737-300/-400/-500 Operations Manual

The Boeing Company

Document Number D6-27370-400E-TBCE
February 13, 1998

Revision Number: 10
Revision Date: December 06, 2002

Preface — Chapter 0
Table of Contents — Section 0

Volume 1 — **Chapter**

Volume 2

Quick Reference Handbook (QRH)

General

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

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

Airplane Number	Registry Number	Serial Number	Tab Number	Model Miscellaneous Data
001			BE300	
002			BE400	
003			BE500	

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General

This Operations Manual has been prepared by the Boeing Commercial Airplane Group, 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 and supplementary procedures. Volume 2 contains systems information. The QRH contains all checklists necessary for normal and non–normal procedures as well as in–flight 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 operations manual 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:

Commercial Aviation Services
Boeing Commercial Airplane Group
P. O. Box 3707, M/S 20–89
Seattle, Washington 98124–2207 USA

Attention: Senior Manager, Flight Technical Publications

Organization

The operations manual 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.

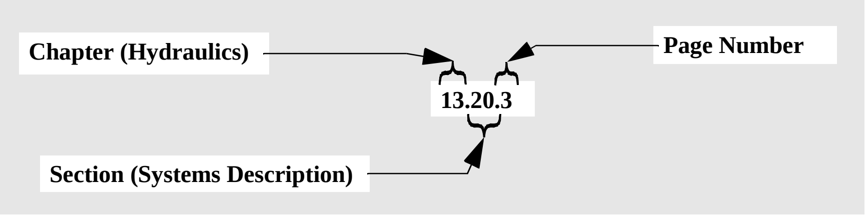
Volume 2 – Chapters 1 through 15 contain general airplane and systems information. These chapters are generally subdivided into sections covering controls and indicators and systems descriptions.

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

Page Numbering

The operations manual 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.

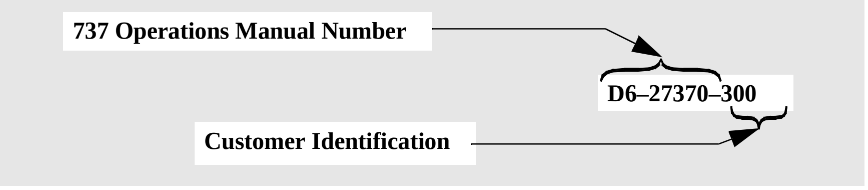
Example Page Number



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 operations manual number, D6–27370–, and is followed by the customer identification. The page date is the date of publication of the manual or the most recent revision date.

Example Page Identification



Warnings, Cautions, and Notes

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

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

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

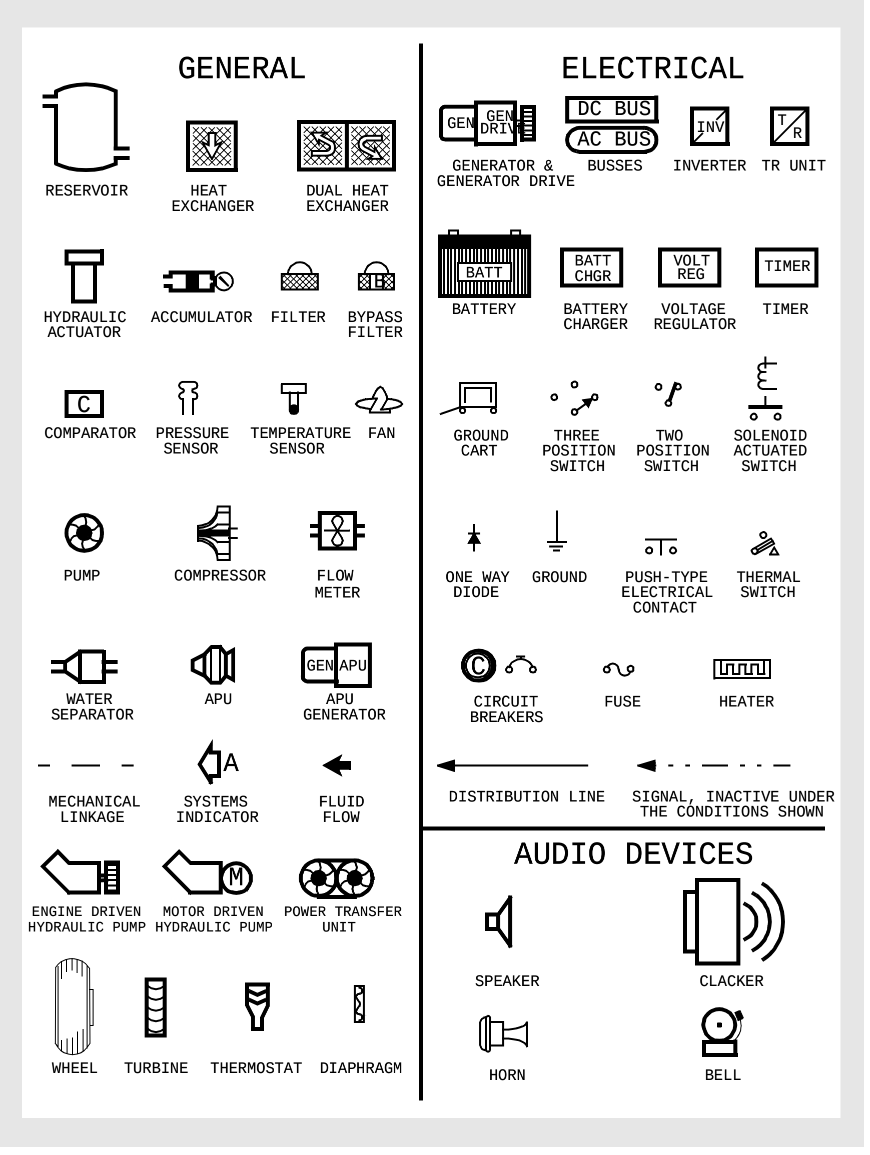
Note: An operating procedure, technique, etc., considered essential to emphasize. Information contained in notes may also be safety related.

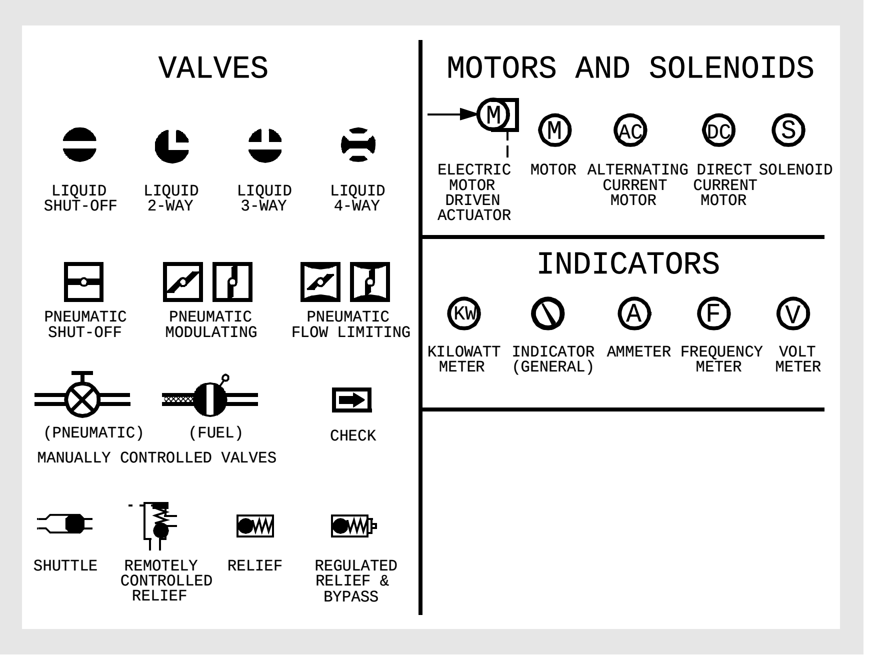
Operations Manual Configuration

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 operations manual does not reflect customer originated modifications without special contract provisions.

Schematic Symbols

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




VALVES
LIQUID SHUT-OFF
LIQUID 2-WAY
LIQUID 3-WAY
LIQUID 4-WAY
PNEUMATIC SHUT-OFF
PNEUMATIC MODULATING
PNEUMATIC FLOW LIMITING
(PNEUMATIC)
(FUEL)
MANUALLY CONTROLLED VALVES
CHECK
SHUTTLE
REMOTELY CONTROLLED RELIEF
RELIEF
REGULATED RELIEF & BYPASS
MOTORS AND SOLENOIDS
M
ELECTRIC MOTOR DRIVEN ACTUATOR
M
MOTOR
AC
ALTERNATING CURRENT MOTOR
DC
DIRECT CURRENT MOTOR
S
SOLENOID
INDICATORS
KW
KILOWATT METER
INDICATOR (GENERAL)
A
AMMETER
F
FREQUENCY METER
V
VOLT METER

General

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

A	
AC	Alternating Current
ACARS	Aircraft Communications Addressing and Reporting System
ACT	Active
ADF	Automatic Direction Finder
ADM	Air Data Module
AFDS	Autopilot Flight Director System
AFM	Airplane Flight Manual (FAA approved)
AGL	Above Ground Level
AI	Anti–Ice
AIL	Aileron
ALT	Altitude
ALTN	Alternate
ANP	Actual Navigation Performance
AOA	Angle of Attack
A/P	Autopilot
APU	Auxiliary Power Unit
ARINC	Aeronautical Radio, Incorporated
ARPT	Airport
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
CANC/ RCL	Cancel/Recall
CB	Circuit Breaker
CDU	Control Display Unit
CG	Center of Gravity
CHKL	Checklist
CLB	Climb
COMM	Communication
CON	Continuous

CONFIG	Configuration
CRZ	Cruise
CTL	Control
D	
DC	Direct Current
DDG	Dispatch Deviations Guide
DEP ARR	Departure Arrival
DES	Descent
DISC	Disconnect
DME	Distance Measuring Equipment
DSPL	Display
E	
E/D	End of Descent
EEC	Electronic Engine Control
EFIS	Electronic Flight Instrument System
EGPWS	Enhanced Ground Proximity Warning System
EGT	Exhaust Gas Temperature
ELEC	Electrical
ELEV	Elevator
ENG	Engine
EXEC	Execute
EXT	Extend
E/E	Electrical and Electronic
F	
F	Fahrenheit
FCTL	Flight Control
F/D or FLT DIR	Flight Director
FMC	Flight Management Computer
FMS	Flight Management System
F/O	First Officer
FPA	Flight Path Angle
FPV	Flight Path Vector
G	
GA	Go–Around
GEN	Generator
GPS	Global Positioning System
GPWS	Ground Proximity Warning System
G/S	Glide Slope
H	
HDG	Heading
HDG REF	Heading Reference
HDG SEL	Heading Select
HPA	Hectopascals
HUD	Head-Up Display

I	
IAS	Indicated Airspeed
IDENT	Identification
IN	Inches
IND LTS	Indicator Lights
ILS	Instrument Landing System
INBD	Inboard
INOP	Inoperative
INTC CRS	Intercept Course
ISLN	Isolation
K	
K	Knots
KGS	Kilograms
L	
L	Left
LBS	Pounds
LDG ALT	Landing Altitude
LIM	Limit
LNAV	Lateral Navigation
M	
MAG	Magnetic
MAN	Manual
MCP	Mode Control Panel
MDA	Minimum Descent Altitude
MEL	Minimum Equipment List
MIN	Minimum
MMO	Maximum Mach Operating Speed
MOD	Modify
MTRS	Meters
N	
NAV RAD	Navigation Radio
ND	Navigation Display
NM	Nautical Miles
NORM	Normal
N1	Low Pressure Rotor Speed
N2	High Pressure Rotor Speed
O	
OHU	Overhead Unit
OVHD	Overhead
OVRD	Override
P	
PASS	Passenger
PERF INIT	Performance Initialization
PF	Pilot Flying
PFC	Primary Flight Computers
PNF	Pilot Not Flying
PNL	Panel
POS	Position
POS INIT	Position Initialization
PRI	Primary
PWS	Predictive Windshear System
R	
R	Right

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

Revision Transmittal Letter

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

Subject: Operations Manual Revision.

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

Revision Record

No.	Revision Date	Date Filed	No.	Revision Date	Date Filed
0	February 13, 1998		1	June 12, 1998	
2	December 04, 1998		3	June 11, 1999	
4	December 03, 1999		5	June 09, 2000	
6	December 01, 2000		7	June 08, 2001	
8	December 07, 2001		9	June 07, 2002	
10	December 06, 2002				

General

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

The revision date is the approximate date the manual is 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 operations manual content.

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

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

Filing Instructions

Consult the List of Effective Pages (0.5). 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 effectivity may be updated to reflect coverage as listed on the Preface - Model Identification page, or to show service bulletin airplane effectivity. Highlights are not supplied.

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

Chapter 0 - Preface

Section 2 - Introduction

0.2.1 - Removed reference to Performance Dispatch information.

Chapter L - Limitations

Section 10 - Operating Limitations

Operational Limitations

L.10.1 - Added limit to ensure an operational check of the flight deck door access system has been accomplished once each flight day.

Aircraft Communications Addressing and Reporting System

L.10.5 - Added clarification to ACARS limit which allows use for certain messages with approved operational procedures.

Flight Management, Navigation

L.10.7 - Added applicable FMC update clarification to raw data limit for VOR approaches.

Fuel Balance

L.10.8 - Revised limit for required main and center tanks quantities to clarify that it applies to ground only.

Chapter NP - Normal Procedures

Section 20 - Amplified Procedures

Flight Deck Safety Inspection – Captain or First Officer

NP.20.1 - Step added to accomodate new Flight Deck Security Door.

Section 30 - Flight Patterns

Visual Traffic Pattern

NP.30.6 - Added TO/GA step for Boeing model standardization.

Chapter SP - Supplementary Procedures

Section 4 - Automatic Flight

Instrument Approach using Vertical Speed (V/S)

SP.4.6 - Added Notes regarding the use of VOR/LOC AFDS mode that were inadvertantly deleted in the previous revision.

Section 9 - Flight Controls

Flight Controls Check

SP.9.1 - The current Flight Controls Check supplementary procedure does not provide an adequate check of the rudder trim system for airplanes with the mechanical cam and spring rudder feel and centering unit. The test should be conducted with hydraulic power on

Section 16 - Adverse Weather

Climb and Cruise

SP.16.8 - Added a CAUTION stating that above approximately Flight Level 350 wing anti-ice should not be used.

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

Section 20 - Instrument Panels

Aft Flight Deck Overview

1.20.3 - Added illustration to match incorporation of Cockpit security doors to some ariplanes

Added a graphic which depicts the Aft Flight Deck with the Enhanced Security Door installed.

Section 30 - Controls and Indicators

Cabin Door

1.30.8 - Modified to show "as installed" for those with new Security Doors installed.

Flight Deck Security Door (As Installed)

1.30.9 - Incorporated new cockpit doors shown "as installed" to reflect incorporation of new door.

Section 40 - Systems Description

Fire Extinguishers

1.40.12 - Modified paragraph to read "fire extinguishers" instead of "halon and water fire extinguishers".

Cabin Door

1.40.21 - Modified illustration to cover incorporation of enhanced cockpit security doors on some airplanes.

Chapter 2 - Air Systems

Section 40 - Pressurization System Description

Auto Mode Operation

2.40.5 - Revised cabin pressure change rate for auto-fail light.

Chapter 3 - Anti-Ice, Rain

Section 10 - Controls and Indicators

Engine Anti–Ice Panel

3.10.5 - Simplified description of engine anti-ice switch.

Wing Anti–Ice Panel

3.10.6 - Simplified description of wing anti-ice switch.

Chapter 4 - Automatic Flight

Section 10 - Controls and Indicators

Vertical Navigation

4.10.5 - Re-formatted VNAV PTH descent bulleted list.

Chapter 6 - Electrical

Section 20 - System Description

Battery Power

6.20.9 - Revised battery voltage value to reflect design specification, 24 VDC.

DC Power System Schematic

6.20.11 - Revised graphic to reflect the airplane configuration as shown.

Chapter 11 - Flight Management, Navigation

Section 31 - Flight Management System Operation

Navigation Performance (U7)

11.31.7 - Revised wording to clarify FMC alerting message for ANP.

Section 32 - Flight Management Computer

Fuel Monitoring

11.32.3 - Corrected wording of invalid fuel quantity for fuel monitoring.

Section 42 - FMC Cruise

Reference Navigation Data (REF NAV DATA) Page

11.42.38 - Added information for Ref Nav Data.

Fix Information Page

11.42.49 - Revised sentence structure for Fix Info.

Chapter 12 - Fuel

Section 20 - System Description

Fuel Pumps

12.20.1 - Moved paragraph to Fuel Crossfeed section for clarity.

Fuel Crossfeed

12.20.2 - Added paragraph to explain fuel imbalance will result if continued crossfeed is used.

Fuel Schematic

12.20.4 - Added check valves to center and No. 1 fuel tank refuel lines to reflect airplane configuration.

12.20.4 - Changed fuel panel font to reflect airplane configuration.

Chapter 15 - Warning Systems

Section 20 - System Description

Inhibits (Without TCAS change 7.0 update)

15.20.12-13 - Revised system description for TCAS inhibits.

Inhibits (With TCAS change 7.0 update)

15.20.13 - Revised system description for TCAS inhibits.

Chapter PI - Performance Inflight -

Section 10 - General

Stab Trim Setting

PI.10.2 - Corrected note to reflect AFM.

Section 12 - Advisory Information

Brake Cooling Schedule

PI.12.6 - Corrected typo "fof" to "of", in heading.

Section 16 - Text

General

PI.16.2 - Added text to address V1 greater than VR.

Section 20 - General

Stab Trim Setting

PI.20.3 - Corrected notes to reflect AFM.

Stab Trim Setting (22K Derate)

PI.20.14 - Corrected notes to reflect AFM.

Section 21 - All Engines

Long Range Cruise Control

PI.21.3 - Corrected optimum altitude shading.

Section 24 - PMC Off

Takeoff %N1 (22K Derate)

PI.24.2 - Formatting change - removed repeat of 22K Derate title.

Takeoff %N1 (20K Derate)

PI.24.3 - Formatting change - removed repeat of 20K Derate title.

Section 26 - Text

General

PI.26.2 - Added text to address V1 greater than VR.

Section 36 - Text

General

PI.36.2 - Added text to address V1 greater than VR.

Chapter NNC - Non-Normal Checklists

Section 0 - Unannunciated

AUTO FAIL/UNSCHEDULED PRESSURIZATION CHANGE

NNC.0.5 - Changed Pack switch position from ON to AUTO.

NNC.0.5 - Added information about setting the cabin altitude and landing field elevation that was inadvertantly removed.

PASSENGER EVACUATION

NNC.0.20 - Added the word "engine" for nomenclature standardization.

SMOKE/FUMES REMOVAL

NNC.0.22 - Changed checklist from a recall to a reference only checklist to be consistent with other Boeing models that have the same checklist.

WINDOW DAMAGE

NNC.0.28 - Removed table for window #3 because when damage occurs on a heated #3 window, the same operational limitations apply to the #3 window as to any other heated window.

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

AUTOMATIC UNLOCK

NNC.1.1 - The FAA requires the installation of a new enhanced flight deck door and associated procedures on all Boeing production and in-service airplanes.

LOCK FAIL

NNC.1.3 - The FAA requires the installation of a new enhanced flight deck door and associated procedures on all Boeing production and in-service airplanes.

WINDOW DAMAGE

NNC.1.5 - Removed table for window #3 because when damage occurs on a heated #3 window, the same operational limitations apply to the #3 window as to any other heated window.

Section 2 - Air Systems

AUTO FAIL/UNSCHEDULED PRESSURIZATION CHANGE

NNC.2.2 - Changed Pack switch position from ON to AUTO.

NNC.2.2 - Added information about setting the cabin altitude and landing field elevation that was inadvertantly removed.

BLEED TRIP OFF

NNC.2.3 - Inappropriate use of wing TAI may cause dual bleed trip off incidents. As a result, added a step to turn the wing anti-ice off.

Section 6 - Electrical

LOSS OF BOTH ENGINE DRIVEN GENERATORS

NNC.6.4 - As the airplane climbs, dissolved air is released from the fuel in the tank due to the decreased air pressure. This air may collect in the suction feed line and restrict fuel flow resulting in thrust deterioriation or engine flameout at high altitudes.

Section 7 - Engines, APU

ENGINE FIRE, SEVERE DAMAGE OR SEPARATION

NNC.7.6 - Revised amplified information to be consistant with other procedures.

Section 8 - Fire Protection

ENGINE FIRE, SEVERE DAMAGE OR SEPARATION

NNC.8.6 - Revised amplified information to be consistant with other procedures.

ENGINE OVERHEAT

NNC.8.8 - Revised procedure to direct the crew to disengage the autothrottles, then close the thrust lever.

SMOKE/FUMES REMOVAL

NNC.8.10 - Changed checklist from a recall to a reference only checklist to be consistent with other Boeing models that have the same checklist.

Section 9 - Flight Controls

ALTERNATE FLAPS OPERATION

NNC.9.4 - Added a Descent and Approach checklist for consistency with other 737 NNC's.

NNC.9.5 - Changed to clarify system operation.

YAW DAMPER

NNC.9.23 - The FCTM includes the note "With yaw damper inoperative, do not exceed flaps 30 if crosswinds exceed 30 knots." This limitation is now included in the YAW DAMPER Non-Normal checklist.

Section 13 - Hydraulics

LOSS OF SYSTEM B

NNC.13.4 - Changed to clarify system operation.

MANUAL REVERSION

NNC.13.6 - Changed to clarify system operation.

Chapter NNM - Non-Normal Maneuvers

Section 2 - Flight Patterns

Visual Traffic Pattern

NNM.2.6 - Added TO/GA step for Boeing model standardization.

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* 0.5.1-12	December 06, 2002
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General

The Boeing Company issues operations manual bulletins as required. Bulletins transmit temporary information which must be issued before the next formal revision to the 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. Each bulletin specifically identifies the airplane effectivity. When appropriate, the next formal operations manual revision will include an updated bulletin record page.

Temporary information is normally incorporated into the manual at the next formal revision. When the condition remains temporary after a bulletin incorporation, the temporary paragraphs are identified by a heading referencing the originating bulletin. When the temporary condition no longer exists, the bulletin is cancelled and the original manual content is restored.

Bulletin status is defined as follows:

- In Effect (IE) – the bulletin contains pertinent information not otherwise covered in the operations manual. The bulletin is recorded in this record and filed as instructed. The bulletin is active and should be retained in the manual.
- Incorporated (INC) – the bulletin material is incorporated into the manual pages. The bulletin remains in effect.
- Cancelled (CANC) – the bulletin is no longer in effect. File the bulletin as instructed and remove it from this section of the manual. The record page should be modified to indicate the CANC bulletin status.

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

Number	Subject	Ref. No. (CS3-)	Date	Status
TBCE–1	EFIS Display Blanking		06–16–95	IE
TBCE–2	Standby Horizon Indicator Display		06–16–95	IE
TBCE–3	Nonselected MCP Setting Changes		06–16–95	IE
TBCE–4	Auxiliary Power Unit (APU) Starting		06–16–95	IE

Number	Subject	Ref. No. (CS3-)	Date	Status
TBCE–5	BLEED TRIP OFF Light Illuminating During A No Engine Bleed Takeoff		06–16–95	IE
TBCE–6 R1	Runaway Stabilizer Procedure		09–20–95	IE
TBCE–12	Maneuvering Speeds for 737-100/200/300/400/500		12–03–99	IE
TBCE–13 R2	Upset Recovery		09–30–00	CANC
TBCE–14	UNCOMMANDED RUDDER Non-Normal Checklist		12–15–00	CANC

Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

S

Number: TBCE-1

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: EFIS DISPLAY BLANKING

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

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

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

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

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

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

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

Administrative Information

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin TBCE-1 “In Effect” (IE).

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

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	737 Model
	Boeing Commercial Airplane Group
	P. O. Box 3707 MS 20-89
	Seattle WA 98124-2207
	U. S. A.
Fax Number:	(206) 662-7700
Telex:	329430 Station 627
SITA:	SEABO7X Station 627

Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

S

Number: TBCE-2

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: STANDBY HORIZON INDICATOR DISPLAY

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

Information in this 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 Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin TBCE-2 “In Effect” (IE).

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

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Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

S

Number: TBCE-3

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: NONSELECTED MCP SETTING CHANGES

Reason: This bulletin provides information contained in Red Bulletin 737-300/400/500 90-2R1, dated April 15, 1992, which advised flight crews that nonselected changes in MCP settings can occur ion 737 airplanes equipped with SP-300 autopilots.

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

There 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:

UNCOMMANDED MCP SETTING CHANGES

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

Anytime electrical power is interrupted:

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

Anytime the MCP selected altitude is changed:

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

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

Administrative Information

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin TBCE-3 “In Effect” (IE).

This Operations Manual Bulletin will be cancelled after Boeing is notified that all affected airplanes in the operator’s fleet have been modified by Service Bulletin 737-22A1098. If the operator does not plan to modify all the airplanes and would like to have the contents of this Bulletin incorporated in the Operations Manual, please advise Boeing accordingly. Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

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Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

S

Number: TBCE-4

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: AUXILIARY POWER UNIT (APU) STARTING

Reason: This bulletin provides information contained in Red Bulletin 737-300/400 90-3R2 and 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 bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

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

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

The only means to detect the torching start and/or flames on the empennage surfaces is by an external observer. By the time the observer communicates to the crew that a torching start has occurred, the excess fuel will most likely be consumed and the torching ceased. Unless the operator sees the evidence that a fire exists on the empennage surface, no other flight crew action is required except for a normal APU shutdown to allow the required inspections of the airplane surfaces.

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

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

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

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

.Operating Instructions

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

1. Following any unsuccessful APU start attempt, the subsequent APU ground start attempt(s) must be monitored by a qualified ground observer to assure that the airplane is not damaged due to torching.

2. The placard may be removed and APU ground starting resumed without an observer following appropriate maintenance action to determine and resolve the cause of the unsuccessful ground start, or successful ground or inflight starting and operation is accomplished.

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

Administrative Information

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin TBCE-4 "In Effect" (IE).

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

1. Installation of a Garrett GTCP 85-129 APU with PRR 33890-86 incorporated (installs a modified drain system on airplanes at production line number 20161 and on).

2. Incorporation of Service Bulletin 737-49-1073 (installs the modified drain system on airplanes delivered prior to incorporation of PRR 33890-86).

3. Installation of the Sundstrand APS 2000 alternative APU (includes the modified drain system).

4. Installation of the Garrett GTCP 36-280 alternative APU (includes the modified drain system).

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

Mailing Address:	Manager Flight Technical Publications 737 Model Boeing Commercial Airplane Group P. O. Box 3707 MS 20-89 Seattle WA 98124-2207 U. S. A.
Fax Number:	(206) 662-7700
Telex:	329430 Station 627
SITA:	SEABO7X Station 627

Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

S

Number: TBCE-5

Date: June 16, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: BLEED TRIP OFF LIGHT ILLUMINATING DURING A NO ENGINE BLEED TAKEOFF

Reason: This bulletin provides information contained in Red Bulletin 737-300/400/500 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 bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

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

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

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

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

Operating Instructions

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

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

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

<u>If the BLEED TRIP OFF light remains illuminated</u>:

Accomplish the BLEED TRIP OFF Checklist.

Administrative Information

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin TBCE-5 “In Effect” (IE).

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

Mailing Address:	Manager Flight Technical Publications 737 Model Boeing Commercial Airplane Group P. O. Box 3707 MS 20-89 Seattle WA 98124-2207 U. S. A.
Fax Number:	(206) 662-7700
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Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207 S

Number: TBCE-6 R1

Date: September 20, 1995

Document Effectivity: D6-27370-400E-TBCE

Subject: RUNAWAY STABILIZER PROCEDURE

Reason: This is a reissue of TBCE-6, dated June 16, 1995, 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 bulletin is recommended by The Boeing Company, but may not be FAA approved at the time of writing. In the event of conflict with the FAA approved Airplane Flight Manual (AFM), the AFM shall supersede. The Boeing Company regards the information or procedures described herein as having a direct or indirect bearing on the safe operation of this model airplane.

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

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

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

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

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

Recommended Operating Procedures

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

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

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

Administrative Information

Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin TBCE-6 R1 “In Effect” (IE).

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

Mailing Address:	Manager Flight Technical Publications 737 Model Boeing Commercial Airplane Group P. O. Box 3707 MS 20-89 Seattle WA 98124-2207 U. S. A.
Fax Number:	(206) 662-7700
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Operations Manual Bulletin
for
The Boeing Company

The Boeing Company
Seattle, Washington 98124-2207

S

Number: TBCE-12

Date: December 3, 1999

Document Effectivity: D6-27370-400E-TBCE

Subject: MANEUVERING SPEEDS FOR 737-100/200/300/400/500

Reason: Revise the Boeing Recommended Maneuvering Speeds

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

THE FOLLOWING PROCEDURE AND/OR INFORMATION IS EFFECTIVE UPON RECEIPT

Background Information

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

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

The maneuvering speeds recommended by Boeing are referred to as Block Speeds. Block Speeds are provided for a specific flap setting and a range of weights. The lateral-directional static balance speed has been referred to as "crossover" speed. This is the airspeed that requires full lateral (roll) control from the ailerons and spoilers to counteract roll due to yaw caused by a full rudder input. At speeds slower than the crossover speed, with full rudder input, the roll induced by the rudder starts to exceed the lateral control authority.

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

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

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

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

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

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

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

Operating Instructions

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

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

Table 1

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

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

Table 2

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

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

Table 3

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

FLAP POSITION	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)
FLAPS UP	220	230	240
FLAPS 1	200	210	220
FLAPS 5	190	200	210
FLAPS 10	170	180	190
FLAPS 15	150	160	170
FLAPS 25	140	150	160

Administrative Information

This bulletin cancels Operations Manual Bulletin TBCE-11, dated May 28, 1999. Insert this bulletin behind the Operations Manual Bulletin Record page in Volume 1 of your Operations Manual. Amend the Operations Manual Bulletin Record to show bulletin TBCE-11 “Cancelled” (CANC) and bulletin TBCE-12 “In Effect” (IE).

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

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

Please send all correspondence regarding Operations Manual Bulletin status to one of the following addresses:

Mailing Address:	Manager Flight Technical Publications
	737 Model
	Boeing Commercial Airplane Group
	P. O. Box 3707 M/C 20-89
	Seattle WA 98124-2207
	U.S.A.
Fax:	(206) 662-7812
Telex:	329430 Station 627
SITA:	SEABO7X

Limitations — Chapter L
Table of Contents — Section 0

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Limitations — Chapter L
Operating Limitations — Section 10

General

This chapter contains Airplane Flight Manual (AFM) limitations and Boeing recommended operating information. 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

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

Non–AFM Operational Information

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

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

The maximum demonstrated takeoff and landing crosswind is 35 knots.

Altitude Display Limits for RVSM Operations

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

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

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

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

Weight Limitations

737–300 Airplanes

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

737–400 Airplanes

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

737–500 Airplanes

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

All Airplanes

C. G. Limits	Use approved weight and balance system

(1) May be further restricted by takeoff, enroute, and landing performance.

(2) May be further restricted by field length or climb limit.

Air Systems

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

Non–AFM Air Systems Operational Information

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

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

Anti–Ice, Rain

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

Autopilot/Flight Director System

Do not use aileron trim with autopilot engaged.

Do not engage the autopilot for takeoff below 1000 feet AGL

For single channel operation, the autopilot shall not be engaged below 50 feet AGL.

Communications

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

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

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

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

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

Aircraft Communications Addressing and Reporting System

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

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

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

Electrical Power

Non–AFM Electrical Power Operational Information

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

Maximum generator drive oil temperature: 157° C

Engines and APU

Engine Limit Display Markings

Maximum and minimum limits are red.

Caution limits are amber.

General Engine Limitations

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

Engine Ignition

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

PMC

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

Reverse Thrust

Intentional selection of reverse thrust in flight is prohibited.

Non–AFM Engine 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.

Starter Duty Cycle (normal start) –

- first attempt: 2 minutes on, 20 seconds off
- second and subsequent attempts: 2 minutes on, 3 minutes off.

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.

Non–AFM APU 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.

Do not start or shut down APU during refueling operations.

Flight Controls

Maximum flap extension altitude is 20,000 ft.

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

Non–AFM Flight Controls 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:

Flaps 0 – 15	5 minutes off
Flaps greater than 15	25 minutes off

Flight Management, Navigation

For airplanes with FMC update earlier than U7.2:
During VOR approaches, one pilot must have raw data from the VOR associated with the approach displayed in the EHSI VOR/ILS mode no later than final approach fix.

Non–AFM Flight Management, Navigation Operational Information

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

Do not operate weather radar during fueling or near fuel spills or people.

Fuel

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.

On the ground, main tanks 1 and 2 must be full if center tank contains more than 1,000 lbs (453 kgs).

Hydraulic Power

Non–AFM Hydraulic Power Operational Information

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

Minimum fuel for ground operation of electric hydraulic pumps is 1,676 lbs (760 kgs) in respective main tank.

Landing Gear

Non–AFM Landing Gear Operational Information

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

Do not apply brakes until after touchdown.

Normal Procedures — Chapter NP
Table of Contents — Section 0

General

This chapter contains Normal Procedures. The first section incorporates routine normal procedures and associated flight patterns. The second section incorporates supplementary procedures that are accomplished as required rather than routinely performed.

Controls and Indications – Nomenclature

Controls and indications appear in all UPPERCASE type to correspond to the words on the control panel or display. For example, the following item has UPPERCASE words to match what is found on the panel:

EQUIPMENT COOLING switches .... NORMAL

The word EQUIPMENT is spelled out, even though it is abbreviated on the panel.

The following appears in all lower case because there are no words identifying the panel name.

Audio selector panel .... Set

Normal Procedures

Normal procedures are used by the trained flight crew to ensure airplane condition is acceptable and that the flight deck is correctly configured for each phase of flight. These procedures assume all systems are operating normally and automated features are fully utilized.

Procedures are performed from recall and follow a panel flow. Checklists are used to verify that critical items affecting safety have been accomplished. These procedures are designed to minimize crew workload and are consistent with flight deck technology.

During accomplishment of procedures, it is the crew member's responsibility to ensure proper system response. If an improper indication is noted, first verify that the system controls are properly positioned. Then, if necessary, check the appropriate circuit breaker(s), and test related system light(s).

Before engine start, individual system lights are used to verify system status. If an individual system light is indicating an improper condition prior to engine start, determine if the condition may affect dispatch and require maintenance action or compliance with the Minimum Equipment List (MEL).

After engine start, the MASTER CAUTION system, annunciator lights, and alerts are used as the primary means to alert the crew to a non-normal system condition. Illumination of the MASTER CAUTION and system annunciator lights requires accomplishment of the appropriate non–normal procedure. Upon completion of the procedure and prior to takeoff, the Dispatch Deviations Guide (DDG) or airline equivalent should be consulted to determine if MEL relief is available.

Flight crew duties are organized in accordance with an area of responsibility concept. Each crewmember is assigned a flight deck area where the crewmember initiates actions for required procedures.The panel illustrations in this section describe each crewmember's area of responsibility for pre/post flight and phase of flight.

Pre/post flight duties are apportioned between the captain and first officer, while phase of flight duties are apportioned between the pilot flying (PF) and pilot not flying (PNF). A normal scan flow is encouraged; however, certain items may be handled in the most logical sequence for existing conditions. Actions outside the crew member's area of responsibility are initiated at the direction of the captain. General phase of flight responsibilities are as follows:

Pilot flying (PF):

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

Pilot not flying (PNF):

- checklist reading
- communications
- tasks requested by PF
- start levers and fire switches (with PF concurrence).

Phase of flight duties, beginning with the Takeoff Procedure and ending with completion of the Landing Roll Procedure, are presented in table form in the appropriate procedures section.

The first officer, when flying the airplane, performs the duties listed under PF, and the captain performs those duties listed under PNF.

Note: Although the mode control panel is designated as the PF's responsibility, the PNF should operate the controls on the mode control panel at the discretion of the PF when the airplane is being flown manually.

The captain retains final authority for all actions directed and performed.

Autopilot Flight Director System and Flight Management System Monitoring

When the autopilot, flight director, or autothrottles are in use and a mode change is selected or is scheduled to occur, the annunciation must be verified on the flight mode annunciation display. Airplane course, vertical path, and speed must always be monitored.

Similarly, when a thrust mode change is selected or is scheduled to occur, the annunciation must be verified on the thrust mode display.

In LNAV and VNAV, all airplane course, vertical path, thrust and speed changes must be verified.

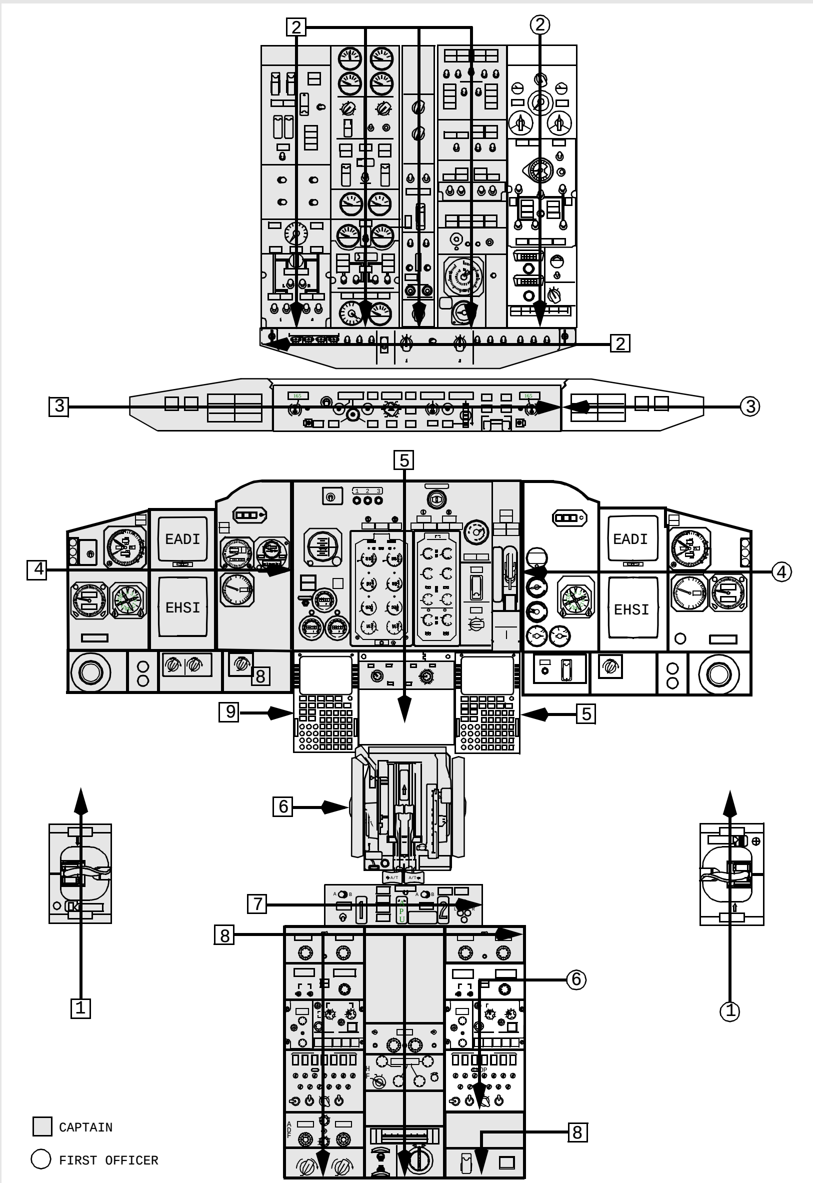
CDU Operation

On the ground, the control display unit (CDU) entries are normally performed by the first officer and verified by the captain.

In flight, CDU entries are normally accomplished by the pilot not flying and verified by the pilot flying prior to execution. CDU entries should be accomplished prior to high workload periods such as departure, arrival, or holding. During high workload periods, using the autopilot modes such as heading select, level change, and the altitude and speed intervention features, if available, may be more efficient than entering complex route modifications into the CDU.

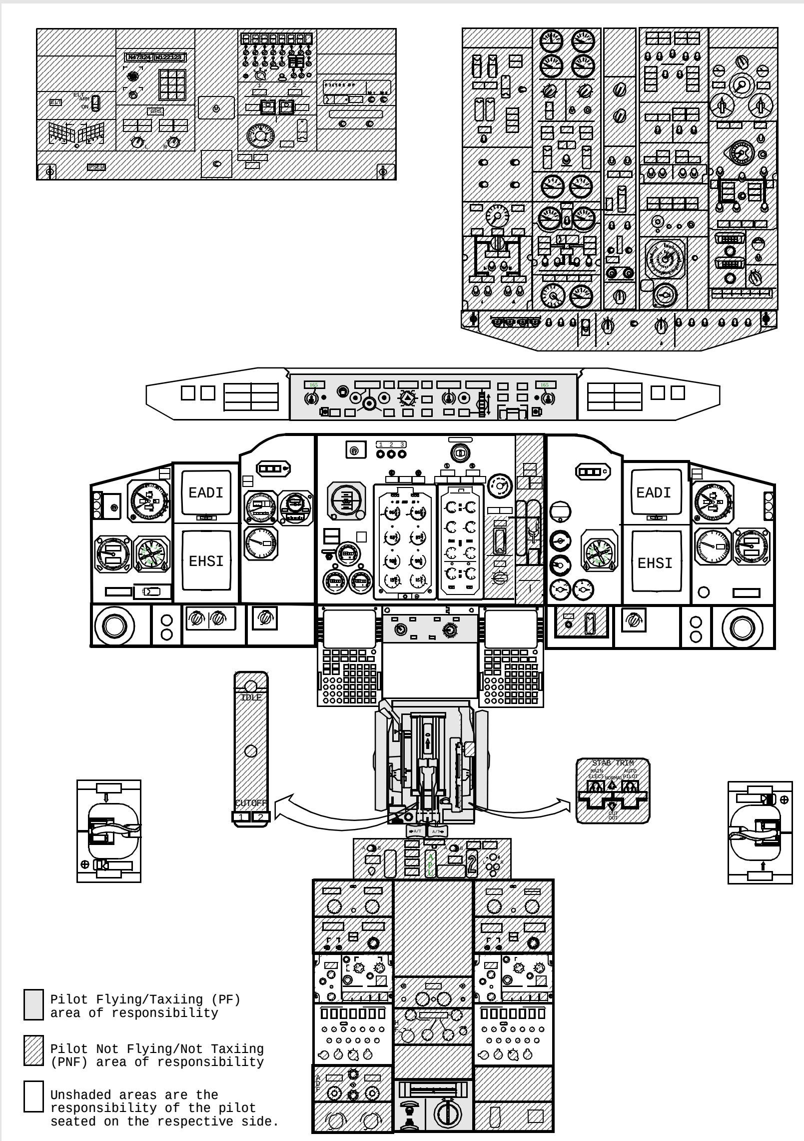
Panel Scan Diagram

The diagram below describes each crew member's area of responsibility and scan flow pattern for each panel when the airplane is not moving under its own power.



Pilot Flying/Taxiing and Pilot Not Flying/Not Taxiing Areas of Responsibility

The diagram below describes each crew member’s area of responsibility for each panel when the airplane is moving under its own power.



Intentionally
Blank

Exterior Safety Inspection – Captain or First Officer

Surfaces and chocks .... Check

Visually check that all movable surfaces are clear and the chocks are in place.

Maintenance status .... Check

Verify maintenance status is acceptable for flight and ensure agreement with authorized dispatch deviations if required.

Flight Deck Safety Inspection – Captain or First Officer

Perform the following checks prior to assuming normal crew positions.

Flight Deck Access Power switch (as installed) .... NORM

BATTERY switch .... ON

Guard – Down

ELECTRIC HYDRAULIC PUMP switches .... OFF

LANDING GEAR lever .... DN

All green landing gear indicator lights – Illuminated

RADAR SWITCHES .... OFF

Preliminary Flight Deck Preparation – Captain or First Officer

GROUND POWER switch (if ground power is available) .... ON

BUS OFF lights – Extinguished

Fault/Inop detection .... Check

OVERHEAT DETECTOR switches – NORMAL

TEST switch – Hold to FAULT/INOP

Verify MASTER CAUTION, OVHT/DET annunciator, FAULT and APU DET INOP lights are illuminated.

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

If APU DET INOP light fails to illuminate, do not operate APU.

Fire/Overheat warning ....Check

Note: Alert ground personnel before this test is accomplished with the APU operating. The fire warning light flashes and the horn sounds on the APU ground control panel.

TEST switch – Hold to OVHT/FIRE

Verify fire warning bell sounds, master FIRE WARN lights, MASTER CAUTION lights and OVHT/DET annunciator illuminate.

Master FIRE WARNING light – Push

Verify master FIRE WARN lights and fire warning bell cancel.

Verify engine No. 1, APU, and engine No. 2 fire warning switch and engine No. 1 and engine No. 2 OVERHEAT lights are illuminated. If AC busses are powered, verify WHEEL WELL fire warning light is illuminated.

Verify FAULT light and APU DET INOP light remain extinguished. If FAULT light illuminates, a detection loop is inoperative.

EXTINGUISHER TEST switch ....Check

Position TEST Switch to 1, verify the green extinguisher test lights are illuminated. Release switch and verify the lights are extinguished. Repeat for test position 2.

APU ....Start & on busses

When the APU GEN OFF BUS light illuminates:

APU GENERATOR bus switches – ON

BUS OFF lights – Extinguished

Note: It is recommended that the APU be operated for one minute before using as a bleed air source.

FLAP lever ....Set

Position the FLAP lever to agree with the FLAPS position indicator.

CARGO FIRE system (as installed) .... Check

DETECTOR SELECT switches – NORM

TEST switch – Push

Verify fire warning bell sounds and master FIRE WARN lights illuminate.

Master FIRE WARN light – Push

Verify master FIRE WARN lights and fire warning bell cancel.

Verify cargo fire (FWD, AFT) warning lights are illuminated.

Verify DETECTOR FAULT light remains extinguished.

Note: If a cargo fire warning light does not illuminate and the DETECTOR FAULT light illuminates, a detection loop is inoperative.

Verify the green EXTINGUISHER test lights are illuminated.

Verify the cargo fire bottle DISCHARGE light is illuminated.

Emergency equipment .... Check

Fire extinguisher – Check and stow

Verify safetied.

Crew oxygen valve .... Open

Circuit breakers (P–6) .... Check

Verify circuit breakers are in or collared in compliance with dispatch requirements.

Flight Recorder .... Test

FLIGHT RECORDER OFF light – Illuminated

FLIGHT RECORDER test switch – TEST

FLIGHT RECORDER OFF light – Extinguished

FLIGHT RECORDER test switch – NORMAL

MACH AIRSPEED WARNING TEST switches .... Push

Verify clacker sounds.

STALL WARNING TEST switches .... Push

Verify control column vibration when each switch is pushed.

Note: With hydraulic power off, the leading edge flaps may droop enough to cause an asymmetry signal, resulting in a failure of the stall warning system test. Should this occur, place the “B” system electric pump ON and retract the flaps. When flaps are retracted, repeat the test.

REVERSER lights ....Extinguished

PMC switches .... ON

Verify INOP lights extinguish.

PASSENGER OXYGEN switch ....NORMAL

Guard – Down

PASS OXY ON light – Extinguished

CAUTION: Switch activation will cause deployment of passenger oxygen masks.

CREW OXYGEN pressure indicator ....Check

Verify pressure meets dispatch requirements.

SERVICE INTERPHONE switch .... As required

IRS mode selectors...NAV

Note: Prior to commencing the alignment procedure the airplane must be parked and not moved until alignment is complete and the ALIGN lights extinguish.

Verify both ON DC lights illuminate momentarily followed by steady illumination of the ALIGN lights. The ALIGN lights will remain illuminated until the IRS enters the NAV mode. If aligning above 70° 12.0’ and less than 78° 15.0’, refer to “IRS HIGH LATITUDE ALIGNMENT” procedure.

Circuit breakers (P–18) ....Check

Verify circuit breakers are in or collared in compliance with dispatch requirements.

Rain repellent .... Check

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

Crash axe .... Stowed

Exterior Inspection

Prior to each flight, the flight crew must accomplish or verify that the maintenance crew has accomplished the following checks.

Note: Alert ground personnel before pressurizing hydraulic system.

ELECTRIC HYDRAULIC PUMP switches .... ON

System A and B pressure – 2800 PSI minimum

Parking brake .... Set

Parking brake warning light – Illuminated

Exterior lights .... Check

General airplane condition .... Check

Check airplane free of damage and fluid leakage.

Probes, sensors, ports, vents and drains .... Unobstructed

Doors, latches and access panels (not in use) .... Properly secured

Tires, brakes and wheels .... Check

If brake wear indicator pins are even with brake housing, check with maintenance.

Gear struts and doors .... Check

Verify door seals secure and struts not fully compressed.

Ground locking pins .... Removed

Nose gear steering lockout pin .... Check

Installed if pushback or tow out will be accomplished, otherwise removed.

Nose wheel snubbers .... In place

Wheel well light switches .... NORMAL

Oxygen pressure relief green disc .... In place

Cargo compartments .... Check

Check condition of compartments, tie–downs and lights.

Ram air deflector door .... Extended

Flight control surfaces .... Unobstructed

Check all surfaces clear of ice, snow, or frost.

Fuel measuring sticks .... Check

Verify measuring sticks agree with alignment marks.

A & B Hydraulic reservoir quantity indicators .... RF or above

Brake accumulator indicator .... 2800 psi minimum

APU fire control handle .... UP

Outflow valve .... Full open

APU fire red and yellow discharge indicators .... In place

Engine fire extinguishers .... Check

Verify pressure adequate per bottle data plate.

ELECTRIC HYDRAULIC PUMP switches .... OFF

Exterior lights .... As required

Flight Deck Preparation – Captain or First Officer

Light test .... Test

Master LIGHTS test and dim switch – TEST

Use scan flow to check all lights flashing or illuminated. Use individual test switches or press to test feature to check appropriate lights which do not illuminate during the light test. The fire warning lights are not checked during this test.

Master LIGHTS test and dim switch – As desired

FMC/CDU .... Set present position

POS INIT page – Select

Using the most accurate information available, enter present position on the SET IRS POS line. Confirm that the box prompts are replaced by the entered present position.

On airplanes with FMC U1.0, U1.1, U1.2 or U3.0 verify that both the ISDU and FMC/CDU display the same present position. Verify for both left and right IRS's.

Flight Deck Preparation – Captain

Escape strap .... Check

Ensure strap is connected to structure.

Sun visor and smoke goggles ....Stowed

Oxygen and interphone .... Check

Audio selector panel – Set

Push FLT INT transmitter selector and receiver switch, and adjust volume controls on receiver switch and overhead speaker. Position microphone selector to MASK.

Oxygen panel – Set

Check mask is properly stowed and NORMAL/100% switch is at 100%.

RESET/TEST slide lever – Push down and hold

Observe momentary yellow cross in flow indicator.

EMERGENCY/TEST selector – Push and hold

While holding RESET/TEST slide lever down, push EMERGENCY/TEST selector and observe constant yellow cross in flow indicator.

Push–To–Talk switch – I/C

While holding RESET/TEST slide lever down and pushing the EMERGENCY/TEST selector, simultaneously key microphone and listen for oxygen flow sound through the overhead speaker. Then release all switches and reposition microphone selector as desired.

Oxygen pressure – Check

Verify pressure meets dispatch requirements.

Flight control panel ....Check

All 5 switch guards – Down

ALTERNATE FLAPS position switch – OFF

YAW DAMPER switch .... ON

YAW DAMPER light – Extinguished

Instrument and
NAV transfer switches ....NORMAL

Fuel system .... _____ LBS/KGS & pumps ON

FUEL VALVE CLOSED light - Illuminated dim

FILTER BYPASS lights – Extinguished

CROSSFEED selector – CLOSED

VALVE OPEN light – Extinguished

Fuel quantity – Check

Verify total fuel quantity meets dispatch requirements.

FUEL PUMP switches (for tanks containing fuel) – ON

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

LOW PRESSURE lights – Extinguished

CAUTION: If a LOW PRESSURE light does not extinguish when the switch is positioned ON, position the switch OFF.

GALLEY power switch .... ON

Electrical system ....Set

STANDBY POWER switch – AUTO

Generator drive DISCONNECT switches – Safetied

BUS TRANSFER switch – AUTO

CIRCUIT BREAKER and PANEL light controls................... As desired

EQUIPMENT COOLING switches .... NORMAL

OFF lights – Extinguished

EMERGENCY EXIT lights switch .... ARMED

Guard – Down

NOT ARMED light – Extinguished

Passenger signs ....Set

NO SMOKING switch – AUTO or ON

FASTEN BELTS switch – AUTO or ON

Windshield WIPER selector .... OFF

If the windshield wipers are not stowed, place the selector in PARK then OFF.

WINDOW HEAT switches ....ON

Position switches ON at least 10 minutes before takeoff.

OVERHEAT lights – Extinguished

ON lights – Illuminated (except at high ambient temperatures)

PITOT STATIC HEAT switches.. OFF

WING and ENGINE ANTI–ICE switches .... OFF

VALVE OPEN lights – Extinguished

Hydraulics... Normal

Note: Alert ground personnel before pressurizing hydraulic system.

System A HYDRAULIC PUMPS switches – ON

System B HYDRAULIC PUMPS switches – ON

Electric pump LOW PRESSURE lights – Extinguished

Brake pressure – 2800 PSI minimum

System A and B pressure – 2800 PSI minimum

Quantity indicators – Above RFL

Pressurization indicators .... Check

Cabin differential pressure – Zero

Cabin altitude – Field elevation

Cabin rate of climb – Zero

Exterior light switches .... As desired

Ignition select switch .... IGN L or R

Alternate ignition select switch on subsequent starts.

ENGINE START switches .... OFF

NAV switches .... As required

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

Mode control panel .... Set

When selecting a value on the MCP, ensure the corresponding display on the instrument panel changes, if applicable.

COURSE(S) – Set and crosscheck

FLIGHT DIRECTOR switches – ON

Position the switch for the pilot flying to ON first.

AUTOTHROTTLE switch – OFF

Heading – Runway heading

Bank angle limit – as desired

Altitude – as desired

Autopilots – DISENGAGE

Marker Beacon Switch .... As desired

Clock .... Set

Left flight instruments .... Set

Note: IRS alignment must be complete.

EFIS – Correct

A/T, Pitch and ROLL FMA's - Blank

A/P STATUS FMA - FD

Flight instrument indications are correct.

Verify no flags displayed.

Altimeter - Set

MAP – Correct

Verify no flags displayed.

Route - Displayed, correct.

NOSE WHEEL STEERING switch ....NORM

Light controls...As desired

Standby instruments .... Check

Standby horizon – Set

Erect horizon and verify proper attitude.

Standby altimeter/airspeed indicator – Set

Set altimeter and verify airspeed is zero.

Fuel quantity indicators .... Check

Test IAW the supplementary procedure.

N1 manual set knobs .... Press

Permits FMC control of the N1 cursors.

Engine Instruments .... Check

Primary and secondary engine indications - Normal

- engine indications display existing conditions
- no exceedance values are displayed
- engine oil quantity meets dispatch requirements

Fuel used reset switch... Press

Engine oil quantity .... Check

ANTISKID switch .... ON

Verify ANTISKID INOP light extinguished.

AUTO BRAKE select switch .... RTO

AUTOBRAKE DISARM light – extinguished

SPEED BRAKE lever .... DOWN detent

Reverse thrust levers .... Down

Forward thrust levers .... Closed

Start levers .... CUTOFF

Parking brake .... Set

Parking brake warning light –Illuminated

STABILIZER TRIM cutout switches .... NORMAL

Wheel well fire warning system .... Test

Note: Delete this test if AC busses were powered during the fire warning check. Alert ground personnel before this test is accomplished with the APU operating. The fire warning light flashes and the horn sounds on the APU ground control panel.

Test switch – Hold to OVHT/FIRE

Verify fire warning bell sounds, master FIRE WARNING lights, MASTER CAUTION lights and OVHT/DET annunciator illuminate.

Fire warning BELL CUTOUT switch – Push

Verify WARN lights and fire warning bell cancel.

WHEEL WELL fire warning light – Illuminated

VHF comm radios .... Set

VHF NAV radios .... Set for departure

EFIS control panel .... Set

EHSI range selector – As desired

EHSI mode selector – MAP

Weather radar switch – OFF

Map switches – As desired

Audio selector panel ....Set

HF radio ....Set

WARNING: Do not key the HF radio while airplane is being fueled. Injury to personnel or fire may result.

FLOOD and PANEL light controls ....As desired

Weather radar ....Set

Transponder ....Set

ADF radio ....Set

RUDDER and AILERON trim ....Free & zero

Check trim for freedom of movement, set trim at zero units.

STABILIZER TRIM override switch .... NORMAL

Seat ....Adjust

Verify positive horizontal (fore and aft) seat lock.

Rudder pedals ....Adjust

Adjust rudder pedals to permit full rudder deflection and brake application. Hold nose wheel steering wheel while moving rudder pedals.

Papers ....Aboard

FMC/CDU ....Set

IDENT page – Check

Verify airplane and engine MODEL and NAV DATA ACTIVE dates are correctly displayed.

POS INIT page – Set

Verify GMT is correct. Enter local time if desired.

RTE page – Select

Enter route by company route identifier or origin and destination airports, then waypoints and/or airways.

DEPARTURES page – Select

Select the active runway and departure/transition procedures, if known.

RTE page – Select

Verify selected departure and route. Correct route discontinuities, ACTIVATE and EXEC.

PERF INIT page – Select

Verify total fuel quantity is displayed on the CDU and that the fuel quantity indicators agree, and are adequate for the planned flight. Enter gross weight or zero fuel weight, fuel reserve and cost index. Enter cruise altitude and verify transition altitude. If desired, enter cruise wind and ISA deviation or top–of–climb temperature. EXEC.

DEPARTURES page – Select (if not previously entered)

Select appropriate runway and departure/transition procedures. Select the RTE page. Verify selected departure. Correct any route discontinuities and EXEC.

Thrust mode display – Check

Verify dashes are displayed.

TAKEOFF REF page – Select

Verify preflight complete. Check displayed OAT against reported value. Enter correct value if necessary.

Enter OAT and takeoff speeds.

If reduced thrust takeoff is planned, enter assumed (SEL) temperature and select the desired mode on the N1 limit page.

Note: Verify N1 reference bugs reflect the full rated N1 value or the derated N1 value if a TAKEOFF DERATE is selected.

Takeoff data .... Check

Verify takeoff data to include N1, V1, VR, V2, flap setting, zero fuel weight, temperature, altimeter setting, gross weight, and stabilizer trim setting.

Flight Deck Preparation – First Officer

Escape strap .... Check

Ensure strap is connected to structure.

Sun visor and smoke goggles ....Stowed

Oxygen and interphone.. Check

Audio selector panel – Set

Push FLT INT transmitter selector and receiver switch, and adjust volume controls on receiver switch and overhead speaker. Position microphone selector to MASK.

Oxygen panel – Set

Check mask is properly stowed and NORMAL/100% switch is at 100%.

RESET/TEST slide lever – Push down and hold

Observe momentary yellow cross in flow indicator.

EMERGENCY/TEST selector – Push and hold

While holding RESET/TEST slide lever down, push EMERGENCY/TEST selector and observe constant yellow cross in flow indicator.

Push–To–Talk switch – I/C

While holding RESET/TEST slide lever down and pushing the EMERGENCY/TEST selector, simultaneously key microphone and listen for oxygen flow sound through the overhead speaker. Then release all switches and reposition microphone selector as desired.

Oxygen pressure – Check

Verify pressure meets dispatch requirements.

Air conditioning system ....____ pack(s), bleeds ON

AIR TEMPERATURE source selector – As desired

Trim air switch (737-400) – ON

Temperature selectors – As desired

RAM DOOR FULL OPEN lights – Illuminated

RECIRCULATION FAN switch(es) – AUTO

Air conditioning PACK switches – One AUTO or HIGH

ISOLATION VALVE switch – AUTO

Engine BLEED air switches – ON

APU BLEED air switch – As required

ON unless external air is used for start.

Pressurization system .... 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

AUTOMATIC FAIL light – Extinguished

NAV switch .... As required

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

Mode control panel .... Set

When selecting a value on the MCP, ensure the corresponding display on the instrument panel changes, if applicable.

COURSE(S) – Set and crosscheck

FLIGHT DIRECTOR switches – ON

Position the switch for the pilot flying to ON first.

Right flight instruments ....Set

Note: IRS alignment must be complete.

EFIS – Correct

A/T, Pitch and ROLL FMA's - Blank

A/P STATUS FMA - FD

Flight instrument indications are correct.

Verify no flags displayed.

Altimeter - Set

MAP – Correct

Verify no flags displayed.

Route - Displayed, correct.

Clock...Set

GROUND PROXIMITY warning SYSTEM
TEST switch .... Push momentarily

Verify switch guards down.

Verify proper operation of the following:
• BELOW G/S and GPWS INOP lights illuminate
• PULL UP and WINDSHEAR alerts illuminate
• "GLIDESLOPE," "PULL UP," and "WINDSHEAR" aurals sound.

Hold the test switch at least 10 seconds to test the above indications and any additional GPWS aural warnings.

Light controls...As desired

VHF NAV radios ....Set for departure

EFIS control panel ....Set

EHSI range selector – As desired

EHSI mode selector – MAP

Weather radar switch – OFF

Map switches – As desired

Audio selector panel .... Set

Seat .... Adjust

Verify positive horizontal (fore and aft) seat lock.

Rudder pedals .... Adjust

Adjust rudder pedals to permit full rudder deflection and brake application. Ensure the captain holds the nose wheel steering wheel while moving rudder pedals.

Takeoff data .... Complete

Complete the takeoff data to include N1, V1, VR, V2, flap setting, zero fuel weight, temperature, altimeter setting, gross weight, and stabilizer trim setting and pass the data card to the captain.

Final Flight Deck Preparation – Captain and First Officer

N1 & IAS bugs .... Set

Verify N1 cursors reflect the full rated N1 value or the derated N1 value if a TAKEOFF DERATE is selected. Set V2 in the MCP IAS/Mach display and check airspeed cursors and speed tape indications. Set airspeed indicator markers (bugs) V1, VR, V2 + 15, and flaps up maneuvering speed.

Engine start clearance .... Obtain

The captain calls “BEFORE START CHECKLIST DOWN TO THE LINE.”

The first officer accomplishes the BEFORE START checklist down to the line.

– – – – – – – – – – – – – CLEARED FOR START – – – – – – – – – – – – –

Doors .... Closed

All exterior door annunciator lights – Extinguished

Flight deck windows .... Locked

Verify the lock levers are in the locked (forward) position.

Air conditioning PACK switches .... OFF

Start pressure ...._____ PSI

The minimum start pressure at sea level is 30 psi. Allow .5 psi reduction for each 1000 feet above sea level.

ANTI–COLLISION light switch ....ON

Alerts the ground crew and tower that the flight crew is starting engines.

The captain calls “BEFORE START CHECKLIST BELOW THE LINE.”

The first officer completes the BEFORE START checklist.

Engine Start Procedure

CAPTAIN	FIRST OFFICER
Announce engine start sequence. Normal starting sequence is 2, 1.	
Announce “STARTING ENGINE No. ___.” Position ENGINE START switch to GRD.	
Verify increase in N2 RPM.	
Acknowledge first officer’s report.	Verify increase in oil pressure by the time engine is stabilized at idle and announce “OIL PRESSURE RISING” when observed.
Position engine start lever to IDLE detent when: • N1 rotation is observed and • N2 RPM reaches 25% or (if 25% N2 is not achievable) • at max motoring and a minimum of 20% N2. Max motoring occurs when N2 acceleration is less than 1% in approximately 5 seconds.	

Verify fuel flow and EGT indication.	
At 46% N2 RPM check ENGINE START switch moves to OFF; if not, position start switch to OFF.	Verify START VALVE OPEN light extinguishes. Verify ENGINE START switch moves to OFF and report "STARTER CUTOUT."
Monitor N1, N2, EGT, fuel flow and oil pressure for normal indications as the engine accelerates and stabilizes at idle.	

Standard day, sea level, approximate stabilized idle indications for CFM56–3.

- N1 RPM – 22%
- N2 RPM – 60%

EGT – 475°C**

Fuel Flow – 326 KGPH

** Idle EGT may vary from 450°C – 650°C depending on OAT, bleed configuration, and engine condition.

CAUTION: Normal engine start considerations:

- Advancing engine start lever to idle prematurely can cause a "HOT" start.
- Keep hand on engine start lever while observing RPM, EGT and fuel flow until stabilized.
- If fuel is shut off inadvertently (by closing engine start lever) do not reopen engine start lever in an attempt to restart engine.
- Failure of ENGINE START switch to hold in GRD until starter cutout RPM is reached can result in a "HOT" start. Do not re–engage ENGINE START switch until engine RPM is below 20% N2.

Note: Accomplish the Aborted Engine Starts procedure for one or more of the following conditions:

- No N1 rotation before the engine start lever is raised to IDLE.
- No oil pressure indication by the time the engine is stabilized at idle.
- No increase in EGT within 10 seconds of raising the engine start lever to IDLE.
- No increase in, or a very slow increase in N1 or N2 after EGT indication.
- EGT rapidly approaching or exceeding the start limit.

After Start Procedure

Electrical ....Generators ON

Both GENERATOR switches – ON

GEN OFF BUS lights – Extinguished

PITOT HEAT switches ....ON

All probe heat lights – Extinguished

Anti–Ice ....As required

Air conditioning system ....SET

Both pack switches - AUTO

APU BLEED air switch – OFF

Flight/Ground switch - FLT

ISOLATION VALVE switch ....AUTO

APU ....As required

Start levers ....IDLE detent

Ground equipment .... Removed

Seat belts and shoulder harnesses .... Fastened

The captain calls “AFTER START CHECKLIST.”

The first officer accomplishes the AFTER START CHECKLIST.

Pushback or Tow Out Procedure

This procedure is required when the airplane is to be pushed back or towed away from the terminal or loading area.

WARNING: Prior to installing the nose gear steering lockout pin, do not make any electrical or hydraulic power changes with tow bar connected. Any change to electrical power may cause momentary pressurization of the nose wheel steering actuators causing unwanted tow bar movement.

Flight interphone contact with ground crew ....Establish

Nose gear steering lockout pin ....Installed

System A HYDRAULIC PUMPS switches .... ON/OFF

If the nose gear steering lockout pin is installed, pushback or tow out may be accomplished with system A pressurized or depressurized.

CAUTION: If the nose gear steering lockout pin is not installed, system A HYDRAULIC PUMPS must be placed OFF.

When cleared for pushback or tow out:

Brakes ....Off

When airplane is stopped:

Brakes .... On

Parking brake .... Set

Tow bar .... Disconnected

Clearance from ground crew ....Clear

Nose gear steering lockout pin ....Removed

System A HYDRAULIC PUMPS switches .... ON

Interphone ....Removed

Before Takeoff

Recall ....Check

Flight controls ....Check

Displace rudder pedals, control wheel and control column in both directions. Verify full travel, freedom of movement and controls return to center. Hold nose wheel steering wheel during rudder check to prevent nose wheel movement.

Flaps .... ______ Green light

Flap position indicator and FLAP lever – Set for takeoff

LEADING EDGE FLAPS EXTENDED green light – Illuminated

Stabilizer trim .... ______units

Verify stabilizer trim is set for takeoff.

Cabin door ....Lock

CABIN DOOR UNLOCKED light – Extinguished

Takeoff briefing .... Review

The pilot taxiing calls “BEFORE TAKEOFF CHECKLIST DOWN TO THE LINE.”

The pilot not taxiing accomplishes the BEFORE TAKEOFF checklist down to the line.

– – – – – – – – – – – – CLEARED FOR TAKEOFF – – – – – – – – – – – –

ENGINE START switches ....CONT

Autothrottle..ARM

When approaching the takeoff runway, arm the autothrottle.

Transponder ....ON

LANDING lights and
STROBE light switches ....As desired

ON unless weather conditions make it undesirable.

FMC position update ....As desired

Enter runway offset on TAKEOFF REF page of FMC/CDU.

The pilot taxiing calls “BEFORE TAKEOFF CHECKLIST BELOW THE LINE.”

The pilot not taxiing completes the BEFORE TAKEOFF checklist.

Takeoff Procedure

PILOT FLYING	PILOT NOT FLYING
Advance thrust levers to approximately 40% N1.	
Observe engine instruments stabilized and normal.	
Press either TO/GA switch to advance the thrust levers to takeoff N1.	
Verify mode annunciation.	Ensure thrust levers advance to takeoff N1. Observe mode annunciation. **Note:** In cases of extreme headwind, the thrust levers may not advance to full N1. In this case, manually advance the thrust levers as required.
Note: After takeoff thrust is set, the captain's hand must be on the thrust levers until V1.	
Hold light forward pressure on the control column, maintain directional control.	Monitor engine instruments. Verify oil pressure is not in the yellow band.
Verify 80 knots.	Call "80 KNOTS." Verify that A/T annunciation changes to THR HLD by 84 knots.
Monitor airspeed, noting V1, and rotate smoothly at VR.	Call "V1," and call "ROTATE" at VR. Monitor flight instruments.
When a positive rate of climb is indicated, call "GEAR UP" and continue rotation to takeoff pitch attitude.	Verify positive rate of climb. Position landing gear lever UP.
Check flight instrument indications.	

After Takeoff Procedure

PILOT FLYING	PILOT NOT FLYING
Maintain a minimum of V2 + 20 kts during initial climb. At light gross weight, a higher speed (up to V2 + 25) may be selected, to synchronize F/D pitch command and avoid objectionable body attitude.	Monitor engine instruments and cross–check flight progress.
Above 400 feet, call for appropriate roll mode, if required. Verify proper mode annunciation.	Select/verify roll mode. Verify proper mode annunciation.
Above 1,000 feet, call for N1 and flaps up maneuvering speed. Verify flight and thrust mode annunciations.	Select N1 and set flaps up maneuvering speed. Verify climb thrust is set. Verify proper mode annunciation.
When above minimum altitude for autopilot engagement, engage A/P. Verify flight mode annunciation.	Verify autopilot engaged.
Retract flaps on takeoff flap retraction speed schedule.	Position FLAP lever as directed and monitor flaps and slats retraction.
Call “AFTER TAKEOFF CHECKLIST” when flaps are up.	Position landing gear lever OFF, APU and engine start switches as required. Verify air conditioning and pressurization operating normally. Accomplish the AFTER TAKEOFF checklist.
Above 3,000 feet AGL, engage VNAV or select normal climb speed and verify annunciation.	Verify proper mode annunciation.

CAUTION: To avoid the possibility of shoulder harness buckles snapping back and pulling or damaging circuit breakers, hold both straps before releasing and then allow straps to retract slowly to the stowed position.

Takeoff Flap Retraction Speed Schedule

T/O FLAPS	SELECT FLAPS	At & below 53,070 Kgs	Above: 53,070 Kgs up to 62,823 Kgs	Above 62,823 Kgs
15	5 1 UP	V2 + 15 170/F 190/F	V2 + 15 180/F 200/F	V2 + 15 190/F 210/F
5	1 UP	V2 + 15 190/F	V2 + 15 200/F	V2 + 15 210/F
1 (737-300 only)	UP	190/F	200/F	210/F

- “F” – Minimum flap retraction speed, existing flap.

Note: 737–400/500 are not certified for flaps 1 takeoff.

Note: Limit bank angle to 15 degrees until reaching V2 + 15.

Climb and Cruise Procedure

PILOT FLYING	PILOT NOT FLYING
	Position landing lights OFF passing through 10,000 feet.
Set altimeters to standard at transition altitude.	
Approaching selected FMC cruise altitude, verify level off and proper mode/N1 limit annunciation.	
	Position center tank fuel pump switches OFF when both pump LOW PRESSURE lights illuminate.
	During the last hour of cruise on all extended range (more than one hour from an adequate airport) flights, perform the Fuel Crossfeed Valve Check.
Set MCP altitude selector for descent.	Prior to top of descent, select and verify the planned arrival procedure on the FMC.
At top of descent point observe descent initiated and verify proper mode annunciation.	

Note: If a center tank LOW PRESSURE light(s) illuminates during takeoff or initial climb, the center tank pump(s) may remain on until the climb attitude is reduced and the light(s) extinguishes or workload allows for the pump(s) to be positioned OFF.

Note: When established in a level attitude at cruise, if the center tank contains usable fuel and the center tank pump switches are off, the center tank pump switches should be positioned ON again. If the center tank contains more than 1000 lbs/453 kgs, the center tank pump switches must be turned ON. Verify the LOW PRESSURE lights extinguish and position both switches OFF when both LOW PRESSURE lights illuminate.

Descent and Approach Procedure

PILOT FLYING	PILOT NOT FLYING
Check and set VREF and approach speeds as required.	
	Set anti–ice as required.
	Verify pressurization is set for destination airport elevation and system operating normally.
Set AUTOBRAKE select switch to desired brake setting.	
Set and crosscheck altimeters at transition level.	
Set and crosscheck course selection and DH REF/radio altimeters as required for approach.	
Set and verify ADF and VHF NAV radios for approach.	
	Position inboard landing lights ON passing through 10,000 feet.
Call "DESCENT–APPROACH CHECKLIST."	Accomplish the DESCENT – APPROACH checklist.
Announce "FLAPS __" according to flap speed schedule.	Position FLAP lever as directed and monitor flap and slat extension. Accomplish standard callouts.
Approaching selected FMC altitude verify level off and mode annunciation.	

Approach Procedure

Using flaps as speedbrakes is not recommended.

The following procedures are used for flap extension:

- Select flaps 1 when decelerating through the flaps–up maneuvering speed, displayed on the speed tape as a green "0."
- When appropriate, select the next flap position and then set the airspeed cursor to that flap maneuver speed.

Note: Flap maneuver speeds provide approximately 15 to 20 knots above the minimum maneuvering speed for each flap setting.

Note: If performance requires use of flaps 15 for landing, place the GROUND PROXIMITY flap inhibit switch to FLAP INHIBIT.

If the flap maneuvering speeds cannot be displayed, reference the Performance In–flight section for speed schedules.

When on final approach in landing configuration, it is not recommended to set the A/T command speed to allow for wind or gust corrections. Through airspeed and acceleration sensing, the A/T corrects for normal wind gusts. Higher command speed settings result in excessive approach speeds. The recommended A/T approach speed setting is VREF + 5.

FLAP MANEUVERING SCHEDULE			
FLAP POSITION	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)
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

Landing Procedure

PILOT FLYING	PILOT NOT FLYING
When on localizer intercept heading, verify ILS tuned and identified, LOC and G/S pointer displayed, arm APP mode and engage the second autopilot.	Set transponder mode selector to desired TCAS mode. (TCAS equipped airplanes.)
Verify mode annunciation.	
At localizer capture, verify proper mode annunciation and set appropriate heading.	Verify proper mode annunciation.
At glide slope “alive,” announce “GEAR DOWN,” “FLAPS 15." Arm the speed brakes and check green light illuminated. Call “LANDING CHECKLIST DOWN TO FLAPS.”	Position landing gear lever DN, and FLAP lever to the 15 detent. Position engine start switch to CONT. Check RECALL.
	Accomplish the LANDING checklist down to flaps. State “HOLDING AT FLAPS.”
At glide slope capture, verify proper mode annunciation, check N1 cursor at the go–around limit and set missed approach altitude.	
Call “FLAPS __” as required for landing. Set MCP speed selector at VREF + 5 kts.	Position FLAP lever as directed.
At final approach fix/OM, verify crossing altitude.	
Call “COMPLETE THE LANDING CHECKLIST.”	Complete the LANDING checklist.
Monitor approach progress and guard the controls. At 500 feet AGL, verify FLARE is armed. At approximately 50 feet AGL, verify FLARE is engaged. Ensure the autothrottle retards the thrust levers to idle by touchdown.	

Go–Around Procedure

PILOT FLYING	PILOT NOT FLYING
Push TO/GA switch. Call “FLAPS 15.” If full GA thrust is required, push TO/GA switch again after reduced GA thrust is established.	Monitor N1 indication. Position FLAP lever to 15 and monitor flap retraction.
Confirm rotation to go–around attitude and monitor autopilot.	
Verify mode annunciation.	
When positive rate of climb is indicated, call “GEAR UP” and monitor acceleration.	Verify positive rate of climb. Position landing gear lever UP.
Check flight instrument indications (MCP speed window blanks.)	
Call “TUNE RADIOS FOR MISSED APPROACH.”	Tune radios as directed.
Above 400 feet, select appropriate roll mode and verify proper mode annunciation.	Observe mode annunciation.
Retract flaps on flap speed schedule.	Position FLAP lever as directed and monitor flaps and slats retraction.
Verify airplane levels off at selected altitude and maintains flap maneuvering speed.	
Call “AFTER TAKEOFF CHECKLIST.”	Accomplish the AFTER TAKEOFF checklist.

Landing Roll Procedure

PILOT FLYING	PILOT NOT FLYING
Ensure thrust levers at idle.	
Disengage autopilot and control airplane manually. Verify autothrottle disengages automatically.	Verify autothrottle is disengaged.
Verify SPEED BRAKE lever (ground spoilers) - UP.	Verify SPEED BRAKE lever UP. Call out “SPEEDBRAKES UP.” If SPEED BRAKE lever is not UP, call “SPPEDBRAKES NOT UP.”
Verify proper autobrake operation.	
Without delay, raise reverse thrust levers to the interlocks, hold light pressure until release, and then apply reverse thrust as required.	Monitor engine instruments and announce any engine limit being approached, exceeded or any other abnormalities.
At 60 knots, reduce reverse thrust to be at IDLE reverse when reaching taxi speed.	Call “60 KNOTS.”
Approaching taxi speed, slowly move the reverse thrust levers to the full down position.	Verify REVERSER UNLOCKED lights extinguished.
Prior to taxi speed, disarm the autobrake and continue manual braking as required.	

WARNING: After reverse thrust has been initiated, a full stop landing must be made.

Taxi In Procedure

When clear of the active runway, the pilot taxiing positions the speed brake lever to the DOWN detent and the pilot not taxiing accomplishes the following:

SPEED BRAKE lever ....Verify DOWN

FLAP lever .... UP

APU (if required) ....START

PITOT STATIC HEAT switches .... OFF

FLT/GRD switch .... GRD

ENGINE START switches .... OFF

LANDING/TAXI light
and STROBE light switches (as installed) ....As desired

FLIGHT DIRECTOR switches .... OFF

WEATHER RADAR .... OFF

Transponder ....As desired

APU GENERATOR switches (if APU operating) ....ON

CAUTION: To avoid the possibility of shoulder harness buckles snapping back and pulling or damaging circuit breakers, hold both straps before releasing and then allow straps to retract slowly to the stowed position.

Shutdown Procedure

After the airplane has come to a complete stop, perform the following actions.

Parking brake ....Set

Parking brake warning light –Illuminated

Electrical ....ON

Verify APU powering busses. If APU is not to be used, connect external power.

Start levers .... CUTOFF

If possible, operate the engines at idle for three minutes prior to shutdown to thermally stabilize the engine hot sections. Operating times at or near idle, such as taxiing before shutdown, are applicable to this three–minute period. If operational requirements dictate, the engines may be shut down with a one–minute cooling period.

FASTEN BELTS switch .... OFF

ANTI–COLLISION light switch .... OFF

FUEL PUMP switches ....OFF

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

GALLEY power switch .... As required

WINDOW HEAT switches ....OFF

WING and ENGINE ANTI–ICE switches ....OFF

ELECTRIC HYDRAULIC PUMP switches ....OFF

RECIRCULATION FAN switch(es) .... As desired

Air conditioning PACK switches .... One AUTO

Engine BLEED air switches.. ON

APU BLEED air switch .... ON

Exterior lights .... As required

AUTO BRAKE select switch..OFF

Flight Deck lights .... As desired

SPEEDBRAKE lever ....DOWN detent

Parking brake .... As required

With chocks in place, the parking brake may be released.

WEATHER RADAR...OFF

Transponder.. As required

Cabin door ....Unlocked

The captain calls “SHUTDOWN CHECKLIST.”

The first officer accomplishes the SHUTDOWN CHECKLIST.

Secure

IRS mode selectors...OFF

EMERGENCY EXIT lights switch ....OFF

Air conditioning PACK switches ....OFF

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/GROUND POWER switch .... OFF

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

The captain calls “SECURE CHECKLIST.”

The first officer accomplishes the SECURE CHECKLIST.

