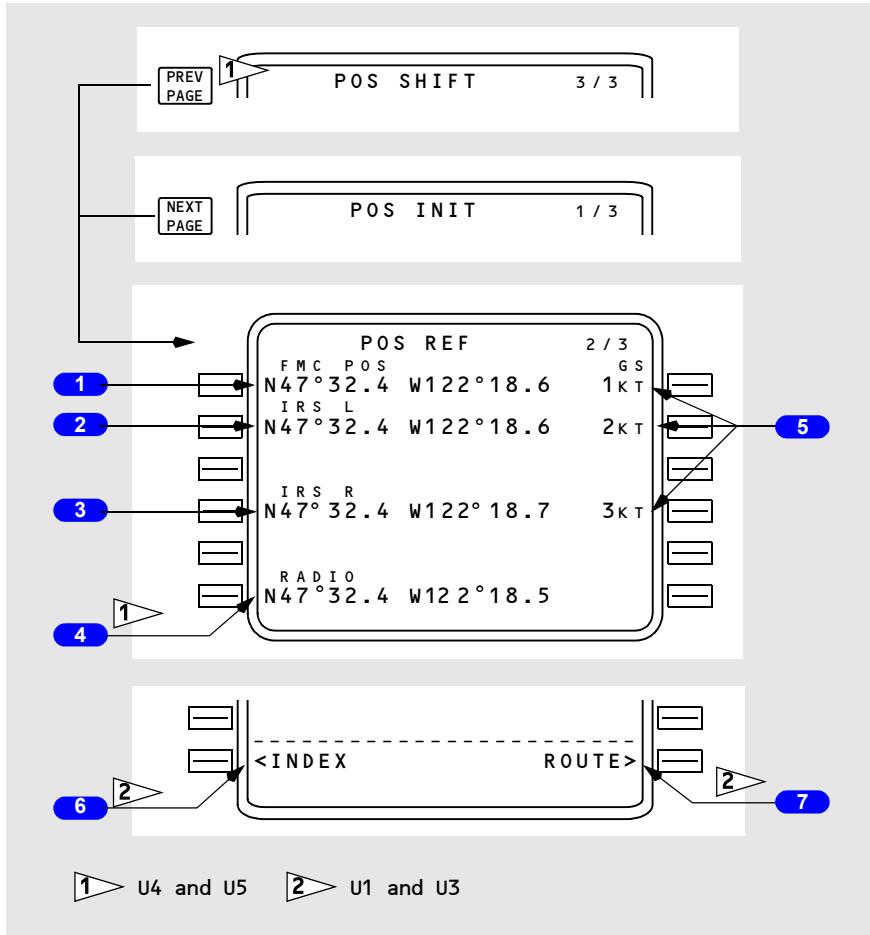
**8 ROUTE**

Push – displays the ROUTE page.

## Position Reference Page

The POS REF page displays the airplane positions as calculated by the FMC, IRS, and (U4 and on) 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 (U4 and On)**

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.

**6 INDEX (U1/U3)**

Push – displays the INIT/REF INDEX page.

**7 ROUTE (U1/U3)**

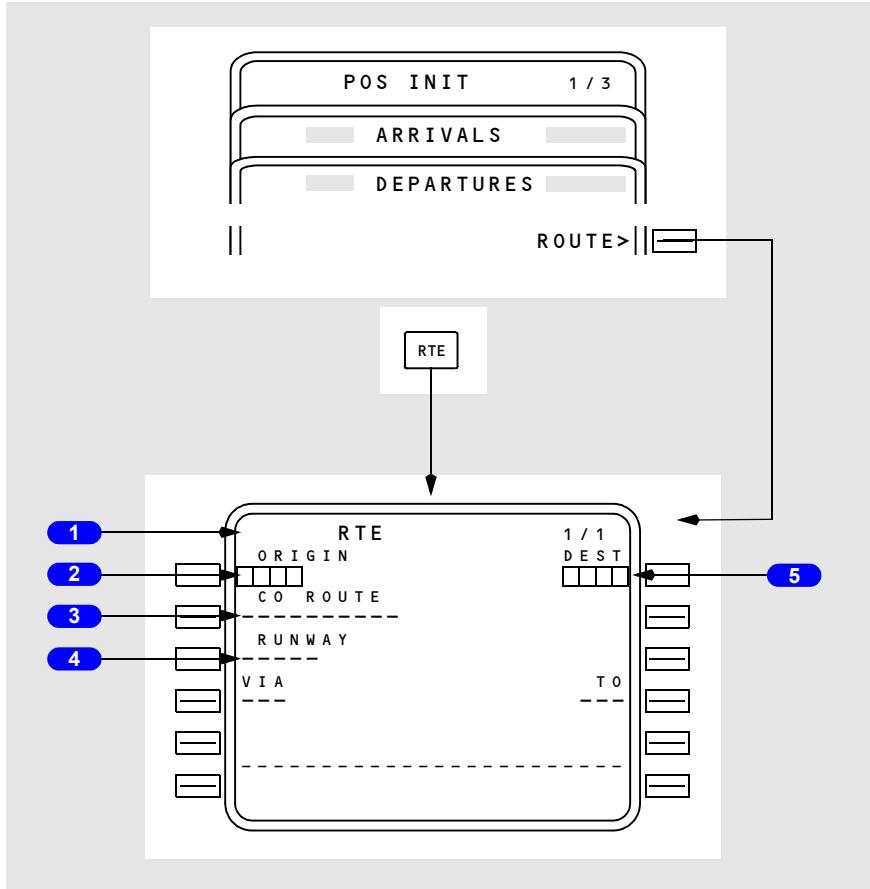
Push – displays the ROUTE page.

## 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.

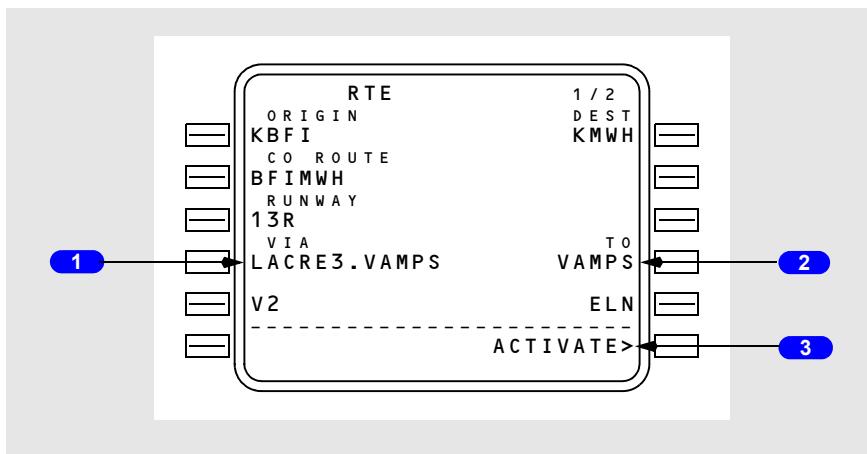
Entries must be in the navigation database.

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.

**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.

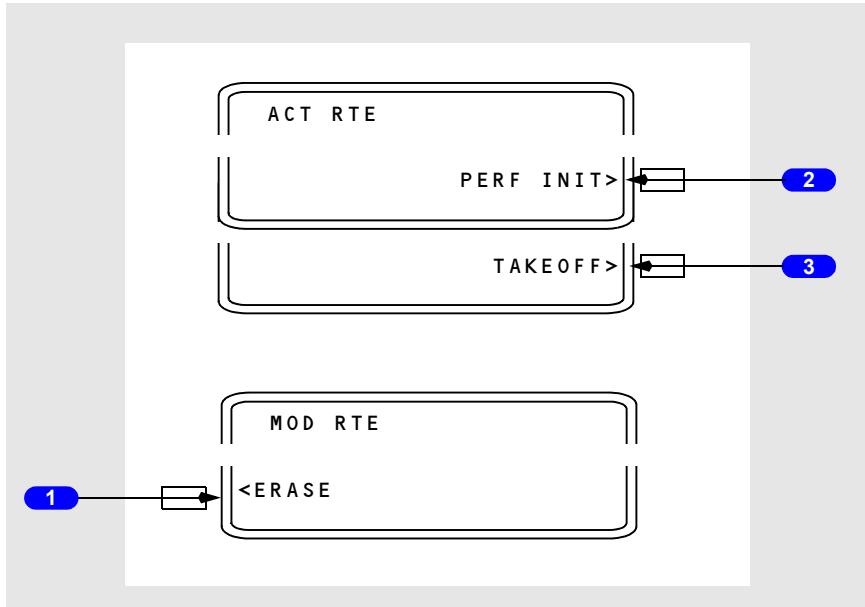
Activation of a route is required for completion of the preflight.

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

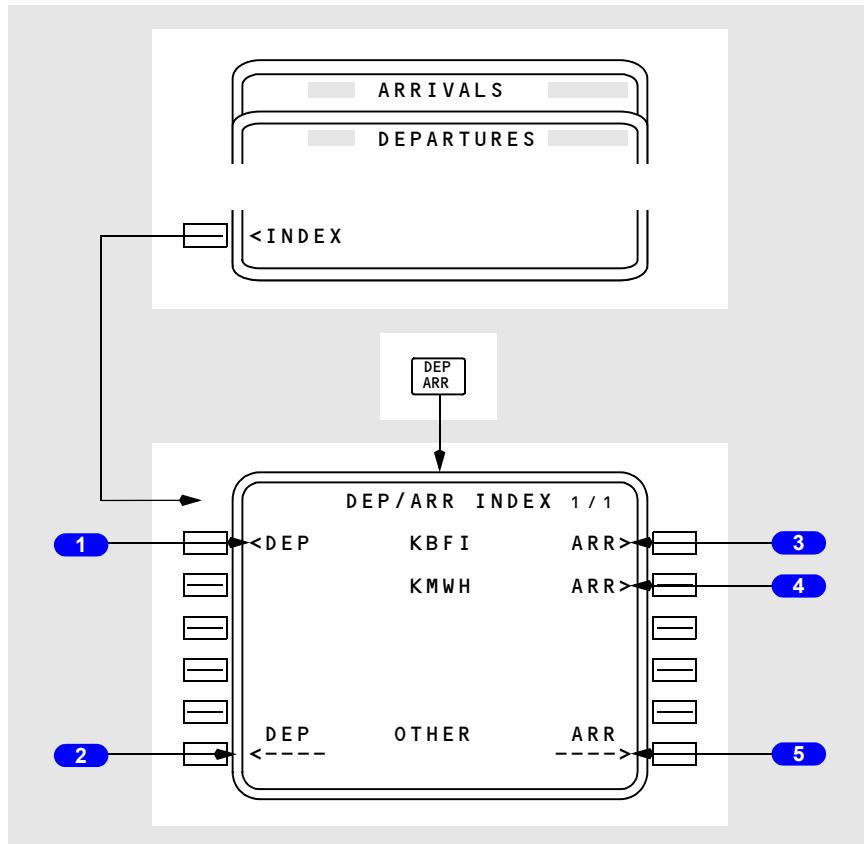
Push – displays TAKEOFF REF page.

Displayed only on the ground when all required entries on the PERF INIT page are complete.

## 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.

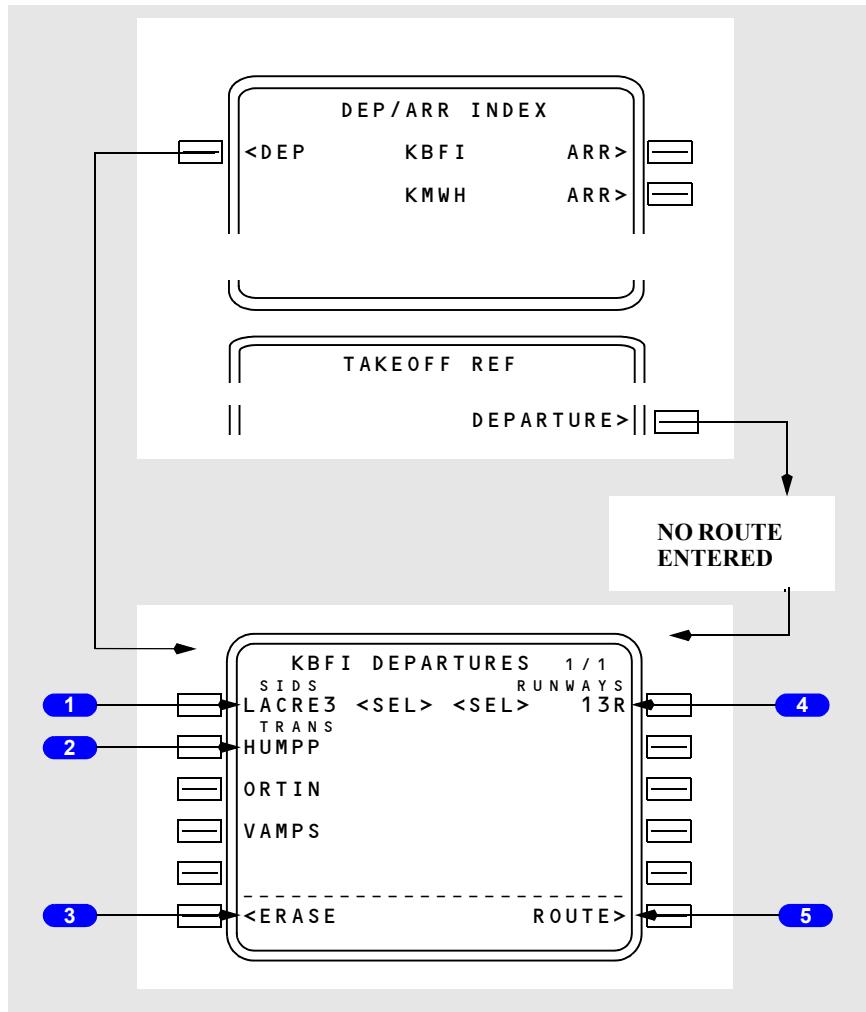
**5 Arrival (ARR) – OTHER**

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**

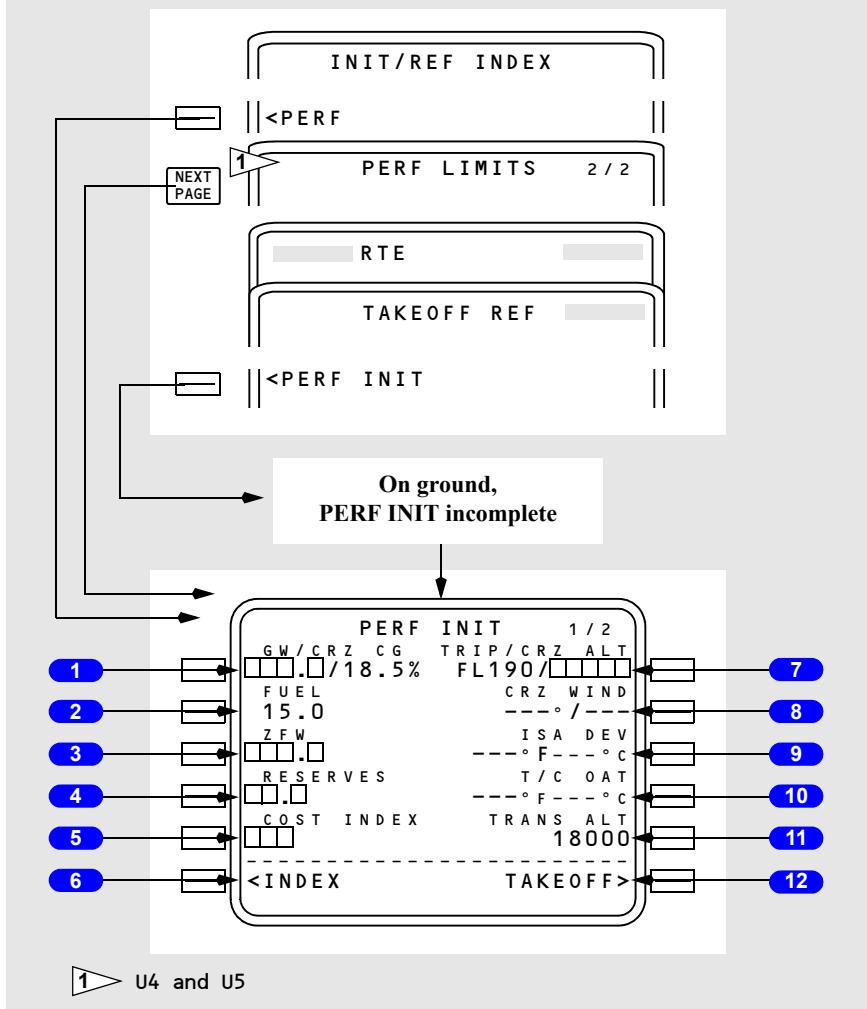
Selecting an option displays <SEL> inboard of the option, and a route modification is created. When the modification is executed, the <SEL> becomes <ACT>. Leaving the page and returning displays all options and the <SEL> or <ACT> prompts.

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Blank

## 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.

(U5 and on) 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.

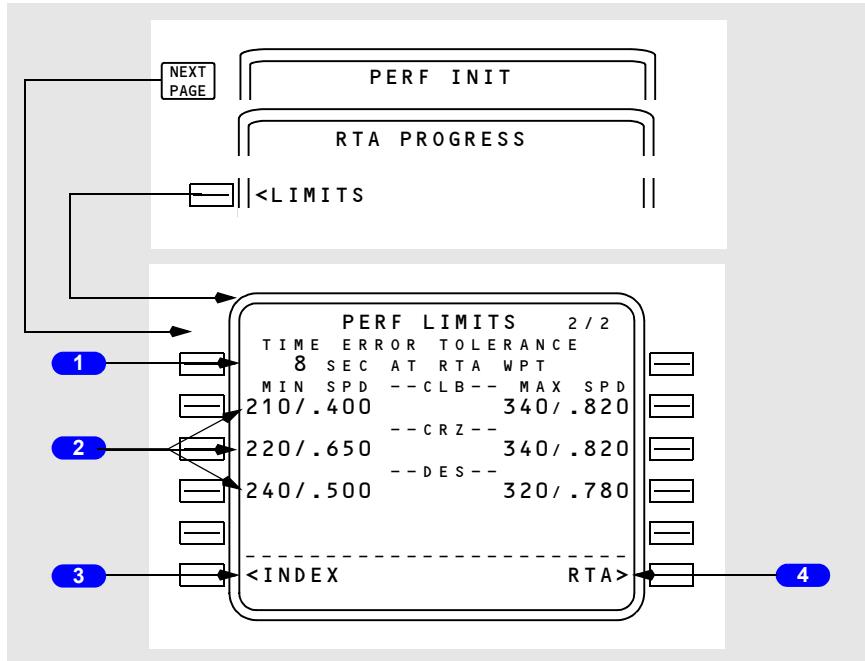
Manual entry has priority.

**12 TAKEOFF**

Push – displays the TAKEOFF page.

**Performance Limits Page (U4 and On)**

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.

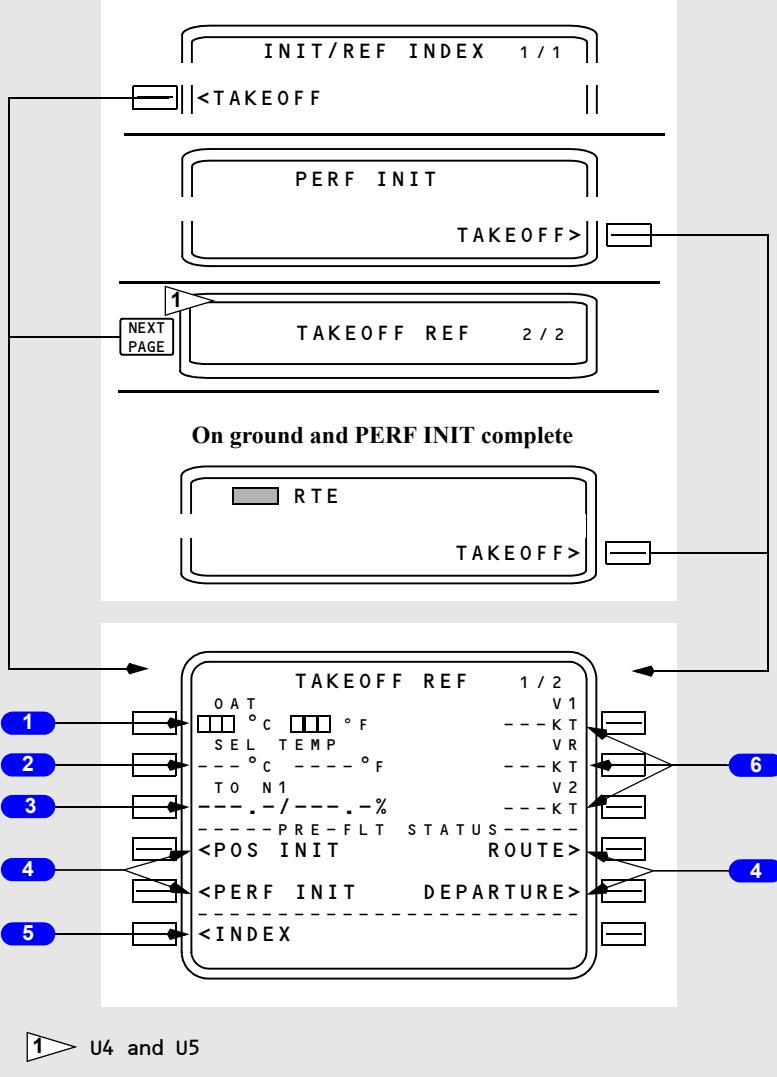
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## Takeoff Page 1

### 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. (U3 and on) 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 (TO N1)**

Displays the FMC computed N1 for takeoff.

Crew entry not allowed.

Data line title displays full rated thrust or (U4/U5) selected takeoff derate thrust. Typical line titles display as “TO N1”.

(U1/U3) Data line title changes to “RED TO N1” when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. The Reference N1 bugs will still display full rated thrust N1 values.

(U4 and U5) Data line title changes to “RED TO 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 “RED TO-1” or “RED TO-2” and the effect on thrust will be additive. The Reference N1 bugs will still display full rated or selected takeoff derate thrust N1 values.

(U4 and U5) 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**

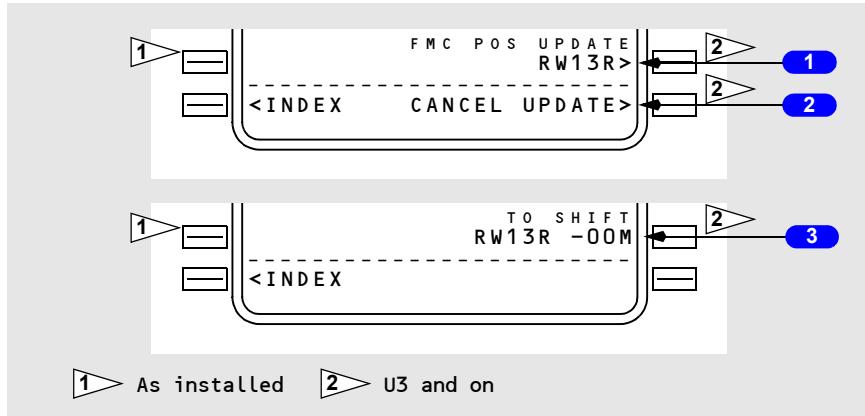
Push – displays the INIT/REF INDEX page.

## 6 V Speeds

Crew calculated V speeds may be entered and displayed for reference.

Any change of performance information results in removal of all V speeds.

### 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.

#### 3 Takeoff Shift (TO SHIFT)

Automatically displays the departure runway from the RTE page.

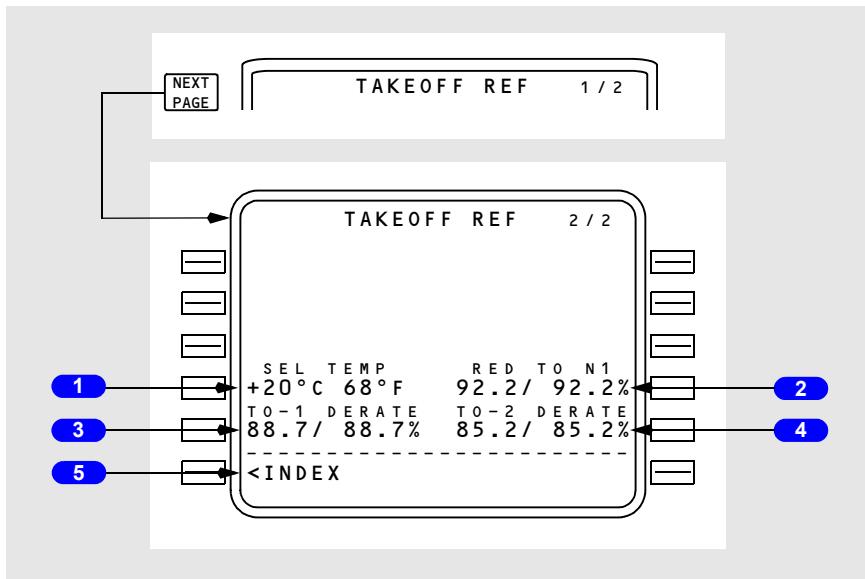
If a takeoff shift distance is not entered, the FMC updates to the runway threshold when TO/GA is pushed.

If a takeoff shift distance is entered, the FMC updates to the threshold of the departure runway plus the entered displacement when the TO/GA switch is pushed.

Following TO/GA activation, the runway identifier and any entered shift value are highlighted in reverse video characters.

To remove a TO SHIFT entry, reselect RWY on RTE page.

Intentionally  
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**Takeoff Page 2****Takeoff Reference Page 2/2 (U4 and On)****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 (TO N1)**

Repeats data shown on TAKEOFF REF page 1.

Displays the FMC computed N1 for takeoff.

Crew entry not allowed.

Data line title changes to RED TO 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 RED TO-1 OR RED TO-2 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 (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 (TO-2 DERATE)**

Selects the second level of takeoff derate providing 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.

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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.

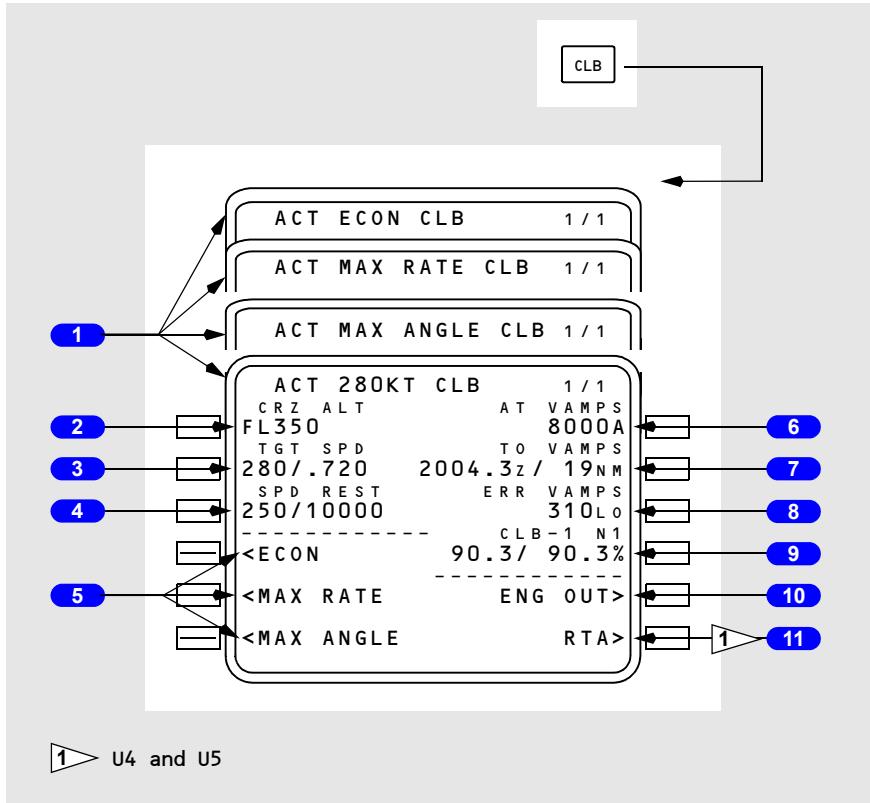
## Climb Pages

### 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.

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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.

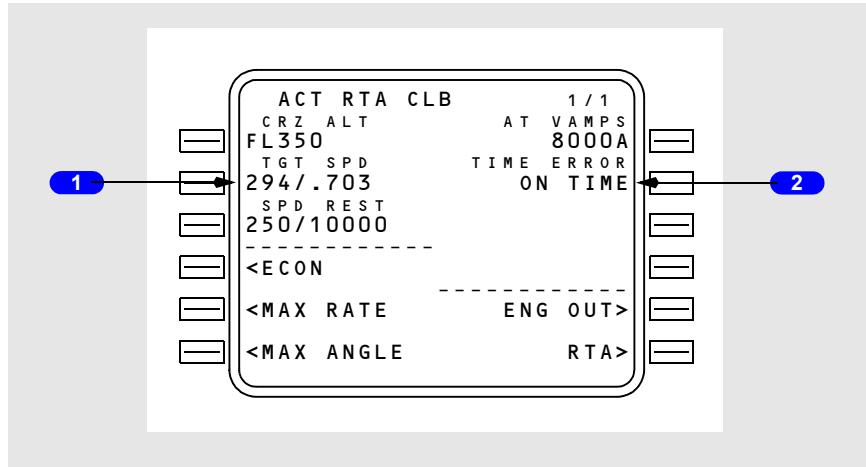
ERASE prompt replaces RTA during a page modification.

### RTA Climb Page (U4 and On)

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)

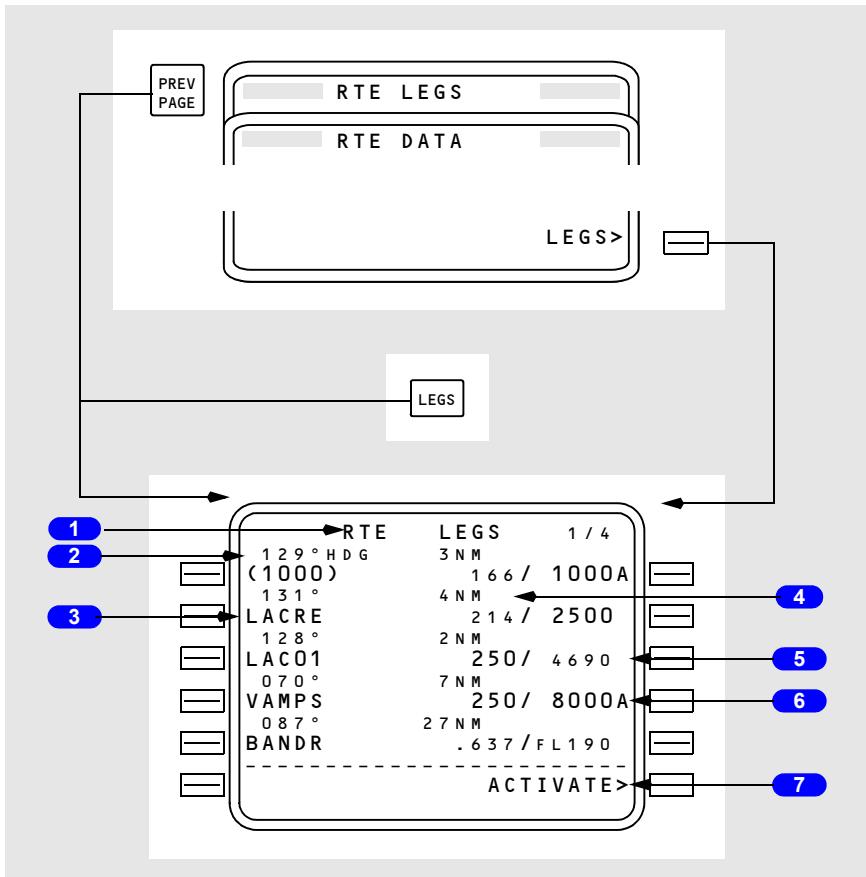
Displays the computed speed required to meet entered RTA.

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

The leg segment direction is displayed as the title of the waypoint line. Courses are displayed in magnetic (xxx°) or true (xxx° T). The 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.

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.

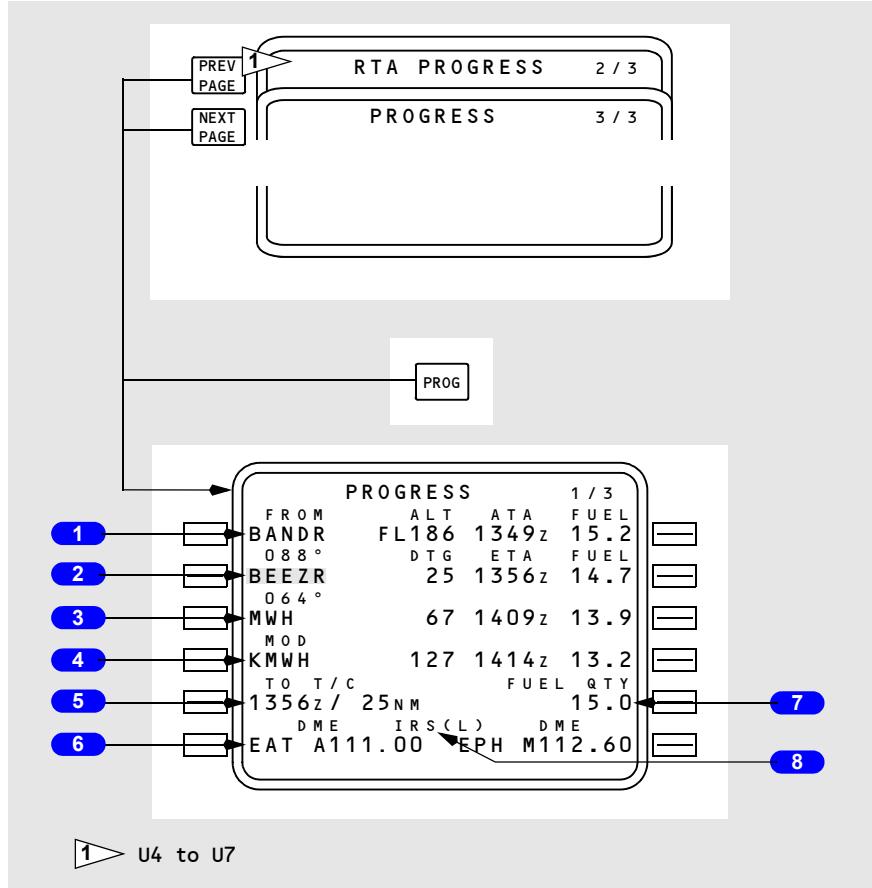
## Progress Pages

### Progress Page 1

The PROGRESS page provides general flight progress information along the route of flight.

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
- navaid and IRS information
- fuel quantity.



## 1 FROM

Displays the identifier of the last (FROM) waypoint, the altitude (ALT), the actual time of arrival (ATA), and (U5 and on) 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. (Prior to U5) a path descent must be available
- (Prior to U5) TO T/D ADVSRY: to top of descent advisory, if no STEP TO entry is made on CRZ page and a path descent is not available
- TO E/D: to the end of descent waypoint for an active path descent; blank if a path descent is not available.

**7 Fuel Quantity (FUEL QTY)**

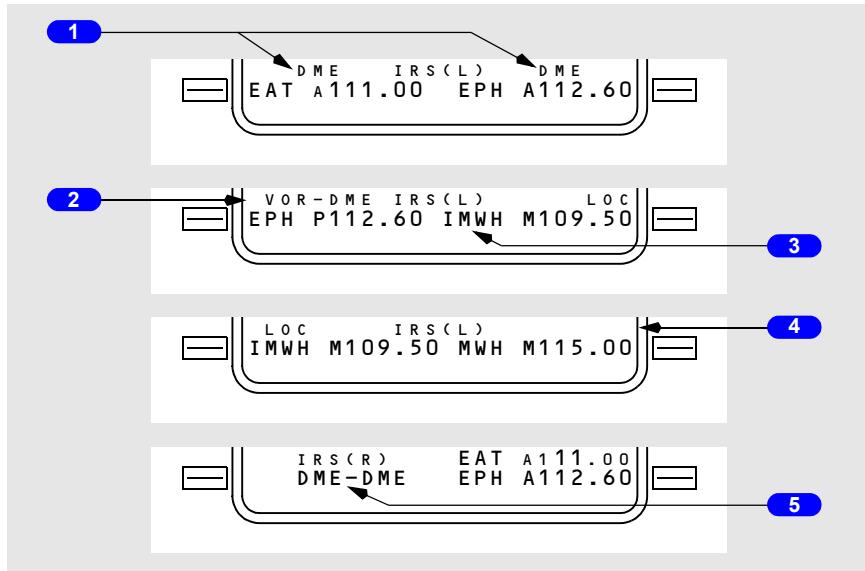
Displays the present total fuel quantity remaining as obtained from the airplane fuel summation unit.

**8 IRS (X)**

Displays currently selected IRS.

## 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 (U1) 40nm or (U3 and on) 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. (U3 and on) 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.

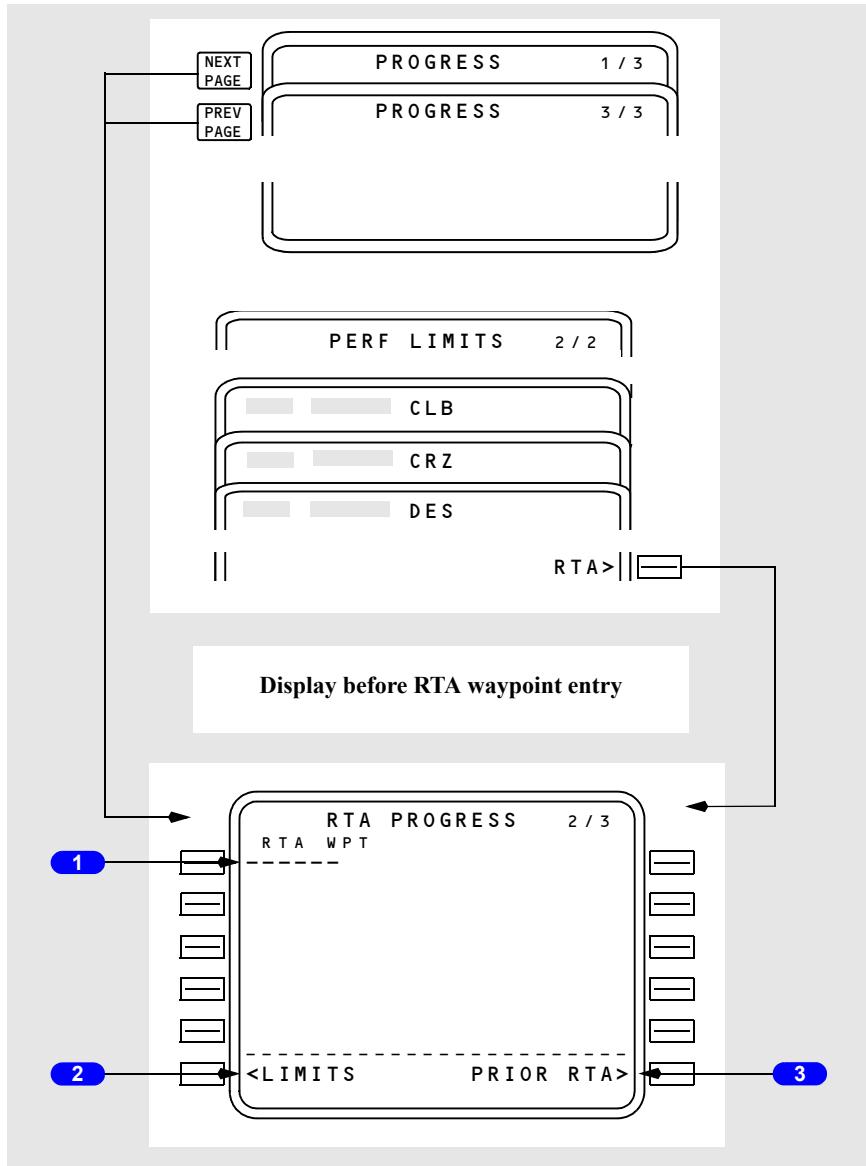
**5 Agility Tuning**

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 (U4 and U5)

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**

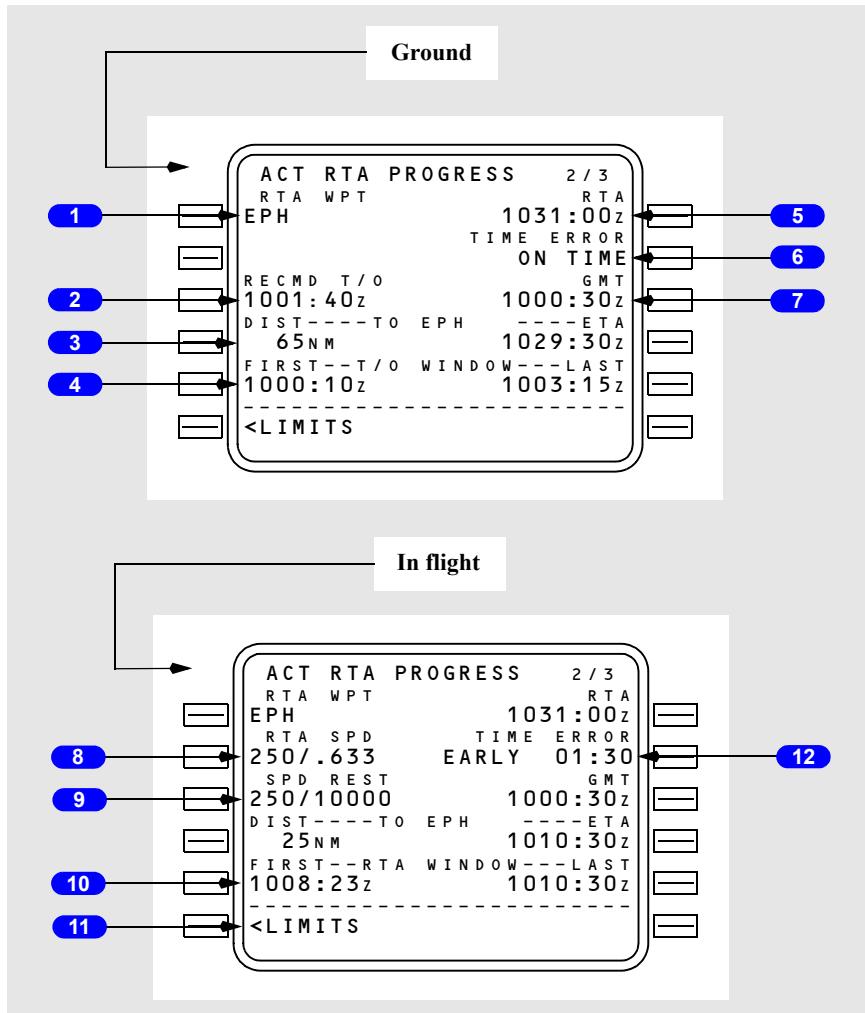
Push – displays the PERF LIMITS page.

**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.

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**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**

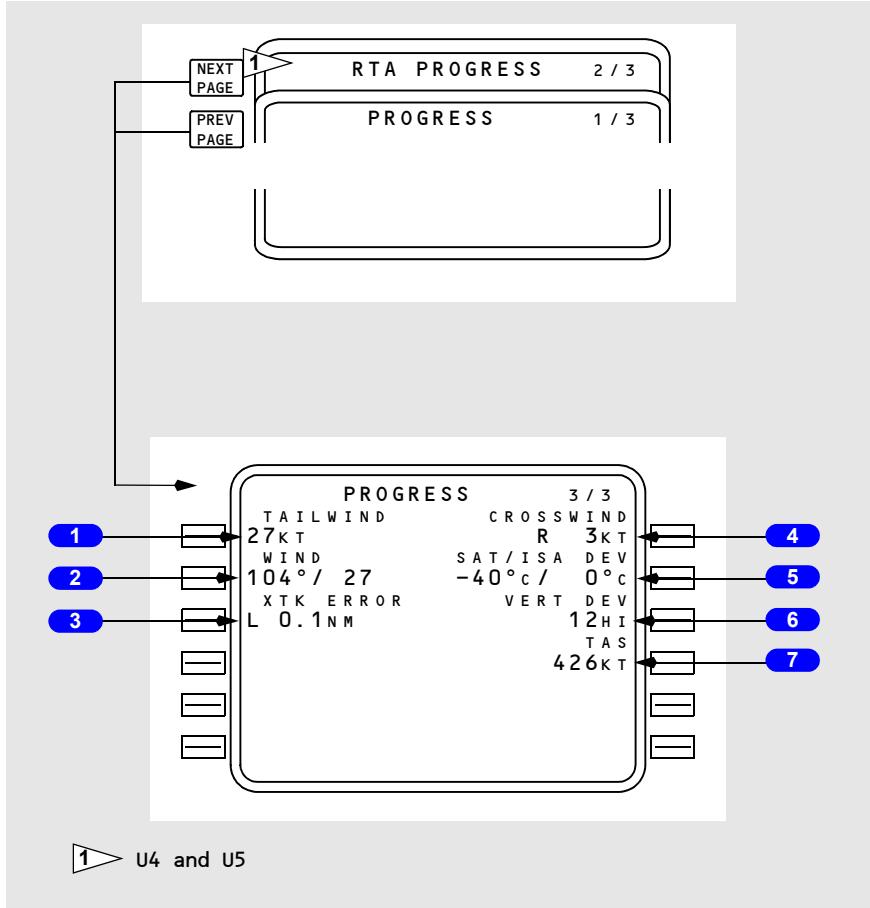
Push – displays PERF LIMITS page.

**12 TIME ERROR**

Displays the difference between the ETA and the RTA plus the TIME ERROR TOLERANCE on the PERF LIMITS page.

## Progress Page 2 or 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 (U1) (+/-) (U3 and on) (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.

## Limit Page

### N1 Limit Page

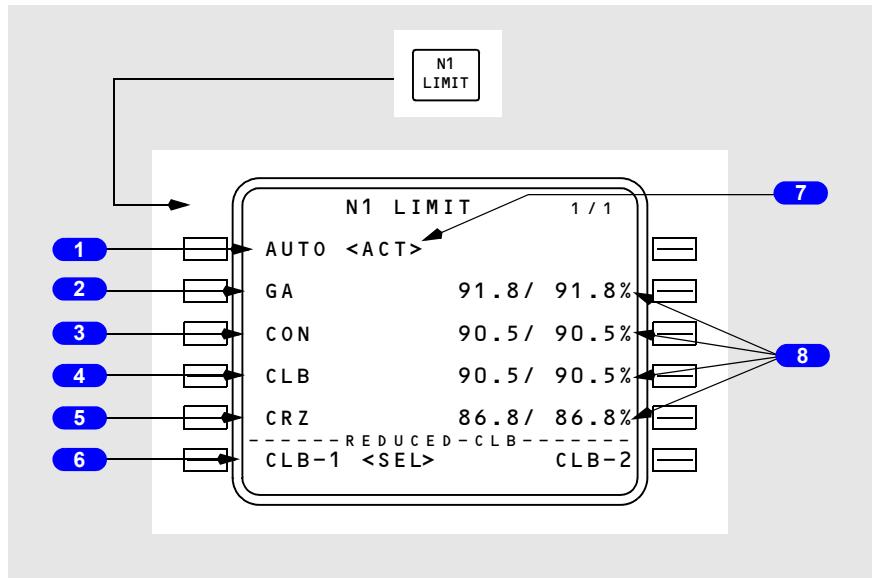
The N1 LIMIT page provides thrust limit and reduced climb thrust selection.

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.

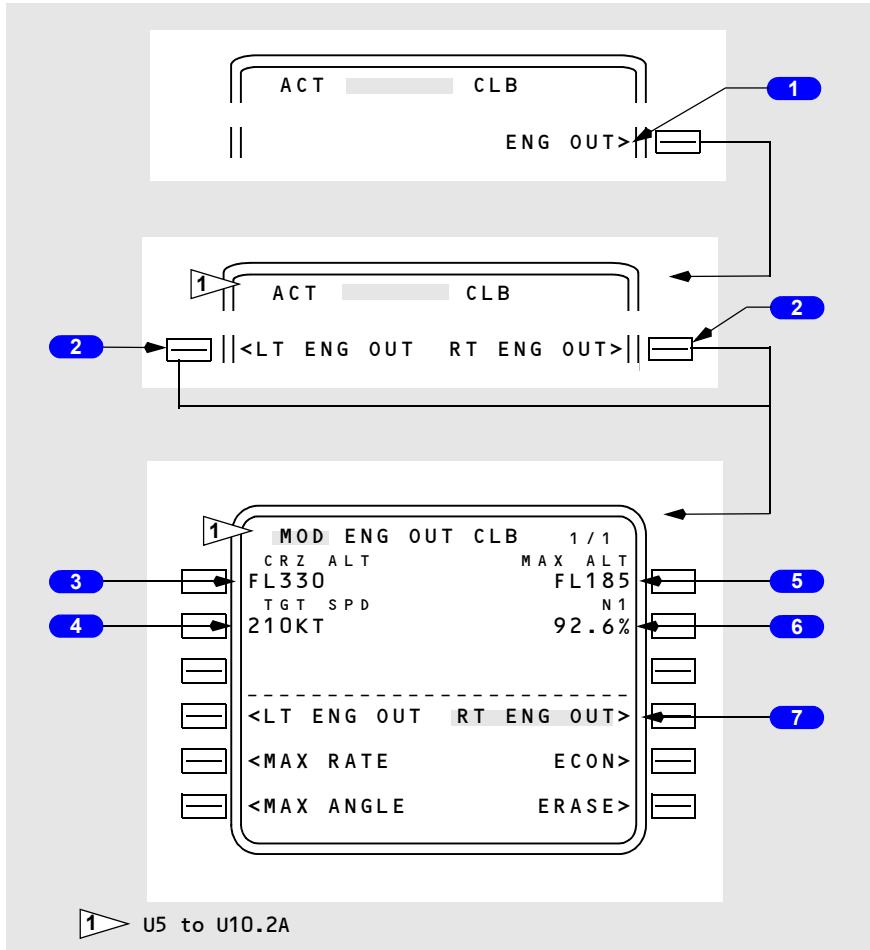
If CLB-1 or CLB-2 is selected, the N1% for CLB and the N1 cursors still display values for full rated climb.