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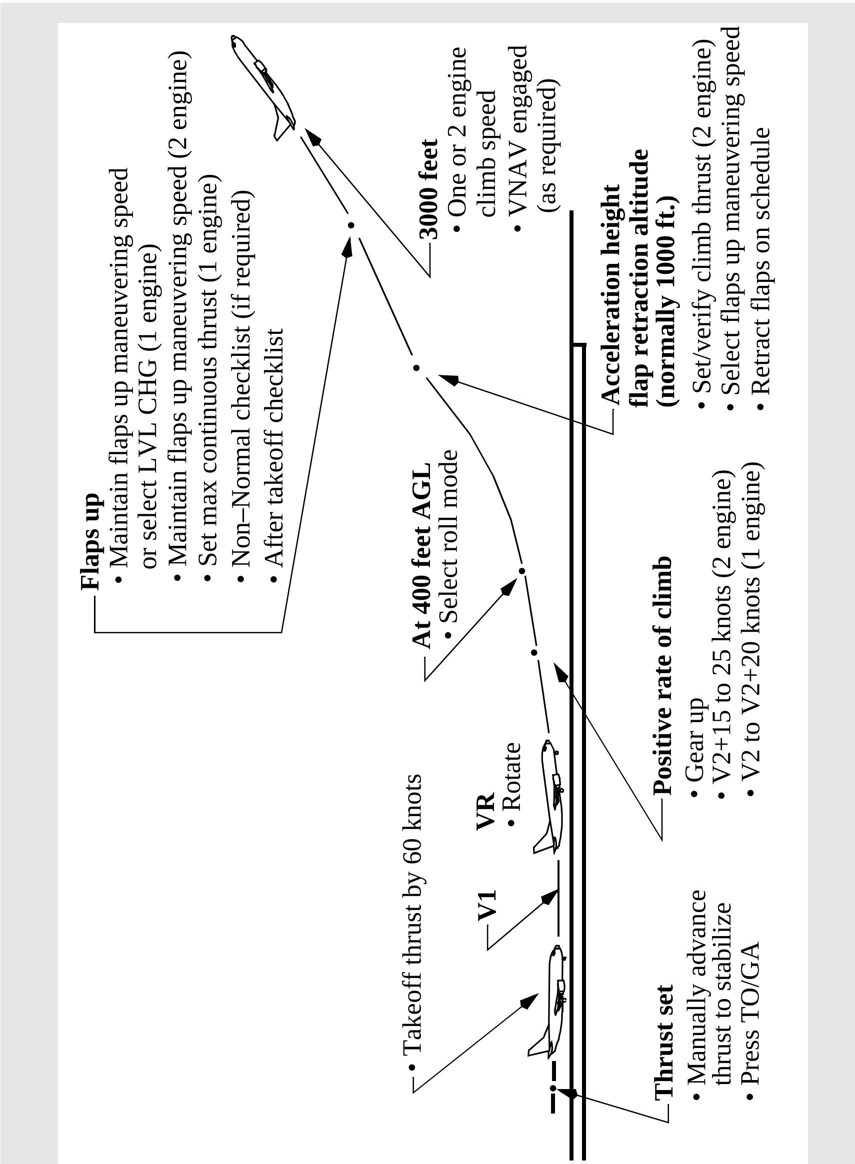
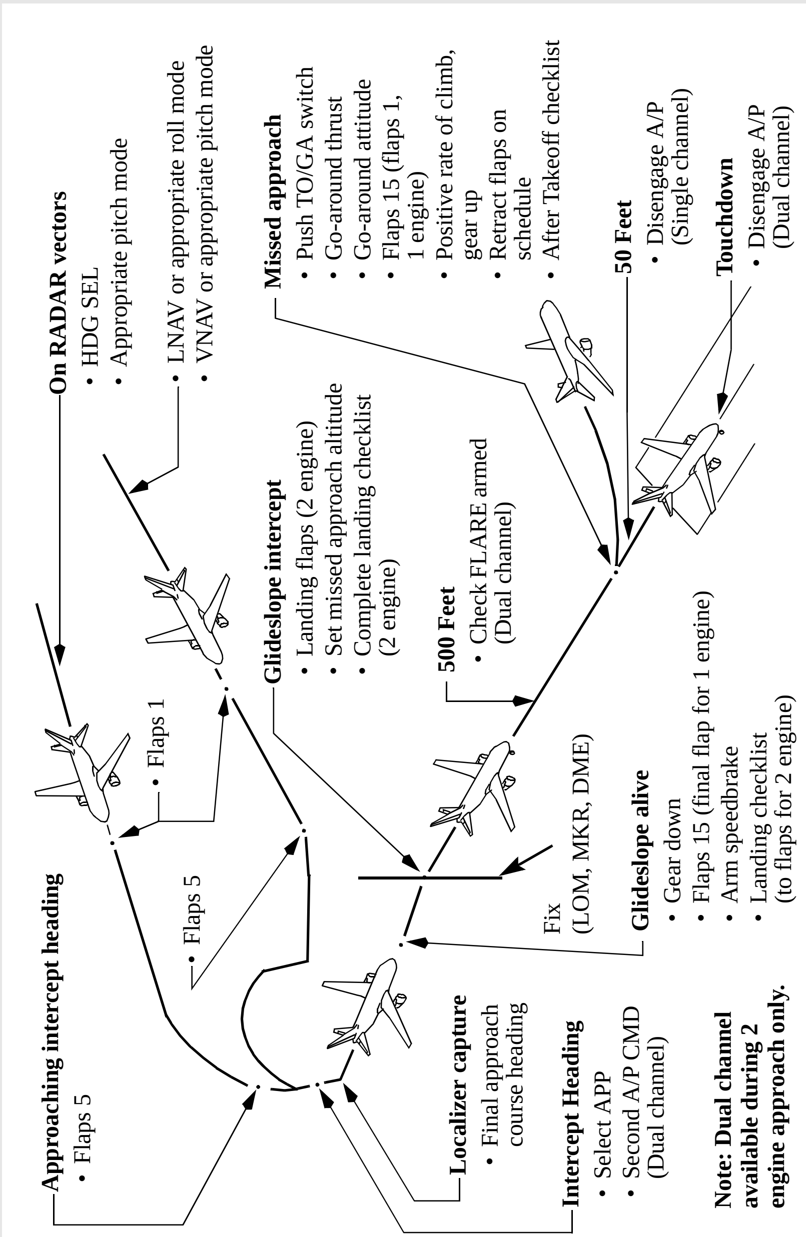
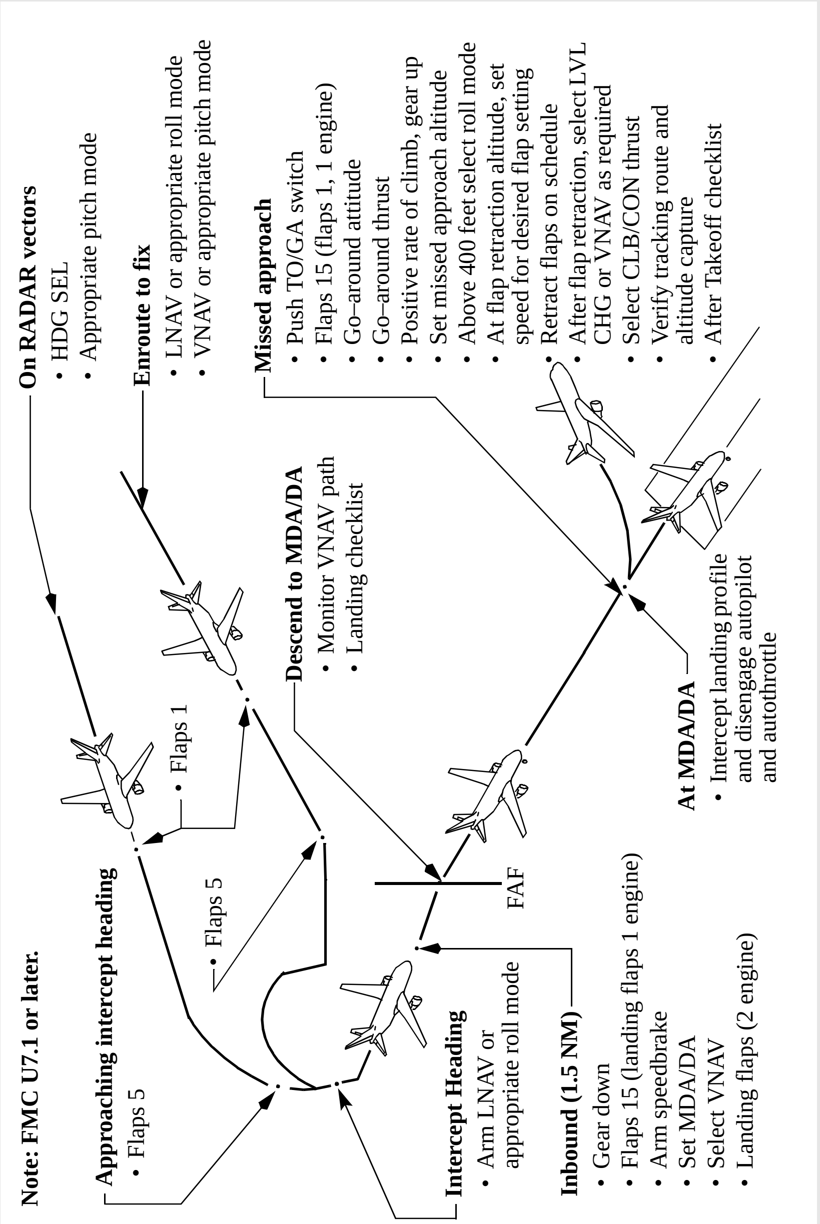
Takeoff


Thrust set
• Manually advance thrust to stabilize
• Press TO/GA
• Takeoff thrust by 60 knots
V1
VR
• Rotate
Positive rate of climb
• Gear up
• V2+15 to 25 knots (2 engine)
• V2 to V2+20 knots (1 engine)
At 400 feet AGL
• Select roll mode
Acceleration height
flap retraction altitude
(normally 1000 ft.)
• Set/verify climb thrust (2 engine)
• Select flaps up maneuvering speed
• Retract flaps on schedule
Flaps up
• Maintain flaps up maneuvering speed or select LVL CHG (1 engine)
• Maintain flaps up maneuvering speed (2 engine)
• Set max continuous thrust (1 engine)
• Non–Normal checklist (if required)
• After takeoff checklist
3000 feet
• One or 2 engine climb speed
• VNAV engaged (as required)

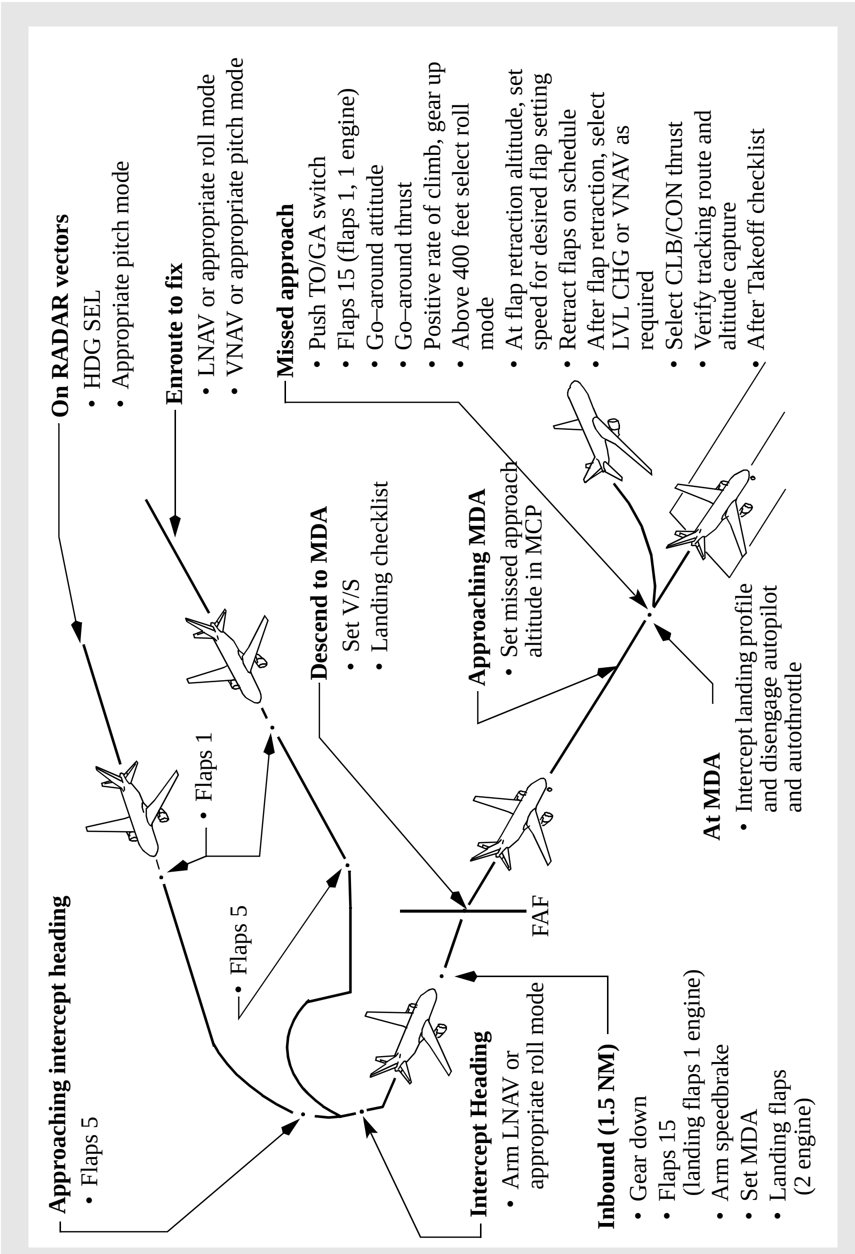
ILS Approach



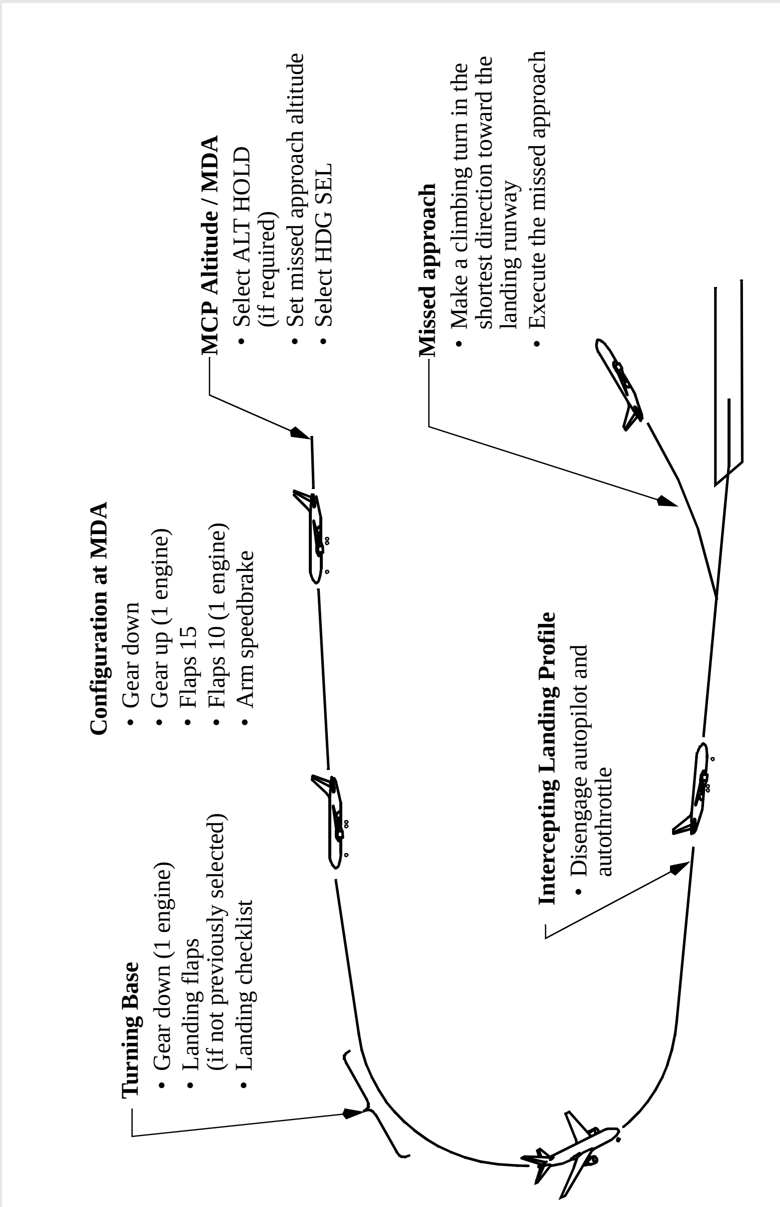
Instrument Approach using VNAV



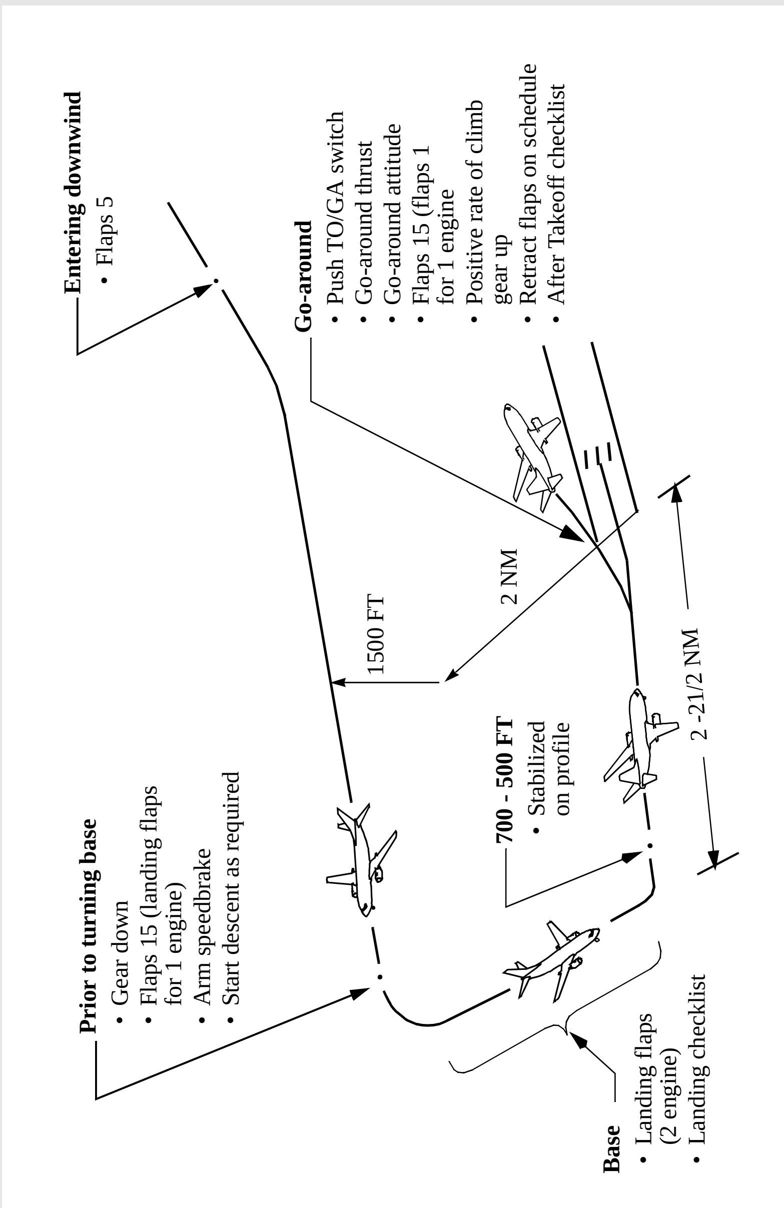
Instrument Approach using V/S



Circling Approach



Visual Traffic Pattern



Supplementary Procedures — Chapter SP
Table of Contents — Section 0

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Supplementary Procedures — Chapter SP
Introduction — 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 recall, 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, Emergency Equipment, 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.

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

CAUTION: Do not move airplane with stair extended.

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

Interior Control

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

To Extend:

Forward Entry Door ....Open to Cocked Position

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

Control Switch..EXTEND

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

Hold until extension is complete.

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

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

Control switch .... Release

Handrail Extensions ....Engage

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

To Retract:

Handrail Extensions ....Disengage

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

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

Control switch .... RETRACT

Hold until retraction is complete.

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

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

Control switch ....Release

Exterior Control

To Extend:

Control Handle .... Push Button to Extend Handle

Control Handle .... Rotate to Extend

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

Control Handle ....Release

Handrail Extensions .... Engage

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

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 Handle .... Rotate to Retract

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

Wing–Body Overheat Test

Wing–body OVHT TEST switch ....Push

Hold for a minimum of 5 seconds.

Both WING–BODY OVERHEAT lights – illuminated

MASTER CAUTION – illuminated

AIR COND system annunciator – illuminated

Wing–body OVHT TEST switch .... Release

Both WING–BODY OVERHEAT lights – extinguished

MASTER CAUTION lights – extinguished

AIR COND system annunciator – extinguished

External Air Cart Use

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

Note: For engine start with a ground air source, see section SP. 7.

APU BLEED air switch .... OFF

ISOLATION VALVE switch .... OPEN

RECIRC FAN switch(es) ....AUTO

PACK switch(es) .... AUTO or HIGH

The operation of two packs from one air source is permitted provided the external air cart can maintain 20 psi minimum with both packs operating.

(737-400) Trim air switch ....ON

Cabin temperature selectors ....AUTO

Set for desired temperature.

Duct pressure ....20 psi min.

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

ISOLATION VALVE switch .... AUTO

APU BLEED air switch .... ON

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

Ground Air Conditioning Cart Use

Before connecting ground air conditioning cart:

PACK switches ....OFF

Allows cart to operate at maximum efficiency.

After disconnecting ground air conditioning cart:

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/GND 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

Flights less than one hour:

Use Normal Procedures.

Flights more than one hour:

Use Normal Procedures except as modified below.

Prior to takeoff:

LAND ALT indicator and
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 final approach turn:

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, configuration for a “No Engine Bleed Takeoff” may be accomplished just after engine start.

Right PACK switch .... AUTO

ISOLATION VALVE switch .... CLOSE

Left PACK switch .... AUTO

Engine No. 1 BLEED air switch ....OFF

APU BLEED air switch .... ON

Engine No. 2 BLEED air switch .... OFF

(737-400) Trim air switch .... ON

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, below 10,000 feet, configure the pressurization system for a no engine bleed landing:

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

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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 power test when all ON lights are illuminated

WINDOW HEAT TEST switch .... PWR

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.

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

Intermediate Level Off (VNAV)

ALTITUDE selector ....Set desired altitude

At MCP altitude:

Verify pitch mode displays ALT HOLD

To continue climb/descent:

ALTITUDE selector..Set desired altitude

VNAV switch .... Push

Verify FMA display:

Thrust mode (climb) – N1

Thrust mode (descent) – RETARD then ARM

Pitch mode – VNAV SPD or VNAV PTH as appropriate

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

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 VNAV

Note: This procedure is not authorized using QFE.

Note: This procedure requires FMC U7.1 or later.

Note: Operational approval required for the use of an MDA as a DA. If required to remain at or above MDA during the missed approach, missed approach must be initiated at least 50 feet above MDA.

Recommended roll modes for final approach:

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

For LOC, LOC-BC, SDF or LDA approaches, ensure appropriate navaids are tuned and identified prior to commencing the approach and monitor raw data throughout the approach. For VOR and NDB approaches, raw data should be monitored, if available.

FMC approach procedure .... Select

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

Verify VNAV glide path angle is displayed on the final approach segment of the LEGS page.

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

[Allows appropriate alerting to occur if ANP exceeds RNP.]

Within 1.5 miles prior to the FAF and after ALT HLD or VNAV PTH is engaged:

MCP altitude ....Set MDA/DA

[Allows VNAV to command descent in VNAV PTH. If the MDA/DA does not end in zero zero, for example, 1820, set MCP ALTITUDE window to the closest 100 foot increment above the constraint.]

Note: There may be a level segment beyond the FAF before intercepting the descent path.

Prior to reaching FAF:

AFDS roll mode ....Verify/select

Verify appropriate roll mode annunciates.

VNAV switch (if required) ....Push

Select VNAV if in ALT HLD. Verify VNAV PTH annunciates.

Autopilot.. Verify engaged

[Autopilot should remain engaged until suitable visual reference is established.]

At MDA/DA/Missed approach point:

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

MCP altitude ....Set missed approach altitude

After suitable visual reference is established:

A/P disengage switch ....Push

Disengage the autopilot before descending below MDA/DA.

A/T disengage switch ....Push

Disengage the autothrottle before descending below MDA/DA.

Instrument Approach using Vertical Speed (V/S)

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

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.

Before descent to MDA:

MCP altitude .... Set

Set the first intermediate altitude constraint or the MDA. 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 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. Use a V/S that results in little or no level flight segment at the MDA.

Verify V/S mode annunciates.

Approaching MDA:

MCP altitude ....Set missed approach altitude

At MDA/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.

A/T disengage switch...Push

Disengage the autothrottle before descending below MDA.

Circling Approach

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

MCP altitude selector ....Set

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

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

Verify ALT HLD mode annunciates.

MCP altitude selector ....Set missed approach altitude

HDG SEL switch ....Push

Verify HDG SEL mode annunciates.

Intercepting the landing profile:

Autopilot disengage switch ....Push

Autothrottle disengage switch ....Push

Intentionally
Blank

Aircraft Communication Addressing and Reporting System (ACARS)

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

Pre-Departure Clearance

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

Digital-Automatic Information Service

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

Oceanic Clearances

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

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

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

Battery Start

(With APU bleed or ground air available)

Prior to a battery start, accomplish the exterior safety inspection and the flight deck safety inspection. Accomplish interior/exterior inspections if required except for items requiring electrical or hydraulic power.

Accomplish the following preliminary flight deck preparation items:

Fault/Inop detection .... Check

Fire/Overheat warning .... Check

EXT TEST switch .... Check

APU (bleed air source if available) .... Start

Flap Lever .... Set

Position the FLAP lever to agree with the FLAPS position indicator.

Emergency equipment .... Check

Circuit breakers .... Check

Flight recorder .... Set

Rain repellent .... Check

Crash axe .... Stowed

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

Oxygen & interphone .... Check

Standby power .... BAT

GALLEY power .... ON

EMER EXIT LIGHTS .... ARMED

Passenger signs .... Set

HYD PUMP switches .... ON

Air conditioning & pressurization .... 1 Pack, bleeds ON, set

Parking brake .... Set

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

Papers .... Aboard

Cleared for Start

PACK switches .... OFF

ANTICOLLISION light switch .... ON

Ignition select switch .... IGN-R

Engine Start

Engine No. 1 should be started first.

Engine No. 1 start .... Accomplish

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

Generator No. 1 switch .... ON

IRS mode selectors .... NAV

FMC/CDU .... Set IRS position

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 No. 2 switch .... ON

After Start

Complete the preliminary flight deck preparation by checking the following items:

MACH AIRSPEED WARNING test switches .... Push

STALL WARNING TEST switches .... Push

REVERSER lights .... Check

PMC switches .... ON

Passenger oxygen switch .... NORMAL

Crew oxygen .... Check

Accomplish panel scan to ensure that the flight deck preparation procedure is complete.

AFTER START checklist .... Accomplish

IRS alignment .... Complete & no flags

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 Start Procedure (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. At least 20% N2 RPM plus an indication of N1 rotation 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 73F (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.

APU Start

Note: With at least one generator operating, subsequent start attempts should be made at succeedingly lower altitudes until a satisfactory start is accomplished.

APU Switch ....START

Momentarily position APU switch to START and release to ON.

Check LOW OIL PRESSURE light illuminates, then extinguishes.

Check APU GEN OFF BUS light illuminates.

Note: The start cycle may take as long as 135 seconds.

Note: If extended APU operation is required on the ground and fuel is loaded in the center tank, place the left center tank fuel pump switch ON to prevent a fuel imbalance before takeoff.

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, extended service life of the APU fuel control unit can be realized by operating at least one fuel boost pump to supply fuel under pressure to the APU.

CAUTION: 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.

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 warning switches illuminate, loop A is good.

If the FAULT light illuminates and one of the ENG OVERHEAT lights and corresponding engine fire warning 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 warning switches illuminate, loop B is good.

If the FAULT light illuminates and one of the ENG OVERHEAT lights and corresponding engine fire warning 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

Flight Controls Check

This is a check of normal flight control functions and is not a complete check of the flight control system. Two people are required; both on interphone.

FLIGHT DECK ACTION	GROUND RESPONSE
Electrical power (APU or external) – On bus	
System A and B electric hydraulic pump switches – OFF	
Control wheel – Left	"LEFT AILERON UP, TAB DOWN; RIGHT AILERON DOWN, TAB UP"
Control wheel – Right	"LEFT AILERON DOWN, TAB UP; RIGHT AILERON UP, TAB DOWN"
Control wheel – Neutral	
Control column – Forward	"ELEVATOR DOWN, TABS UP"
Control column – Aft	"ELEVATOR UP, TABS DOWN"
Control column – Neutral	
Request hydraulic clearance	"CLEAR FOR HYDRAULIC PRESSURE, WING AND CONTROL AREAS CLEAR"
System A and B electric hydraulic pump switches – ON Verify System A & B pressure indicators and brake pressure indicator read 2800 psi minimum	
Parking brake – Set	
Rudder trim – Turn left Verify left rudder pedals move forward	

FLIGHT DECK ACTION	GROUND RESPONSE
Rudder trim – Turn right Verify right rudder pedals move forward	
Rudder trim – Zero, pedals centered	
Aileron trim – Turn left Verify control wheel turns to left	
Aileron trim – Turn right Verify control wheel turns to right	
Aileron trim – Zero, control wheels centered	
Nose gear steering wheel – Hold Control wheel – Left Control column – Forward Rudder pedal – Left	“LEFT AILERON UP, TAB DOWN; LEFT FLIGHT SPOILERS UP; RIGHT AILERON DOWN, TAB UP; RUDDER LEFT; ELEVATORS DOWN, TABS UP”
Nose gear steering wheel – Hold Control wheel – Right Control column – Aft Rudder pedal – Right	“LEFT AILERON DOWN, TAB UP; RIGHT FLIGHT SPOILERS UP; RIGHT AILERON UP, TAB DOWN; RUDDER RIGHT; ELEVATORS UP, TABS DOWN”
Flight controls – Neutral	
Alternate flaps master switch – ARM	
Flap lever – Position 1 Verify no flap movement	

FLIGHT DECK ACTION	GROUND RESPONSE
Alternate flaps position switch – hold DOWN until flap position indicator indicates 1	"FLAPS MOVING DOWN"
Flap position indicator – flaps 1 Verify aft overhead leading edge devices annunciator panel indicates all green (FULL EXTEND) with no amber lights illuminated. Verify LE FLAPS TRANSIT light remains illuminated	"ALL LEADING EDGE DEVICES FULLY EXTENDED"
Alternate flaps master switch – OFF Verify Aft overhead leading edge devices annunciator panel indicates all leading edge flaps full extended and all leading edge slats in extend position Verify LE FLAPS EXT light illuminated	"LEADING EDGE FLAPS FULLY EXTENDED, ALL LEADING EDGE SLATS RETRACTED TO EXTEND POSITION"
Speed brake lever – UP	"ALL SPOILERS UP"
Speed brake lever – DOWN	"ALL SPOILERS DOWN"
Stabilizer trim switches – NOSE DOWN	"STABILIZER LEADING EDGE MOVING UP"
Stabilizer trim switches – NOSE UP	"STABILIZER LEADING EDGE MOVING DOWN"
With stabilizer still moving: Stabilizer trim cutout switches – CUTOUT Verify trim motor stops	

FLIGHT DECK ACTION	GROUND RESPONSE
Stabilizer trim cutout switches – NORMAL Verify Trim motor resumes Control column – Forward Verify Trim motor stops Column actuated stab trim override – OVERRIDE Verify Trim motor resumes	
Stabilizer trim switches – Trim into green band	
Column actuated stab trim override – NORMAL Switch guard – Close	
Request clearance to flaps 30	“FLAPS CLEAR”
Flap lever – Position 30	“FLAPS MOVING DOWN”
Flap lever – UP	“FLAPS MOVING UP”
Parking Brake – As desired Electrical power – As desired	

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	50 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. Differences greater than 400 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

Navigation/General

Transponder Test

Transponder switch .... TEST

Check that the FAIL light illuminates.

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

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

Weather Radar Test

EHSI mode selector .... Expanded scale mode except PLAN

TEST .... ON

WXR (EHSI control panel) .... ON

Verify test pattern consists of the following colors:

- Green
- Yellow
- Red
- Magenta.

Verify no fault messages are present.

IRS Fast Realignment

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

FMC/CDU POS INIT page .... Select

Enter the correct present position (PPOS) into the scratch pad. Use the most accurate PPOS available.

IRS mode selector .... ALIGN

Observe ALIGN light illuminates steadily.

FMC/CDU POS INIT page .... Select

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

IRS mode selector .... NAV

Observe ALIGN light extinguished within 30 seconds.

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

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

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

IRS 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 Align Lights Flashing

When an ALIGN light is flashing, one or more of the following conditions exist:

The IRS present position has not been entered; position entry was attempted before the IRS's entered the ALIGN mode; the entered PPOS may not be within the required accuracy tolerance; or the data entered on the CDU scratch pad may not have been received by the IRS.

CDU Message: ENTER IRS POSITION

CORRECTIVE ACTION: Check and re–enter the correct PPOS into the CDU Scratch Pad and again line select the “SET IRS POS” line (4R).

Note: Pressing Line Select Key 4R without first re–entering the PPOS into the Scratch Pad, will not send the displayed data to the IRS. Also, the PPOS data can be entered by overwriting the data currently displayed in the “SET IRS POS” line; Box prompts are not required.

If repeated attempts to enter the correct PPOS through the CDU are unsuccessful, enter the PPOS directly into the IRS Display Unit.

Special 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 (Update) Entry

Note: Due to IRS drift rate when in the ATT mode, periodic heading updates are required.

IRS mode selector.. ATT

If the FAULT light illuminates when in NAV, select ATT. If the FAULT and ALIGN lights are extinguished after 30 seconds in ATT, then attitude and heading are available (initial magnetic heading must be entered in order to have heading information).

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 ISDU, RDMI's and HSI's.

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 RDMI's and HSI's.

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.

Navigation/Flight Management

Lateral Navigation Using the FMC/CDU

Proceeding Direct To a Waypoint (overwrite)

RTE LEGS page .... Select

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

Observe INTC CRS prompt in line 6R.

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

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

EXEC key .... Push

Observe the MOD RTE LEGS page changes to ACT.

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

Proceeding Direct To a Waypoint (DIR/INTC)

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.

Intercepting a Leg (Course) To a Waypoint

DIR INTC key .... Push

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

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

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

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

EXEC key .... Push

Observe the MOD RTE LEGS page changes to ACT.

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

Route Modification

RTE LEGS or RTE page .... Select

Line select existing waypoints in the desired sequence.

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

EXEC key .... Push

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

Linking a Route Discontinuity

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

EXEC key .... Push

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

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

FIX INFO page .... Select

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

Time and distance to go .... Check

Check ETA and DTG, as desired.

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

Changing Destination

RTE page .... Select

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

EXEC key .... Push

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

Note: If destination is changed during climb, performance predictions may be blanked if the new flight plan is incompatible with the entered cruise altitude. Correct by entering a lower CRZ ALT on the CLB page.

Entering Holding Fix Into Route

HOLD key .... Push

If the RTE HOLD page is displayed, observe the NEXT HOLD prompt. Line select 6L until the (RTE LEGS) HOLD AT page is displayed.

Observe that HOLD AT box prompts and the PPOS prompt (if in flight) are displayed. Enter the holding fix in line 6L, or line select PPOS.

If the holding fix is a waypoint in the active route, or PPOS was selected, observe the MOD RTE HOLD page displayed. If the holding fix is a waypoint not in the active route, observe the message HOLD AT XXXXX displayed in the scratch pad. Enter the holding fix into the route by line selecting in the desired waypoint sequence. Observe the MOD RTE HOLD page displayed. If displayed holding details are incorrect or inadequate, enter correct information on the appropriate line(s).

EXEC key .... Push

Observe the MOD RTE HOLD page changes to RTE HOLD (ACT RTE HOLD if holding at PPOS).

Exiting Holding Pattern

HOLD key .... Push

Observe EXIT HOLD prompt displayed.

EXIT HOLD line select key .... Push

Observe EXIT HOLD prompt changes to EXIT ARMED.

EXEC key .... Push

Observe that EXIT ARMED is highlighted in reverse video and LNAV flight returns to the holding fix and resumes the active route.

Note: The holding pattern may be exited by performing a DIRECT TO modification if desired. In this case, the flight path may not return to the holding fix before proceeding to the selected waypoint.

Entering Created Waypoints on the Route or Route Legs Pages

Note: Created waypoints are stored in the temporary navigation data base for one flight only.

RTE or RTE LEGS page .... Select

Using any of the following methods, key into the scratch pad the parameters which define the new created waypoint (the place identifiers must already be stored in one of the FMC data bases):
- Place bearing/distance (for example, SEA250/40);
- Place bearing/place bearing (for example, SEA180/ELN270);
- Along–track displacement (for example, SEA/-10);
- Latitude and longitude (for example, N4731.8W12218.3).

Enter into the route by line selecting to the appropriate waypoint sequence.

Repeat the above steps to define additional created waypoints as desired. Correct any ROUTE DISCONTINUITY.

EXEC key .... Push

Observe the MOD RTE or MOD RTE LEGS page changes to ACT (for an inactive route, ACTIVATE and EXECute on the RTE or RTE LEGS page).

Along Track Displacement

RTE LEGS page .... Select

Line select the reference waypoint to the scratch pad. Add a "/" and the + or - distance desired. (EX: SEA/15 for a point 15 miles downtrack from SEA.)

Line select the reference waypoint. (The FMC will automatically position the created waypoint to the appropriate position.)

EXEC key .... Push

Observe the MOD RTE LEGS page change to ACT.

Entering Created Waypoints on the Nav Data Pages

Note: Created waypoints entered on the SUPP NAV DATA pages (permitted on the ground only) are stored in the supplemental navigation data base for an indefinite time period; those entered on the REF NAV DATA pages are stored in the temporary navigation data base for one flight only.

INIT/REF key .... Push

Observe the INDEX prompt displayed.

INIT/REF INDEX page .... Select

Observe the NAV DATA prompt displayed. To access the SUPP NAV DATA page, key SUPP into the scratch pad.

NAV DATA page .... Select

If the SUPP NAV DATA page is selected, observe the EFF FRM date line displayed. Enter the current or appropriate date on line 3R and EXECute.

Enter a crew–assigned identifier on either the WPT IDENT, NAVAID IDENT, or AIRPORT IDENT line, as appropriate. Use the navaid category only for stations with DME.

DATA .... Enter

For a WPT IDENT entry, define the waypoint with entries for either latitude and longitude, or with entries for REF IDENT and RADIAL/DIST (the REF IDENT identifier must already be stored in one of the FMC data bases).

For a NAVAID IDENT or AIRPORT IDENT entry, enter appropriate data.

The EXEC key illuminates when data has been entered into all box prompts.

EXEC key .... Push

Repeat the above steps to define additional created waypoints as desired. To enter a new identifier in the same category, simply overwrite the previous identifier.

Note: To enter a created waypoint into the flight plan, key the identifier into the scratch pad and follow the route modification procedure.

Deleting Created Waypoints on the Nav Data Pages

INIT/REF key .... Push

Observe the INDEX prompt displayed.

INIT/REF INDEX page .... Select

Observe the NAV DATA prompt displayed. (U3 and on) To access the SUPP NAV DATA page, key SUPP into the scratch pad.

NAV DATA page .... Select

Enter the identifier on either the WPT IDENT, NAVAID IDENT, or AIRPORT IDENT line, as appropriate.

DATA ....Delete

Press the DEL Key and then line select the identifier. Observe the EXEC Key illuminate.

EXEC Key .... Push

Data previously entered is deleted. Observe NAV DATA page displayed with prompts.

Entering a Crossing Radial (Bearing) or Distance from a Fix as a Route Waypoint

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 Use for Position Updating

Note: This procedure inhibits the use of VOR bearing information or DME information for FMC position updating. Use the DEL key to remove a VOR or DME from inhibit status.

INIT/REF key (prior to U7) .... Push

Observe the INDEX prompt displayed.

INIT/REF INDEX (U7 - PROG) page .... Select

Observe the NAV DATA (U7 - nav status) prompt displayed.

REF NAV DATA (U7 - NAV STATUS) page .... Select

NAV OPTIONS (U7) .... Select (NEXT/PREV PAGE)

Observe dash prompts for VOR or DME INHIBIT. Enter the desired VOR or DME identifier (a previous entry may be overwritten but will no longer be inhibited.)

Entering a Lateral Offset (U7)

RTE page .... Select

Observe OFFSET prompt displayed.

LATERAL OFFSET page .... Select

Observe the dash prompts for OFFSET DIST.

OFFSET DIST .... Enter

Enter desired offset distance using formal Lxx or Rxx for left or right offset up to 99 nm. Observe the dash prompts for START WAYPOINT and END WAYPOINT.

START/END WAYPOINT .... Enter

If no start/end waypoint is entered, offset will begin/end at first/last valid offset leg.

FMC Navigation Check

If the IRS NAV ONLY, VERIFY POSITION or UNABLE REQUIRED NAV PERFORMANCE – RNP message is displayed in the CDU scratch pad, or course deviation is suspected, accomplish the following as necessary to ensure navigation accuracy:

Ensure that one VOR is operating in the AUTO tuning mode so that the FMC can update its position if navaids are available. Check the (prior to U7) PROGRESS or (U7) NAV STATUS page to ensure that radio updating is occurring. In some cases, it may be necessary to switch both VOR's to the AUTO mode to achieve radio updating.

Determine the actual airplane position using raw data from the VHF navigation or ADF radios and compare that position with the FMC position. (Use the FIX page.)

If radio navaids are unavailable, compare the FMC position with the IRS positions using the POS REF page of the FMC CDU. If the two IRS positions are in agreement and the FMC position is significantly different, the FMC position is probably unreliable. The POS SHIFT page may be used to shift the FMC position to one of the IRS positions. This is accomplished by line selecting the IRS or radio position and then pressing the EXEC Key.

Confirm actual position with ATC radar or visual reference points if available.

Navigate using the most accurate information available. The possibilities are: LNAV (continue to monitor FMC position using VOR/ADF raw data displays on the non–flying pilot's EHSI).

CAUTION: Navigating in the LNAV mode with an unreliable FMC position may result in significant navigation errors.

Conventional VOR/ADF procedures. Radar vectors from ATC. Dead reckoning from last known position. Alternate Navigation System (ANS). Use of visual references.

Lateral Navigation Using the AN/CDU

Entering Active FMC Flight Plan into AN/CDU

INIT/REF key .... Push

Observe the INDEX prompt is displayed.

INIT REF INDEX page .... Select

Press the INDEX prompt. Observe the INIT REF INDEX page displayed and the IRS NAV prompt in line (5R).

IRS LEGS page .... Select

Press the IRS NAV prompt. Observe the IRS LEGS page displayed and the prompt in line 5L: CROSSLOAD prompt if an active FMC flight plan exists; LAST FMC PLAN prompt if the FMC has failed and an active FMC flight plan existed prior to the failure.

FMC flight plan ....Enter

Line select 5L to display the active (or most recent) flight plan. A maximum of 20 waypoints can be displayed. Undefined procedural legs contained in the FMC flight plan are bypassed in the AN/CDU flight plan. Modify the flight plan if desired.

EXEC key .... Push

Observe the IRS LEGS page changes to ACT.

Note: If the present FMC flight plan exceeds 20 waypoints: Repeat the above procedure during flight to update the AN/CDU flight plan with additional waypoints.

Manual Entry of AN/CDU Flight Plan

INIT/REF key .... Push

Observe the INDEX prompt is displayed.

INIT REF INDEX page .... Select

Press the INDEX prompt. Observe the INIT REF INDEX page displayed and the IRS NAV prompt in line (5R).

IRS LEGS page .... Select

Key any of the following into the scratch pad:

- For a crew assigned identifier, key in the identifier (6 characters maximum) followed by latitude and longitude (for example, SIMONE/N4802.2W12241.3).

-For an AN/CDU assigned identifier, key in only latitude and longitude (for example, S3618.5E14136.9). The AN/CDU assigns a sequential identifier WPT01, etc.

-If repeating an identifier which is already in the flight plan, key in only the identifier (for example, SEA).

Enter each waypoint into the route by line selecting to the desired sequence. A maximum of 20 waypoints can be in the flight plan at any one time. If required, additional waypoints can be entered as the flight progresses.

EXEC key .... Push

Observe the IRS LEGS page changes to ACT.

Proceeding Direct to a Waypoint

IRS LEGS page .... Select

Key any of the following into the scratch pad:

- For a crew assigned identifier, key in the identifier (6 characters maximum) followed by latitude and longitude (for example, SIMONE/N4802.2W12241.3).

-For an AN/CDU assigned identifier, key in only latitude and longitude (for example, S3618.5E14136.9). The AN/CDU assigns a sequential identifier WPT01, etc.

-If repeating an identifier which is already in the flight plan, key in only the identifier (for example, SEA).

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

EXEC key .... Push

Observe the MOD IRS LEGS page changes to ACT.

Route Modification

IRS LEGS page .... Select

Line select existing waypoints in the desired sequence.

Key in any new waypoints in the scratch pad and line select into the flight plan.

EXEC key .... Push

Observe the MOD IRS LEGS page changes to ACT.

Vertical Navigation Using the FMC/CDU

Temporary Level Off During Climb or Descent (Not at FMC Cruise Altitude)

MCP altitude selector .... Set

Set level–off altitude. Observe VNAV ALT on the flight mode annunciator as level–off is initiated.

MCP N1 light will extinguish if leveling from a climb.

N1 Limit changes to CRZ if leveling from a climb.

To Continue Climb or Descent

MCP altitude selector .... Set

Set level–off altitude.

VNAV switch .... Push

Observe climb or descent 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.

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 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

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.

Intentionally
Blank

Fuel Balancing

Maintain main tank No. 1 and No. 2 fuel balance within limitations.

Note: Fuel pump pressure should be supplied to the engines at all times. At high altitude, without fuel pump pressure, thrust deterioration or engine flameout may occur.

If the center tank contains fuel:

Center tank fuel pump switches .... OFF

Crossfeed selector .... Open

Fuel pump switches (low tank) .... OFF

When quantities are balanced:

Fuel pump switches (main tank) .... ON

Center tank fuel pump switches .... ON

Crossfeed selector .... Close

If the center tank contains no fuel:

Crossfeed selector .... Open

Fuel pump switches (low tank) .... OFF

When quantities are balanced:

Fuel pump switches .... ON

Crossfeed selector .... Close

Refueling

Fuel Load Distribution

Main tanks No. 1 and No. 2 should normally be serviced equally until full. Additional fuel is loaded into the center tank until the desired fuel load is reached.

Note: Main tanks No. 1 and No. 2 must be scheduled to be full if the center tank contains more than 453 kilograms of fuel. With less than 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 1136 liters per minute.

Normal Refueling

When a full fuel load is required, the fuel shutoff system closes the fueling valves automatically when the tanks are full. When a partial fuel load is required, the fuel quantity indicators are monitored and the fueling valves are closed by manually positioning the fueling valve switches to CLOSED when the desired fuel quantity is aboard the airplane.

Refueling with Battery Only

When the APU is inoperative and no external power source is available, refueling can be accomplished as follows:

Battery switch .... ON

Standby power switch ....BAT

The battery operates the entire fueling system normally, including the gages and fuel shutoff system. The only limitation during this type of operation is the battery life.

Refueling with No AC or DC Power Source Available

When it becomes necessary to refuel with the APU inoperative, the aircraft battery depleted, and no external power source available, refueling can still be accomplished:

Fueling hose nozzle .... Attached to the refueling receptacle

Fueling valves .... Open for the tanks to be refueled

Note: Main tanks No. 1 and No. 2, and the center tank refueling valves each have a red override button that must be pressed and held while fuel is being pumped into the tank. Releasing the override button allows the spring in the valve to close the valve.

Caution must be observed not to overfill a tank, since there is no automatic fuel shutoff during manual operation. When the desired amount of fuel has been pumped into the tanks, the refueling valves for the respective tanks can be released. Main tanks No. 1 and No. 2 may also be refueled through filler ports over the wing. It is not possible to refuel the center tank externally.

Ground Transfer of Fuel

Fuel can be transferred from one tank to another tank by using the appropriate fuel pumps, the defueling valve and the crossfeed valve. AC power must be available. To transfer fuel from the main tanks to the center tank:

Main tank fuel pump switches .... ON

Crossfeed selector .... Open

Manual defueling valve .... Open

Center tank fueling valve switch .... OPEN

Fuel transfer .... Monitor

The center tank fuel quantity indicator shows an increase in fuel. The main tank indicators show a decrease in fuel.

Center tank fueling valve switch .... CLOSED

When the required amount of fuel has been transferred, the switch is closed at the fueling panel.

Manual defueling valve .... Close

Crossfeed selector .... Close

Main tank fuel pump switches .... OFF

Main Tanks .... Refill

Refueling panel and defuel panel access doors .... Close

Fuel Crossfeed Valve Check

Crossfeed selector ....Open

Verify Crossfeed VALVE OPEN light illuminates bright and then dim.

Crossfeed selector ....Close

Verify Crossfeed VALVE OPEN light illuminates bright and then extinguishes.

Fuel Quantity Indicators Test

Note: With a fuel quantity indicator inoperative, a zero fuel quantity input will be sent to the fuel summation unit causing a possible FMC gross weight error.

Fuel quantity test switch .... Push and hold

Hold until the fuel quantity indicators drive to zero and "ERR 4" is displayed.

Note: Do not push the QTY TEST switch when the airplane is being fueled. This will cause inaccurate indications at the external fueling panel.

Fuel quantity test switch ....Release

Releasing the test switch initiates a self-test. The fuel quantity indicators display:

All segments for two seconds

Blank for two seconds

Stored error codes (if any) for two seconds each

Indicator full scale value for two seconds

Actual fuel quantity.

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.

The following recommendations apply to adverse weather operations in general:

- Do not use assumed temperature reduced thrust for takeoff on a contaminated runway.
- V1 may be reduced to minimum V1 (assuming all weight limitations are considered) to provide increased stopping distance performance.
- Takeoffs on slippery runways are not recommended if the crosswind exceeds 15 knots or when slush or wet snow is more than 1/2 inch (13mm) in depth.
- Improved stall margins can be achieved by the following:
  - If excess runway is available, consider using improved climb procedures for flaps 1 or 5 (737-300) or flaps 5 (737-400/500.)
  - If runway is limited for the planned takeoff flap setting, consider using the next greater flap position with improved climb performance. This will provide additional stall margins with minimum performance penalties.

Cold Weather Operation

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

Icing conditions exist when TAT is 10°C (50°F) or below and:

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

CAUTION: Do not operate engine or wing anti–ice when the total air temperature (TAT) is above 10°C (50°F).

Preflight

Although removal of surface snow, ice or frost is normally a maintenance function, the flight crew should use additional care and scrutiny during preflight preparation to inspect areas where surface snow or frost could change or affect normal system operations.

Exterior Safety Inspection

Surface..Check

Takeoff with light coatings of frost, up to 1/8 inch (3mm) in thickness on lower wing surfaces due to cold fuel, is permissible; however, all leading edge devices, all control surfaces, tab surfaces, upper wing surfaces and balance panel cavities must be free of snow or ice.

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 refreeze in flight.

Landing gear doors..Check

Landing gear doors should be free of snow or ice.

Air conditioning inlets and exits ....Clear

Verify air inlets and exits, including the outflow valve, are clear of snow or ice. If the APU is operating, check that the outflow valve is full open.

Engine inlets..Clear

Check inlet cowling free of ice or snow and verify the fan is free to rotate.

APU air inlets ....Check

The APU inlet door and cooling air inlet must be free of snow or ice prior to APU start.

Fuel tank vents ....Clear

Check all fuel tank vents. All traces of ice or frost should be removed.

Pitot static ports...Clear

Check all pitot probes and static ports free of ice and snow. Water rundown after snow removal may refreeze 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 themselves are clear.

Flight Deck Preparation

PITOT HEAT .... ON

All probe heat lights – extinguished.

Flight controls .... Check

This check should be accomplished whenever the airplane has been exposed to snow, freezing rain or other conditions which could restrict flight control movement.

Increase in control forces can be expected at low temperatures because of increased resistance in cables and thickened oil in snubbers and bearings.

If any flight control is suspected of binding or restricted movement, maintenance personnel should accomplish the appropriate portion of the flight control checks in SP.9, supplementary procedures

Engine Start

Accomplish a normal engine start with the following modifications:

- If ambient temperature is below -35°C (-31°F), idle the engine for two minutes before changing thrust lever position.
- Up to three and one–half minutes may be allowed for oil pressure to reach the minimum operating pressure. During this period, the LOW OIL PRESSURE light may remain illuminated, 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.

After Start

Electrical power .... Generators ON

Normally the generator drive will stabilize within one minute, although due to cold oil, up to five minutes may be required to produce steady power.

Flight controls .... Check

Move flight controls through full travel to ensure freedom of movement.

Flaps .... Check

Move flaps through full travel to ensure freedom of movement.

CAUTION: The flap position indicator and 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.

Engine Anti–Ice Operation–On the Ground

Engine anti–ice must be 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.

When engine anti–ice is required (on the ground):

ENGINE START switches .... CONT

ENG ANTI–ICE switches .... ON

COWL VALVE OPEN lights – illuminated dim

COWL ANTI–ICE lights – extinguished

Note: If 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).

Engine run–up .... Accomplish as required

Run–up to as high a thrust setting as practical (70% N1 recommended) at 30 minute intervals for approximately 30 seconds duration.

Wing Anti–Ice Operation–On the Ground

Wing anti–ice must be ON during all ground operations between engine start and takeoff, when icing conditions exist or are anticipated, unless the airplane is protected by the application of Type II or Type IV fluid in compliance with an approved ground deicing program.

WARNING: Ground use of the wing anti–ice system is intended to complement, and not replace, ground deicing/anti–icing and inspection procedures. Close inspection is still required 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.

WING ANTI–ICE switch .... As required

If wing anti–ice switch is ON:

VALVE OPEN lights – illuminated 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.

Taxi–Out

Nose wheel steering .... Check

Nose wheel steering should be exercised in both directions during taxi to circulate warm hydraulic fluid through steering cylinders and minimize steering lag caused by low temperatures.

Flaps .... As required

If taxi route is through slush or standing water in low temperatures or if precipitation is falling with temperatures below freezing, taxi with flaps up. Taxiing with flaps extended subjects the flaps and flap drives to snow and slush accumulations from the main gear wheels. Leading edge devices are also susceptible to slush accumulations.

If exterior deicing is required:

Flaps .... UP

Prevents ice and slush from accumulating in flap cavities.

Thrust levers .... Idle

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

Stabilizer trim .... Full APL NOSE DOWN

Set stabilizer to the APL NOSE DOWN limit to prevent deicing fluid and slush run–off from entering the stabilizer balance panel cavity.

Trim the airplane to the electrical APL NOSE DOWN limit. Then continue trimming manually to the manual APL NOSE DOWN limit.

WARNING: To avoid personal injury, ensure that the stabilizer trim wheel handle is stowed prior to using electric trim.

APU and engine BLEED air switches .... OFF

Reduces the possibility of fumes entering the air conditioning system.

APU .... As required

If not required, the APU should be shut down to eliminate the possibility of deicing fluid entering the APU inlet.

CAUTION: With APU operating, ingestion of deicing fluid causes objectionable fumes and odors to enter the airplane. This may also cause erratic operation or damage to the APU.

Wait approximately one minute after completion of deicing to turn engine BLEED air switches on to ensure all deicing fluid has been cleared from the engine:

Engine BLEED air switches .... ON

Before Takeoff

Flaps .... Set

Extend the flaps to the takeoff setting at this time if they have been held due to slush, or standing water or icing conditions.

BEFORE TAKEOFF Checklist..Accomplish

To ensure the airplane is configured for takeoff, accomplish the complete BEFORE TAKEOFF checklist.

If airplane deicing was accomplished:

A visual inspection of the airplane wings should be made just prior to takeoff.

Engine run–up .... Accomplish as required

If moderate to severe icing conditions are present, takeoff roll must be preceded by a static run–up to 70% N1 and stable engine operation observed prior to brake release. If the airplane starts to slide on ice or snow during engine power check, release brakes and begin takeoff roll. Continue engine check during early part of takeoff roll.

Climb and Cruise

Note: After the flaps are up, wing anti–ice should be used to melt any accumulation of slush.

Engine Anti–Ice Operation-Inflight

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 prior to, and during, descent in all icing conditions, including temperatures below –40°C SAT.

When operating in areas of possible icing, activate engine anti–ice prior to entering icing conditions. Late selection of engine anti–ice may allow inlet ice buildup and ice shedding into the engine.

WARNING: Do not rely on airframe visual icing cues before activating engine anti–ice. Use the temperature and visible moisture criteria.

When engine anti–ice is required inflight:

ENGINE START switches ....CONT

ENG ANTI–ICE switches ....ON

COWL VALVE OPEN lights – illuminated dim

COWL ANTI–ICE lights – extinguished

Note: If 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.)

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 accomplish the following, on both engines, one engine at a time at approximately 15 minute intervals:

Thrust .... Increase

Increase thrust to a minimum of 80% N1 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, accomplish the following on both engines, one engine at a time:

ENGINE START switch ....FLT

Thrust .... Adjust

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, accomplish the procedure for HIGH ENGINE VIBRATION “If not in icing conditions.”

When engine anti–ice is no longer required:

ENG ANTI–ICE switches .... OFF

COWL VALVE OPEN lights – extinguished

ENGINE START switches .... OFF

Wing Anti–Ice Operation-Inflight

The wing anti–ice system may be used as a deicer or anti–icer in flight. The primary method is to use it as a deicer 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.

The secondary method is to use wing anti–ice prior to 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.

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.

Normally it is not necessary to shed ice periodically unless extended flight through icing conditions is necessary (holding).

CAUTION: Use of wing anti-ice above approximately FL350 may cause bleed trip off and possible loss of cabin pressure.

When wing anti–ice is required:

WING ANTI–ICE switch .... ON

R and L VALVE OPEN lights – illuminated dim

When wing anti–ice is no longer required:

WING ANTI–ICE switch .... OFF

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.

Approach and Landing

If ice formations are observed on the airplane surfaces, (wings, windshield wipers, window frames, etc.):

Final Approach Airspeed .... Add 10 knots

Ensures maneuvering capability.

Note: The combined airspeed corrections for steady wind, gust, and icing should not exceed a maximum of 20 knots.

Taxi–In and Park

If prolonged operation in icing conditions with the leading and trailing edge flaps extended was required:

Flaps 15

Retraction to less than flaps 15 is not recommended until ice has been removed or a ground inspection has been made.

Engine anti–ice .... As required

If icing conditions exist, engine anti–ice must be ON.

After landing in icing conditions:

Stabilizer trim .... Set 0 to 2 units

Prevents melting snow and ice from running into balance bay areas and prevents the stabilizer limit switch from freezing. With flaps retracted, this requires approximately eight hand wheel turns of manual trim.

WARNING: To avoid personal injury, ensure that the stabilizer trim wheel handle is stowed prior to using electric trim.

Secure (Airplane Attended)

The following procedure may be used to circulate warm air in the cargo and E/E compartments, thereby reducing the possibility of freezing the battery or water container. If all doors are to be closed during this period, a flight crewmember or cockpit qualified ground crewmember must remain in attendance in side the airplane to depressurize in the event of inadvertent closure of the main outflow valve.

APU .... ON

APU GEN switches .... ON

One PACK switch .... AUTO

ISOLATION VALVE switch .... AUTO

Pressurization mode selector .... MAN AC

FLT/GRD switch .... GRD

Outflow valve switch .... OPEN

Prevents aircraft pressurization.

Note: The airplane must be parked into the wind when the outflow valve is full open.

APU BLEED switch .... ON

CAUTION: With packs operating and all doors closed, inadvertent closure of the main outflow valve could result in unscheduled pressurization of the airplane. With the airplane in this configuration, do not leave the interior unattended.

Secure (Airplane Unattended)

If remaining overnight at off-line stations or at airports where normal support is not available, the flight crew should arrange for or ascertain that the following actions have been accomplished.

Pressurization mode selector .... MAN AC

Outflow valve .... Closed

Wheel chocks .... Check in place

Parking brakes .... OFF

Eliminates the possibility of brakes freezing.

Protective covers and plugs ....Installed

Water storage containers...Drained

Toilets ....Drained

Battery .... Removed

If the battery will be exposed to temperatures below -18° C (0° F), the battery should be removed and stored in an area warmer than -18° C (0° F), but below 40° C (104° F.) Subsequent, installation of the warm battery will ensure the starting capability of the APU.

Doors and sliding windows ....Closed

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.

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

Flights should be conducted to avoid thunderstorm or hail activity by overflight or circumnavigation. To the maximum extent possible, moderate to heavy rain should also be avoided.

If heavy rain is encountered:

ENGINE START switches .... CONT

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.

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

Passengers must be advised 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

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 required for the phase of flight. Change thrust setting only if required 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 Performance–Inflight section for approximate N1 settings that maintain near optimum penetration airspeed.
DESCENT	.73 Mach/280/250 KIAS. If severe turbulence is encountered at altitudes below 15,000 feet and the airplane gross weight is less than the maximum landing weight, the airplane may be slowed to 250 knots in the clean configuration.

Note: If an approach must be made into an area of severe turbulence, delay flap extension as long as possible. The airplane can withstand higher gust loads in the clean configuration.

Windshear

Windshear is a change of wind speed and/or direction over a short distance along the flight path. Severe windshear is that which produces airspeed changes greater than 15 knots or vertical speed changes greater than 500 feet per minute.

Avoidance

The flight crew should search for any clues to the presence of windshear along the intended flight path. Stay clear of thunderstorm cells and heavy precipitation and areas of known windshear. If severe windshear is indicated, delay takeoff or do not continue an approach.

The presence of windshear may be indicated by:

- Thunderstorm activity
- Virga (rain that evaporates before reaching the ground)
- PIREPS
- Low level windshear alerting system (LLWAS) warnings

Precaution

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.
- Use the longest suitable runway.
- 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 not flying 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.
- If windshear should be encountered near VR, and airspeed suddenly decreases, there may not be sufficient runway left to accelerate back to the normal VR. If there is insufficient runway left to stop, initiate a normal rotation at least 2000 feet before the end of the runway even if airspeed is low. Higher than normal attitudes may be required to lift–off in the remaining runway.

Approach and Landing

- Select the minimum landing flap position consistent with field length.
- Add an appropriate airspeed correction (correction applied in the same manner as gust), the maximum command speed should not exceed the lower of Vref + 20 knots or landing flap placard speed minus 5 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 not flying should call out

any deviations from normal. Use of the autopilot and autothrottle for the approach may provide more monitoring and recognition time.

Recovery

Accomplish the Windshear Maneuver found in Non–Normal Maneuvers section of this manual.

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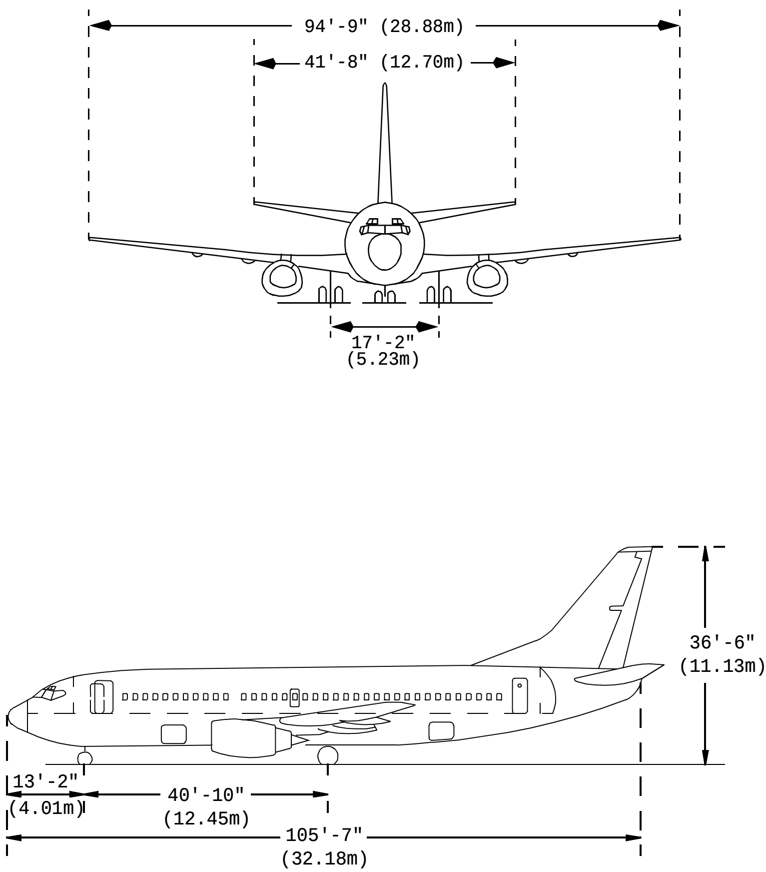
Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Table of Contents — Section 0

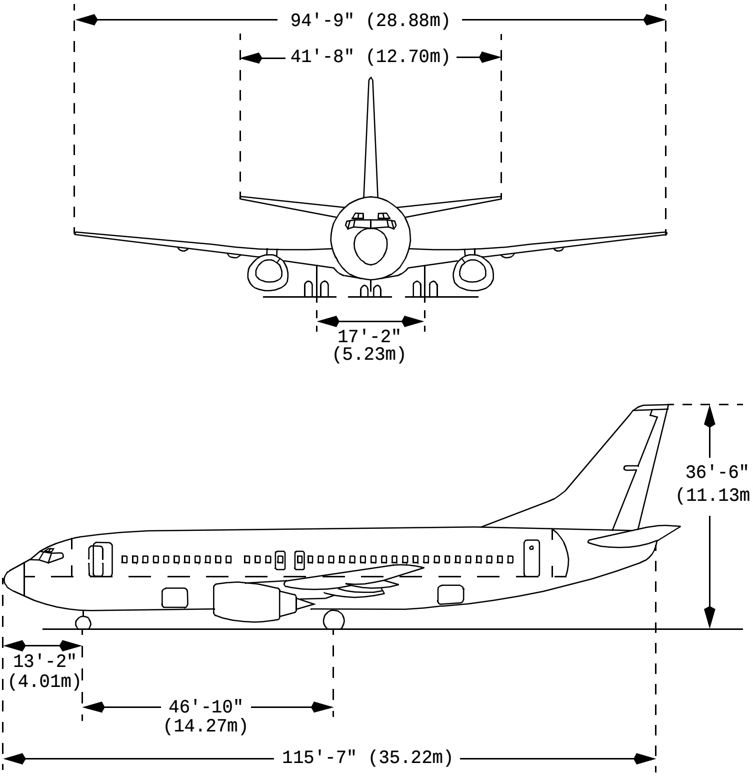
Airplane General, Emergency Equipment, Doors, Windows — Chapter 1

Dimensions — Section 10

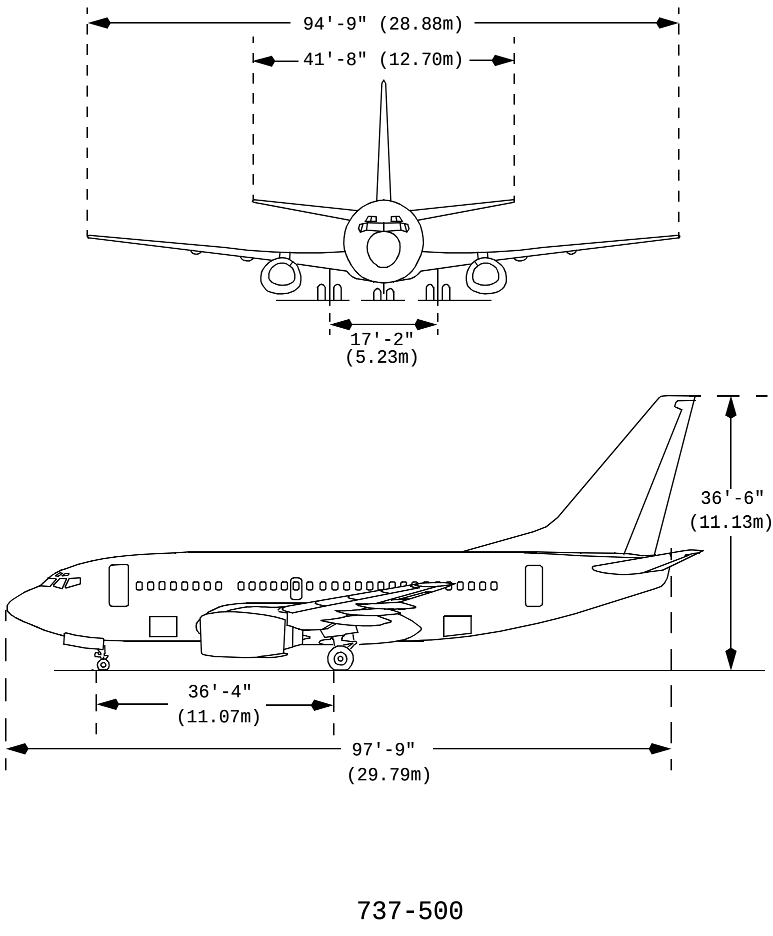
Principal Dimensions



737-300


94'-9" (28.88m)
41'-8" (12.70m)
17'-2"
(5.23m)
36'-6"
(11.13m)
13'-2"
(4.01m)
46'-10"
(14.27m)
115'-7" (35.22m)

737-400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17'-2"
(5.23m)
36'-6"
(11.13m)
36'-4"
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97'-9"
(29.79m)
737-500

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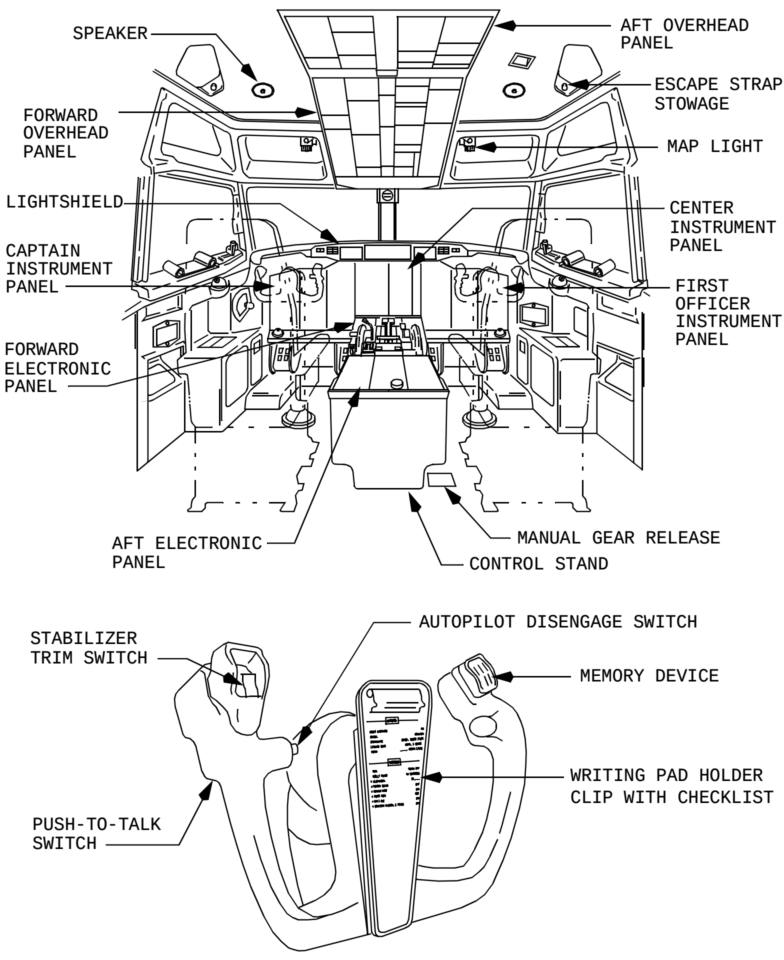
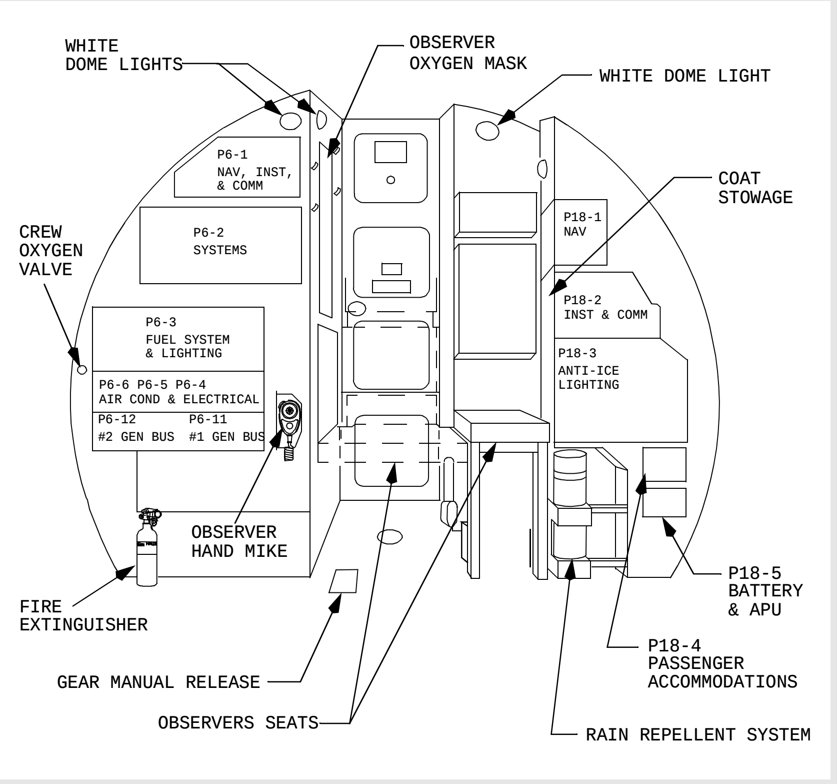
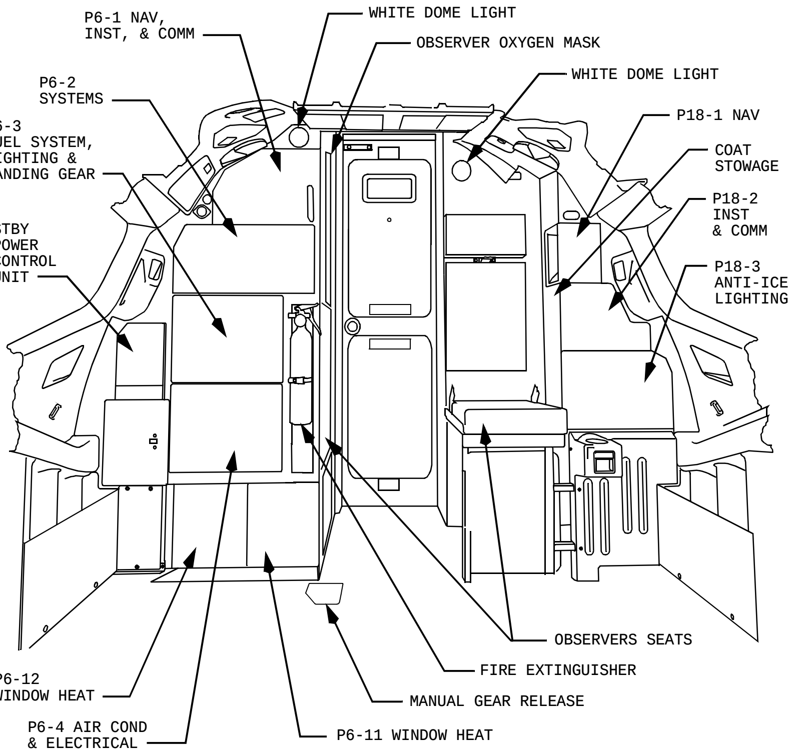
Panel Arrangement



CAPTAIN CONTROL WHEEL DETAIL

Aft Flight Deck Overview





AFT FLIGHT DECK OVERVIEW

1 As installed

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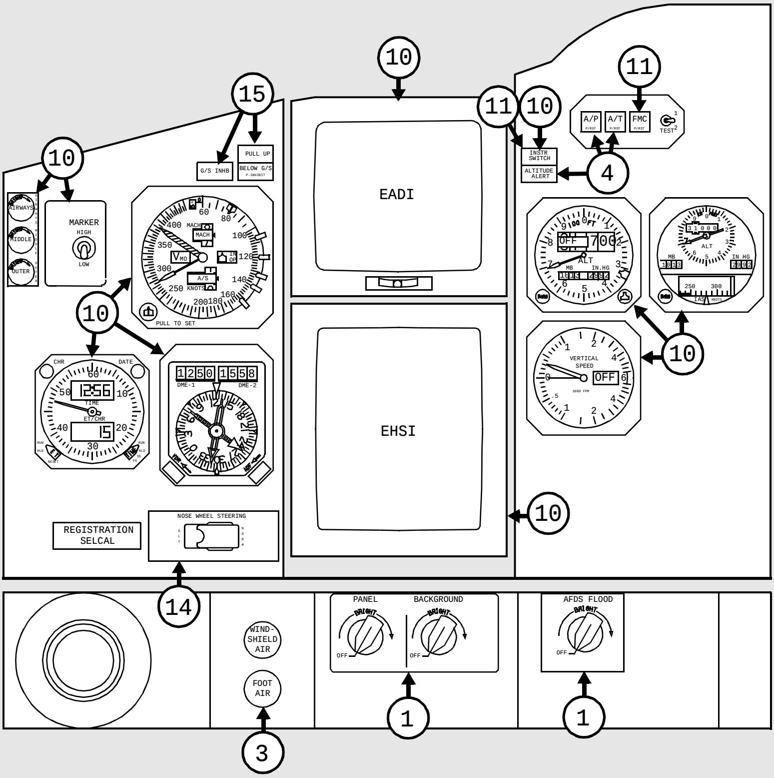
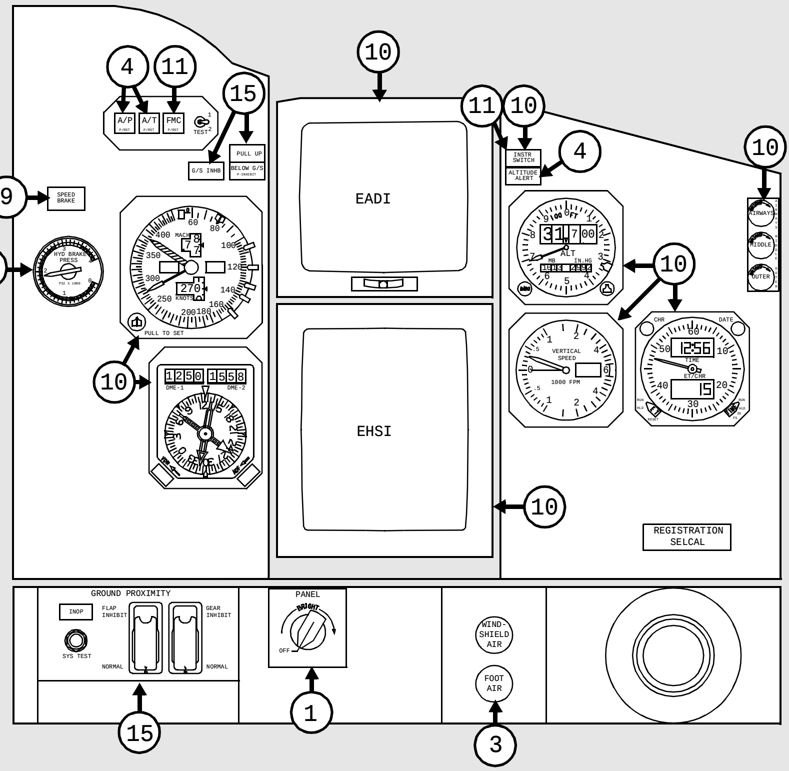
Captain's Instrument Panel



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

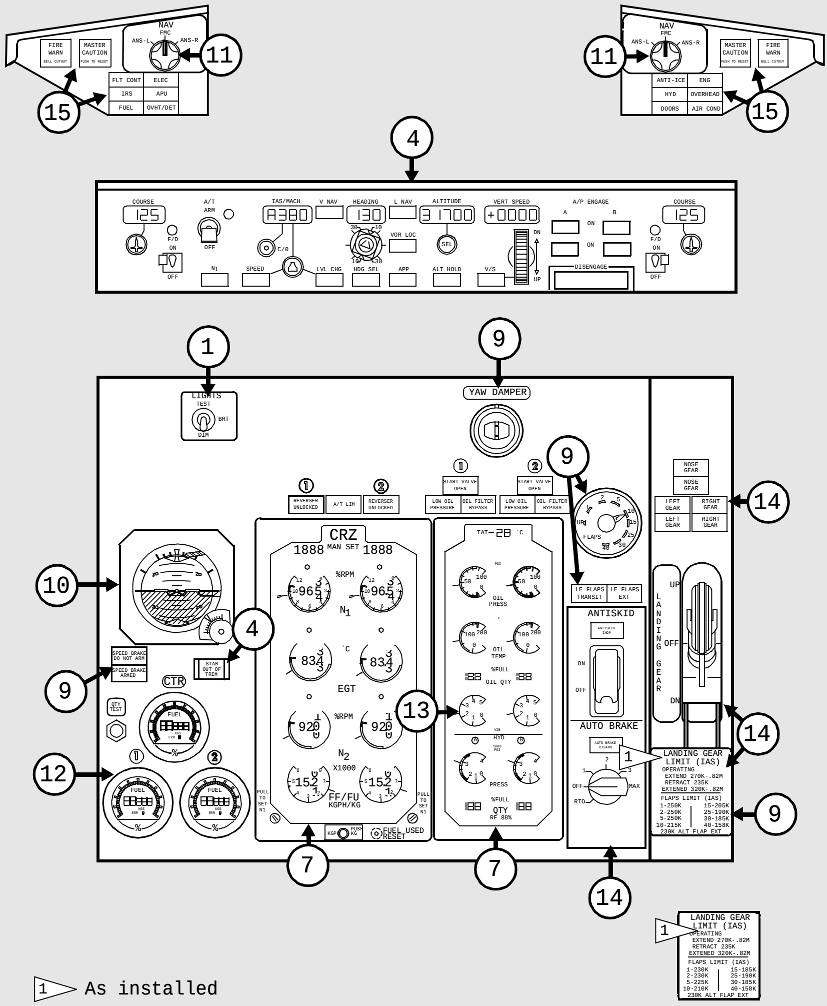
The controls, panels, and indicators shown in this chapter are representative of installed units and may not exactly reflect the details of the latest configuration. Refer to the corresponding chapter under system descriptions for current chapter information.