## 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.

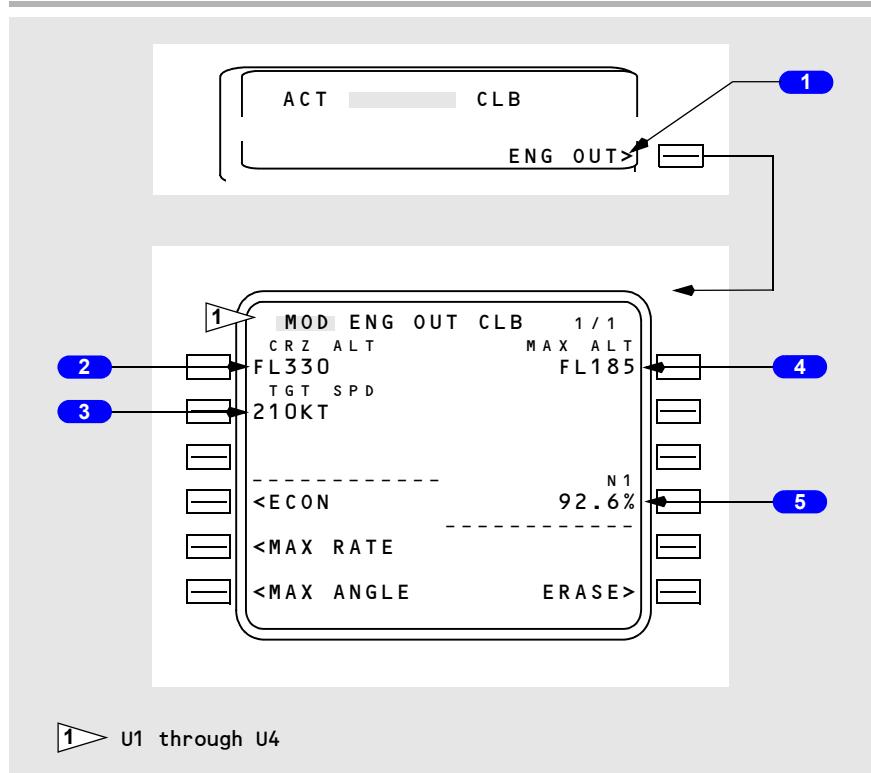
**6 N1**

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.



1 U1 through U4

### 1 Engine Out (ENG OUT)

Push – selects ENG OUT CLB page.

### 2 Cruise Altitude (CRZ ALT)

Displays the cruise altitude from either the PERF INIT or another CLB page.

### 3 Target Speed (TGT SPD)

Displays the optimum engine out climb speed.

### 4 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).

The computation is based on current gross weight and:

- wing and engine anti-ice OFF
- air conditioning pack switches AUTO above 17,000 feet
- engine bleed air switches OFF below 17,000 feet.

**5 N1**

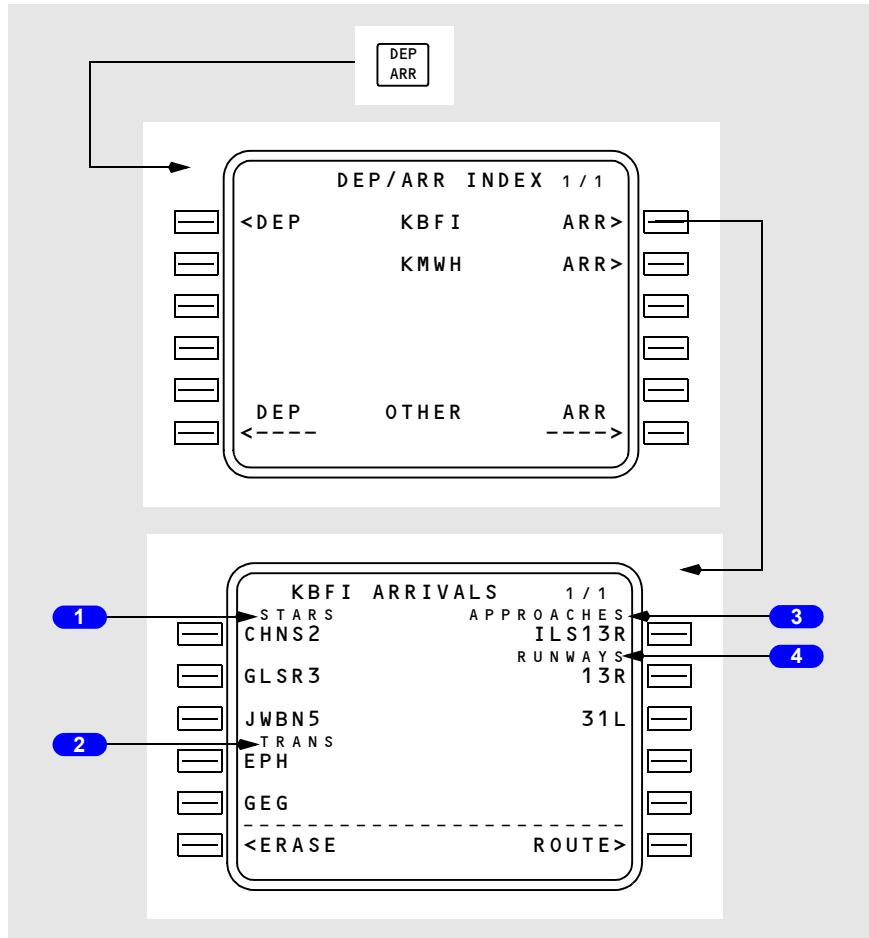
Displays N1 for maximum continuous thrust.

If the page is executed, this becomes the active N1 limit.

## 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)
- (U4 and On) 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
- 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.

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.

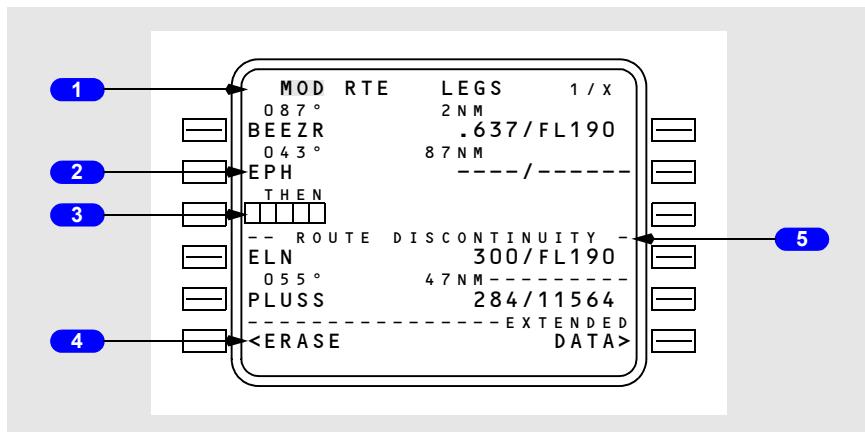
### Adding Waypoints

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.



#### 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**

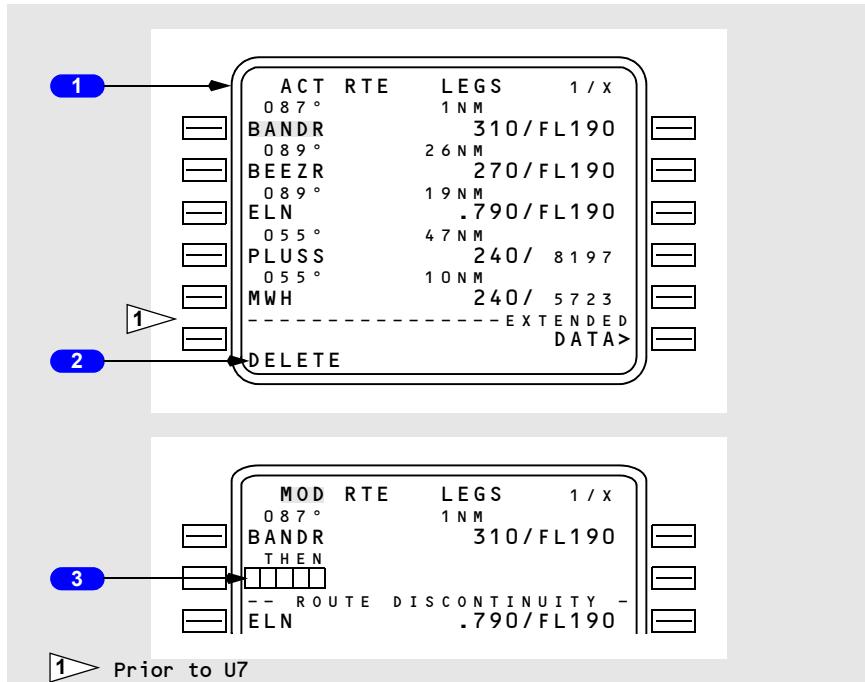
Indicates that the route is not continuous. Distance to destination on the PROGRESS page is not correct.

## 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)

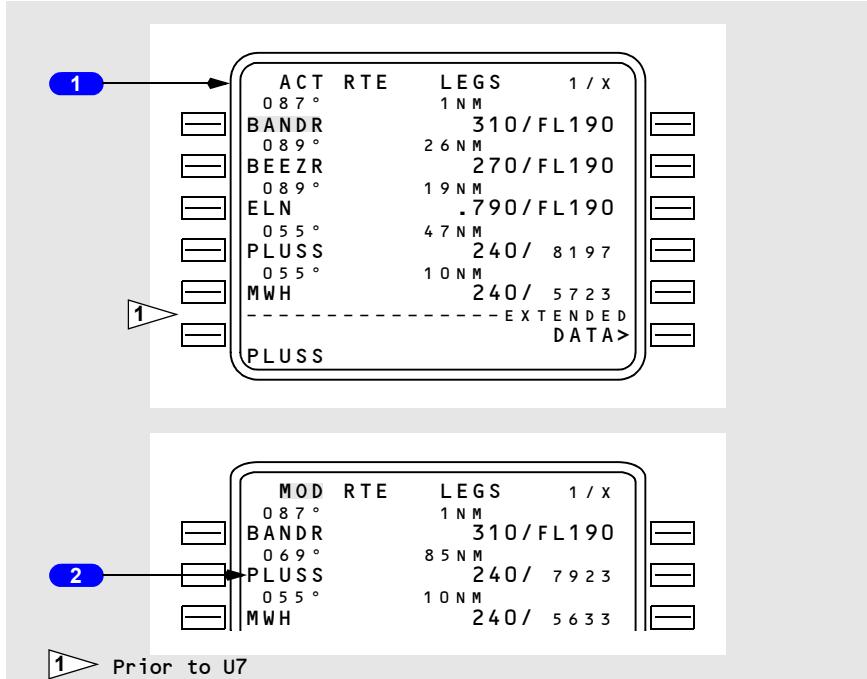
The existing route shows BANDR followed by BEEZR and ELN.

### 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.

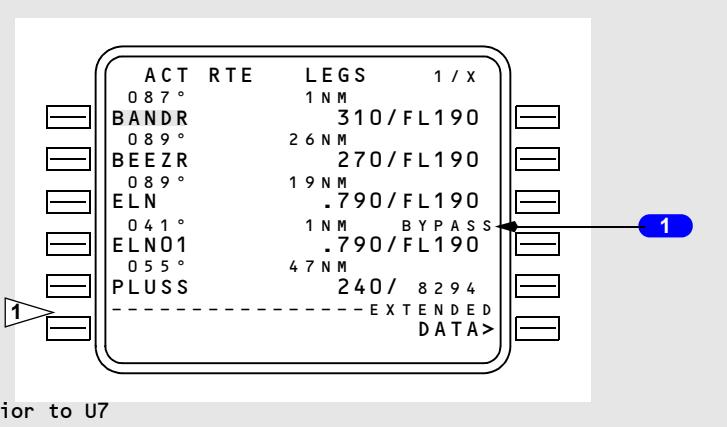
**Resequencing Waypoints****1 Active Route**

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

Prior to U7

### 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.

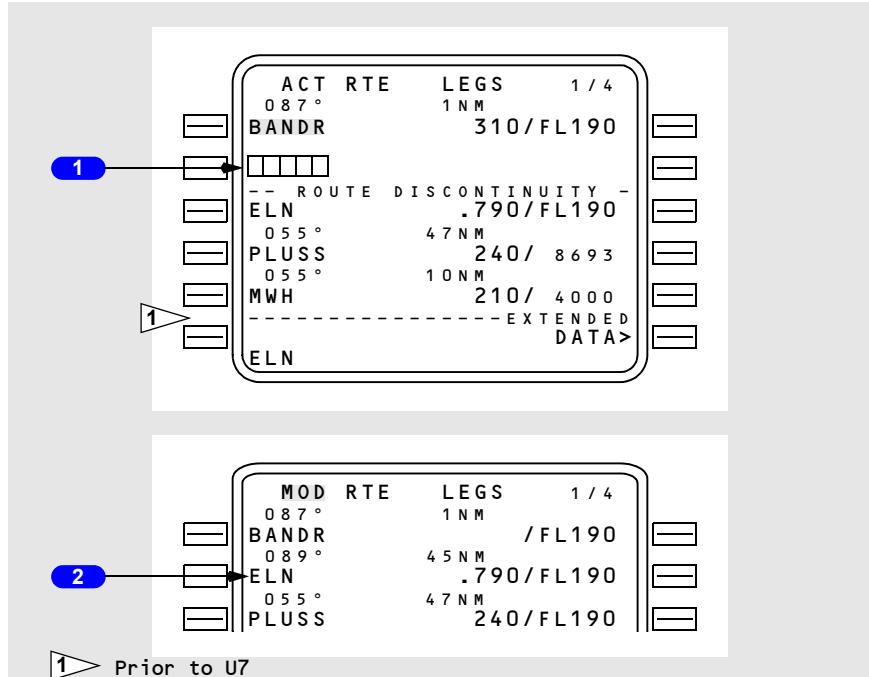
Any mandatory altitude-crossing restriction for the bypass waypoint is still observed if VNAV is engaged, based on passing abeam the waypoint.

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.

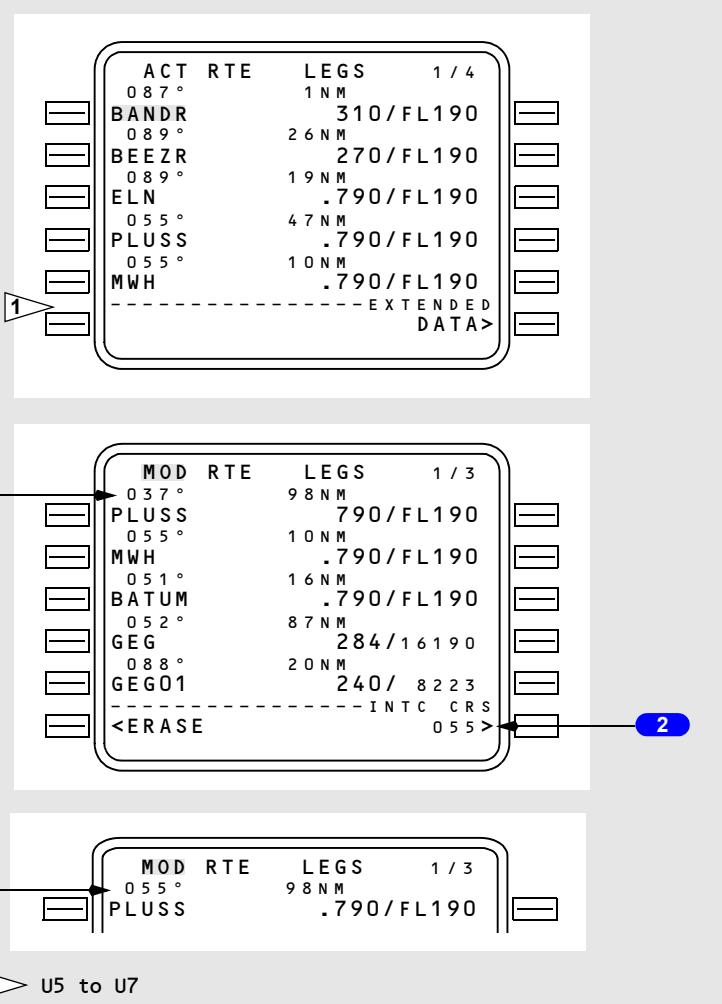
### 2 Continuous Route

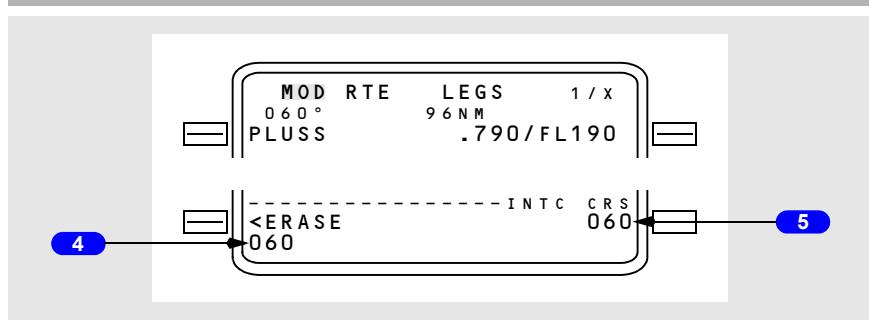
ELN is copied into the box prompts to remove the discontinuity.

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 (U5 and On)**

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.

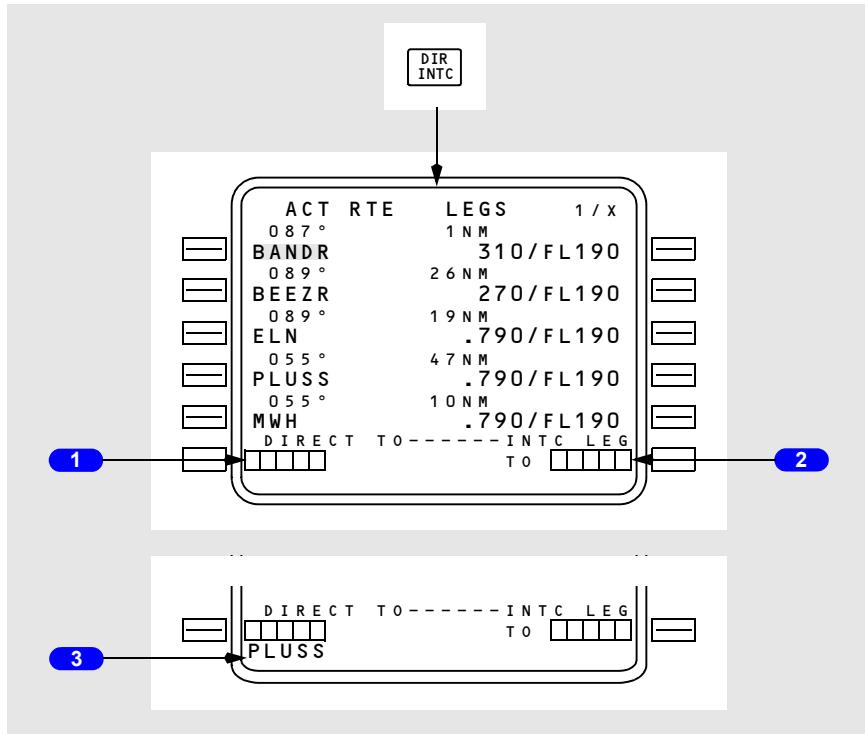
The example shows 060° intercept course to PLUSS entered in the INTC CRS line.

## 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.

On airplanes with U1 FMC, only waypoints already in the active flight plan may be selected.



### 1 DIRECT TO Boxes

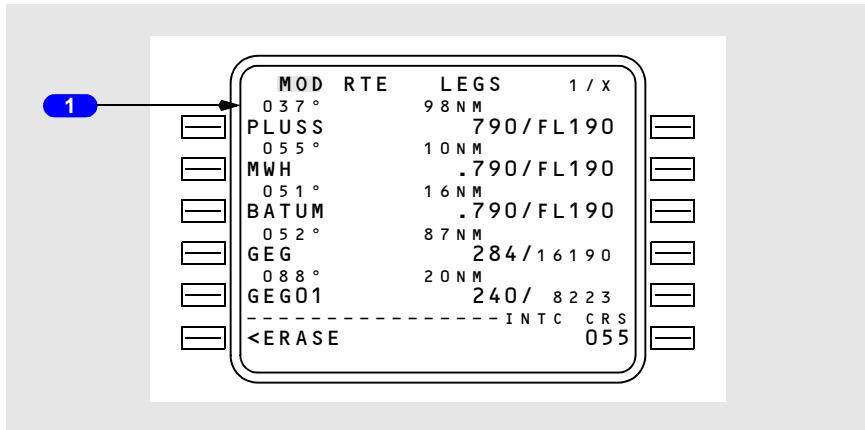
Entering the desired waypoint in these boxes makes that waypoint the active waypoint and establishes a course direct to the waypoint.

### 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. With a U1 FMC, the waypoint entered into the box prompts must be from the flight plan.

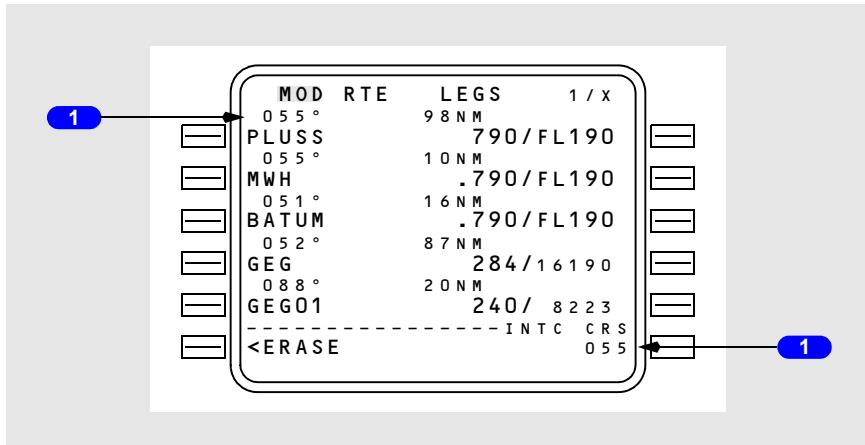
**3 Scratchpad Entry**

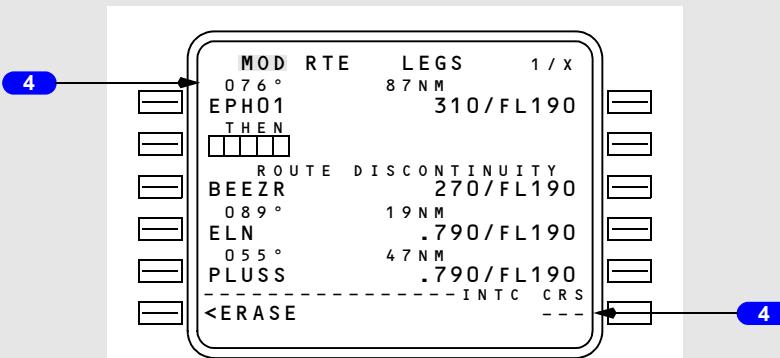
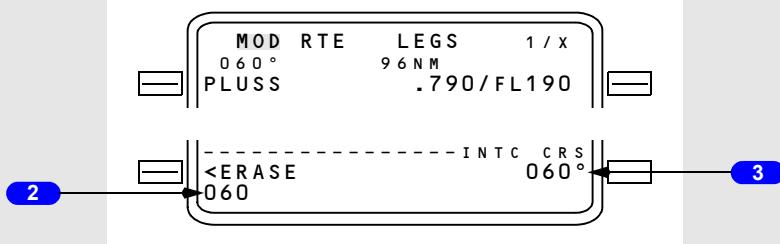
The desired waypoint is entered in the scratchpad, then line selected to the appropriate boxes.

**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.

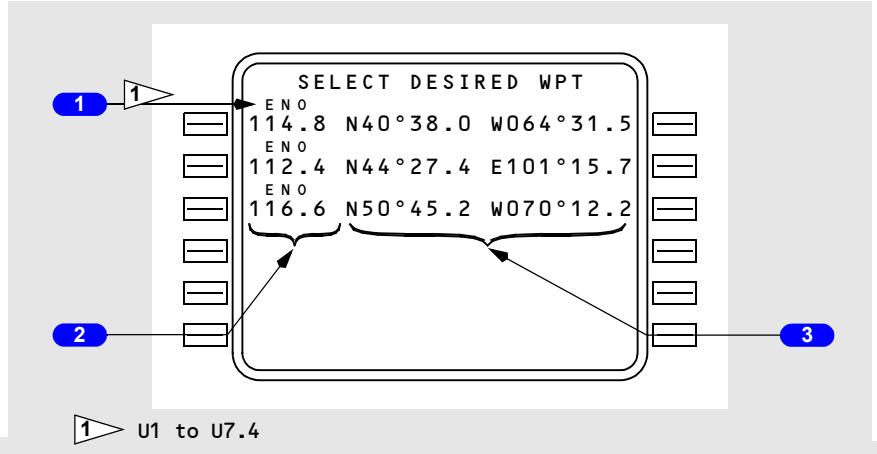
Intentionally  
Blank

## 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

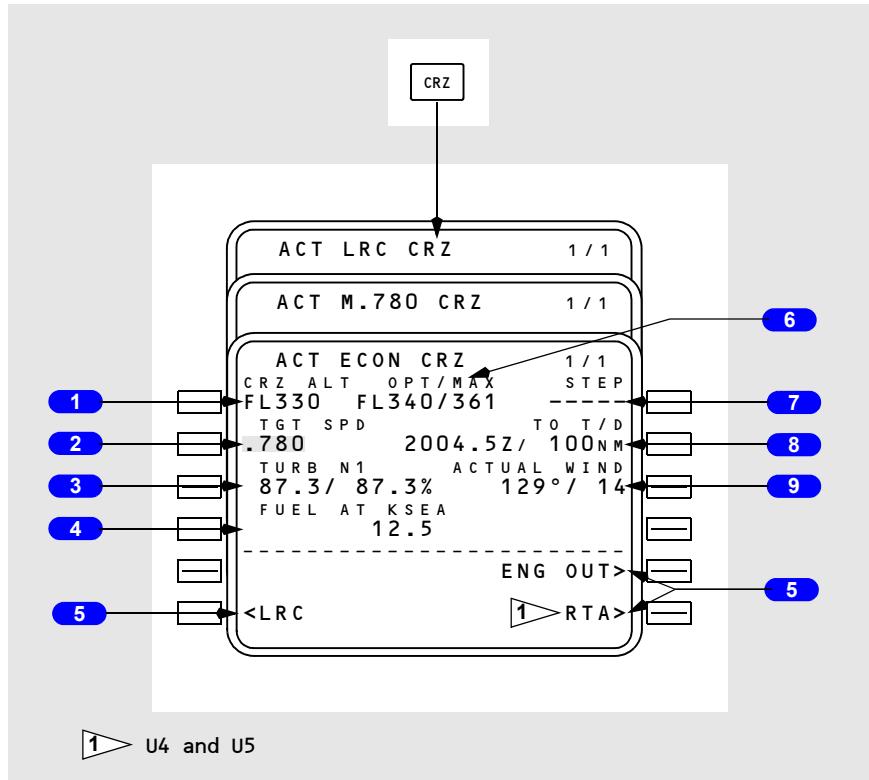
The latitude/longitude is displayed for each duplicate name.

Intentionally  
Blank

## 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.

(U4 and on) 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).

(U5 and on) 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.

(FMC U4 and prior) “STEP TO” is displayed on the data line.

**8 To Top of Descent (TO T/D)/To T/D Advisory (TO T/D ADVSRY)**

Displays time of arrival at and distance to top of descent point.

(U5 and on) 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.

(Prior to U5) TO T/D is displayed if a path descent is available.

(Prior to U5) To T/D advisory (TO T/D ADVSRY) is displayed if a path descent is not available.

**9 ACTUAL WIND/Estimated Wind (EST WIND)**

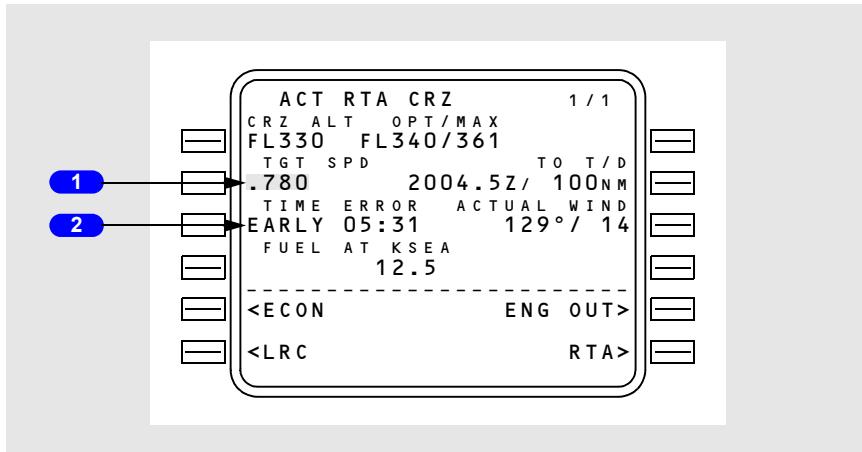
Displays computed or manually entered true wind for present altitude.

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 (U4 and On)**

If an RTA waypoint has been specified, the CRZ page will reflect the RTA data.

**1 Target Speed (TGT SPD)**

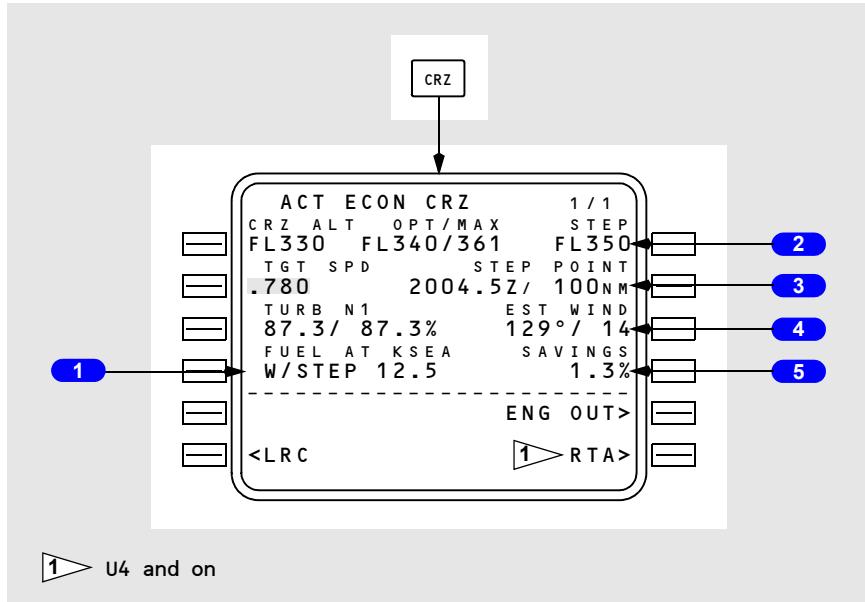
Displays the computed speed required to meet the RTA.

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.

(FMC U4 and Prior) Displays STEP TO on data line.

**3 STEP POINT**

(U4 and earlier) Displays the computed ETA at, and distance to, the optimum point at which to initiate the step.

(U5 and on) Displays the computed ETA at, and distance to, the first possible step climb point based on gross weight.

(U4 and earlier) Altitude entered is not evaluated for buffet margin criteria.

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.

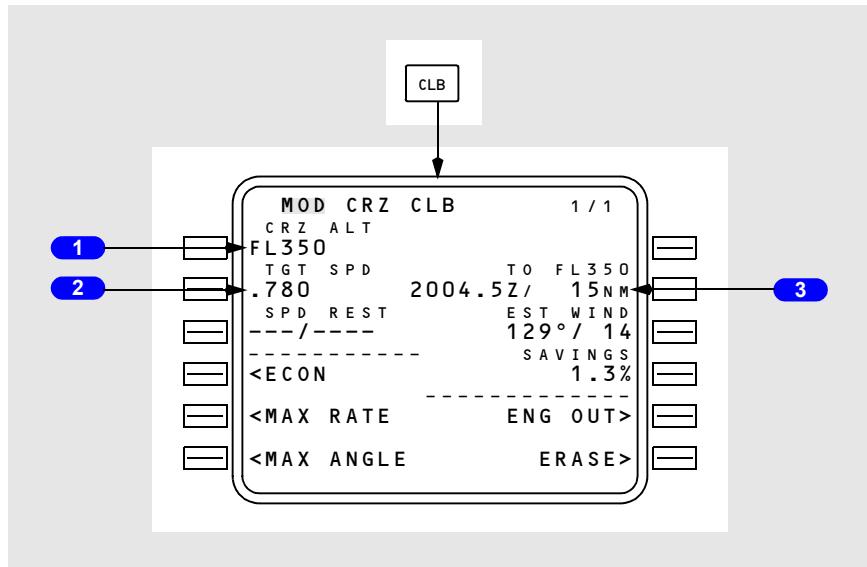
### Cruise Climb

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.

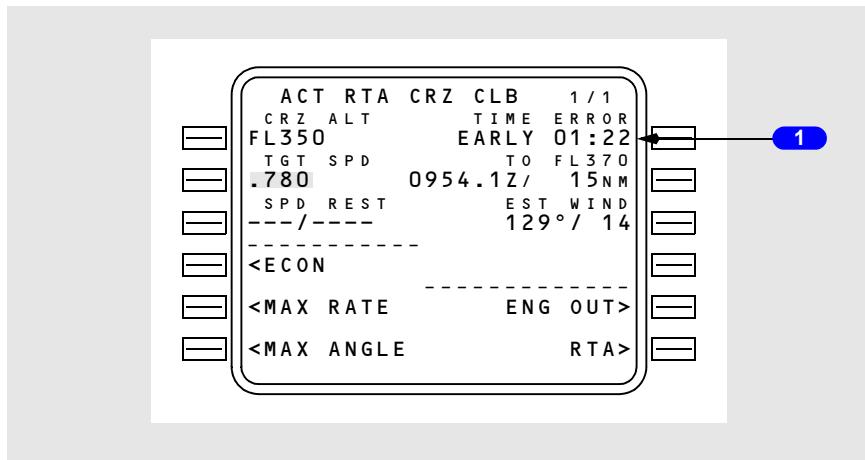
Manual entry may be made.

## 3 TO FLXXX

Displays ETA at, and distance to, the displayed cruise altitude.

## RTA Cruise Climb (U4 and On)

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.

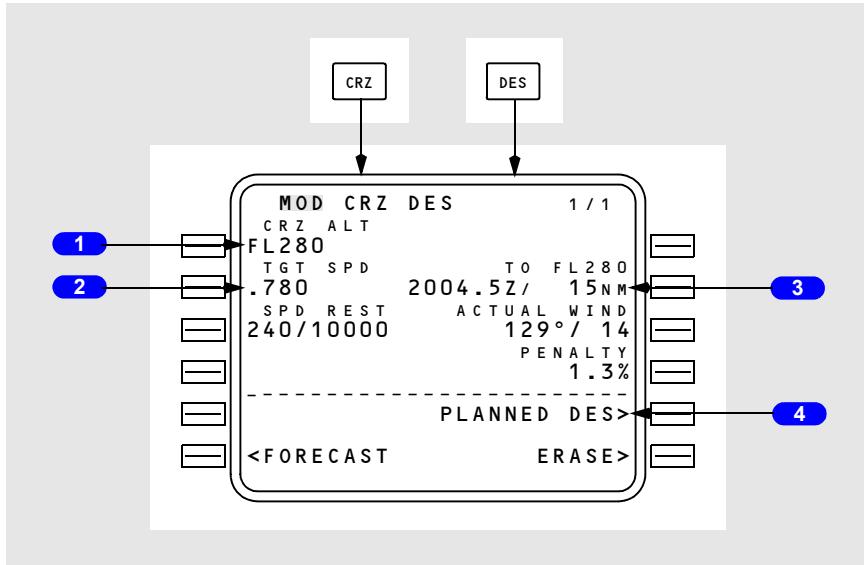
Same as time error on RTA PROGRESS page.

## 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

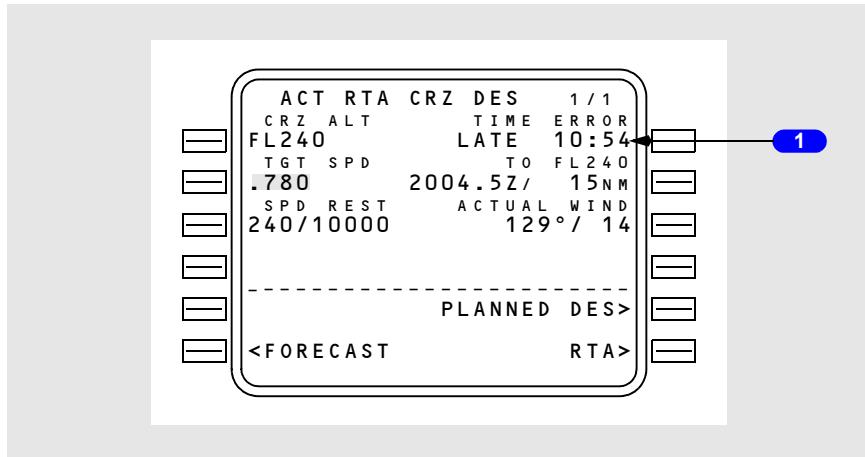
Displays ETA at, and distance to, the displayed cruise altitude.

### 4 Planned Descent (PLANNED DES)

Shows the planned DES page and allows access to the planned standard descent mode.

**RTA Cruise Descent (U4 and on)**

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.

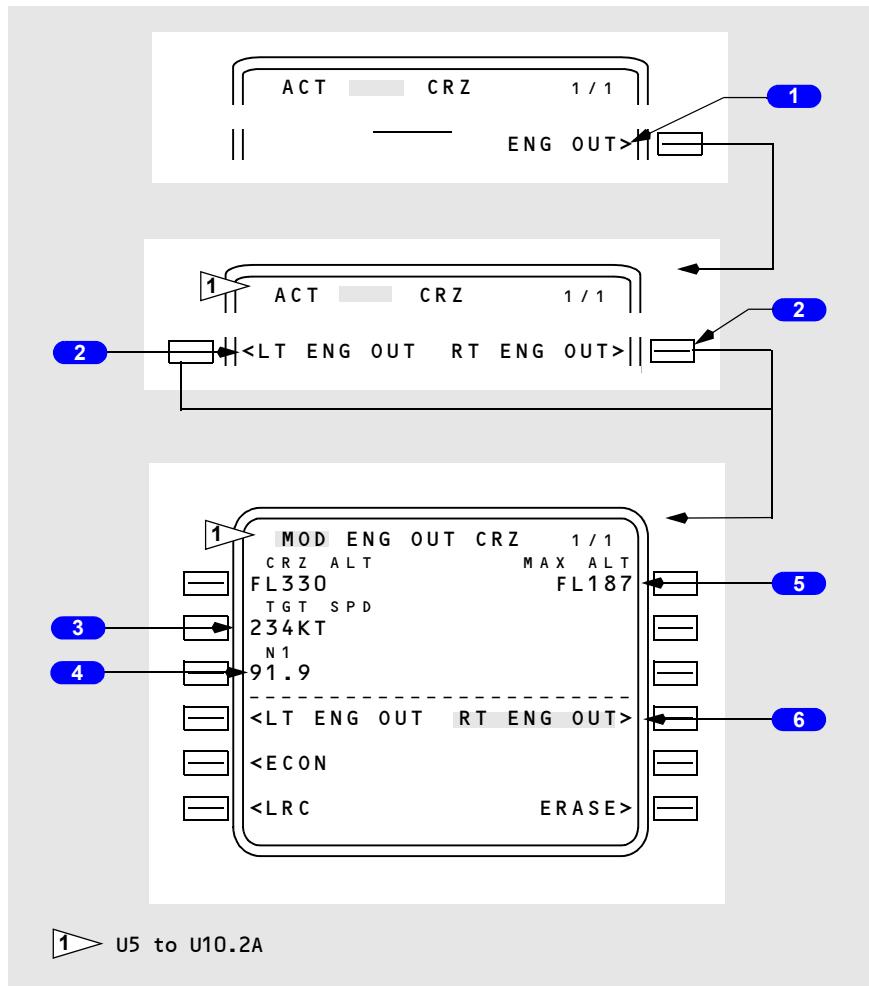
(U5 and on) The FMC accounts for current gross weight and actual bleed conditions.

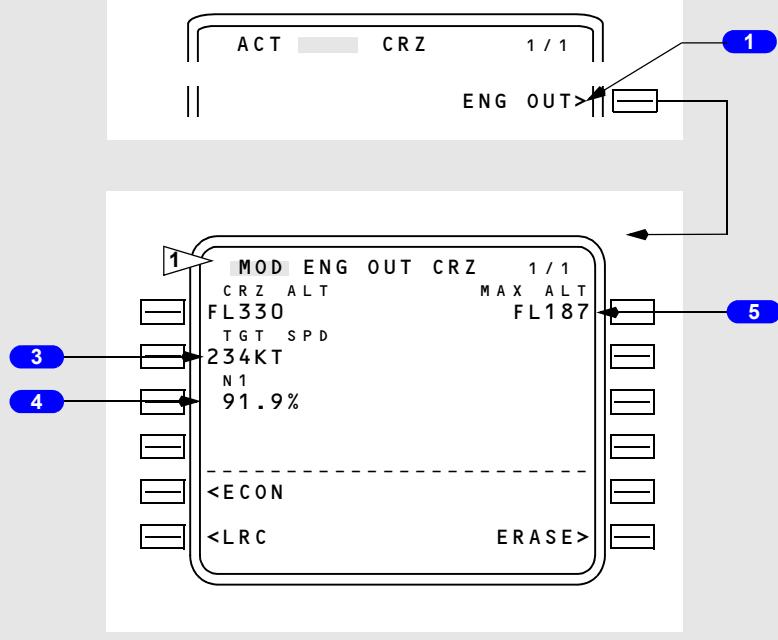
(U4 and earlier) The FMC accounts for:

- current gross weight
- wing and engine anti-ice OFF
- air conditioning pack switches AUTO above 17,000 feet
- engine bleed air switches OFF below 17,000 feet.

## 737 Flight Crew Operations Manual

When activated, all subsequent performance predictions are blanked and VNAV cannot be engaged.





1 ▶ U4 and prior

## 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.

(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.

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)

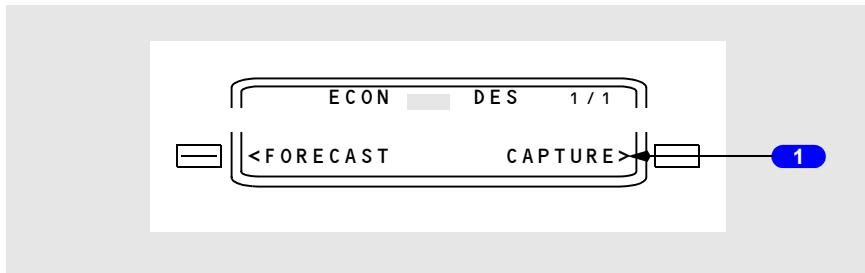
Selected engine out is shown in reverse highlighting.

## 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. (U1 to U4) This is the only way to begin a speed descent.

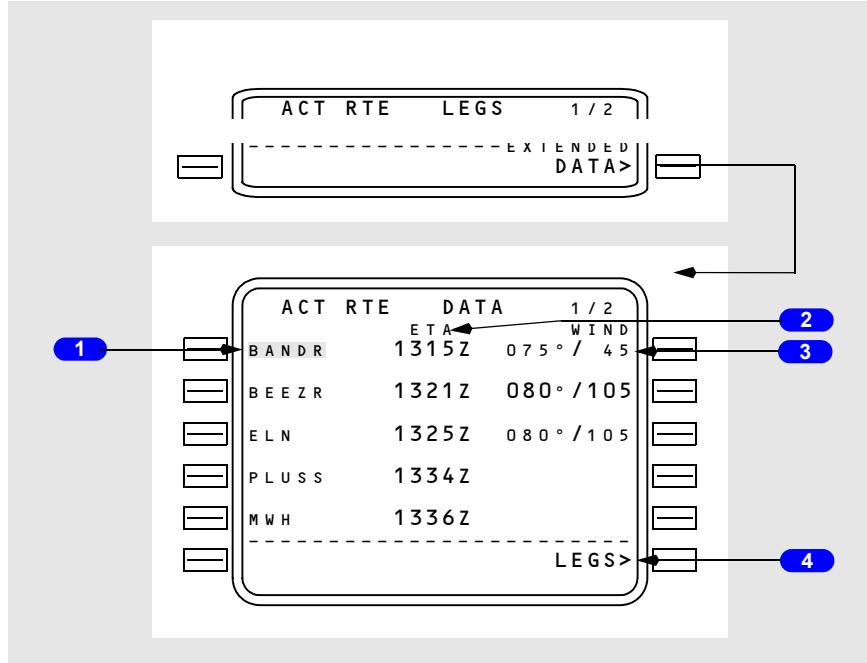
Intentionally  
Blank

## 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 (U3 and on) propagates to all down path cruise waypoints (an entry of 080°/105 at BREEZR is depicted). The entry must be executed.

(U3 and On) 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.

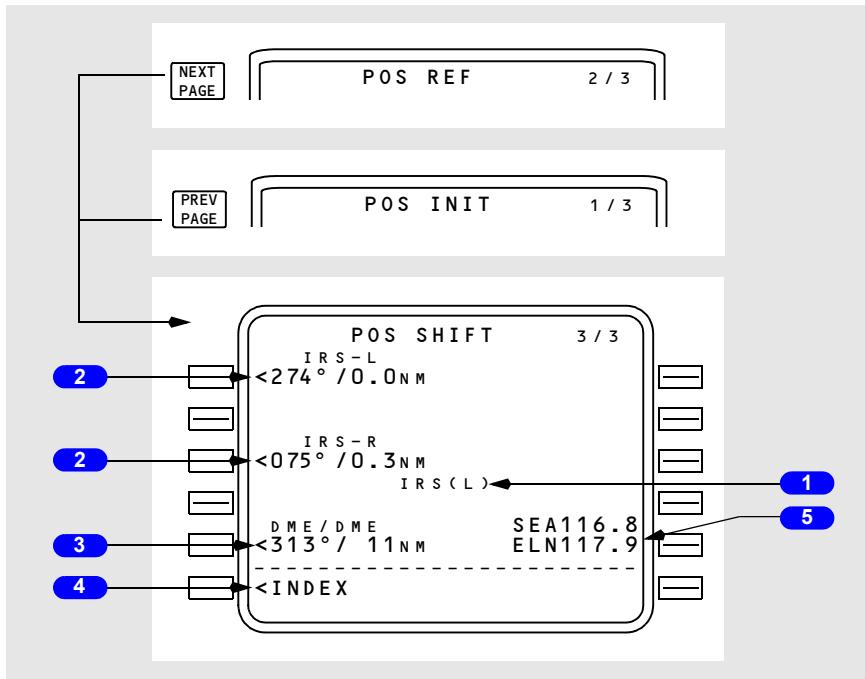
#### **4 LEGS**

Selection displays the RTE LEGS page.

## Position Shift Page (U4 and On)

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 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.