First Officer's Instrument Panel



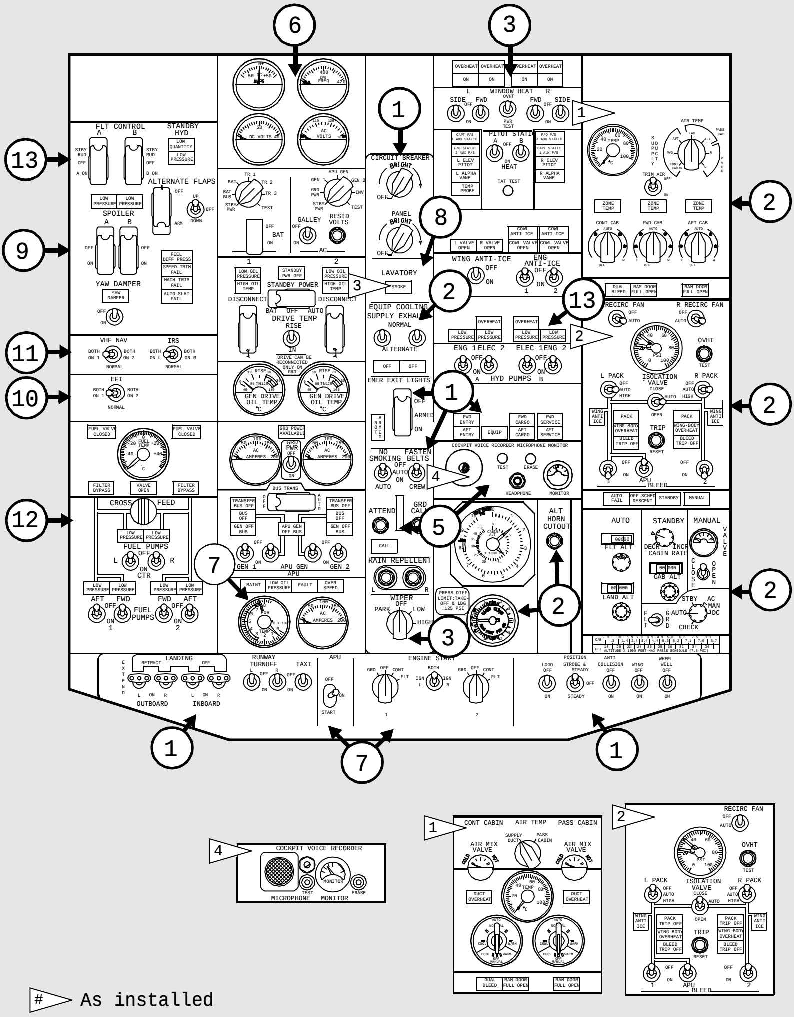
Circled numbers refer to chapters where information on the item may be found.

Center Instrument Panel and Lightshield



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

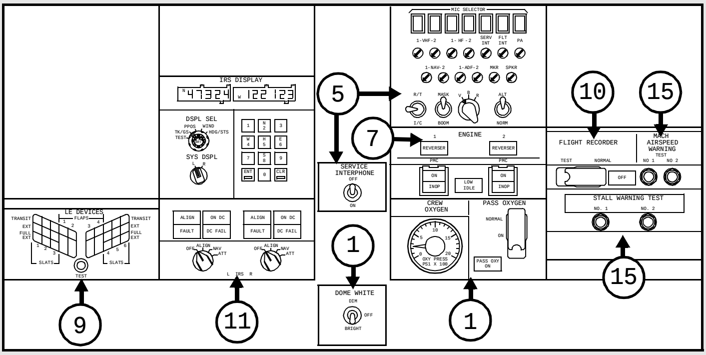
Forward Overhead Panel



▷ As installed

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

Aft Overhead Panel



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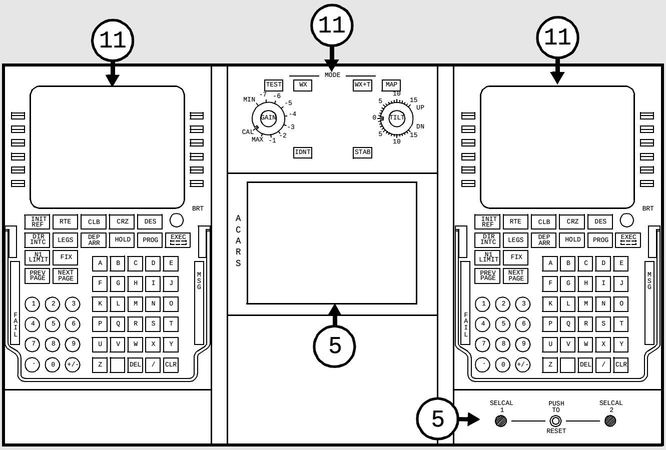
Forward Electronic Panel



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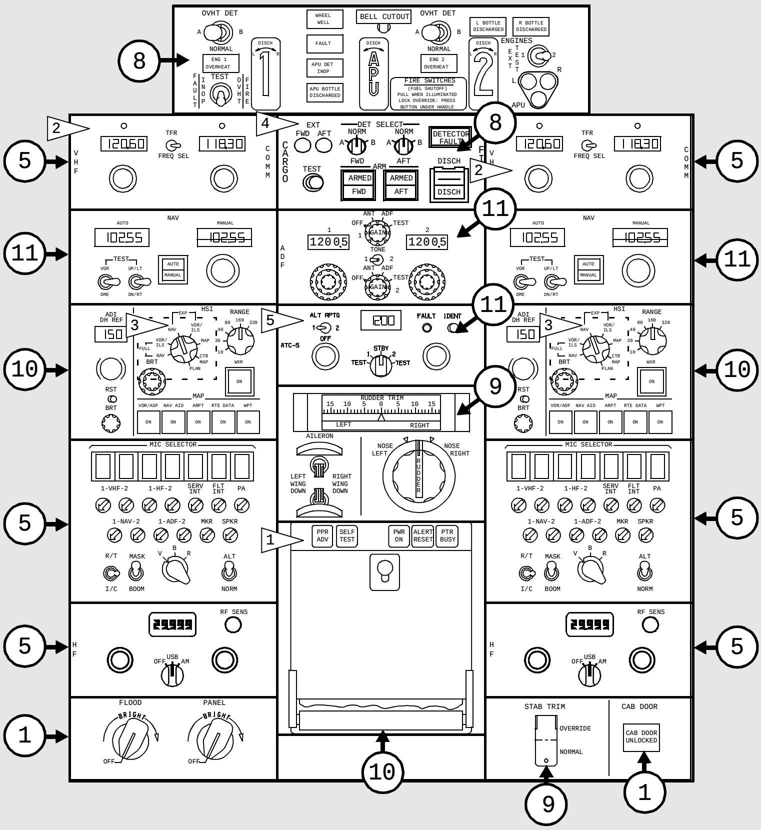
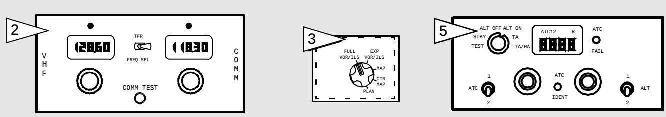
Aft Electronic Panel





\# As installed

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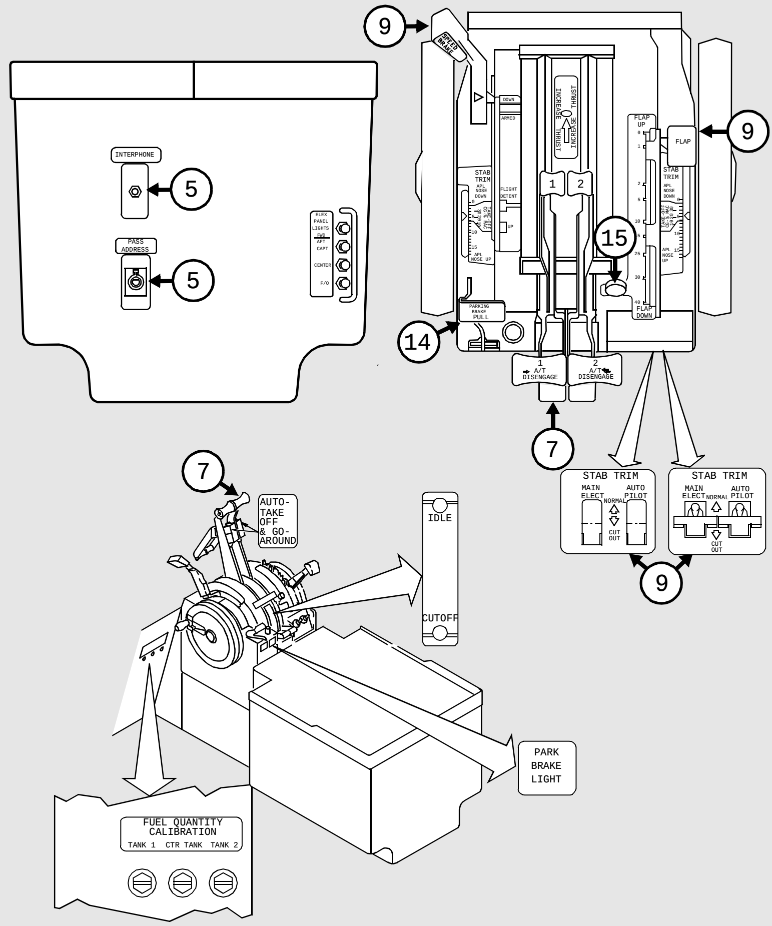
Control Stand



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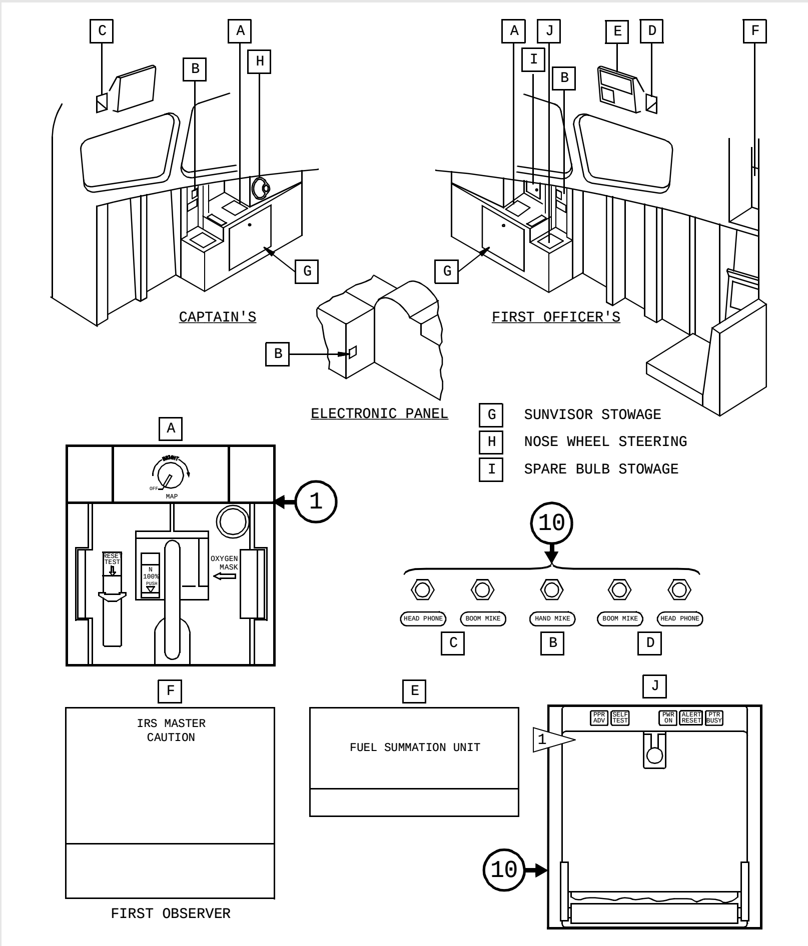
Auxiliary Panels



1 As installed

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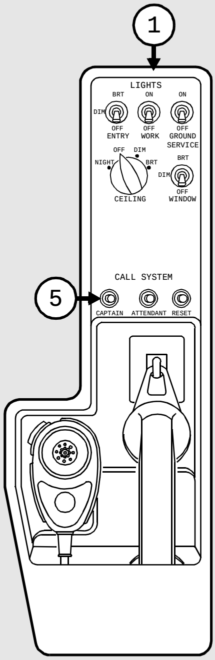
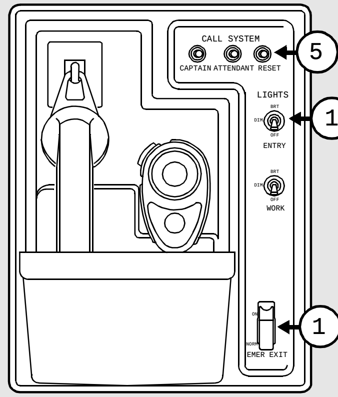
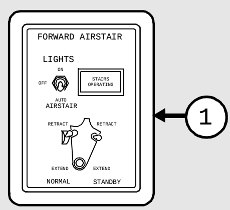
Attendant Panels



FORWARD ATTENDANT PANEL



AFT ATTENDANT PANEL

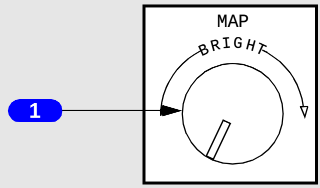


FORWARD AIRSTAIR

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

Flight Deck Lighting

Map Light Controls

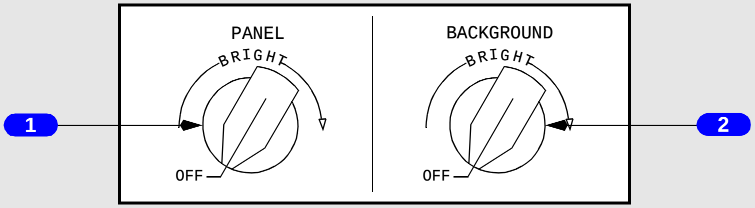


SIDEWALL PANELS

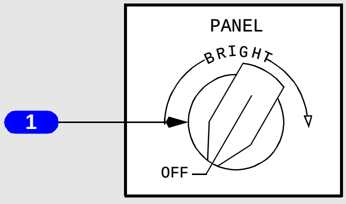
1 MAP Light Control

Push/Rotate – adjusts brightness of Captain/First Officer map lights. Pull to illuminate, and push to extinguish.

Panel and Background Lighting



CAPTAIN'S PANEL



FIRST OFFICER'S PANEL

1 PANEL Light Control

Rotate –

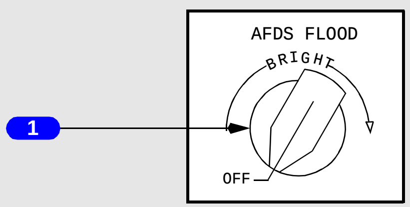
- Captain's – controls brightness of Captain's panel and instrument lighting, center instrument panel, and AFDS panel displays and edge lighting
- First Officer's – controls brightness of First Officer's panel and instrument lighting.

2 BACKGROUND Light Control

Rotate –

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

AFDS Flood Light Control

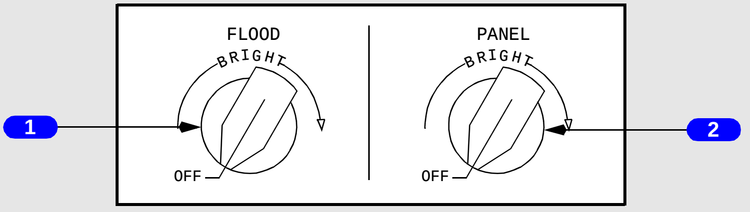


CAPTAIN'S PANEL

1 AFDS FLOOD Light Control

Rotate – controls brightness of lighting directed at AFDS panel.

Flood and Aft Electronic Panel Lights Controls



AFT ELECTRONIC PANEL

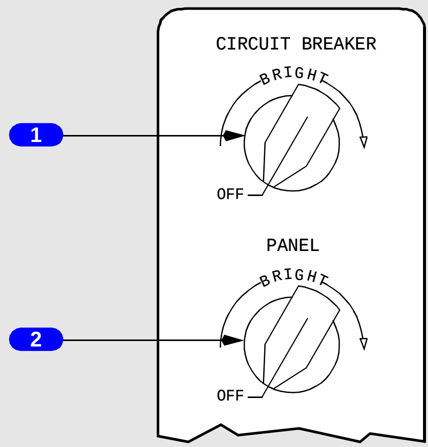
1 FLOOD Light Control

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



FORWARD OVERHEAD PANEL

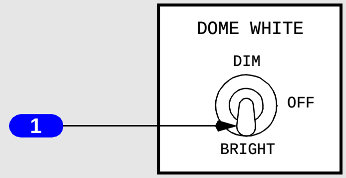
1 **CIRCUIT BREAKER Light Control**

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



AFT OVERHEAD PANEL

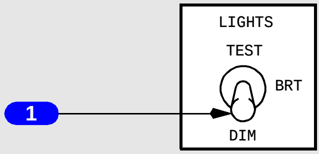
1 **DOME Light Control**

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



CENTER INSTRUMENT PANEL

1 Master LIGHTS TEST and DIM Switch

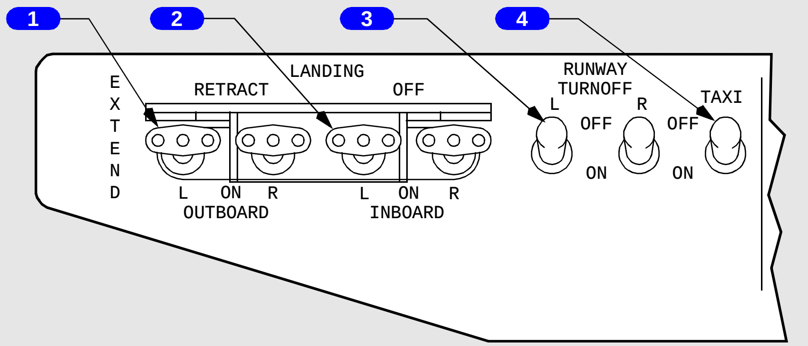
TEST – illuminates all system lights on forward and aft overhead panels, and some lights on Captain’s and First Officer’s instrument panels to full brightness.

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



FORWARD OVERHEAD PANEL

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.

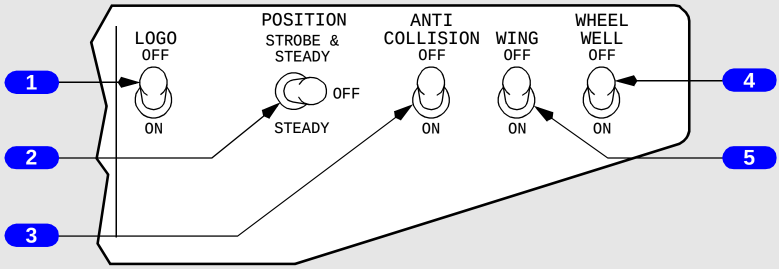
ON – runway turnoff lights are illuminated.

4 TAXI Light Switch

OFF – nose wheel taxi light extinguished.

ON – nose wheel taxi light illuminated.

Miscellaneous Exterior Lights



FORWARD OVERHEAD PANEL

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.

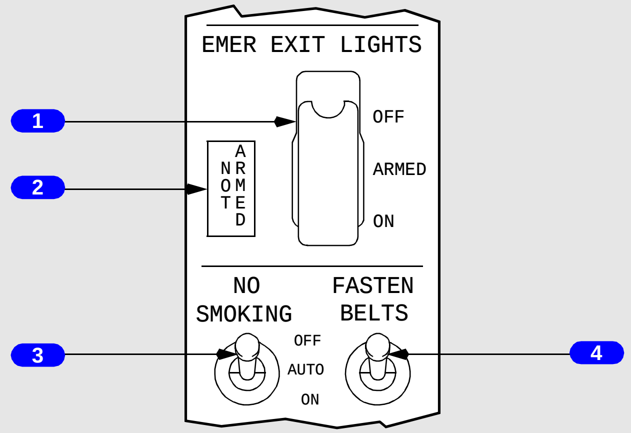
5 WING Illumination Switch

OFF – wing leading edge lights extinguished.

ON – wing leading edge lights on fuselage forward of wing illuminated.

Emergency Lighting and Passenger Signs

Flight Deck



FORWARD OVERHEAD PANEL

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.

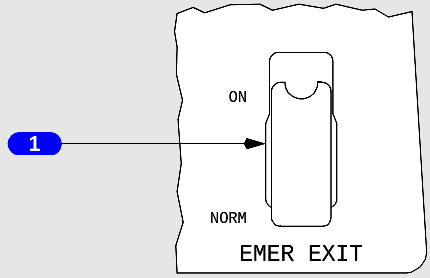
4 SEAT BELTS Lights Switch

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



AFT FLIGHT ATTENDANT PANEL

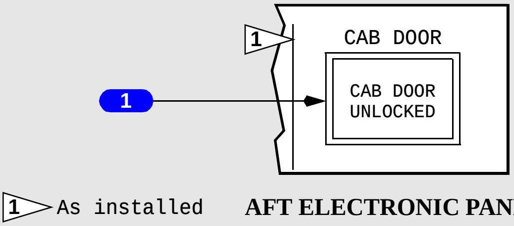
1 Passenger Cabin Emergency Exit Lights Switch (guarded, red)

ON – all interior and exterior emergency lights are illuminated.

NORM – Emergency lights OFF unless activated by the flight deck switch.

Doors

Cabin Door



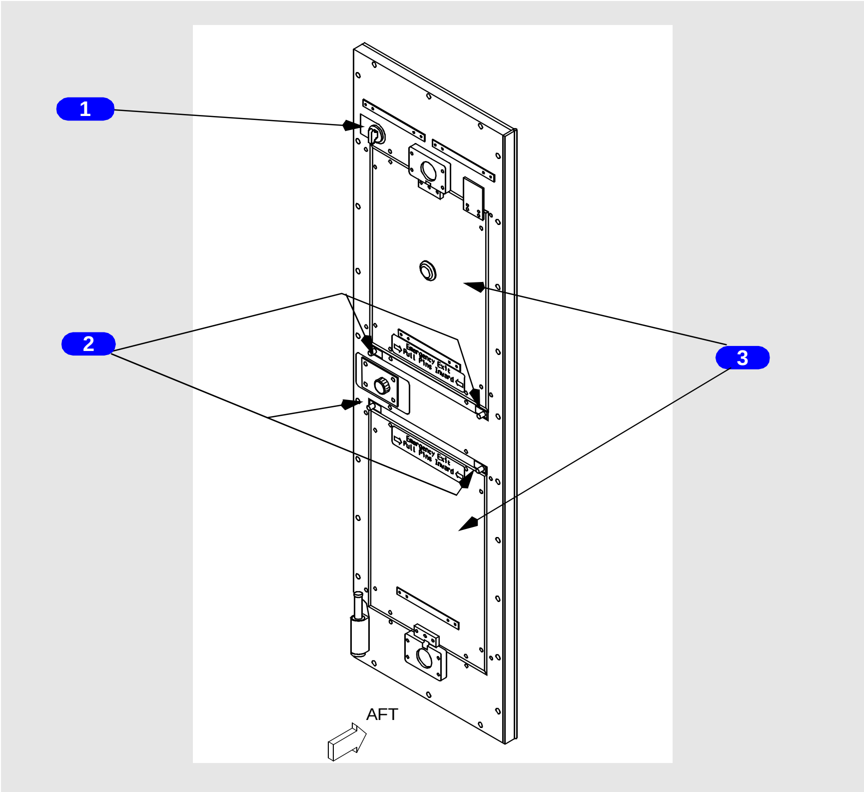
AFT ELECTRONIC PANEL

1 Cabin Door (CAB DOOR) Lock Switch

Illuminated (amber) – cabin door is unlocked.

Push – with AC power available, locks cabin door.

Flight Deck Security Door (As Installed)



1 Deadbolt

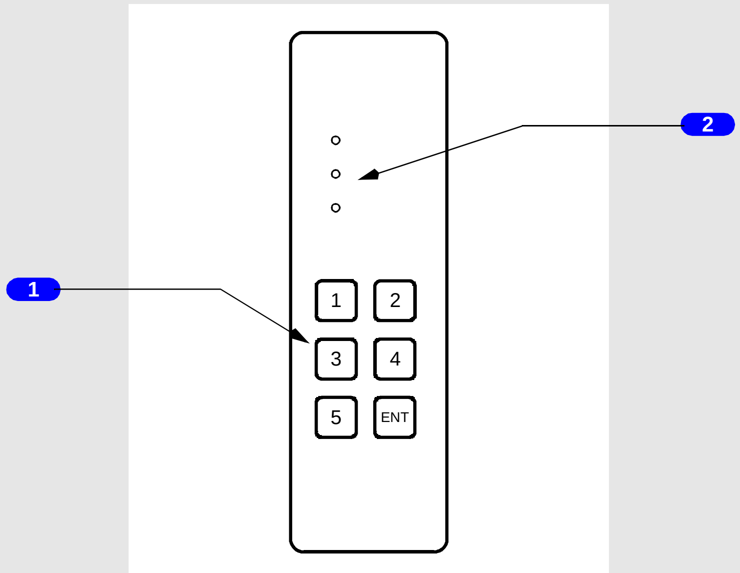
2 Release Pins

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 numeric access code. Entry of correct emergency access code sounds flight deck chime.

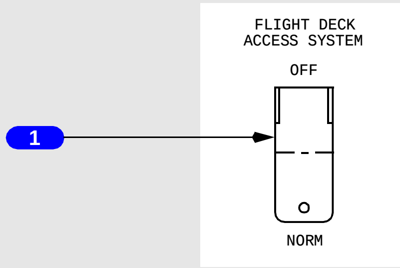
2 Access Lights

Illuminated (red) - door locked.

Illuminated (amber) - correct emergency access code entered.

Illuminated (green) - door unlocked.

Flight Deck Access System Switch



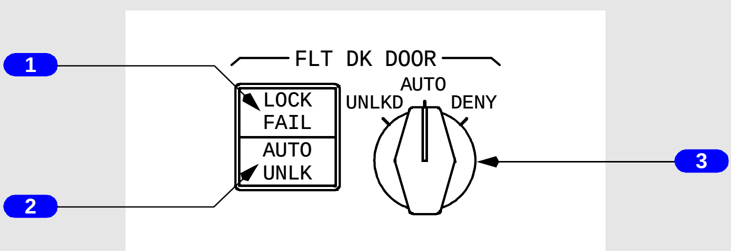
FLIGHT DECK SIDE DOOR POST

1 Flight Deck Access System Switch

OFF - removes electrical power from door lock.

NORM (Normal) - flight deck access system configured for flight.

Flight Deck Door Lock Panel



AISLE STAND

1 LOCK FAIL Light

Illuminated (amber) - Flight Deck Door Lock selector in AUTO and door lock has failed or Flight Deck Access System switch is OFF.

2 AUTO Unlock (UNLK) Light

Illuminated (amber) - correct emergency access code entered in keypad. AUTO UNLK light flashes and continuous chime sounds before timer expires and door unlocks.

3 Flight Deck (FLT DK) Door Lock Selector

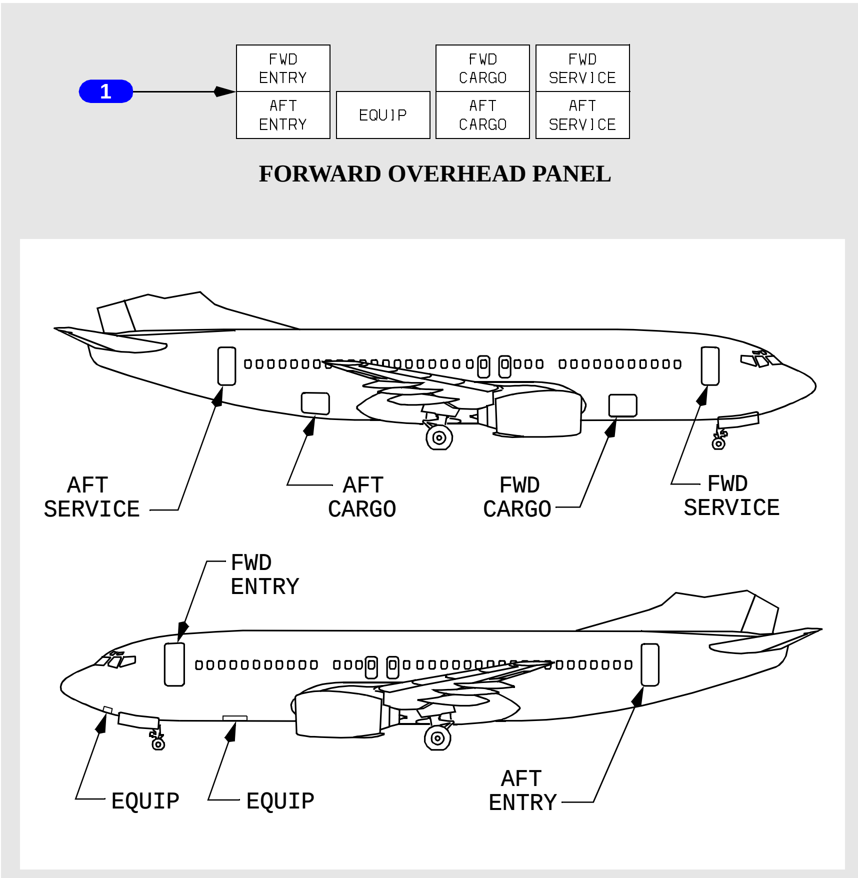
Spring loaded to AUTO. Selector must be pushed in to rotate from AUTO to UNLKD. Selector must not be pushed in to rotate from AUTO to DENY.

UNLKD - door unlocked while selector in UNLKD.

AUTO - door locked. Allows door to unlock after entry of emergency access code and expiration of timer, unless crew takes action.

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

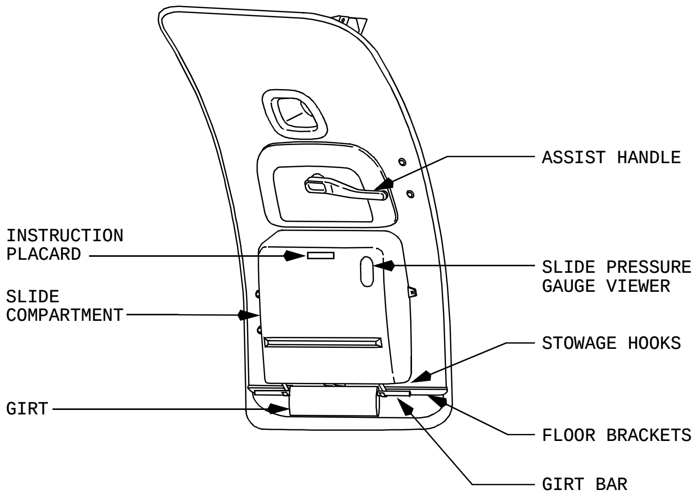
Exterior Door Annunciator Lights



1 Interior Door Annunciations

Illuminated (amber) – related door is unlocked.

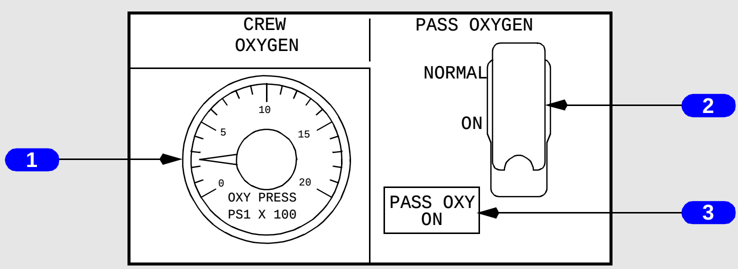
Passenger Entry/Galley Service Doors



PASSENGER CABIN

Oxygen

Oxygen Panel



AFT OVERHEAD PANEL

1 Flight Crew Oxygen (CREW OXYGEN) Pressure Indicator

Indicates pressure at the crew oxygen cylinder.

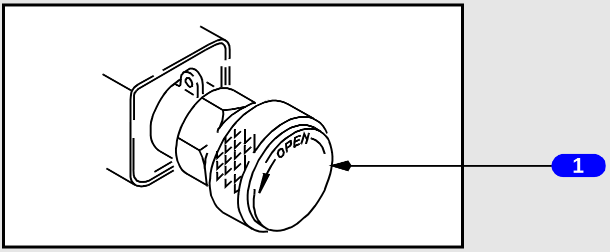
2 Passenger Oxygen (PASS OXYGEN) Switch

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.



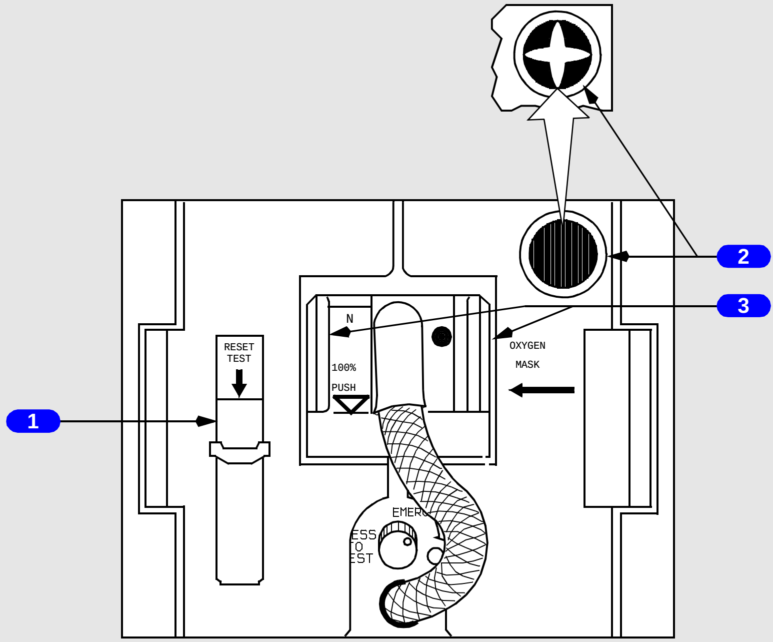
RIGHT FLIGHT DECK BULKHEAD
BEHIND FIRST OFFICER'S SEAT

1 Flight Crew Oxygen (CREW OXYGEN) Shutoff Valve

TURN COUNTERCLOCKWISE - Allows oxygen to flow.

TURN CLOCKWISE - Shuts off oxygen flow.

Oxygen Mask Panel



CREWMEMBER STATION (1 each)

1 RESET TEST Button

Push –

- if mask is stowed, activates oxygen flow momentarily to test regulator
- if mask is not stowed and stowage box doors are closed, shuts off oxygen.

2 Oxygen Flow Indicator

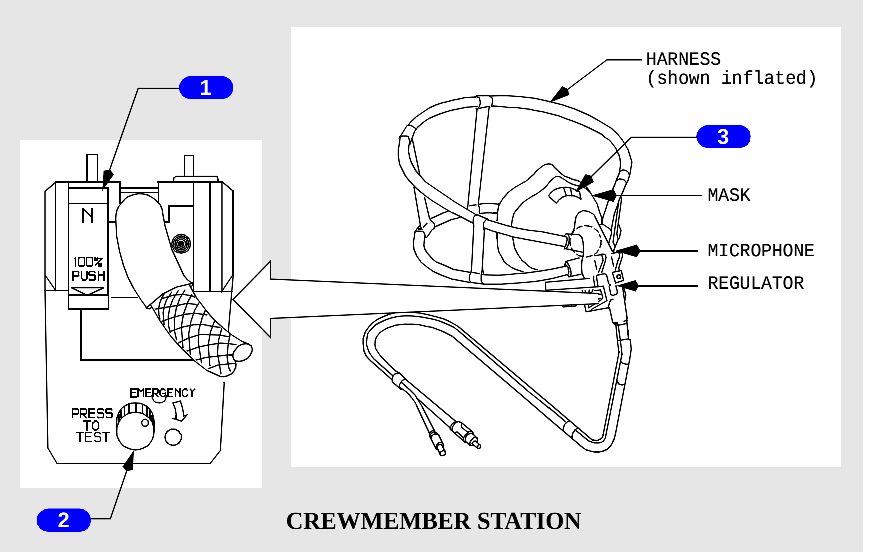
Indicates a yellow cross when oxygen is flowing.

3 Oxygen Mask Release Levers

Squeeze and pull –

- releases mask from stowage box
- activates oxygen 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)

Rotate – supplies 100% oxygen under positive pressure at all cabin altitudes.

PRESS TO TEST – tests positive pressure supply to regulator.

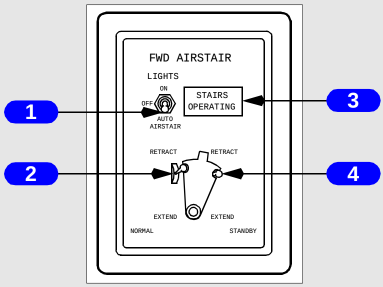
3 Smoke Vent Valve Selector

Up - vent valve closed.

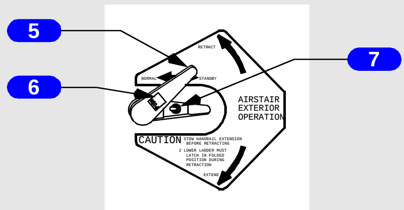
Down - vent valve open, allowing oxygen flow to smoke goggles.

Forward Airstairs

Interior and Exterior Controls



FORWARD AIRSTAIR
INTERIOR CONTROL
(above forward entry door)



FORWARD AIRSTAIR
EXTERIOR CONTROL
(below and aft of
forward entry door)

1 LIGHTS Switch

AUTO – the airstair tread lights illuminate automatically upon airstair extension and extinguish upon retraction.

ON – illuminates the airstair tread lights.

OFF – airstair tread lights extinguish.

2 Normal Control Switch

Note: AC and DC electrical power must be available on airplane.

RETRACT – retracts the airstair. The handrail extensions must be stowed prior to retracting the airstair.

EXTEND – extends the airstair.

3 STAIRS Operating Light

Illuminated (amber) – indicates the airstair is in transit.

4 STANDBY Control Switch

Note: Switch must be held in while using EXTEND or RETRACT. Battery switch must be ON. For airplanes delivered prior to November, 1991, 115V AC electrical power must be available.

Extend – extends the airstair.

Retract – retracts the airstair.

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

5 Exterior Control Handle

Rotate clockwise – airstair extends.

Rotate counterclockwise – airstair retracts.

6 Control Handle Release

Push – extends the exterior control handle.

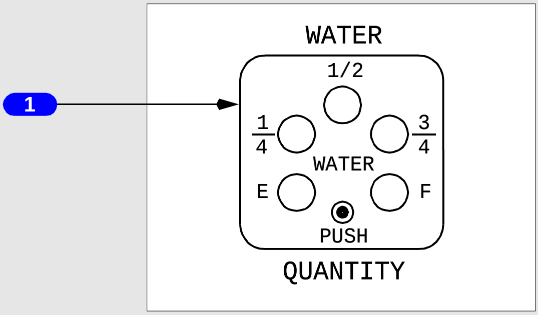
7 NORMAL/STANDBY Switch

(spring–loaded to NORMAL)

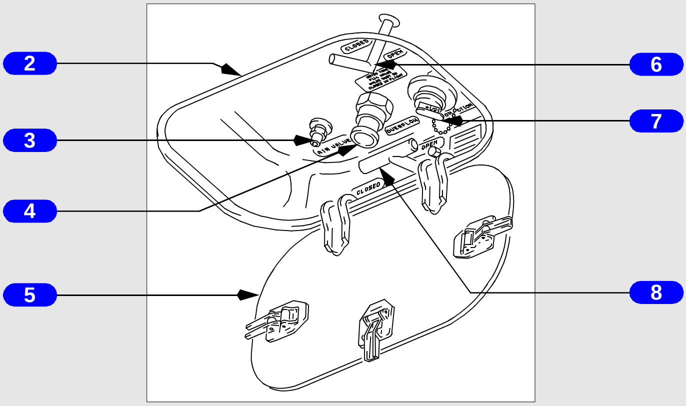
NORMAL – requires both AC and DC power.

STANDBY – requires DC power.

Water System Controls



GALLEY AREA



BELOW AFT ENTRY DOOR

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**

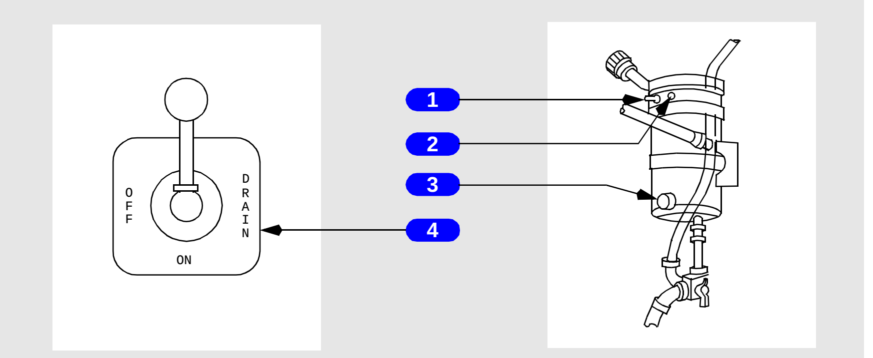
Used to fill tank.

8 **Tank Drain Valve Handle**

Open – drains water from tank.

Closed – normal position.

Lavatory Controls



LAVATORY SINK CABINET

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.

Intentionally
Blank

Airplane General, Emergency Equipment, Doors, Windows — Chapter 1
Systems Description — Section 40

Introduction

This chapter describes miscellaneous airplane systems, including:

- lighting systems
- oxygen systems
- fire extinguishers
- emergency equipment
- doors and windows
- cargo compartments
- emergency egress
- flight deck seats
- galleys
- water systems
- lavatories
- airstairs.

Lighting Systems

Lighting systems described in this chapter include:

- exterior lighting
- flight deck lighting
- passenger cabin lighting
- emergency lighting.

Exterior Lighting

Exterior lighting consists of these lights:

- landing
- runway turnoff
- taxi
- logo
- position (navigation)
- strobe
- anti–collision
- wing illumination
- wheel well.

Outboard Landing Lights

Outboard landing lights are installed in the outboard flap track fairings. The lights are designed to extend and shine forward, parallel to the waterline of the airplane. The lights may be extended at any speed.

Inboard Landing Lights

Two inboard landing lights are in the wing leading edge. The lights shine forward and down in a fixed position.

Runway Turnoff Lights

Runway turnoff lights are in each wing root. The lights illuminate the area in front of the main gear.

Taxi Lights

The taxi light is mounted on the nose wheel strut and points in the same direction as the nose wheel. For increased service life of the taxi light, it is recommended that the taxi light not be used for takeoff and landing.

Logo Lights

Logo lights are located on the top of each wing tip to illuminate both sides of the vertical stabilizer.

Position Lights

The navigation lights are the standard red (left forward wingtip), green (right forward wingtip), and white (aft tip of both wings) position lights.

Strobe Lights

Three high intensity white strobe lights are installed on the left forward wing tip, right forward wing tip, and tail cone.

Anti–collision Lights

Two red anti–collision strobe lights are located on the top and bottom of the fuselage.

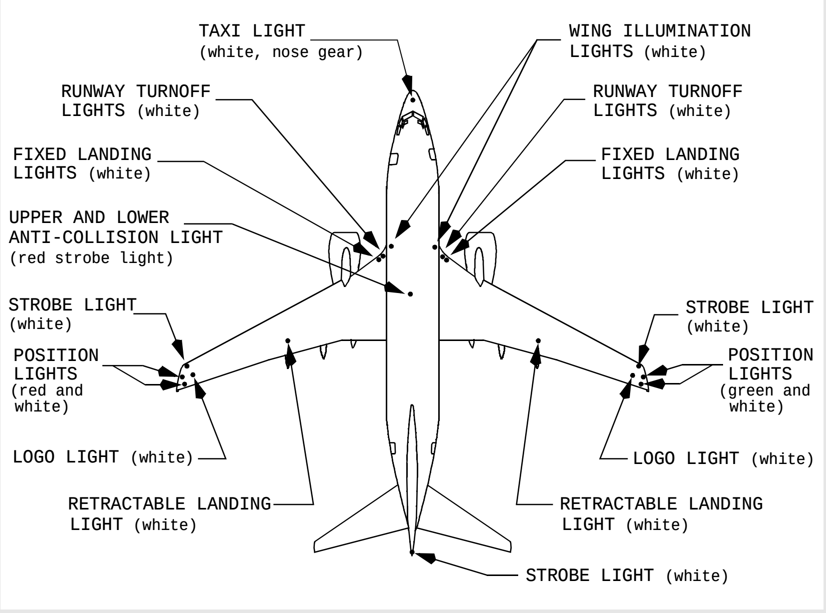
Wing Illumination Lights

Wing lights are installed on the fuselage and illuminate the leading edge of the wing.

Wheel Well Lights

Lights are installed in the wheel well of the nose gear and each main gear.

Exterior Lighting Locations



Flight Deck Lighting

Flight deck lighting is provided for panel illumination, area lighting and localized illumination. Dome lights supply general flight deck flood lighting. The glareshield supplies background light for the main instrument panels. Each instrument and instrument panel has its own integral lights. Floodlights are installed for the MCP, aisle stand, and aft circuit breaker panel.

Map lights and utility lights are available at the pilot stations, each with individual controls.

If normal electrical power is lost, standby electrical power is automatically provided to the standby compass light, dome lights, instrument flood lights and selected system information and warning lights.

Passenger Cabin Lighting

Passenger cabin lighting is supplied by incandescent and fluorescent lights. General cabin lighting is provided by window lights, ceiling lights, and entry lights. Reading lights are located above each passenger seat in the passenger service unit. Lights are also installed in the lavatories and galleys.

Passenger Cabin Signs

The passenger cabin signs are controlled by a switch on the forward overhead panel. With AUTO selected, the signs are controlled automatically by reference to landing gear and flap positions:

FASTEN BELTS and RETURN TO SEAT signs:

- illuminate when flaps or gear are extended
- extinguish when flaps and gear are retracted.

NO SMOKING signs:

- illuminate when gear is extended
- extinguish when gear is retracted.

All passenger signs can be controlled manually by positioning the respective switch to ON or OFF.

When the passenger cabin signs illuminate or extinguish, a low tone sounds over the PA system.

Emergency Lighting

Exit lights are located throughout the passenger cabin to indicate the approved emergency exit routes. The system is controlled by a switch on the overhead panel. The switch has three positions: OFF, ARMED and ON, and is guarded to the ARMED position. With the switch in the ARMED position, the emergency exit lights are normally extinguished. If electrical power to DC bus No. 1 fails or if AC power has been turned off, the emergency exit lights illuminate automatically.

The emergency exit lights may also be illuminated by a switch on the aft attendant's panel. Lifting the guard and pushing the switch ON overrides the flight deck control and illuminates the emergency exit lights. Control from this panel is available in the event of failure of the automatic control.

The flight deck aft DOME light contains a separate bulb that is powered by the emergency lighting system to provide for flight deck evacuation.

Interior Emergency Lighting

Interior emergency exit lights are located:

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

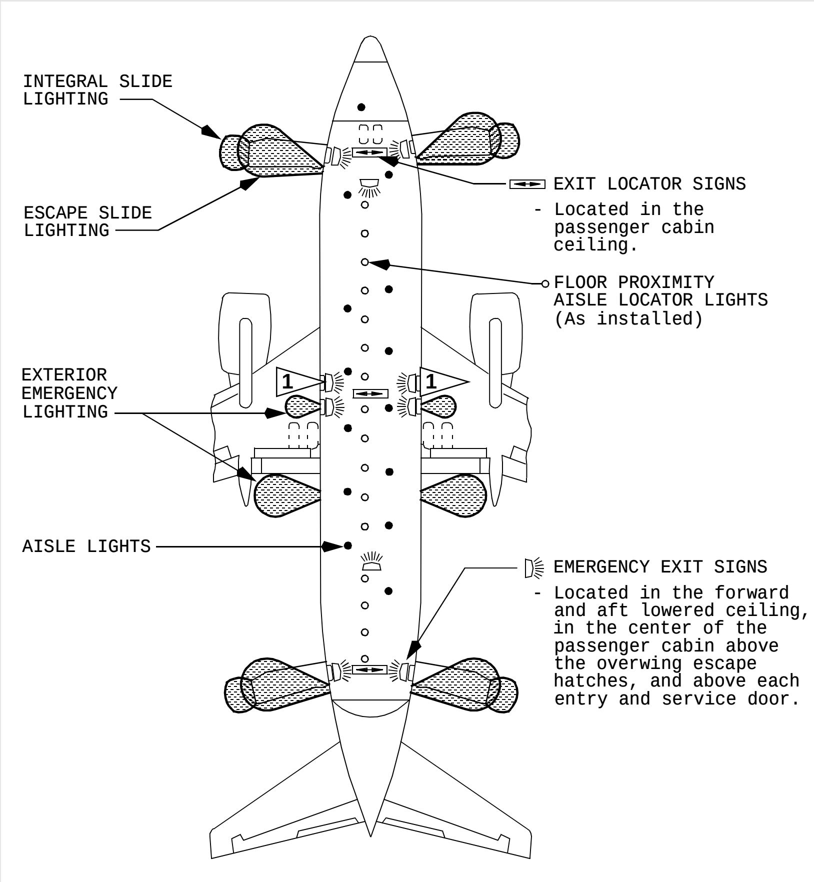
Self-illuminating exit locator signs are installed at the forward, middle, and aft end of the passenger cabin.

Floor proximity emergency escape path lighting consists of locator lights spaced at regular intervals down one side of the aisle. Lighted arrows point to overwing exits and a lighted EXIT indicator is near the floor by each door and overwing exit. Escape path markings are provided for visual guidance for emergency cabin evacuation when other sources of cabin lighting are obscured.

Exterior Emergency Lighting

Exterior emergency lights illuminate the escape slides. The fuselage-installed escape slide lights are adjacent to the forward and aft service and entry doors. Two lights are also installed on the fuselage to illuminate the overwing escape routes and ground contact area.

Emergency Exit Lighting

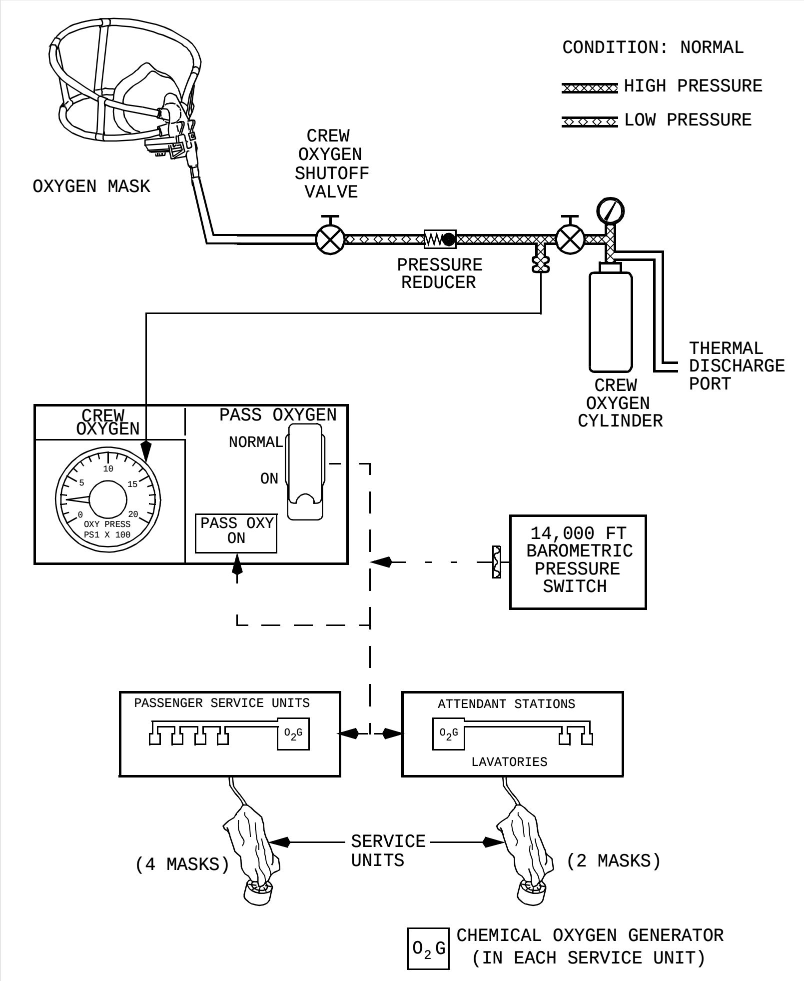


1 737-400

Oxygen Systems

Two independent oxygen systems are provided, one for the flight crew and one for the passengers. Portable oxygen cylinders are located throughout the airplane for emergency use.

Oxygen System Schematic



Flight Crew Oxygen System

The flight crew oxygen system uses quick–donning diluter demand masks/ regulators located at each crew station. Oxygen is supplied by a single cylinder. Oxygen pressure is displayed on the indicator located on the aft overhead panel when the battery switch is ON. Oxygen flow is controlled through a pressure–reducing regulator to supply low pressure oxygen. Normal pressure is 1850 psi.

The mask/regulator is stored in a box immediately adjacent to each crew station. To use the mask, squeeze the red Release Levers with the thumb and forefinger and remove from stowage. Squeezing the Release Levers:

- inflates the mask harness
- momentarily displays the yellow oxygen flow indicator

Place the mask over the head and release the levers. The harness contracts to fit the mask to head and face.

Oxygen flow is controlled by a regulator that is mounted on the oxygen mask. The regulator may be adjusted to supply 100% oxygen by pushing the NORMAL/100% Selector.

The observer's oxygen mask, regulator, and harness unit is the same as the 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 Portable Oxygen

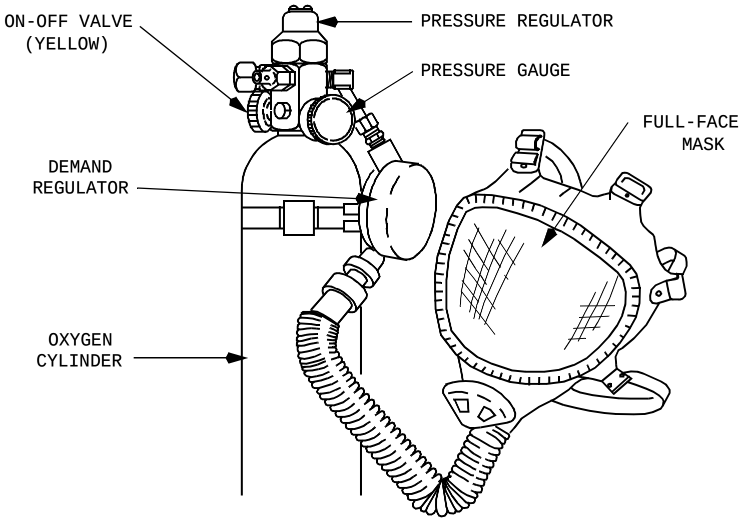
The flight crew portable oxygen unit is a completely self–contained oxygen system, offering both demand and constant flow capabilities. It consists of a portable oxygen cylinder, a pressure regulator (constant flow), an on–off valve, a pressure gauge to show oxygen supply, a demand regulator, and a sling–type carrying strap.

The portable oxygen cylinder is installed behind and adjacent to the First Officer's seat. When charged to 1800 psi at 70° Fahrenheit (21° Celsius), it contains 11 cubic feet (311 liters) of free oxygen.

The demand regulator has a connection for a demand type full–face mask and supplies 100% oxygen. Normally, the full face mask is attached to the unit and provides portable full–face and respiratory protection from hazardous smoke and fumes.

For constant flow oxygen, a bayonet–type fitting accommodates a disposable continuous flow mask. The cylinder provides oxygen for a duration of approximately 103 minutes using the 3 liter constant flow outlet.

Flight Crew Portable Oxygen Equipment



11 Cu. Ft. Cylinder			
Alt (Feet) or Cabin Alt. Equiv.	IF DEMAND FLOW OUTLET IS USED Estimated Duration in minutes*		
	Max.	Mean	Min.
0	21	12	7
5,000	25	15	9
10,000	31	18	11
15,000	37	22	13
20,000	46	27	16
25,000	57	33	20
30,000	71	41	25

*Estimated duration based on an assumed use rate of 14 LPM-ATPD (sedentary), 24 LPM-ATPD (normal activity), 40 LPM-ATPD (severe activity).

FOR 100% OXYGEN (DEMAND FLOW) USE FULL FACE MASK	1. TURN YELLOW KNOB OPEN 2. ATTACH FULL FACE MASK TO LARGE OUTLET. 3. APPLY MASK TO FACE (TIGHTEN LOWER STRAPS FIRST)
FOR SUPPLEMENTAL OXYGEN (CONSTANT FLOW) USE REBREATHER TYPE MASK	1. TURN YELLOW KNOB OPEN 2. ATTACH MASK HOSE TO SMALL CONSTANT FLOW OUTLET 3. APPLY REBREATHER TYPE MASK TO FACE

Portable Protective Breathing Equipment

Protective Breathing Equipment (PBE/Smoke Hood) devices for crew use (for combating fires and/or entering areas of smoke or fume accumulation) are stowed throughout the airplane. The device is placed over the head and, when activated, provides approximately 15 minutes of oxygen. Manufacturer’s operating instructions are placarded on the container.

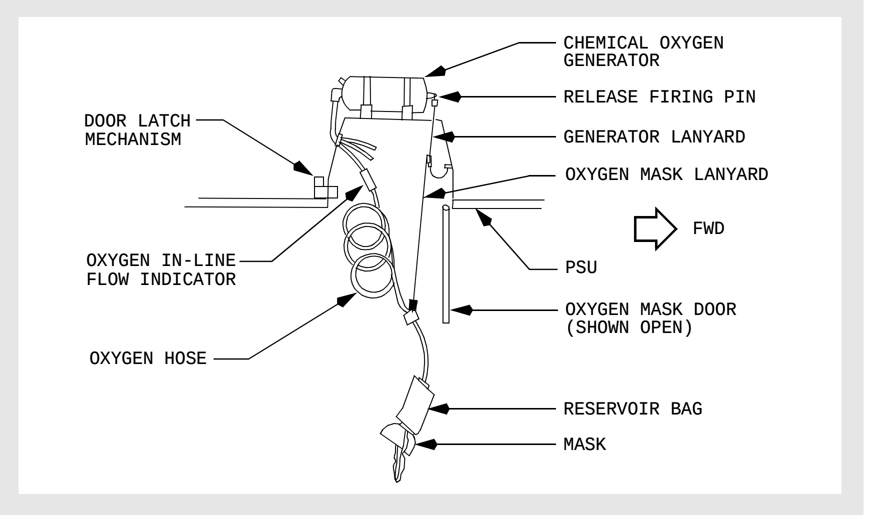
Passenger Oxygen System

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

The system is activated automatically by a pressure switch at a cabin altitude of approximately 14,000 feet or when the Passenger Oxygen Switch on the aft overhead panel is positioned to ON. When the system is activated, the PASS OXY ON light illuminates and OVERHEAD illuminates on the Master Caution System.

Activating the system causes the masks to drop from the stowage compartments. The oxygen generators are activated when any mask in the unit is pulled down. Pulling one mask down causes all masks in that unit to come down and 100% oxygen flows to all masks. A green in–line flow indicator is visible in the transparent oxygen hose whenever oxygen is flowing to the mask. Oxygen flows for approximately 12 minutes and cannot be shut off. If the passenger oxygen is activated and a PSU oxygen mask compartment does not open, the masks may be dropped manually.

PSU Oxygen Mask Compartment



WARNING: When using passenger oxygen, the "NO SMOKING" sign should be strictly observed. Once the generator is activated, the flow of oxygen is constant, whether or not the mask is being worn.

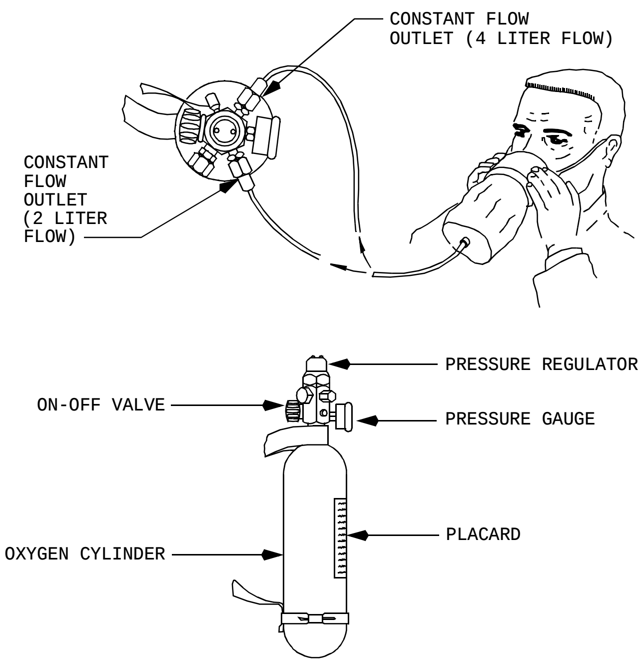
WARNING: Do not use passenger oxygen with cabin altitude below 14,000 feet when smoke or an abnormal heat source is present. The use of passenger oxygen does not prevent the passengers from inhaling smoke. Air inhaled is a mixture of oxygen and cabin air.

Passenger Portable Oxygen

First aid and supplemental portable oxygen cylinders are installed at suitable locations in the passenger cabin. The cylinders are fitted with a pressure guage, pressure regulator and an on–off valve. The cylinders are pressurized to 1800 psi. At this pressure and a temperature of 70° Fahrenheit (21° Celsius), the cylinders have a capacity of 11 cubic feet (311 liters) of free oxygen. Two continuous flow outlets are provided on each cylinder, one regulates flow at two liters per minute for walk–around; the second outlet provides flow at four liters per minute. The four–liter flow is used for first aid.

Duration can be determined by dividing capacity by outflow (311 liters divided by 4 liters/minute = 77 minutes).

Passenger Portable Oxygen Equipment



Fire Extinguishers

Fire extinguishers are located in the flight deck and passenger cabin.

Water Fire Extinguishers

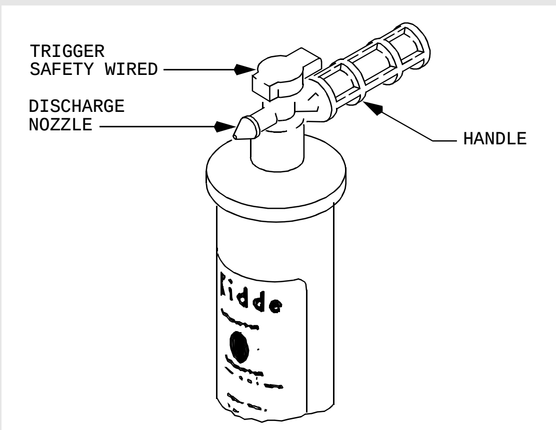
Water fire extinguishers contain a solution of water mixed with antifreeze. The container is pressurized by a CO2 cartridge when the extinguisher handle is rotated fully clockwise. The extinguisher should be used on fabric, paper or wood fires only.

To use the water fire extinguisher:

- remove from stowage
- rotate handle fully clockwise
- aim at base of fire and press trigger.

CAUTION: Do not use on electrical or grease type fires.

Water Fire Extinguisher



Halon (BCF) Fire Extinguishers

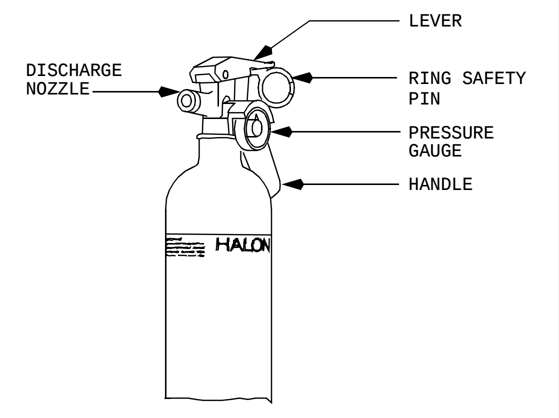
Halon (BCF) fire extinguishers contain a liquefied gas agent under pressure. The pressure indicator shows an acceptable pressure range, a recharge range, and an overcharged range. A safety pin with a pull ring prevents accidental trigger movement. When released the liquefied gas agent vaporizes and extinguishes the fire. The extinguisher is effective on all types of fires, but primarily on electrical, fuel and grease fires.

To use the Halon fire extinguisher:

- remove from stowage
- hold upright and remove ringed safety pin

- aim at base of fire from a distance of six feet and press top lever
- use side-to-side motion to suppress fire.

BCF Fire Extinguisher (Halon 1211)



Fire Extinguisher Usage

Each class of fire calls for specialized action. Using the wrong extinguisher may do more harm than good. For your own protection, you should know these basic types, how to use them, and why.

CLASSES OF FIRE There are three common classes of fire:	EXTINGUISHER TYPE
CLASS A COMBUSTIBLE MATERIALS - paper, wood, fabric, rubber, certain plastics, etc., where quenching by water is effective.	TYPE A Water (H_2O) saturates material and prevents rekindling.
CLASS B FLAMMABLE LIQUIDS - gasoline, oils, greases, solvents, paints, burning liquids, cooking fats, etc., where smothering action is required.	TYPE B BCF (Halon 1211)
CLASS C LIVE ELECTRICAL - fires started by short circuit or faulty wiring in electrical or electronic equipment, or fires in motors, switches, galley equipment, etc., where a nonconducting extinguisher agent is required. NOTE: Whenever possible, electrical equipment should be de-energized before attacking a class C fire.	TYPE C BCF (Halon 1211)

WARNING: THE WRONG EXTINGUISHER ON A FIRE COULD DO MORE HARM THAN GOOD. FOR EXAMPLE, B C RATED EXTINGUISHER IS NOT AS EFFECTIVE AS H2O 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.

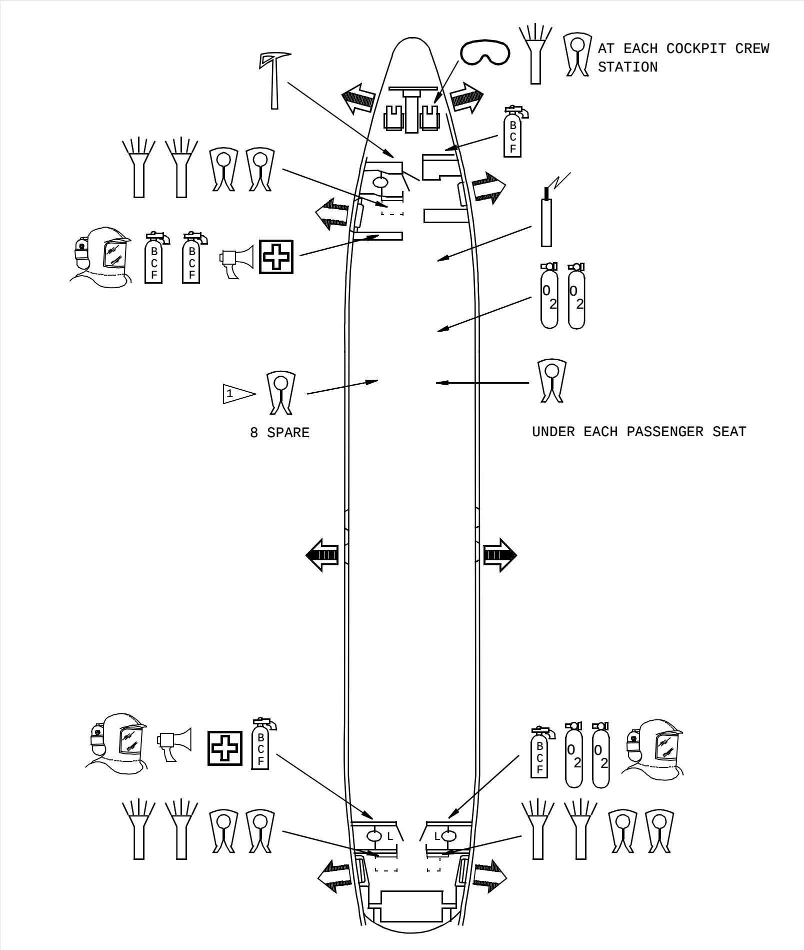
WARNING: The concentrated agent, or the by–products created by the heat of the fire, are toxic when inhaled.

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

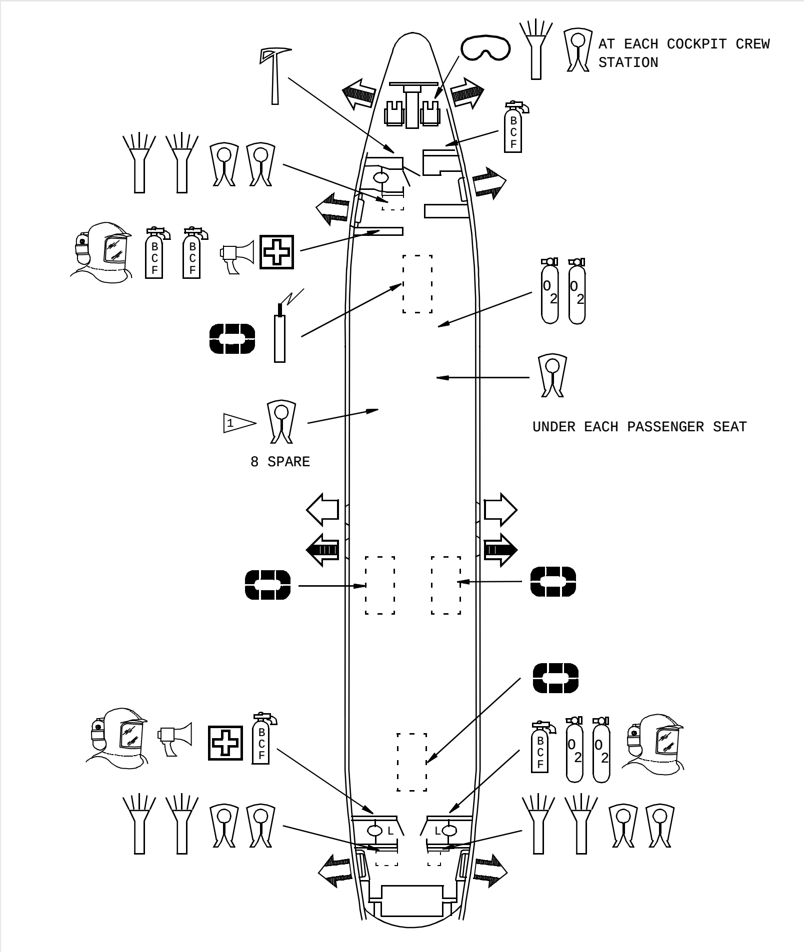
NOTE: Some symbols do not apply to all configurations.

Emergency Equipment Locations



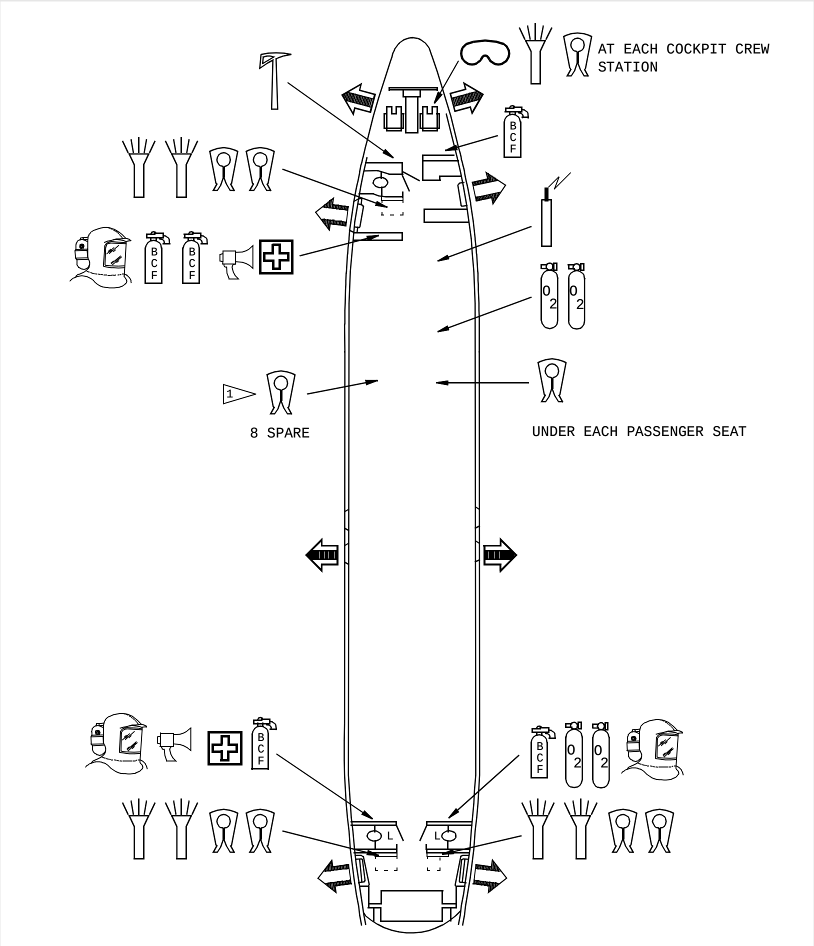
1 As installed

EMERGENCY EQUIPMENT LOCATIONS
737-300



1 As installed

EMERGENCY EQUIPMENT LOCATIONS
737-400



1 As installed

EMERGENCY EQUIPMENT LOCATIONS
737-500

Doors and Windows

The airplane has two passenger entry doors, one cabin door (the flight deck/passenger cabin entry), two service doors, and two cargo doors. There is also a center electrical and electronic (E/E) equipment access door and an equipment compartment access door on the bottom of the airplane.

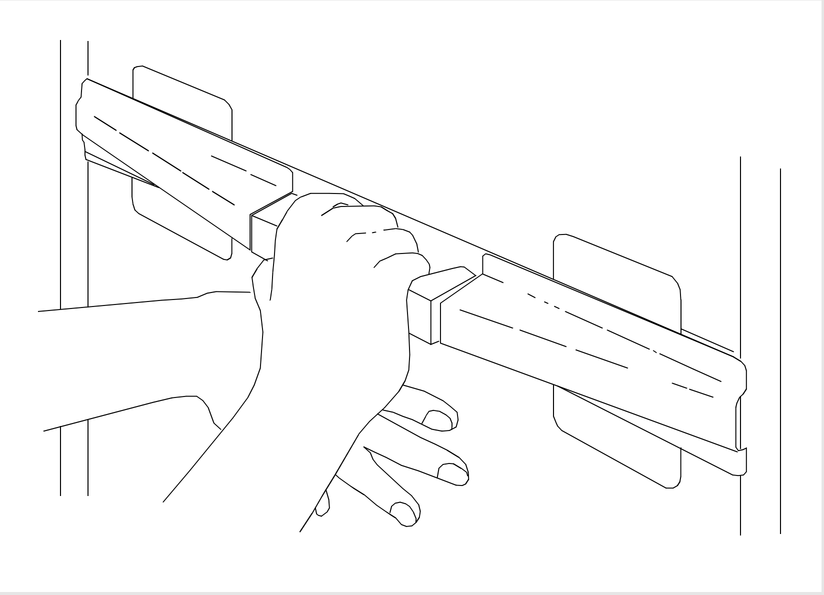
The flight deck number two windows, one on the left and one on the right, can be opened by the flight crew.

Cabin Door

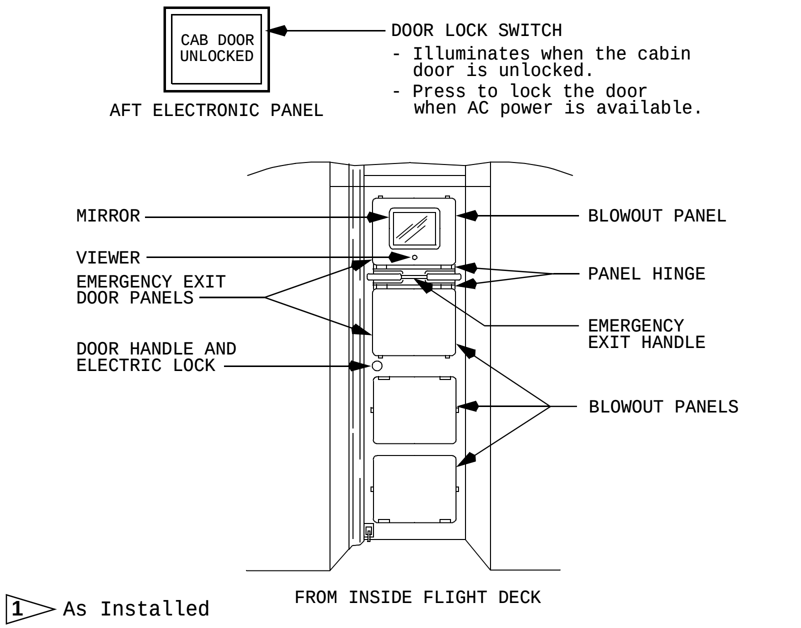
An electrical and keyed lock permits the door to be opened, closed, and locked from either side. With 115 volt AC power available, the door may be electrically locked or unlocked by pressing the door lock switch on the control stand; entrance from the passenger cabin requires a key when the door is electrically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

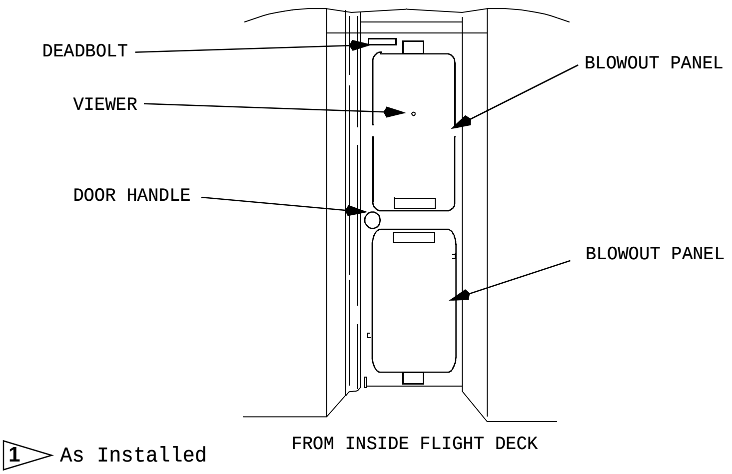
An emergency exit feature is also provided which permits the release and removal of the two upper blowout panels from the door. To operate, pull on the release handle while pressing on the panel below the release handle. Panel will not release unless both ends of handle have been pulled away from their locked position.



CABIN DOOR


CAB DOOR
UNLOCKED
AFT ELECTRONIC PANEL
DOOR LOCK SWITCH
- Illuminates when the cabin door is unlocked.
- Press to lock the door when AC power is available.
MIRROR
VIEWER
EMERGENCY EXIT DOOR PANELS
DOOR HANDLE AND ELECTRIC LOCK
BLOWOUT PANEL
PANEL HINGE
EMERGENCY EXIT HANDLE
BLOWOUT PANELS
FROM INSIDE FLIGHT DECK
1 As Installed

CABIN DOOR



FLIGHT DECK SECURITY DOOR

Flight Deck Security Door (As Installed)

The flight deck security 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. Locking the deadbolt on the flight deck side prevents the key from unlocking the door on the passenger cabin side.

The flight deck access system consists of an emergency access panel, chime module, three position door lock selector, two indicator lights, and a power cutoff 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. The associated window lock lever locks or unlocks the window.

Lower Cargo Compartments

The lower cargo compartments, if equipped with smoke and fire detectors and with a built-in fire extinguisher system controlled from the flight deck, satisfy the requirements for Class C compartments.

Note: The certification standards for fire safety in Class D cargo and baggage compartments have been changed. Class D compartments in airplanes used for passenger service must now comply with the standards for Class C compartments. Class C standards require that a compartment be equipped with smoke and fire detectors and with a built-in fire extinguisher system controlled from the flight deck. No inflight access is necessary, but the flight crew must be able to control the ventilating airflow into these compartments. Class D compartments in airplanes used only for cargo service must also comply with the standards for Class C, or with the detection standards for Class E compartments.

There are two cargo compartment doors on the lower right side of the fuselage. Both are plug type, inward opening pressure doors, hinged at their upper edges and operated manually from either inside or outside the airplane. Except for slight difference in shape, both doors are similar in design and operation. The door is locked closed by four latches. Each door has a balance mechanism which creates door–open force slightly more than equal to the weight of the door. The door can therefore, with little effort, be swung open, until it engages a mechanical lock. The door can be closed easily by pulling a lanyard attached to the door, releasing the uplatch, grasping the handle and closing the door.

A pressure equalization valve is in the aft bulkhead of each compartment. The valves let only enough air flow into or out of the cargo compartments to keep the pressures nearly the same as the cabin pressure.

Blowout panels in the lower cargo compartments provide pressure relief at a greater rate than the pressure equalization valve in case the airplane pressurization is lost.

Emergency Escape

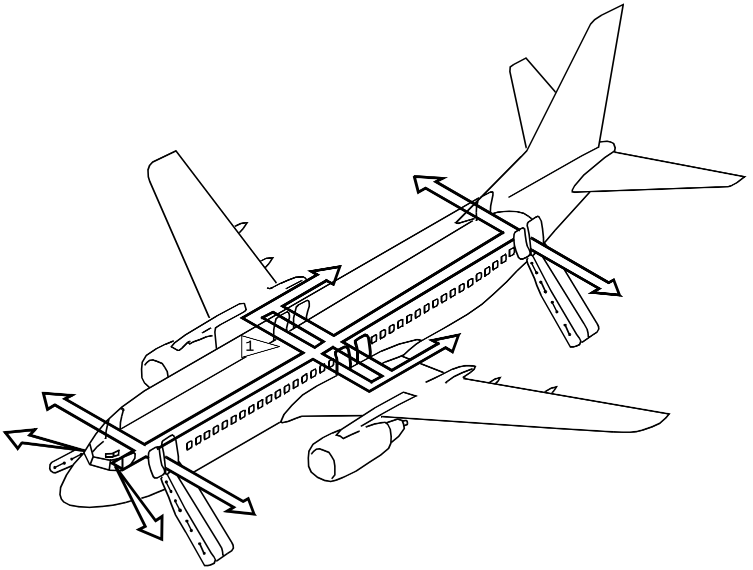
Emergency escape information included in this chapter includes:

- emergency evacuation routes
- flight deck windows
- escape slides
- escape straps
- escape hatches

Emergency Evacuation Routes

Emergency evacuation may be accomplished through four entry/service doors and two overwing escape hatches. 737–400 airplanes have four overwing escape hatches. Flight deck crew members may evacuate the airplane through two sliding flight deck windows.

Emergency Evacuation Routes



1 737-400

Flight Deck Window Emergency Egress

Flight Deck Escape Straps

An escape strap is attached to a compartment above each No. 2 window. The straps may be used by a crewmember for escape.

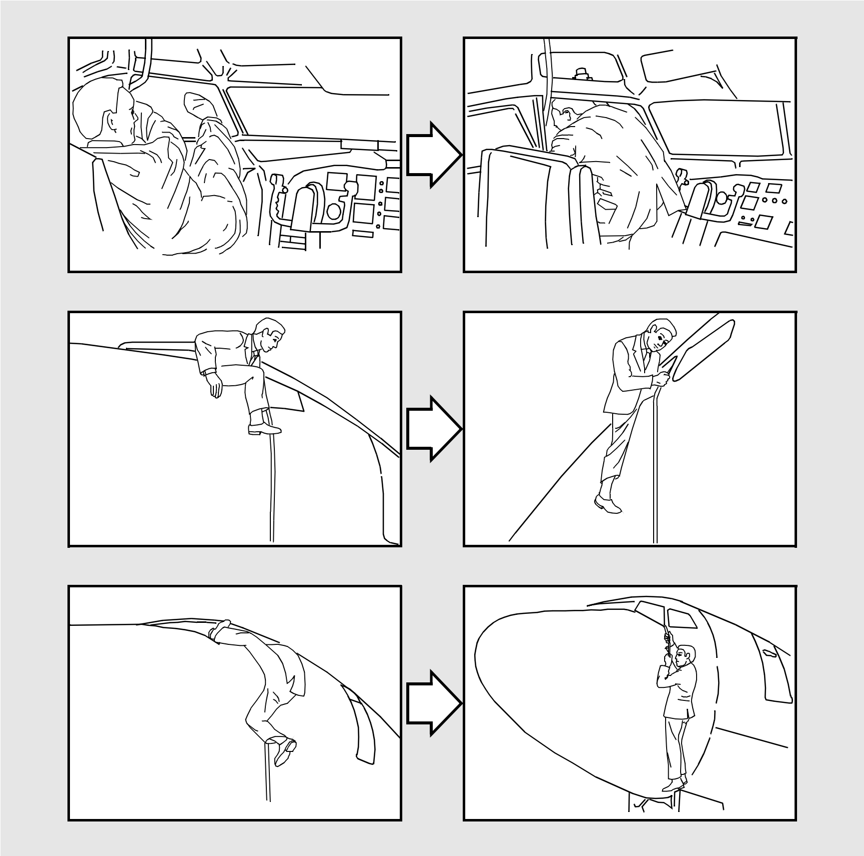
Flight Deck Number Two Windows

Flight deck sliding windows are opened by squeezing the lock release in the handle, rotating the handle inward, and sliding the window aft until it locks. The right hand window has provisions for exterior access as well.

If the flight deck number two windows must be used for emergency egress, use the following procedure:

- open the window
- open the escape strap compartment (above and aft of window)
- pull on the escape strap to ensure it is securely attached
- throw the strap out the window
- sit on the window sill with upper body outside
- exit in accordance with the following illustration.

CAUTION: Ensure the escape strap is securely fastened to the airplane.



The above illustrated method of departure would probably be the easiest for most crewmembers. This technique is difficult and should be used only in extreme emergency.

Flight Deck Escape Straps

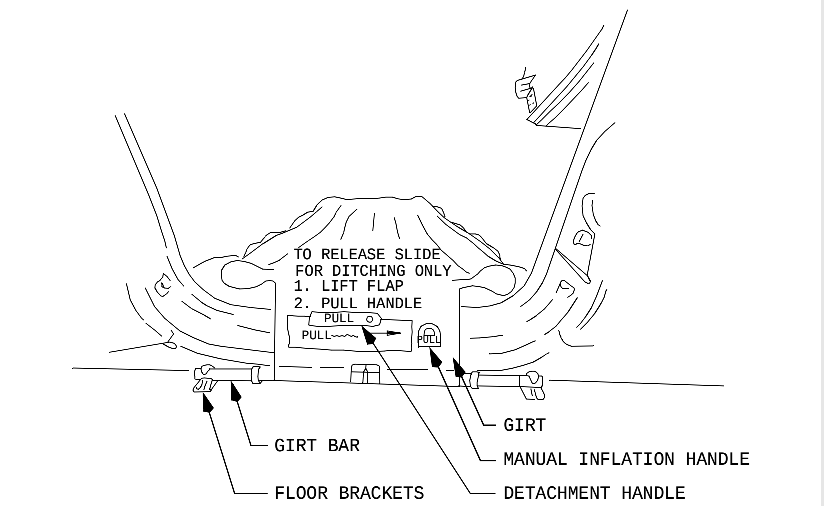
Escape straps are attached to compartments above flight deck sliding windows. The straps may be used by crew members to lower themselves to the ground.

Escape Straps

Escape Slide Detachment Handle

The slide has not been certified to be part of the water landing emergency equipment. In a water environment, the slide may not properly inflate when deployed. If the deployed slide is recognized to be a potential obstruction to egress, a quick release handle is provided near the top of the slide. This handle is protected by a cover and is placarded. The escape slide is detached from the airplane by pulling the detachment handle. Once detached from the door sill, the slide is tethered to the door sill by a lanyard. A properly inflated slide could be buoyant, and useful as a flotation device for passengers in the water. Hand grips are positioned along the sides of the slide.

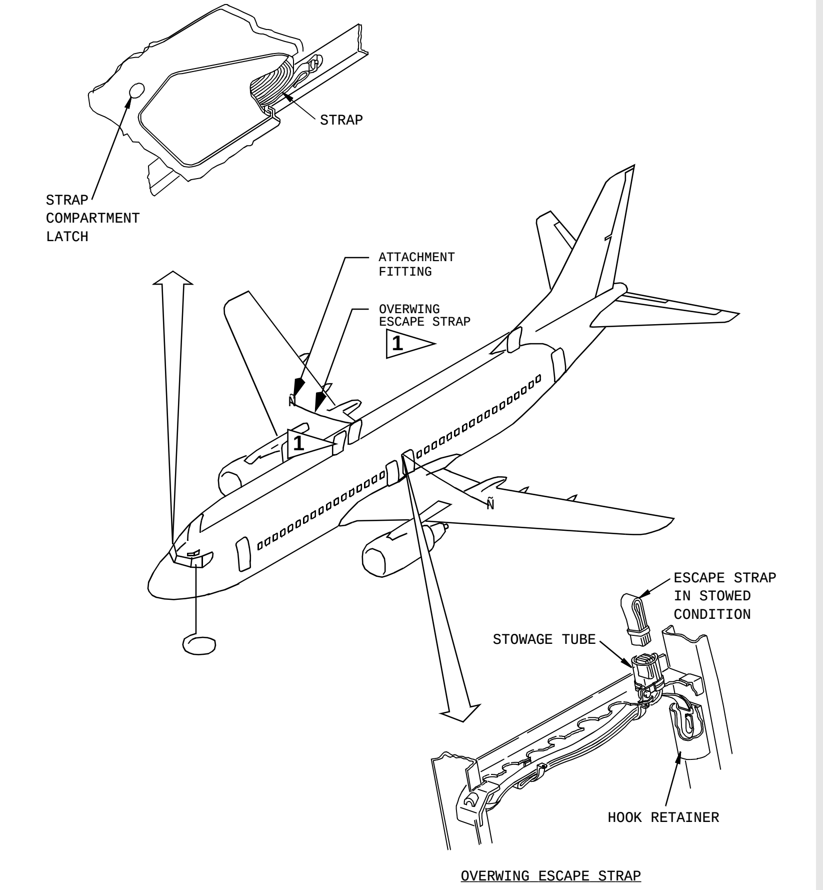
Escape Slide Detachment Handle



Overwing Escape Straps

Escape straps are installed above each emergency escape hatch frame. The overwing escape hatches must be removed to expose the straps. One end of the strap is attached to the hatch frame. The remainder of the strap is stowed in a tube extending into the cabin ceiling. To use, the strap is pulled free from its stowage and attached to a ring on the top surface of the wing. The escape strap can be used as a hand hold in a ditching emergency for passengers to walk out on the wing and step into a life raft.

Overwing Escape Straps

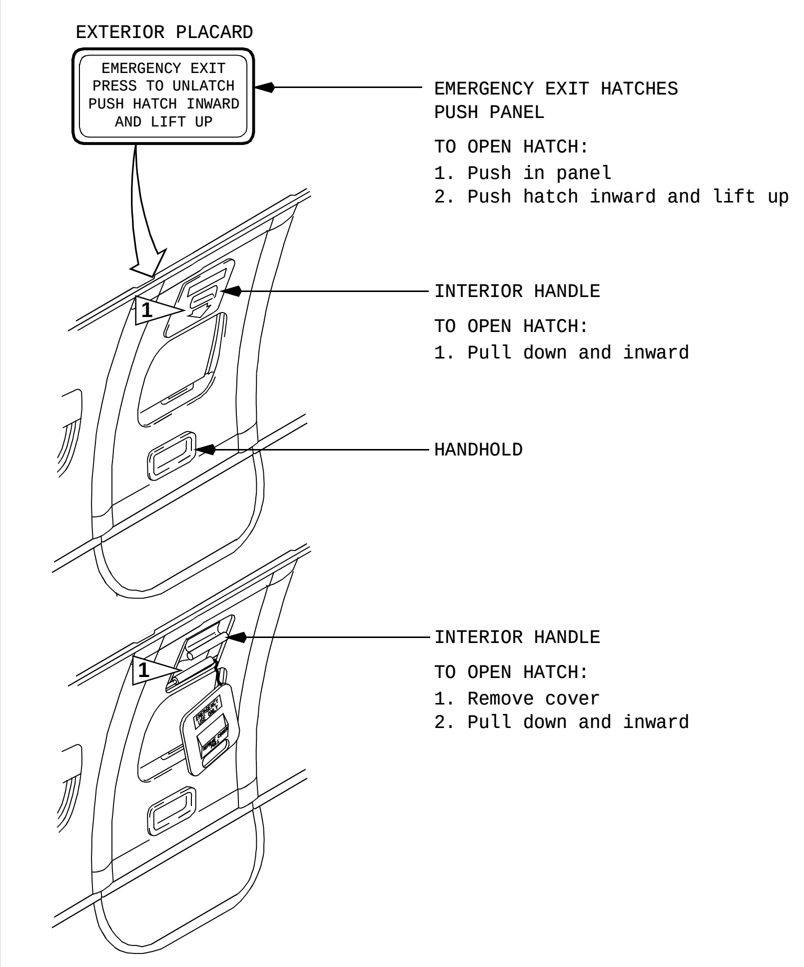


1 737-400

Overwing Escape Hatches

Two escape hatches are located in the passenger cabin over the wings. These are plug type hatches and are held in place by mechanical locks and airplane cabin pressure. The hatches can be opened from the inside or from outside of the airplane by a spring–loaded handle at the top of the hatch. A seat back blocking an exit may be pushed forward by applying force to the top of the seat back. For safety reasons, hatches should not be removed in flight.

Overwing Escape Hatches



1 As installed

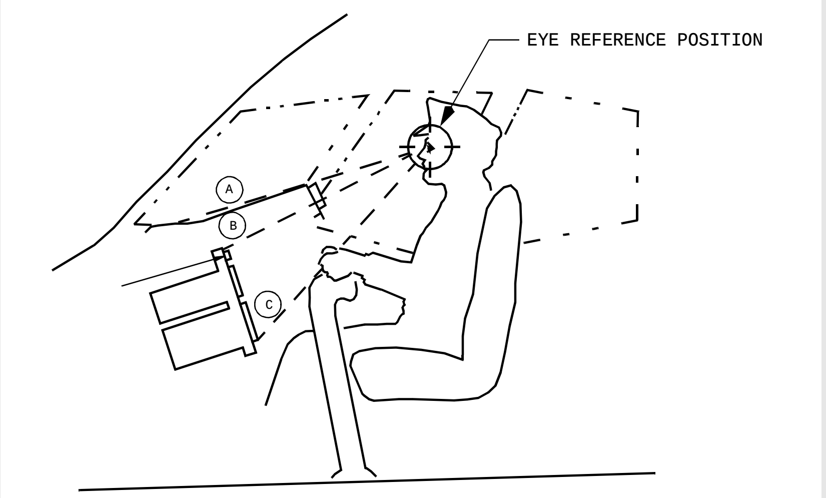
WARNING: Do not remove hatches in flight in preparation for passenger evacuation. For emergency evacuation on the ground or in water, remove hatch and place so as not to obstruct egress. The hatch may be thrown out onto the wing, placed on the seat arm rests, or placed in any other suitable location as dictated by the conditions at the time of airplane evacuation.

Pilot Seat Adjustment

Adjust the seat position with the appropriate controls to obtain the optimum eye reference position. Use the handhold above the forward window to assist. The following sight references are used:

- Sight along the upper surface of the glareshield with a small amount of the airplane nose structure visible (A)
- Sight under the glareshield to view the A/P–A/T–FMC lights panel (B)
- Sight over the control column until the bottom of the EHSI is visible (C).

Pilot Seat Adjustment



Galleys

Galleys are located in the passenger cabin to provide convenient and rapid service to the passengers. Generally, they are installed in the cabin adjacent to the forward and aft galley service doors.

In general the equipment of the galley unit consists of the following main items:

- high speed ovens
- hot beverage containers
- hot cup receptacles
- refrigeration and main storage compartments

Electrical control panel switches and circuit breakers to operate the above equipment are conveniently located within the galley work area. Storage space, miscellaneous drawers, and waste containers are also integrated in the galley units.

Electrical Power

Electricity for the galleys is 115V AC supplied from the airplane transfer buses and controlled by a switch on the overhead panel. Circuit breakers are located on the galleys and on the P-6 circuit breaker panel.

Water Service

Water is supplied to the galleys from the airplane's pressurized water system and, in an emergency, may be shut off at the galley.

Water System

The airplane's potable water system is supplied from a single tank located behind the aft cargo compartment. Fresh water is supplied to the galleys and lavatory sinks.

Quantity Indication and System Operation

A quantity indicator is located on the attendant's panel. When the "PUSH" button on the indicator is pressed, lights illuminate to show the water level. When full, approximately 20 U.S. gallons (737-500) 30 U.S. gallons (737-300), or 40 gallons (737-400) are available. The system is pressurized by engine bleed air or by the water system air compressor. Shutoff valves are located on each galley and below the sink in each lavatory. The drain position of this valve is used to drain all water overboard. Normally, the drain shutoff valves are ON.

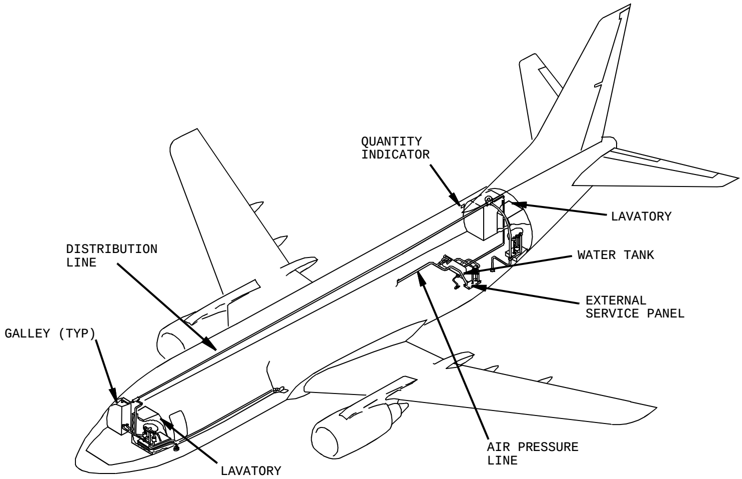
Hot Water

Hot and cold water is available in some lavatories. The water heater is located below the lavatory sink. When emptied, it heats a new water charge in four minutes. An amber light is ON when the heater is operating normally. The heater has an overheat switch which turns off the heating element if an excess temperature is reached. The heater may be turned off at any time by using a manual switch on the heater. Hot and cold water is also supplied at the galleys.

Servicing

The system is serviced from an exterior panel on the aft left side of the airplane. Pressure filling is required. Waste water from the galleys and lavatory wash basins is drained overboard through two heated drain masts. The drain masts are on the bottom of the fuselage, one forward and one aft.

Water System



Forward Airstair

The forward airstair provides the capability of boarding passengers without relying on the availability of airport ground equipment. The airstair is electrically operated and may be controlled from either inside or outside the airplane. The airstair is stowed inside a compartment just below the forward entry door. The compartment has a pressure door that automatically opens before the airstair can operate. For passenger safety, upper handrails are attached to support brackets inside the entry door after the airstair is fully extended.

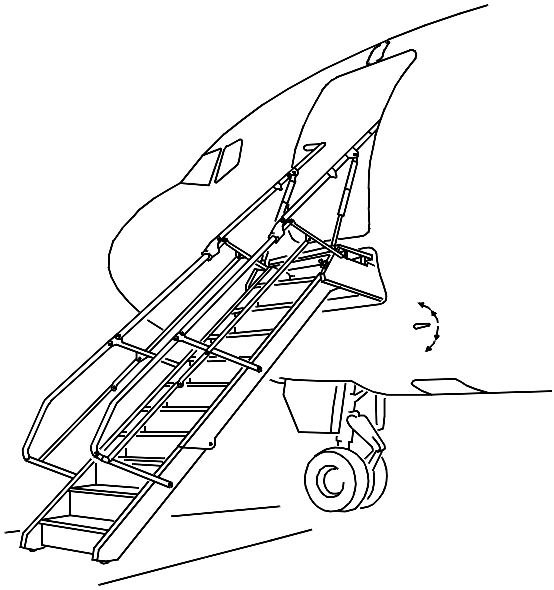
Interior Control

The interior control panel is located above the forward entry door. An amber STAIRS OPERATING light on the panel illuminates when the airstair is in transit. The airstair tread lights on the airstair steps are controlled by a single three–position airstair LIGHTS switch. With the switch in the AUTO position, the tread lights illuminate when the airstair makes contact with the ground and extinguish when the airstair retracts. The interior control panel has two modes of operation, normal and standby. The standby system provides an alternate means of electrical control in the event the normal mode of operation is not available. Normal operation requires both AC and DC power. Standby operation requires the battery switch to be ON. Both operating modes require the forward entry door to be partially open. The two airstair control switches have three positions - EXTEND, RETRACT, and a center neutral (off) position. For standby operation, hold the spring-loaded guard to the left, then select either EXTEND or RETRACT. The guard is spring-loaded to the right to prevent inadvertent operation of the airstair in standby.

Exterior Control

The exterior control is located to the right and below the airstair compartment. Operating instructions are located around the handle. When operating the airstair with the exterior control, the forward entry door need not be open. The exterior control handle by–passes the door–open requirement. The control handle is normally flush with the fuselage. Pushing the button in the center of the handle extends the handle for easy operation. The handle rotates clockwise or counterclockwise to extend or retract the airstair. A two–position switch, labeled NORMAL and STANDBY, is located in the exterior handle recess. The switch is spring–loaded to NORMAL. Holding the NORMAL/STANDBY Switch to STANDBY provides DC power from the battery bus for airstair operation. The BAT switch on the flight deck does not need to be ON when operating the airstair on standby from the exterior control panel. The control handle rotates to extend or retract airstair. The use of the standby system from either the interior or exterior control by–passes the handrail and lower ladder safety circuits. Caution must be exercised when using the standby system. If the upper handrail extensions are not properly stowed before retraction, damage to the airplane structure or damage to the airstair's handrail may result. An amber AIRSTAIR light, located on the overhead door caution annunciator panel illuminates when the airstair pressure door is unlocked. Illumination of the AIRSTAIR light also activates the DOORS annunciator light and the MASTER CAUTION lights. The Airstair light is inoperative when the main AC bus is not powered. The MASTER CAUTION and DOORS lights illuminate in normal or standby operation of the airstair.

Forward Airstair



Air Systems — Chapter 2
Table of Contents — Section 0

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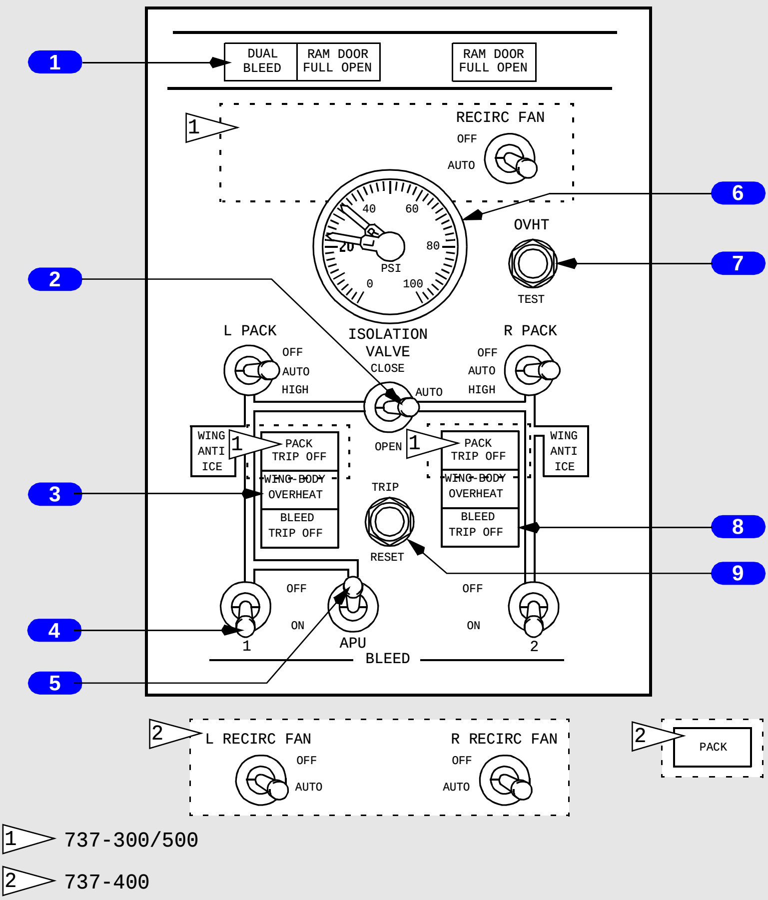
Bleed Air Controls and Indicators



FORWARD OVERHEAD PANEL

1 DUAL BLEED Light

Illuminated (amber) – APU bleed air valve open and engine No. 1 BLEED air switch ON, or engine No. 2 BLEED air switch ON, APU bleed air valve and isolation valve open.

2 ISOLATION VALVE Switch

CLOSE – closes isolation valve.

AUTO –

- closes isolation valve if both engine BLEED air switches are ON and both air conditioning PACK switches are AUTO or HIGH
- opens isolation valve automatically if either engine BLEED air or air conditioning PACK switch positioned OFF.

OPEN – opens isolation valve.

3 WING–BODY OVERHEAT Light

Illuminated (amber) –

- left light indicates overheat from bleed air duct leak in left engine strut, left inboard wing leading edge, left air conditioning bay, keel beam or APU bleed air duct
- right light indicates overheat from bleed air duct leak in right engine strut, right inboard wing leading edge or right air conditioning bay.

4 Engine BLEED Air Switches

OFF – closes engine bleed air valve.

ON – opens engine bleed air valve when engines are operating.

5 APU BLEED Air Switch

OFF – closes APU bleed air valve.

ON – opens APU bleed air valve when APU is operating.

6 Bleed Air DUCT PRESSURE Indicator

Indicates pressure in L and R (left and right) bleed air ducts.

7 Wing–Body Overheat (OVHT) TEST Switch

PUSH –

- tests wing–body overheat detector circuits
- illuminates both WING–BODY OVERHEAT lights.

8 BLEED TRIP OFF Light

Illuminated (amber) – excessive engine bleed air temperature or pressure

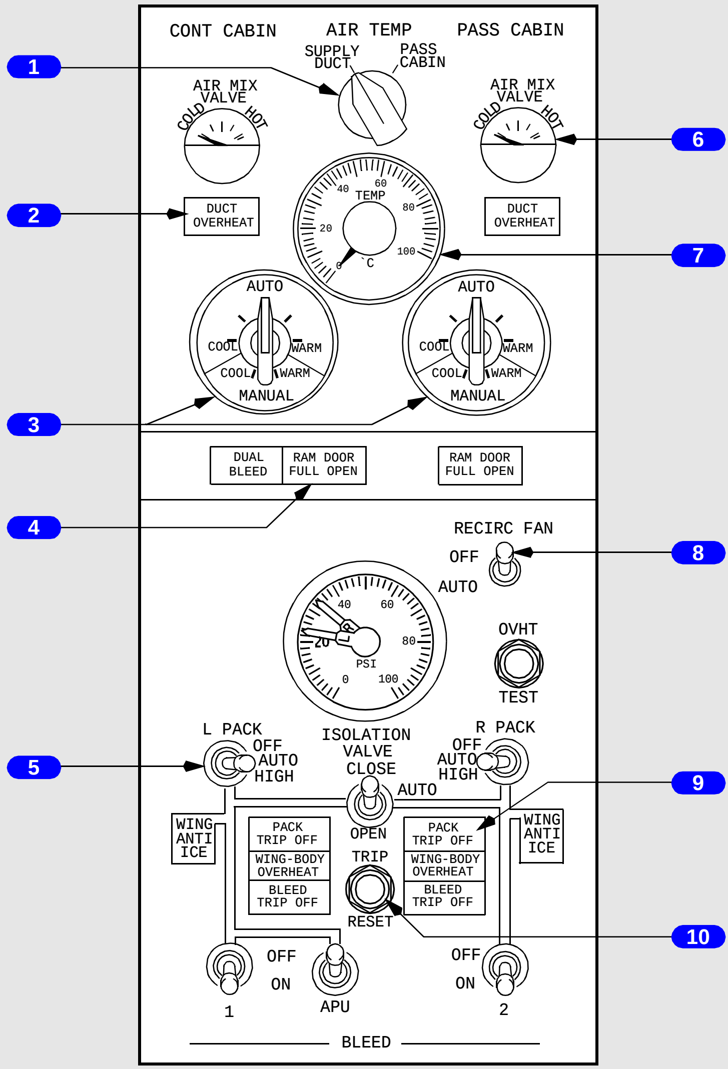
- related engine bleed air valve closes automatically
- requires reset.

9 TRIP RESET Switch

PUSH (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK TRIP OFF and DUCT OVERHEAT lights (BLEED TRIP OFF, PACK and ZONE TEMP lights for 737-400)
- lights remain illuminated until reset.

Air Conditioning Controls and Indicators (737-300/500)



FORWARD OVERHEAD PANEL

1 AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – selects main distribution supply duct sensor for TEMP indicator.

PASS CABIN – selects passenger cabin sensor for TEMP indicator.

2 DUCT OVERHEAT Light

Illuminated (amber) –

- bleed air temperature in related duct exceeds limit
- air mix valves drive full cold
- requires reset.

3 Control (CONT) CABIN and Passenger (PASS) CABIN Temperature Selector

AUTO – automatic temperature controller controls passenger cabin or flight deck temperature as selected.

MANUAL – air mix valves controlled manually. Automatic temperature controller bypassed.

4 RAM DOOR FULL OPEN Light

Illuminated (blue) – indicates ram door in full open position.

5 Air Conditioning PACK Switch

OFF – pack signalled OFF.

AUTO –

- with both packs operating, each pack regulates to low flow
- with one pack operating, operating pack regulates to high flow in flight with flaps up
- when operating one pack from APU (both engine BLEED air switches OFF), regulates to high flow.

HIGH –

- pack regulates to high flow
- provides maximum flow rate on ground with APU BLEED air switch ON.

6 AIR MIX VALVE Indicator

Indicates position of air mix valves:

- controlled automatically with related temperature selector in AUTO
- controlled manually with related temperature selector in MANUAL.

7 Air Temperature (TEMP) Indicator

Indicates temperature at location selected with AIR TEMP source selector.

8 Recirculation (RECIRC) FAN Switch

OFF – fan signalled OFF

AUTO – fan signalled on except when both packs operating with either PACK switch in HIGH.

9 PACK TRIP OFF Light

Illuminated (amber) –

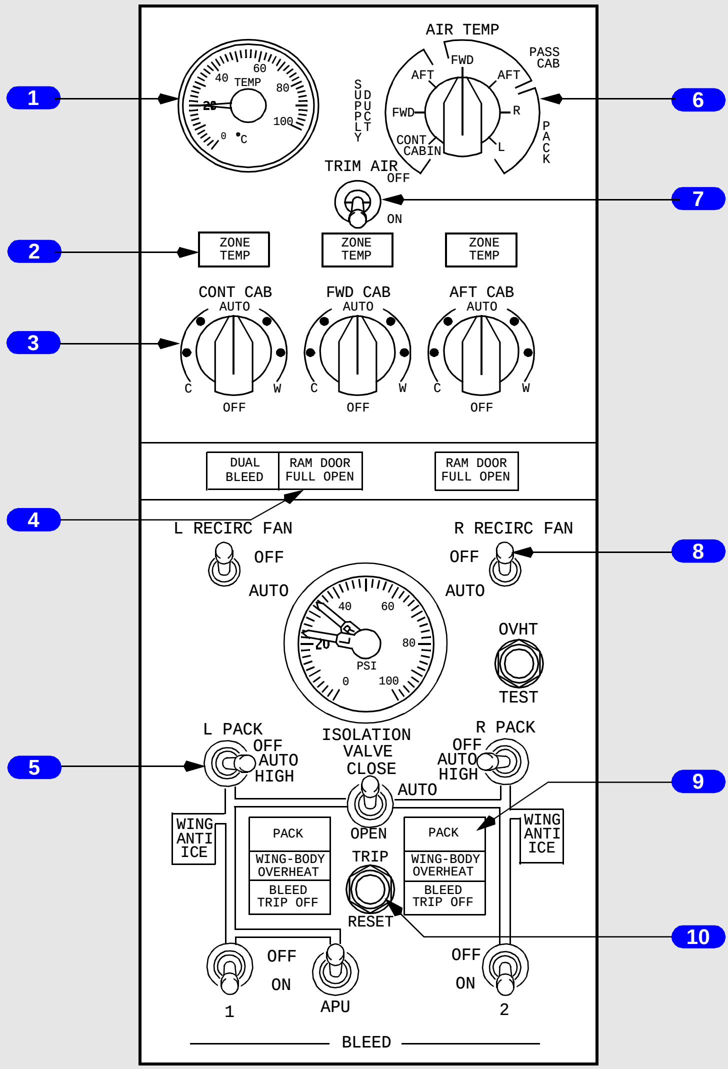
- indicates pack temperature has exceeded limits
- related pack valve automatically closes and mix valves drive full cold
- requires reset.

10 TRIP RESET Switch

PUSH (if fault condition is corrected) –

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

Air Conditioning Controls and Indicators (737-400)



FORWARD OVERHEAD PANEL

1 Air Temperature (TEMP) Indicator

Indicates temperature at location selected with AIR TEMP source selector

2 ZONE TEMP Lights

Illuminated (amber) –

- CONT CAB indicates a duct temperature overheat, or failure of the flight deck primary and standby temperature control
- FWD CAB or AFT CAB indicates duct temperature overheat.

During Master Caution light recall:

- CONT CAB indicates failure of the flight deck primary or standby temperature control
- either FWD CAB or AFT CAB indicates failure of the associated zone temperature control
- lights will extinguish when MASTER CAUTION is reset.

3 Temperature Selector

AUTO – provides automatic temperature control for the associated zones. Rotating the controls towards C (cool) or W (warm) sets the desired temperature

OFF – closes the associated trim air modulating valve.

4 RAM DOOR FULL OPEN Light

Illuminated (blue) – indicates ram door in full open position.

5 Air Conditioning PACK Switch

OFF – pack signalled OFF.

AUTO –

- with both packs operating, each pack regulates to low flow
- with one pack operating, operating pack regulates to high flow in flight with flaps up
- when operating one pack from APU (both engine BLEED air switches OFF), regulates to high flow.

HIGH –

- pack regulates to high flow
- provides maximum flow rate on ground with APU BLEED air switch ON.

6 AIR Temperature (TEMP) Source Selector

SUPPLY DUCT – selects appropriate zone supply duct temperature

PASS CABIN – selects forward or aft passenger cabin temperature

PACK – selects left or right pack temperatures.

7 TRIM AIR Switch

ON – trim air pressure regulating and shutoff valve signaled open.

OFF – trim air pressure regulating and shutoff valve signaled closed.

8 Recirculation (RECIRC) FAN Switch

OFF – fan signalled OFF

AUTO –

- in flight –
  - the left recirculation fan operates if both packs are operating unless either PACK switch is in HIGH
  - the right recirculation fan operates if both packs are operating unless both PACK switch are in HIGH.
- on the ground –
  - the left recirculation fan operates unless both PACK switches are in HIGH
  - the right recirculation fan operates even if both PACK switches are in HIGH.

9 PACK Light

Illuminated (amber) –

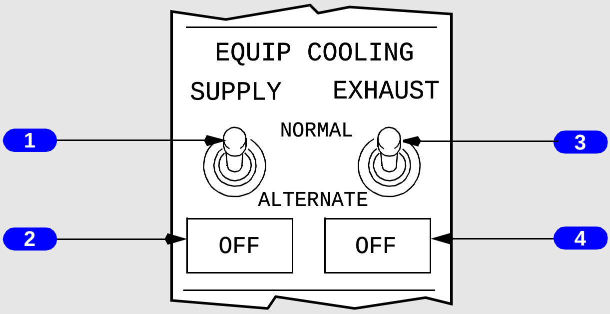
- indicates pack trip off or failure of both primary and standby pack controls
- during MASTER CAUTION light recall, indicates failure of either primary or standby pack control . Extinguishes when MASTER CAUTION is reset.

10 TRIP RESET Switch

PUSH (if fault condition is corrected) –

- resets BLEED TRIP OFF, PACK and ZONE TEMP lights
- lights remain illuminated until reset.

Equipment Cooling Panel



FORWARD OVERHEAD PANEL

1 Equipment (EQUIP) COOLING SUPPLY Switch

NORMAL – normal cooling supply fan activated.

ALTERNATE – alternate cooling supply fan activated.

2 Equipment Cooling Supply OFF Light

Illuminated (amber) – no airflow from selected cooling supply fan.

3 Equipment (EQUIP) COOLING EXHAUST Switch

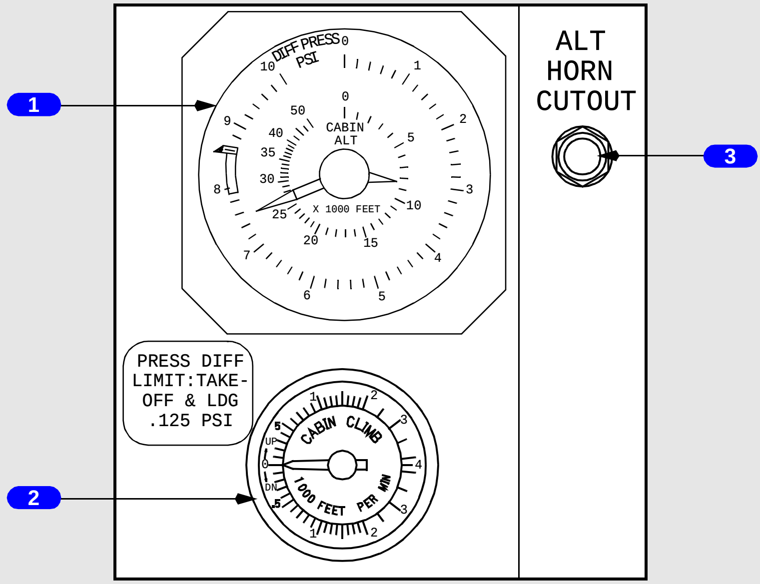
NORMAL – normal cooling exhaust fan activated.

ALTERNATE – alternate cooling exhaust fan activated.

4 Equipment Cooling Exhaust OFF Light

Illuminated (amber) – no airflow from selected cooling exhaust fan.

Cabin Altitude Panel



FORWARD OVERHEAD 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

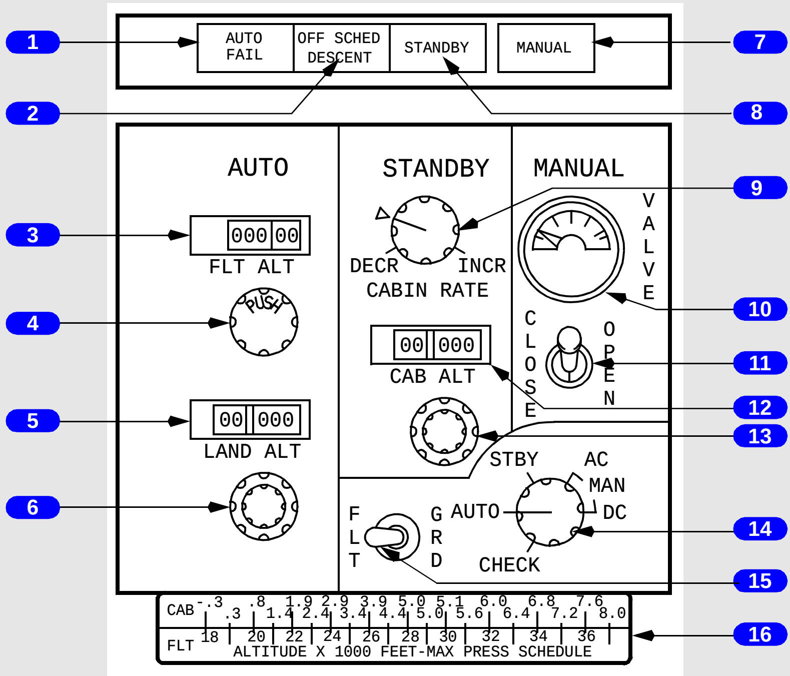
Indicates cabin rate of climb or descent in feet per minute.

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



FORWARD OVERHEAD 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

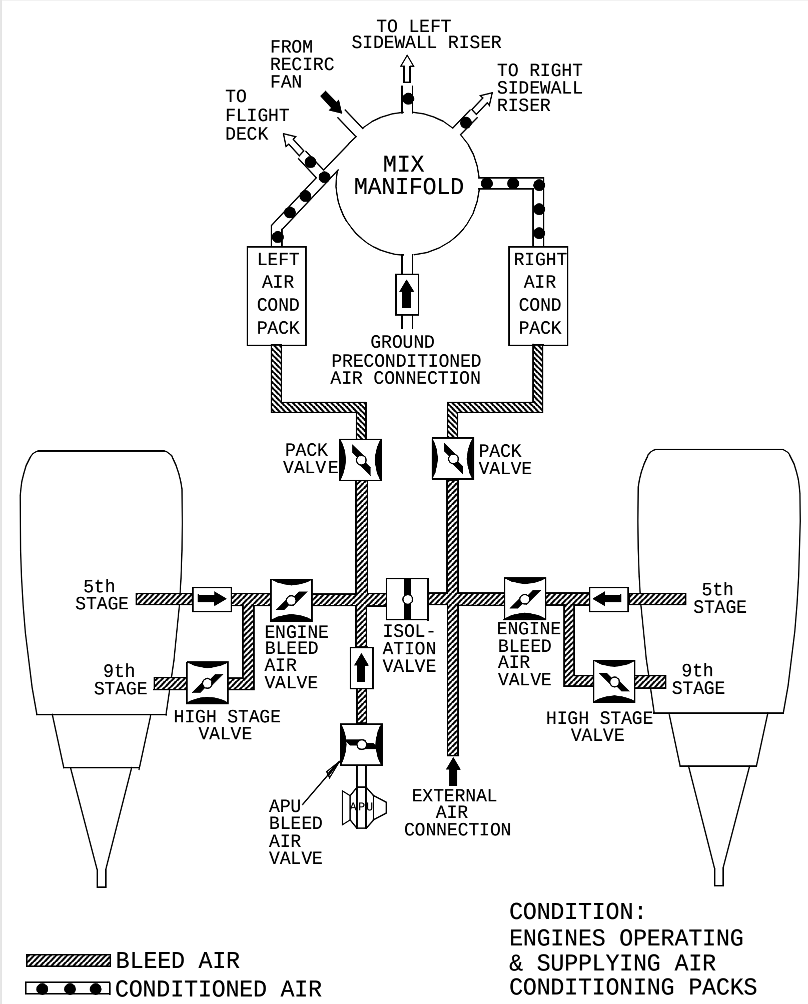
AUTO mode –
- GRD – on the ground, drives the pressurization outflow valve full open at a controlled rate and depressurizes the airplane. After takeoff, inhibited; functions the same as FLT position
- FLT – on the ground, pressurizes the cabin to approximately (-200ft) below airport elevation. After 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).

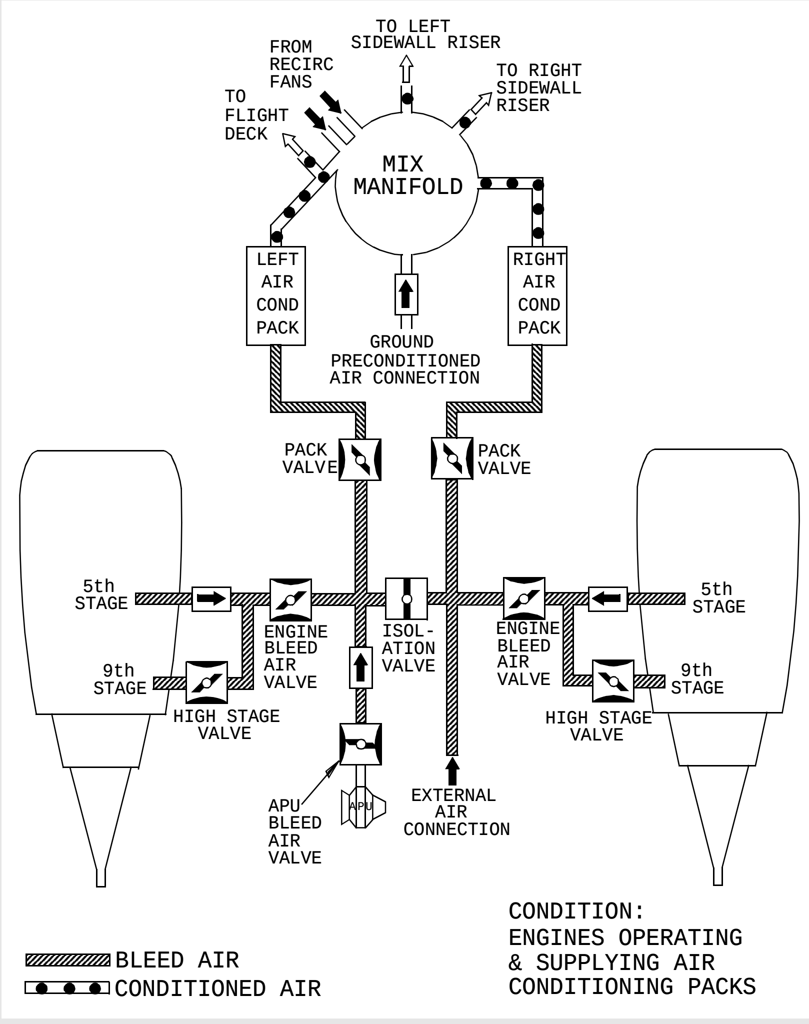
16 Cabin /Flight Altitude (CAB ALT)(FLT ALT) Placard

Used to determine setting for cabin altitude when operating in standby and manual modes.

Air Systems Schematic (737-300/500)



Air Systems Schematic (737-400)



Air Systems — Chapter 2
Bleed Air System Description — Section 20

Introduction

Air for the bleed air system can be supplied by the engines, APU, or an external air cart/source. The APU or external cart supplies air to the bleed air duct prior to engine start. After engine start, air for the bleed air system is normally supplied by the engines.

The following systems rely on the bleed air system for operation:

- Air conditioning/pressurization
- Wing and engine thermal anti-icing
- Engine starting
- Hydraulic reservoirs pressurization
- Water tank pressurization
- Aspirated TAT probe

Switches on the air conditioning panel operate the APU and engine bleed air supply system.

Engine Bleed System Supply

Engine bleed air is obtained from the 5th and 9th stages of the compressor section. When 5th stage low pressure bleed air is insufficient for the bleed air system requirements, the high stage valve modulates open to maintain adequate bleed air pressure. During takeoff, climb, and most cruise conditions, low pressure bleed air from the 5th stage is adequate and the high stage valve remains closed.

Engine Bleed Air Valves

The engine bleed air valve acts as a pressure regulator and shutoff valve. With the engine bleed air switch ON, the valve is DC activated and pressure operated. The valve maintains proper system operating pressure and reduces bleed air outflow in response to high bleed air temperature.

Bleed Trip Sensors

Bleed trip sensors illuminate the respective BLEED TRIP OFF light when engine bleed air temperature or pressure exceeds a predetermined limit. The respective engine bleed air valve closes automatically.

Duct Pressure Transmitters

Duct pressure transmitters provide bleed air pressure indications to the respective (L and R) pointers on the bleed air duct pressure indicator. The indicator is AC operated.

Isolation Valve

The isolation valve isolates the left and right sides of the bleed air duct during normal operations. The isolation valve is AC operated.

With the isolation valve switch in AUTO, both engine bleed air switches ON, and both air conditioning pack switches AUTO or HIGH, the isolation valve is closed. The isolation valve opens if either engine bleed air switch or air conditioning pack switch is positioned OFF. Isolation valve position is not affected by the APU bleed air switch.

External Air Connection

An external air cart/source provides an alternate air source for engine start or air conditioning.

APU Bleed Air Valve

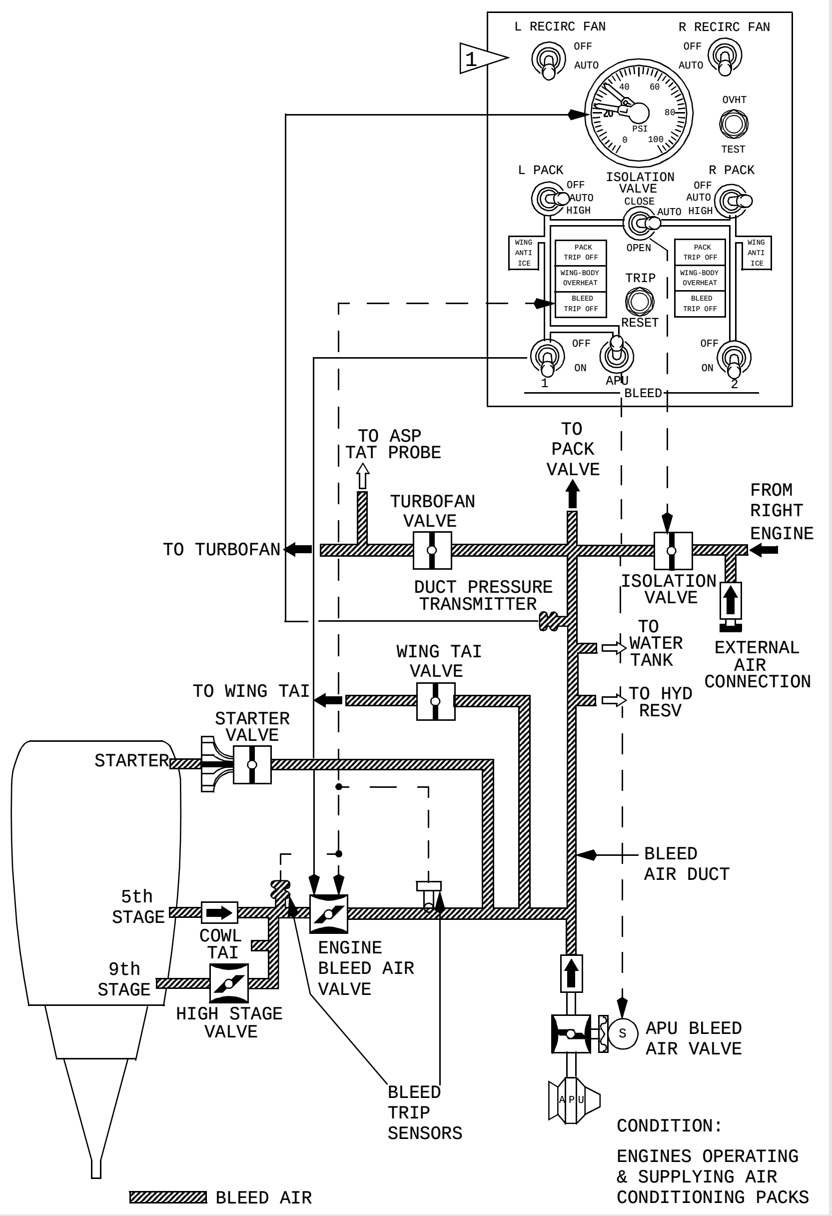
The APU bleed air valve permits APU bleed air to flow to the bleed air duct. The valve closes automatically when the APU is shut down. The APU bleed air valve is DC controlled and pressure operated.

With both the APU and engine bleed air valves open, and the engines operating at idle thrust, there is a possibility of APU bleed air backpressuring the 9th stage modulating and shutoff valve. This would cause the 9th stage valve to close.

DUAL BLEED Light

The DUAL BLEED light illuminates whenever the APU bleed air valve is open and the position of the engine bleed air switches and isolation valve would permit possible backpressure of the APU. Therefore, thrust must be limited to idle with the DUAL BLEED light illuminated.

Bleed Air System Schematic

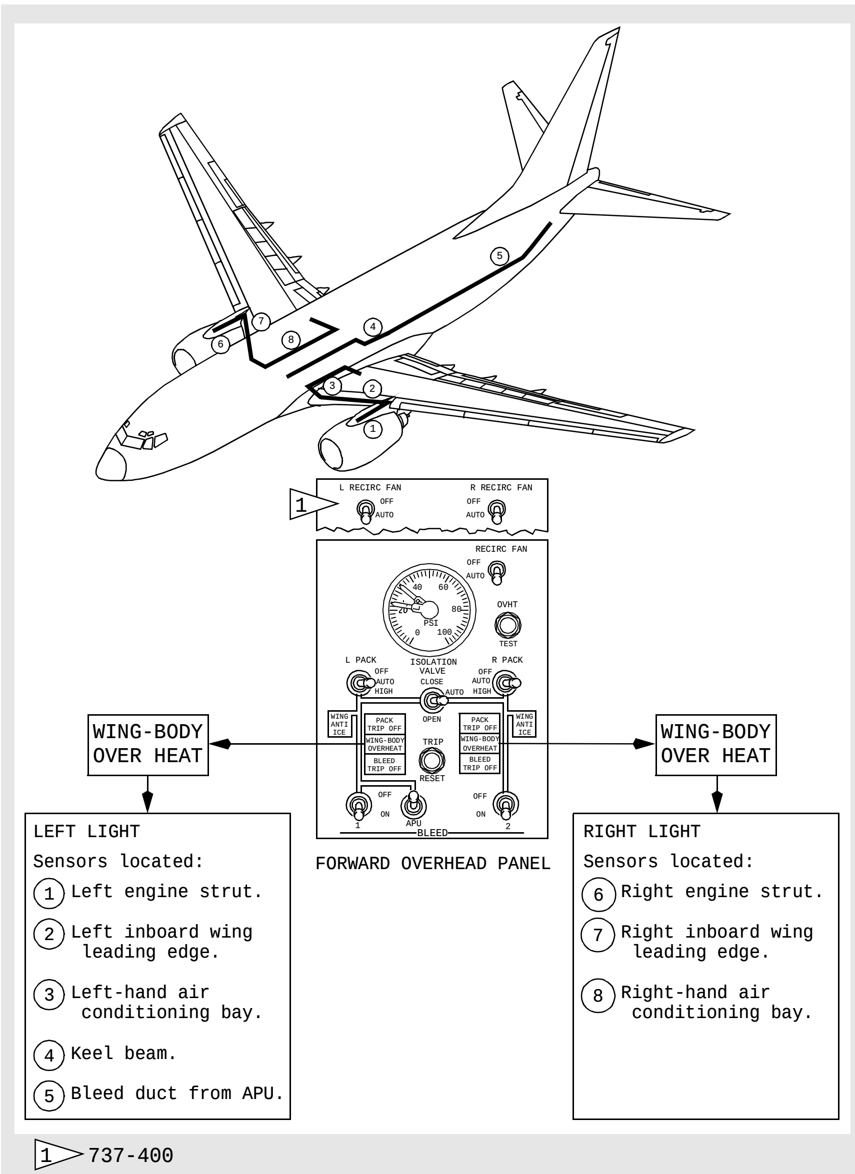


1 737-400

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



Preface

This section describes the air conditioning system for the 737–300 and the 737–500. For information concerning the 737–400, see section 2.31.

Introduction

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.

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.

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 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 just upstream of the exit louvres. It augments the ram airflow on the ground or during slow flight (flaps not retracted). The fan operates pneumatically using bleed air. It is activated electrically, when the pack is on, by the air-ground safety sensor or flap limit switch.

Deflector doors are installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. The deflector doors extends when activated electrically by the air–ground safety sensor.

Cooling Cycle

The flow through the cooling cycle starts with bleed air passing through a heat exchanger for cooling. The air then flows to an air cycle machine for refrigeration and to a water separator which removes moisture. The processed cold air is then combined with hot air. The conditioned air flows into the mix manifold and distribution system.

Overheat protection is provided by temperature sensors located in the cooling cycle. An overheat condition causes the pack valve to close and the PACK TRIP OFF light to illuminate.

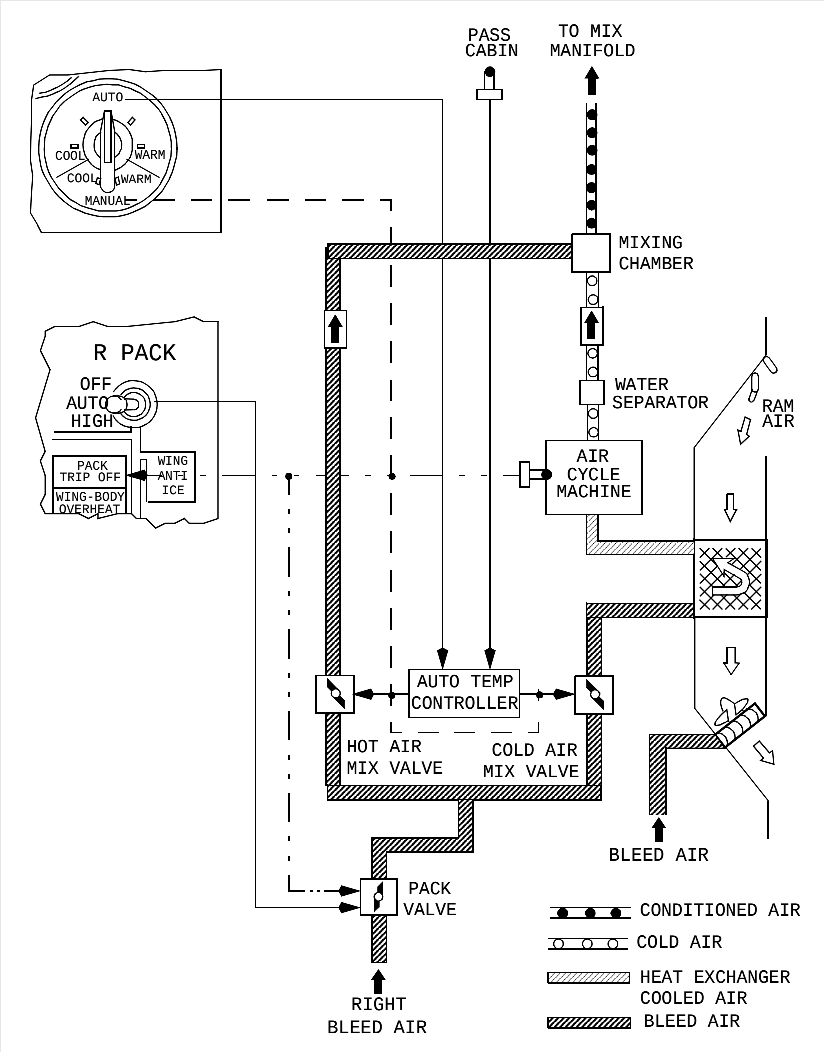
Air Mix Valves

The two air mix valves for each pack control hot and cold air according to the setting of the CONT CABIN or PASS CABIN temperature selector. Air that flows through the cold air mix valve is processed through a cooling cycle and then combined with hot air flowing from the hot air mix valve.

In the automatic temperature mode, the air mix valves are operated by the automatic temperature controller. The automatic temperature controller uses inputs from the respective temperature selector and cabin temperature sensor. The automatic temperature controller is bypassed when the temperature selector is positioned to MANUAL.

Anytime the pack valve closes, the air mix valves are driven to the full cold position automatically. This aids start-up of the cooling cycle and prevents nuisance hot air trips when the pack is turned on.

Air Conditioning Pack Schematic



Air Conditioning Distribution

Conditioned air is collected in the mix manifold. The temperature of the air is directly related to the setting of the CONT CABIN and PASS CABIN temperature selectors.

Overheat detection is provided by temperature sensors located downstream of the packs. An overheat condition causes the appropriate mix valves to drive full cold and the DUCT OVERHEAT light to illuminate. A temperature higher than the duct overheat causes the appropriate pack valve to close and the PACK TRIP OFF light to illuminate.

Flight Deck

Since the flight deck requires only a fraction of the air supply provided by the left pack, most of the left pack air output is mixed with the right pack supply and routed to the passenger cabin.

Conditioned air for the flight deck branches into several risers which end at the floor, ceiling, and foot level outlets. Air diffusers on the floor under each seat deliver continuous air flow as long as the manifold is pressurized.

Overhead diffusers are located on the flight deck ceiling, above and aft of the No. 3 windows. Each of these outlets can be opened or closed as desired by turning a slotted adjusting screw.

There is also a dual purpose valve behind the rudder pedals of each pilot. These valves provide air for warming the pilots' feet and for defogging the inside of the No. 1 windshields. Each valve is controlled by knobs located on the Captain's and First Officer's panel, respectively.

Passenger Cabin

The passenger cabin air supply distribution system consists of the mix manifold, sidewall risers, and an overhead distribution duct.

Sidewall risers go up the right and left wall of the passenger cabin to supply air to the overhead distribution duct. The overhead distribution duct routes conditioned air to the passenger cabin. It extends from the forward to the aft end of the ceiling along the airplane centerline and also supplies the sidewall diffusers.

Recirculation Fan

The recirculation fan system reduces the air conditioning system pack load and the engine bleed air demand. Air from the passenger cabin and electrical equipment bay is drawn to the forward cargo bay where it is filtered and recirculated to the mix manifold. The fan is driven by an AC motor. The fan operates with the recirculation fan switch in AUTO except with both packs on and one or both in HIGH.

Equipment Cooling

The equipment cooling system cools electronic equipment in the flight deck and the E & E bay.

The equipment cooling system consists of a supply duct and an exhaust duct. Each duct has a normal fan and an alternate fan. The supply duct supplies cool air to the flight deck displays and electronic equipment in the E & E bay. The exhaust duct collects and discards warm air from the flight deck displays, the overhead and aft electronic panels, circuit breaker panels in the flight deck, and electronic equipment in the E & E bay.

Loss of airflow due to failure of an equipment cooling fan results in illumination of the related equipment cooling OFF light. Selecting the alternate fan should restore airflow and extinguish the OFF light within approximately 5 seconds.

If an overtemperature occurs on the ground, alerting is provided through the crew call horn in the nose wheel well.

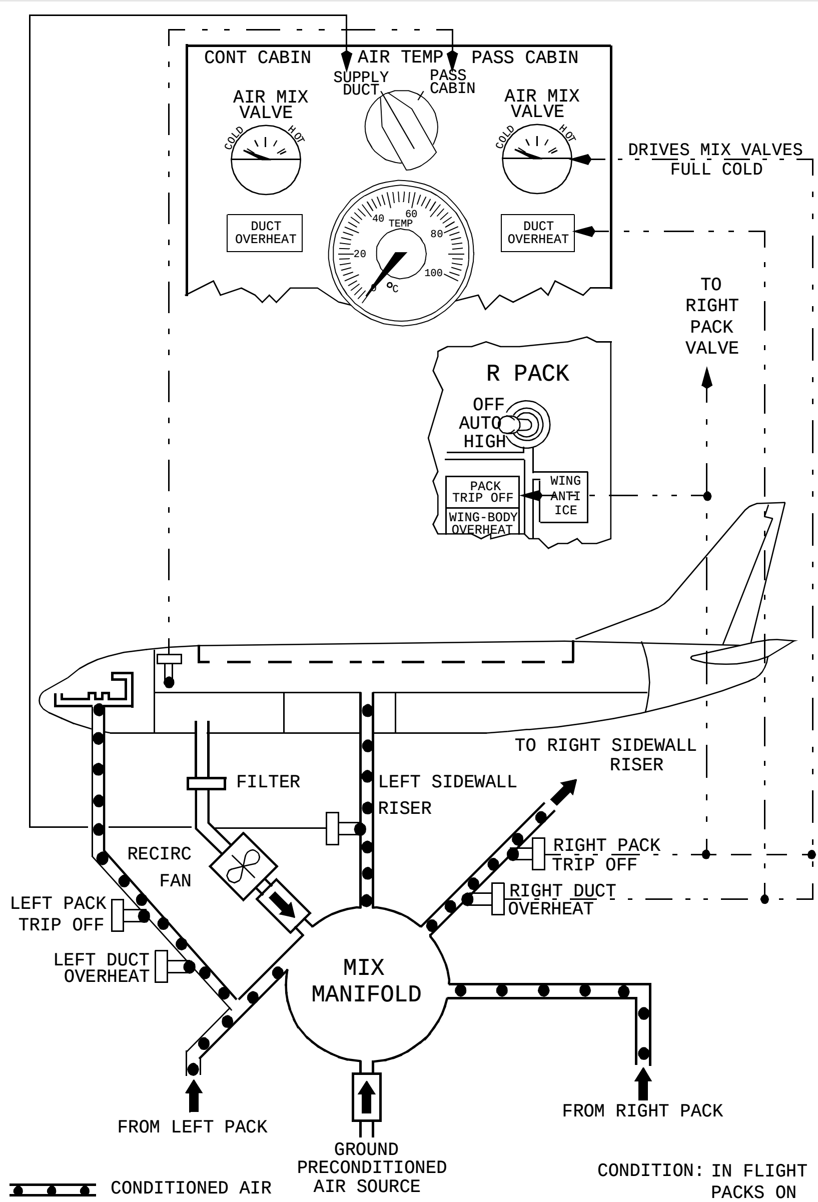
Forward Cargo Compartment

The recirculation fan system circulates air from the passenger cabin around the lining of the forward cargo compartment. On the ground, or with the cabin differential pressure less than 2.5 psi, the exhaust fan air is blown through a flow control valve and exhausted out the bottom of the airplane. With increasing airflow at greater cabin differential pressures, the flow control valve closes and exhaust air from the equipment cooling system is now diffused to the lining of the forward cargo compartment for in-flight heating.

Conditioned Air Source Connection

A ground air conditioning source may be connected to the mix manifold to distribute preconditioned air throughout the airplane.

Air Conditioning Distribution Schematic



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Air Systems — Chapter 2

Air Conditioning System Description (737–400) — Section 31

Introduction

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.

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.

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 is capable of maintaining pressurization and acceptable temperatures throughout the airplane up to the maximum certified ceiling.

Two pack operation from a single bleed air source is not recommended due to excessive bleed air requirements.

Airflow Control

With both air conditioning pack switches in AUTO and both packs operating, the packs provide “normal air flow”. However, with one pack not operating, the other pack automatically switches to “high air flow” in order to maintain the necessary ventilation rate. This automatic switching is inhibited when the airplane is on the ground, or inflight with the flaps extended, to insure adequate engine power for single engine operation. Automatic switching to “high air flow” occurs if both engine bleed air switches are OFF and the APU bleed air switch is ON, regardless of flap position, air/ground status or number of packs operating.

With the air conditioning pack switch in HIGH, the pack provides “high air flow”. Additionally, an “APU high air flow” rate is available when the airplane is on the ground, the APU bleed air switch is ON and either or both pack switches are positioned to HIGH. This mode is designed to provide the maximum airflow when the APU is the only source of bleed air.

Ram Air System

The ram air system provides cooling air for the heat exchangers. Operation of the system is automatically controlled by the packs through operation of a ram door.

On the ground, or during slow flight with the flaps not fully retracted, the ram door moves to the full open position for maximum cooling. In normal cruise, the doors modulate between open and closed. The RAM DOOR FULL OPEN light illuminates whenever the ram door is fully open.

A turbofan is located in each ram air exit duct just upstream of the exit louvres. It augments the ram airflow on the ground or during slow flight (flaps not retracted). The fan operates pneumatically using bleed air. It is activated electrically, when the pack is on, by the air-ground safety sensor or flap limit switch.

A deflector door is installed forward of the ram air inlet doors to prevent slush ingestion prior to liftoff and after touchdown. The deflector door extends when activated electrically by the air–ground safety sensor.

Cooling Cycle

Flow through the cooling cycle starts with bleed air passing through a heat exchanger for cooling. The air then flows to an air cycle machine for refrigeration. The processed cold air is then combined with hot air which has bypassed the air cycle machine, then through a high pressure water separator which removes moisture. This conditioned air then flows into the mix manifold and distribution system.

Overheat protection is provided by temperature sensors located in the cooling cycle. An overheat condition causes the pack valve to close and the PACK light to illuminate.

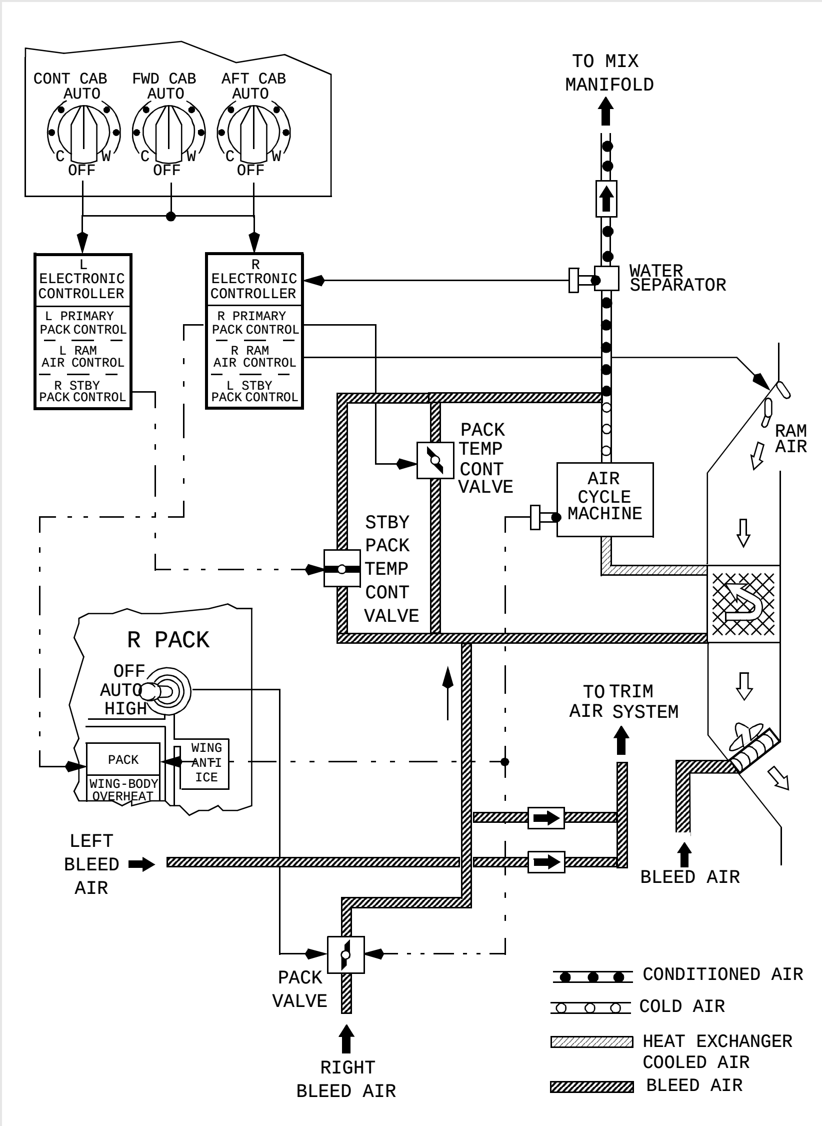
Pack Temperature Control

Electronic controllers command the pack temperature control valve toward open or closed to satisfy pack discharge requirements.

If a primary pack control fails, the affected pack is controlled by the standby pack control in the opposite controller. A primary or standby pack control failure causes the PACK, MASTER CAUTION and AIR COND System Annunciator lights to illuminate during recall.

If both the primary and the standby pack controls fail for the same pack, the PACK, MASTER CAUTION, and AIR COND System Annunciator lights illuminate. The pack will continue to operate without control unless excessive temperatures cause the pack to trip off.

Air Conditioning Pack Schematic



Zone Temperature Control

There are three zones: flight deck, forward cabin and aft cabin. Desired zone temperature is set by adjusting the individual Temperature Selectors. The selector range is approximately 65°F (18°C) to 85°F (30°C).

The packs produce an air temperature that satisfies the zone which requires the most cooling. Zone temperature is controlled by introducing the proper amount of trim air to the zone supply ducts. The quantity of trim air is regulated by individual trim air modulating valves.

During single pack operation with the TRIM AIR selected ON, zone temperature is controlled the same as during two-pack operation. During single pack operation with the TRIM AIR selected OFF, the pack attempts to produce an air temperature to satisfy the averarage temperature demands of all three zones.

If air in a zone supply duct overheats, the associated amber ZONE TEMP light illuminates, and the associated trim air modulating valve closes. The trim air modulating valve may be reopened after the duct has cooled by pushing the TRIP RESET Switch.

Zone Temperature Control Modes

The left electronic controller controls the aft cabin zone and provides backup control for the flight deck. The right controller controls the forward cabin zone and provides primary control for the flight deck.

Failure of the primary flight deck temperature control will cause an automatic switch to the back up control and will illuminate the CONT CAB amber ZONE TEMP light upon Master Caution Recall. Failure of both the primary and standby controls will illuminate the lights automatically.

Failure of the forward or aft cabin temperature control will cause the associated trim air modulating valve to close. The Temperature Selectors operate normally, but the Temperature Selector settings of the two passenger cabin zones will be averaged. The amber ZONE TEMP light will illuminate upon Master Caution Recall to indicate failure of the associated zone control.

Unbalanced Pack Temperature Control Mode

Any failure affecting the supply of trim air will cause the temperature control system to control both packs independently. If flight deck trim air is lost, the left pack will provide conditioned air to the flight deck at the selected temperature and the right pack will satisfy the demand of the passenger zone which requires the most cooling. If a passenger cabin zone trim air, or all trim air is lost, the forward and aft zone temperature demands will be averaged for control of the right pack.

If any individual zone is switched OFF, the Temperature Selector setting will be ignored by the temperature control system.

Standby Pack Average Temperature

If all zone controls and primary pack controls fail, the standby pack controls command the packs to produce air temperatures which will satisfy the average temperature demand of the two cabin zones. The trim air modulating valves will close. The flight deck zone Temperature Selector will have no effect on the standby pack controls.

Fixed Cabin Temperature

If all Temperature Selectors are positioned OFF, the pack controls will cause the left pack to maintain a fixed temperature of 75°F (24°C) and the right pack to maintain 65°F (18°C) as measured at the pack temperature sensor.

Air Conditioning Distribution

Conditioned air is collected in the mix manifold. The temperature of the air is directly related to the setting of the Temperature Selectors.

Overheat detection is provided by temperature sensors located downstream of the packs and the mix manifold. An overheat condition causes the appropriate trim air modulating valve to close and the ZONE TEMP light to illuminate.

Flight Deck

Since the flight deck requires only a fraction of the air supply provided by the left pack, most of the left pack output is routed to the mix manifold.

Conditioned air for the flight deck branches into several risers which end at the floor, ceiling and foot level outlets. Air diffusers on the floor under each seat deliver continuous air flow as long as the manifold is pressurized.

Overhead diffusers are located on the flight deck ceiling, above and aft of the No. 3 windows. Each of these outlets can be opened or closed as desired by turning a slotted adjusting screw.

There is also a dual purpose valve behind the rudder pedal of each pilot. These valves provide air for warming the pilots' feet and for defogging the inside of the No. 1 windshields. Each valve is controlled by knobs located on the Captain's and First Officer's panels.

Passenger Cabin

The passenger cabin air supply distribution system consists of the mix manifold, sidewall risers, and an overhead distribution duct.

Sidewall risers go up the right and left walls of the passenger cabin to supply air to the overhead distribution duct. The overhead distribution duct routes conditioned air to the passenger cabin. It extends from the forward to the aft end of the ceiling along the airplane centerline and also supplies the sidewall diffusers.

Recirculation Fan

The recirculation fan system reduces the air conditioning system pack load and the engine bleed air demand. Air from the passenger cabin and electrical equipment bay is drawn to the forward cargo bay where it is filtered and recirculated to the mix manifold. The fans are driven by AC motors. Each recirculation fan operates only if the respective RECIRC FAN switch is selected to AUTO. In flight, the left recirculation fan operates if both packs are operating unless either PACK switch is in HIGH. The right recirculation fan operates in flight if both packs are operating unless both PACK switches are in HIGH. On the ground, the left recirculation fan operates unless both PACK switches are in HIGH and the right recirculation fan operates even if both PACK switches are in HIGH.

Equipment Cooling

The equipment cooling system cools electronic equipment in the flight deck and the E & E bay.

The equipment cooling system consists of a supply duct and an exhaust duct. Each duct has a normal fan and an alternate fan. The supply duct supplies cool air to the flight deck displays and electronic equipment in the E & E bay. The exhaust duct collects and discards warm air from the flight deck displays, the overhead and aft electronic panels, circuit breaker panels in the flight deck, and electronic equipment in the E & E bay.

Loss of airflow due to failure of an equipment cooling fan results in illumination of the related equipment cooling OFF light. Selecting the alternate fan should restore airflow and extinguish the OFF light within approximately 5 seconds.

If an overtemperature occurs on the ground, alerting is provided through the crew call horn in the nose wheel well.

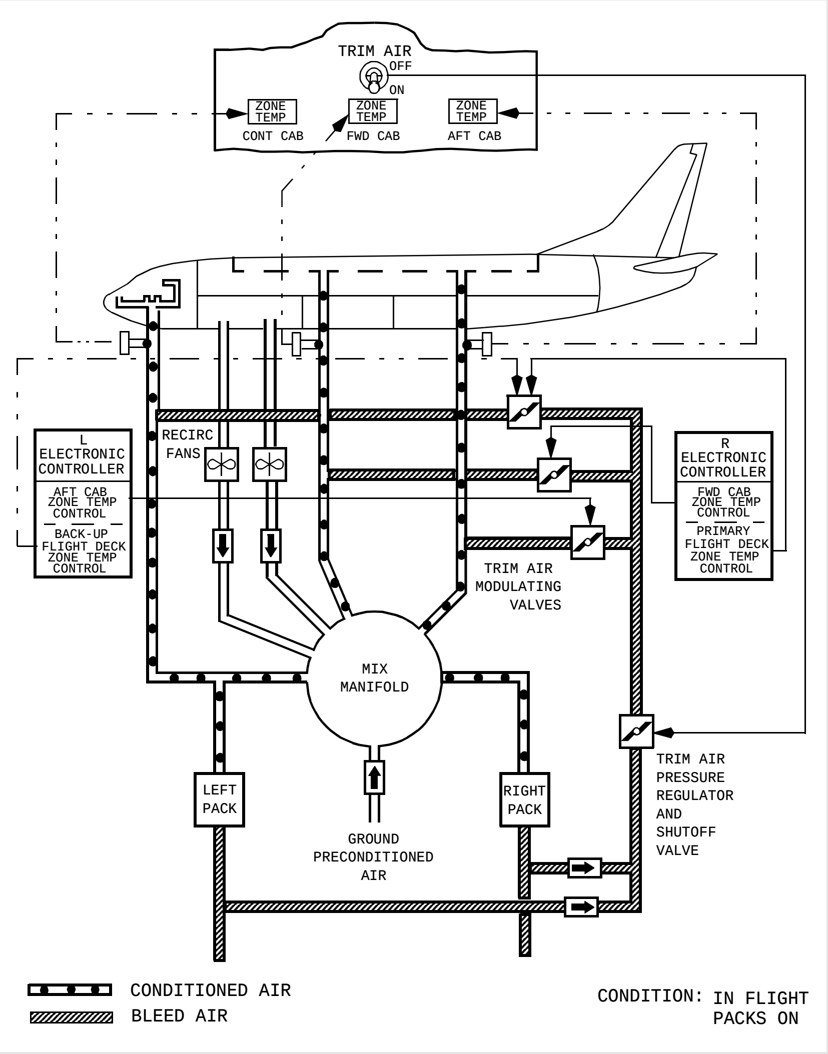
Forward Cargo Compartment

The forward cargo compartment is warmed in flight when more than 2.5 psi pressure differential exists. Air from the E & E compartment flows up and around the forward cargo compartment lining. The right recirculation fan maintains this warming air flow. When the right recirculation fan is off, the forward outflow valve remains open to ensure this warm air flow (except when closed in order to maintain pressurization).

Conditioned Air Source Connection

A ground air conditioning source may be connected to the mix manifold to distribute preconditioned air throughout the airplane.

Air Conditioning Distribution Schematic



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Introduction

Cabin pressurization is controlled during all phases of airplane operation by the cabin pressure control system (CPCS). The CPCS includes one automatic controller and one standby controller available by selecting AUTO or STBY, and two manual (MAN) pilot-controlled modes.

The system uses bleed air supplied to and distributed by the air conditioning system. Pressurization and ventilation are controlled by modulating the outflow valves.

Pressure Relief Valves

Two pressure relief valves provide safety pressure relief by limiting the differential pressure to a maximum of 8.65 psi. A negative relief valve prevents external atmospheric pressure from exceeding internal cabin pressure.

Cabin Pressure Controller

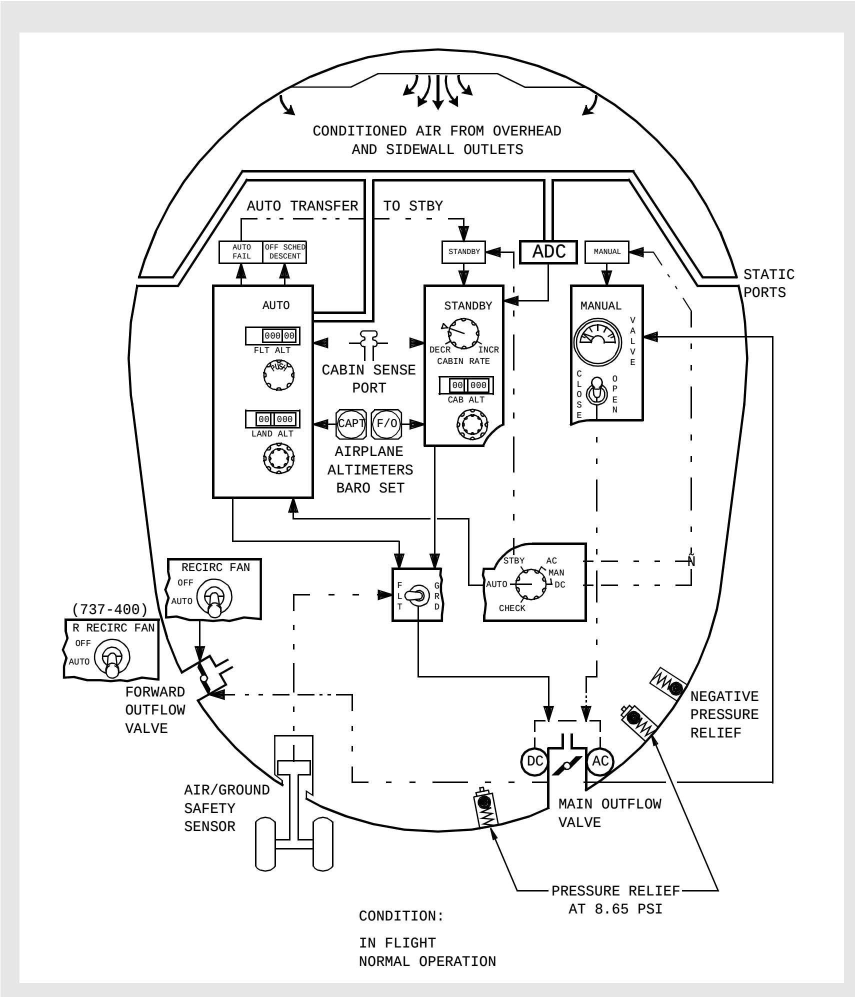
Cabin altitude is normally rate–controlled by the cabin pressure controller up to a cabin altitude of 8,000 feet at the airplane maximum certified ceiling of 37,000 feet. The cabin pressure controller controls cabin altitude in the following modes:

- AUTO – Automatic pressurization control; normal mode of operation. Uses AC motor.
- STBY – Semiautomatic pressurization control; standby mode of operation. Uses DC motor.
- MAN AC – Manual control of the system using the AC motor.
- MAN DC – Manual control of the system using the DC motor.

In the automatic mode of operation, airplane altitude is sensed directly from the static ports. In the standby mode, airplane altitude is sensed electrically from the air data computer (ADC). Barometric corrections to these pressures come from the Captain’s altimeter in AUTO and the First Officer’s altimeter in STBY.

The controller receives additional information from the air/ground sensor and the cabin pressure altitude sensing port.

Cabin Pressure Control System Schematic



Pressurization Outflow

Cabin air outflow is controlled by the main outflow valve, the forward outflow valve and the flow control valve. During pressurized flight, the flow control valve is closed, and the majority of the overboard exhaust is through the main and forward outflow valves. A small amount is also exhausted through toilet and galley vents, miscellaneous fixed vents, and by seal leakage.