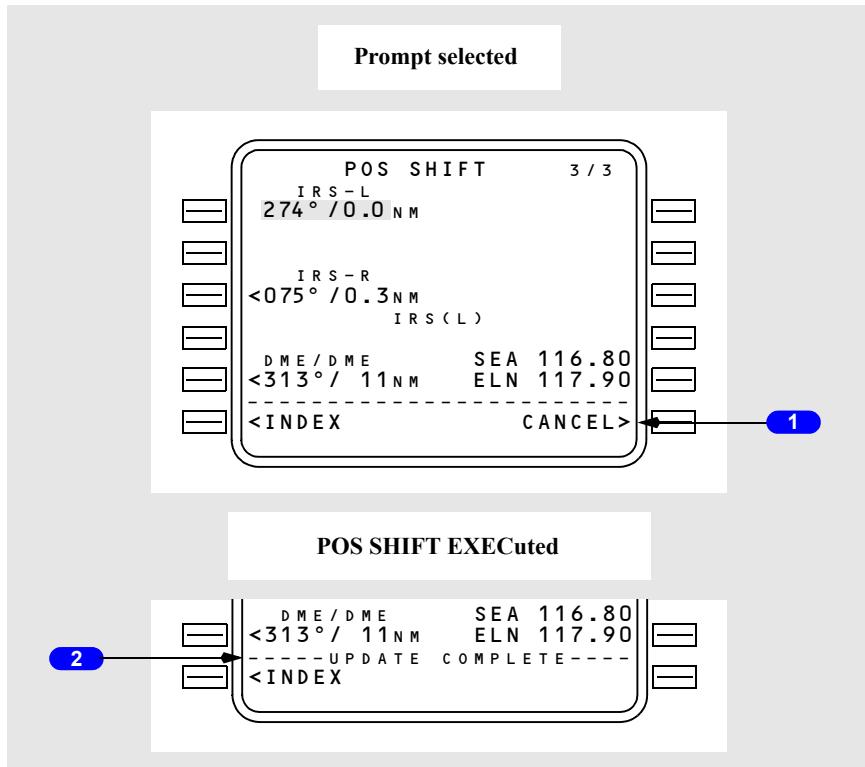
#### 5 Radio Identifiers

Displays navaid identifiers and frequencies being used for position updating.  
Blank if radio position is invalid.

### Inflight Position Update (U4 and On)

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.



**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

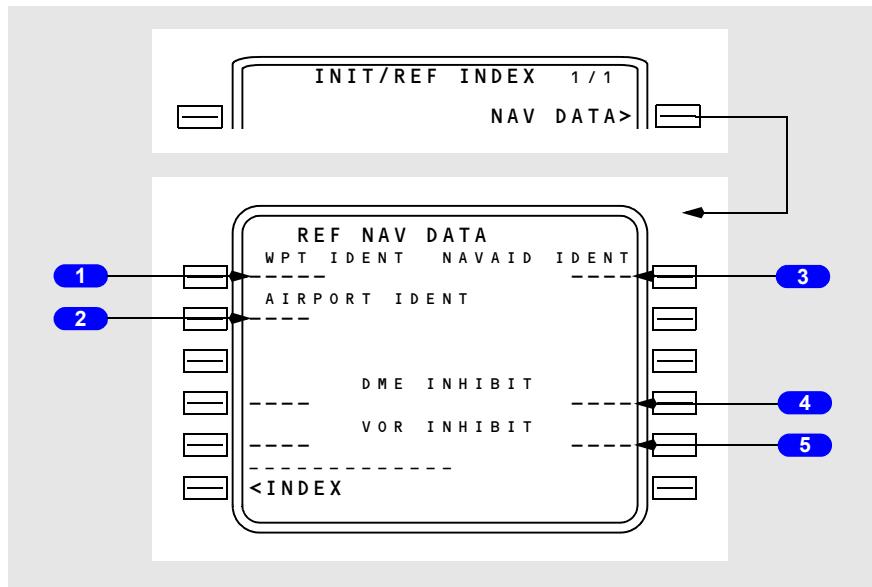
The REF NAV DATA page provides information about waypoints, navaids, airports, and runways. Entering the appropriate identifier initiates the display.

(U3 and on) 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 “RWnn” 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.

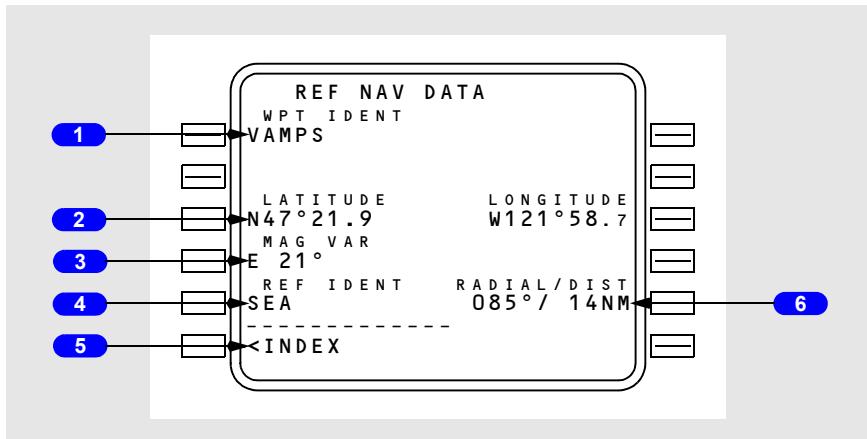
Any associated VOR can still be used for FMC position updating out to 25NM from the station.

## **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.

## 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.

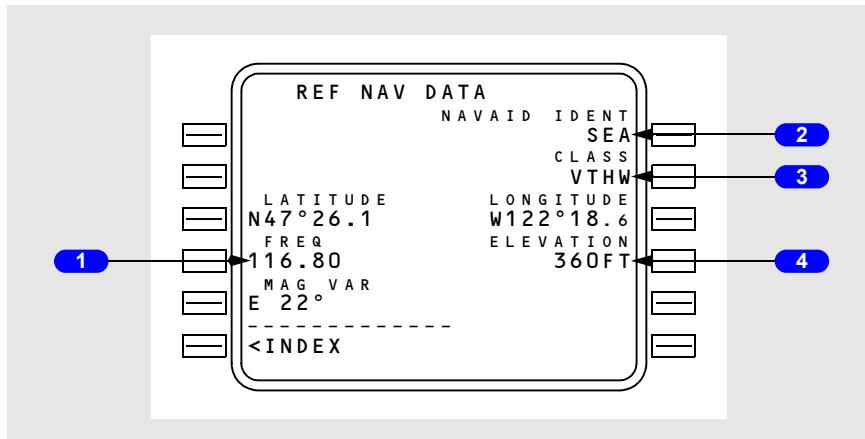
### 5 INDEX

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.

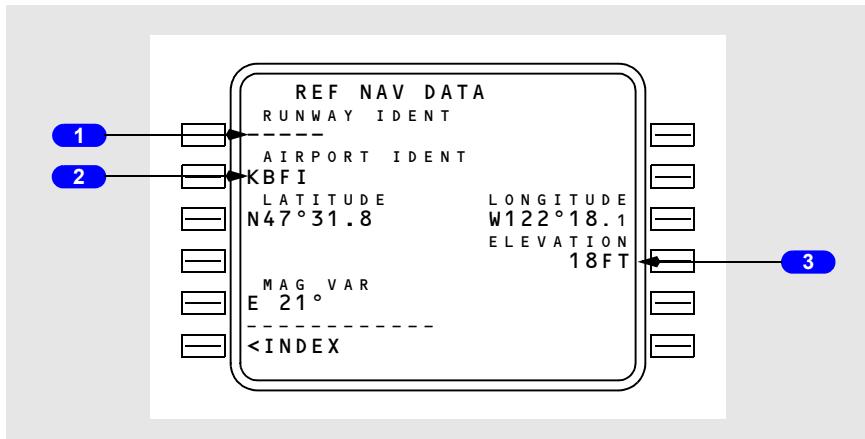
### 3 Classification (CLASS)

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) (U3 and on)**

Permits entry of runway identifier.

### **2 Airport Identifier (AIRPORT IDENT)**

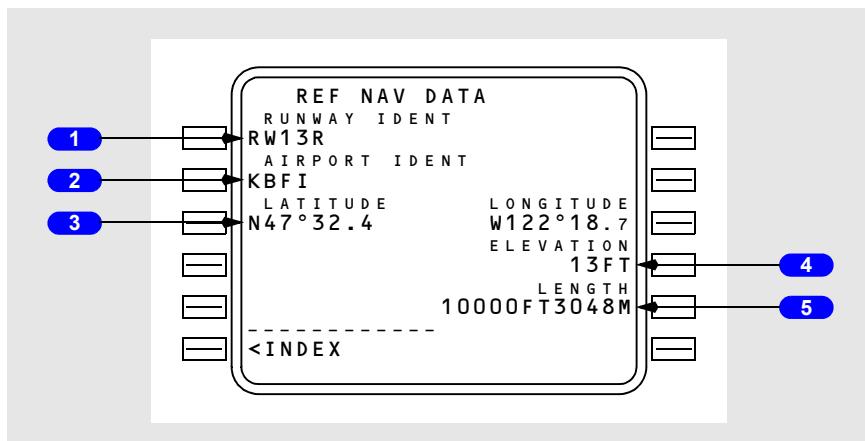
Displays airport identifier.

### **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 as a waypoint on the REF NAV DATA page or, (U3 and on) on the airport data display 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

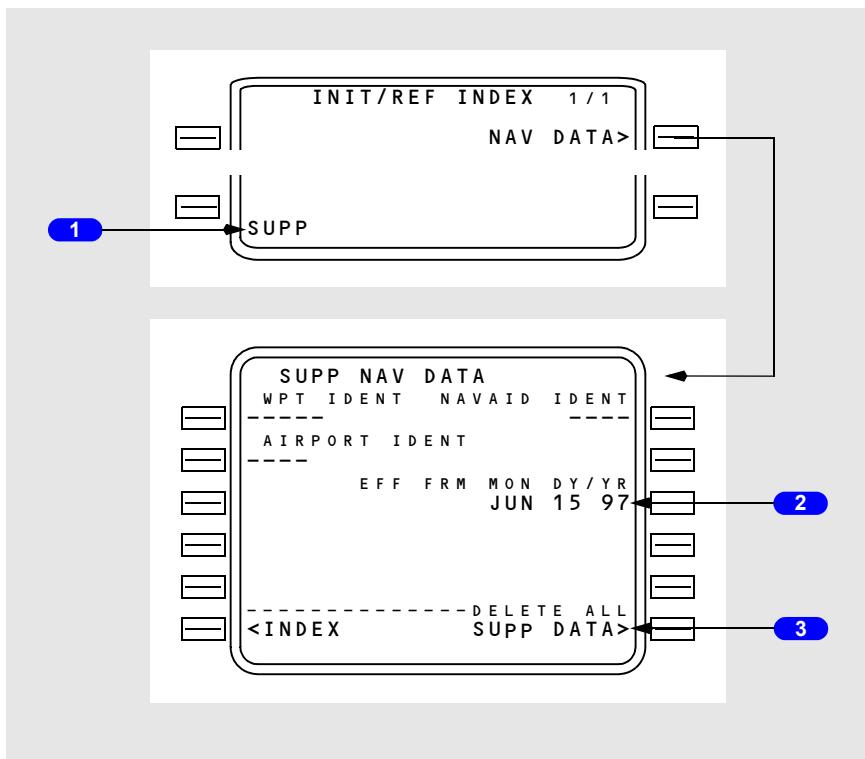
Displays elevation (feet above MSL) of the entered runway.

### 5 Runway Length (LENGTH)

Displays length of entered runway in feet and meters.

(U1) Displays length of entered runway in feet.

## Supplemental Nav Data (U3 and On)



### 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)

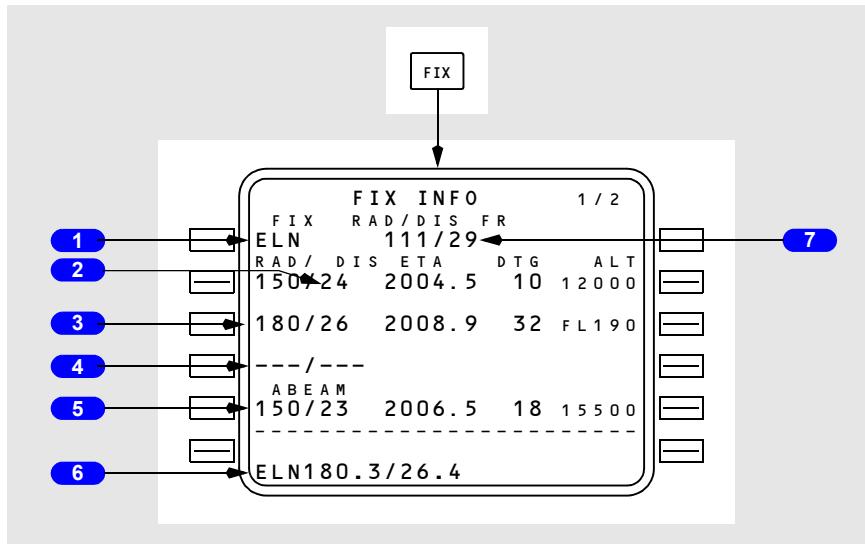
Allows entry of month, day, and year that the supplemental database becomes valid. The date will be displayed on the IDENT page after entry. Box prompts are displayed if an effectivity date is not entered.

### 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.

## **Fix Information Page**

Two identical FIX INFO pages are used to identify waypoint fixes. 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.

### **2 Distance Entry (DIS)**

(U1) RAD/DIS is replaced by DNTKFX.

Enter a distance from 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 /
- (U1) distance only entries do not need a slash
- 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.

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. ETA and ALT fields will be blank.

**5 ABEAM**

Displays the abeam point and calculates the ETA, DTG, and ALT information.

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.

(U1) Bearing/Distance From (BRG DIS FR) displays the bearing and distance from the fix to the airplane.

Intentionally  
Blank

**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**

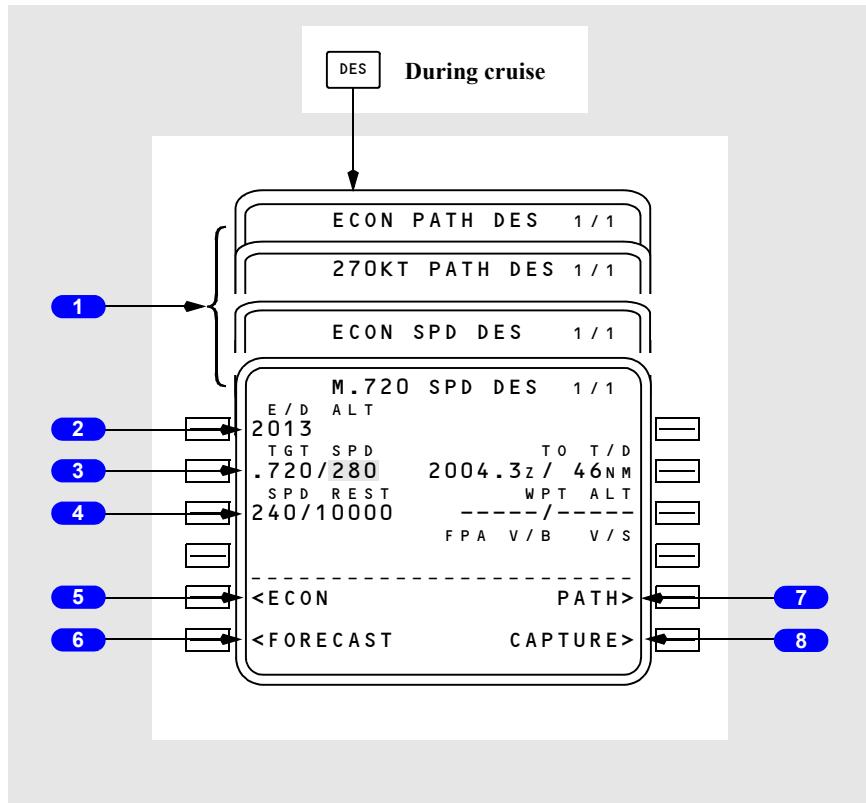
During descent, LNAV progress is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

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, (U5 to U10.5A) the lowest “at” altitude constraint, whichever is lower.

(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.

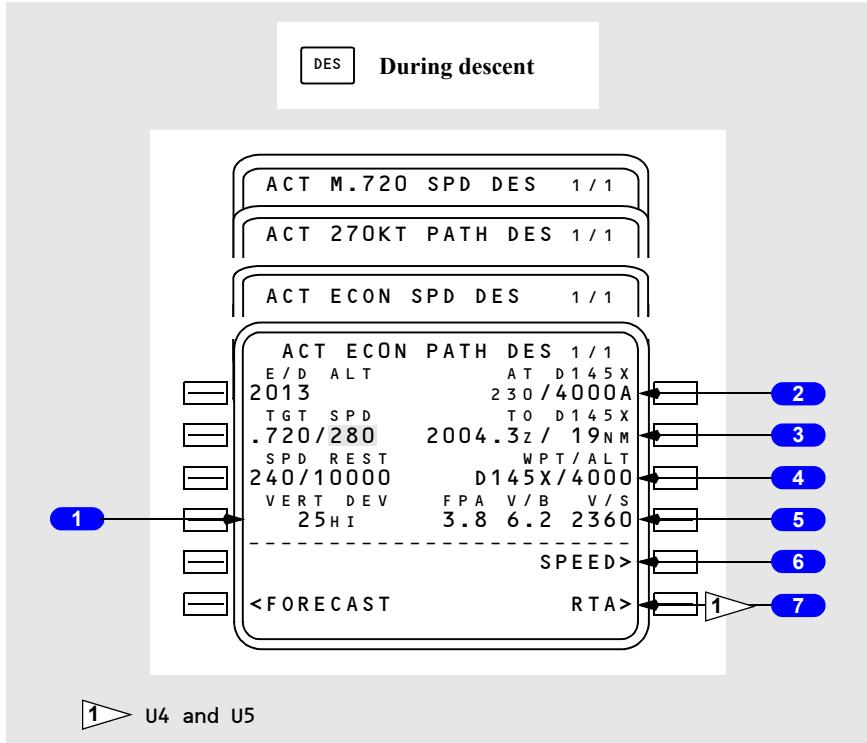
Push – arms the CAPTURE function and illuminates the EXEC light.

Execution allows early initiation of PATH descent at 1000 fpm until intercepting the computed path.

Execution is the only way to initiate a SPD descent or (U5 and on) 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 or, (U4 and earlier) T/D ADVSRY 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.

(U4 and earlier) The display is blank for all SPD DES pages unless 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.

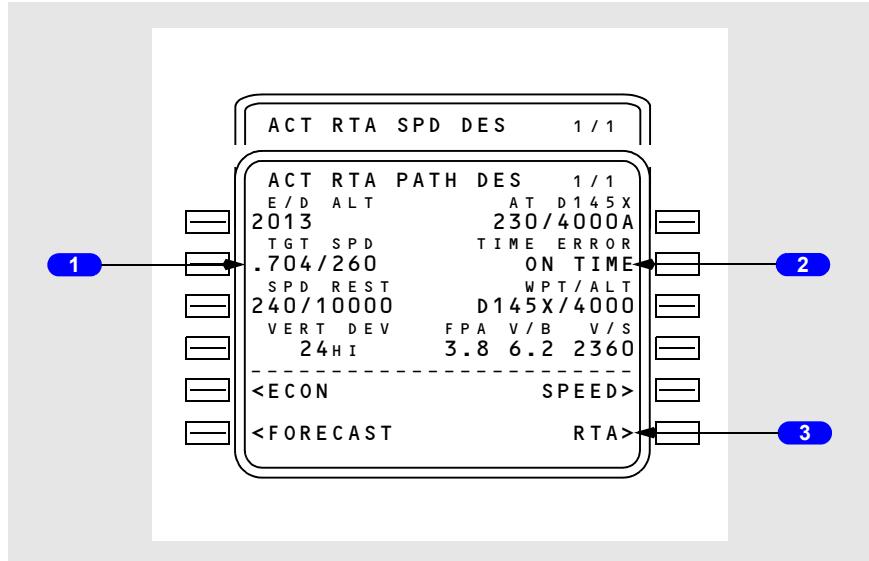
### 7 RTA

Displayed when CAPTURE or ERASE prompt is not displayed.

Push – selects the RTA PROGRESS page.

## RTA Descent Page (U4 and On)

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.

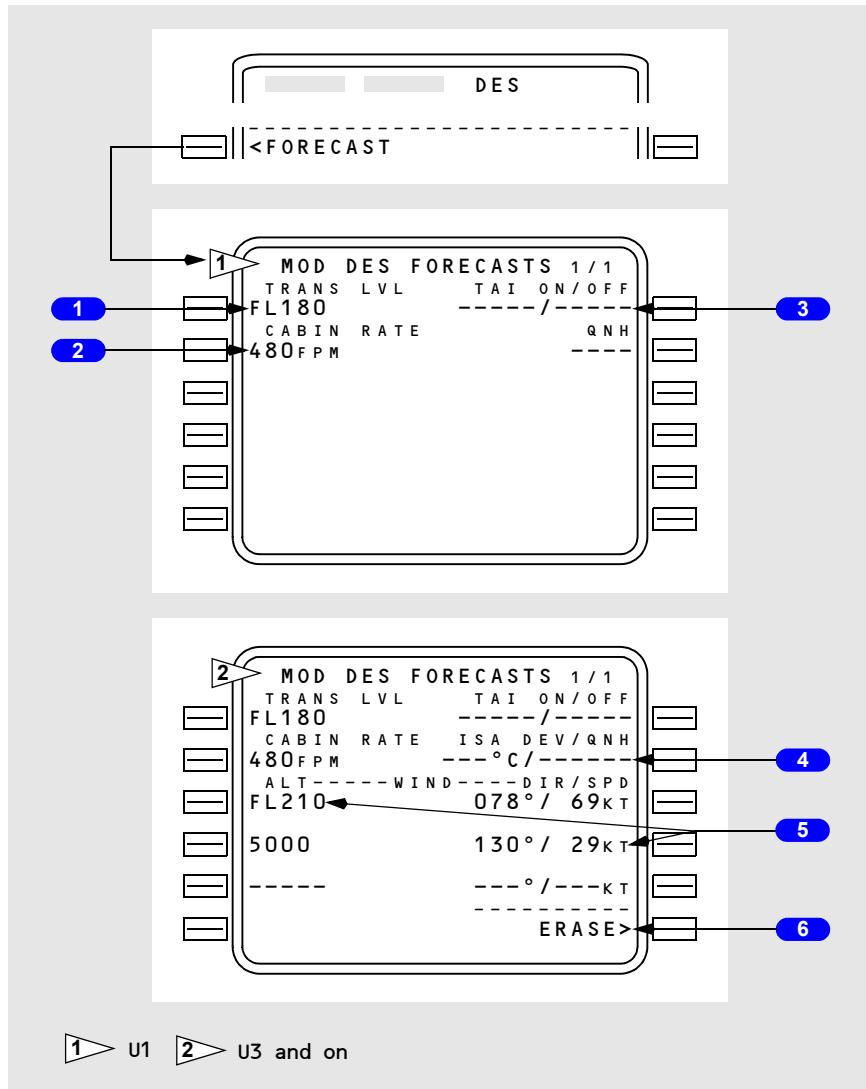
### 3 RTA

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 (U3 and on) 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.

(U4 and earlier) FMC computations assume thrust at high idle between these altitudes.

(U5 and on) 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:

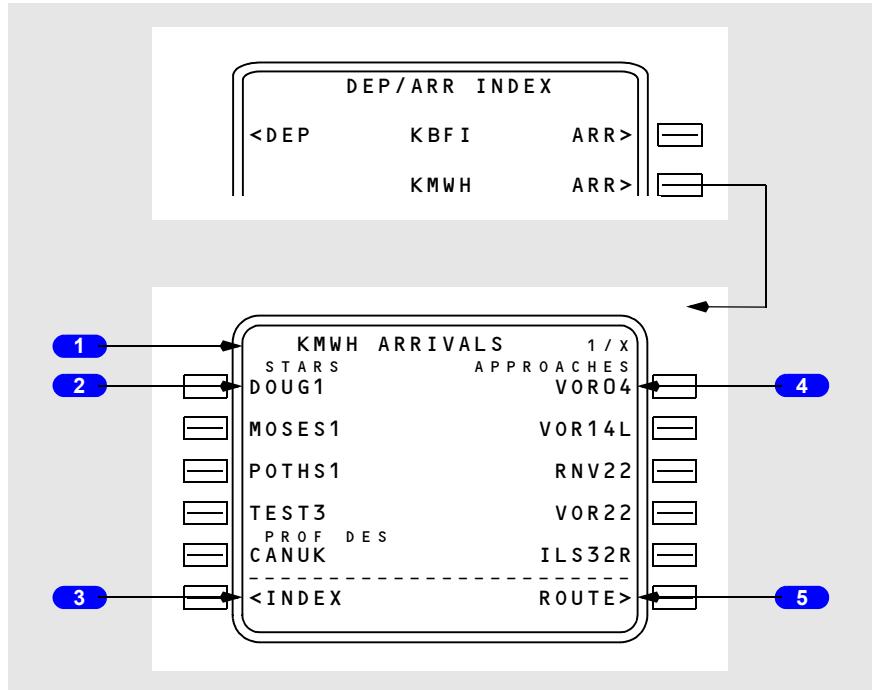
- APPROACH REF page – to select the approach VREF
- ARRIVALS page – to select the desired arrival and approach procedures
- HOLD page – to manage holding patterns.