Flow Control Valve

The flow control valve opens to exhaust the cooling air from the E & E compartment overboard during ground operation, unpressurized flight and pressurized flight below a cabin differential pressure of 2.5 psi.

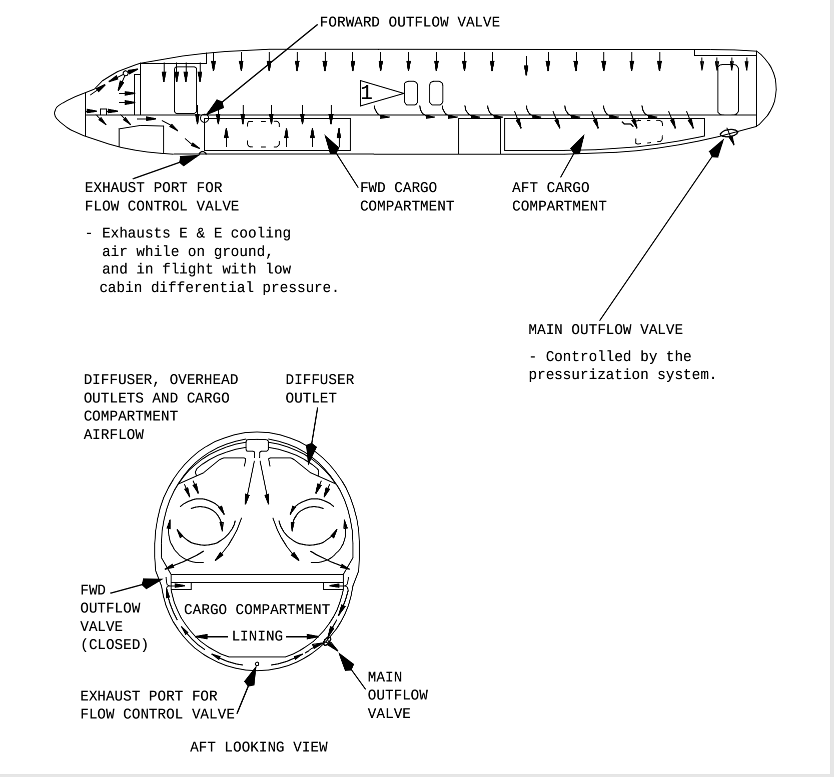
When the flow control valve closes, air is directed around the forward cargo compartment liner for inflight heating.

Outflow Valves

The main outflow valve can be actuated by either an AC or a DC motor. The AC motor is used during AUTO and MAN AC operation. The DC motor is used during STANDBY and MAN DC operation.

The forward outflow valve closes automatically to assist in maintaining cabin pressure when the main outflow valve is almost closed or when the recirculation fan (right recirculation fan on 737–400 airplanes) is operating. The forward outflow valve is the overboard discharge exit for air circulated around the forward cargo compartment. The main outflow valve is the overboard exhaust exit for the majority of the air circulated through the passenger cabin. Passenger cabin air is drawn through foot level grills, down around the aft cargo compartment, where it provides heating, and is discharged overboard through the main outflow valve.

Pressurization Outflow Schematic



1 737-400

Auto Mode Operation

In AUTO, the pressurization control panel is used to preset two altitudes into the pressure controller:

- FLT ALT (flight or cruise altitude).
- LAND ALT (landing or destination airport altitude).

Takeoff airport altitude (actually cabin altitude) is input into the pressurization controller at all times when on the ground.

The air/ground safety sensor signals whether the airplane is on the ground or in the air. On the ground, the FLT/GRD switch is used to keep the cabin depressurized by driving the main outflow valve full open when the switch is in the GRD position. With the switch in the FLT position, the controller modulates the main outflow valve toward close, slightly pressurizing the cabin. This ground pressurization of the cabin makes the transition to pressurized flight more gradual for the passengers and crew, and also gives the system better response to ground effect pressure changes during takeoff.

In the air, the auto controller maintains a proportional pressure differential between airplane and cabin altitude. By increasing the cabin altitude at a rate proportional to the airplane climb rate, cabin altitude change is held to the minimum rate required.

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.

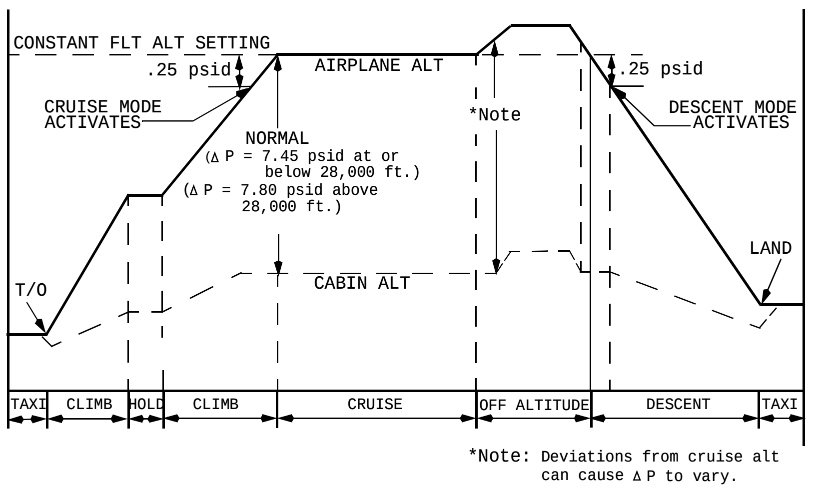
An amber AUTO FAIL light illuminates if any one of these conditions occurs:

- Loss of AUTO AC power
- Excessive rate of cabin pressure change (1890 sea level feet/minute)

- Excessive differential pressure
- 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



CABIN ALTITUDE VS. AIRPLANE ALTITUDE

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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Anti-Ice, Rain — Chapter 3
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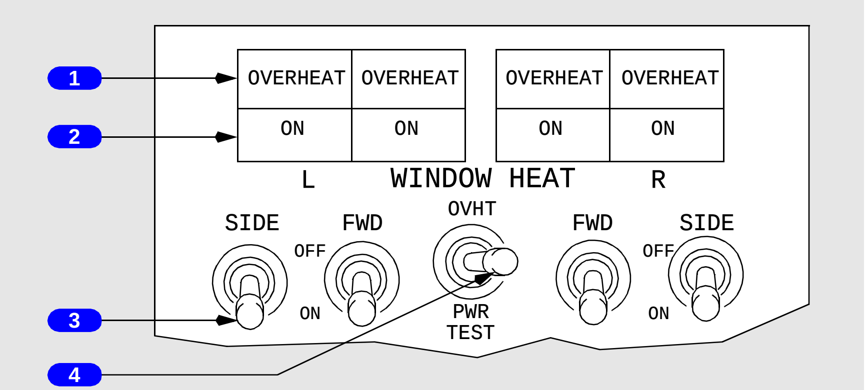
Window Heat Panel



FORWARD OVERHEAD 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.

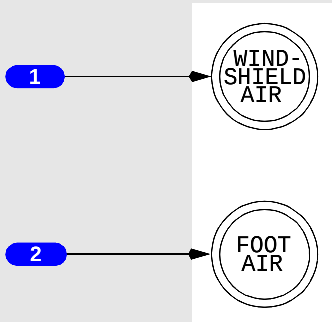
4 WINDOW HEAT Test Switch (spring–loaded to neutral)

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



BELOW CAPTAIN'S AND FIRST OFFICER'S INSTRUMENT PANELS

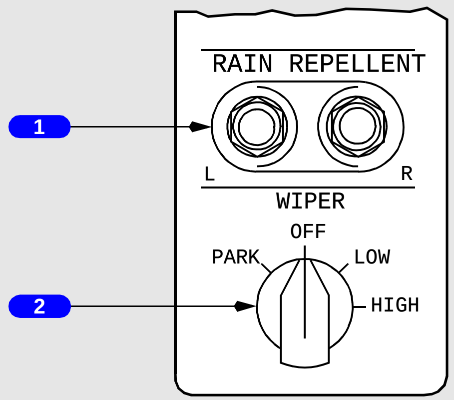
1 WINDSHIELD AIR Controls

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



FORWARD OVERHEAD PANEL

1 Rain Repellent Switches

Push – applies measured amount of repellent on related window 1.

2 Windshield WIPER Selector

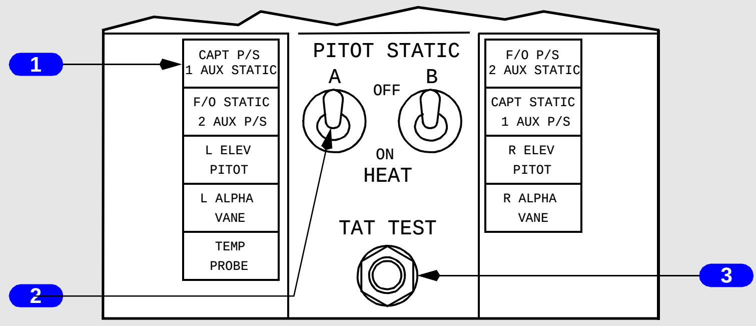
PARK – turns off wiper motors and stows wiper blades.

OFF – turns off wiper motors.

LOW – low speed operation.

HIGH – high speed operation.

Pitot Static Heat Panel



FORWARD OVERHEAD PANEL

1 Pitot Static Lights

Illuminated (amber) – related probe not heated.

2 PITOT STATIC Switches

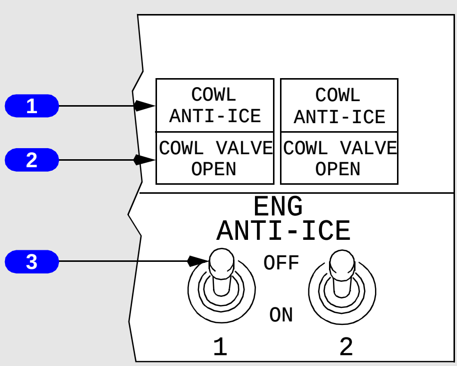
ON – power is supplied to heat related system.

OFF – power off.

3 TAT TEST Switch

Push (on ground) – power is applied to temp probe.

Engine Anti–Ice Panel



FORWARD OVERHEAD 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).

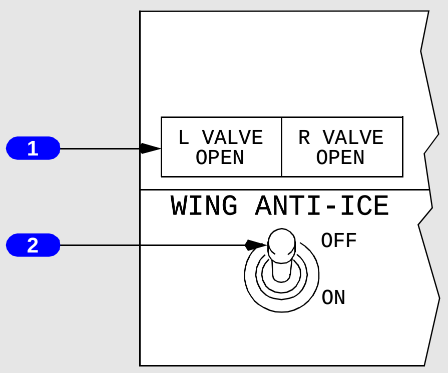
Extinguished – related cowl anti–ice valve is closed (switch OFF).

3 ENGINE ANTI–ICE Switch

ON – related engine anti–ice valve opens.

OFF – related engine anti–ice valve closes.

Wing Anti–Ice Panel



FORWARD OVERHEAD 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.

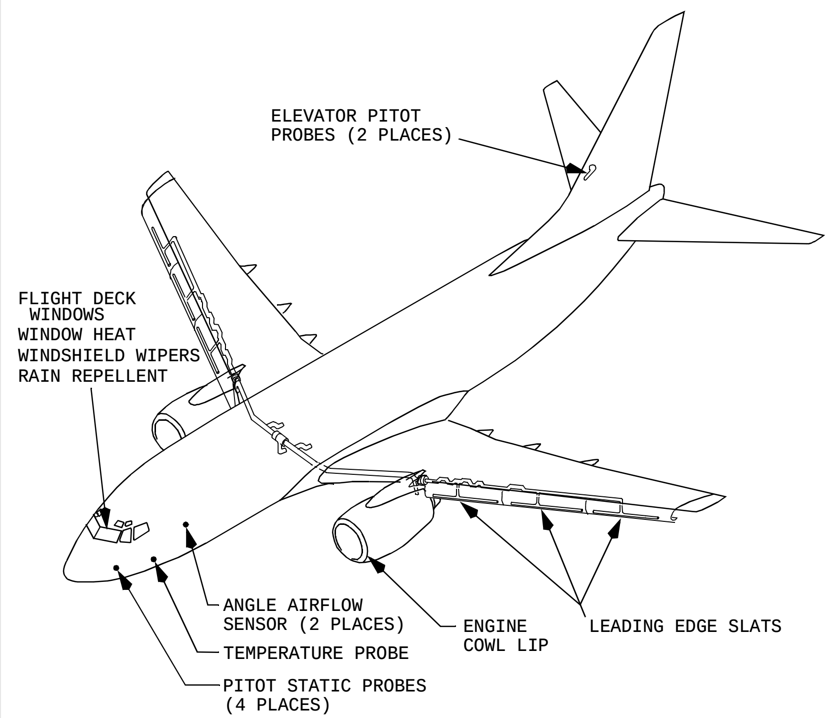
Introduction

Thermal anti-icing (TAI), electrical anti-icing, and windshield wipers are the systems provided for ice and rain protection.

The anti-ice and rain systems include:

- Flight Deck Window Heat
- Windshield Wipers and Rain Repellent
- Probe and Sensor Heat
- Engine Anti-Ice System
- Wing Anti-Ice System

Anti-Ice Components Diagram



Flight Deck Window Heat

Flight deck windows 1, 2, 4 and 5 consist of glass panes laminated to each side of a vinyl core. Flight deck window 4 has an additional vinyl layer and acrylic sheet laminated to the inside surface. Flight deck window 3 consists of two acrylic panes separated by an air space.

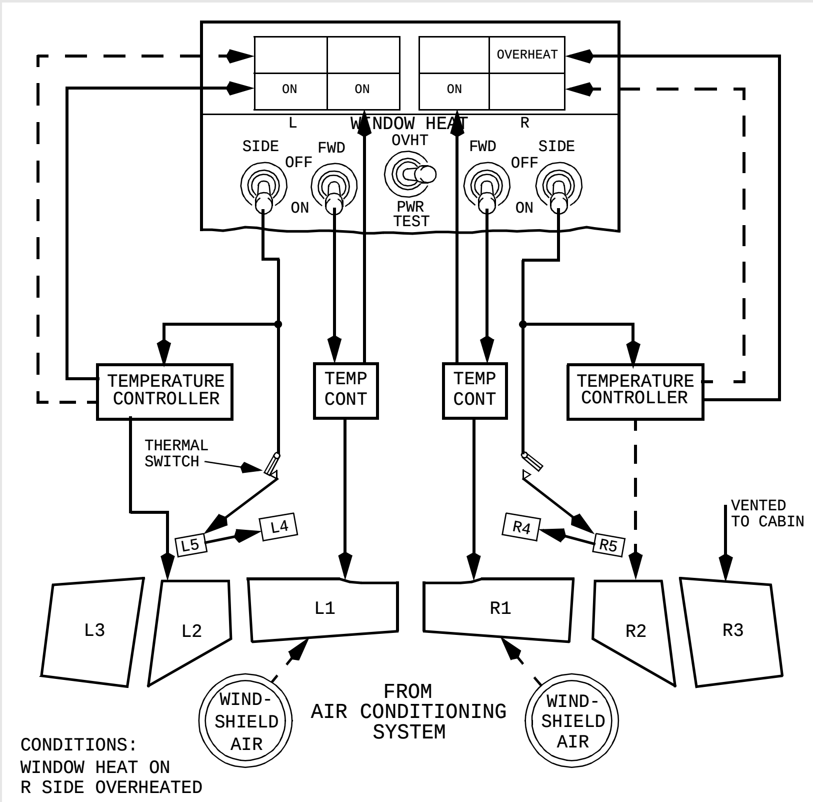
A conductive coating on the outer glass pane of windows 1 and 2 permits electrical heating to prevent ice build–up and fogging. A conductive coating on the inner glass pane of windows 4 and 5 permits electrical heating to prevent fogging. Window 3 is not electrically heated.

Flight Deck Window Heat Operation

The FWD WINDOW HEAT switches control heat to window 1. The SIDE WINDOW HEAT switches control heat to windows 2, 4 and 5.

Temperature controllers maintain windows 1 and 2 at the correct temperature to ensure maximum strength of the windows in the event of bird impact. Power to windows 1 and 2 is automatically removed if an overheat condition is detected. A thermal switch located on window 5 opens and closes to maintain the correct temperature of windows 4 and 5.

Flight Deck Window Heat Schematic



Windshield Wipers and Rain Repellent

The rain removal system for the forward windows consists of windshield wipers and rain repellent. One windshield wiper is located on each No. 1 window. Each wiper is electrically operated by a separate system. Both wiper systems are controlled by a common switch. Each push of a rain repellent switch applies a measured amount of repellent on the related No. 1 windshield.

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

Probe and Sensor Heat

All pitot-static probes, the total air temperature probe, and angle airflow sensors are electrically heated to prevent the formation of ice. Alternate static ports are not heated.

Engine Anti–Ice System

Engine bleed air thermal anti–icing prevents the formation of ice on the engine cowl lip. Engine anti–ice operation is controlled by individual ENG ANTI–ICE switches. The engine anti–ice system may be operated on the ground and in flight.

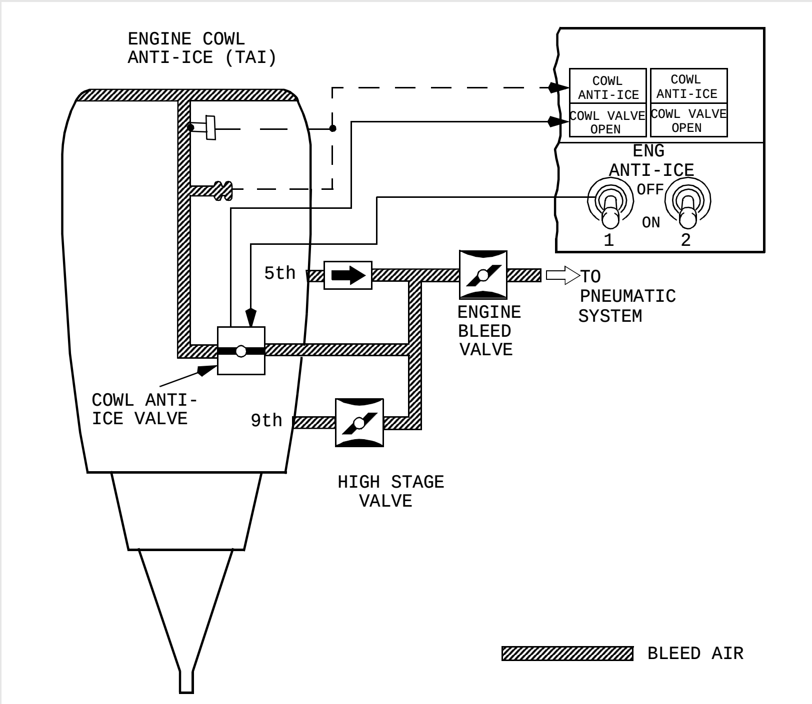
Engine Anti–Ice System Operation

Each cowl anti–ice valve is electrically controlled and pressure actuated. Positioning the ENG ANTI–ICE switches to ON allows engine bleed air to flow through the cowl anti–ice valve for cowl lip anti–icing.

If the cowl anti–ice valve fails to move to the position indicated by the ENG ANTI–ICE switch, the COWL VALVE OPEN light remains illuminated bright blue.

The amber COWL ANTI–ICE light illuminates due to excessive temperature or pressure in the duct leading from the cowl anti–ice valve to the cowl lip.

Engine Anti–Ice System Schematic



Wing Anti–Ice System

The wing anti–ice system provides protection for the leading edge slats by using bleed air. The wing anti–ice system does not include the leading edge flaps.

The wing anti–ice control valves are AC motor–operated. With a valve open, bleed air flows to the leading edge slats through a telescoping duct, and is then exhausted overboard. The wing anti–ice system is effective with the slats in any position.

Wing Anti-Ice System Operation

On the ground, positioning the WING ANTI–ICE switch ON opens both control valves if thrust on both engines is below the setting for takeoff warning activation and the temperature inside both wing distribution ducts is less than the thermal switch activation temperature.

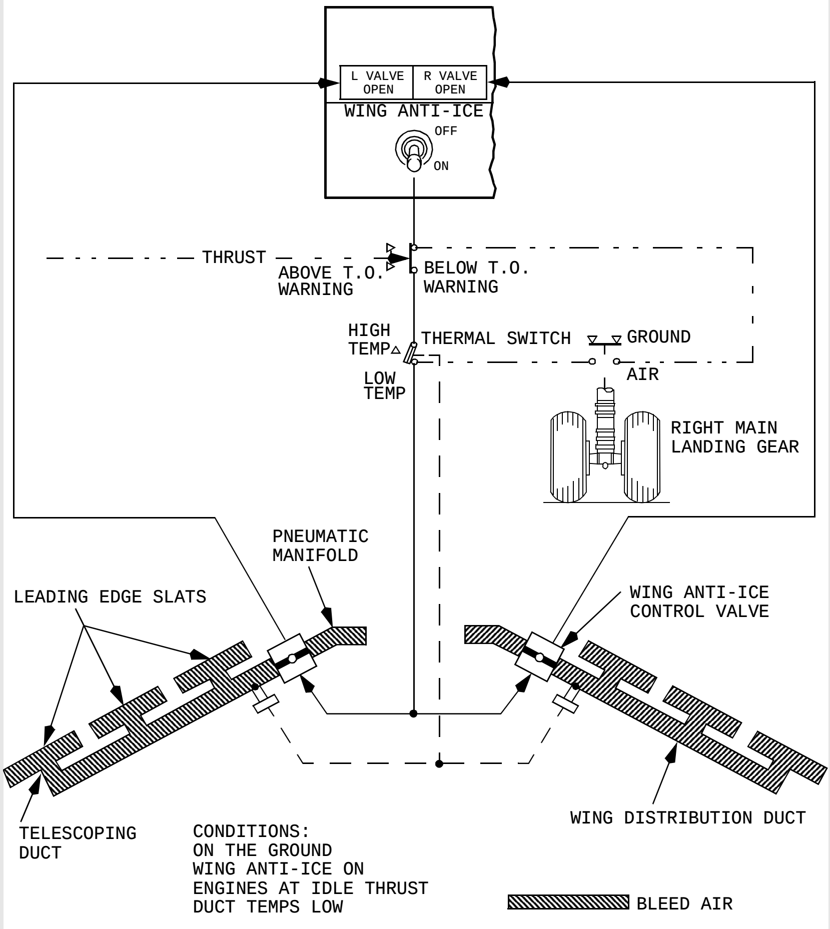
Both valves close if either engine thrust is above the takeoff warning setting or either temperature sensor senses a duct overtemperature. The valves automatically reopen if thrust on both engines is reduced and both temperature sensors are cool.

With the air/ground sensor in the ground mode and the WING ANTI–ICE switch ON, the switch remains in the ON position regardless of control valve position. The WING ANTI–ICE switch automatically trips OFF at lift–off when the air/ground sensor goes to the air mode.

In flight, both control valves open when the WING ANTI–ICE switch is positioned ON. Duct temperature and thrust setting logic are disabled and have no affect on control valve operation in flight.

Valve position is monitored by the blue VALVE OPEN lights.

Wing Anti–Ice System Schematic



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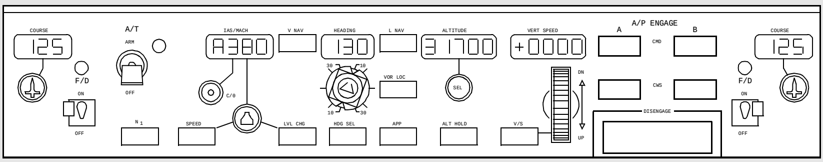
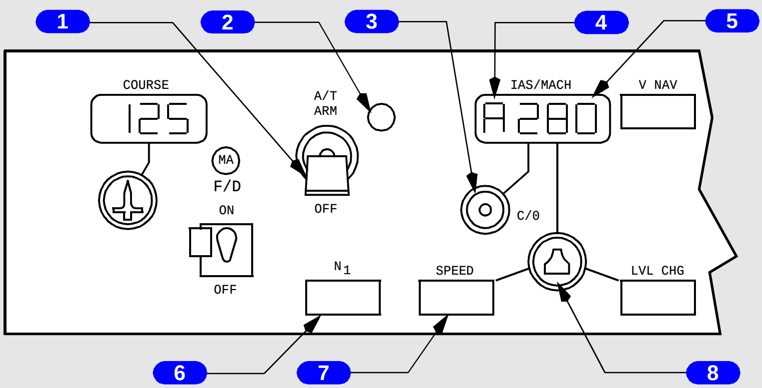
Mode Control Panel (MCP)



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.

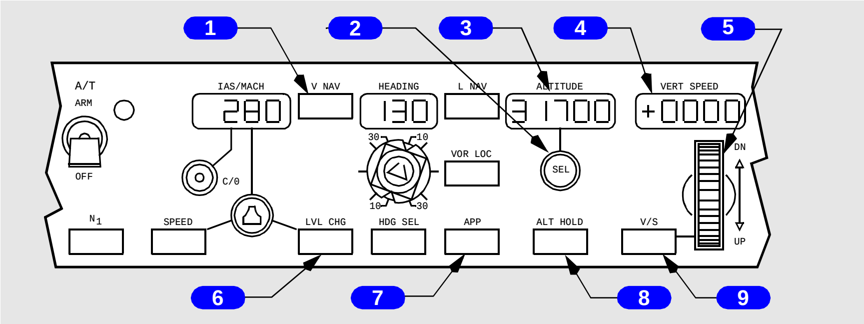
A/T does not set thrust above displayed N1 limit, however, A/T can exceed N1 value manually set by N1 Manual Set Knob.

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



GLARESHIELD

1 VNAV Switch

Push –

- VNAV switch light illuminates
- pitch mode annunciates VNAV SPD, VNAV PTH
- A/T mode annunciates FMC SPD, N1, RETARD, or ARM
- IAS/MACH display blanks and airspeed cursors positioned to FMC commanded airspeed.

VNAV Mode

The FMC commands AFDS pitch and autothrottle to fly vertical profile selected on FMC CDUs. Profile includes climb, cruise, descent, speeds, and can also include waypoint altitude constraints.

Note: If the airplane is between the FMC target altitude (depicted on the RTE LEGS page for the active waypoint) and the manually entered MCP target altitude, VNAV will not engage. To enable VNAV, adjust the FMC or MCP target altitude as appropriate.

Climb –

- autothrottle holds FMC thrust limit
- AFDS holds FMC target speed
- automatic level off occurs at MCP altitude or VNAV altitude, whichever is reached first.

Cruise –

- autothrottle holds FMC target speed
- AFDS holds FMC altitude
- selecting a lower MCP altitude arms FMC to automatically begin descent upon arrival at FMC top of descent point.

Descent –

- VNAV SPD descent
  - autothrottle holds idle
  - AFDS holds FMC target speed
- VNAV PTH descent
  - autothrottle holds idle but can command FMC SPD mode if ground speed becomes too slow to maintain FMC vertical path
  - AFDS tracks FMC descent path
  - automatic level-off occurs at MCP altitude or VNAV altitude, whichever is reached first
    - VNAV constrained level-off annunciates VNAV PTH.

Inhibited below 400 ft. RA or if performance initialization not complete.

VNAV mode is terminated by any one of the following:

- Selecting another pitch mode
- Glideslope capture
- Transition of glideslope intercept waypoint
- flaps extended beyond 15 (prior to FMC U7.1)
- Crosstrack greater than RNP while active leg has a nav data base vertical angle (FMC U7.1 or later, but prior to U10.3)

2 Altitude Selector (SEL)

Rotate –

- sets altitude in ALTITUDE display in 100 foot increments
- arms V/S mode if rotated while in ALT HOLD at selected altitude

3 ALTITUDE Display

Displays selected altitude

- displayed altitude is reference for altitude alerting and automatic level–offs
- altitude range is 0 to 50,000 feet in 100 foot increments
- displays previously selected altitude when power first applied

4 Vertical Speed (VERT SPEED) Display

Displays:

- blank when V/S mode not active
- present V/S when V/S mode is engaged with V/S switch
- selected V/S when V/S set with thumbwheel
- range is –7900 to +6000 fpm.

Displays in increments of:

- 50 fpm if V/S is less than 1000 fpm
- 100 fpm if V/S is 1000 fpm or greater.

5 Vertical Speed Thumbwheel

Rotate –

- DN –
  - sets vertical speed in VERT SPEED display
  - increases rate of descent or reduces rate of ascent
- UP –
  - sets vertical speed in VERT SPEED display.
  - increases rate of ascent or reduces rate of descent

6 Level Change (LVL CHG) Switch

Push –

- LVL CHG switch light illuminates
- pitch mode annunciates MCP SPD for climb or descent
- autothrottle mode annunciates N1 for climb and RETARD followed by ARM for descent
- IAS/MACH display and airspeed cursors display target speed.

LVL CHG Mode

The LVL CHG mode coordinates pitch and thrust commands to make automatic climbs and descents to preselected altitudes at selected airspeeds.

A LVL CHG climb or descent is initiated by:

- selecting a new altitude
- pushing LVL CHG switch
- setting desired airspeed.

Climb –

- autothrottle holds limit thrust
- AFDS holds selected airspeed.

Descent –

- autothrottle holds idle thrust
- AFDS holds selected airspeed.

Airspeed –

- if a speed mode is active when LVL CHG is engaged, this speed is retained as target speed
- if a speed mode is not active when LVL CHG is engaged, existing speed becomes target speed
- speed can be changed with MCP IAS/MACH Selector.

The LVL CHG mode is inhibited after glideslope capture.

7 Approach (APP) Switch

(See Lateral Navigation)

8 Altitude Hold (ALT HLD) Switch

Push –

- engages ALT HOLD command mode
- commands pitch to hold uncorrected barometric altitude at which switch was pressed
- annunciates ALT HOLD pitch mode and illuminates ALT HLD switch light.

Altitude Hold Command Mode

ALT HOLD mode commands pitch to hold either:

- MCP selected altitude
  - pitch mode annunciates ALT HOLD
  - ALT HLD switch light extinguishes
- uncorrected barometric altitude at which ALT HLD switch was pressed if not at MCP selected altitude
  - pitch mode annunciates ALT HOLD
  - ALT HLD switch light illuminates.

When in ALT HOLD at selected MCP altitude:

- selecting a new MCP altitude illuminates the ALT HLD switch light and arms V/S mode
- LVL CHG, V/S, and VNAV climb and descent functions are inhibited until a new MCP altitude is selected.

ALT HOLD mode is inhibited after G/S capture.

The selected MCP altitude is referenced to:

- Captain’s barometric altimeter setting for A A/P and F/D.
- First Officer’s barometric altimeter setting for B A/P and F/D.

Note: After ALT HOLD engages, changes in altimeter barometric settings do not change the selected altitude reference.

9 Vertical Speed (V/S) Switch

Push –

- arms or engages V/S command mode
- commands pitch to hold vertical speed
- engages A/T in speed mode to hold selected airspeed
- annunciates V/S pitch mode and illuminates V/S switch light.

Vertical Speed Command Mode

The V/S mode commands pitch to hold selected vertical speed and engages A/T in SPEED mode to hold selected airspeed. V/S mode has both an armed and an engaged state.

Engaged –

- annunciates V/S pitch mode
- vertical speed display changes from blank to present vertical speed
- desired vertical speeds can be selected with vertical speed thumbwheel.

V/S becomes armed if:

- pitch mode is ALT HLD at selected MCP altitude and
- new MCP altitude is selected (more than 100 feet from current altitude).

With V/S armed, V/S mode is engaged by moving vertical speed thumbwheel.

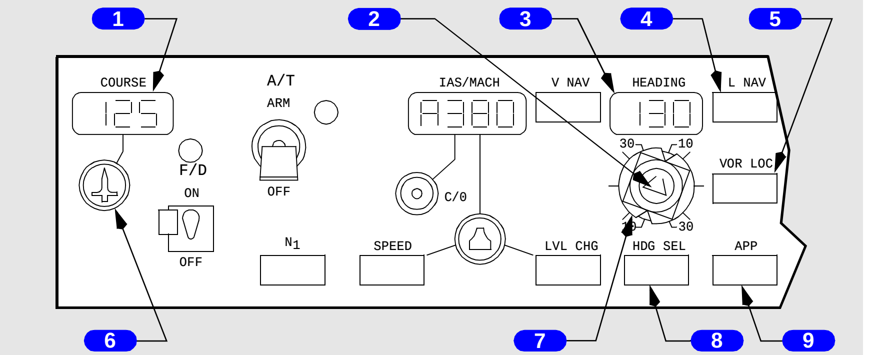
V/S mode automatically engages if ALT ACQ mode is engaged and a new MCP altitude is selected which is more than 100 feet different from previously selected altitude

- Vertical speeds can be selected which command flight toward or away from selected altitude.

Inhibited if:

- ALT HOLD mode is active at selected MCP altitude
- glide slope captured in APP mode.

Lateral Navigation



GLARESHIELD

1 COURSE Display

Displays course set by course selector.

Note: Different courses and frequencies on two VHF NAV receivers can cause disagreement between Captain and FO F/D displays and affect A/P operation.

2 Heading Selector

Rotate –

- sets heading in HEADING display
- positions selected heading bugs on both HSIs.

3 HEADING Display

Displays selected heading – same heading as HSI selected heading bug.

4 LNAV Switch

Push –

- commands AFDS roll to intercept and track the active FMC route
- annunciates LNAV as roll mode and illuminates LNAV switch light.

LNAV Mode

In LNAV mode, the FMC controls AFDS roll to intercept and track active FMC route. Active route is entered and modified through FMC CDUs and can include SIDs, STARs, and instrument approaches.

LNAV engagement criteria:

- active route entered in FMC
- within 3 NM of active route, LNAV engagement occurs with any airplane heading
- outside of 3 NM, airplane must:
  - be on intercept course of 90 degrees or less
  - intercept route segment before active waypoint.

LNAV automatically disconnects for following reasons:

- reaching end of active route
- reaching a route discontinuity
- intercepting or missing the intercept of a selected approach course in VOR LOC or APP modes (VOR/LOC armed)
- selecting HDG SEL
- loss of capture criteria.

5 VOR Localizer (LOC) Switch

Push –

- commands AFDS roll to capture and track selected VOR or LOC course
- annunciates VOR/LOC armed or engaged as roll mode and illuminates VOR LOC switch light.

VOR LOC Mode

Pushing the VOR LOC switch selects VOR mode if a VOR frequency is tuned or selects LOC mode if a localizer frequency is tuned.

The VOR mode provides roll commands to track selected VOR course.

The LOC mode provides roll commands to track selected localizer course along inbound front course bearing.

The selected course can be intercepted while engaged in:

- LNAV
- HDG SEL
- CWS R if an autopilot is engaged in CMD.

The capture point is variable and depends on intercept angle and closure rate. Localizer capture occurs not later than 1/2 dot deviation. Course capture is indicated when VOR/LOC annunciation changes from armed to engaged.

While engaged in VOR or LOC modes:

- A autopilot and Captain's F/D use information from Captain's course selector and No. 1 VHF NAV receiver
- B autopilot and First Officer's F/D use information from First Officer's course selector and No. 2 VHF NAV receiver
- different courses and/or frequencies for two VHF NAV receivers can cause disagreement between the Captain's and First Officer's F/D displays and affect A/P operation.

Note: When a localizer frequency is selected, VHF NAV radios automatically switch from tail antenna to nose antenna when VOR/LOC is annunciated (armed or engaged). If antenna switching does not occur, LOC mode is inhibited.

Note: Localizer backcourse tracking is not available.

6 Course Selector

Sets course in COURSE display for related VHF NAV receiver, AFDS and HSI. Two course selectors and COURSE displays are located on the MCP.

Rotate Captain's course selector – provides selected course information to:

- A FCC
- No. 1 VHF NAV receiver
- Captain's HSI course pointer and course deviation bar.

Note: In VOR LOC or APP mode, the A A/P and Captain's F/D use selected course and navigation data from the No. 1 VHF NAV receiver.

Rotate First Officer's course selector – provides selected course information to:

- B FCC
- No. 2 VHF NAV receiver
- First Officer's HSI course pointer and course deviation bar.

Note: In VOR LOC or APP mode, B A/P and First Officer's F/D use selected course and navigation data from No. 2 VHF NAV receiver.

7 Bank Angle Selector

Rotate –

- Sets maximum bank angle for AFDS operation in HDG SEL or VOR modes
- commanded bank angle can be selected at 10, 15, 20, 25, or 30 degrees.

8 Heading Select (HDG SEL) Switch

Push –

- engages HDG SEL command mode
- commands roll to follow selected heading
- annunciates HDG SEL as FMA roll mode and illuminates HDG SEL switch light.

Heading Select Command Mode

The HDG SEL mode commands roll to turn to and maintain heading shown in MCP HEADING display:

- initial selection commands turn in shortest direction toward selected heading bug
- after mode engagement, roll commands are given to turn in same direction as rotation of heading selector
- bank angle limit is established by bank angle selector
- HDG SEL mode automatically disengages upon capture of selected radio course in VOR LOC and APP modes (VOR/LOC armed).

9 Approach (APP) Switch

Push –

- illuminates APP switch light
- arms the AFDS for localizer and glideslope capture
- roll mode annunciates VOR/LOC armed
- pitch mode annunciates G/S armed
- enables engagement of both autopilots.

APP Mode

The approach mode arms AFDS to capture and track localizer and glideslope and can be engaged for dual or single autopilot operation.

One VHF NAV receiver must be tuned to an ILS frequency before approach mode can be engaged. With one VHF NAV receiver tuned, onside AFDS is enabled for guidance and operation.

For dual autopilot operation, both VHF NAV receivers must be tuned to the ILS frequency and both autopilots must be selected in CMD prior to 800 feet RA.

APP mode operation:

- localizer must be captured prior to glideslope
- localizer can be intercepted in HDG SEL, LNAV, or CWS R
- glideslope capture occurs at 2/5 dot below glideslope
- APP switch light extinguishes after localizer and glideslope capture.

After localizer and glideslope capture, APP mode can be disengaged by:

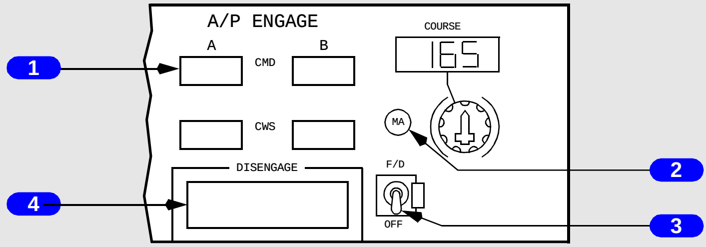
- pushing a TO/GA switch
- disengaging autopilot(s) and turning off both F/D switches
- retuning the VHF NAV receiver.

While engaged in the APP mode:

- the A autopilot and Captain’s F/D use information from Captain’s Course Selector and No. 1 VHF NAV receiver
- the B autopilot and First Officer’s F/D use information from First Officer’s Course Selector and No. 2 VHF NAV receiver
- different courses and/or frequencies for the two VHF NAV receivers can cause disagreement between Captain’s and First Officer’s F/D displays and affect A/P operation.

Note: After localizer and glideslope capture during a dual autopilot approach, CWS cannot be engaged by manually overriding pitch and roll. Manual override of autopilots causes autopilot disengagement.

Autopilot / Flight Director



GLARESHIELD

1 Autopilot Engage Switch

Push –

CMD

- engages related autopilot in command mode (switch illuminates)
- enables all command modes for AFDS in addition to autopilot CWS operation
- selecting a second A/P in CMD disengages the first A/P, unless in APP mode.

CWS

- engages related autopilot in control wheel steering mode (switch illuminates)
- pitch and roll are controlled through application of control wheel and column pressure
- if attitudes acquired exceed autopilot limits, autopilot returns to attitude limits when control pressure is released
- flight directors can be operated in command modes while an autopilot is engaged in CWS.

2 Master (MA) Flight Director Indicators (white letters)

If a F/D switch is ON, the light indicates which FCC is controlling the F/D modes.

- Illuminated – related FCC is controlling F/D modes.
- Extinguished – F/D modes are controlled from opposite FCC.
- Both lights illuminated – each FCC is controlling modes for related F/D.

3 Flight Director (F/D) Switch

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

ON –

- enables command bar display on related pilot's ADI
- command bars are displayed if command pitch and/or roll modes are engaged
- displays FD in A/P status display if A/P is OFF or engaged in CWS
- on ground, arms pitch and roll modes for engagement in TO/GA and WINGS LEVEL when TOGA switch is pushed
- in flight with A/P ON and F/Ds OFF, turning a F/D switch ON engages F/D in currently selected A/P modes.

OFF – Command bars retract from related pilot's ADI.

4 Autopilot Disengage Bar

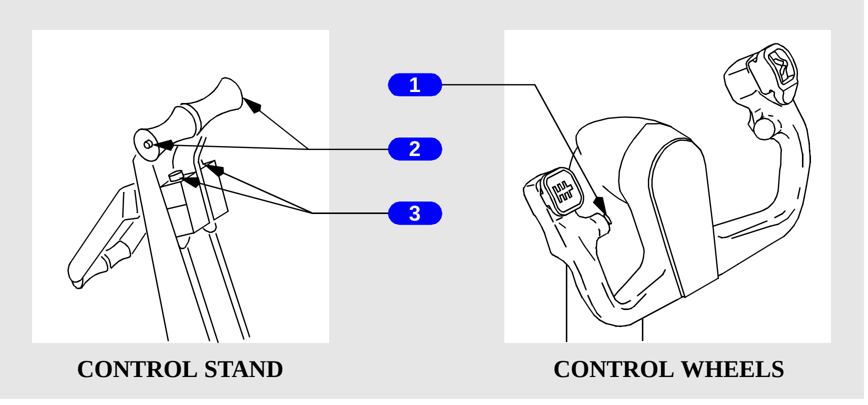
Push down –

- disengages both autopilots
- exposes yellow background
- prevents autopilot engagement.

Lift up –

- enables autopilot engagement
- conceals yellow background.

Autopilot / Autothrottle Controls



1 Autopilot Disengage Switch

Push –

- disengages both autopilots
- A/P disengage lights flash
- A/P disengage warning tone sounds for a minimum of two seconds

- second push extinguishes disengage lights and silences disengage warning tone
- if autopilot automatically disengages, extinguishes A/P Disengage lights and silences A/P warning tone.

2 Autothrottle Disengage Switches

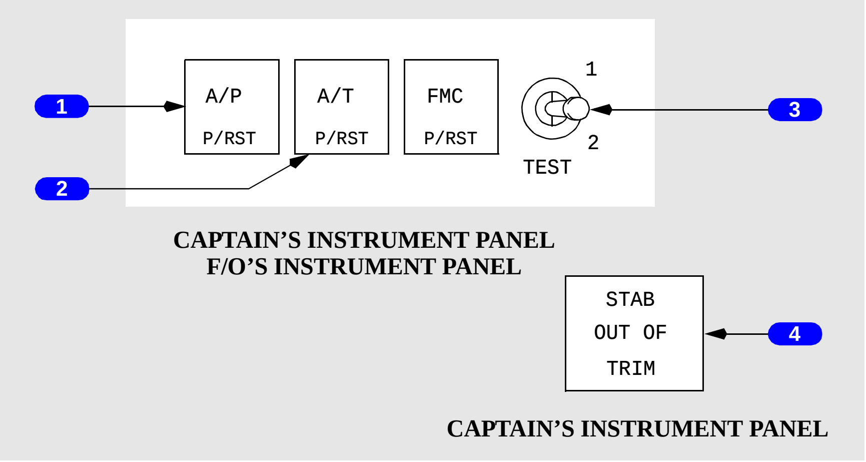
Push –

- disengages autothrottle
- A/T disengage lights flash
- A/T ARM switch trips OFF
- second press extinguishes A/T disengage lights
- extinguishes A/T disengage lights after automatic A/T disengagement.

3 Takeoff/Go–Around (TO/GA) Switches

Push – engages AFDS and A/T in takeoff or go–around mode if previously armed.

Autopilot / Autothrottle Indicators



1 Autopilot (A/P) Disengage Light

Illuminated (red) –

- flashing – autopilot has disengaged (tone sounds)
  - reset by pushing either disengage light or either A/P disengage switch
- steady –
  - stabilizer out of trim below 800 feet RA on dual channel approach
  - ALT ACQ mode inhibited during A/P go–around if stabilizer not trimmed for single A/P operation

    - disengage light test switch held in position 2
    - automatic ground system tests fail.

Illuminated (amber) –

- flashing – autopilot has automatically reverted to CWS pitch or roll while in CMD
    - resets when either light is pressed or another mode engaged

  steady – disengage light test switch held in position 1.

2 Autothrottle (A/T) Disengage Light

Illuminated (red) –

- flashing – autothrottle has disengaged
- steady – disengage light test switch held in position 2.

Illuminated (amber) –

- flashing – indicates autothrottle speed error if speed not held within +10 or -5 knots of commanded speed when all of the following conditions exist:
    - in flight
    - flaps not up
    - A/T engaged in MCP SPD or FMC SPD mode
- automatic test of flashing function is performed if the A/T is engaged under the above conditions when more than 150 seconds have passed since liftoff
    - amber light flashes for 2 seconds, remains extinguished for 2 seconds, then flashes again for 2 seconds

  steady – disengage light test switch held in position 1.

3 Disengage Light TEST Switch

TEST 1 – illuminates autopilot/autothrottle disengage and FMC alert lights steady amber.

TEST 2 – illuminates autopilot/autothrottle disengage lights steady red and FMC alert light steady amber.

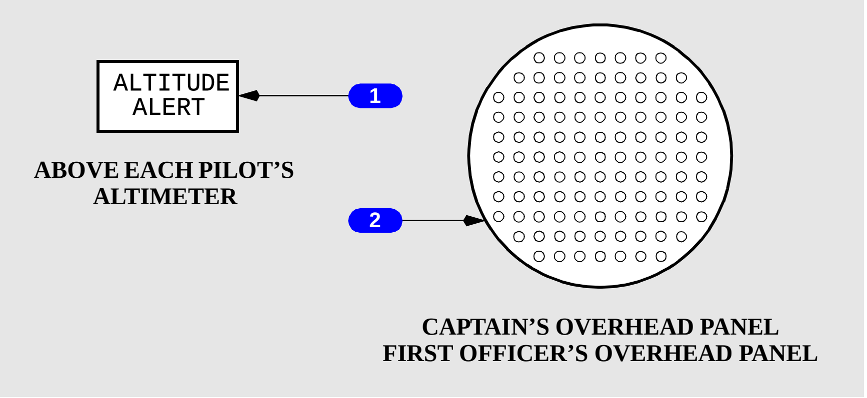
Spring–loaded to center position.

4 Stabilizer Out Of Trim (STAB OUT OF TRIM) Light

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

Illuminated (amber) – autopilot not trimming stabilizer properly.

Altitude Alert



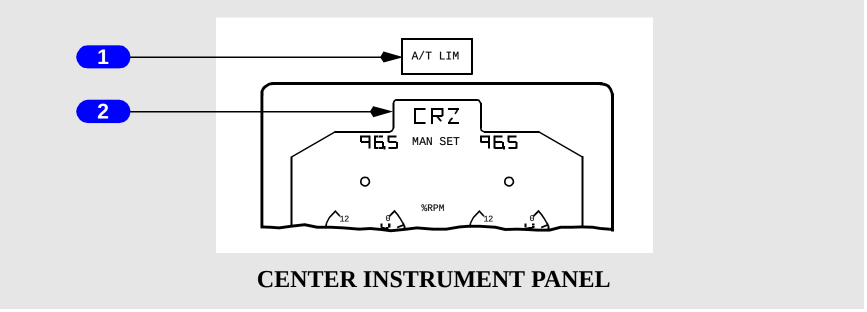
1 ALTITUDE ALERT Light

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

2 Speaker

Transmits alert tone when airplane approaches or departs selected altitude.

Thrust Mode Display



1 Autothrottle Limit (A/T LIM) Light

Illuminated (white) – Indicates A/T computer is calculating a degraded N1 limit for the affected engine or engines.

2 Thrust Mode Display

N1 limit reference is the active N1 limit for autothrottle and manual thrust control.

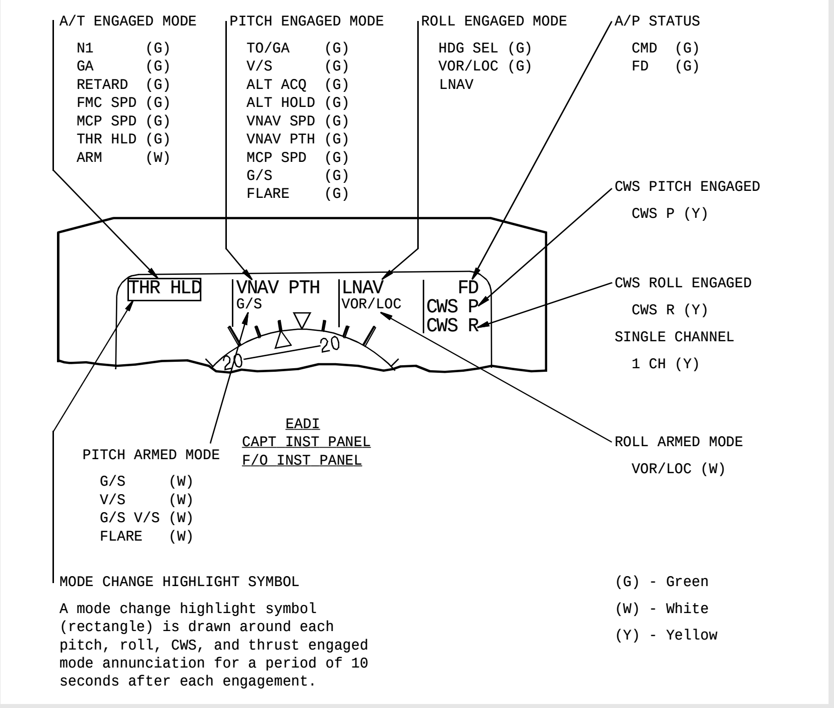
N1 limit reference is also displayed by N1 reference bugs with N1 SET control in AUTO position.

N1 limit reference is normally calculated by the FMC.

Thrust mode display/Thrust mode annunciator panel annunciations are:

- R - Reduced. Can appear with TO or CLB
- TO - Takeoff
- CLB - Climb
- CRZ - Cruise
- G/A - Go–around
- CON - Continuous
- – – – - FMC not computing thrust limit.

Flight Mode Annunciations (FMAs)



CAPTAIN'S EADI
FIRST OFFICER'S EADI

General

The automatic flight system (AFS) consists of the autopilot flight director system (AFDS) and the autothrottle (A/T). The flight management computer (FMC) provides N1 limits and target N1 for the A/T and command airspeeds for the A/T and AFDS.

The AFDS and A/T are controlled using the AFDS mode control panel (MCP) and the FMC. Normally, the AFDS and A/T are controlled automatically by the FMC to fly an optimized lateral and vertical flight path through climb, cruise and descent.

AFS mode status is displayed on the flight mode annunciation on each pilot's EADI.

Autopilot Flight Director System

The AFDS is a dual system consisting of two individual flight control computers (FCCs) and a single mode control panel.

The two FCCs are identified as A and B. For A/P operation, they send control commands to their respective pitch and roll hydraulic servos, which operate the flight controls through two separate hydraulic systems.

For F/D operation, each FCC positions the F/D command bars on the respective ADI.

MCP Mode Selector Switches

The mode selector switches are pushed to select desired command modes for the AFDS and A/T. The switch illuminates to indicate mode selection and that the mode can be deselected by pressing the switch again. While a mode is active, deselection can be automatically inhibited, indicated by the switch being extinguished.

When engagement of a mode would conflict with current AFS operation, pushing the mode selector switch has no effect. All AFDS modes can be disengaged either by selecting another command mode or by disengaging the A/P and turning the F/Ds off.

Autopilot Engagement Criteria

Each A/P can be engaged separately in CMD or CWS. A/P engagement in CMD or CWS is inhibited unless both of the following pilot–controlled conditions are met:

- No force is being applied to the control wheel
- The STAB TRIM AUTOPILOT cutout switch is at NORMAL.

Only one A/P can be engaged at a given time unless the approach (APP) mode is engaged. Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides control through landing flare and touchdown or an automatic go–around.

In single A/P operation, full automatic flare and touchdown capability and A/P go–around capability are not available.

If an autopilot is engaged in CMD with one or both F/Ds operating in command modes and the F/D command bars are not within approximately 1/2 scale of being centered, the A/P automatically engages in CWS for pitch and/or roll, and the F/D command bars retract.

Autopilot Disengagement

The A/P automatically disengages when any of the following occurs:

- Pushing either A/P disengage switch
- Pushing either Takeoff/Go–around (TO/GA) switch with a single A/P engaged in CWS or CMD below 2000 feet RA
- Pushing either TO/GA switch after touchdown with both A/Ps engaged in CMD
- Moving the A/P engage paddle to OFF
- Activating either pilot’s control wheel trim switch
- Moving the STAB TRIM AUTOPILOT cutout switch to CUTOUT
- Loss of respective hydraulic system pressure
- Repositioning the EFI transfer switch
- Either left or right IRS system failure or FAULT light illuminated
- Loss of electrical power or a sensor input which prevents proper operation of the engaged A/P and mode.

Note: Loss of the system A engine-driven hydraulic pump and a heavy demand on system A may cause A/P A to disengage.

AFS Failures

Power interruption or loss may cause disengagement of the AFDS and/or A/T. Re-engagement is possible after power is restored.

Dual channel A/P operation is possible only when two generators are powering the busses.

Two independent radio altimeters provide radio altitude to the related FCC. The Captain's radio altimeter provides radio altitude to the A/T. With a radio altimeter inoperative, do not use the associated FCC or the A/T, if affected, for the approach or landing.

Flight Director Display

Turning a F/D switch ON displays command bars on the respective pilot's ADI if command pitch and roll modes are engaged. If command pitch and roll modes are not engaged, the F/D command bars do not appear. The F/Ds can be operated with or without the A/P and A/T. F/D command modes can be used with an A/P engaged in CWS.

F/D commands operate in the same command modes as the A/P except:

- The takeoff mode is a F/D only mode
- Dual F/D guidance is available for single engine operation
- The F/D has no landing flare capability. F/D command bars retract from view at approximately 50 feet RA on an ILS approach.

Normally, FCC A drives the captain's command bars and FCC B drives the first officer's command bars. With both F/D switches ON, the logic for both pilot's F/D modes are controlled by the master FCC, and both FMA displays show the same mode status.

The master FCC is indicated by illumination of the related master (MA) F/D indicator light. The master FCC is determined as follows:

- With neither A/P engaged in CMD, the FCC for the first F/D turned on is the master
- With one or both A/Ps engaged in CMD, the FCC for the first A/P in CMD is the master FCC, regardless of which F/D is turned on first.

F/D modes are controlled directly from the respective FCC under certain conditions. This independent F/D operation occurs when neither A/P is engaged in CMD, both F/D switches are ON and one of the following mode conditions exists:

- APP mode engaged with LOC and G/S captured
- GA mode engaged and below 400 feet RA
- TO mode engaged and below 400 feet RA.

Independent F/D operation is indicated by illumination of both MA lights. When independent operation terminates, the MA light extinguishes on the slaved side.

If a generator is lost during a F/D TO or GA, or while in dual F/D APP mode below 800 feet, the FCC on the unaffected side positions the F/D command bars on both ADIs. If the F/D MA light on the affected side had been illuminated, it extinguishes upon electrical bus transfer.

AFDS Status Annunciation

The following AFDS status annunciations are displayed in the A/P status display located on the EADI:

- CMD (one or both autopilots are engaged)
- FD (the flight director is ON and the autopilot is either OFF or engaged in CWS)
- CWS P (pitch mode engaged in CWS)
- CWS R (roll mode engaged in CWS).

AFDS Flight Mode Annunciations

The flight mode annunciations are displayed on the EADI. The modes are in these categories:

- autothrottle
- pitch
- roll

Engaged or captured modes are shown at the top of the flight mode annunciation boxes in large green letters. Armed modes are shown in smaller white letters at the bottom of the flight mode annunciation boxes.

Autothrottle Modes

- N1 – The autothrottle maintains thrust at the selected N1 limit displayed on the thrust mode display
- GA – The autothrottle maintains thrust at reduced go–around setting or full go–around N1 limit
- RETARD – Displayed while autothrottle moves thrust levers to the aft stop; RETARD mode is followed by ARM mode
- FMC SPD – The autothrottle maintains speed commanded by the FMC; the autothrottle is limited to the N1 value shown on the thrust mode display
- MCP SPD – The autothrottle maintains speed set in the MCP IAS/MACH display; the autothrottle is limited to the N1 value shown on the thrust mode display
- THR HLD – The thrust lever autothrottle servos are inhibited. The pilot can set the thrust levers manually
- ARM – No autothrottle mode engaged. The thrust lever autothrottle servos are inhibited; the pilot can set thrust levers manually

Pitch Modes

- TO/GA – Takeoff

  Engaged for takeoff by turning both F/D switches ON and pressing either TO/GA switch. Both F/Ds must be ON to engage TO/GA prior to starting takeoff.

  The AFDS commands pitch attitude in the following order:

- 10 degrees nose down until 60 knots IAS
- 15 degrees nose up after 60 knots IAS
- 15 degrees nose up after lift-off until a sufficient climb rate is acquired. Then, pitch is commanded to maintain MCP speed plus 20 knots.

  TO/GA can also be engaged for takeoff with F/D switches OFF if a TO/GA switch is pushed after 80 knots IAS below 2,000 feet AGL and prior to 150 seconds after lift-off.

- TO/GA – Go-around

  Engaged for go-around by pressing the TO/GA switch under the following conditions:

  - in flight below 2,000 feet radio altitude
  - Not in takeoff mode
  - Either F/D ON or OFF

    The F/Ds command 15 degrees nose up pitch and roll to hold the approach ground track at time of go–around engagement. After reaching a programmed rate of climb, pitch commands the maneuvering speed for each flap setting based on maximum weight calculations.

- VNAV –

  VNAV is engaged by pushing the VNAV switch. With a VNAV mode engaged, the FMC commands AFDS pitch and A/T modes to fly the vertical profile selected on the FMC CDUs.

  - VNAV SPD – The AFDS maintains the FMC speed displayed on the airspeed cursor and/or the CDU CLIMB or DESCENT pages
  - VNAV PTH – The AFDS maintains FMC altitude or descent path with pitch commands.

- V/S (armed) – V/S mode can be engaged by moving Vertical Speed thumbwheel
- V/S (engaged) – Pitch commands hold selected vertical speed
- ALT ACQ – Transition maneuver entered automatically from a V/S, LVL CHG, or VNAV climb or descent to selected MCP altitude. Engages but does not annunciate during VNAV transition
- ALT HOLD – Pitch commands hold MCP selected altitude or uncorrected barometric altitude at which ALT HOLD switch was pushed
- MCP SPD – Pitch commands maintain IAS/MACH window airspeed or Mach
- G/S (armed) – The AFDS is armed for G/S capture
- G/S (engaged) – The AFDS follows the ILS glideslope.

- FLARE (armed) – During a dual A/P ILS approach, FLARE is displayed after LOC and G/S capture and below 1500 feet RA. The second A/P couples with the flight controls, and A/P go–around mode arms.
- FLARE (engaged) – During a dual A/P ILS approach, flare engages at 50 feet radio altitude. FLARE accomplishes the autoland flare maneuver.

Roll Modes

- LNAV – The AFDS intercepts and tracks the active FMC route. Either of the following capture criteria must be met:
  - On any heading and within 3 NM of the active route segment
  - If outside of 3 NM of active route segment, airplane must be on an intercept course of 90 degrees or less and intercept the route segment before the active waypoint.
- HDG SEL – The airplane is turning to or is on the heading selected in the MCP heading display
- VOR/LOC (armed) – AFDS is armed to capture selected VOR or LOC COURSE
- VOR/LOC (engaged) – AFDS tracks selected VOR course or tracks selected localizer course along the inbound front course bearing.

Autopilot Control Wheel Steering

CWS Engage Switch Selected

Pressing a CWS engage switch engages the A/P pitch and roll axes in the CWS mode and displays CWS P and CWS R on the FMAs.

With CWS engaged, the A/P maneuvers the airplane in response to control pressures applied by either pilot. The control pressure is similar to that required for manual flight. When control pressure is released, the A/P holds existing attitude.

If aileron pressure is released with 6 degrees or less bank, the A/P rolls the wings level and holds existing heading. This heading hold feature with bank less than 6 degrees is inhibited when any of the following conditions exist:

- Below 1,500 feet RA with the landing gear down
- After F/D VOR capture with TAS 250 knots or less
- After F/D LOC capture in the APP mode.

Pitch CWS with a CMD Switch Selected

The pitch axis engages in CWS while the roll axis is in CMD when:

- A command pitch mode has not been selected or was deselected
- A/P pitch has been manually overridden with control column force. The force required for override is greater than normal CWS control column force. This manual pitch override is inhibited in the APP mode with both A/Ps engaged

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

When approaching a selected altitude in CWS P with a CMD engage switch selected, CWS P changes to ALT ACQ. When at the selected altitude, ALT HOLD engages.

If pitch is manually overridden while in ALT HOLD at the selected altitude, ALT HOLD changes to CWS P. If control force is released within 250 feet of the selected altitude, CWS P changes to ALT ACQ, the airplane returns to the selected altitude, and ALT HOLD engages. If the elevator force is held until more than 250 feet from the selected altitude, pitch remains in CWS P.

Roll CWS with a CMD Engage Switch Selected

The roll axis engages in CWS while the pitch axis is in CMD when:

- A command roll mode has not been selected or was deselected
- A/P roll has been manually overridden with control wheel force. The force required for override is greater than the normal CWS control wheel force.

CWS R is annunciated on the FMAs while this mode is engaged.

CWS R with a CMD engage switch illuminated can be used to capture a selected radio course while the VOR/LOC or APP mode is armed. Upon intercepting the radial or localizer, the F/D and A/P annunciations change from CWS R to VOR/LOC engaged, and the A/P tracks the selected course.

Autothrottle System

The A/T system provides automatic thrust control from the start of takeoff through climb, cruise, descent, approach and go–around or landing. In normal operation, the FMC provides the A/T system with N1 limit values.

The A/T moves the thrust levers with a separate servo motor on each thrust lever. Manually positioning the thrust levers does not cause A/T disengagement unless 10 degrees of thrust lever separation is exceeded during a dual channel approach after FLARE armed is annunciated. Following manual positioning, the A/T may reposition the thrust levers to comply with computed thrust requirements except while in the THR HLD and ARM modes.

The A/T system operates properly with the PMCs ON or OFF. In either case, the A/T computer controls to the FMC N1 limits. During A/T operation, it is recommended that both PMCs be ON or both OFF, as this produces minimum thrust lever separation. A/T takeoffs may be performed with both PMCs OFF.

Autothrottle Engagement

Moving the A/T arm switch to ARM arms the A/T for engagement in the N1, MCP SPD or FMC SPD mode. The A/T arm switch is magnetically held at ARM and releases to OFF when the A/T becomes disengaged.

A general summary of A/T mode engagement is as follows:

- A/T SPD or N1 modes automatically engage when AFDS command pitch modes become engaged
- Engaging LVL CHG or VNAV climb modes automatically engages the A/T N1 mode
- Engaging LVL CHG or VNAV descent modes automatically engages the A/T in RETARD and then ARM when thrust is at idle
- If not in a VNAV mode, engagement of ALT ACQ or ALT HOLD automatically engages the A/T in the MCP SPD mode; otherwise the A/T remains in FMC SPD.
- Engagement of G/S capture automatically engages the A/T in the MCP SPD mode.

Autothrottle Disengagement

Any of the following conditions or actions disengages the A/T:

- Moving the A/T Arm switch to OFF
- Pressing either A/T Disengage switch
- An A/T system fault is detected
- Two seconds have elapsed since landing touchdown
- Thrust levers become separated more than 10 degrees during a dual channel approach after FLARE armed is annunciated.

Additionally, on some airplanes, a thrust split monitor disengages the autothrottle if autopilot roll control requires significant spoiler deployment and thrust levers become separated. The thrust split monitor is active when flaps are less than 15, and the A/T is not engaged in the takeoff or go-around mode.

A/T disengagement is followed by A/T Arm switch releasing to OFF and flashing red A/T Disengage lights. The A/T Disengage lights do not illuminate when the A/T automatically disengages after landing touchdown.

Altitude Alerting System

Altitude alerting references the altitude selected on the MCP. Alerting occurs when approaching or departing the selected altitude. Altitude alerting is inhibited when wing flaps are extended to 25 or greater, or while G/S is captured.

Alerting consists of a momentary tone and illumination of an ALTITUDE ALERT light located adjacent to each pilot’s primary altimeter.

Acquisition Alerting

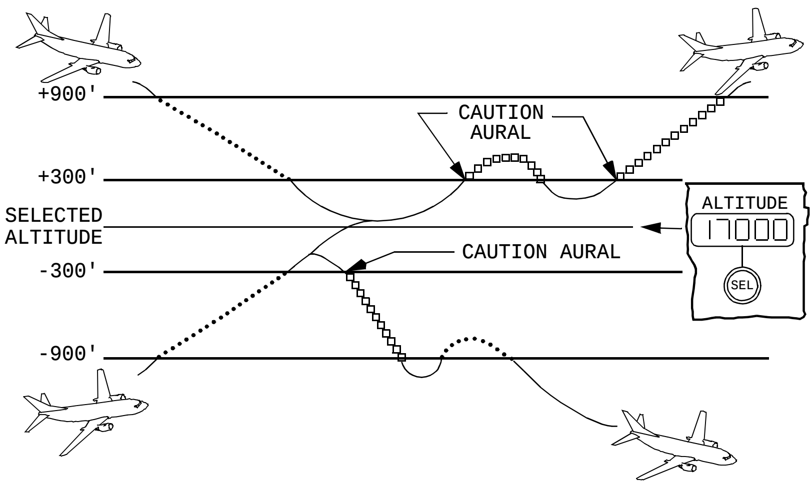
When approaching within 900 feet of selected altitude both ALTITUDE ALERT lights illuminate steady, and a momentary tone sounds. When at 300 feet from selected altitude, both ALTITUDE ALERT lights extinguish.

Deviation Alerting

Upon deviating from the selected altitude by more than 300 feet, a momentary tone sounds, and the ALTITUDE ALERT lights flash. Flashing continues until one of the following occurs:

- Altitude deviation becomes less than 300 feet.
- Altitude deviation becomes more than 900 feet.
- A new altitude is selected.

Altitude Alert



—— NO INDICATIONS

... Acquisition: Aural warning tone momentarily sounds and both ALT ALERT lights illuminate steady.

▫▫▫ Deviation: Aural warning tone momentarily sounds and both ALT ALERT lights flash.

Automatic Flight Operations

The phases of flight for automatic flight operations are:

- Takeoff and climb
- Enroute
- Approach and landing
- Go–around

Automatic Flight Takeoff and Climb

Takeoff is a flight director only function of the TO/GA mode. Flight director pitch and roll commands are displayed, and the autothrottle maintains takeoff N1 thrust limit as selected from the FMC. The autopilot may be engaged after takeoff.

Both F/Ds must be ON to engage the takeoff mode prior to starting the takeoff. The F/D takeoff mode is engaged by pressing the TO/GA switch on either thrust lever. The FMAs display FD as the A/P status, TO/GA as the pitch mode, and blank for the roll mode.

During takeoff, pushing a TO/GA switch engages the autothrottle in the N1 mode. The A/T annunciation changes from ARM to N1 and thrust levers advance toward takeoff thrust.

The F/D can also be engaged in the takeoff mode with the F/D switches off. If a TO/GA switch is pushed after 80 knots below 2000 feet AGL and prior to 150 seconds after lift–off, the F/D command bars automatically appear for both pilots.

During takeoff, prior to 60 KIAS:

- the pitch command is 10 degrees nose down
- the roll command is wings level
- the autothrottle is engaged in the N1 mode
- thrust levers advance until the engines reach takeoff thrust
- the FMAs display N1 for the autothrottle mode, TO/GA for the pitch mode, and blank for the roll mode for airplanes which maintain wings level.

At 60 knots, the F/D pitch commands 15 degrees nose up.

At 84 knots (64 knots for airplanes with an earlier autothrottle computer), the A/T mode 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).

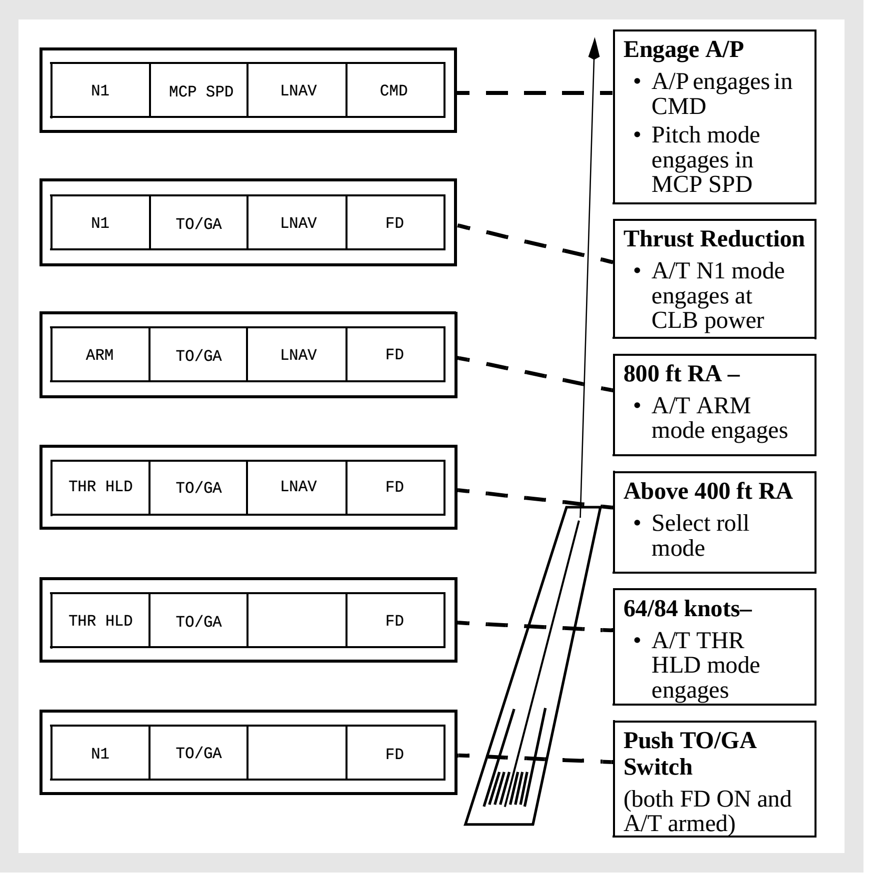
After lift-off:

- 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.

After lift–off:

To terminate the takeoff mode below 400 feet RA, both F/D switches must be turned OFF. Above 400 feet RA, selection of another pitch mode or engaging an autopilot will terminate the takeoff mode; other F/D roll modes can be also selected.

Automatic Flight Takeoff Profile



Automatic Flight En Route

The autopilot and/or the flight director can be used after takeoff to fly a lateral navigation track (LNAV) and a vertical navigation track (VNAV) provided by the FMC.

Other roll modes available are:

- VOR course (VOR/LOC)
- heading select (HDG SEL).

Other pitch modes available are:

- altitude hold (ALT HOLD)
- level change (MCP SPD)
- vertical speed (V/S).

Automatic Flight Approach and Landing

The AFDS provides guidance for single A/P non–precision approaches. The VOR/LOC switch arms the AFDS for VOR or localizer tracking. Descent prior to the Final Approach Fix may be accomplished using VNAV, LVL CHG, or V/S. VOR/LOC, LNAV, or HDG SEL may be used for the roll mode.

The AFDS provides guidance for single or dual A/P precision approaches. The approach mode arms the AFDS to capture and track the localizer and glide slope.

Approach (APP) Mode Dual Autopilots

Approach mode allows both A/Ps to be engaged at the same time. Dual A/P operation provides fail passive operation through landing flare and touchdown or an automatic go–around. During fail passive operation, the flight controls respond to the A/P commanding the lesser control movement. If a failure occurs in one A/P, the failed channel is counteracted by the second channel such that both A/Ps disconnect with minimal airplane maneuvering and with aural and visual warnings to the pilot.

One VHF NAV receiver must be tuned to an ILS frequency before the approach mode can be selected. For a dual A/P approach, the second VHF NAV receiver must be tuned to the ILS frequency and the corresponding A/P engaged in CMD prior to 800 feet RA.

Localizer and Glide Slope Armed

After setting the localizer frequency and course, pressing the APP switch selects the APP mode. The APP switch illuminates, and VOR/LOC and G/S annunciate armed. The APP mode permits selecting the second A/P to engage in CMD. This arms the second A/P for automatic engagement after LOC and G/S capture and when descent below 1500 RA occurs.

The localizer can be intercepted in the HDG SEL, CWS R or LNAV mode. Glide slope capture cannot occur prior to localizer capture.

Localizer Capture

The LOC capture point is variable and depends on intercept angle and rate of closure, but does not occur at less than 1/2 dot. Upon LOC capture, VOR/LOC annunciates captured, 1 CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

Glide Slope Capture

The G/S cannot be captured prior to localizer capture. The G/S can be captured from above or below. Capture occurs at 2/5 dot and results in the following:

- G/S annunciates captured
- previous pitch mode disengages
- APP light extinguishes if localizer has also been captured

- airplane pitch tracks the G/S
- GA displayed on thrust mode display (N1 thrust limit).

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

- pressing a TO/GA switch
- disengaging A/P and turning off both F/D switches
- retuning a VHF NAV receiver.

After LOC and G/S Capture

Shortly after capturing both LOC and G/S and below 1500 feet RA:

- the second A/P couples with the flight controls
- test of the ILS deviation monitor system is performed and the G/S and LOC displays turn amber and flash
- FLARE armed is annunciated
- the 1 CH annunciation extinguishes
- A/P go–around mode arms but is not annunciated.

Note: After localizer and glideslope capture during a dual autopilot approach, CWS cannot be engaged by manually overriding pitch and roll. Manual override of autopilots causes autopilot disengagement.

The A/Ps disengage and the F/D command bars retract to indicate an invalid ILS signal.

800 Feet Radio Altitude

The second A/P must be engaged in CMD by 800 feet RA to execute a dual channel A/P approach. Otherwise, CMD engagement of the second A/P is inhibited.

400 Feet Radio Altitude

The stabilizer is automatically trimmed an additional amount nose up. If the A/Ps subsequently disengage, forward control column force may be required to hold the desired pitch attitude.

If FLARE is not armed by approximately 350 feet RA, both A/Ps automatically disengage.

Flare

The A/P flare maneuver starts at approximately 50 feet RA and is completed at touchdown:

- FLARE engaged is annunciated and F/D command bars retract
- The stabilizer is automatically trimmed an additional amount nose up at 50 feet RA
- The A/T begins retarding thrust at approximately 27 feet RA so as to reach idle at touchdown. A/T FMA annunciates RETARD

- The A/T automatically disengages approximately 2 seconds after touchdown
- The A/P must be manually disengaged after touchdown. Landing rollout is executed manually after disengaging the A/P.

Automatic Flight Approach

The AFDS provides guidance for single A/P non–precision approaches. The VOR/LOC switch arms the AFDS for VOR or localizer tracking. Descent prior to the final approach fix may be accomplished using VNAV, LVL CHG, or V/S. V/S is the appropriate mode for descent on final approach. VOR/LOC, LNAV, or HDG SEL may be used for the roll mode.

The AFDS provides guidance for single A/P precision approaches. The approach mode arms the AFDS to capture and track the localizer and glide slope.

Approach (APP) Mode Single A/P

A single A/P ILS approach can be executed by engaging only one A/P in CMD. Single A/P approach operation is the same as dual, with the following exceptions:

- Full automatic flare and touchdown capability are not available. FLARE is not annunciated, and stabilizer trim bias is not applied
- An A/P go–around is not available.

One VHF NAV receiver must be tuned to an ILS frequency before the approach mode can be selected.

Localizer and Glide Slope Armed

After setting the localizer frequency and course, pressing the APP switch selects the APP mode. The APP switch illuminates, and VOR/LOC and G/S annunciate armed. The APP mode permits selecting the second A/P to engage in CMD. This arms the second A/P for automatic engagement after LOC and G/S capture and when descent below 1500 RA occurs.

The localizer can be intercepted in the HDG SEL, CWS R or LNAV mode. Glide slope capture cannot occur prior to localizer capture.

Localizer Capture

The LOC capture point is variable and depends on intercept angle and rate of closure, but does not occur at less than 1/2 dot. Upon LOC capture, VOR/LOC annunciates captured, 1 CH is annunciated for A/P status, the previous roll mode disengages and the airplane turns to track the LOC.

Glide Slope Capture

Glide slope capture cannot occur prior to localizer capture. The G/S can be captured from above or below. Capture occurs at 2/5 dot and results in the following:

- G/S annunciates captured
- previous pitch mode disengages
- APP light extinguishes if localizer has also been captured
- airplane pitch tracks the G/S
- GA displayed on thrust mode display (N1 thrust limit).

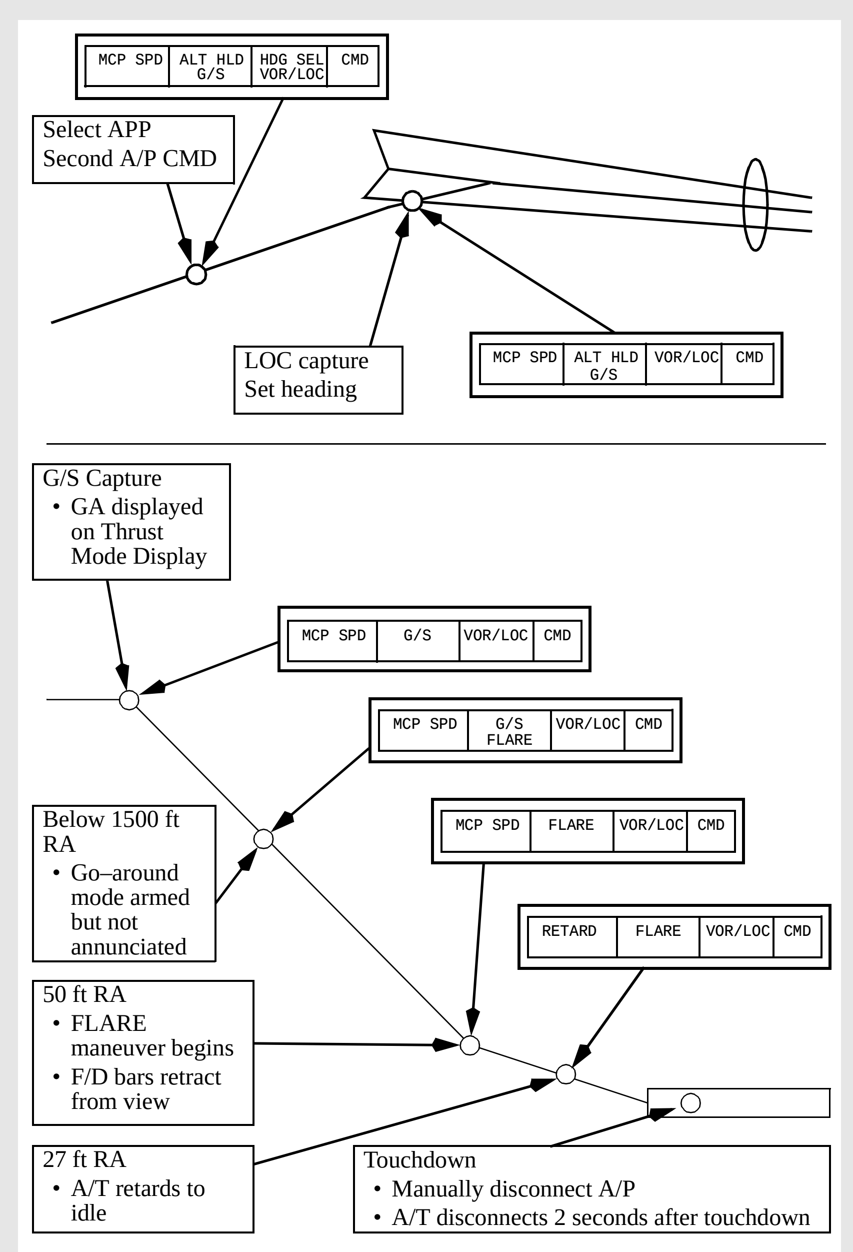
After VOR/LOC and G/S are both captured, the APP mode can be exited by:

- pressing a TO/GA switch
- retuning a VHF NAV receiver
- 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 and at 50 feet RA during the approach.

With pitch mode engaged in TO/GA, ALT ACQ engages when approaching the selected altitude, and ALT HOLD engages at the selected altitude if the stabilizer position is satisfactory for single A/P operation.

- If stabilizer trim 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:
    - the F/D roll mode automatically changes to HDG SEL
    - F/D pitch engages in the selected mode.
  - 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:

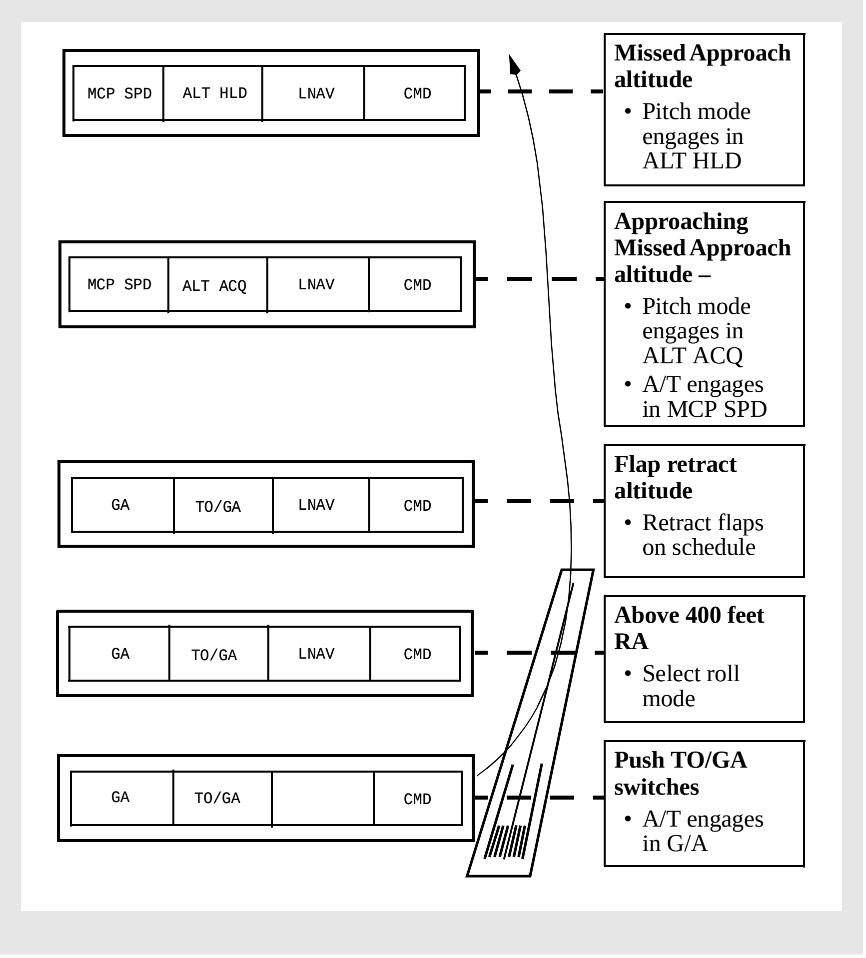
- F/D roll commands hold current ground track. The Roll Engaged Mode annunciation on the FMA is blank
- Pitch mode engages in TO/GA and the Pitch Engaged Mode annunciation on the FMA indicates TO/GA
- The F/D target speed is displayed on IAS/Mach display
- The F/D target speed is displayed on the airspeed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

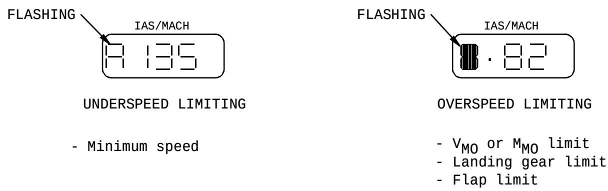
Approach and Landing

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.



MCP SPEED CONDITION SYMBOLS

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
- Minimum airspeed reversion

Mode reversion occurs slightly before reaching the limit speed. Both the AFDS and A/T have reversion modes which activate according to the condition causing the reversion.

Placard Limit Reversion

When one of the placard limit reversions (gear, flap or Vmo/Mmo) is reached, the overspeed limiting symbol appears in the MCP IAS/Mach display and the following occurs:

- If not in AFDS or A/T speed control and the A/T is armed, the A/T reverts to SPEED and controls speed to the placard limit.
- If in AFDS or A/T speed control, no reversion is necessary. The AFDS or A/T, whichever is controlling speed, holds speed slightly below the placard limit.
- 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 and the AFDS is in ALT HOLD, ALT ACQ, or after G/S capture. Minimum speed reversion is also not available when in VNAV PTH and capturing or flying a level segment.

Communications — Chapter 5
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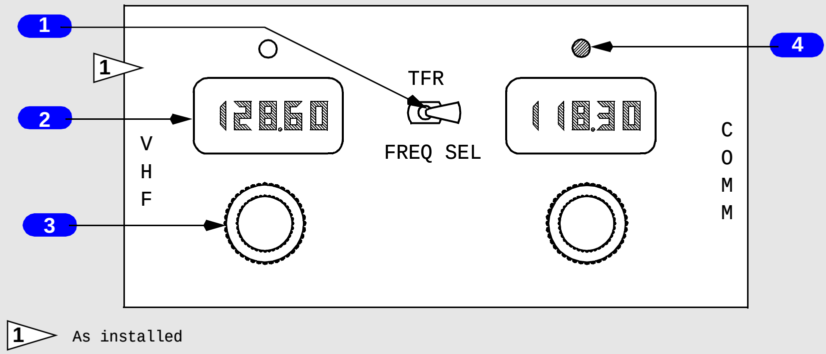
VHF Communication Panel



AFT ELECTRONIC PANEL

1 VHF Communications Transfer (TFR) Switch

Selects which frequency as active for the transceiver.

2 Frequency Indicator

Indicates selected frequency.

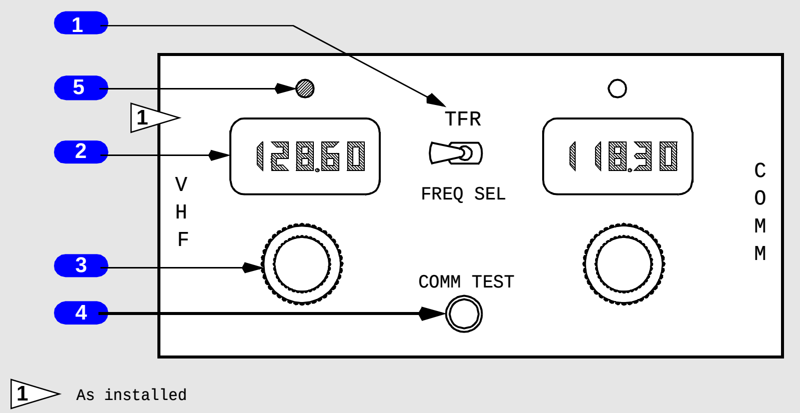
3 Frequency Selector

Rotate – selects frequency in related indicator:

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

4 Active Frequency Light

Illuminated (white)–indicates related frequency is selected.



AFT ELECTRONIC PANEL

1 VHF Communications Transfer (TFR) Switch

Selects which frequency as active for the transceiver.

2 Frequency Indicator

Indicates selected frequency.

3 Frequency Selector

Rotate – selects frequency in related indicator:

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

4 Communication (COMM) TEST Switch

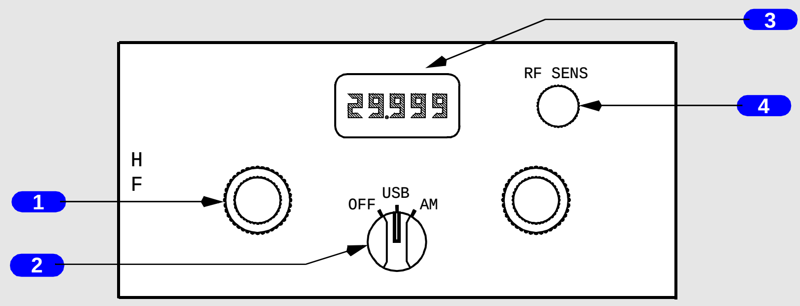
Push –

- removes automatic squelch feature, permitting reception of background noise and thereby testing receiver operation
- improves reception of weak signals.

5 Active Frequency Light

Illuminated (white)–indicates related frequency is selected.

HF Communication Panel



AFT ELECTRONIC PANEL

1 Frequency Selector

Rotate – selects frequency.

2 Mode Selector

OFF – transceiver not powered.

USB (Upper Sideband) – transmits and receives on higher side of frequency.

AM (Amplitude Modulation) – transmits and receives on selected frequency with a carrier wave.

3 Frequency Indicator

- indicates selected frequency
- frequency range from 2,000 to 29,000 megahertz.

4 RF/HF Sensitivity Control

Rotate–controls sensitivity of receiver.

- (clockwise) increases sensitivity for reception of weak or distant stations
- (counterclockwise) decreases sensitivity to reduce noise and static.

Note: decreasing sensitivity too far prevents reception, including SELCAL monitoring of HF radio.

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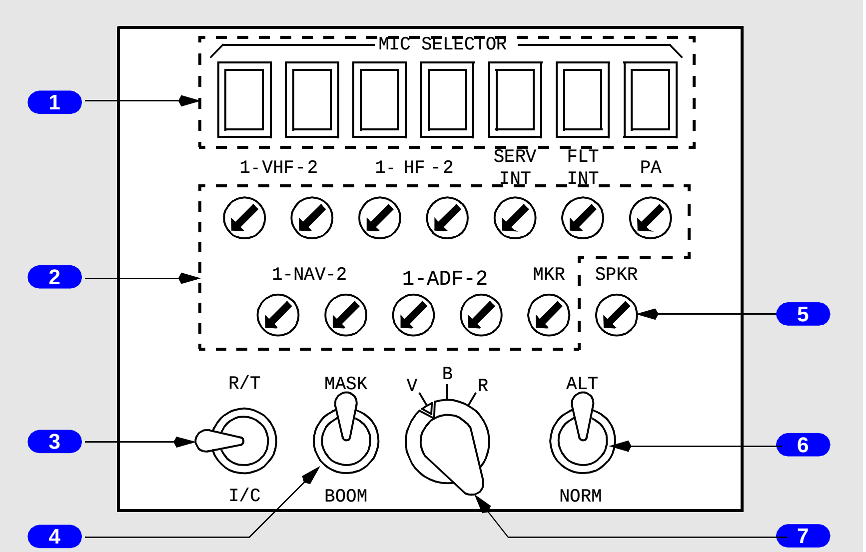
Audio Selector Panel (ASP)



FLIGHT DECK CREW STATIONS

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.

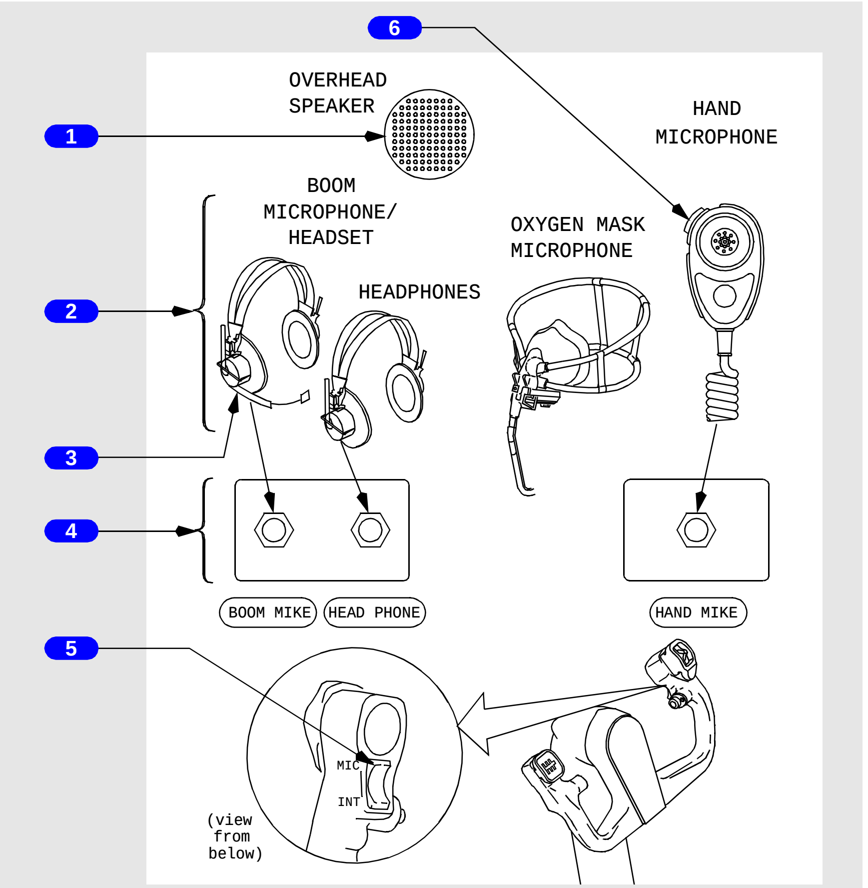
7 Filter Switch

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)



FLIGHT DECK CREW STATIONS

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) –

- selects 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.

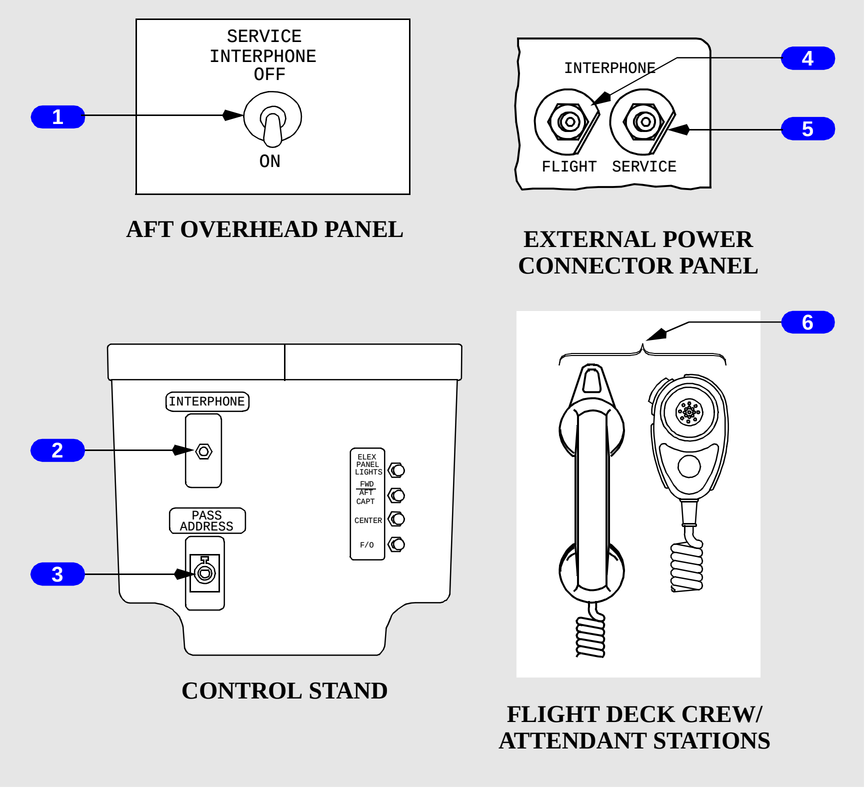
INT (interphone) –

- selects oxygen mask or boom microphone for direct transmission over flight interphone
- bypasses ASP transmitter selector
- same as using ASP PTT switch (I/C position).

6 Push–To–Talk Switch

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

Interphone and Passenger Address Controls



1 SERVICE INTERPHONE Switch

OFF –

- external jacks are deactivated
- communication between flight deck and flight attendants is still possible.

ON – adds external jacks to service interphone system.

2 Service INTERPHONE Handset Jack

With microphone installed, used to communicate with flight attendant stations:

- with SERVICE INTERPHONE switch ON, also used to communicate with any external jack location
- bypasses ASP.

3 Passenger Address (PASS ADDRESS) Hand Microphone Jack

With microphone installed:

- used to make PA announcements
- bypasses ASPs.

4 FLIGHT INTERPHONE Jack

Connects ground crew to Flight Interphone system.

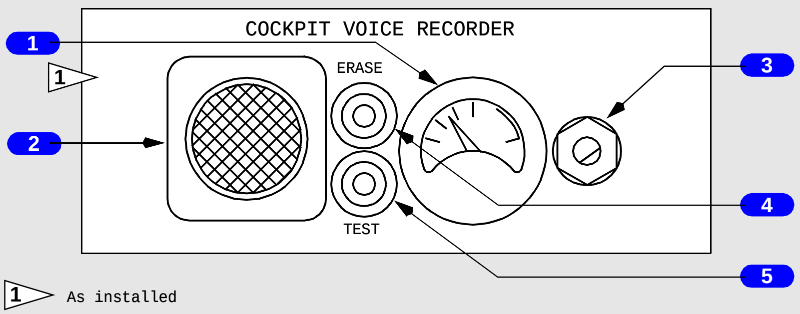
5 SERVICE INTERPHONE Jack

Connects ground crew to Service Interphone system if Service Interphone switch is ON.

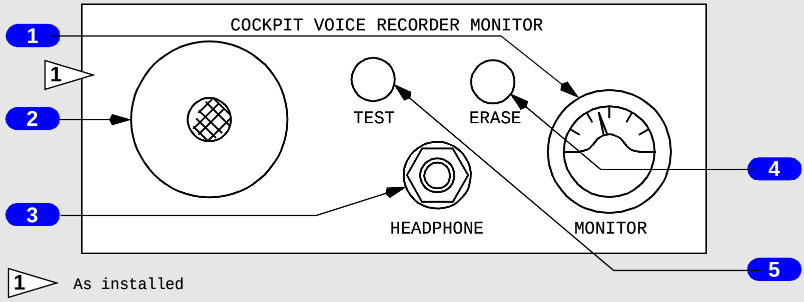
6 Flight Deck / Attendant PA Hand Microphone

Used to make PA announcements.

Cockpit Voice Recorder



FORWARD OVERHEAD PANEL



FORWARD OVERHEAD PANEL

1 Monitor Indicator

Pointer deflection indicates recording or erasure on all four channels (approximately a one second delay); during test, pointer rises into green band.

2 Area Microphone

Active anytime 115V AC is applied to airplane.

3 HEADSET Jack

Headset may be plugged into jack to monitor tone transmission during test, or to monitor playback of voice audio.

4 ERASE Switch

Push (14 seconds) –

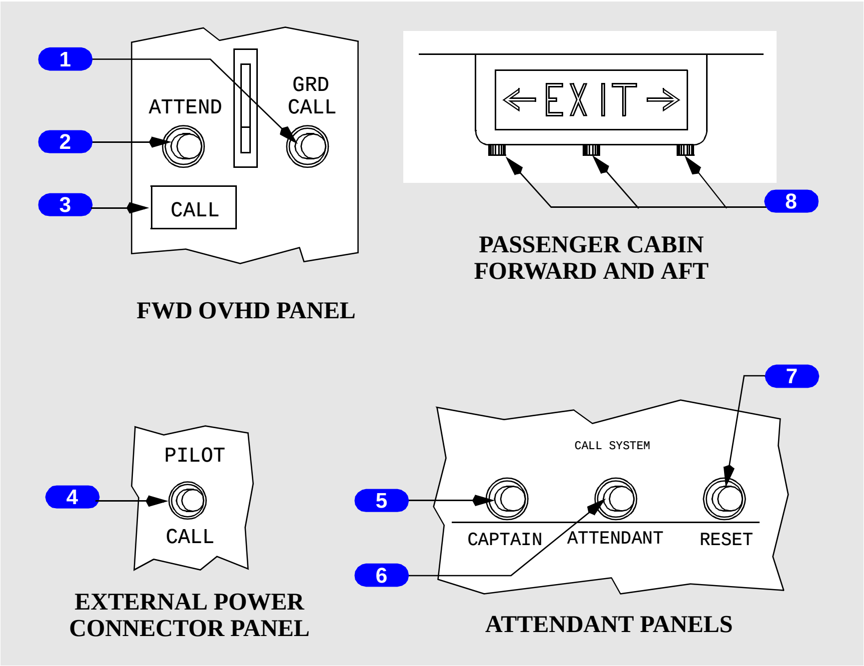
- all four channels are erased
- monitor indicator momentarily deflects
- operates only when airplane is on ground and parking brake is set.

5 TEST Switch

Push –

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

Call System



1 Ground Call (GRD CALL) Switch

Push – sounds a horn in nose wheel well until released.

2 Attendant Call (ATTEND CALL) Switch

Push –

- sounds a two-tone chime in the passenger cabin.
- illuminates both pink master call lights.

3 Flight Deck CALL Light

Illuminated (blue) – flight deck is being called by flight attendants or ground crew.

Extinguished when Captain Call or Pilot Call switch released.

4 PILOT CALL Switch

Push – sounds a single–tone chime in flight deck.

Flight deck CALL light extinguished when switch is released.

5 CAPTAIN Call Switch

Push – sounds a single–tone chime in flight deck

Flight deck CALL light extinguished when switch is released.

6 ATTENDANT Call Switch

Push –

- sounds a two–tone chime in passenger cabin
- illuminates both pink master call lights.

7 Call RESET Switch

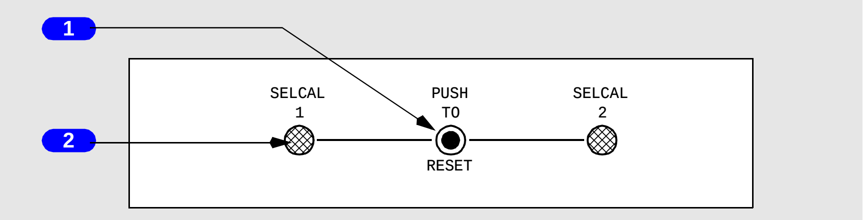
Push – extinguishes both pink master call lights.

8 Master Call Light

Illuminated –

- amber – a lavatory call switch is activated or smoke has been detected in a lavatory
- pink – flight deck or other flight attendant station is calling
- blue – a passenger seat call switch is activated.

Selective Calling Panel (SELCAL)



FORWARD ELECTRONIC PANEL

1 SELCAL Reset Switch

Push – extinguishes SELCAL light and resets decoder.

2 SELCAL Light

Illuminated–

- alerts crew that communication is desired on a communication radio
- SELCAL 1 light illuminates for a call on VHF –1 or HF
- SELCAL 2 light illuminates for a call on VHF– 2.

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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 volume for the headset and speaker at the related crew stations. Audio from each ASP is monitored using a headset/headphones or the related pilot’s speaker.

Audio warnings for altitude alert, GPWS, and windshear are also heard through the speakers and headsets at preset volumes. They cannot be controlled or turned off by the crew.

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.

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

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 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 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
Nose wheel well	Flight deck	Blue flight deck call light	Single high–tone chime
Flight deck	Passenger cabin	NO SMOKING or FASTEN BELT signs illuminate/ extinguish	Single low–tone chime

Selective Calling (SELCAL)

A ground station desiring communication with the flight deck can use the SELCAL system. SELCAL monitors selected frequencies on VHF and HF radios. Each airplane is assigned a unique four–letter SELCAL identification code. When the system receives an incoming call from a ground station, a two–tone chime sounds, and the related SELCAL light illuminates.

VHF Communications

Primary short–range voice communication is provided in the VHF range by two or three independent radios. Each radio provides for selection of an active frequency and an inactive (preselected) frequency. Voice transmission and reception are controlled at the related ASP.

VHF–3 communication on airplanes equipped with three VHF transceivers is used in conjunction with ACARS. Frequency tuning for this radio is provided by the ACARS system.

VHF–1 is located on the left aft electronic panel, VHF–2 on the right. The VHF–1 antenna is located on the upper fuselage, VHF–2 and VHF–3 on the lower fuselage.

HF Communications

HF transmission and reception are controlled at the related ASP. When the HF transmitter is keyed after a frequency change, the antenna tunes. While the antenna is tuning, a steady or intermittent tone may be heard through the audio system (tuning takes a maximum of 15 seconds). The antenna is located in the vertical stabilizer.

Note: Keying HF transmitter on the ground may cause oil and fuel quantity indicators to fluctuate if one or more of the following conditions exist:

- cargo or passenger entry door open
- service interphone microphone plugged into service interphone jack
- airplane grounding wire attached to airplane
- ground power cart connected.

Cockpit Voice Recorder

The cockpit voice recorder uses four independent channels to save the last 30 minutes of flight deck audio. Recordings older than 30 minutes are automatically erased. One channel records flight deck area conversations using the area microphone. The other channels record individual ASP output (headset) audio and transmissions for the pilots and observer.

ACARS System

The ARINC Communication Addressing and Reporting System (ACARS) is an addressable digital data link system which permits exchange of data and messages between an airplane and a ground–based operations center utilizing the onboard VHF–3 communication system.

The ACARS airborne subsystem provides for the manual entry of routine data such as departure/arrival information. Also possible is manual entry of addresses (telephone codes) of parties on the ground for voice communications.

The airborne system consists of a management unit (MU) in the E & E compartment, and interactive display unit (IDU), and a multiport printer. Data is entered and automatically transmitted to the ground operations center.

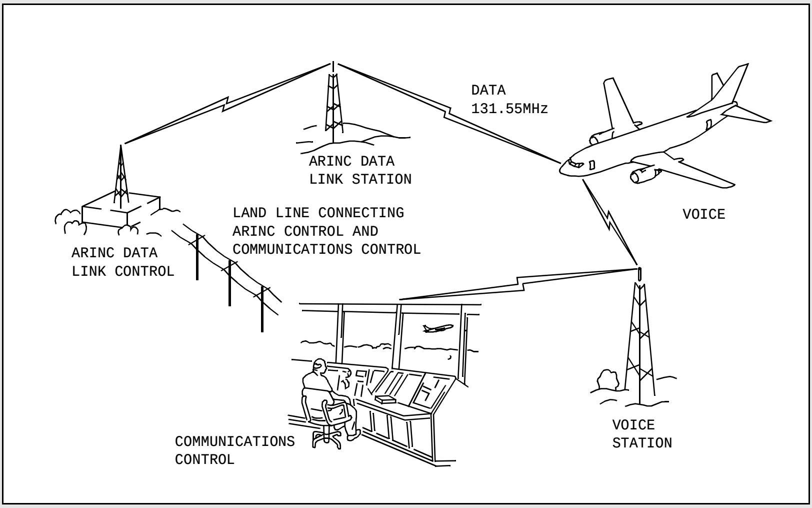
Page Routines

When the IDU is initially powered up (AC busses powered), it establishes contact with the ACARS and the digital flight data acquisition unit (DFDAU). The IDU screen then displays the MAIN MENU. This is the root page for accessing all other ACARS pages. Return to this MAIN MENU is possible by touching the MENU cue on any displayed page.

When a cue is touched on the IDU screen, the cue name is highlighted in reverse video. Moving the finger to another cue without breaking screen contact returns the cue first touched to normal video and highlights the new cue being touched. Releasing the highlighted cue activates the cue’s function.

The following cues are special in that they always perform the same functions:MENU, RTN, ENT, CLR, SEND, RE–DO, and VOX. Other cues are advisory cues. Advisory cues appear in place of **** on the standard ACARS menu. Some advisory cues flash from normal to reverse video: FAIL, DATA, SELC, MSG, and INIT. Other advisories are diaplayed in normal video: NOCOM, VOICE; and in reverse video: FAIL.

ACARS System Diagram



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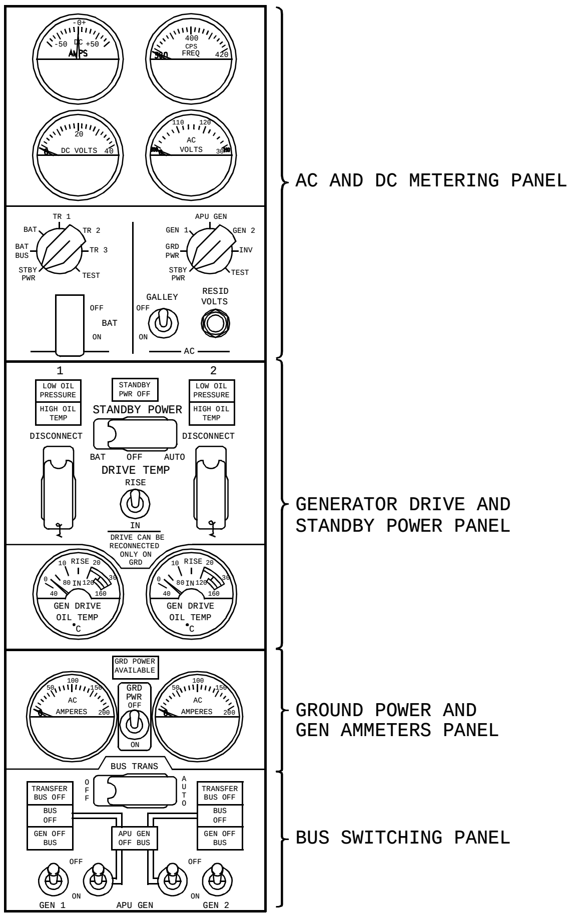
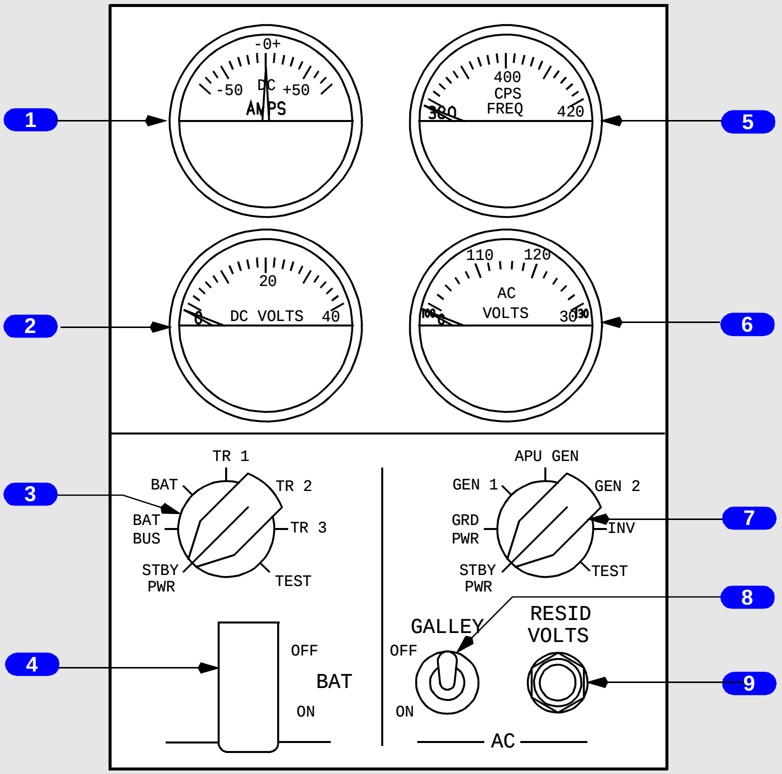
Electrical — Chapter 6
Table of Contents — Section 0

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.

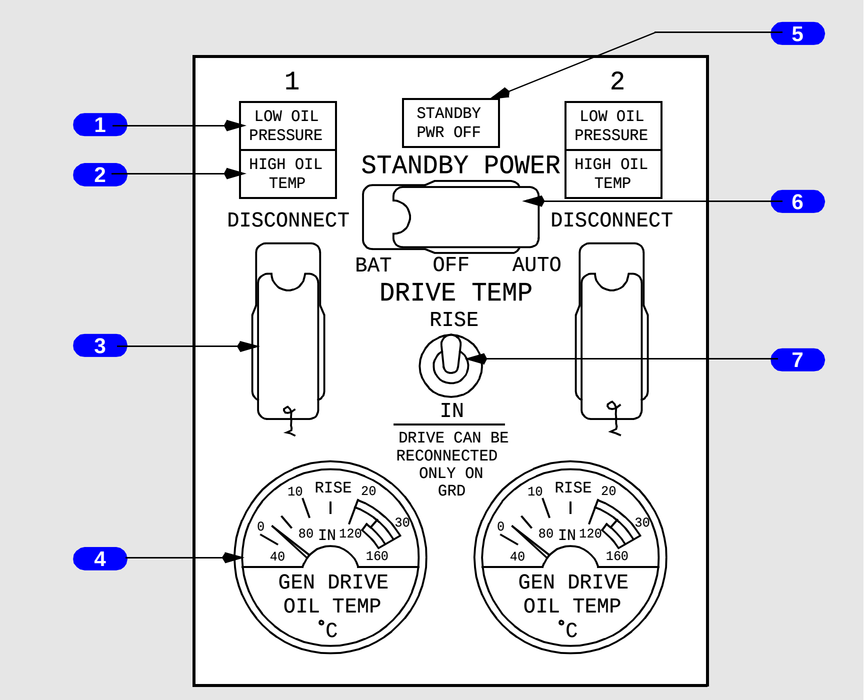
ON – electrical power is supplied to galleys when both AC generator busses are powered.

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



FORWARD OVERHEAD 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.

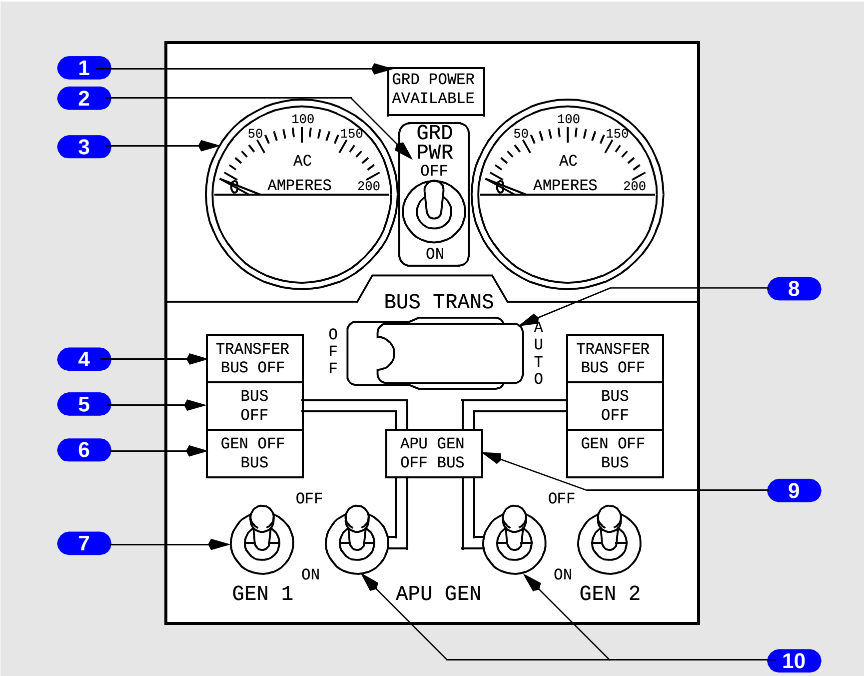
BAT (unguarded position) –

- 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 is connected.

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 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

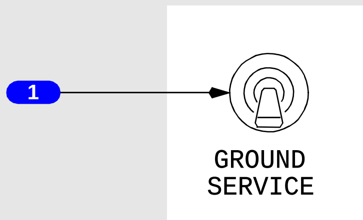
Three position switch, spring–loaded to center position.

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 move 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.

Introduction

Primary electrical power is provided by two engine driven generators which supply three-phase, 115 volt, 400 cycle alternating current. Each generator supplies its own bus system in normal operation and can also supply essential loads of the opposite side bus system when one generator is inoperative. Transformer rectifier (TR) units and a battery supply DC power. The battery also provides backup power for the AC and DC standby systems. The APU operates a generator and can supply power to both AC generator busses on the ground or one AC generator bus in flight.

There are two basic principles of operation for the 737 electrical system:

- There is no paralleling of the AC sources of power.
- The source of power being connected to a generator bus automatically disconnects an existing source.

The electrical power system may be categorized into three main divisions: the AC power system, the DC power system, and the standby power system.

Electrical Power Generation

Engine Generators

Primary power is obtained from two engine driven generators. Each generator is part of a generator drive unit which maintains a constant frequency throughout the normal operating range of the engine. The generator is coupled directly to the engine and operates whenever the engine is running.

APU Generator

The APU generator can supply primary power on the ground and can serve as a backup for either generator in flight. The APU generator is identical to the engine generators but has no generator drive unit, since the APU itself is governed and will maintain a constant speed. As the only power source, the APU generator can meet electrical power requirements for all ground conditions and all essential flight requirements.

External Ground Power

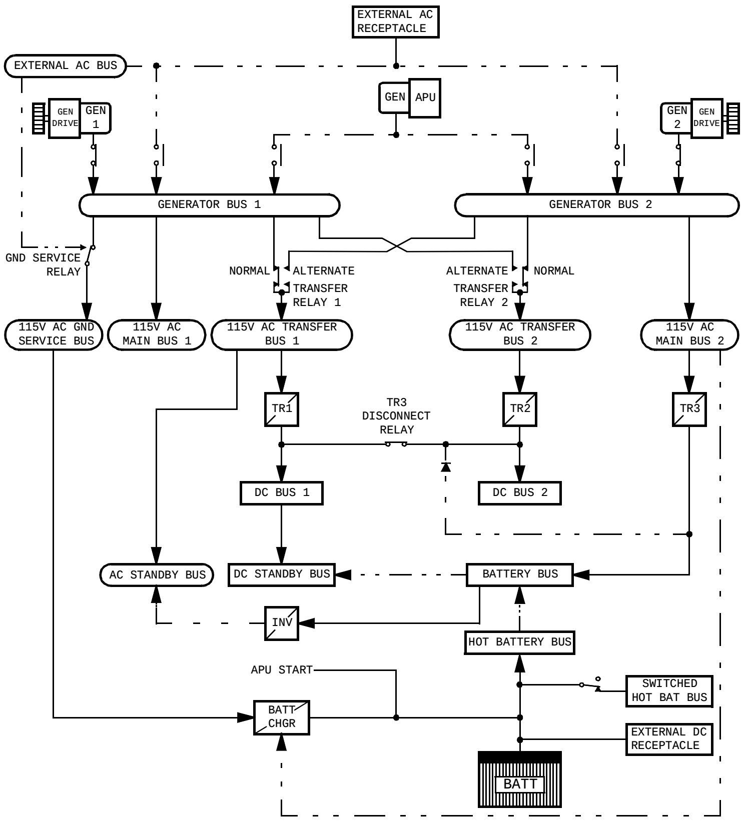
An external AC power receptacle located near the nose gear wheel well, on the lower right side of the fuselage, allows the use of an external power source. Status lights on a panel adjacent to the receptacle permit the ground crew to determine if external power is being used. A GRD POWER AVAILABLE light provides flight deck indication that AC ground power is connected to 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




```
Airplane Configuration - Inflight
  Battery Switch        - ON
  Standby Power Switch - AUTO
  Bus Transfer Switch  - AUTO
  ENGINE GENERATOR CONNECTED
  TO RESPECTIVE BUS
```

AC Power System

Each AC power system consists of a generator bus, a main bus, and a transfer bus. The left AC power system also includes a ground service bus. Transfer bus 1 supplies power to the AC standby bus. If the source powering either AC power system fails or is disconnected, a transfer relay automatically selects the opposite generator bus as an alternate power source for the transfer bus.

Generator busses can be powered from the engine generators by momentarily positioning the related generator switch to ON. This connects the voltage regulator to the generator and connects the generator to its associated generator bus. Selecting a new power source disconnects the existing power source.

When the APU is operating, selecting either APU GEN switch ON connects APU power to its associated generator bus. On the ground, the APU can supply electrical power to both generator busses.

With the airplane on the ground and external power available, selecting the GRD PWR switch ON connects external power to both generator busses. The APU or an engine generator can supply power to one generator bus while external power supplies the other generator bus.

In flight, each engine generator normally powers its own generator bus. If an engine generator is no longer supplying power, the APU generator may be used to power one generator bus. Since the entire electrical system is powered from the two generator busses, all electrical components can be powered with any two operating generators.

Bus Transfer System

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

If a generator trips off, its generator bus and main bus will not be powered. Each transfer bus has a transfer relay which automatically selects the opposite generator bus as its power source. The BUS TRANS switch must be in the AUTO position to enable this transfer.

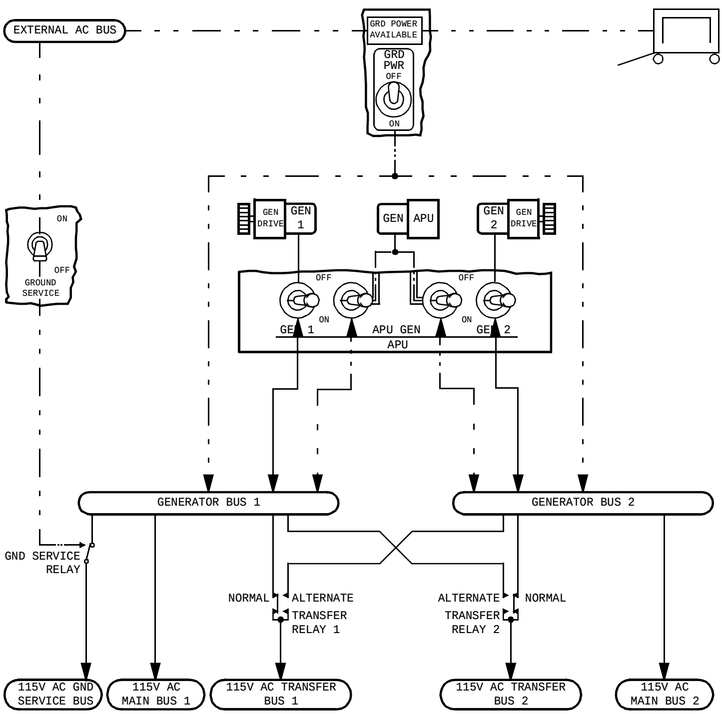
Automatic Galley Load Shedding

In flight, all galley power is automatically removed when operating on one generator. This automatic galley load shedding feature reduces the total electrical load on the remaining generator, protecting it from overload.

APU Automatic Galley Load Shedding

Galley electrical loads will automatically be shed should the total airplane electrical power requirements exceed design limits with the APU providing electrical power.

AC Power Schematic




```
Airplane Configuration:
  Battery Switch        - ON
  Standby Power Switch - AUTO
  Bus Transfer Switch  - AUTO
  ENGINE GENERATOR CONNECTED
  TO RESPECTIVE BUS
```

Electrical Power Controls and Monitoring

Generator Drive

Each engine driven generator is connected to its engine through a generator drive unit. Each generator drive is a self-contained unit consisting of an oil supply, cooler, instrumentation and disconnect device which provides for complete isolation of the generator in the event of a malfunction.

Operating conditions of the generator drive can be observed on the generator drive oil temperature indicator. Oil temperature is measured as it enters and leaves the generator drive. Temperature of oil entering the generator is indicated on the IN scale. Temperature differential between outlet and inlet is indicated as RISE - (out temperature minus in temperature). During normal operation, the oil temperature rise should be less than 20 deg. C. Readings above 20 deg. C indicate excessive generator load or poor condition of the drive and are used by maintenance in troubleshooting drive problems.

The amber HIGH OIL TEMPERATURE light illuminates when oil temperature in the internal oil tank exceeds limitations. The amber LOW OIL PRESSURE light illuminates when oil pressure is below the operating limit. When the generator has been disconnected, the LOW OIL PRESSURE light will be on, and the HIGH OIL TEMPERATURE light remains on until the oil is cooled.

A generator drive disconnect switch is installed. This switch disconnects the generator from the engine in the event of a generator drive malfunction. Reactivation of the generator may be accomplished only on the ground by maintenance personnel.

AC Voltmeter and Frequency Meter

AC voltage and frequency may be read on the AC voltmeter and frequency meter for standby power, ground power, generator No. 1, APU generator, generator No. 2 and the static inverter. Frequency is indicated only when the generator is electrically excited. The voltage regulator automatically controls the generator output voltage.

Current readings for the two engine generators and the APU generator may be read on the AC ammeter.

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

Normal indications are:

- AC voltmeter – 115 +/- 5 volts.
- Frequency meter – 400 CPS +/- 10 CPS.

Note: Normal AC voltmeter indications for the APU generator with the AC buses loaded are: 110-125 volts.

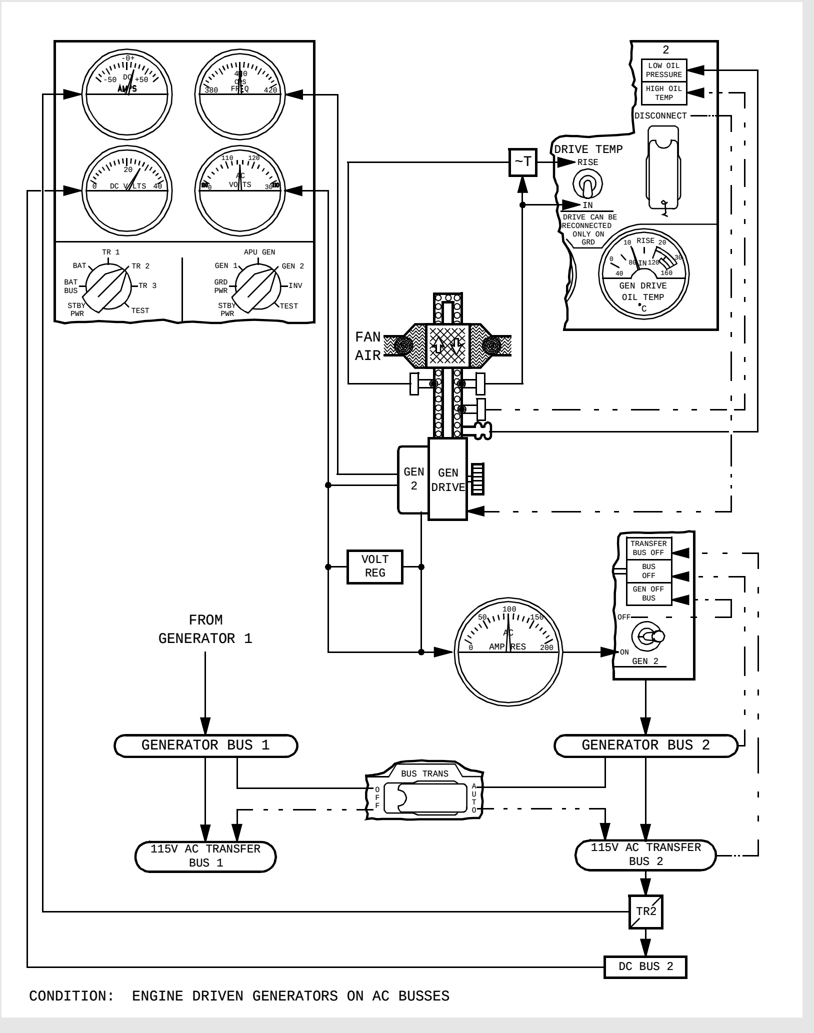
DC Voltmeter and Ammeter

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.

Normal indication is 26 +/- 4 volts.

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.

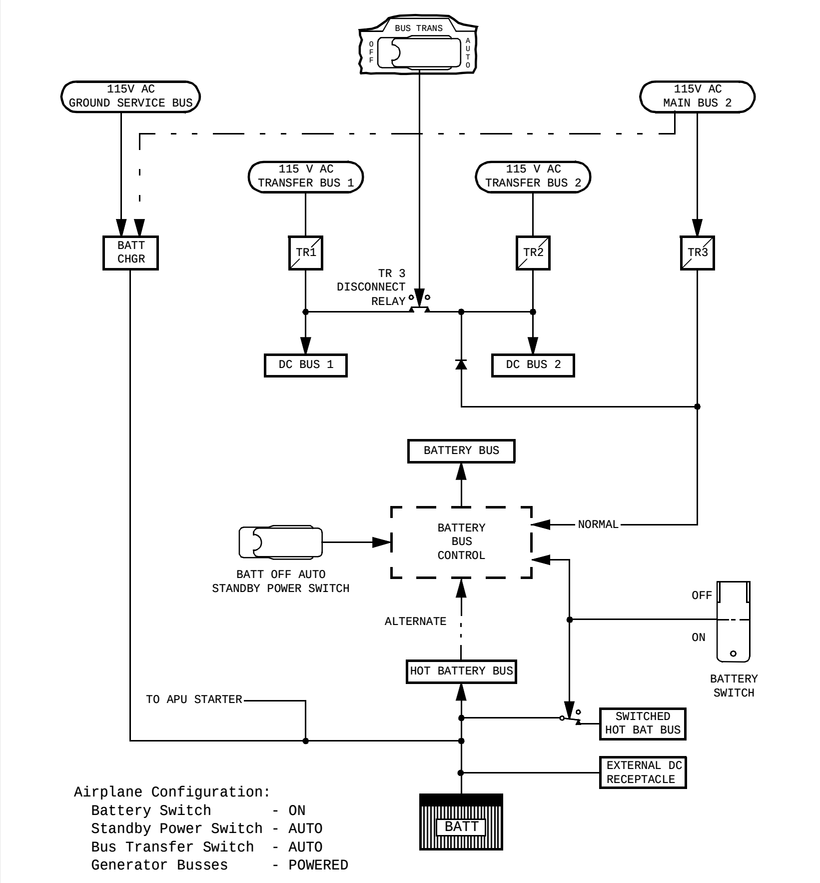
Battery Charger

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



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 sources 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.

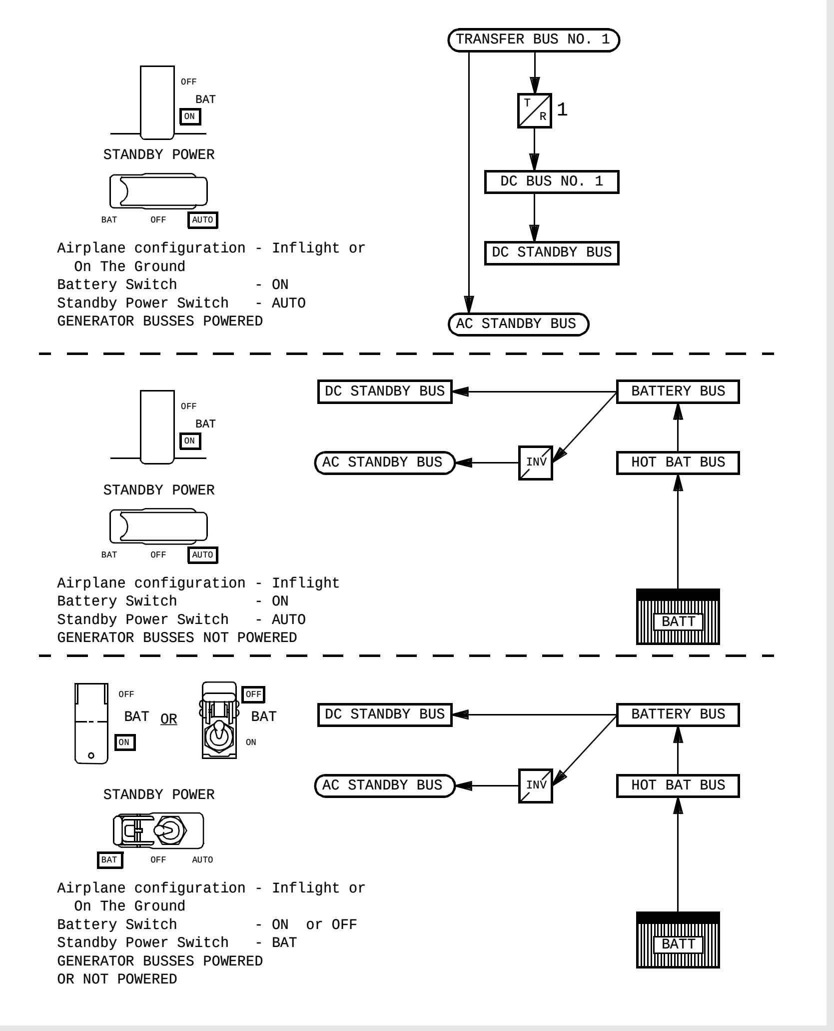
A fully charged battery has sufficient capacity to provide power to the minimum essential flight instruments, communications and navigation equipment for a minimum of 30 minutes.

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



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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
- crew and passenger oxygen
- standby forward airstair operation

Air Systems

- A/C pack valves
- altitude warning horn
- manual pressurization control
- PACK TRIP OFF lights
- BLEED TRIP OFF lights

Engines, APU

- N1, N2, fuel flow, EGT indications
- right igniters
- starter valves
- thrust reversers (switched hot battery bus)
- APU operation (start attempts not recommended above 25,000 feet)

Communications

- flight interphone system
- passenger address system
- VHF No. 1

Electrical

- STANDBY POWER OFF light
- external power control (hot battery bus)
- APU & engine generator power control (switched hot battery bus)

Flight Instruments

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

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

- ANTISKID INOP light
- inboard antiskid system
- parking brake

Navigation

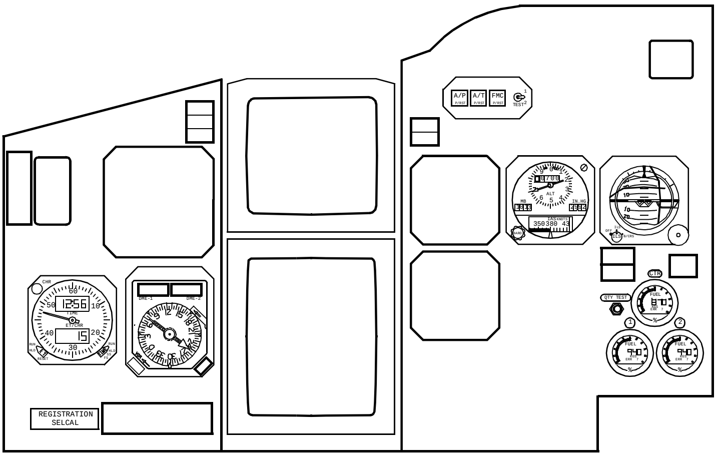
- ADF No. 1
- captain’s RDMI
- left IRS - AC
- left & right IRS - DC (switched hot battery bus)
- VHF NAV No. 1

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 and the below listed systems and engine instruments.

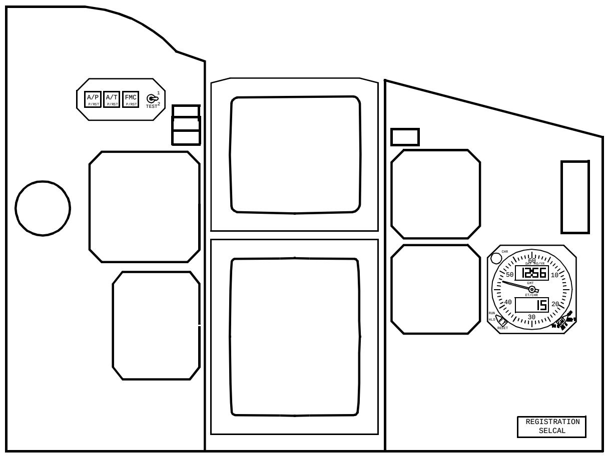
- Left IRS
- No. 1 VHF Navigation System (VOR, GS, and LOC)
- No. 1 ADF Navigation System
- No. 1 VHF Communication System
- N1, N2, Fuel Flow, and EGT.

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

NOTE: All of the Captain's instruments including the engine and fuel quantity indicators, that are powered by standby power are also integrally lighted by standby power.

Airplane Configuration - Inflight Battery Switch - ON Standby Power Switch - AUTO	This illustration shows the instruments which are useable with only the battery and standby busses powered.	☐ Indicates Inoperative Instruments

First Officer Instrument Panel



COCKPIT COMMUNICATION

Audio Selector Panels
Flight Interphone
Passenger Address System
Service Interphone

COCKPIT LIGHTS

Standby Instrument Floodlight
White Dome Light
Magnetic Compass Light

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 Center tank right fuel pump	LOW PRESSURE light LOW PRESSURE light
Galley(s)	Inoperative
No.1 Generator Generator bus No. 1	GEN OFF BUS light BUS OFF light
Left forward window heat Right side window heat Left No. 3, 4, & 5 window heat	ON light – extinguished ON light – extinguished Inoperative
Left elevator pitot heat	L ELEV PITOT light
System B electric pump	LOW PRESSURE light
Left outboard landing light Right inboard landing light Left runway turnoff light Nose gear taxi light	Inoperative Inoperative Inoperative Inoperative
Equipment cooling normal	OFF light
Right recirculation fan	Inoperative

No. 2 Generator Inoperative

Failure In Flight, Transfer Busses Normal

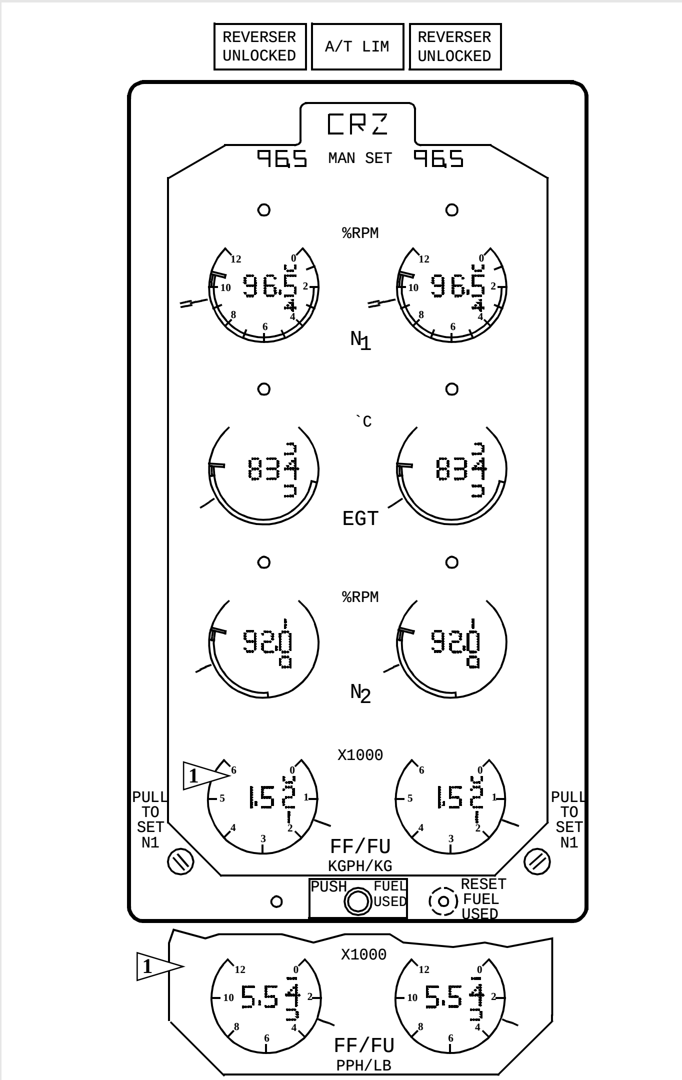
Inoperative Components	Indication
No.2 tank forward fuel pump Center tank left fuel pump Fuel temperature indicator	LOW PRESSURE light LOW PRESSURE light Inoperative
Galley(s)	Inoperative
No.2 Generator Generator bus No. 2 TR unit No. 3	GEN OFF BUS light BUS OFF light TR No. 3 voltage - Zero
Left side window heat Right forward window heat Right No. 3, 4, & 5 window heat	ON light – extinguished ON light – extinguished Inoperative
Right elevator pitot heat TEMP PROBE Heat	R ELEV PITOT light TEMP PROBE light
System A electric pump	LOW PRESSURE light
Right outboard landing light Left inboard landing light Right runway turnoff light	Inoperative Inoperative Inoperative
Equipment cooling - Alternate	If switch is to alternate, OFF light
Left recirculation fan	Inoperative

Intentionally
Blank

Engines, APU — Chapter 7

Table of Contents — Section 0

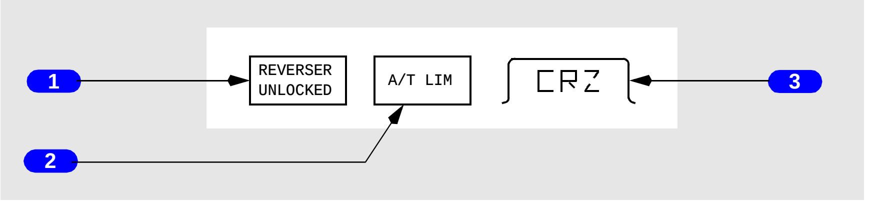
Engine Instrument System (EIS) Primary Panel



1 As installed

CENTER INSTRUMENT PANEL

Reverser Unlocked, Autothrottle Limit, and Thrust Mode Display



1 Reverser Unlocked Light

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

2 Autothrottle Limit (A/T LIM) Indication

Illuminated (white) – A/T computer is calculating a single fixed N1 thrust limit for affected engine(s) when FMC calculations become invalid or if either engine N1 is less than 18%.

3 Thrust Mode Display

Displays the active N1 limit reference mode.

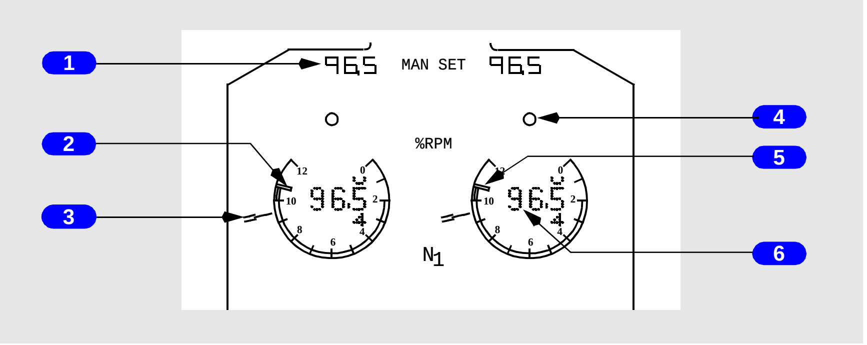
With N1 manual set knob pushed in, active N1 limit is displayed by reference N1 bugs. If knob is pulled out, FMC computed N1 is disabled.

Active N1 limit is normally calculated by FMC.

Thrust mode display annunciations are:

- R – reduced (can appear with TO or CLB)
- TO – takeoff
- CLB – climb
- CRZ – cruise
- G/A – go–around
- CON – continuous
- – – – – FMC not computing thrust limit.

N1 Indications



1 N1 Manual Set Indication

Set by N1 manual set knob.

Blank when manual set knob is pushed in.

2 N1 RPM Indication (green)

Displays N1 % RPM.

3 Reference N1 Bug (yellow)

With N1 manual set knob pushed in:

- positioned by FMC
- based on N1 limit page and takeoff reference page
- displays active N1 limit for A/T operation.

With N1 manual set knob pulled out:

- displays crew selected N1 limit
- has no effect on A/T operation.

4 Warning Light

Illuminated (red) –

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

Note: Failure of an N1 input signal to the primary EIS panel will cause the affected display pointer and digital counter to slew to their lower stops and hold for two seconds. The pointer will then disappear and the counter will display dashes. An internal failure will cause the display(s) to simply blank.

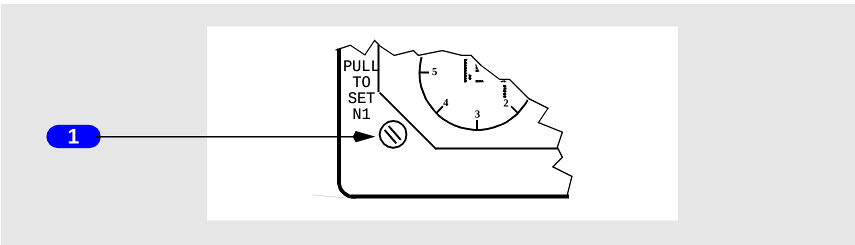
5 **N1 Red Radial**

Shows N1 % RPM operating limit.

6 **N1 RPM Readout (digital)**

Displays N1 % RPM.

N1 Manual Set Knob



1 **N1 Manual Set Knob**

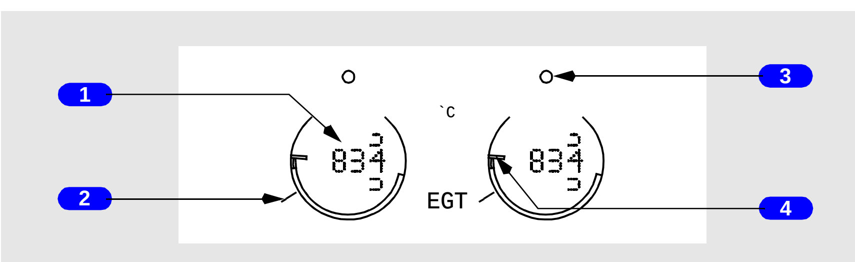
Push in –

- reference N1 bug set by FMC based on N1 limit page and takeoff reference page
- blanks N1 manual set indication.

Pull out –

- disables FMC input signal
- rotation sets desired N1 RPM in the N1 manual set indication and moves the reference N1 bug to the corresponding location.

EGT Indications



1 **Exhaust Gas Temperature (EGT) Readout (digital)**

Displays engine EGT in degrees C.

If flashing, indicates the abnormal start advisory system has sensed conditions which may lead to an abnormal engine start.

2 **Exhaust Gas Temperature (EGT) Indication (green)**

Displays engine EGT in degrees C.

3 **Warning Light**

Illuminated (red) –

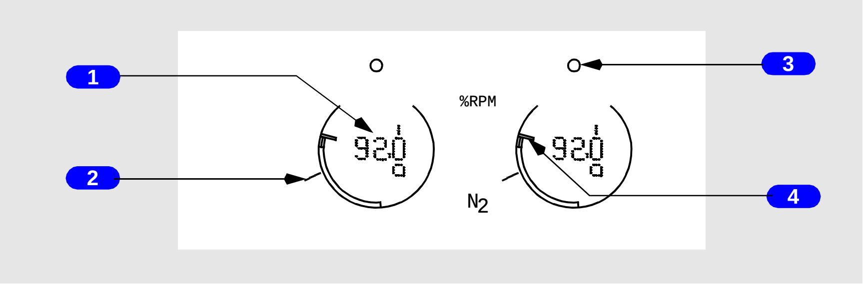
- indicates the EGT limit has been reached or exceeded
- remains illuminated until EGT is reduced below the limit.

4 **Exhaust Gas Temperature (EGT) Red Radial**

Displays maximum takeoff EGT limit.

Note: Failure of an EGT input signal to the primary EIS panel will cause the affected display pointer and digital counter to slew to their lower stops and hold for two seconds. The pointer will then disappear and the counter will display dashes. An internal failure will cause the display(s) to simply blank.

N2 Indications



1 **N2 Readout (digital)**

Displays N2 % RPM.

2 **N2 RPM Indication (green)**

Displays N2 % RPM.

3 **Warning Light**

Illuminated (red) –

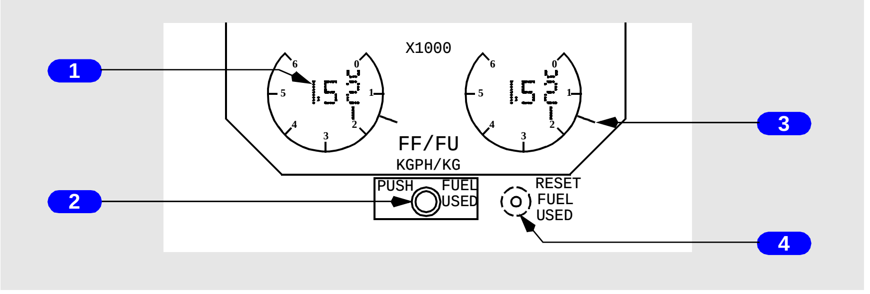
- indicates the N2 limit has been reached or exceeded
- remains illuminated until N2 is reduced below the limit.

4 **N2 Red Radial**

Displays N2 % RPM operating limit.

Note: Failure of an N2 input signal to the primary EIS panel will cause the affected display pointer and digital counter to slew to their lower stops and hold for two seconds. The pointer will then disappear and the counter will display dashes. An internal failure will cause the display(s) to simply blank.

Fuel Flow/Fuel Used Indications



1 **Fuel Flow/Fuel Used (FF/FU) Readout (digital)**

Normally displays the present rate of fuel flow in pounds or kilograms per hour X 1000.

After the fuel used reset switch has been pushed, this readout displays current fuel used for one second, decreases to zero, then displays fuel flow.

After the fuel flow/used switch is pushed, this readout shows fuel used since the last reset. After 10 seconds, display automatically reverts to fuel flow.

2 **Fuel Flow/Used Switch**

Push – digital readout shows fuel used since last reset. After 10 seconds, display automatically reverts to fuel flow.

3 **Fuel Flow Indicator**

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

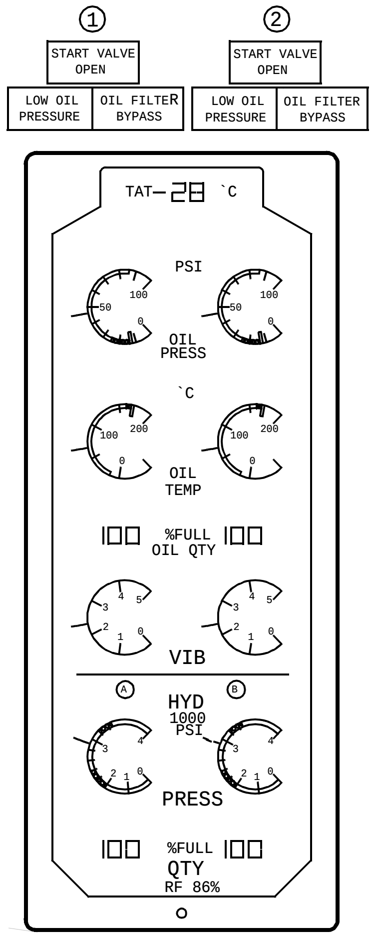
4 FUEL USED RESET Switch (recessed)

Push –

- resets computed fuel used to zero
- digital readout displays current fuel used for one second, decreases to zero, then fuel flow
- resets abnormal start advisory system.

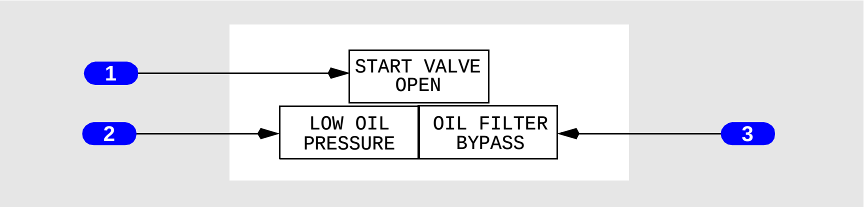
Note: Failure of a fuel flow input signal to the primary EIS panel will cause the affected display pointer and digital counter to slew to their lower stops and hold for two seconds. The pointer will then disappear and the counter will display dashes. An internal failure will cause the display(s) to simply blank.

Engine Instrument System (EIS) Secondary Panel



CENTER INSTRUMENT PANEL

Caution Lights



1 START VALVE OPEN Light

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

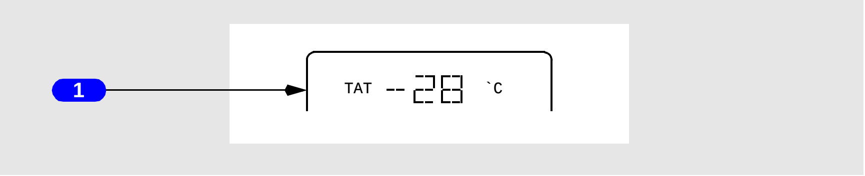
2 LOW OIL PRESSURE Light

Illuminated (amber) – related engine oil pressure is at or below the red radial.

3 OIL FILTER BYPASS Light

Illuminated (amber) – indicates an impending bypass of scavenge oil filter.

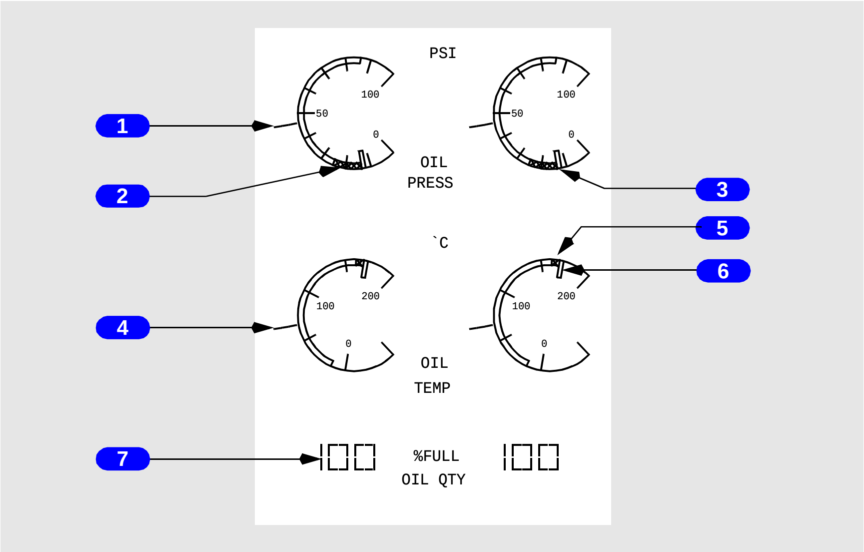
Total Air Temperature Indication



1 Total Air Temperature (TAT) Indicator

Displays total air temperature in degrees C.

Engine Oil Indications



1 Oil Pressure (OIL PRESS) Indication (green)

Displays engine oil pressure in psi.

Note: Oil pressure is unregulated and is primarily a function of engine speed (N2).

2 Low Oil Pressure Yellow Band

With takeoff thrust set, indicates minimum oil pressure limit.

Note: Yellow band is valid only at takeoff thrust.

3 Low Oil Pressure Red Radial

Indicates minimum oil pressure limit.

4 Oil Temperature (OIL TEMP) Indication (green)

Displays engine oil temperature in degrees C.

5 High Oil Temperature Yellow Band

Indicates oil temperature caution range.

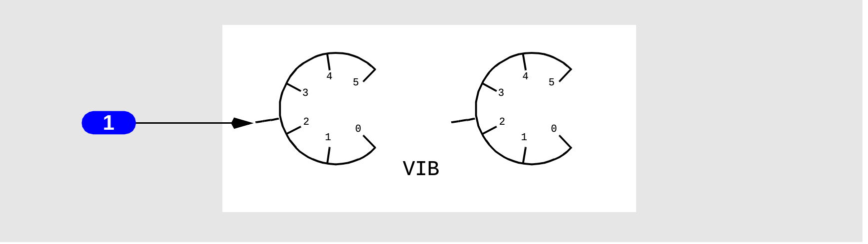
6 High Oil Temperature Red Radial

Indicates maximum oil temperature limit.

7 **Oil Quantity (OIL QTY) Indication**

Displays engine oil quantity in percentage of full quantity.

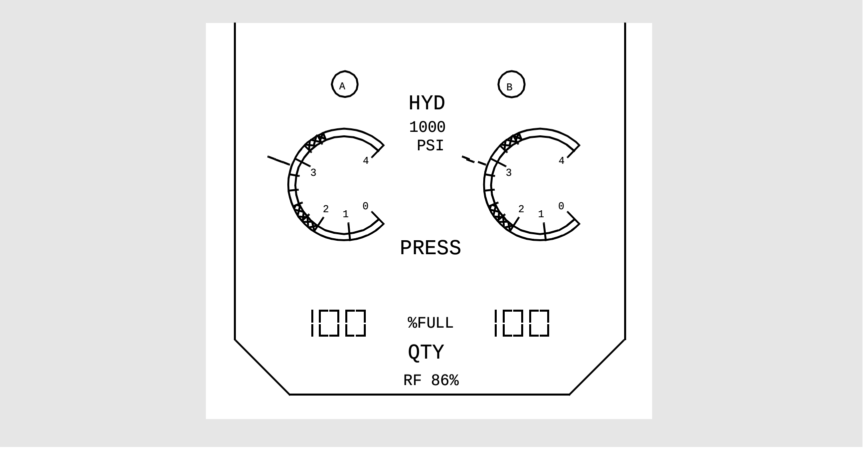
Engine Vibration Indications



1 **Airborne Vibration (VIB) Monitor (green)**

Indicates engine vibration level.

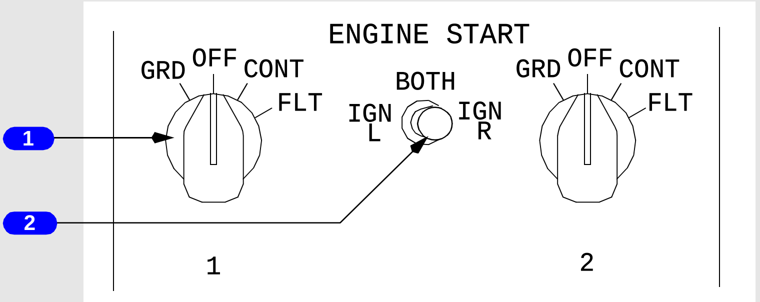
Hydraulic System Pressure and Quantity Indications



Described in Chapter 13 – Hydraulics.

Note: Failure of an input signal to the secondary EIS panel will cause an affected pointer to blank or an affected digital counter to display dashes. An internal failure will cause either type of display to blank.

Engine Start Switches



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.

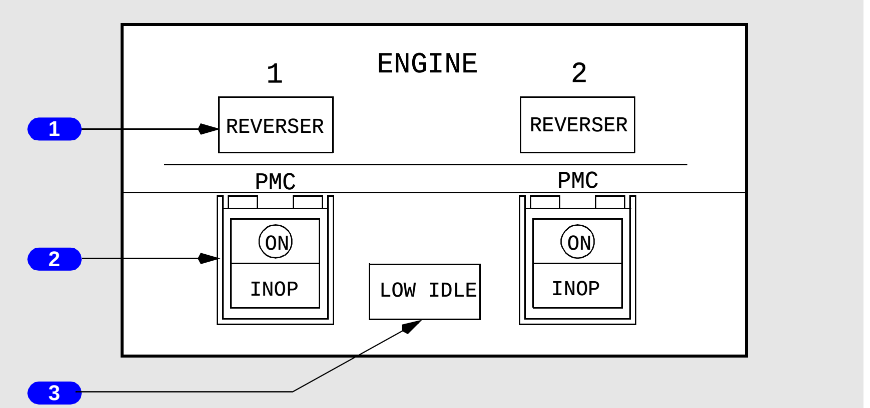
2 Ignition Select Switch

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



AFT OVERHEAD PANEL

1 REVERSER Light

Illuminated (amber) – one or more of following has occurred:

- isolation valve or thrust reverser control valve is not in commanded position
- thrust reverser sleeve position sensors are in disagreement
- auto–restow circuit has been activated

2 Power Management Control (PMC) Switch

ON (ON in view – white) – PMC is selected ON.

INOP (INOP in view – amber) – PMC is inoperative when engine speed is above 46% N2, or the PMC is selected OFF.

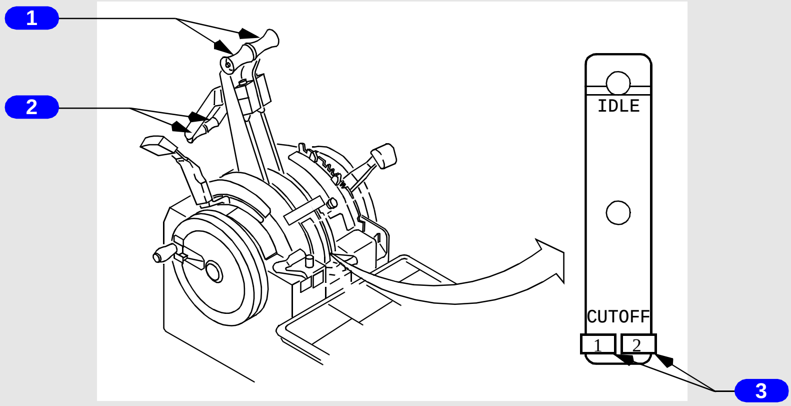
3 LOW IDLE Light

Illuminated (amber) –

- the thrust lever for either engine is near idle and the MEC on either engine is not commanded to maintain high idle RPM in flight
- the speed of either engine is below 25% N1 in flight

If an engine start lever is in CUTOFF, the light is deactivated.

Engine Controls



CONTROL STAND

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

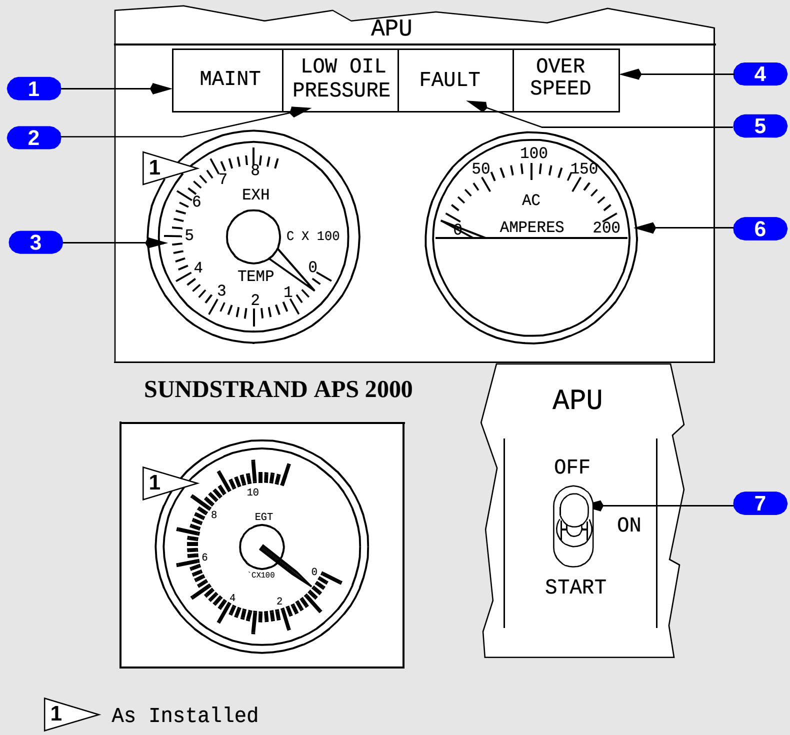
IDLE –

- 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



FORWARD OVERHEAD PANEL

1 APU Maintenance (MAINT) Light

Illuminated (blue) – APU maintenance problem exists:

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

2 APU LOW OIL PRESSURE Light

Illuminated (amber) –

- during start until the APU oil pressure is normal
- oil pressure is low causing an automatic shutdown (after start cycle is complete)
- if light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes.
- light is disarmed when APU switch is OFF.

3 APU Exhaust Gas Temperature (EGT) Indicator

Displays APU EGT

EGT indicator remains powered for 5 minutes after APU shutdown.

4 APU OVERSPEED Light

Illuminated (amber) –

- APU RPM limit has been exceeded resulting in an automatic shutdown
- overspeed shutdown protection feature has failed a self–test during a normal APU start or shutdown
- if light is illuminated when APU switch is placed to OFF, light extinguishes after 5 minutes.
- light is disarmed when APU switch is OFF.

5 APU FAULT Light

Illuminated (amber) –

- a malfunction exists causing APU to initiate an automatic shutdown
- if light is illuminated when APU switch is placed to OFF, light extinguishes within 5 minutes.
- Additional restarts may be attempted.
- light is disarmed when APU switch is OFF.