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.

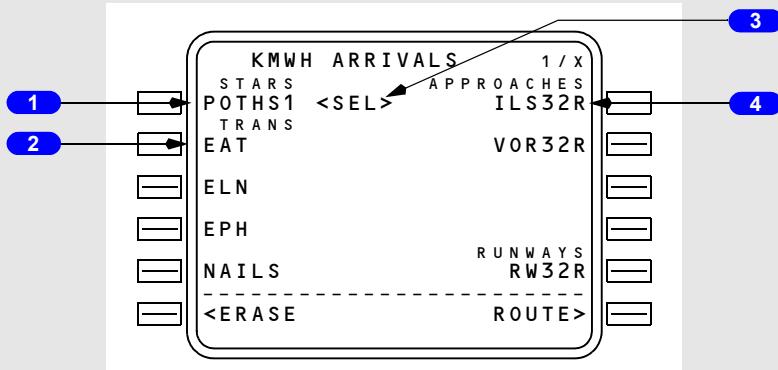
Selection of the desired approach or runway deletes all other approaches/runways.

**5 ROUTE**

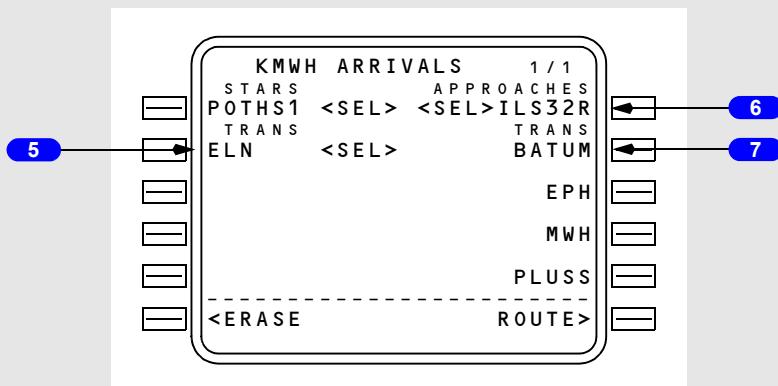
Push – displays the RTE page.

## Arrivals Page during approach selection

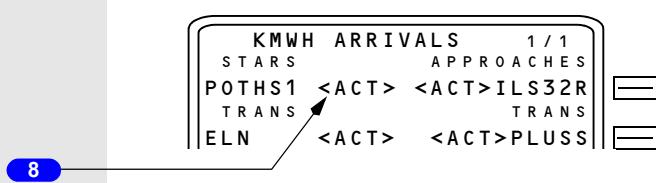
Display after STAR selected



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.

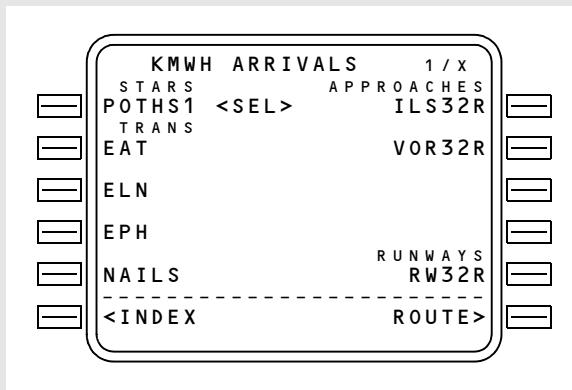
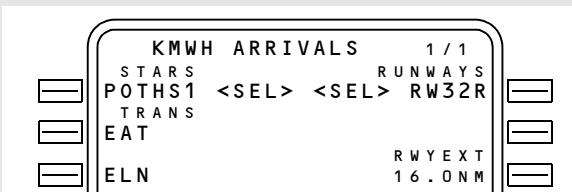
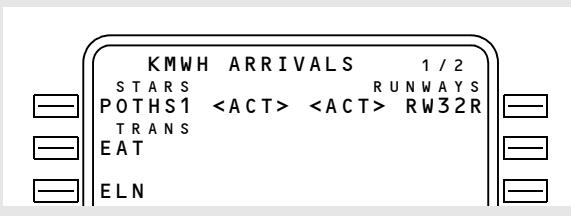
**7 Approach Transition (TRANS)**

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 (U5 to U10.5A)****Initial display****Display after runway 32R selected****Display after runway 32R extension inserted****Display after execution**

---

## 1 Runway Extension (RWY EXT)

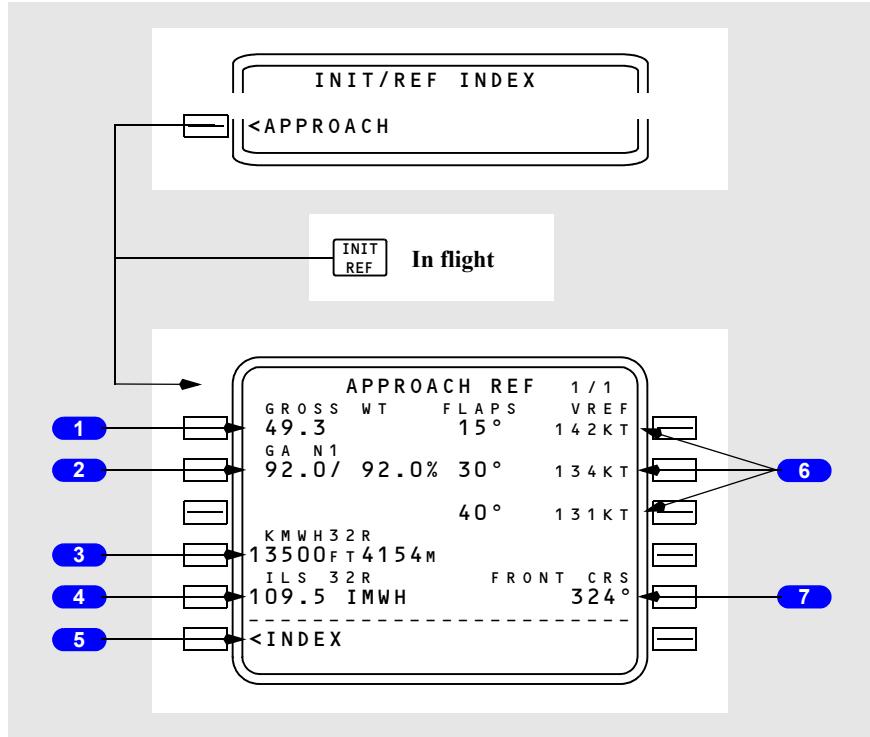
Permits entry of runway extension waypoint following selection of desired runway.

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. With FMC U3 and on, the displayed data is for the DEST airport and the arrival/approach entered into the FMC flight plan. With U1 FMC, the displayed data is for the ORIGIN airport and departure runway until 50 NM after takeoff (or until halfway to a nearby destination); the data then changes to the DEST airport and arrival runway.



### 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.

(U1) Displays the length of the referenced runway in feet.

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.

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.

## 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.

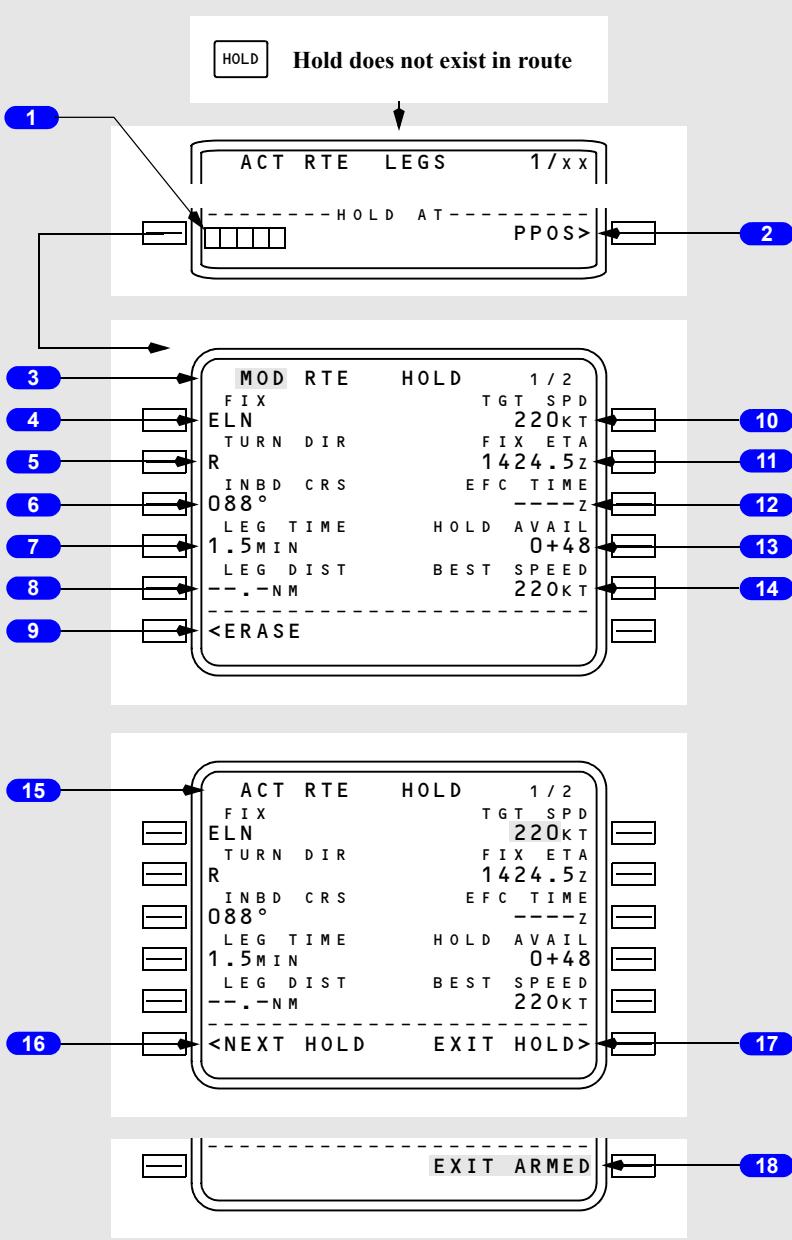
Two versions of the hold page are possible:

- 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.

With FMC U3 and on, pushing the HOLD key when a holding pattern already exists in the route displays the hold page for the next hold. With U1 FMC only one holding pattern can exist at a time. 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 (U3 and On)**

Displayed with FMC U3 and on 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.

With FMC U3 and on, a maximum of five holding patterns may exist at one time. With U1 FMC, only one holding pattern can exist at a time.



Proposed holding fix in current route; no holding pattern currently exists in route

1

2

3

ACT	RTE	LEGS	1 / XX
0 8 7 °		1 1 N M	
BANDR		3 1 0 / FL 1 9 0	
0 8 9 °		3 2 0 / FL 1 9 0	
BEEZR		3 2 0 / FL 1 9 0	
0 8 9 °		3 2 0 / FL 1 9 0	
ELN		3 2 0 / FL 1 9 0	
0 6 9 °		2 4 0 / 6 2 7 9	
D182X		2 4 0 / 6 2 7 9	
0 9 2 °		2 4 0 / 5 3 5 2	
D160X		2 4 0 / 5 3 5 2	
	HOLD AT		
	ELN	P POS >	



After executing route hold at downtrack waypoint

4

ACT	RTE	LEGS	1 / XX
0 8 7 °		1 1 N M	
BANDR		3 1 0 / FL 1 9 0	
0 8 9 °		3 2 0 / FL 1 9 0	
BEEZR		3 2 0 / FL 1 9 0	
0 8 9 °		3 2 0 / FL 1 9 0	
ELN		3 2 0 / FL 1 9 0	
HOLD AT			
ELN		2 2 5 / FL 1 9 0	
0 6 9 °		2 4 0 / 6 2 7 9	
D189X		2 4 0 / 6 2 7 9	
		EXTENDED DATA >	

**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
087 °		11 NM	
BANDR		310 / FL190	
089 °		26 NM	
BEEZR		320 / FL190	
089 °		19 NM	
ELN		320 / FL190	
069 °		42 NM	
D182X		240 / 6279	
092 °		4 NM	
D160X		240 / 5352	
			----- EXTENDED DATA >
			HOLD AT PLUSS

**1**

After line selecting the desired LEGS page sequence and executing the off route hold

ACT	RTE	LEGS	1 / xx
067 °		96 NM	
PLUSS		310 / FL190	
HOLD AT		220 / FL190	
PLUSS			
THEN			
			----- ROUTE DISCONTINUITY -----
			BANDR 320 / FL190
			089 ° 26 NM
			BEEZR 320 / FL190
			----- EXTENDED DATA >

**2**

**3**

### **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

## **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

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 FLIGHT**Flight Management, Navigation -  
FMC/CDU Messages

## 737 Flight Crew Operations Manual

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.

## 737 Flight Crew Operations Manual

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.

## 737 Flight Crew Operations Manual

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 FLIGHT**Flight Management, Navigation -  
FMC/CDU Messages

## 737 Flight Crew Operations Manual

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.

**DO NOT USE FOR FLIGHT**Flight Management, Navigation -  
FMC/CDU Messages

## 737 Flight Crew Operations Manual

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.

**DO NOT USE FOR FLIGHT**Flight Management, Navigation -  
FMC/CDU Messages

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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.

# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Fuel**

### **Chapter 12**

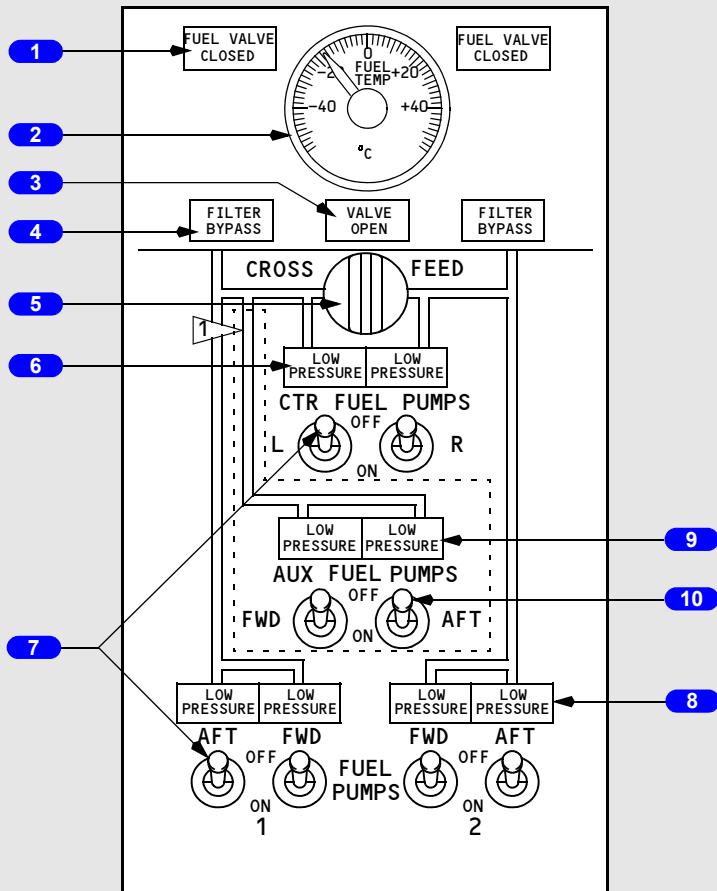
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#### Fuel Control Panel



1 ▶ As installed

#### 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.

### 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.

### 9 Aux Tank Fuel Pump LOW PRESSURE Light

Illuminated (amber) – fuel pump output pressure is low, and the FUEL PUMP switch is ON.

**Note:** Illumination of two LOW PRESSURE lights illuminates the 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.

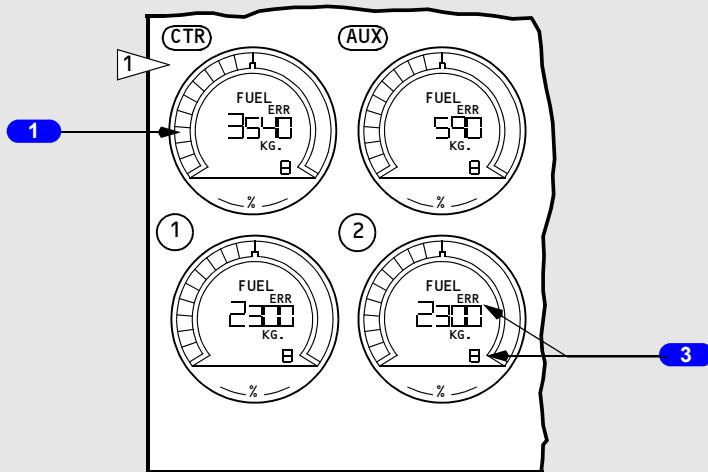
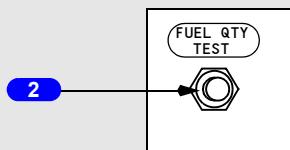
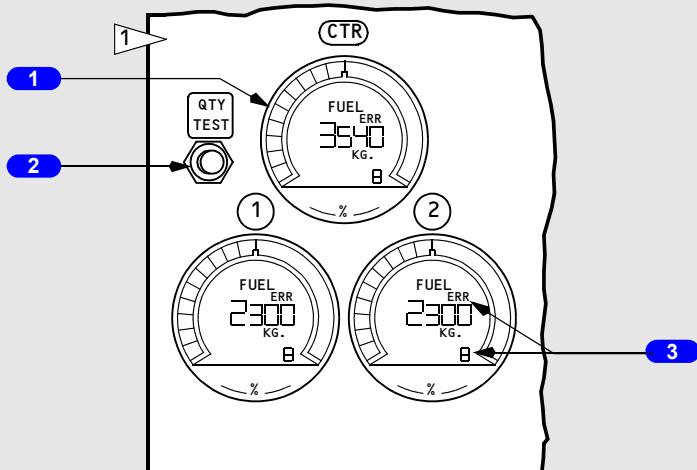
Extinguished – fuel pump output pressure is normal, or the FUEL PUMP switch is OFF.

### 10 Aux Tank FUEL PUMP Switch

ON – activates fuel pump.

OFF – deactivates fuel pump.

## Fuel Quantity Indications



As installed

**CENTER INSTRUMENT PANEL**

### 1 Fuel Quantity Indicator

- indicates usable fuel in the related tank
- standby AC power is required.

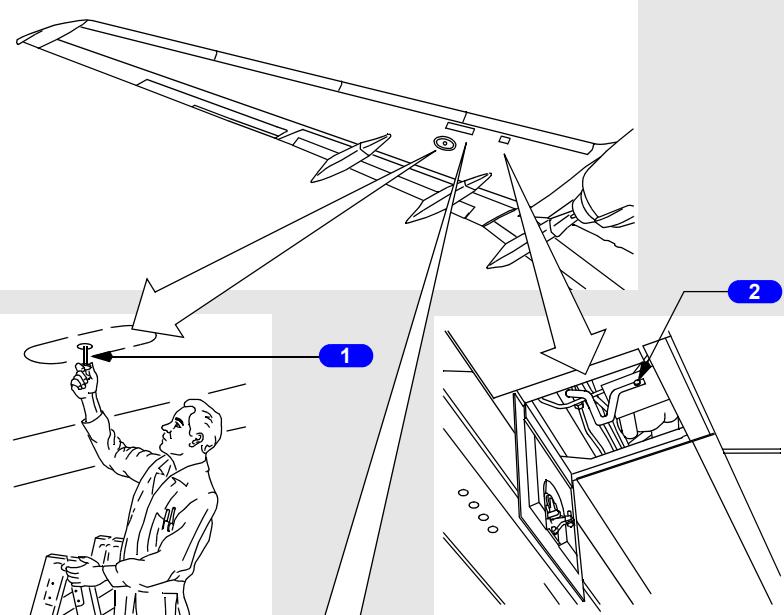
### 2 Fuel Quantity Test (QTY TEST) Switch

Indicator test is described in Supplementary Procedures.

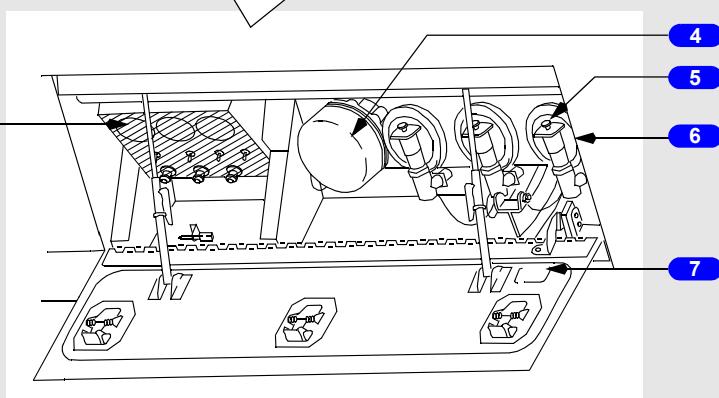
### 3 Error (ERR) Indicator

- 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 measuring stick from tank until a steady drip of fuel commences at the drip hole near the base.

**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**

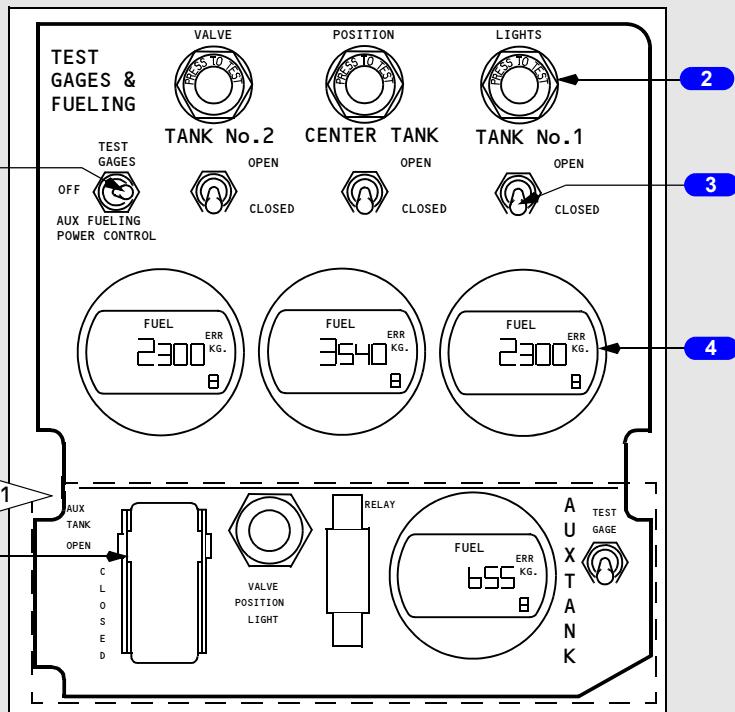
With battery switch ON, fuel pressure opens valve, if energized.

**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



As installed

**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.

### 5 AUX TANK Fueling Valve Switch

Controls refueling of the aft body auxiliary tank.

Raise – the crossfeed selector is overridden, and the crossfeed valve opens.