6 APU Generator AC Ammeter

Displays APU generator load current

7 APU Switch

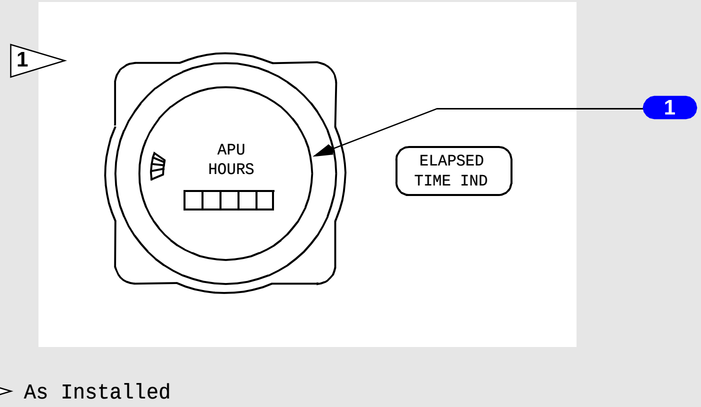
OFF – normal position when APU is not running.

- positioning switch to OFF with APU running initiates APU shutdown, trips APU generator off the bus(es), if connected, and closes APU bleed air valve. On some airplanes, the APU continues to run for a 30 second cooldown period before it automatically shuts down. An immediate shutdown can be accomplished by pulling the APU fire switch or the APU fire control handle in the main wheel well.

ON – normal position when APU is running.

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

APU Hours Indicator



AFT OVERHEAD PANEL

1 APU Hours Indicator

Indicates elapsed hours of APU operation since last reset.

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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 gearboxes. 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. The reverse thrust levers control thrust from reverse idle to maximum reverse.

Certain engine malfunctions can result in airframe vibrations from the windmilling engine. As the airplane transitions from cruise to landing, there can be multiple, narrow regions of altitudes and airspeeds where the vibration level can become severe. In general, airframe vibrations can best be reduced by descending and reducing airspeed. However, if after descending and reducing airspeed, the existing vibration level is unacceptable, and if it is impractical to further reduce airspeed, the vibration level may be reduced to a previous, lower level by a slight increase in airspeed.

Engine Indications

Engine indications are displayed on the center instrument panel by the Engine Instrument System (EIS). N1, EGT, N2, and FF/FU are the primary indications and are displayed as both digital readouts and round dial/moving pointer indications. N1, EGT, and N2 have operating and caution ranges and limits indicated by green and yellow bands and red radials. When the round red warning light above the indicator is illuminated it indicates the limit for the engine parameter displayed below it has been reached or exceeded. The red warning light remains illuminated until the engine parameter is reduced below the limit.

Oil pressure and oil temperature indications are displayed with a round dial/moving pointer. Operating and caution ranges and limits are displayed with green and yellow bands and red radials. The oil quantity indicator displays a digital readout of quantity as a percentage of full.

The airborne vibration monitor indications are displayed with a round dial/moving pointer.

N1, N2, oil quantity, and engine vibration are displayed directly from the engine sensors.

Power Management Control (PMC)

The thrust control system consists of a hydromechanical MEC unit and a PMC unit mounted on each engine. The PMC is an electronic system with limited authority over the MEC.

The PMC uses MEC power lever angle, N1 speed, and inlet temperature and pressure to adjust, or trim, the MEC to obtain the desired N1 speed. The PMC adjusts fuel flow as a function of thrust lever angle.

The PMC provides a constant thrust climb feature once the thrust lever is set as the beginning of climb. Thus, when thrust is set for the climb, the PMC automatically maintains that thrust throughout the climb profile with no further thrust lever adjustments. If the thrust lever is repositioned, the PMC maintains the setting corresponding to the new thrust lever angle.

The PMC includes failure detection and annunciation modules which detect PMC failures and provide a signal to the crew. For detectable failure conditions, the PMC schedules a slow N1 drift over approximately 30 seconds and then illuminates the PMC INOP light, the ENG system annunciator, and the MASTER CAUTION lights. For a PMC failure, the PMC can be selected OFF by a switch on the aft overhead panel. The engine speed is then controlled by the hydromechanical MEC only. The PMC INOP Light is suppressed below starter cutout engine speed.

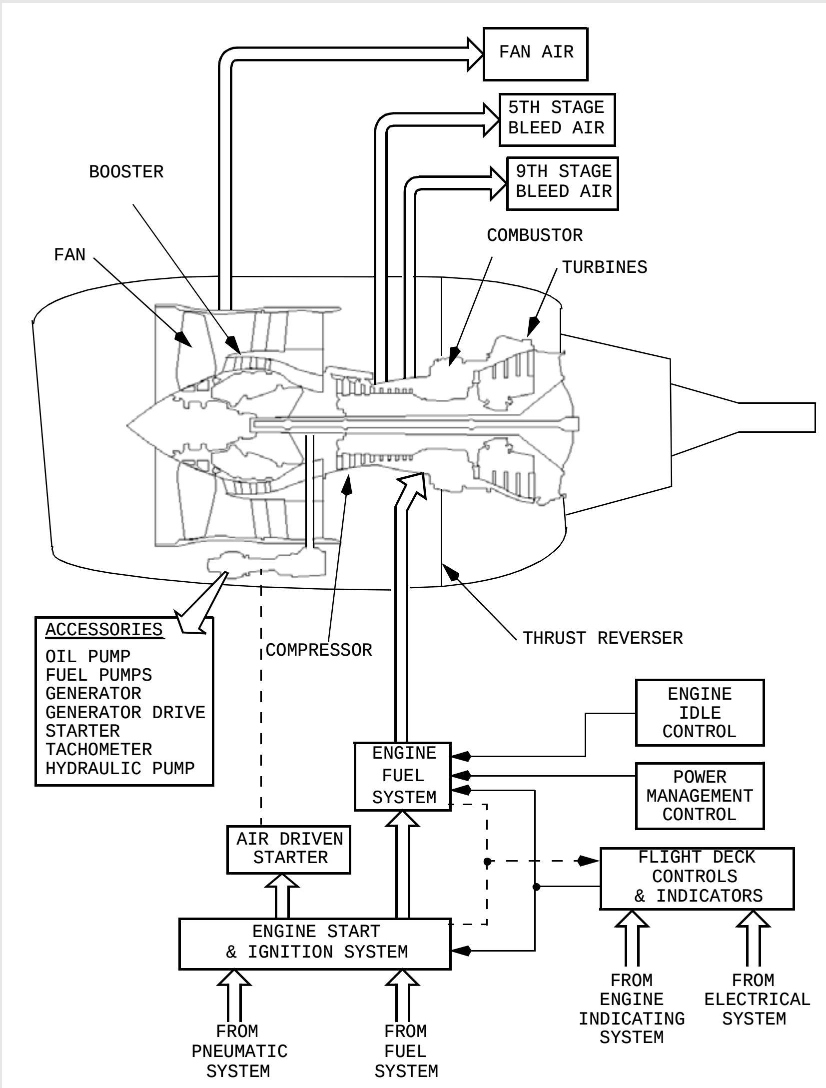
Idle RPM

There are two engine idle speeds, low idle and high idle.

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

To reduce braking activity, engine idle speed is reduced to low idle, approximately 22% N1, four seconds after touchdown. The four second delay is provided to enhance engine speed acceleration for reverse thrust.

Power Plant Schematic



Engine Fuel System

Fuel is delivered under pressure from fuel pumps located in the fuel tanks. The fuel enters the engine through the fuel shutoff valve. The fuel passes through the first stage engine fuel pump where pressure is increased. It then passes through two fuel/oil heat exchangers where engine oil heats the fuel. A fuel filter then removes contaminants. Fuel automatically bypasses the filter if the filter becomes saturated. Before the fuel bypass occurs, the fuel FILTER BYPASS alert illuminates on the fuel control panel. The second stage engine fuel pump provides high pressure fuel to the main engine control (MEC). As the fuel leaves the second stage pump, a portion of the fuel is diverted to run the hydromechanical portion of the MEC. This fuel is filtered again and then routed through the fuel heater a second time. The MEC meters the correct amount of fuel to the combustor.

The engine fuel shutoff valve and MEC fuel shutoff valve allow fuel flow to the engine when both valves are open. The valves are open when the engine fire warning switch is in and the start lever is in IDLE. The engine fuel shutoff valve closes when either the start lever is in CUTOFF or the engine fire warning switch is out. The MEC fuel shutoff valve closes only when the start lever is in CUTOFF. The FUEL VALVE CLOSED light on the fuel control panel indicates engine fuel shutoff valve position.

Fuel flow is measured after the MEC fuel shutoff valve and is displayed on the center instrument panel. Fuel flow information is also provided to the FMS.

Engine Oil System

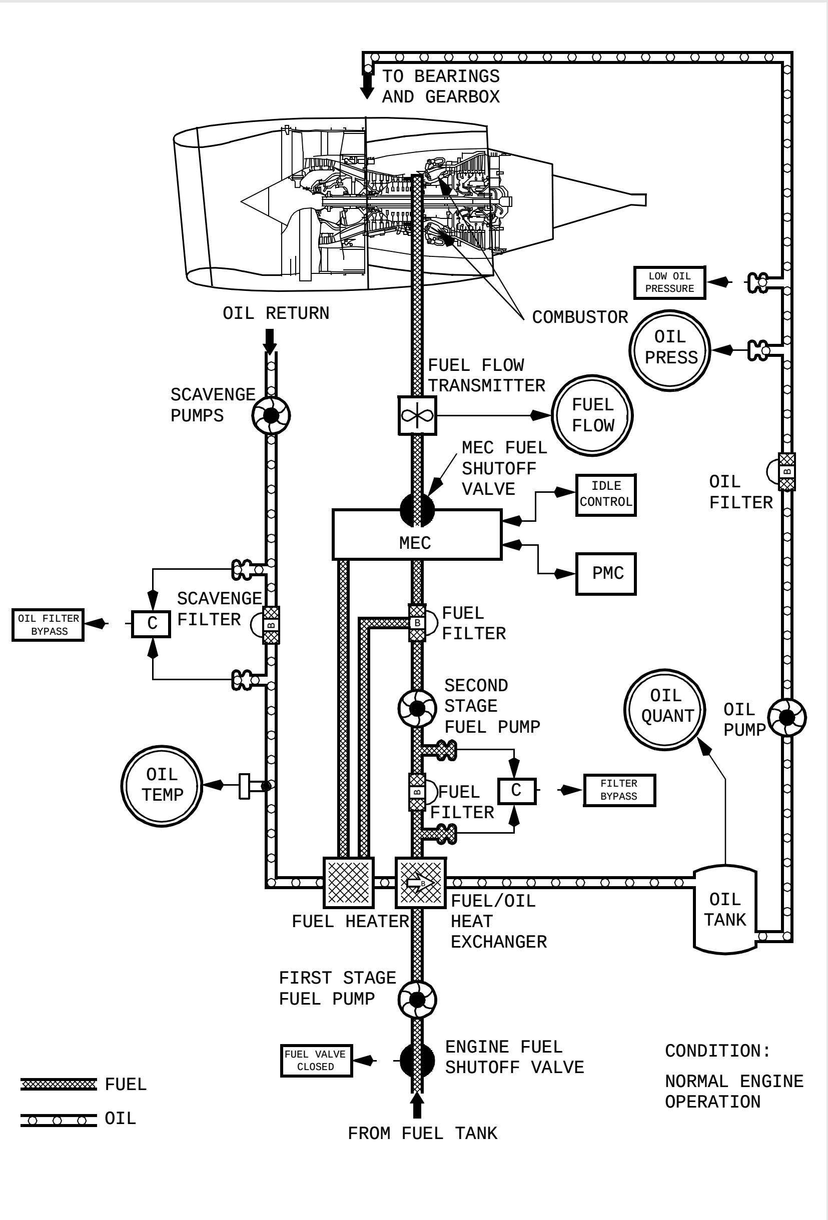
Oil from the individual engine tank is circulated under pressure through the engine to lubricate the engine bearings and accessory gearbox. Oil quantity is displayed on the oil quantity indicator, located on the center instrument panel.

The oil system is pressurized by the engine driven oil pump. Oil from the pump is filtered and then passes to the engine bearings and gearbox. Sensors for the oil pressure indicator and LOW OIL PRESSURE light are located downstream of the oil filter prior to engine lubrication.

Oil is returned to the oil tank by engine driven 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.

Abnormal Start Advisory System

The abnormal start advisory system monitors N2, fuel flow, EGT, and outside air temperature during ground engine starts to detect conditions which may lead to an abnormal engine start. The crew is alerted to such a situation by the flashing EGT digital display.

During an engine start, the alert indication will occur if:

- the EGT exceeds a calculated EGT limit based on inputs of N2 and outside air temperature
- the EGT reaches 725°C
- the engine fails to accelerate properly after N2 reaches 32%.

If a normal start occurs, the alert indication can be reset by pressing the fuel used reset switch on the EIS panel. The alert indication is automatically reset when zero fuel flow is sensed

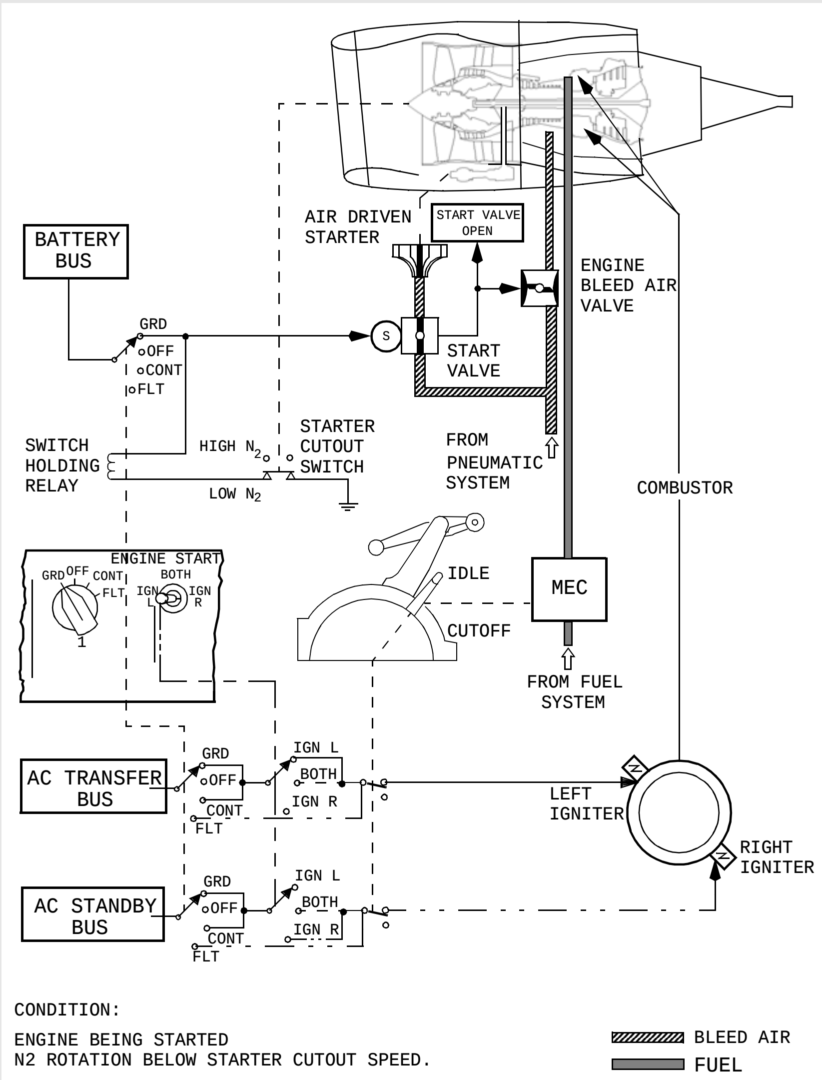
Engine Ignition System

Each engine has two igniters. The ignition select switch selects either the left, right, or both igniters for both engines. The ignition select switch is bypassed when the engine start switch is in FLT.

IGN L, powered by the AC transfer bus, provides high energy ignition to the left igniter. IGN R, powered by the AC standby bus, provides high energy ignition to the right igniter.

With the engine start switch in the GRD position, the selected igniter(s) are energized when the engine start lever is positioned to IDLE. The CONT position energizes the selected igniter(s) continuously. The FLT position energizes both igniters when the engine start lever is positioned to IDLE.

Engine Start and Ignition System Schematic



Thrust Reverser

Each engine is equipped with a hydraulically operated thrust reverser, consisting of left and right translating sleeves. Aft movement of the reverser sleeves causes blocker doors to deflect fan discharge air forward, through fixed cascade vanes, producing reverse thrust. The thrust reverser is for ground operations only and is used after touchdown to slow the airplane, reducing stopping distance and brake wear.

Hydraulic pressure for the operation of engine No. 1 and engine No. 2 thrust reversers comes from hydraulic systems A and B, respectively. If hydraulic system A or B fails, alternate operation for the affected thrust reverser is available through the standby hydraulic system. When the standby system is used, the affected thrust reverser deploys and retracts at a slower rate, and some thrust asymmetry can be anticipated.

The thrust reverser can be deployed when either radio altimeter senses less than 10 feet altitude, or when the air/ground safety sensor is in the ground mode. Movement of the reverse thrust levers is mechanically restricted until the forward thrust levers are in the idle position.

When reverse thrust is selected, the isolation valve opens, and the thrust reverser control valve moves to the deploy position, allowing hydraulic pressure to unlock and deploy the reverser system. An interlock mechanism restricts movement of the reverse thrust lever until the reverser sleeves have approached the deployed position. When either reverser sleeve moves from the stowed position, the amber REVERSER UNLOCKED light on the center instrument panel illuminates. As the thrust reverser reaches the deployed position, the reverse thrust lever can be raised to detent No. 2. This position provides adequate reverse thrust for normal operations. When necessary, the reverse thrust lever can be pulled beyond detent No. 2, providing maximum reverse thrust.

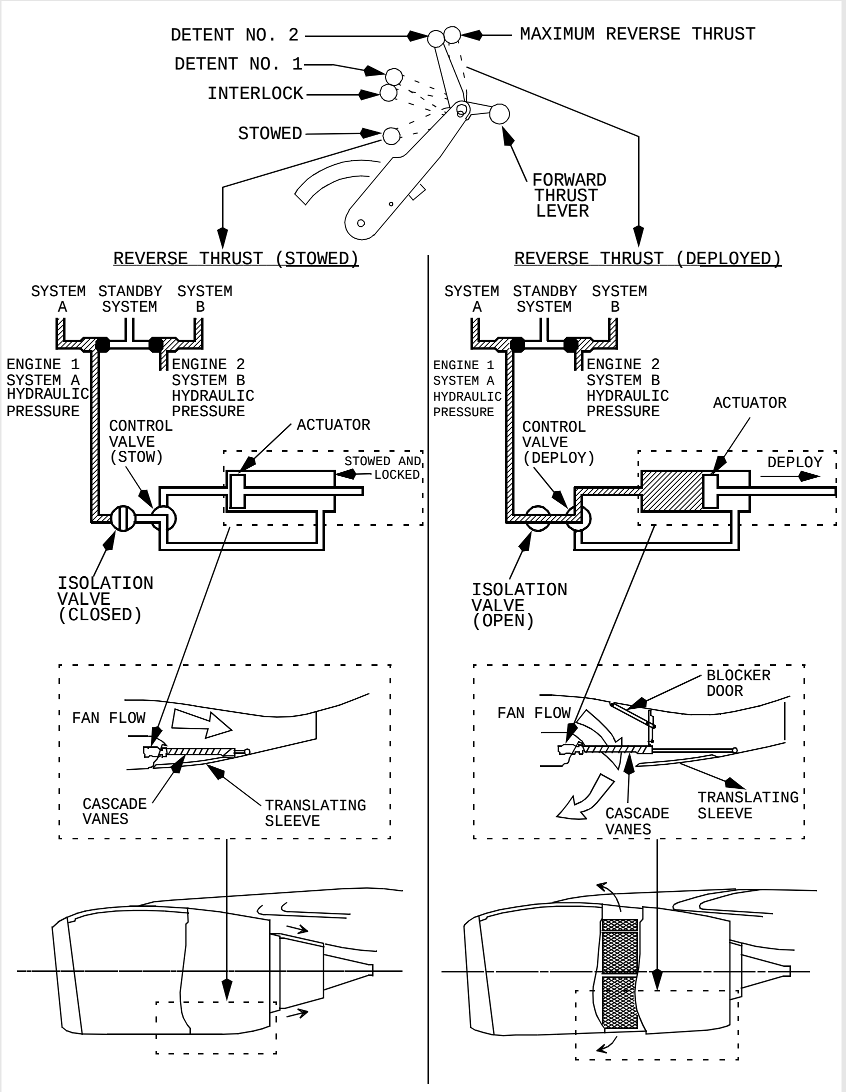
Downward motion of the reverse thrust lever past detent No. 1 commands the reverser to stow. Once the thrust reverser is commanded to stow, the control valve moves to the stow position allowing hydraulic pressure to stow and lock the reverser sleeves. After the thrust reverser is stowed, the isolation valve closes.

The REVERSER light, located on the aft overhead panel, illuminates when the thrust reverser is commanded to stow and extinguishes 10 seconds later when the isolation valve closes. Any time the REVERSER light illuminates for more than approximately 12 seconds, a malfunction has occurred, and the MASTER CAUTION and ENG system annunciator lights illuminate.

When the reverser sleeves are in the stowed position, a hydraulically operated locking actuator inhibits motion to each reverser sleeve until reverser extension is selected. Additionally, an auto–restow circuit compares the actual reverser sleeve position and the commanded reverser position. In the event of incomplete stowage or uncommanded movement of the reverser sleeves toward the deployed position, the auto–restow circuit opens the isolation valve and commands the control valve to the stow position, directing hydraulic pressure to stow the reverser sleeves. Once the auto–restow circuit is activated, the isolation valve remains open and the control valve is held in the stowed position until the thrust reverser is commanded to deploy or until corrective maintenance action is taken.

WARNING: Actuation of the thrust reversers on the ground without suitable precautions is dangerous to ground personnel.

Thrust Reverser Schematic

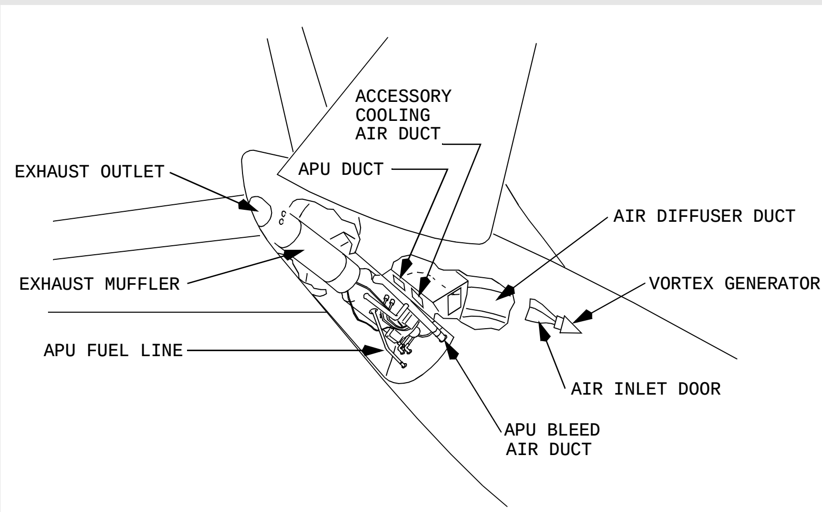


Introduction

The auxiliary power unit (APU) is a self–contained gas turbine engine installed within a fireproof compartment located in the tail of the airplane.

The APU supplies bleed air for engine starting or air conditioning. An AC electrical generator on the APU provides an auxiliary AC power source.

APU Location



APU Operation

The APU operates up to the airplane maximum certified altitude.

The APU supplies bleed air for one air conditioning pack either on the ground or in flight. Both generator busses can be powered on the ground. In flight only one generator bus can be powered.

APU Fuel Supply

Fuel to start and operate the APU comes from the left side of the fuel manifold when the AC fuel pumps are operating. If the AC fuel pumps are not operating, fuel is suction fed from the No. 1 tank. During APU operation, fuel is automatically heated to prevent icing.

With the APU operating and AC electrical power on the airplane busses, operate at least one fuel boost pump to supply fuel under pressure to the APU.

APU Engine and Cooling Air

APU engine and cooling air is routed to the APU through an automatically operated air inlet door located on the right side of the fuselage. APU exhaust gases are discharged overboard through an exhaust muffler.

The APU oil cooler and electrical generator are provided positive cooling airflow by a gear-driven fan.

Electrical Requirements for APU Operation

APU operation requires the following:

- APU fire switch on the overheat/fire panel must be IN
- APU fire control handle on the APU ground control panel must be IN
- Battery switch must be ON.

Electrical power to start the APU comes from the airplane battery.

Moving the battery switch to OFF on the ground shuts down the APU.

APU Start

The automatic start sequence begins by moving the APU switch momentarily to START. This initiates opening of the air inlet door. When the APU inlet door reaches the full open position the start sequence begins. After the APU reaches the proper speed, ignition and fuel are provided. When the APU is ready to accept a bleed air or electrical load the APU GEN OFF BUS light illuminates.

If the APU does not reach the proper speed with the proper acceleration rate within the time limit of the starter, the start cycle automatically terminates. The start cycle may take as long as 135 seconds.

Operate the APU for one full minute before using it as a bleed air source. This one minute stabilization is recommended to extend the service life of the APU.

APU Shutdown

Moving the APU switch to OFF shuts down the APU, trips the APU generator, and closes the APU bleed air valve. On some airplanes, the APU continues to run for a 30 second cooling period before it automatically shuts down. Shutdown can also be accomplished by pulling the APU fire switch.

Fuel Control Unit (FCU)

A Fuel Control Unit (FCU) controls APU engine speed and exhaust gas temperature. Automatic shutdown protection is provided for overspeed conditions, low oil pressure, high oil temperature, APU fire, and fuel control unit failure. Control air input is provided to the fuel control unit through a solenoid operated three-way control valve.

The control air pressure is modulated in response to EGT changes. When electrical load and bleed air extraction combine to raise the EGT above acceptable levels, the bleed air valve will modulate toward the closed position. In the event of an overtemperature, the APU will shut down, and the FAULT light will illuminate.

APU Automatic Galley Load Shedding

Galley electrical loads will automatically be shed should the total airplane electrical power requirements exceed design limits with the APU generator providing electrical power.

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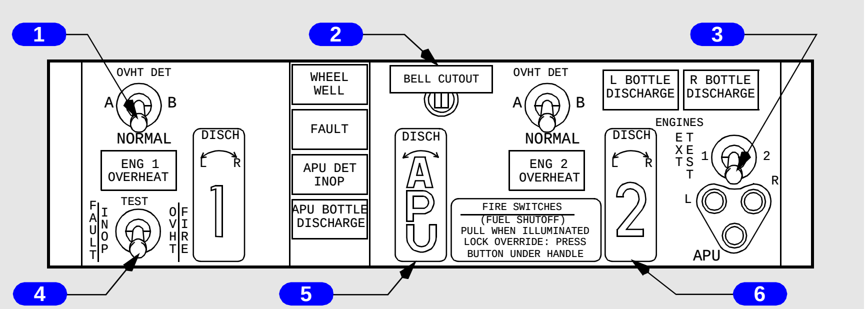
Fire Protection — Chapter 8
Table of Contents — Section 0

Overheat/Fire Protection Panel Switches



AFT ELECTRONIC PANEL

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 Warning Switch

Illuminated (red) –

- indicates fire in APU
- unlocks APU fire warning 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 warning switch to rotate.

Rotate (left or right) –

- discharges APU fire bottle.

6 Engine Fire Warning Switch

Illuminated (red) –

- indicates fire in related engine
- unlocks related engine fire warning switch.

Note: Master FIRE WARN lights illuminate and fire warning bell sounds.

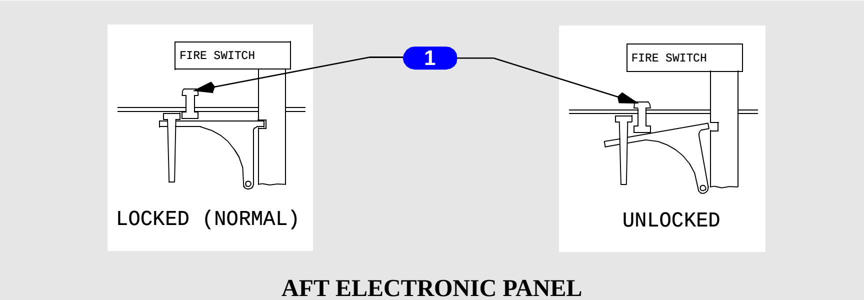
In – normal position, mechanically locked if no fire signal.

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 warning switch to rotate.

Rotate (left or right) – discharges related fire bottle.

Fire Warning Switch Override

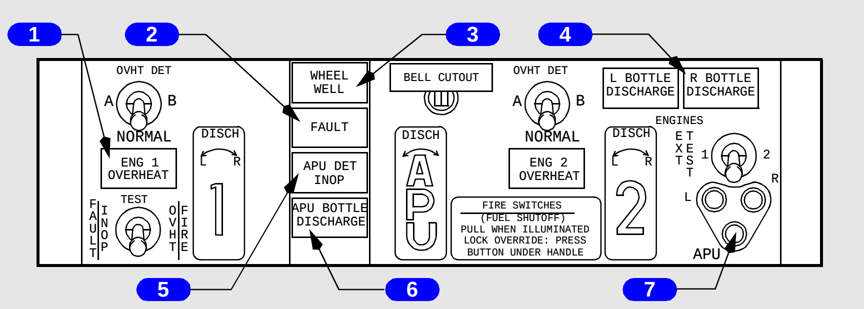


AFT ELECTRONIC PANEL

1 Fire Warning Switch Override

Push – unlocks fire warning switch.

Overheat/Fire Protection Panel Lights



AFT ELECTRONIC PANEL

1 Engine (ENG) OVERHEAT Light

Illuminated (amber) – indicates overheat 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 selected loop for an engine has failed.

Note: MASTER CAUTION and OVHT/DET system annunciator 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 annunciator lights illuminate.

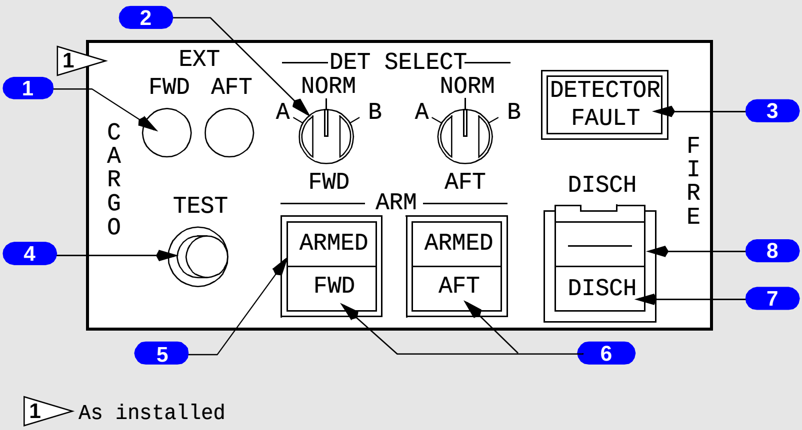
6 APU BOTTLE DISCHARGE Light

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



AFT ELECTRONIC 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 selected 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.

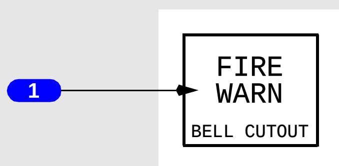
7 **Cargo Fire Bottle Discharge (DISCH) Light**

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



LIGHT SHIELD

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)

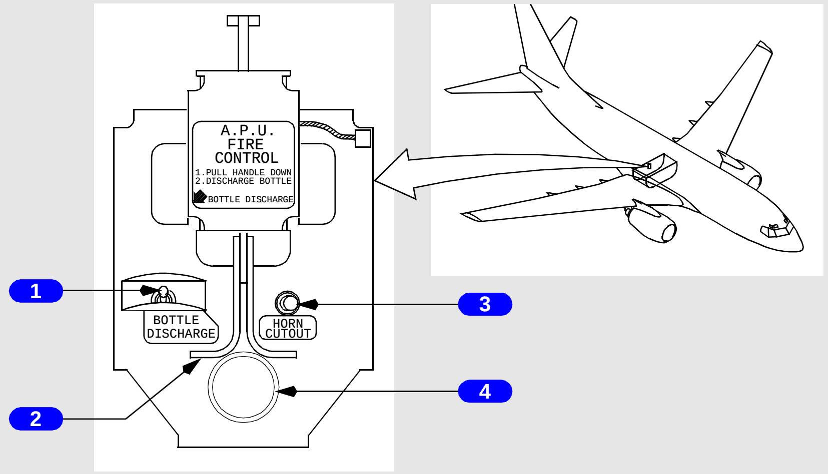
- fire warning bell sounds
- if on ground, remote APU fire warning horn sounds.

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



MAIN WHEEL WELL

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

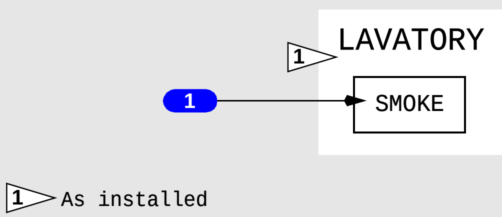
Illuminated (red flashing) – indicates fire in APU.

Note: Also, flight deck fire warning bell sounds and APU fire warning horn in main wheel wails.

Illuminated (red steady) – indicates APU fire warning HORN CUTOUT switch has been pushed following an APU fire indication.

Lavatory Fire

Lavatory Smoke Detection



FORWARD OVERHEAD PANEL

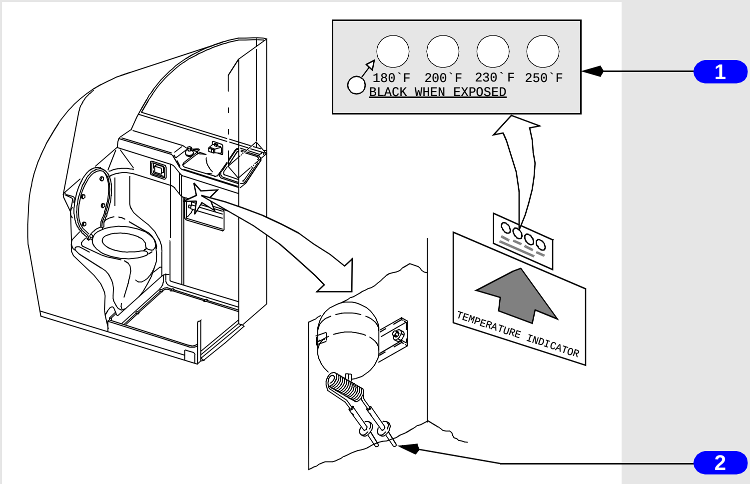
1 LAVATORY SMOKE Light

Illuminated (amber) –

- smoke has been detected in a lavatory or
- a test is being conducted.

Note: MASTER CAUTION and OVERHEAD system annunciator lights illuminate.

Lavatory Fire Extinguisher



BELOW LAVATORY SINK

1 TEMPERATURE INDICATOR Placard

White – normal condition.

Black – exposed to high temperatures.

2 Heat Activated Nozzles

Flat black – normal condition.

Aluminum – indicates extinguisher has discharged.

On early airplanes one nozzle discharges toward the towel disposal container, the other under the sink. On later airplanes (illustrated) both nozzles discharge toward the towel disposal container.

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Fire Protection — Chapter 8
System Description — Section 20

Introduction

There are fire detection and extinguishing systems for:

- engines
- APU
- lavatories
- 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 warning 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 warning 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 warning switches, two BOTTLE DISCHARGE lights, and an EXT TEST switch. Either or both bottles can be discharged into either engine.

The engine fire warning switches are normally locked down to prevent inadvertent shutdown of an engine. Illumination of an engine fire warning switch or ENG OVERHEAT light unlocks the engine fire warning switch. The switches may also be unlocked manually.

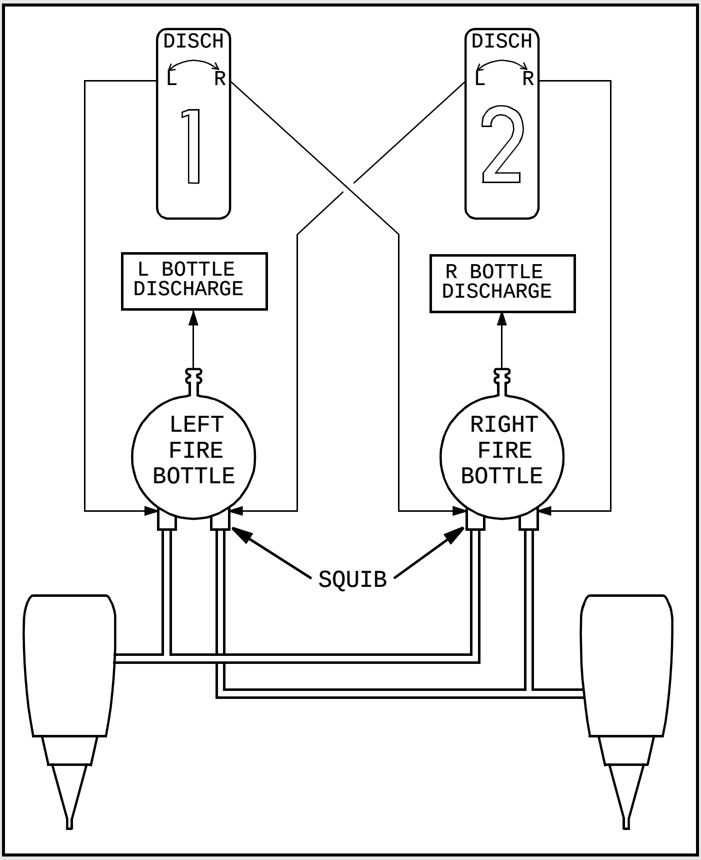
Pulling the engine fire warning switch up:

- 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 warning switch to be rotated for discharge
- arms one discharge squib on each engine fire extinguisher bottle.

Rotating the engine fire warning 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 warning 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 warning 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 warning 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 warning 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 warning switch is normally locked down to prevent inadvertent shutdown of the APU. Illumination of the APU fire warning switch unlocks the switch. The switch may also be unlocked manually.

Pulling the APU fire warning 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 warning switch to be rotated for discharge
- arms the APU fire extinguisher bottle squib.

Rotating the APU fire warning switch in either direction electrically “fires” the squib discharging the extinguishing agent into the APU. The APU BOTTLE DISCHARGE light illuminates after a few seconds, indicating the bottle has discharged.

Main Wheel Well Fire Protection

Main wheel well fire protection consists of fire detection powered by the No. 1 AC transfer bus.

Note: The main wheel well has no fire extinguishing system. The nose wheel well does not have a fire detection system.

Main Wheel Well Fire Detection

A single fire detector loop is installed in the main wheel well. As the temperature of the detector increases to a predetermined limit, the detector senses a fire condition. The WHEELWELL fire warning light remains illuminated until the temperature of the detector has decreased below the onset temperature.

The indications for a main wheel well fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the WHEEL WELL fire warning light illuminates.

Cargo Compartment Fire Protection (as installed)

Cargo fire protection consists of these systems:

- cargo compartment smoke detection powered by DC bus 1 and DC bus 2
- cargo compartment fire extinguishing powered by the hot battery bus.

Cargo Compartment Smoke Detection

The forward and aft cargo compartments each have smoke detectors in a dual loop configuration. Normally, both detection loops must sense smoke to cause an alert. These loops function in the same manner as the engine overheat/fire detection loops.

Cargo Compartment Fire Warning

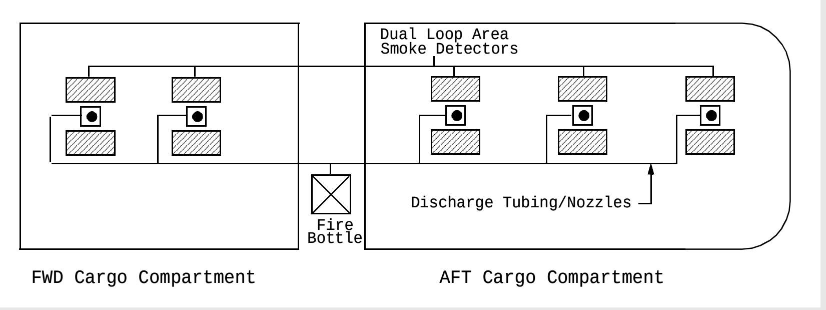
The indications of a cargo compartment fire are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- the FWD/AFT cargo fire warning light(s) illuminates.

Cargo Compartment Fire Extinguishing

A single fire extinguisher bottle is installed in the air conditioning mix bay on the forward wing spar. Detection of a fire in either the forward or aft compartment will cause the FWD or AFT cargo fire warning light to illuminate. The extinguisher is armed by pushing the appropriate cargo fire ARMED switch. Once armed, the system is discharged by pushing the cargo fire DISCH switch. This results in the total discharge of the bottle contents into the selected compartment. The cargo fire DISCH light illuminates once the bottle is discharged. It may take up to 30 seconds for the light to illuminate.

Cargo Fire Extinguisher Schematic



Lavatory Fire Protection

Lavatory fire protection consists of these systems:

- lavatory smoke detection
- lavatory fire extinguishing (heat activated).

Lavatory Smoke Detection

The lavatory smoke detection system monitors for the presence of smoke. When smoke is detected:

- an aural warning sounds over the passenger address system
- the red alarm indicator light on the lavatory smoke detector panel illuminates
- pressing the interrupt switch silences the aural warning. If smoke is still present when the switch is released, the alarm will sound again
- on some airplanes flight deck LAVATORY SMOKE, OVERHEAD system annunciator, and MASTER CAUTION lights illuminate

When smoke is no longer present the system automatically resets.

Lavatory Fire Extinguisher System

A fire extinguisher system is located beneath the sink area in each lavatory. When a fire is detected:

- fire extinguisher operation is automatic
- flight deck has no indication of extinguisher discharge.

Fire and Overheat System Tests

The fire and overheat detection systems can be tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch. Extinguisher continuity can be tested by pushing and holding the EXT TEST switch. All test indications clear when switches are released.

FAULT/INOP Test Detection

The fault detection circuits for both the engines and the APU are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the FAULT/INOP position.

The indications for the FAULT/INOP test are:

- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- the FAULT light illuminates
- the APU DET INOP light illuminates.

OVERHEAT/FIRE Test Detection

The overheat and fire detection loops on both engines, the APU, and the fire detector in the wheel well are tested by pushing and holding the FAULT/INOP and OVHT/FIRE TEST switch in the OVHT/FIRE position.

The indications for the OVHT/FIRE test are:

- the fire warning bell sounds
- both master FIRE WARN lights illuminate
- both MASTER CAUTION lights illuminate
- the OVHT/DET system annunciator light illuminates
- both engine fire warning switches illuminate
- the APU fire warning 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 warning 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.

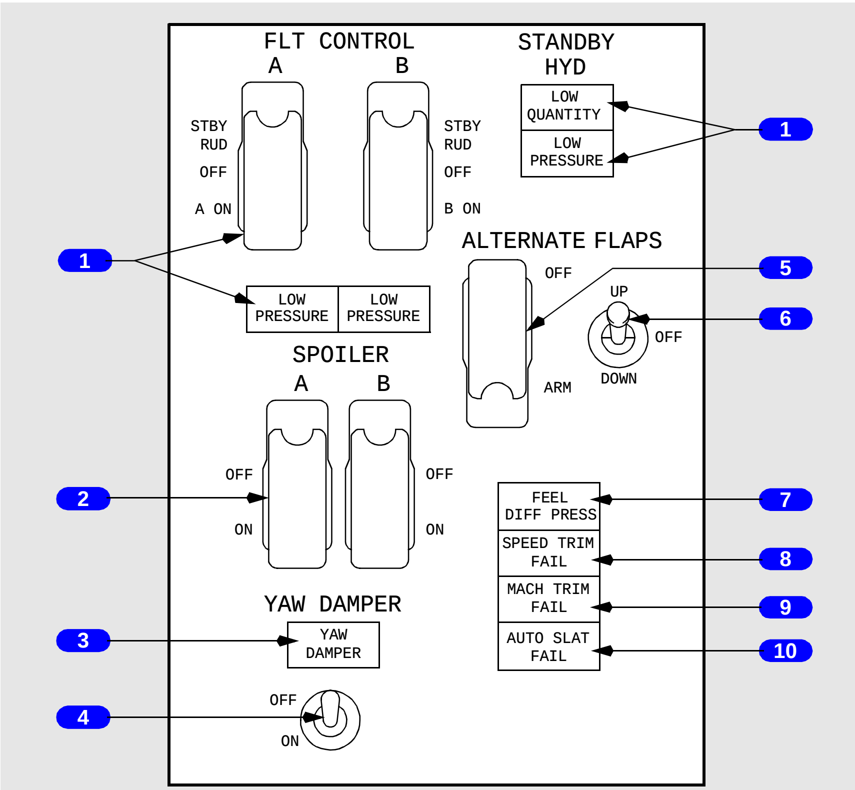
Note: At the end of cargo fire testing, a four second delay allows all applicable indications to extinguish at the same time.

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.

Flight Controls — Chapter 9
Table of Contents — Section 0

Flight Control Panel



FORWARD OVERHEAD PANEL

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) –

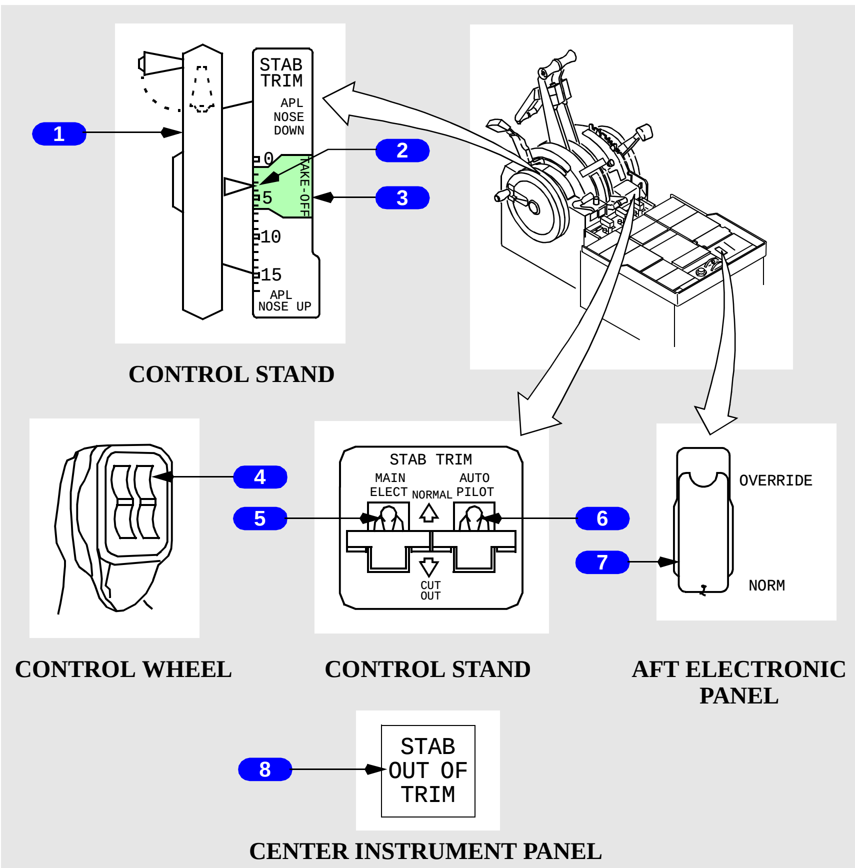
- indicates failure of the mach trim system
- indicates failure of a single FCC channel when MASTER CAUTION light recall is activated and light extinguishes when master caution system is reset.

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.

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.

CUTOUT – deactivates stabilizer trim switch operation.

6 Stabilizer Trim AUTOPILOT Cutout Switch

NORMAL – normal operating position.

CUTOUT –

- deactivates autopilot stabilizer trim operation
- autopilot disengages if engaged.

7 Stabilizer Trim Override Switch

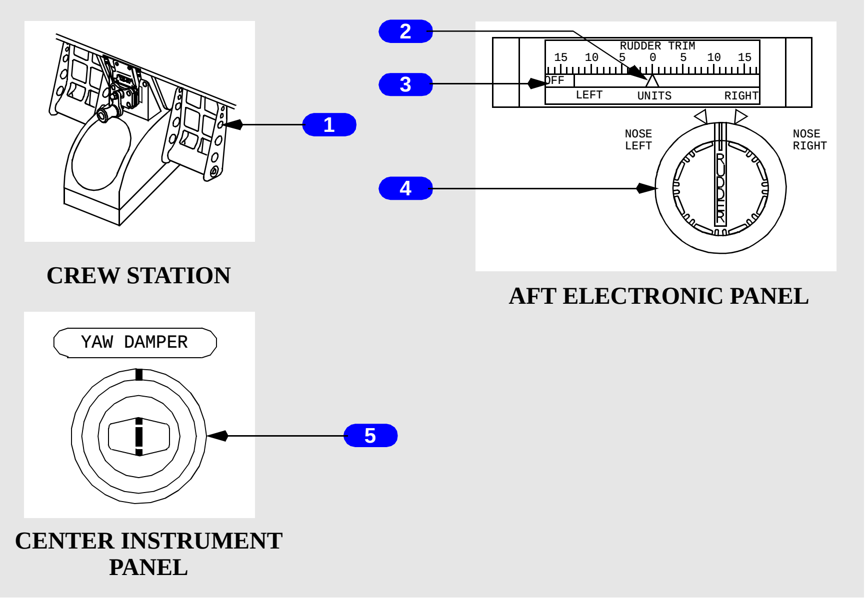
OVERRIDE – bypasses the control column actuated stabilizer trim cutout switches to restore power to the stabilizer trim switches

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.

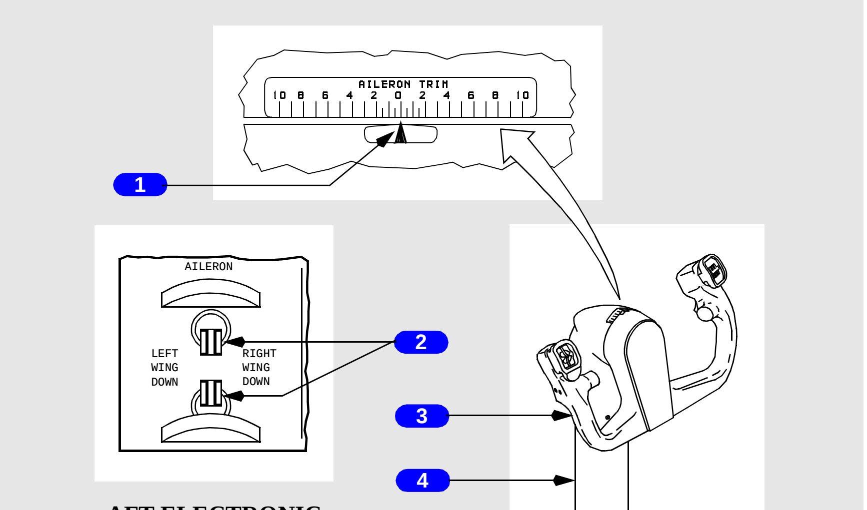
4 Rudder Trim Control (spring–loaded to neutral)

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



AFT ELECTRONIC PANEL

CREW STATION

1 **AILERON TRIM Indicator**

Includes units of aileron trim.

2 **AILERON TRIM (spring–loaded to the neutral position)**

Movement of both switches repositions the aileron neutral control position.

3 **Control Wheel**

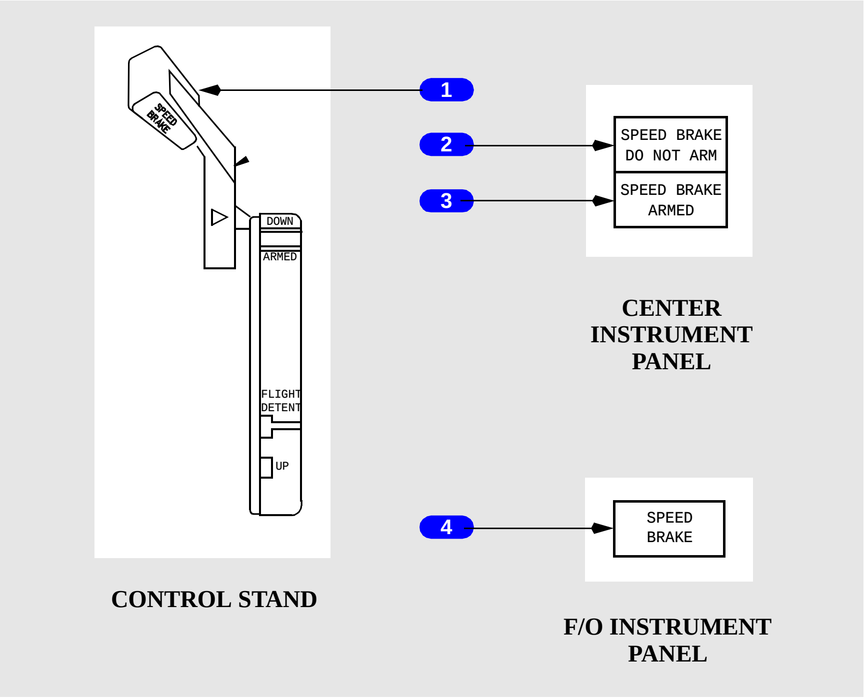
Rotate – operates ailerons and flight spoilers in desired direction.

4 **Control Column**

Push/Pull –

- operates elevators in the desired direction
- movement opposing stabilizer trim stops electric trimming.

Speed Brakes



1 SPEED BRAKE Lever

DOWN (detent) – all flight and ground spoiler panels in faired position.

ARMED –

- automatic speed brake system armed
- upon touchdown, the SPEED BRAKE lever moves to the UP position, and all flight and ground spoilers extend.

FLIGHT DETENT – all flight spoilers are extended to their maximum position for inflight use.

UP – all flight and ground spoilers are extended to their maximum position for ground use.

2 SPEED BRAKE DO NOT ARM Light

Light deactivated when SPEED BRAKE lever is in the DOWN position.

Illuminated (amber) – indicates abnormal condition or test inputs to the automatic speed brake system.

3 SPEED BRAKE ARMED Light

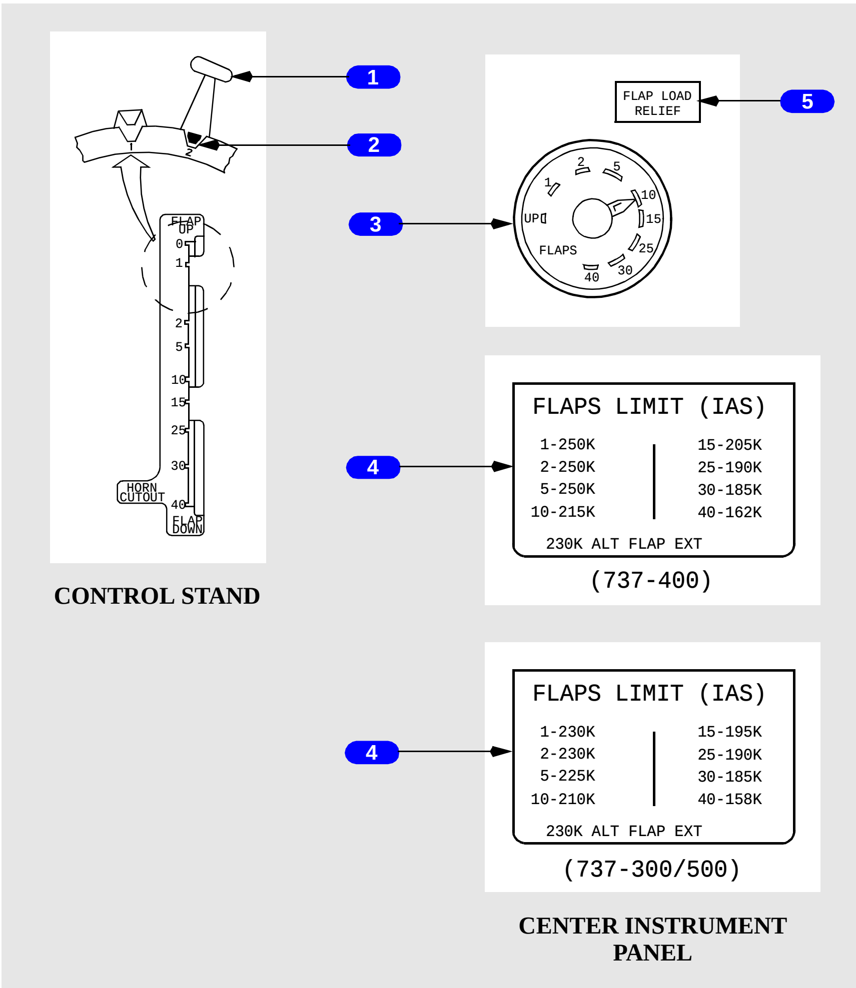
Light deactivated when SPEED BRAKE lever is in the DOWN position.

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

4 SPEED BRAKE Caution Light

Flashing (amber) – indicates air/ground sensor in air position, SPEED BRAKE lever aft of ARMED position and flaps extended beyond position 10.

Trailing Edge Flaps



1 Flap Lever

- selects position of flap control valve, directing hydraulic pressure for flap drive unit
- position of the leading edge devices is determined by selecting trailing edge flap position
- flap position 40 arms the flap load relief system.

2 Flap Gates

Prevents inadvertent flap lever movement beyond:

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

3 Flap Position Indicator

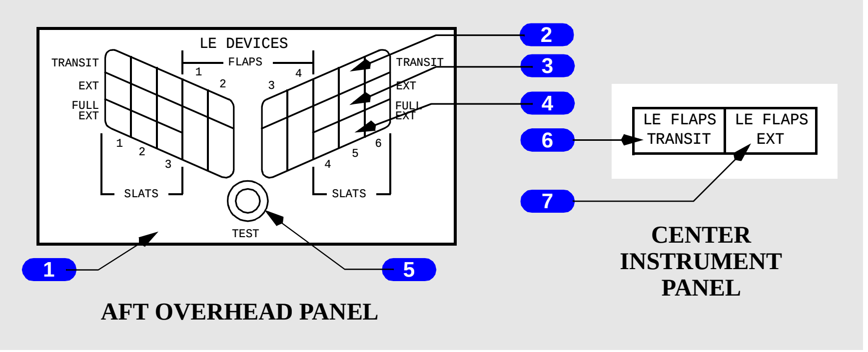
- indicates position of left and right trailing edge flaps
- provides trailing edge flaps asymmetry protection.

4 FLAPS LIMIT Placard

5 FLAP LOAD RELIEF Light

Illuminated (amber) – indicates flaps have retracted from 40 to 30 due to excess airspeed.

Leading Edge Devices



1 Leading Edge Devices (LE DEVICES) Annunciator Panel

Indicates position of individual leading edge flaps and slats.

Extinguished – related leading edge device retracted.

2 Leading Edge Devices TRANSIT Lights

Illuminated (amber) – related leading edge device in transit.

3 Leading Edge Devices Extended (EXT) Lights

Illuminated (green) – related leading edge slat in extended (intermediate) position.

4 Leading Edge Devices FULL Extended (EXT) Lights

Illuminated (green) – related leading edge device in full extended position.

5 Leading Edge Annunciator Panel TEST Switch

Press – tests all annunciator panel lights.

6 Leading Edge Transit (LE FLAPS TRANSIT) Light

Illuminated (amber) – any leading edge device in transit, or not in programmed position with respect to trailing edge flaps.

Note: Light is inhibited during autoslat operation in flight.

7 Leading Edge (LE) FLAPS Extended (EXT) Light

Illuminated (green) –

- all leading edge flaps extended and all leading edge slats in extended (intermediate) position (trailing edge flap positions 1, 2 and 5)
- all leading edge devices in full extended position (trailing edge flap positions 10 through 40).

Flight Controls — Chapter 9
System Description — Section 20

Introduction

The primary flight control system uses conventional control wheel, column, and pedals linked mechanically to hydraulic power control units which command the primary flight control surfaces; ailerons, elevators and rudder. The flight controls are powered by redundant hydraulic sources; system A and system B. Either hydraulic system can operate all primary flight controls. The ailerons and elevators may be operated manually if required. The rudder may be operated by the standby hydraulic system if system A and system B pressure is not available.

The secondary flight controls, high lift devices consisting of trailing edge (TE) flaps and leading edge (LE) flaps and slats (LE devices), are powered by hydraulic system B. In the event hydraulic system B fails, the TE flaps can be operated electrically. Under certain conditions the power transfer unit (PTU) automatically powers the LE devices. (Refer to Chapter 13, Hydraulics, Power Transfer Unit). They can also be extended using standby hydraulic pressure.

Pilot Controls

The pilot controls consist of:

- two control columns
- two control wheels
- two pairs of rudder pedals
- SPEED BRAKE lever
- FLAP lever
- STAB TRIM cutout switches
- STAB TRIM override switch
- stabilizer trim switches
- stabilizer trim wheel
- AILERON trim switches
- RUDDER trim control
- YAW DAMPER switch
- ALTERNATE FLAPS master switch
- alternate flaps position switch
- FLT CONTROL switches
- flight SPOILER switches

The control wheels are connected through transfer mechanisms which allow the pilots to bypass a jammed control or surface.

There is a rigid connection between both pairs of rudder pedals.

The SPEED BRAKE lever allows manual or automatic symmetric actuation of the spoilers.

Flight Control Surfaces

Pitch control is provided by:

- two elevators
- a movable horizontal stabilizer.

Roll control is provided by:

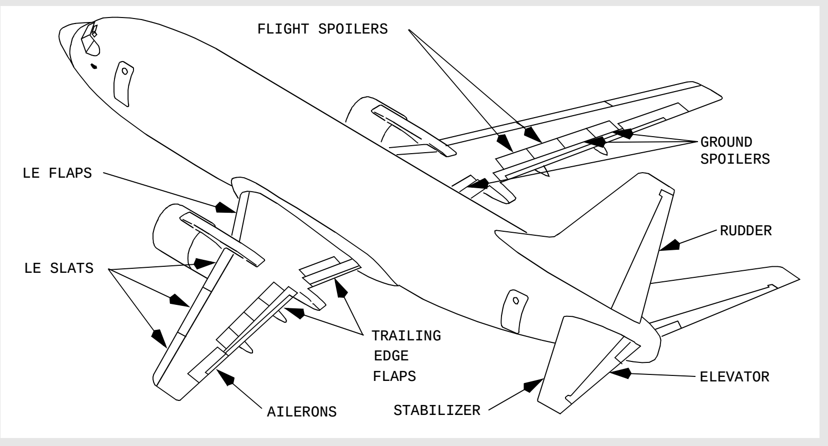
- two ailerons
- four flight spoilers.

Yaw control is provided by a single rudder. During takeoff, the rudder becomes aerodynamically effective between 40 and 60 knots.

TE flaps, and LE flaps and slats provide high lift for takeoff, approach, and landing.

In the air symmetric flight spoilers are used as speed brakes. On the ground symmetric flight and ground spoilers destroy lift and increase braking efficiency.

Flight Control Surfaces Location



Roll Control

The roll control surfaces consist of hydraulically powered ailerons and flight spoilers, which are controlled by rotating either control wheel.

Ailerons

The ailerons provide roll control around the airplane’s longitudinal axis. The ailerons are positioned by the pilots' control wheels. The A and B FLT CONTROL switches control hydraulic shutoff valves. These valves can be used to isolate ailerons, elevators and rudder, from the related hydraulic system pressure.

The Captain’s control wheel is connected by cables to the aileron power control units (PCUs) through the aileron feel and centering unit. The First Officer’s control wheel is connected by cables to the spoiler PCUs through the spoiler mixer. The two control wheels are connected by a cable drive system which allows actuation of both ailerons and spoilers by either control wheel. With total hydraulic power failure the ailerons can be mechanically positioned by rotating the pilots' control wheels. Control forces are higher due to friction and aerodynamic loads.

Aileron Transfer Mechanism

If the ailerons or spoilers are jammed, force applied to the Captain’s and the First Officer’s control wheels will identify which system, ailerons or spoilers, is usable, and which control wheel, Captain’s or First Officer’s, can provide roll control. If the aileron control system is jammed, force applied to the First Officer’s control wheel provides roll control from the spoilers. The ailerons and the Captain’s control wheel are inoperative. If the spoiler system is jammed, force applied to the Captain’s control wheel provides roll control from the ailerons. The spoilers and the First Officer’s control wheel are inoperative.

Aileron Trim

Dual AILERON trim switches, located on the aft electronic panel, must be pushed simultaneously to command trim changes. The trim electrically repositions the aileron feel and centering unit, which causes the control wheel to rotate, and redefines the aileron neutral position. The amount of aileron trim is indicated on a scale on the top of each control column.

If aileron trim is used with the autopilot engaged, the trim is not reflected in the control wheel position. The autopilot overpowers the trim and holds the control wheel where it is required for heading/track control. Any aileron trim applied when the autopilot is engaged can result in an out of trim condition and an abrupt rolling movement when the autopilot is disconnected.

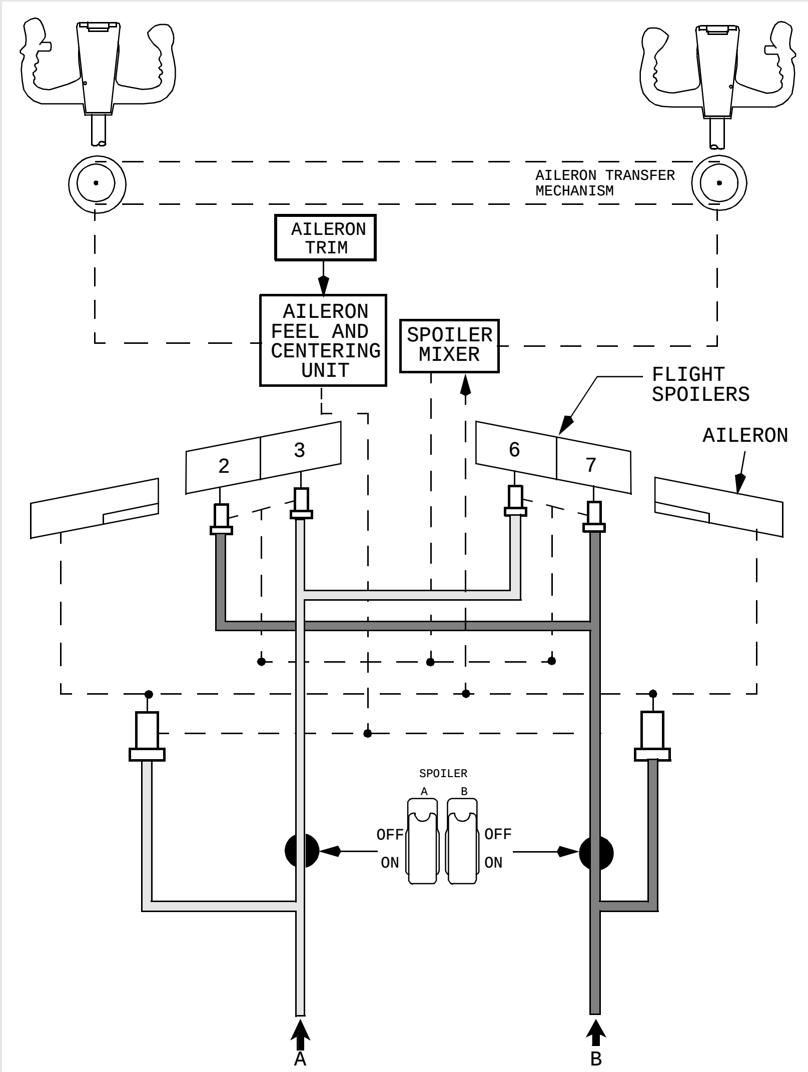
Flight Spoilers

Two flight spoilers are located on the upper surface of each wing. Each hydraulic system, A and B, is dedicated to a different set of spoilers to provide isolation and maintain symmetric operation in the event of hydraulic system failure. Hydraulic pressure shutoff valves are controlled by the two flight SPOILER switches.

Flight spoiler panels are used as speed brakes to increase drag and reduce lift, both in flight and on the ground. The flight spoilers also supplement roll control in response to control wheel commands. A spoiler mixer, connected to the aileron cable–drive, controls the hydraulic power control units on each spoiler panel to provide spoiler movement proportional to aileron movement.

The flight spoilers rise on the wing with up aileron and remain faired on the wing with down aileron. When the control wheel is displaced more than approximately 10°, spoiler deflection is initiated.

Roll Control Schematic



Pitch Control

The pitch control surfaces consist of hydraulically powered elevators and an electrically powered stabilizer. The elevators are controlled by forward or aft movement of the control column. The stabilizer is controlled by either the stabilizer trim switches on the control wheel, the autopilot, or manual trim.

Elevators

The elevators provide pitch control around the airplane's lateral axis. The elevators are positioned by the pilots' control columns. The A and B FLT CONTROL Switches control hydraulic shutoff valves for the elevators.

Cables connect the pilots' control columns to elevator power control units (PCUs) which are powered by hydraulic system A and B. The elevators are interconnected by a torque tube. With loss of hydraulic system A and B the elevators can be mechanically positioned by forward or aft movement of the pilots' control columns. Control forces are higher due to friction and aerodynamic loads.

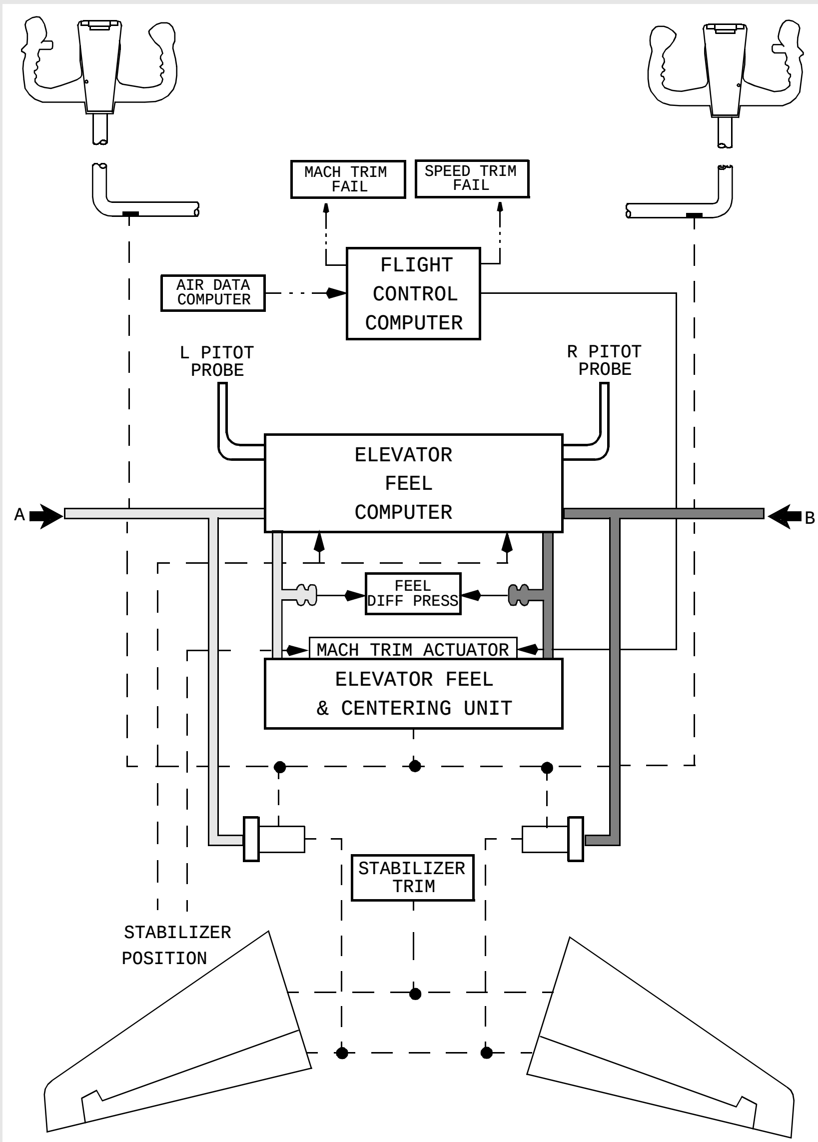
Elevator Feel System

The elevator feel computer provides simulated aerodynamic forces using airspeed (from the elevator pitot system) and stabilizer position. Feel is transmitted to the control columns by the elevator feel and centering unit. To operate the feel system the elevator feel computer uses either hydraulic system A or B pressure, whichever is higher. When either hydraulic system or elevator feel pitot system fail, excessive differential hydraulic pressure is sensed in the elevator feel computer and the FEEL DIFF PRESS light illuminates.

Mach Trim System

A Mach trim system provides speed stability at the higher Mach numbers. Mach trim is automatically accomplished above Mach .615 by adjusting the elevators with respect to the stabilizer as speed increases. The flight control computers use Mach information from the flight data computer to compute a Mach trim actuator position. The Mach trim actuator repositions the elevator feel and centering unit which adjusts the control column neutral position.

Pitch Control Schematic



Stabilizer

The horizontal stabilizer is positioned by the main electric trim motor controlled through either the stabilizer trim switches on the control wheel or by the autopilot trim servo motor. The stabilizer may also be positioned by manually rotating the stabilizer trim wheel.

Stabilizer Trim

Stabilizer trim switches on each control wheel actuate the electric trim motor through the main electric stabilizer trim circuit when the airplane is flown manually. With the autopilot engaged, stabilizer trim is accomplished through the autopilot stabilizer trim circuit. The main electric and autopilot stabilizer trim have two speed modes: high speed with flaps extended, and low speed with flaps retracted. If the autopilot is engaged, actuating either pair of stabilizer trim switches automatically disengages the autopilot. The stabilizer trim wheels rotate whenever electric stabilizer trim is actuated.

The STAB TRIM MAIN ELEC cutout switch and the STAB TRIM AUTOPILOT cutout switch, located on the control stand, are provided to allow the autopilot or main electric trim inputs to be disconnected from the stabilizer trim motor.

Control column actuated stabilizer trim cutout switches stop operation of the main electric and autopilot trim when the control column movement opposes trim direction. When the STAB TRIM override switch is positioned to OVERRIDE, electric trim can be used regardless of control column position.

Manual stabilizer control is accomplished through cables which allow the pilot to position the stabilizer by rotating the stabilizer trim wheels. The stabilizer is held in position by two independent brake systems. Manual rotation of the trim wheels can be used to override autopilot or main electric trim. The effort required to manually rotate the stabilizer trim wheels may be higher under certain flight conditions. Grasping the stabilizer trim wheel will stop stabilizer motion.

Stabilizer Trim Operation with forward or AFT CG

In the event the stabilizer is trimmed to the end of the electrical trim limits, additional trim is available through the use of the manual trim wheels. If manual trim is used to position the stabilizer beyond the electrical trim limits, the stabilizer trim switches may be used to return the stabilizer to electrical trim limits.

Stabilizer Position Indication and Green Band

Stabilizer position is displayed in units on two STAB TRIM indicators located inboard of each stabilizer trim wheel. The STAB TRIM indicators also display the TAKEOFF green band indication.

The trim authority for each mode of trim is limited to:

- Main Electric Trim
  Flaps retracted 2.5 to 12.5 units (–300)
  Flaps retracted 2.8 to 12.5 units (–400/500)
  Flaps extended 0.25 to 12.5 units
- Autopilot Trim 0.25 to 14.0 units
- Manual Trim 0 to 17.0 units

The green band range of the STAB TRIM indicator shows the takeoff trim range. An intermittent horn sounds if takeoff is attempted with the stabilizer trim outside the takeoff trim range.

Speed Trim System

The speed trim system is designed to improve flight characteristics during operations with a low gross weight, aft center of gravity, high thrust. It monitors inputs of stabilizer position, thrust lever position, airspeed, and vertical speed and then trims the stabilizer using the autopilot stabilizer trim. It operates most frequently during takeoffs and go–arounds. Conditions for speed trim operation are listed below:

- Flaps not up (737–300)
- Flaps up or down (737–400/500)
- Airspeed 100 – 300 KIAS
- 10 seconds after takeoff
- 5 seconds following release of trim switches
- N1 above 60%
- Autopilot not engaged
- Sensing of trim requirement

Yaw Control

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)

On some airplanes, 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

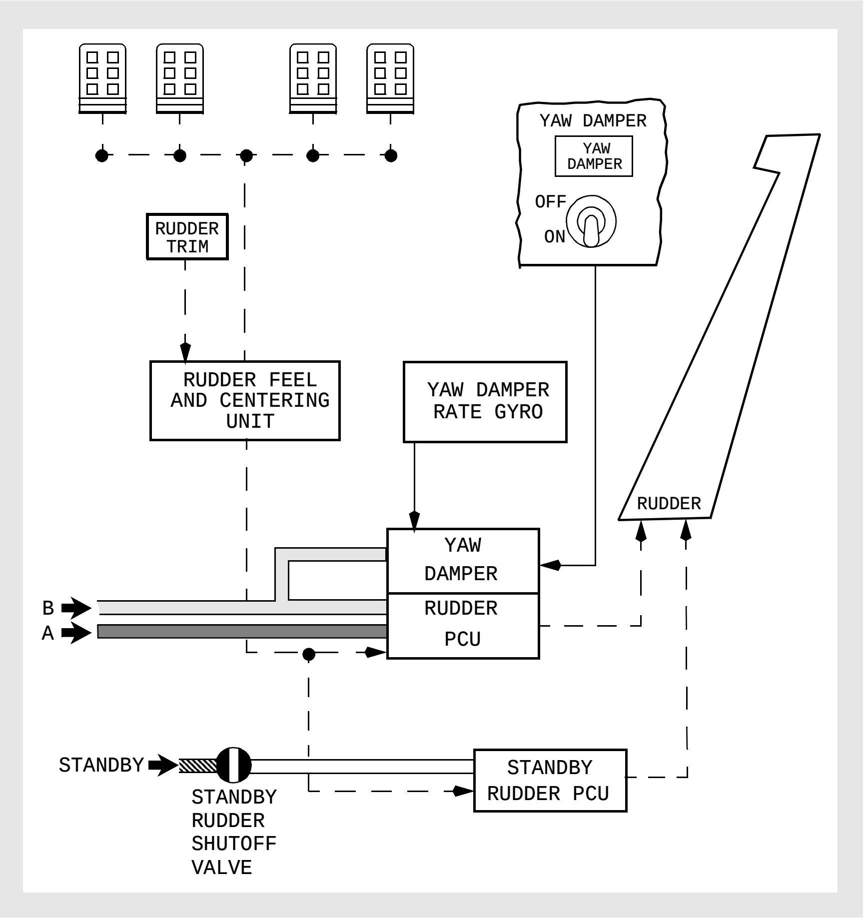
The RUDDER trim control, located on the aft electronic panel, electrically repositions the rudder feel and centering unit which adjusts the rudder neutral position. The rudder pedals are displaced proportionately. The rudder trim indicator displays the rudder trim position in units.

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



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 shutoff valve, and the ground spoilers deploy

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

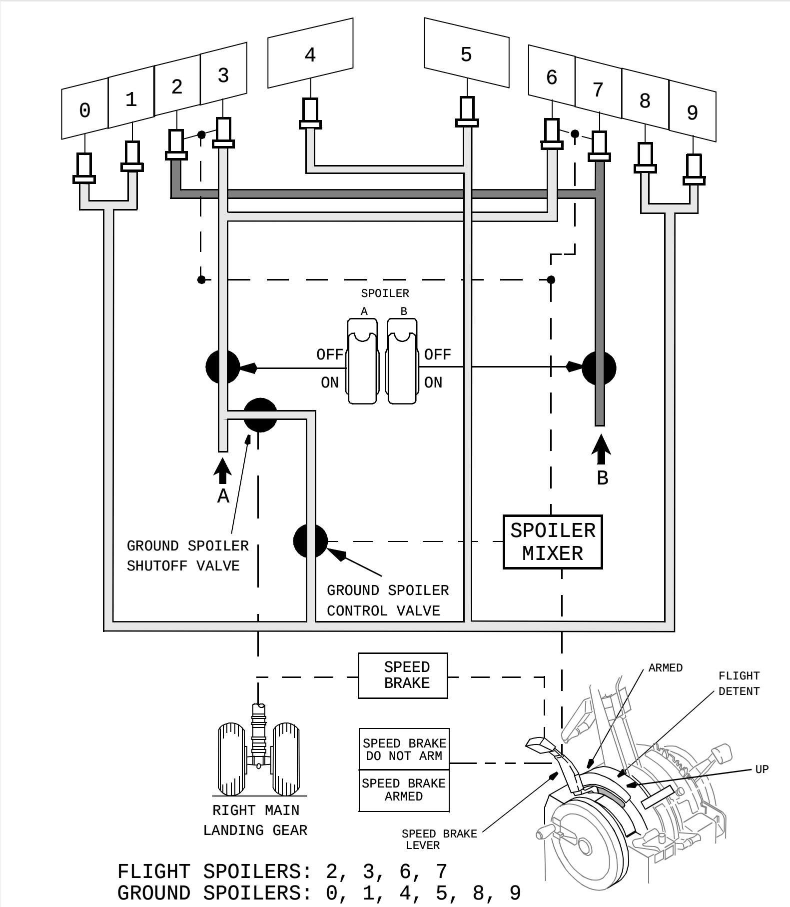
During a rejected takeoff (RTO), the auto speed brake system operates when these conditions occur:

- main landing gear wheels spin–up (more than 60 kts)
- takeoff is rejected, both thrust levers are retarded to IDLE and the reverse thrust levers are positioned for reverse thrust – SPEED BRAKE lever automatically moves to the UP position and all spoilers deploy.

After a RTO or landing, if either thrust lever is advanced, the SPEED BRAKE lever automatically moves to the DOWN detent and all spoiler panels retract. The spoiler panels may also be retracted by manually moving the SPEED BRAKE lever to the DOWN detent.