Intentionally  
Blank

## 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

TANK	LITERS	KILOGRAMS*
AUXILIARY (as installed)	1,476	1,185
TOTAL	21,579	17,324

\* Usable fuel at level attitude, fuel density = 0.8029 kilograms per liter

TANK	GALLONS	POUNDS*
AUXILIARY (as installed)	390	2,613
TOTAL	5,701	38,196

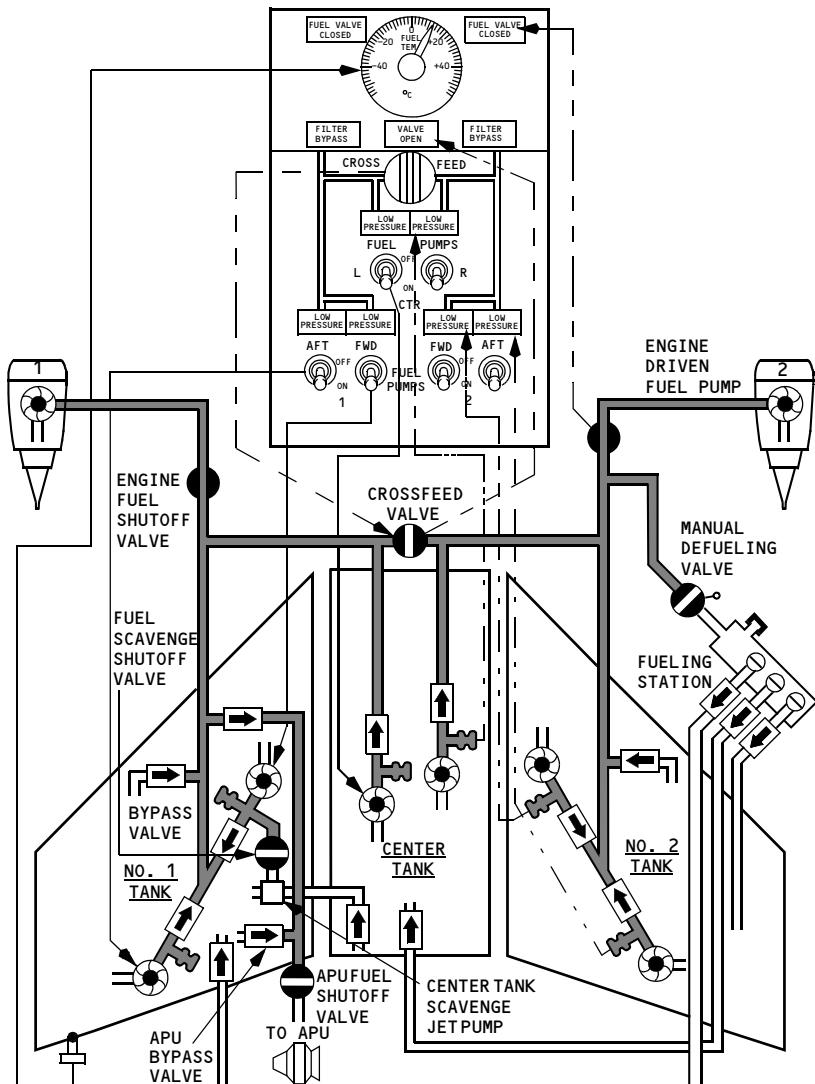
\* Usable fuel at level attitude, fuel density = 6.7 pounds per US gallon

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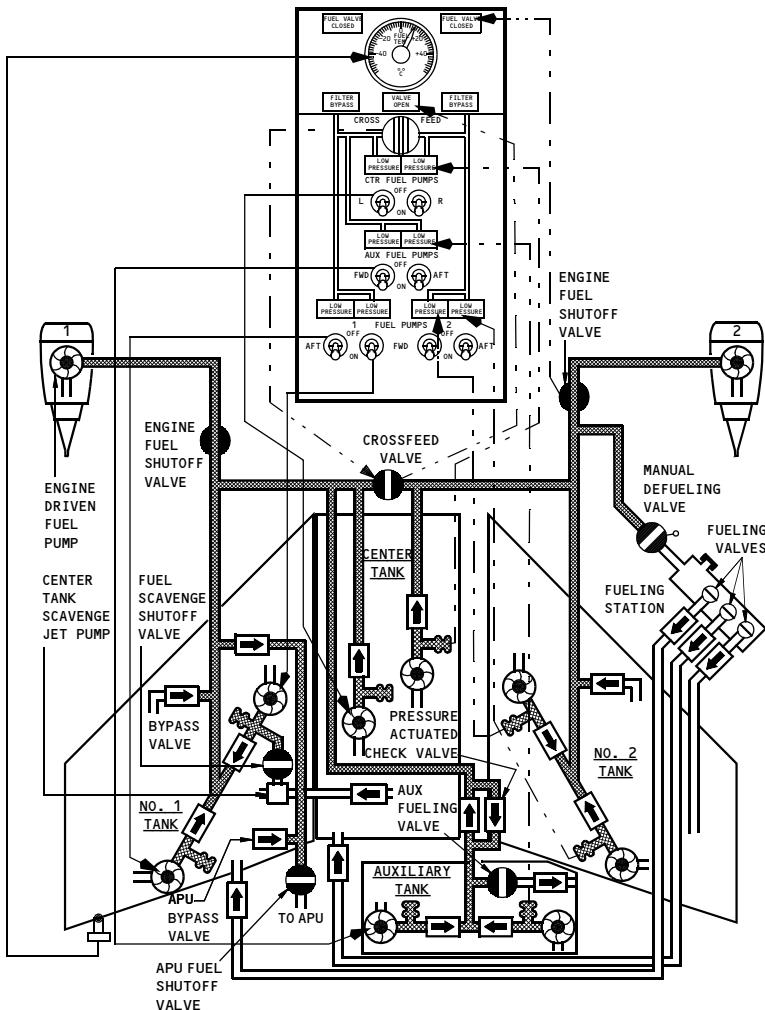
Fuel -  
System Description

# **737 Flight Crew Operations Manual**

## Fuel Schematic



CONDITION: ENGINES OPERATING  
CENTER TANK FEEDING ENGINES



CONDITION: ENGINES OPERATING  
CENTER TANK FEEDING ENGINE NO. 2  
AUX TANK FEEDING ENGINE NO. 1

Airplanes with Auxiliary Tank

FUEL FEED

# **DO NOT USE FOR FLIGHT**

## **737 Flight Crew Operations Manual**

### **Hydraulics**

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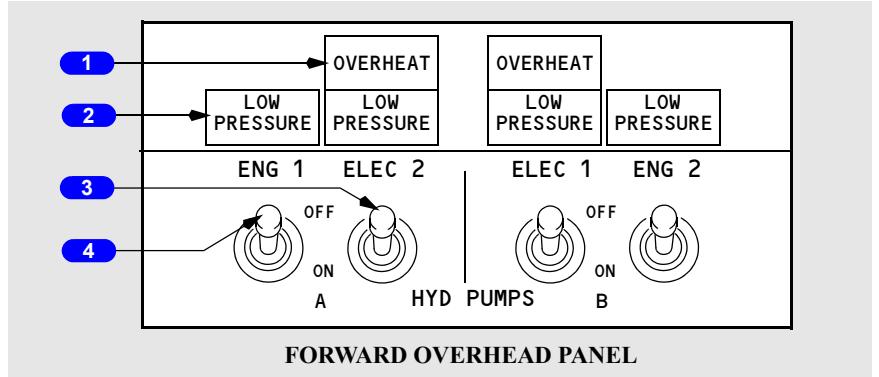
## Hydraulics

### Controls and Indicators

## Chapter 13

### Section 10

#### Hydraulic 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.

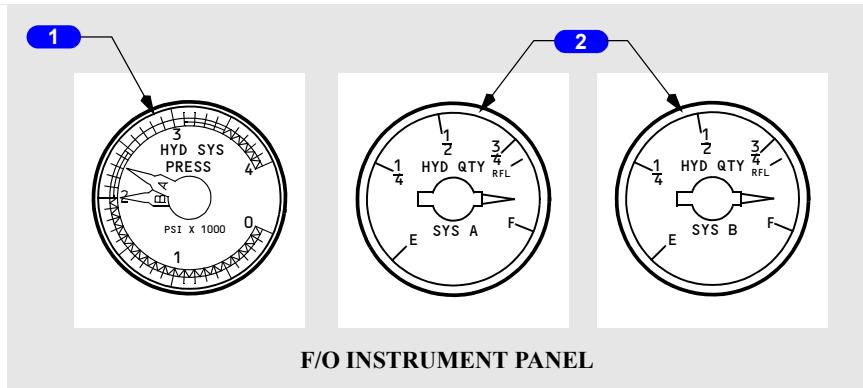
#### 4 ENGINE HYDRAULIC PUMPS Switches

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



F/O INSTRUMENT PANEL

### **1 HYDRAULIC System PRESSURE Indications**

Indicates system pressure:

- Normal pressure (green) – 3000 psi
- Maximum pressure (red) – 3500 psi.

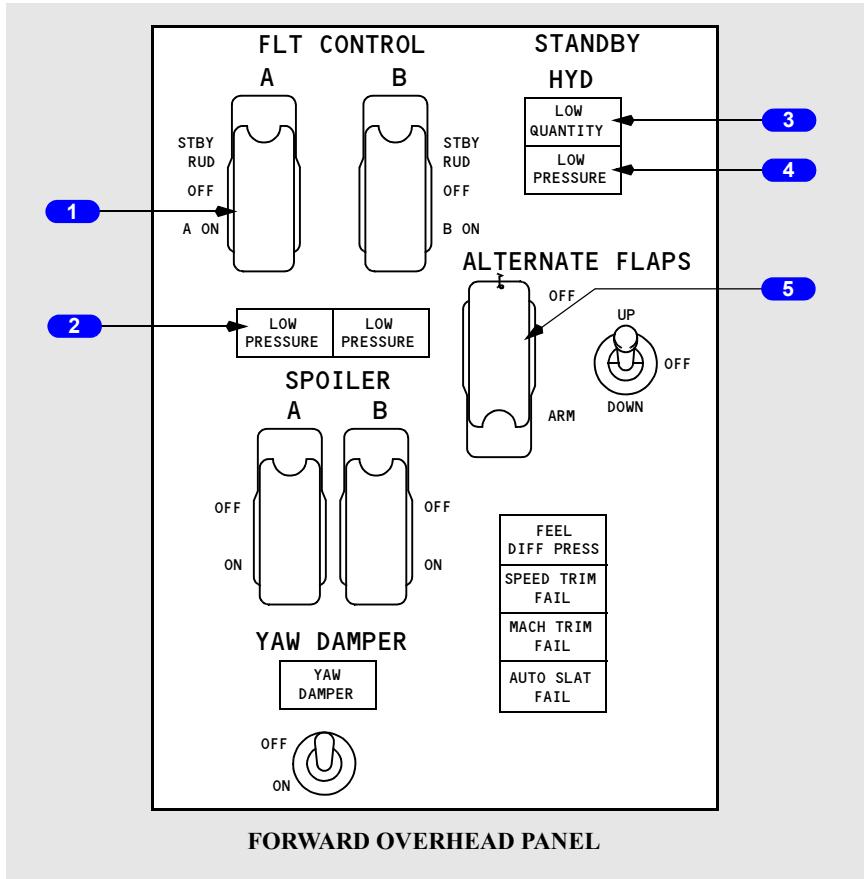
**Note:** When both pumps for a system are OFF, respective pointer reads zero.

### **2 HYDRAULIC System QUANTITY Indications**

Indicates system quantity:

- System A: Full 4.7 U.S. gallons; Refill 4.2 U.S. gallons.
- System B: Full 7.2 U.S. gallons; Refill 6.4 U.S. gallons.

## 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) –

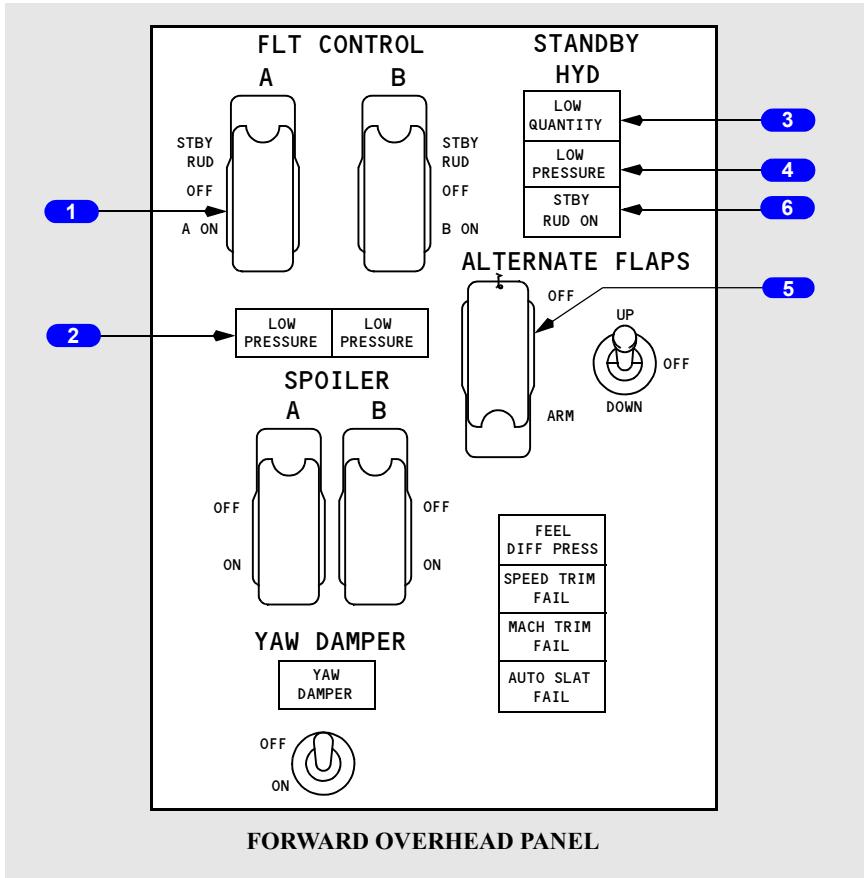
- indicates output pressure of standby pump is low
- armed only when standby pump operation has been selected or automatic standby function is activated.

## 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

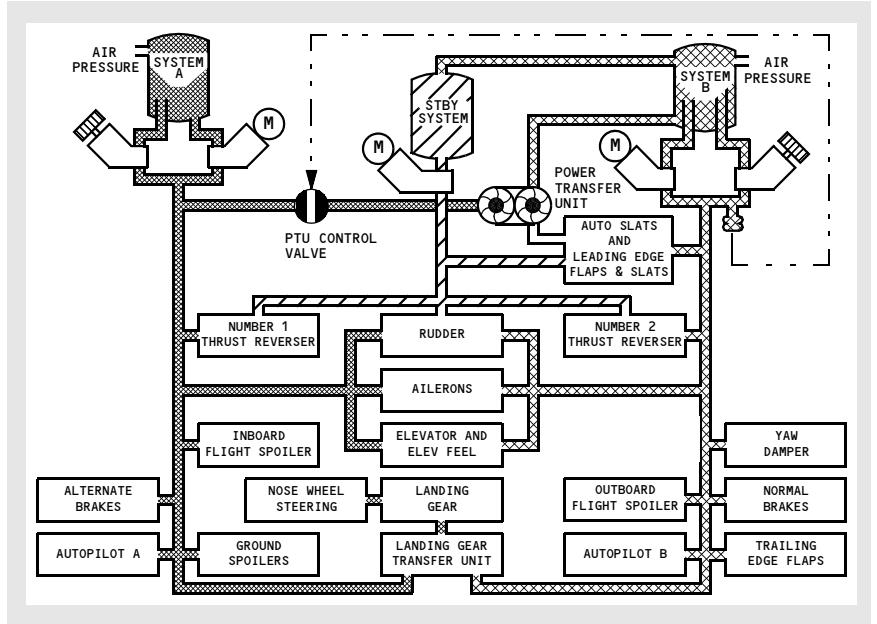
The airplane has three hydraulic systems: A, B and standby. The standby system is used if system A and/or B pressure is lost. The hydraulic systems power the following airplane systems:

- 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
- 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 annunciator 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 1/4 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 1/2 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

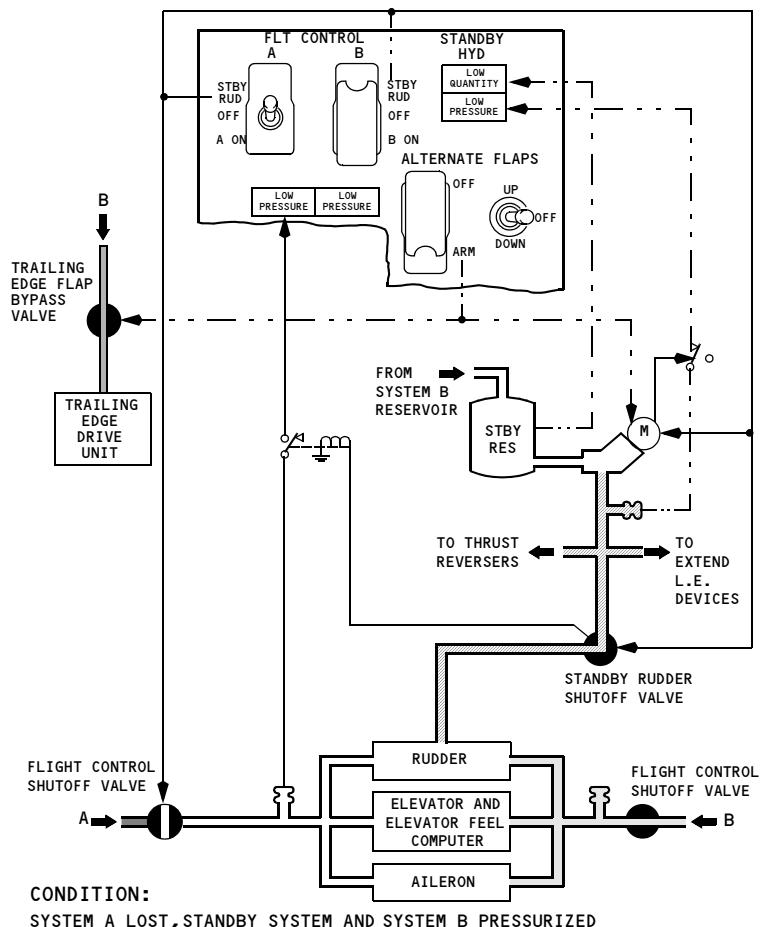
OR (after RSEP modification)

- 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

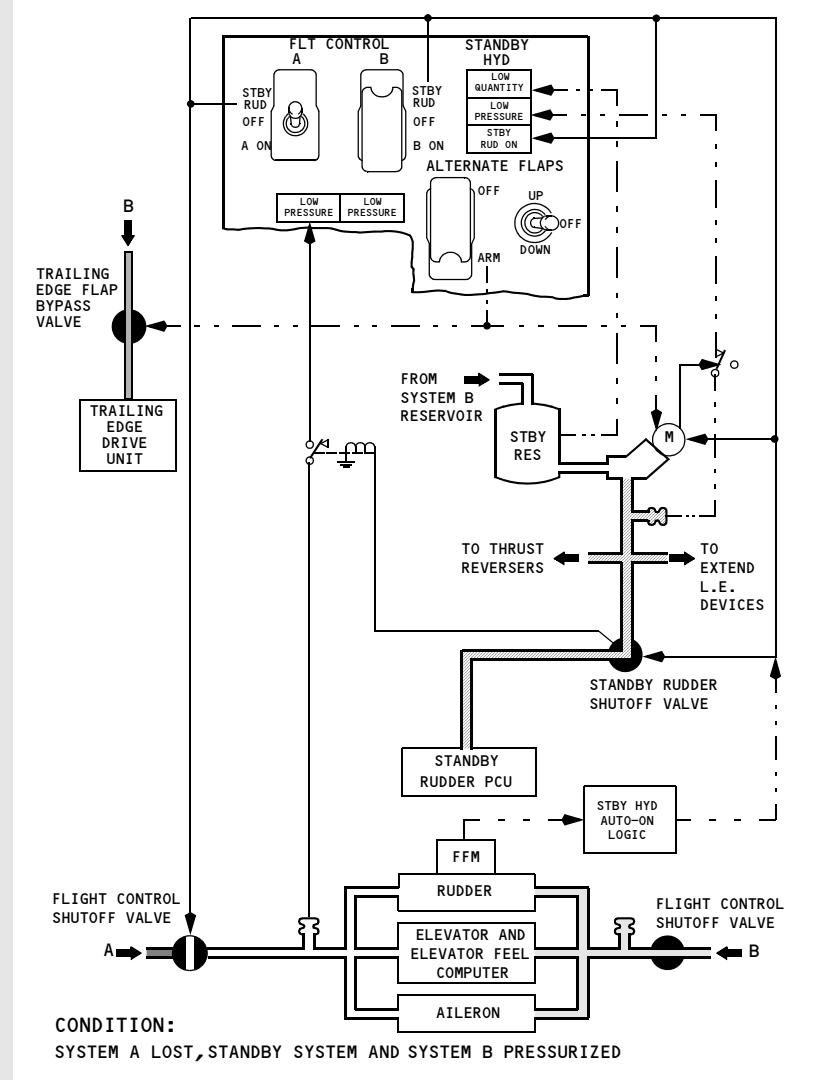


**(before RSEP modification)**

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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 between 1/2 & RFL indications.

---

## 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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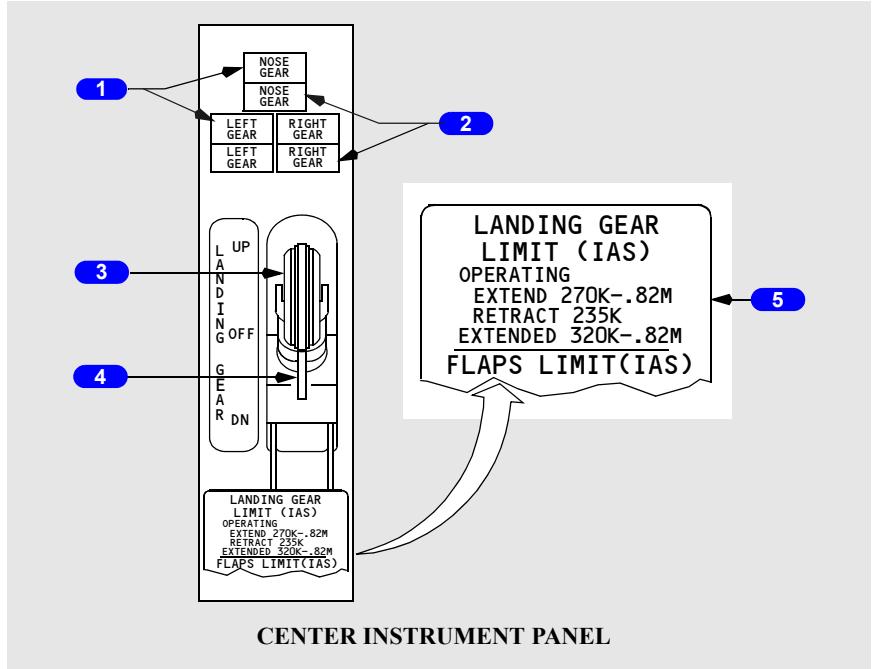
### **Chapter 14**

#### **Section 0**

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Intentionally  
Blank

## 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.

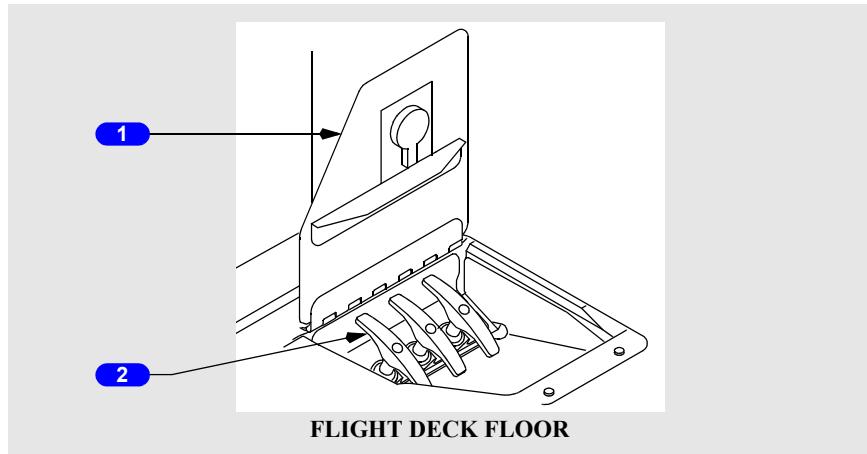
### 4 Override Trigger

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

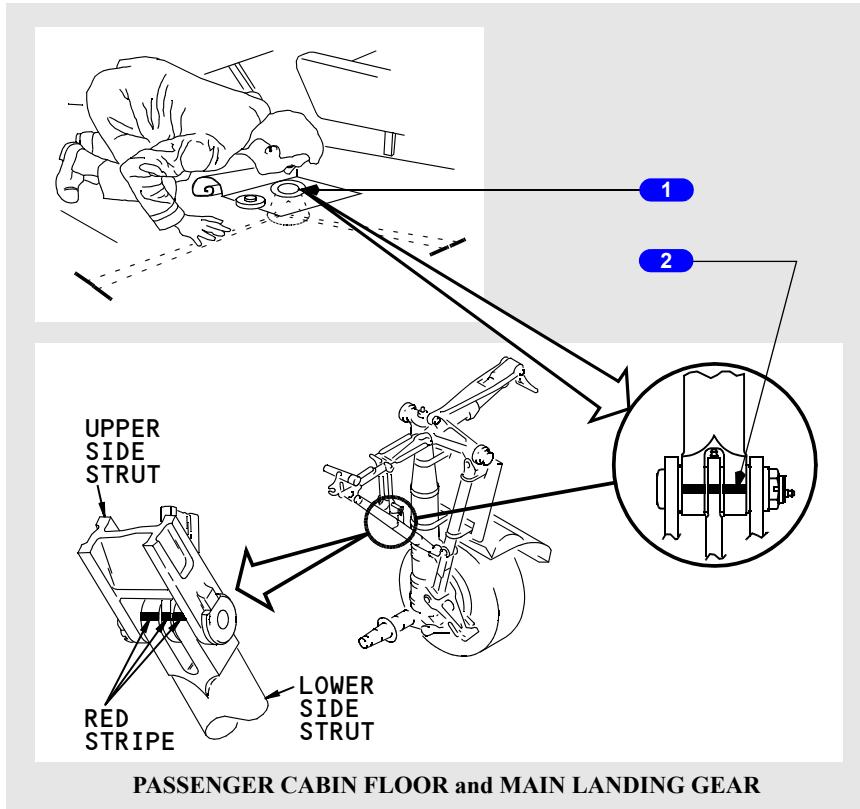


### 1 Manual Extension Access Door

### 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

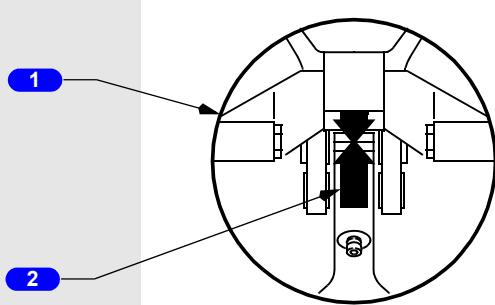
Opposite the 3rd window behind the aft overwing exit and one foot left of center. Pull up the carpet identified by a metal button to sight through viewer. Before leaving the cockpit, position the WHEEL WELL light switch ON.

**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



**FLIGHT DECK FLOOR**

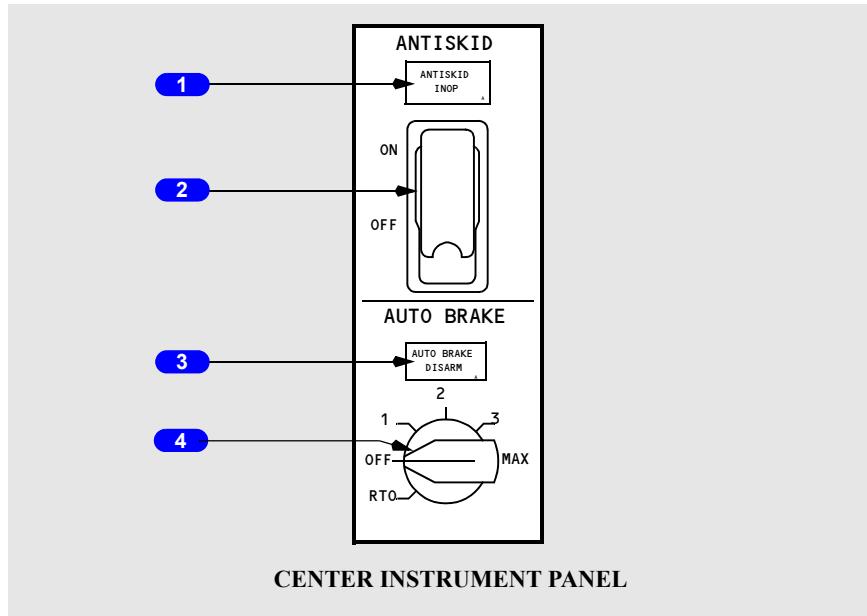
### **1** Viewer Access –

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

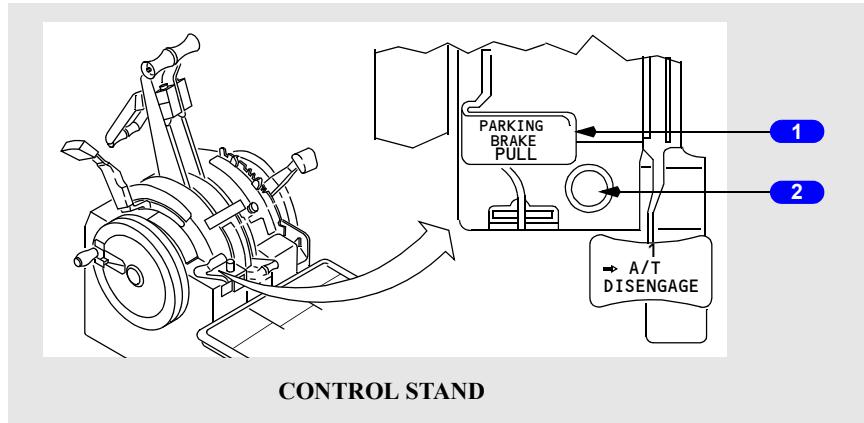
OFF – autobrake system deactivated

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

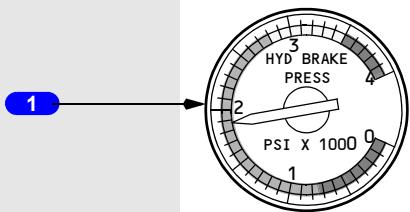
Aft – sets parking brakes when either Captain's or First Officer's brake pedals are fully depressed.

#### 2 Parking Brake Warning Light

Illuminated (red) – parking brake is set (lights operate from battery power)

Extinguished – parking brake is released.

## Hydraulic Brake Pressure Indicator



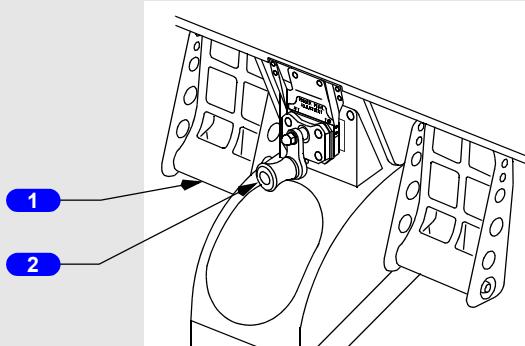
FIRST OFFICER'S INSTRUMENT PANEL

### 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

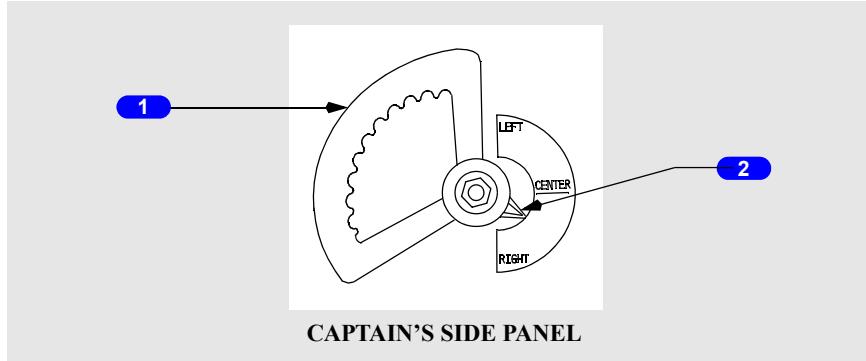
Refer to Chapter 9 Flight Controls for rudder description.

## 2 RUDDER PEDAL ADJUSTMENT Crank

AFT (counter-clockwise) – adjusts rudder pedals aft

FWD (clockwise) – adjusts rudder pedals forward.

## Nose Wheel Steering 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

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#### 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 supplied by hydraulic system A. A manual system for extending the landing gear is installed. Without hydraulic system A, nose wheel steering is unavailable.

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.

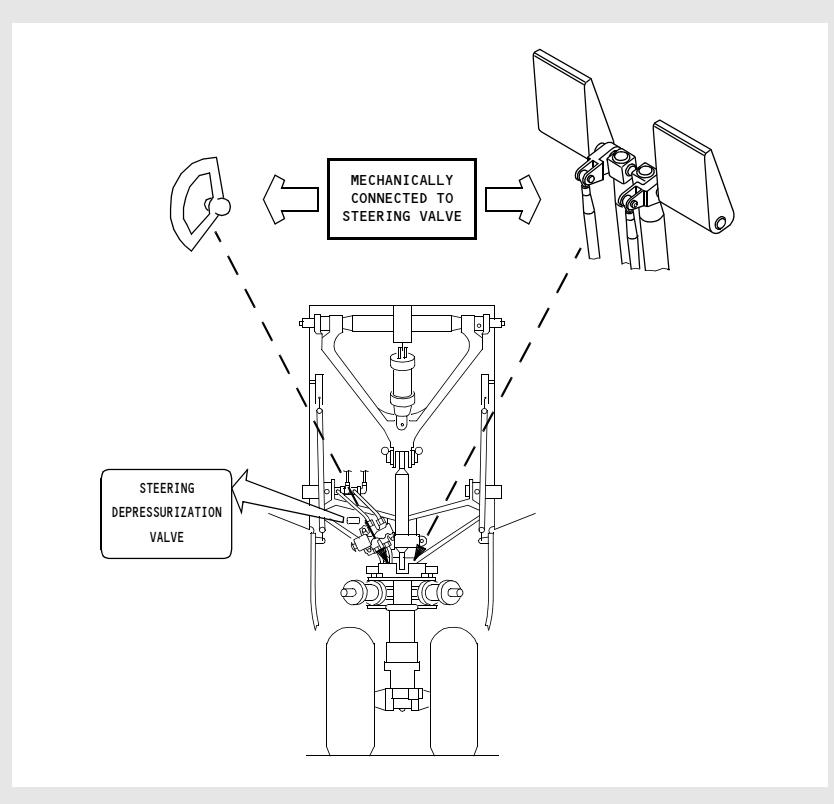
## **Landing Gear Extension**

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

The airplane is equipped with nose wheel steering which is powered by hydraulic system A. Nose wheel steering is operative only when hydraulic system A is pressurized.

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.

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## 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

# DO NOT USE FOR FLIGHT

Landing Gear -  
System Description

## 737 Flight Crew Operations Manual

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
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
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

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
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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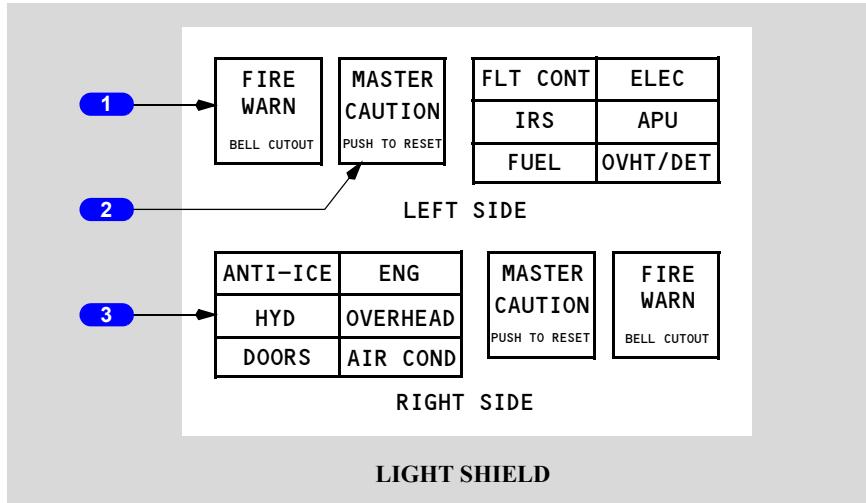
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## Fire Warning and Master Caution System



### 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

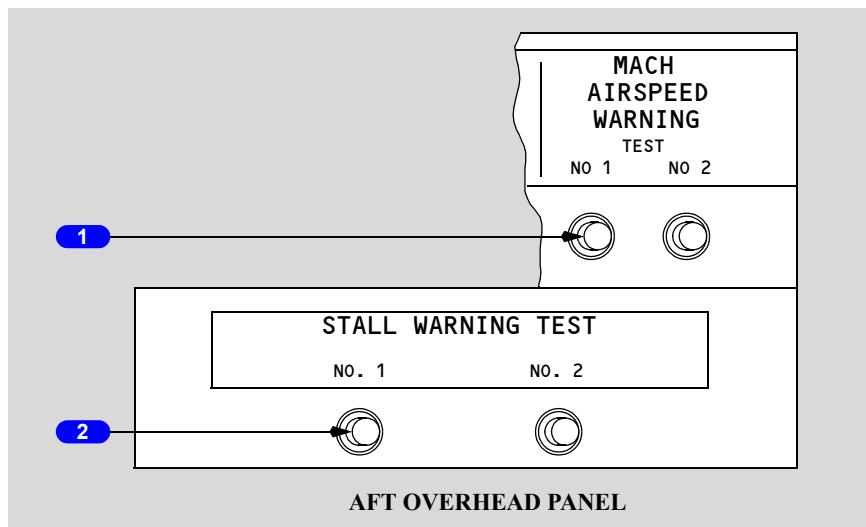
Illuminated (amber) – an amber light, relating to illuminated system annunciator, has illuminated on forward overhead, aft overhead or overheat/fire protection panel.

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:

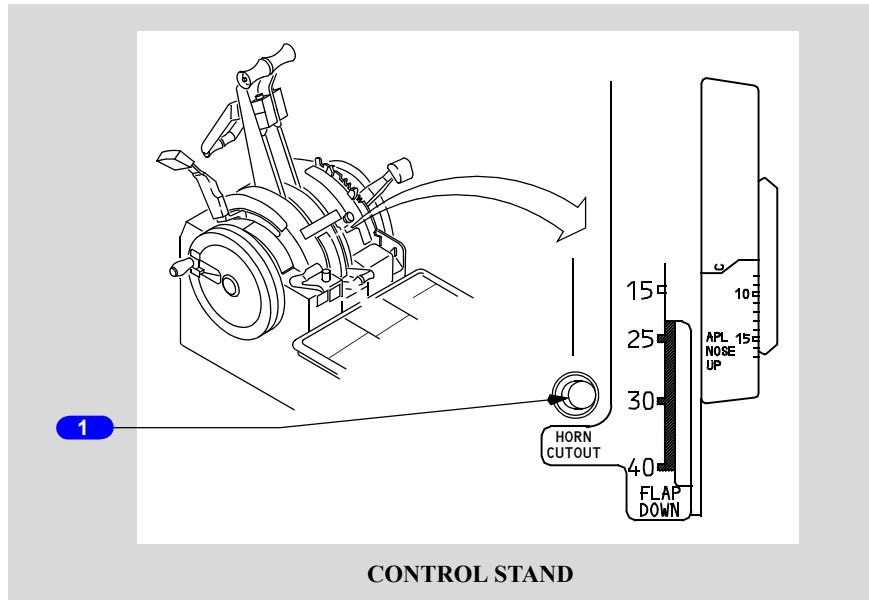
- clacker sounds

### 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) –

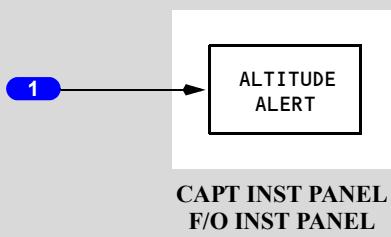
- illuminates at 10,000 feet if the cabin has not been pressurized
- illuminates during flight when loss of cabin pressure occurs
- activation is simultaneous with aural warning intermittent horn for CABIN ALTITUDE alert.

## 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

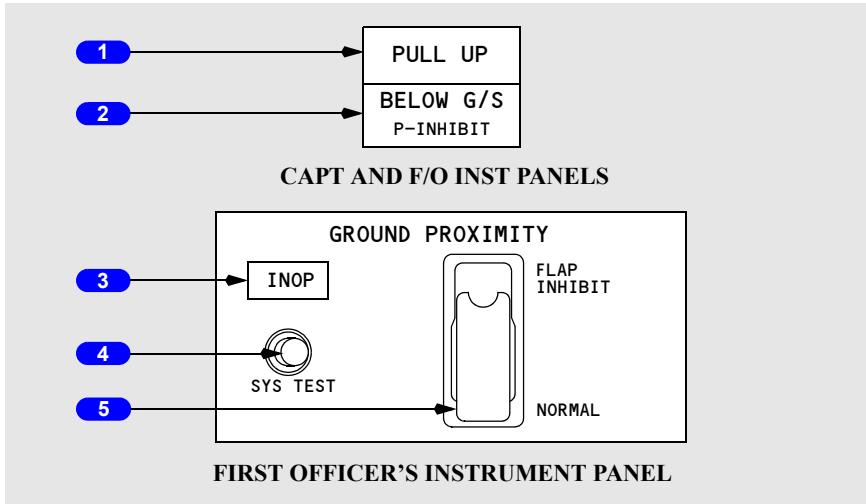
One on each pilot's primary display above altimeter

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 –

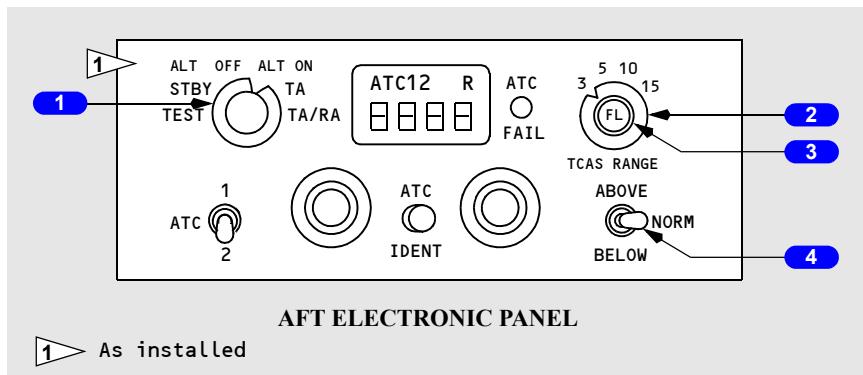
- momentarily on ground, or above 1,000 feet radio altitude in flight:
  - illuminates BELOW G/S, PULL UP, and INOP lights, and causes “GLIDESLOPE” and “WHOOP, WHOOP, PULL UP” aural to sound
- at least 10 seconds, on ground – above indications always occur first, followed by any additional aural, as installed
- system test is inhibited from lift-off to 1000 feet radio altitude.

#### 5 GROUND PROXIMITY Flap/Gear Inhibit Switch

FLAP/GEAR INHIBIT – inhibits or cancels warnings/alerts caused by flaps not in 30 or 40 position or landing gear not down.

NORMAL (guarded position) – flap and landing gear position logic is provided for GPWS.

### Transponder Panel (TCAS)



#### 1 Transponder Mode Selector

TEST – starts ATC transponder functional test.

STBY – does not transmit.

**Note:** Transponder modes are enabled only when airplane is airborne.

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 TCAS Range Switch

Selects range for TCAS display when weather radar is operating in TCAS mode only.

### 3 Absolute Altitude Display Selector

Press – displays absolute altitudes of TCAS targets for 15 seconds.

### 4 Altitude Range Switch

Allows shifting of TCAS coverage up and down from baseline:

- ABOVE – sets TCAS display at upper elevation limit.
- NORM – sets TCAS display for normal limit.
- BELOW – sets TCAS display at lower elevation limit.

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.

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Generally, aural silence when the associated non-normal condition no longer exists.

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## 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.

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## 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			HIGH OIL TEMP/
DC FAIL			FAULT
FUEL			OVERSPEED
LOW PRESSURE			OVHT/DET
FILTER BYPASS			ENGINE 1 OVERHEAT
			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 PASS OXY-ON
DOORS	RIGHT SIDE LIGHT SHIELD		AIR COND
FWD/AFT ENTRY			DUCT OVERHEAT
EQUIP			DUAL BLEED
FWD/AFT CARGO			PACK TRIP OFF
FWD/AFT SERVICE			WING-BODY OVERHEAT
AIRSTAIR			BLEED TRIP OFF
			AUTO FAIL
			OFF SCHED DESCENT

**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 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.

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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

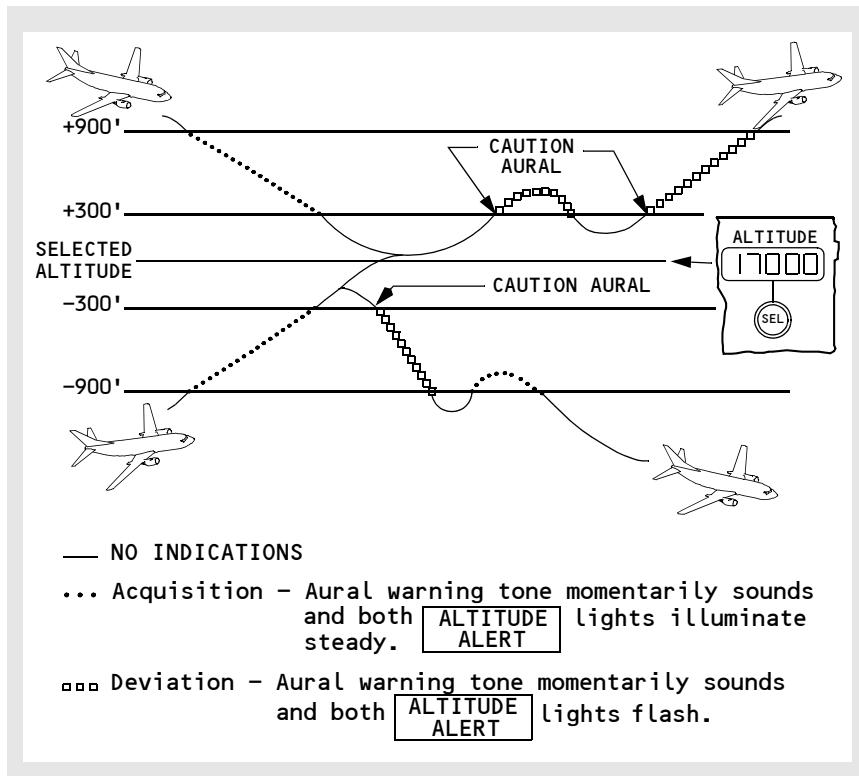
When approaching within 900 feet of selected altitude both ALTITUDE ALERT lights illuminate steady and a momentary tone sounds. When at 300 feet from selected altitude, both ALTITUDE ALERT lights extinguish.

## 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



— NO INDICATIONS

... Acquisition — Aural warning tone momentarily sounds and both **ALTITUDE ALERT** lights illuminate steady.

... Deviation — Aural warning tone momentarily sounds and both **ALTITUDE ALERT** lights flash.

## Ground Proximity Warning System (GPWS)

**WARNING:** Do not deactivate the GPWS (by pulling the circuit breaker or using the inhibit switch) except for approved procedures where landing flaps are required at a less-than-normal position, or where leaving landing gear up is specified.

The GPWS provides alerts for potentially hazardous flight conditions. To the extent GPWS warnings are installed, they warn of imminent impact with the ground, detected windshear condition, excessive angle of bank, and glide slope deviation.

GPWS may also provide radio altitude and decision height callouts.

**Note:** GPWS does not provide alerts for flight toward vertically sheer terrain, or of shallow descents when the airplane is in landing configuration.

## Alert Conditions

The GPWS provides alerts based on radio altitude and combinations of barometric altitude, airspeed, glide slope deviation, and airplane configuration. The alerts are for:

- excessive barometric 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 glide slope
- descent below specific radio altitudes
- windshear.

The GPWS alerts and the condition which causes each alert are presented on the following GPWS annunciation chart.

## GPWS Annunciations

AURAL ALERT	VISUAL ALERT	DESCRIPTION
WHOOP WHOOP PULL UP	PULL UP lights	Follows "SINK RATE" if sink rate becomes severe. Also follows "TERRAIN" alert if excessive terrain closure rate continues and landing gear and/or flaps not in landing configuration.
DON'T SINK	PULL UP lights	Excessive altitude loss after takeoff or go-around.
GLIDESLOPE	BELOW G/S lights P-INHIBIT lights on	Deviation below glideslope. The volume and repetition rate increase as deviation continues.
SINK RATE	PULL UP lights	Excessive descent rate.
TERRAIN	PULL UP lights	Excessive terrain closure rate.

TOO LOW FLAPS	PULL UP lights	Unsafe clearance during approach with flaps not in landing configuration.
TOO LOW GEAR	PULL UP lights	Unsafe clearance during approach with landing gear up.
TOO LOW TERRAIN	PULL UP lights	Unsafe terrain clearance with landing gear up or flaps not in landing position.

## Decision Height Callouts

On airplanes with decision height callout, the following callout is subject to the altitude set on the Captain's DH selector:

"MINIMUMS – MINIMUMS"

## Windshear Warning (Airplane in Windshear)

AURAL ALERT	VISUAL ALERT	DESCRIPTION
Two-tone siren followed by WINDSHEAR WINDSHEAR WINDSHEAR	Red WINDSHEAR on both attitude indicators.	Excessive windshear at the current airplane position detected by GPWS. Enabled below 1,500 feet RA. GPWS Windshear detection begins at rotation.

## Traffic Alert and Collision Avoidance System (TCAS) (as installed)

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 without EFIS

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 traffic display(s). The range and relative bearing of the other airplane are also displayed. Altitude and vertical motion are included 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 other airplane’s range, relative bearing, and altitude appear on the traffic display(s). An RA vertical speed restriction or maneuver appears on the VSI.

**Note:** Maneuvering is required if the existing vertical velocity is in the red band (RA VSI).

An OFFSCALE traffic symbol appears during a TA or RA if the traffic’s position is outside the selected traffic display’s range.

A TA or RA message followed by the traffic’s range, altitude, and (if applicable), vertical motion arrow appear on the traffic display if TCAS cannot determine the other airplane’s bearing.

### 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.