The SPEED BRAKE caution light flashes continuously if the Speed Brake Lever is aft of the ARMED position, the air/ground sensor is in the air position, and the flaps are extended beyond position 10.

Speed Brakes Schematic



Flaps and Slats

The flaps and slats are high lift devices that increase wing lift and decrease stall speed during takeoff, low speed maneuvering and landing.

LE devices consist of four flaps and six slats: two flaps inboard and three slats outboard of each engine. Slats extend to form a sealed or slotted leading edge depending on the TE flap setting. The TE devices consist of triple slotted flaps inboard and outboard of each engine.

TE flap positions 1–15 provide increased lift; positions 15–40 provide increased lift and drag. Flap positions 15, 30 and 40 are normal landing flap positions.

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 full extended position, and
- slats extend to the extend 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 full extended position, and
- slats extend to the full extended position.

The LE devices sequence is reversed upon retraction.

Mechanical gates hinder inadvertent FLAP lever movement beyond flaps 1 for one engine inoperative go–around, and flaps 15 for normal go–around.

Indicator lights on the center instrument panel provide overall LE devices position status. The LE DEVICES annunciator on the aft overhead panel indicates the positions of the individual flaps and slats.

Flap Load Relief

A flap load limiter provides a TE flap load relief function which protects the flaps from excessive air loads. This function is operative at the flaps 40 position only. The FLAP lever does not move, but the flap position indicator displays flap retraction and re–extension and the FLAP LOAD RELIEF light illuminates.

When the flaps are set at 40 the TE flaps:

- retract to 30 if airspeed exceeds 158 knots (-300/500)
- re–extend when airspeed is reduced to 153 knots.
- retract to 30 if airspeed exceeds 162 knots (-400)
- re–extend when airspeed is reduced to 157 knots.

Autoslats

At flap positions 1, 2 and 5 an autoslat function is available that moves the LE slats to FULL EXTEND if the airplane approaches a stall condition.

The autoslat system is designed to enhance airplane stall characteristics at high angles of attack during takeoff or approach to landing. When TE flaps 1 through 5 are selected, the LE slats are in the extend position. As the airplane approaches the stall angle, the slats automatically drive to the full extended position, prior to stick shaker activation. The slats return to the extend position when the pitch angle is sufficiently reduced below the stall critical attitude.

Autoslat operation is normally powered by hydraulic system B. An alternate source of power is provided by system A through a power transfer unit (PTU) if a loss of pressure is sensed from the higher volume system B engine driven pump. The PTU provides 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

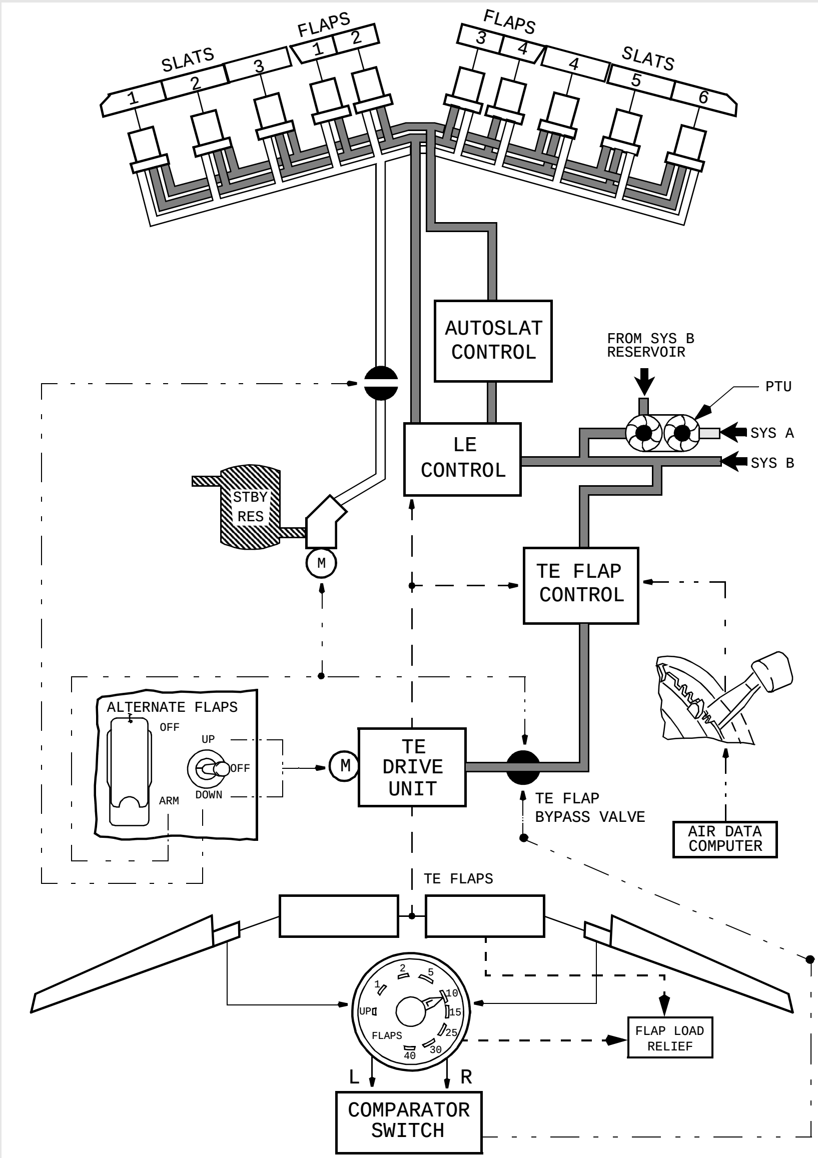
In the event that hydraulic system B fails, an alternate method of extending the LE devices, and extending and retracting the TE flaps is provided.

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.

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Flight Instruments, Displays — Chapter 10
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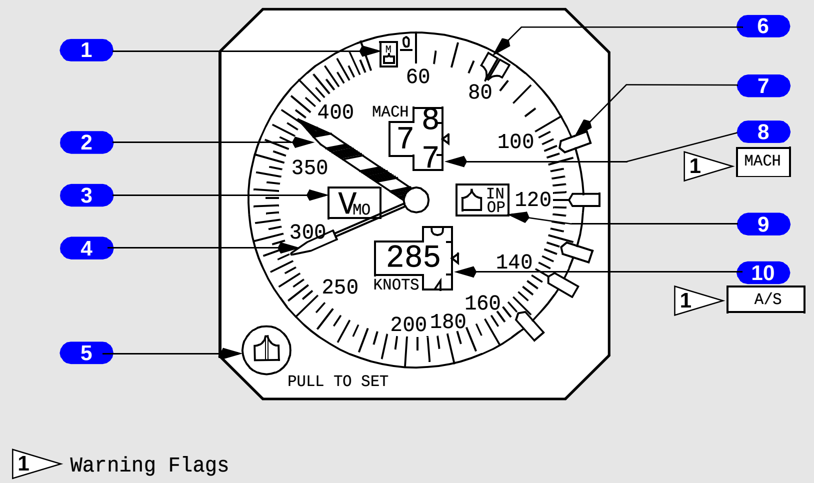
Conventional Flight Instruments

Mach/Airspeed Indicator



CAPTAIN'S INSTRUMENT PANEL
FIRST OFFICER'S INSTRUMENT PANEL

1 Airspeed Cursor Mode Annunciator

- auto mode: out of view.
- manual mode: in view.

2 Vmo Pointer

Indicates the maximum operating (indicated) airspeed in knots.

3 Vmo Flag

In view –

- indicates the Vmo pointer is inoperative.

4 Airspeed Pointer

Indicates airspeed in knots.

5 Airspeed Cursor Control

- push in –
  - auto mode
  - airspeed cursor is position from the AFDS FCC
- pull out –
  - manual mode
  - airspeed cursor is positioned by rotating the control.

6 Airspeed Cursor

- indicates target airspeed
- positioned manually or automatically, as selected by the airspeed cursor control.

7 Airspeed Markers

Positioned manually to the desired airspeed reference.

8 Mach Digital Counter

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

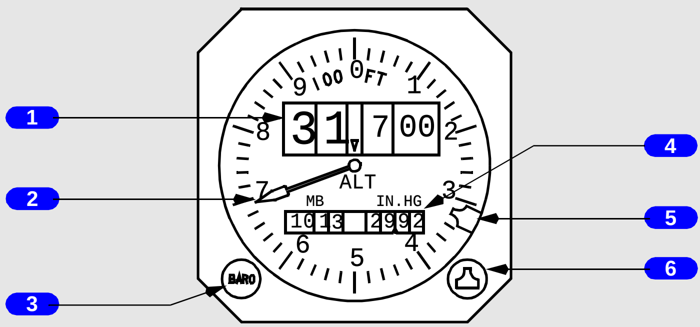
9 Airspeed Cursor Flag

- manual mode: retracted
- auto mode: in view if airspeed cursor signals, as determined by the AFDS FCC, are unreliable.

10 Airspeed Digital Counter

- digital display of indicated airspeed in knots
- warning flag covers the counter when the airspeed pointer and airspeed digital counter are unreliable.

Altimeter



CAPTAIN’S INSTRUMENT PANEL
FIRST OFFICER’S INSTRUMENT PANEL

1 Digital Counter

Indicates current altitude in increments of thousands, hundreds and twenty feet.

- warning flag appears whenever the ADC signal is lost or a malfunction exists
- green flag appears in the left window when the altitude is below 10,000 feet
- a NEG flag appears in the two left–hand windows when altitude below zero feet is displayed.

2 Altitude Pointer

Makes one revolution each one thousand feet.

3 Barometric Setting Control

Rotate –

- adjusts barometric settings.

4 Barometric Setting Window

Displays barometric correction (in millibars and inches of mercury) as set by the barometric setting control.

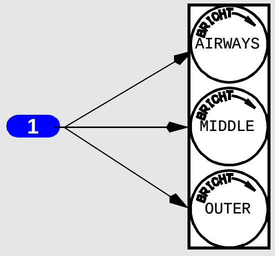
5 Reference Altitude Marker

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

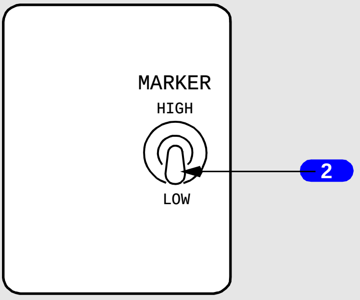
6 **Reference Altitude Marker Control**

Used to manually set the reference altitude marker.

Marker Beacon



CAPTAIN'S INSTRUMENT PANEL
FIRST OFFICER'S INSTRUMENT PANEL



CAPTAIN'S INSTRUMENT PANEL

1 **Marker Beacon Lights**

AIRWAYS (white) – illuminates over an inner or airways marker beacon.

MIDDLE (amber) – illuminates over a middle marker beacon.

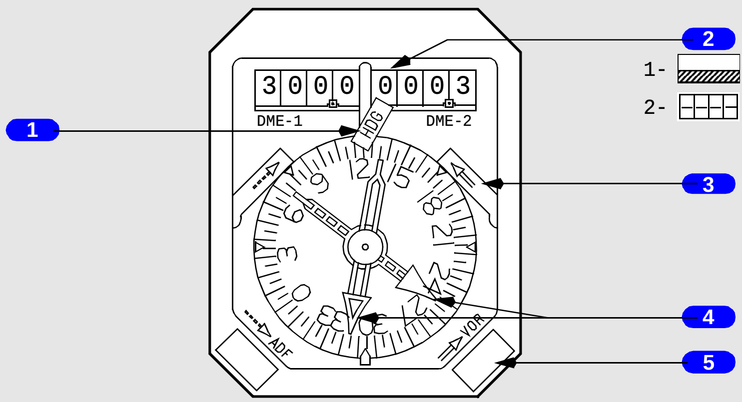
OUTER (blue) – illuminates over an outer marker beacon.

2 **Marker Beacon Switch**

HIGH – selects high sensitivity of receiver.

LOW – selects low sensitivity of receiver.

Radio Distance Magnetic Indicator



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

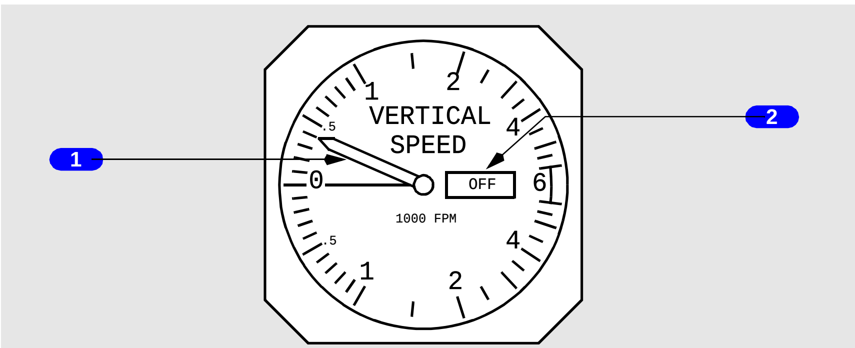
4 **Bearing Pointers**

- 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



CAPTAIN'S INSTRUMENT PANEL
FIRST OFFICER'S INSTRUMENT PANEL

1 **Vertical Speed Pointer**

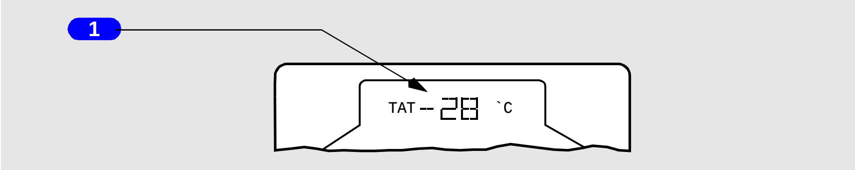
- depicts rate of climb or descent from 0 to 6,000 feet per minute
- indicates zero when IRS vertical speed is unreliable.

2 **OFF Flag**

In view –

- respective VSI and/or ADC has failed
- selected IRS vertical speed data are unreliable.

Air Temperature

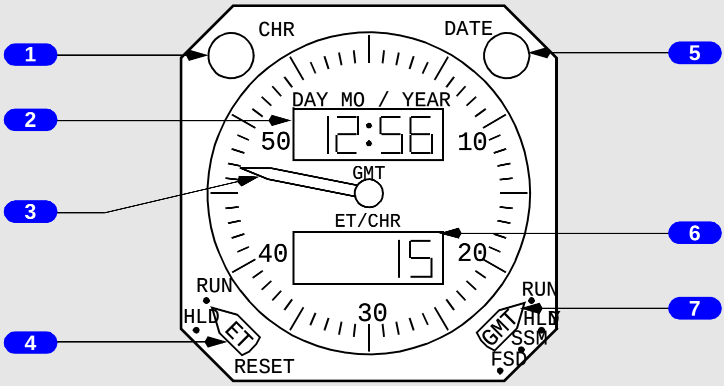


CENTER INSTRUMENT PANEL

1 Digital Display

Displays TAT (deg C) indications in digital form.

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

- overrides any existing ET display.

2 Time/Date Window

- displays time (hours, minutes) when time is selected with the time/date selector
- alternately displays day–month and year when date is selected with the time/date selector.

3 Chronograph Second Hand

- indicates chronograph seconds
- controlled by the CHR control.

4 Elapsed Time (ET) Selector (three position, rotary)

Controls the elapsed time function.

RESET – returns ET display to zero (spring loaded to HLD).

HLD (hold) – stops the elapsed time display.

RUN – starts the elapsed time display.

5 Date Control

Push – displays date (day, month) alternating with year

Push – returns display to time.

6 Elapsed Time (ET)/Chronograph Window

- displays elapsed time (hours, minutes) or chronograph minutes
- the chronograph display replaces the elapsed time display
- elapsed time continues to run in the background and displays after the chronograph is reset.

7 Time Control (four position, rotary)

Sets the time and date when the time/date selector is set to manual

FS D (fast slew, day) –

- advances hours when time is selected with the time/date selector
- advances days when date is selected with the time/date selector

SS M (slow slew, month) –

- advances minutes when time is selected with the time/date selector
- advances months when date is selected with the time/date selector

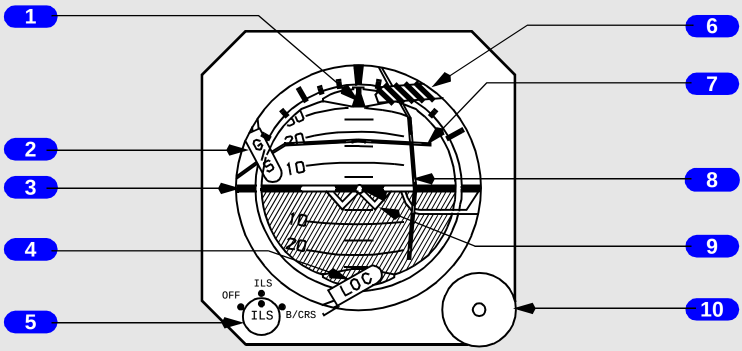
HLD Y (hold, year) –

- stops the time indicator and sets the seconds to zero when time is selected with the time/date selector
- advances years when date is selected with the time/date selector

RUN – starts the time indicator.

Standby Flight Instruments

Standby Horizon



CENTER INSTRUMENT PANEL

1 Bank Indicator and Scale

Scale marks are at 0, 10, 20, 30, 45 and 60 degrees.

2 Glideslope Flag

In view – glideslope receiver has failed.

3 Horizon Line and Pitch Angle Scale

Pitch scale is in 5 degree increments.

4 LOC Flag

In view – Localizer receiver has failed.

5 Approach Mode Selector

OFF – glideslope and localizer pointers retracted from view.

ILS – glideslope and localizer pointers in view; ILS signals provided by the No. 1 ILS receiver.

B/CRS – reverses sensing for localizer pointer during back course approaches; glideslope pointer not displayed.

6 GYRO Flag

In view –

- attitude is unreliable
- power has been lost.

7 Glideslope Pointer and Deviation Scale

- pointer indicates glideslope position
- pointer is not displayed when
  - approach selector is off
  - no computed data exists
  - glideslope receiver has failed
- scale indicates deviation.

8 Localizer Pointer and Deviation Scale

- pointer indicates localizer position
- pointer is not displayed when
  - approach selector is off
  - no computed data exists
  - localizer receiver has failed
- scale indicates deviation.

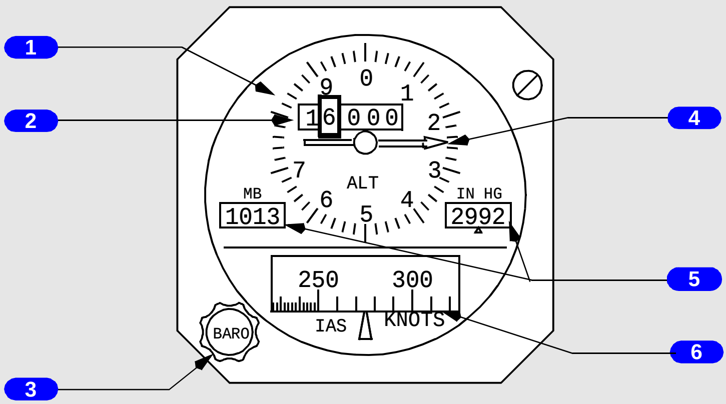
9 Airplane Symbol

10 Caging Control

Pull – provides fast erection (caging) of the gyro.

Release – control retracts.

Standby Altimeter/Airspeed Indicator



CENTER INSTRUMENT PANEL

1 Standby Altimeter

Indicates current altitude in feet.

2 Digital Counter

Indicates thousands of feet

- a green flag appears in the left window when altitude is less than 10,000 feet
- a striped flag appears in the left window when altitude is less than zero feet.

3 Barometric Setting Control

Rotate –

- adjusts the barometric correction in both barometric windows.

4 Altitude Pointer

Indicates hundreds of feet.

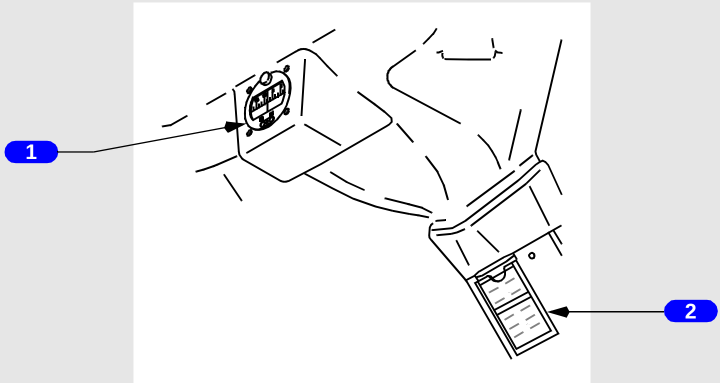
5 Barometric Setting Windows

Displays barometric correction in millibars and inches of mercury as set by the barometric setting control.

6 **Standby Airspeed Indicator**

Indicates current airspeed in knots.

Standby Magnetic Compass



CENTERPOST ABOVE GLARESHIELD

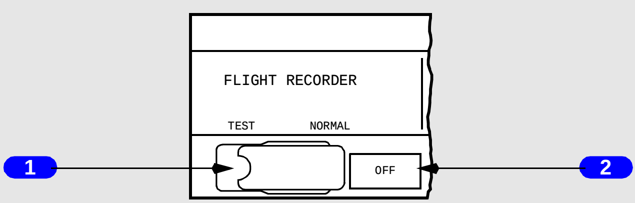
1 **Standby Magnetic Compass**

Displays magnetic heading.

2 **Standby Magnetic Compass Correction Card**

Provides appropriate heading corrections.

Flight Recorder



AFT OVERHEAD PANEL

1 Flight Recorder Test Switch

NORMAL (guarded position) –

- in flight – the recorder operates anytime electrical power is available
- on the ground – either engine must also be operating.

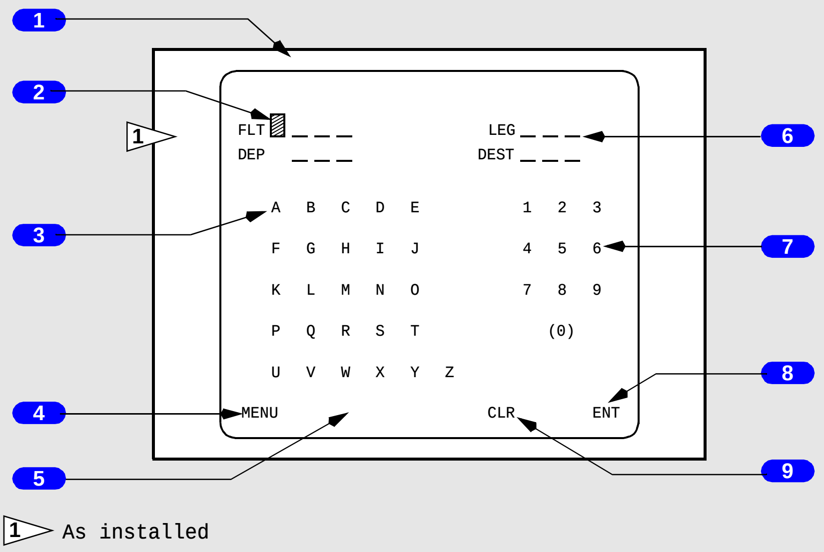
TEST – bypasses the engine oil pressure switches and the air ground switch to power the flight recorder on the ground.

2 OFF Light

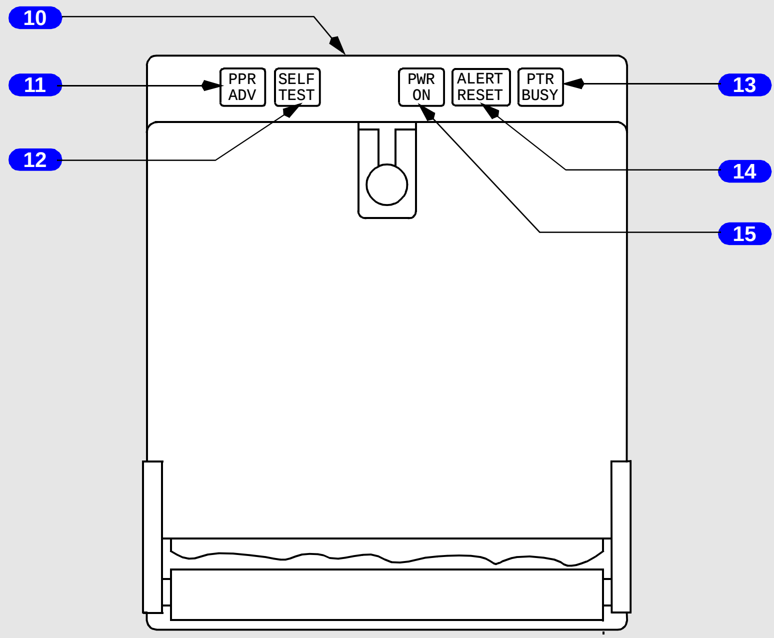
Illuminated (amber) – indicates the recorder is not operating or the test is invalid. May indicate power failure, loss of input data, or electronic malfunction.

Aircraft Condition Monitoring System (ACMS)

Interactive Display Unit and Printer



FORWARD ELECTRONIC PANEL



AFT ELECTRONIC PANEL

1 **Interactive Display Unit (IDU)**

Push – marks specific occurrence for future reference.

2 **Cursor (typical)**

Moves right as each character is entered.

3 **Alpha Pad**

Touch – individual characters are entered in data display.

4 **MENU Cue**

Touch – displays previous menu.

5 **Advisory Space**

Advisory may be displayed as flashing, reverse, or normal video.

6 **Data Display**

Data appears here as entered.

7 **Numerical Pad**

Touch – individual characters are entered in data display.

8 **Enter (ENT) Cue**

Touch – enters data and turns page if entering final data.

9 **Clear (CLR) Cue**

Touch – blanks character under cursor and to its right.

10 **ACMS Printer**

11 **Paper Advance (PPR ADV) Switch**

Push – advances printer paper as long as switch is held down.

12 **SELF TEST Switch**

Push – produces a test pattern as long as switch is depressed.

13 **Printer Busy (PTR BUSY) Light**

Illuminated (amber) – printer is processing message text.

14 **ALERT RESET Switch**

Push – resets aural/visual printer alert.

15 **Power On (PWR ON) Light**

Illuminated (green) – power is applied to printer.

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Introduction

The flight instruments provide information to aid the pilots in controlling the airplane throughout its flight regime. The electric flight instruments receive input from one of the two air data computers. The pneumatic flight instruments receive input directly from the pitot–static system.

Air Data System

The air data system consists of the pitot–static system and the air data computers. The system provides pitot and/or static pressure information to various flight instruments and airplane systems. The pressure information is provided in one of two ways; either directly from the pitot–static system, or indirectly from an air data computer.

Pitot Static System

The pitot–static (P/S) system provides pitot and static pressure inputs to pressure–sensing instruments and systems which have functions that vary with altitude and/or airspeed.

There are four primary P/S systems; the Captain's, the First Officer's, No. 1 auxiliary, and No. 2 auxiliary. The pilots' systems are used by the flight instruments and air data computers. The auxiliary systems are used by various airplane systems.

The alternate static system provides static pressure inputs to the standby airspeed indicator/standby altimeter.

Pressure inputs to the primary P/S systems are provided by four combination pitot and static probes located the forward fuselage. Each probe provides one pitot and two static inputs. The alternate static ports are located on each side of the fuselage. All static systems are cross–connected for dynamic balance.

A separate pitot system with probes mounted on the vertical stabilizer is provided for the elevator feel system.

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

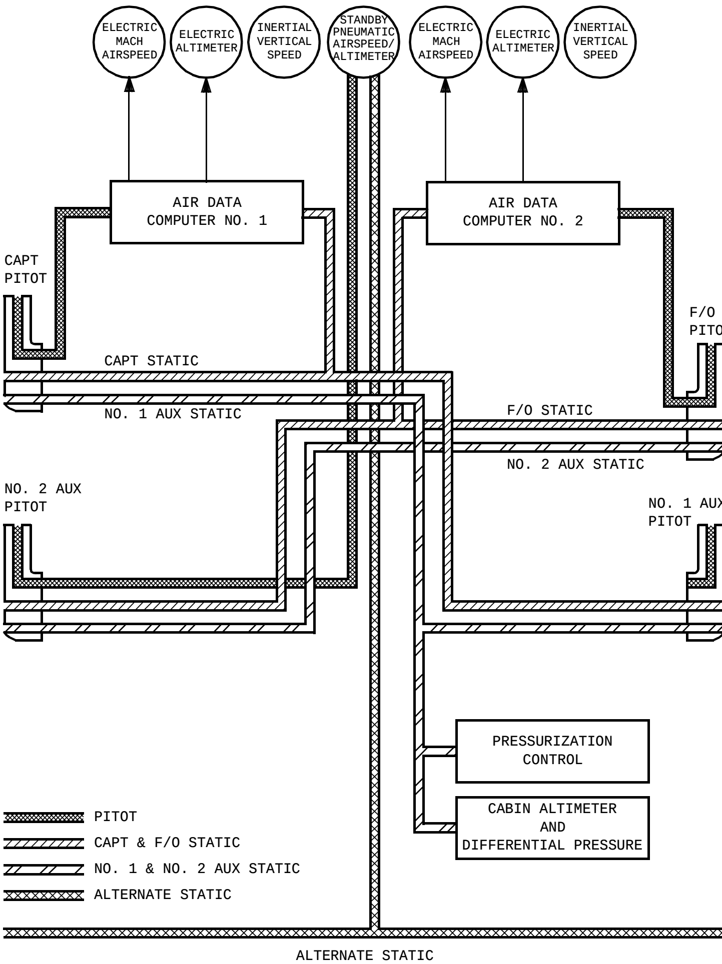
- FMC
- autothrottle
- Mach/airspeed indicator
- Vmo/Mmo warning
- altimeter

- vertical speed indicator
- IRS
- true airspeed
- static air temperature
- flap load relief system
- elevator feel system
- flight control computers
- ground proximity warning system
- altitude alert
- cabin pressure
- flight recorder
- transponder altitude reporting
- stall warning computers
- TAT
- yaw damper
- Mach trim
- symbol generator

Air Data Computers

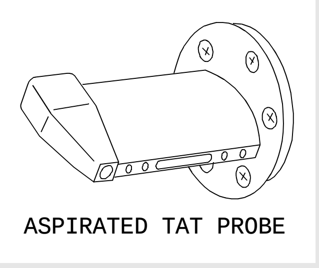
Two air data computers (ADCs) are installed. Each ADC receives pitot and static pressure inputs from the respective pilot's P/S system. The ADCs convert these pressure inputs to electrical signals which are used to operate various flight instruments and airplane systems. The ADC computers are powered whenever the AC busses are powered.

Pitot–Static System Schematic



Total Air Temperature

One aspirated TAT probe is installed. It provides independent temperature data to each ADC. Total air temperature data derived from ADC No.1 is used by the left IRS, the FMC, autothrottle, FCC “A” and the air temperature indicator. Total air temperature derived data from ADC No. 2 is used by the right IRS, the FMC, autothrottle and FCC “B.”



LEFT FORWARD FUSELAGE

The inflight TAT indication is comprised of outside air temperature (OAT) plus all of the ram rise. On the ground, with an air conditioning pack switched to AUTO or HIGH, the TAT indication is approximately OAT. In flight, the following table is used to convert indicated TAT to true OAT.

	INDICATED MACH NUMBER										
	.30	.40	.50	.60	.70	.73	.76	.78	.80	.82	.84
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	14
50	45	40	35	28	21	19	17	15	13	11	10
45	40	35	30	23	17	15	12	11	9	7	5
40	35	30	25	19	12	10	8	6	4	3	1
35	30	26	20	14	8	6	3	1	0	- 2	- 3
30	25	21	16	10	3	1	- 1	- 3	- 5	- 6	- 7
25	20	16	11	5	- 2	- 3	- 6	- 7	- 9	-11	-12
20	15	11	6	0	- 6	- 8	-10	-12	-13	-15	-16
15	10	6	2	- 5	-11	-13	-15	-16	-18	-19	-21
10	5	1	- 3	- 9	-15	-17	-19	-21	-22	-24	-25
5	0	- 3	- 8	-14	-20	-21	-24	-25	-27	-28	-29
0	- 5	- 8	-13	-18	-24	-26	-28	-30	-31	-33	-34
- 5	-10	-13	-18	-23	-29	-31	-33	-34	-35	-37	-38
-10	-15	-18	-22	-28	-33	-35	-37	-39	-40	-41	-43
-15	-20	-23	-27	-32	-38	-39	-42	-43	-44	-46	-47
-20	-24	-27	-32	-37	-42	-44	-46	-47	-49	-50	-51
-25	-29	-32	-36	-42	-47	-49	-51	-52	-53	-55	-56
-30	-34	-37	-41	-46	-51	-53	-55	-57	-58	-59	-60
-35	-39	-42	-46	-51	-56	-58	-60	-61	-62	-63	-65
-40	-44	-47	-51	-56	-61	-62	-64	-65	-66	-68	-69

NOTE: Probe Recovery Factor is 100%.

Static Air Temperature

Static air temperature, displayed on the CDU PROGRESS page, is derived from the TAT by ADC No. 1.

Angle–of–Attack

There are two angle–of–attack sensors, one located on each side of the forward fuselage. The vanes measure airplane angle–of–attack relative to the air mass.

Primary Flight Instruments

Mach/Airspeed Indicators

Two electric Mach/airspeed indicators display indicated airspeed, Mach, and Vmo derived from the respective air data computer.

The airspeed cursor on each pilot's indicator can be automatically positioned through the related flight control computer (FCC) using inputs from the flight management computer (FMC) or from the speed selector on the AFDS mode control panel. Each airspeed cursor can also be manually positioned.

Altimeters

Two electric altimeters indicate current altitude in feet, derived from the respective air data computer. The altimeters have a range of –1,000 to 50,000 feet.

Vertical Speed Indicators

Two inertial vertical speed indicators display instantaneous vertical speed derived from the respective inertial reference system.

Clocks

Two electronic clocks are installed, with two digital displays on each clock. Either coordinated universal time (UTC) or local time may be set on the upper time display. The lower ET/CHR display is used for either elapsed time or the chronograph. Separate controls are provided for each display.

Standby Flight Instruments

Standby Horizon Indicator

The standby horizon indicator provides attitude information that is independent of the primary attitude displays. The indicator is powered by the battery bus and remains powered after the loss of all normal AC power as long as battery power is available. The gyro reaches operational speed approximately 60 seconds after power is applied. The indicator requires three minutes to achieve accuracy requirements.

Standby Altimeter/Airspeed Indicator

Standby altitude and airspeed are displayed on a single indicator.

The standby altimeter indicates current altitude in feet. It receives static pressure from the alternate static ports. The altimeter has a range of –1,000 to 50,000 feet.

The standby airspeed indicator provides current airspeed in knots. It receives ram pressure from the No. 2 auxiliary pitot probe and static pressure from the alternate static ports.

Standby Magnetic Compass

A standard liquid–damped magnetic standby compass is provided. A card located near the compass provides heading correction factors.

Flight Recorder

The flight recorder provides a permanent record on tape of selected operational and systems information such as altitude, heading, acceleration, and airspeed. The recorder is housed in a sealed, fire–resistant container located behind an access door in the aft cabin ceiling.

Operational and systems information is automatically recorded whenever the flight recorder is powered. On the ground, the recorder begins operating as the low oil pressure switch closes during either engine start. Oil pressure switches are bypassed in the air, and the flight recorder is powered even with both engines shut down as long as electrical power is available.

Aircraft Condition Monitoring System (ACMS)

The ACMS consists of a digital flight data recorder (DFDR), accelerometer, airborne printer, control display unit (CDU), and digital flight data acquisition unit (DFDAU).

The DFDAU receives signals representing certain flight conditions and airplane systems' operating performance and converts them to a digital form for recording on the DFDR.

The DFDR records airplane system and flight data on a continuous loop of magnetic tape. The tape is of sufficient length to record the last 25 hours of operation. The DFDR is located in the aft fuselage area.

The CDU contains the controls and indicators for operation of the ACMS.

The printer allows data to be printed as required.

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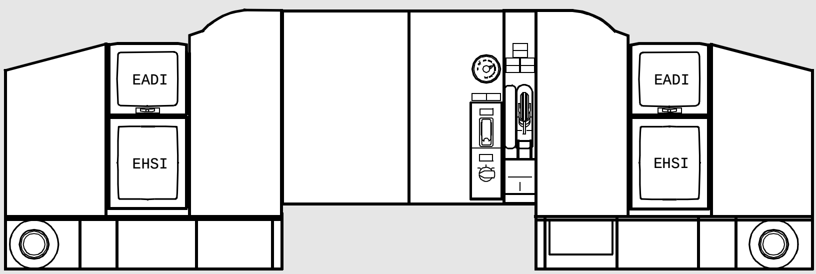
Introduction

The electronic flight instrument system (EFIS) presents a dynamic color display of the parameters necessary for flight path control. The displays provide the following information:

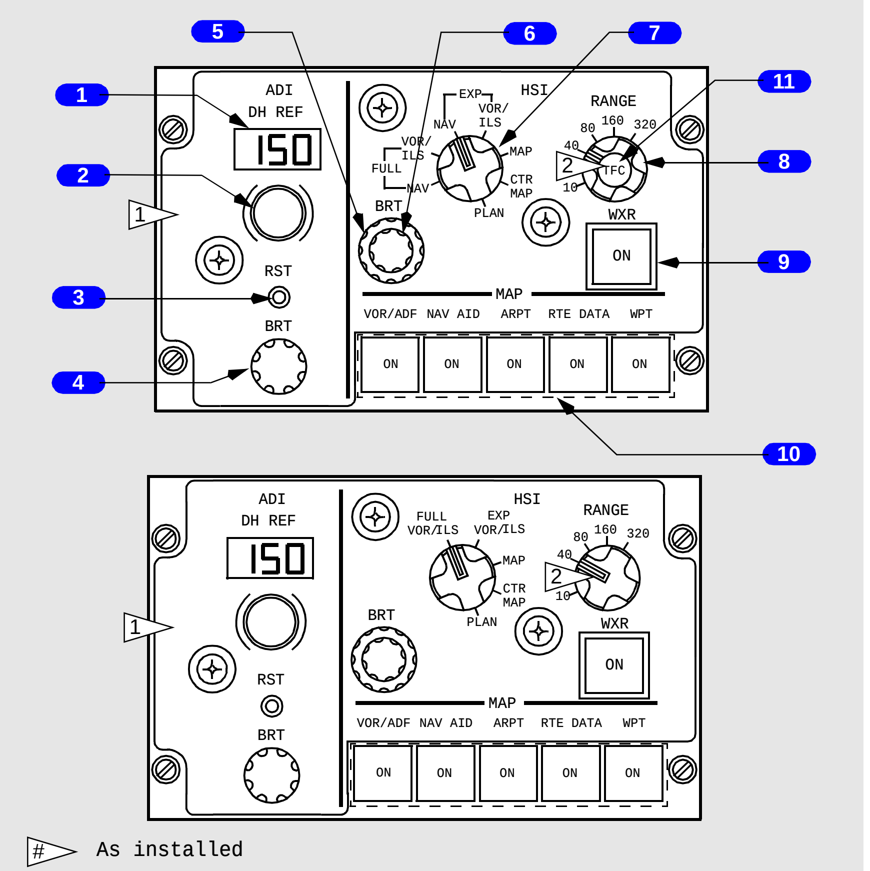
Primary flight instruments are electronically displayed on the Captain's and First Officer's panels. They consist of an Electronic Attitude Director Indicator (EADI) and an Electronic Horizontal Situation Indicator (EHSI).



INSTRUMENT PANEL

EFIS Control Panel

The left EFIS control panel controls the Captain's EADI and EHSI. The right EFIS control panel controls the First Officer's EADI and EHSI.



AFT ELECTRONIC PANEL

1 Decision Height Reference Indicator

- displays selected decision height
- display on EADI blanks when a negative decision height is selected.

2 Decision Height Selector

Rotate - selects decision height for DH alerting.

3 Decision Height Reset Switch

Push –

- resets DH alert on related EADI
- changes RA display from yellow to white
- blanks radio height alert on related EADI.

4 EADI Brightness Control

Rotate – adjusts brightness of EADI display.

5 EHSI Brightness (outer)

Rotate – adjusts brightness of EHSI display.

6 EHSI Brightness (inner)

Rotate – adjusts brightness of weather radar display.

7 EHSI Mode Selector

(see following pages)

8 EHSI Range Selector

Rotate – Selects nautical mile range for MAP, CTR MAP, PLAN, and weather radar displays.

9 Weather Radar Switch

Push – displays weather radar information (refer to Chapter 11, Flight Management, Navigation)

10 Map Switches

Push –

- selects detailed information displays
- displays can be selected simultaneously
- illuminated white when selected
- second push removes the information.

VOR/ADF - Displays VOR and/or ADF relative bearing radials if VOR/ADF receivers are tuned to usable stations and valid data is being received.

Navigation Aids (NAV AID) –

- displays FMC data base high altitude navigation aids on map scales 80, 160, or 320 NM
- displays all FMC data base navigation aids if on map scales 10, 20, or 40 NM.

Airports (ARPT) – displays all airports stored in FMC data base which are within viewable map area of EHSI.

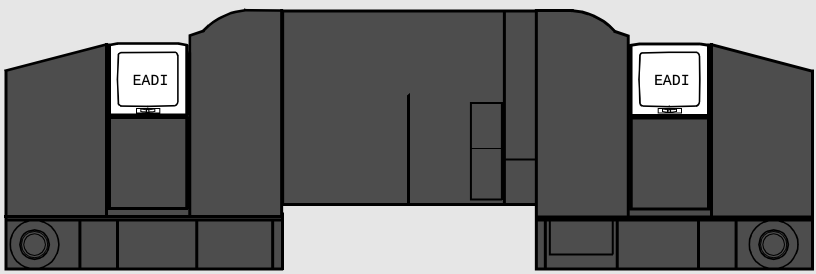
Route Data (RTE DATA) – displays altitude constraint (if applicable) and ETA for each active route waypoint.

Waypoints (WPT) – displays waypoints in FMC data base not in flight plan route if selected range is 40 NM or less.

11 Traffic (TFC) Switch

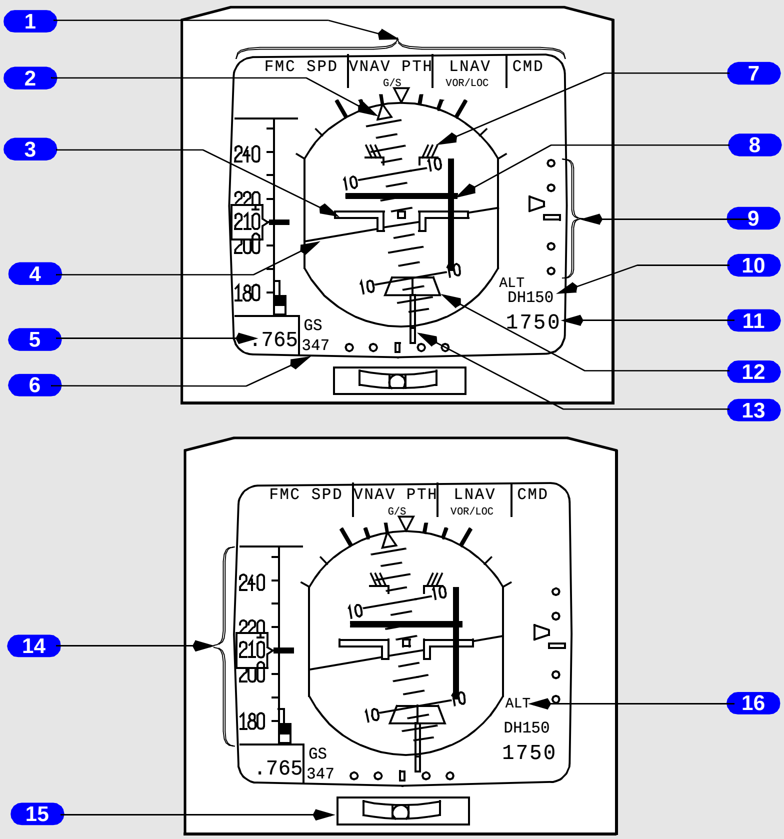
- displays or removes TCAS information on EHSI
- removes TCAS FAIL message, if displayed.

Electronic Flight Instrument Displays



INSTRUMENT PANEL

Electronic Attitude Director Indicator (EADI) Display



CAPTAIN'S INSTRUMENT PANEL
FIRST OFFICER'S INSTRUMENT PANEL

1 Flight Mode Annunciations

(See Automatic Flight, Chapter 4).

2 Bank Indicator and Scale (white)

Provides fixed reference for the bank pointer; scale marks are at 0, 10, 20, 30, 45, and 60 degrees.

3 Airplane Symbol (black with white outline)

Indicates airplane attitude relative to the horizon.

4 **Horizon Line and Pitch Scale (white)**

5 **Current Mach (white)**

- displayed when Mach increases above.40 Mach
- display blanked when Mach decreases below .38 Mach.

6 **Groundspeed (GS) (white)**

Displays FMC/IRS groundspeed in knots.

7 **Pitch Limit Indicator (yellow)**

Indicates pitch attitude corresponding to stick shaker activation.

8 **Flight Director Command Bars (magenta)**

- displayed when related FD switch is ON and valid command steering is available, or during automatic operation of the FD
- blanked when the respective FD switch is OFF or command steering becomes invalid.

9 **Glide Slope Pointer and Deviation Scale (magenta/white)**

- pointer indicates glide slope position
- scale indicates deviation
- pointer not displayed when glide slope unusable or when track and front course on the MCP differ by more than 90° (back course).

10 **Decision Height (green)**

- displays selected decision height as set on the EFIS control panel when radio altitude is above 1,000 feet AGL
- blank when negative DH selected.

11 **Radio Altitude (white)**

- displays radio altitude below 2500 feet AGL
- blanked above 2500 feet AGL
- changes color from white to yellow when below selected DH on descent
- changes back to white:
  - when passing selected DH plus 75 feet during go-around
  - after touchdown
  - after pressing RST switch on EFIS control panel.

12 **Rising Runway (green)**

- displayed when localizer pointer is in view and radio altitude is valid
- rises towards airplane symbol when radio altitude is below 200 feet AGL.

13 Localizer Pointer and Deviation Scale (magenta/white)

- pointer indicates localizer position
- scale indicates deviation
- when LOC is engaged and deviation is slightly more than one half dot, scale expands (not shown)
- pointer blanked when ILS LOC signal is too weak to be usable.
- at low radio altitudes, with autopilot engaged, scale turns yellow and pointer flashes to indicate excessive localizer deviation.

14 Speed Tape

(See following pages).

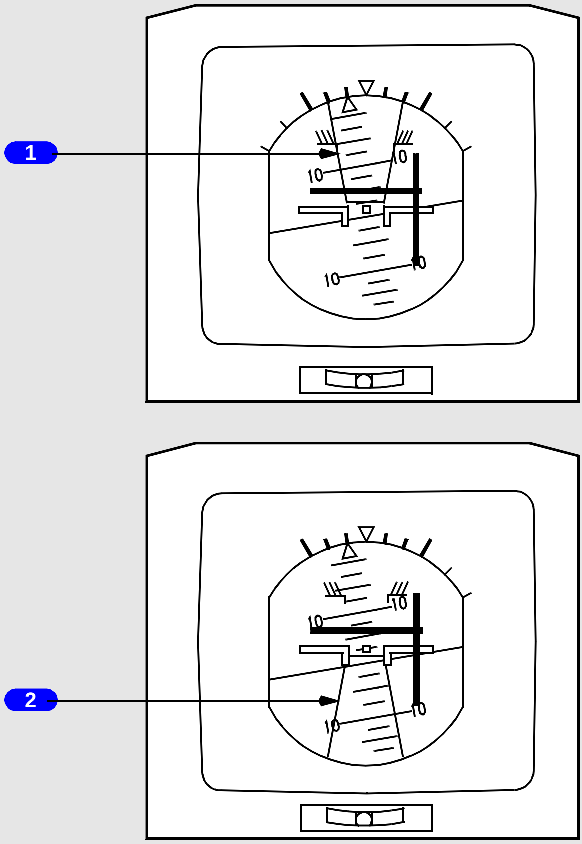
15 Slip Indicator

Indicates slip or skid during turns.

16 Radio Height Alert (white)

- displayed during a descent when radio altitude decreases to 2,500 feet AGL
- display is turned off when:
  - airplane descends below 500 feet AGL
  - airplane climbs above 2,500 feet AGL prior to descending to 500 feet
  - when reset (RST) button on EFIS control panel is pushed.

EADI TCAS Display



Airplanes with TCAS

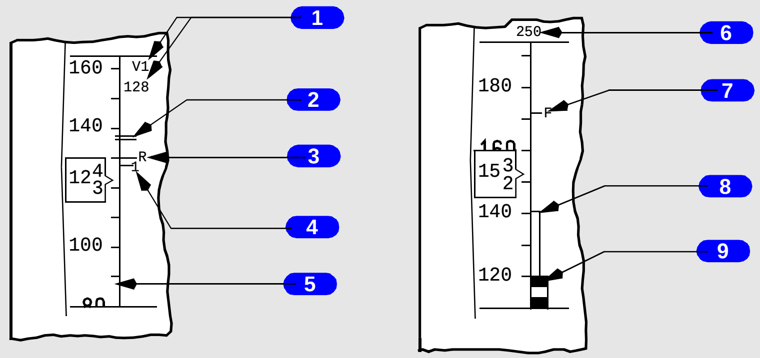
1 TCAS RA Pitch Command (red)

- down advisory
- displayed during RA condition
- indicates pitch attitude to be avoided for traffic separation.

2 TCAS RA Pitch Command (red)

- up advisory
- displayed during RA condition
- indicates pitch attitude to be avoided for traffic separation.

EADI Speed Tape



CAPTAIN'S EADI
FIRST OFFICER'S EADI

1 **V1 (Decision Speed) (green)**

- displayed after manual entry on the FMC/CDU TAKEOFF REF page
- displayed in this location during initial takeoff roll when V1 is beyond the displayed range.

2 **FMC/MCP Command Speed (magenta)**

Displayed in this location when the FMC/MCP command speed is in the displayed range.

3 **Vr (Rotation Speed) (green)**

Displayed after manual entry on the FMC/CDU TAKEOFF REF page.

4 **V1 (Decision Speed) (green)**

This symbol replaces digital V1 display (upper right corner of the speed tape when the V1 speed is within the displayed range.

5 **Speed Tape Scale (white)**

- scrolls up or down in response to ADC calibrated airspeed
- range is 45 to 420 knots.

6 FMC/MCP Command Speed (magenta)

Displayed in this location when the FMC/MCP command speed is above displayed range.

7 Minimum Flap Retraction Speed (green)

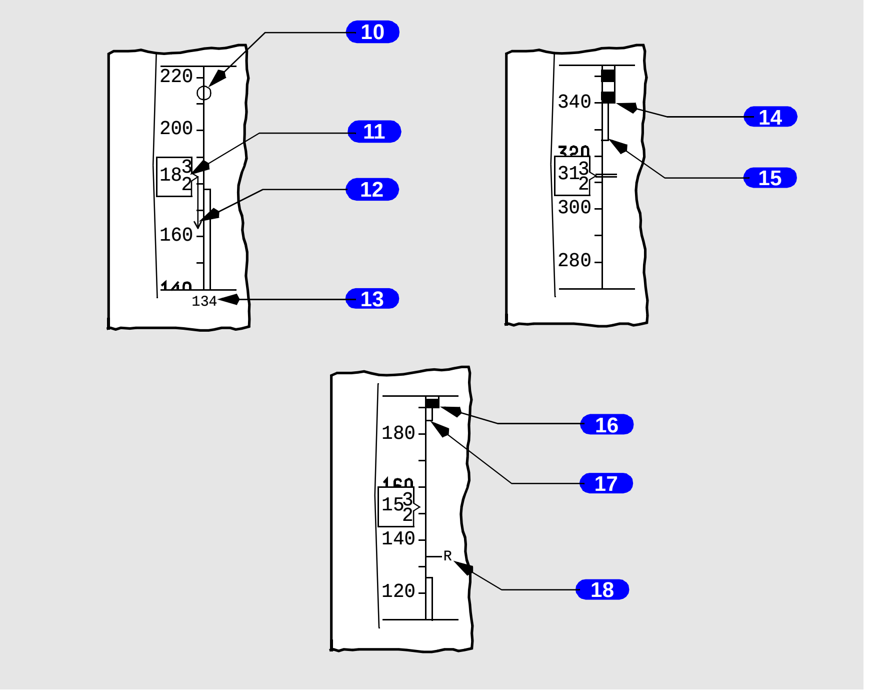
Displayed on speed tape during takeoff or go–around.

8 Minimum Maneuver Speed (yellow)

Top of hollow yellow bar indicates minimum maneuver speed.

9 Stick Shaker Speed (red and black)

Top of barber pole indicates speed at which stick shaker is activated.



10 Flaps Up Maneuvering Speed (green)

Displayed when flaps are up.

11 Rolling Digits Display (white)

- indicates current airspeed
- position is fixed relative to ADI display.

12 **Airspeed Trend Arrow (green)**

Tip of arrow depicts predicted airspeed within the next 10 seconds based on present airspeed and acceleration.

13 **FMC/MCP Command Speed (magenta)**

Displayed in this location when the FMC/MCP command speed is below displayed range.

14 **Max Operating Speed (red and black)**

Indicates Vmo/Mmo.

15 **High Speed Buffet Limit**

Bottom of yellow bar indicates speed that provides .3G maneuver margin to high speed buffet at high altitudes.

16 **Placard Speed (red and black)**

Indicates gear extended placard speed or flap extended placard speed for selected flap position, as applicable.

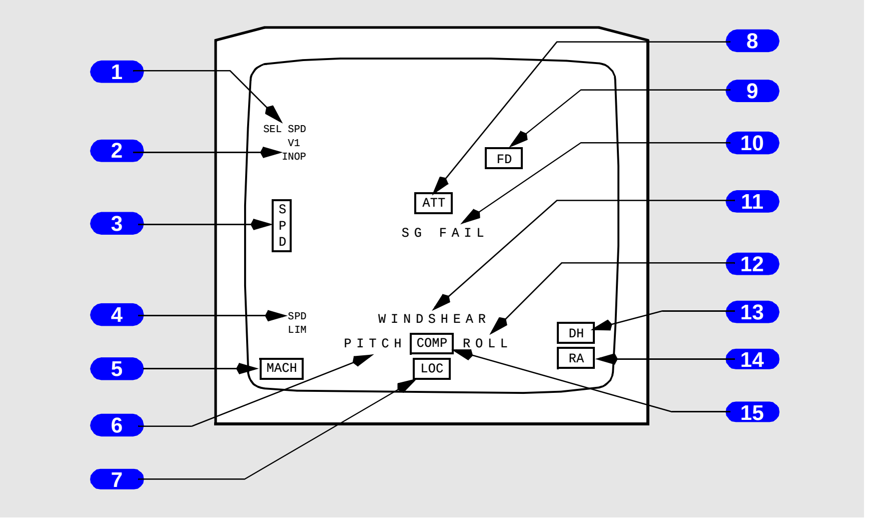
17 **Next Flap Position Placard Speed (yellow)**

Bottom of hollow yellow bar indicates the flap extended placard speed for the next normal flap position.

18 **Vref Speed (green)**

Indicates the Vref speed for the landing flap configuration as selected on the FMC/CDU APPROACH REF page.

EADI System Failure Flags and Annunciations



1 Selected Speed Annunciation (yellow)

Command speed symbol and displays inoperative.

2 V1 Inoperative Annunciation (yellow)

V1 display inoperative.

3 Speed Flag (yellow)

Speed tape display inoperative.

4 Speed Limit Annunciation (yellow)

Displays related to stick shaker and Maximum Operating Speeds failed.

5 Mach Flag (yellow)

Mach number display failed.

6 Pitch Comparator Annunciation (yellow)

Captain’s and F/O’s pitch angle displays differ by more than 3 degrees.

7 Localizer Flag (yellow)

Localizer deviation display on EADI failed.

8 **Attitude Flag (yellow)**

Attitude display failed.

9 **Flight Director Flag (yellow)**

Pitch and/or roll flight director commands failed.

10 **Symbol Generator Fail Annunciation (yellow)**

Selected symbol generator failed.

11 **Windshear Warning Annunciation (red)**

Ground proximity computer has detected a windshear condition.

12 **Roll Comparator Annunciation (yellow)**

Captain’s and F/O’s bank angle displays differ by more than 3 degrees.

13 **Decision Height Flag (yellow)**

Selected decision height display failed.

14 **Radio Altitude Flag (yellow)**

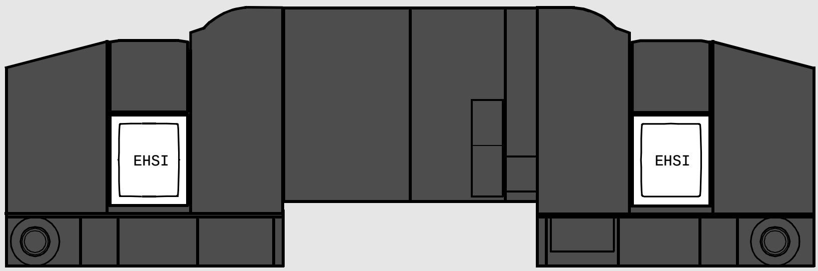
Radio altitude display failed.

15 **Pitch and Roll Comparator Function Flag (yellow)**

Comparator function failed.

Intentionally
Blank

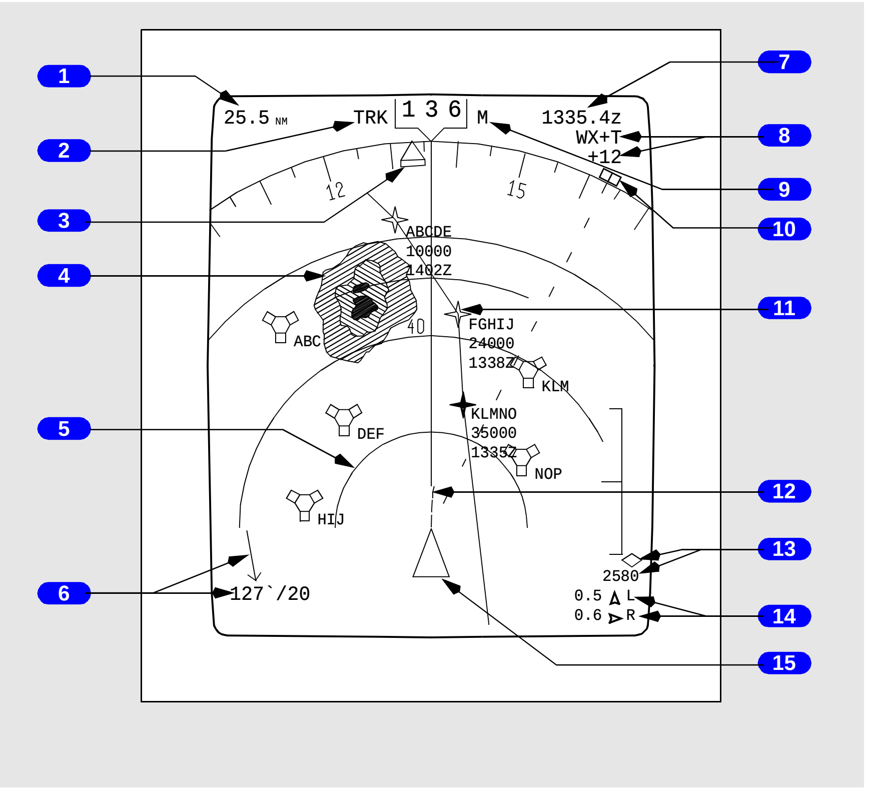
EHSI Displays



INSTRUMENT PANEL

Note: A detailed explanation of the navigation symbology immediately follows this section.

MAP Mode


1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
25.5 NM
TRK
1 3 6
M
1335.4z
WX+T
+12
12
15
ABCDE
10000
1402Z
40
FGHIJ
24000
1338Z
ABC
KLM
KLMNO
35000
1335Z
DEF
NOP
HIJ
2580
0.5 L
0.6 R
127`/20

1 Distance to Next Active Waypoint

2 Current Track

3 Heading Pointer

4 Weather Radar Returns

5 Weather Range Arcs

6 Wind Direction and Speed

7 Estimated Time of Arrival at Next Active Waypoint

8 Weather Radar Annunciations

9 Magnetic/True Reference

10 Selected Heading Bug

11 Active LNAV Route

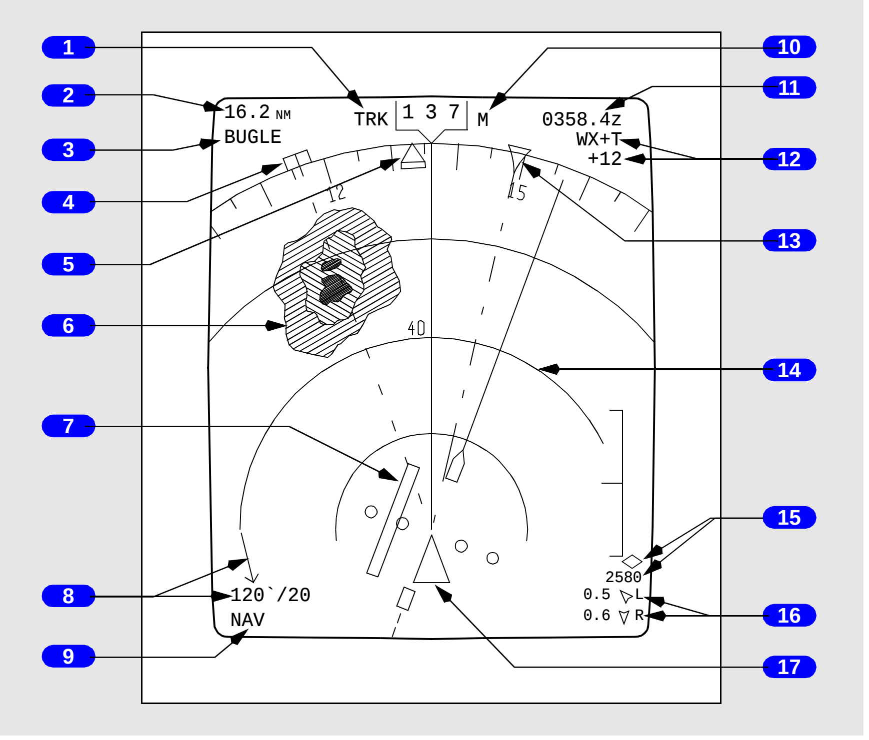
12 Position Trend Vector

13 Vertical Deviation Scale and Pointer

14 Position Difference Display

15 Airplane Symbol

Expanded Navigation Mode (As Installed)



1 Current Track

2 Distance to Next Active Waypoint

3 Active Waypoint Name

4 Selected Heading Bug

5 Heading Pointer

6 Weather Radar Returns

7 Lateral Deviation Indicator and Deviation Scale

8 Wind Direction and Speed

9 Nav Data Source

10 Magnetic/True Reference

11 Estimated Time of Arrival at Next Active Waypoint

12 Weather Radar Annunciations

13 Waypoint Bearing Pointer

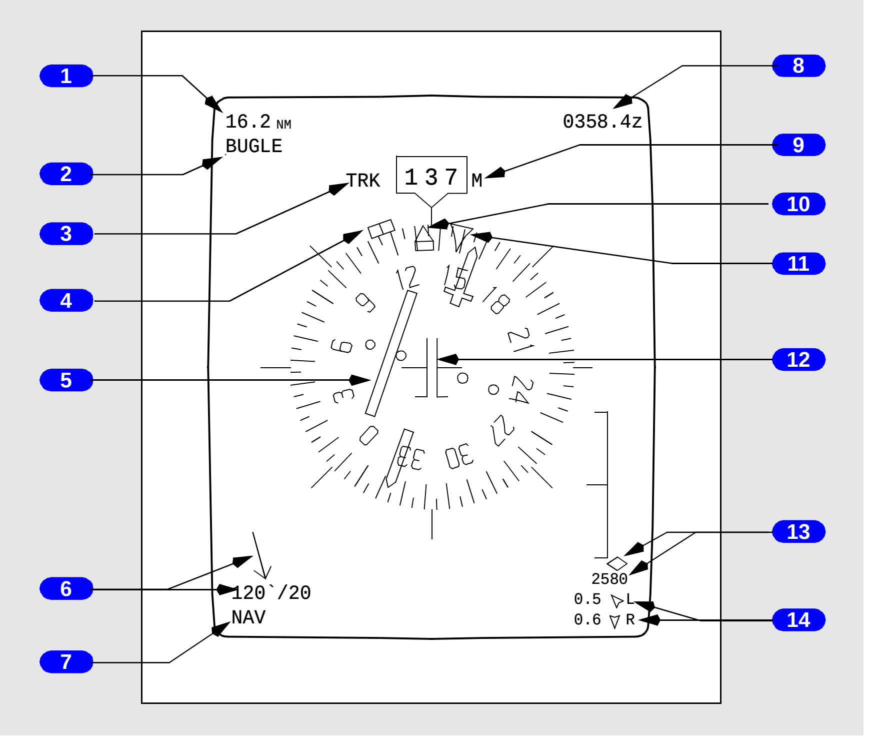
14 Weather Range Arcs

15 Vertical Deviation Scale and Pointer

16 Position Difference Display

17 Airplane Symbol

Full Rose Navigation Mode (As Installed)



1 **Distance to Next Active Waypoint**

2 **Active Waypoint Name**

3 **Current Track**

4 **Selected Heading Bug**

5 **Lateral Deviation Indication and Scale**

6 **Wind Direction and Speed**

7 **Nav Data Source**

8 **Estimated Time of Arrival at Next Active Waypoint**

9 **Magnetic/True Reference**

10 **Heading Pointer**

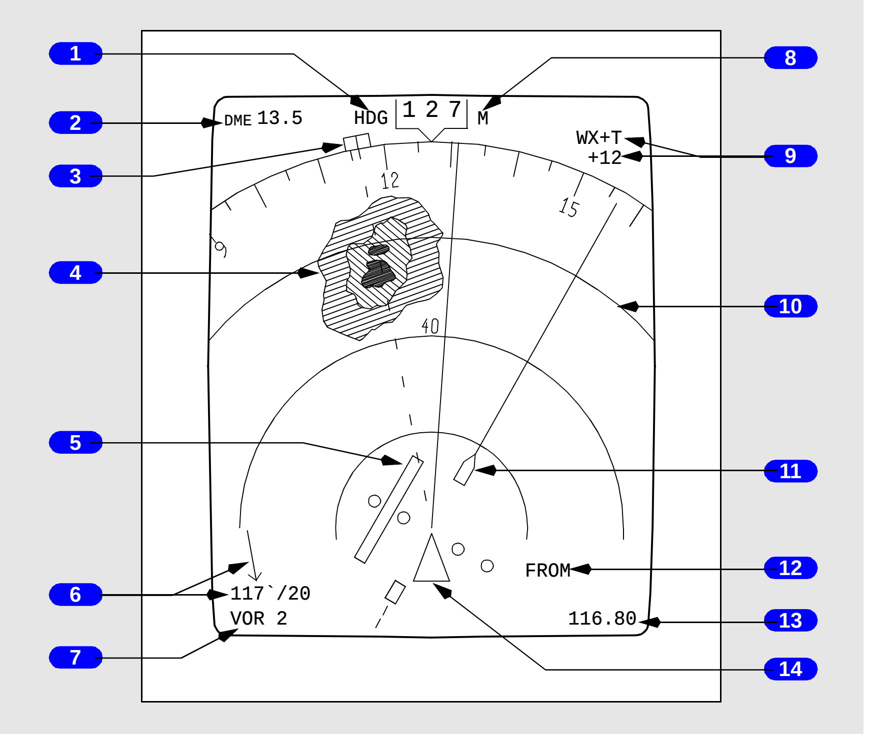
11 **Waypoint Bearing Pointer**

12 **Airplane Symbol**

13 **Vertical Deviation Scale and Pointer**

14 **Position Difference Display**

Expanded VOR Mode



1 **Current Heading**

2 **Reference VOR DME**

3 **Selected Heading Bug**

4 **Weather Radar Returns**

5 **Lateral Deviation Indication and Scale**

6 **Wind Direction and Speed**

7 **Reference VOR Receiver**

8 **Magnetic/True Reference**

9 **Weather Radar Annunciations**

10 **Weather Range Arcs**

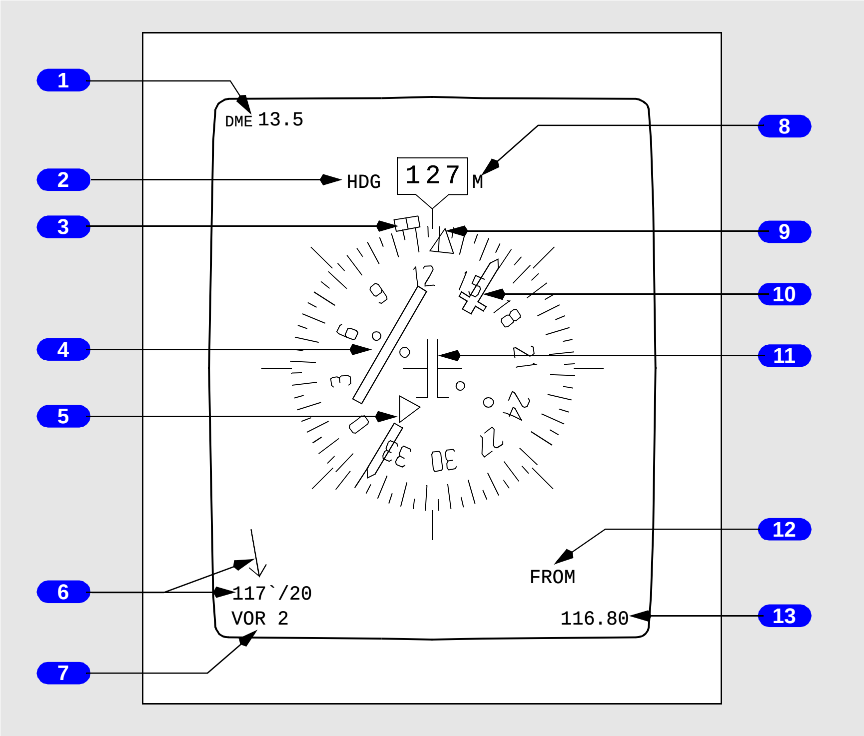
11 **Selected Course Pointer**

12 **TO/FROM Indication**

13 **Reference VOR Frequency**

14 **Airplane Symbol**

Full Rose VOR Mode



1 **Reference VOR DME**

2 **Current Heading**

3 **Selected Heading Bug**

4 **Lateral Deviation Indication and Scale**

5 **TO/FROM Indication**

6 **Wind Direction and Speed**

7 **Reference VOR Receiver**

8 **Magnetic/True Reference**

9 **Drift Angle Pointer**

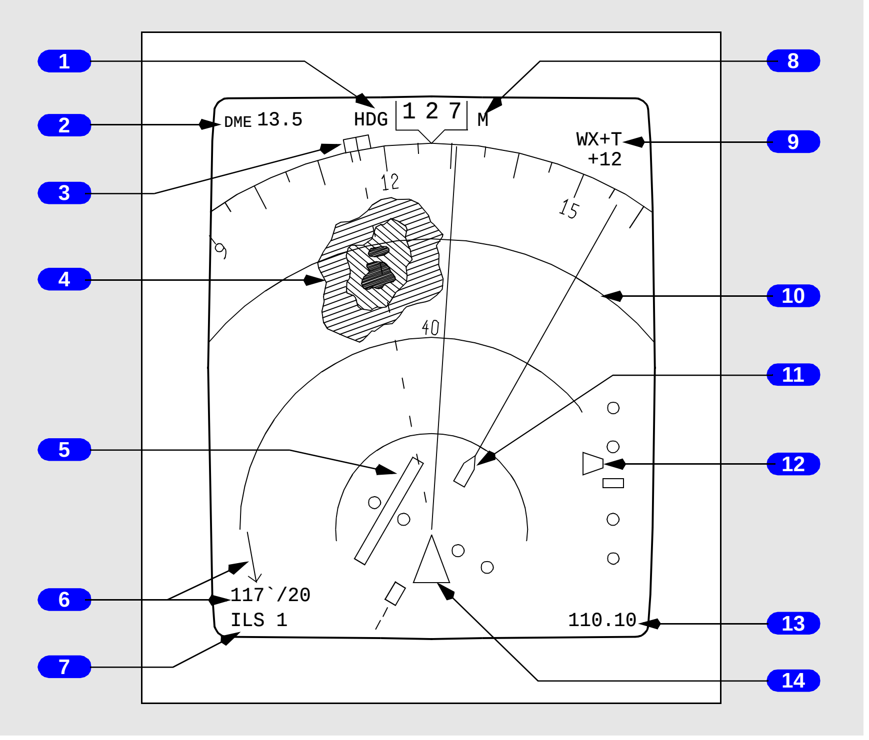
10 **Selected Course Pointer**

11 **Airplane Symbol**

12 **TO/FROM Indication**

13 **Reference VOR Frequency**

Expanded ILS Mode



1 **Current Heading**

2 **Reference ILS DME**

3 **Selected Heading Bug**

4 **Weather Radar Returns**

5 **Localizer Deviation Indication and Scale**

6 **Wind Direction and Speed**

7 **Reference ILS Receiver**

8 **Magnetic/True Reference**

9 **Weather Radar Annunciations**

10 **Weather Range Arcs**

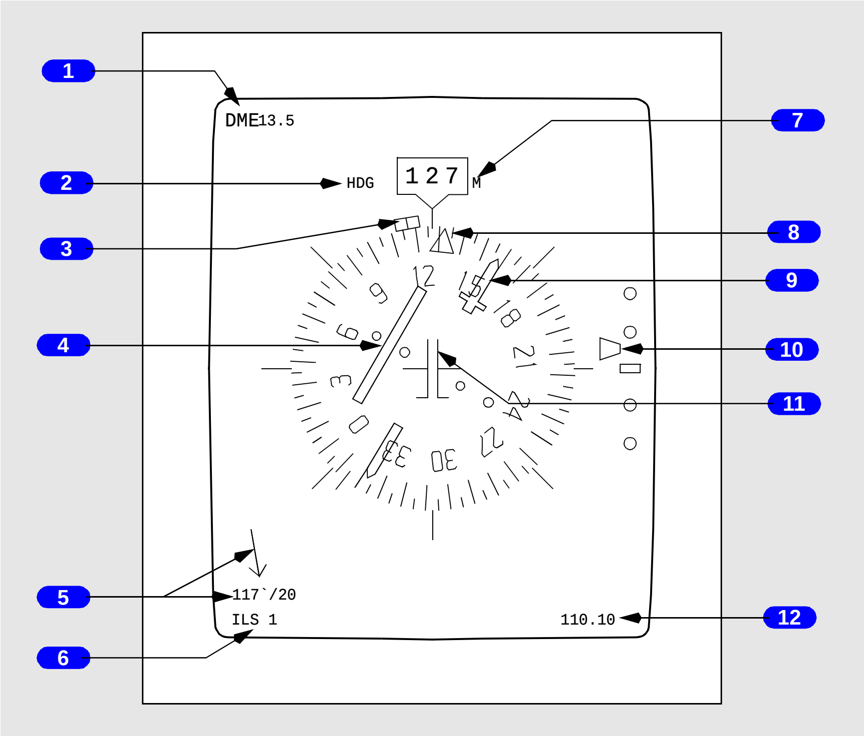
11 **Selected Course Pointer**

12 **Glideslope Pointer and Scale**

13 **Reference ILS Frequency**

14 **Airplane Symbol**

Full Rose ILS Mode



1 **Reference ILS DME**

2 **Current Heading**

3 **Selected Heading Bug**

4 **Lateral Deviation Indication and Scale**

5 **Wind Direction and Speed**

6 **Reference ILS Receiver**

7 **Magnetic/True Reference**

8 **Drift Angle Pointer**

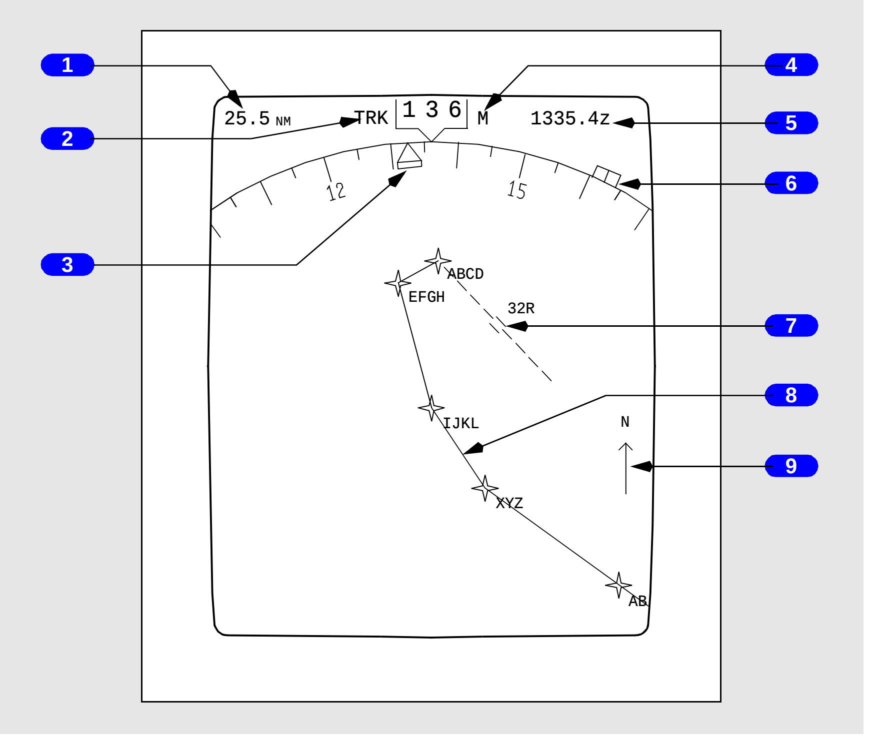
9 **Selected Course Pointer**

10 **Glideslope Pointer and Scale**

11 **Airplane Symbol**

12 **Reference ILS Frequency**

Plan Mode



1 **Distance to Next Active Waypoint**

2 **Current Track**

3 **Heading Pointer**

4 **Magnetic/True Reference**

5 **Estimated Time of Arrival at Next Active Waypoint**

6 **Selected Heading Bug**

7 **Airport and Runway**

8 **Active Route**

9 **True North Pointer**

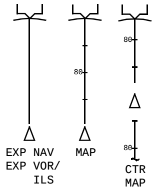
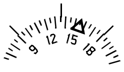
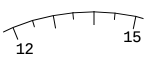
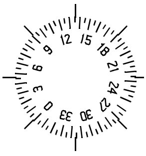
EHSI Symbology

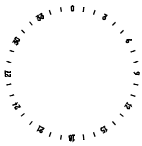
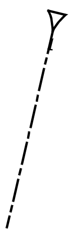
The following symbols can be displayed, depending on EFIS control panel switch selections. Colors indicate the following:

- W (white) – present status, range scales
- G (green) – active or selected mode and/or dynamic conditions
- M (magenta/pink) – command information, pointers, symbols, fly–to condition, weather radar turbulence
- C (cyan/blue) – nonactive or background information
- A (amber) – cautions, faults, flags
- R (red) – warnings
- B (black) – blank area, off condition.

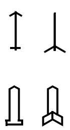
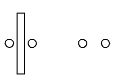
Heading, Track, and Wind

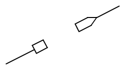
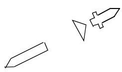
Symbol	Name	Applicable Mode(s)	Remarks
TRK 062 M	Track orientation (G), current track (W), and track reference (G)	MAP CTR MAP FULL NAV EXP NAV PLAN	Displays TRK as the orientation, the current track, and M or TRU as the reference, and points to the heading on the compass rose.
HDG 062 M	Heading orientation (G), current heading (W), heading reference (G), and heading pointer (W)	FULL VOR/ ILS EXP VOR/ ILS	Displays HDG as the display orientation, current heading, M or TRU as the heading reference, and points to the heading on the compass rose.
	Selected heading bug (M) and reference line (M)	All	Displays the MCP–selected heading. A dashed line (M) extends from the marker to the airplane symbol (except for PLAN mode.

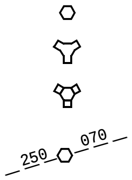
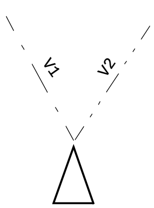
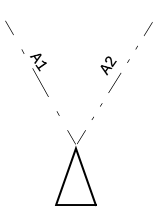
Symbol	Name	Applicable Mode(s)	Remarks
	Track line and range scale (W)	MAP CTR MAP EXP NAV EXP VOR/ ILS	Displays present ground track based on airplane heading and wind. The displayed range numeric value(s) is (are) one-half the actual selected range. With heading-up orientation (VOR/ILS mode), the track line will be rotated left or right at an angle equal to the drift angle.
M OR TRU	Heading/track reference (G), box (W) in TRU, box (A) if TRU displayed in descent	ALL	Indicates heading/track is referenced to magnetic north or true north. On transition from TRU to M, a highlight box is displayed around M for 10 seconds. When TRU is the reference, the highlight box is displayed full time (white).
	Drift Angle Pointer (W)	FULL VOR/ ILS	Displays present ground track. Replaces track line when a full rose mode is selected.
	Expanded compass (W)	MAP EXP NAV EXP VOR/ ILS PLAN	Displays 70 degrees of compass rose.
	Full compass rose (W) Fixed reference marks (W)	FULL NAV FULL VOR/ ILS	The compass rose rotates through 360 degrees as a function of airplane heading or track. Fixed reference marks are evenly spaced at 45 degree intervals.

Symbol	Name	Applicable Mode(s)	Remarks
	Center Map full compass rose(W)	CTR MAP	The compass rose rotates through 360 degrees as a function of airplane track.
	Current heading pointer (W)	MAP CTR MAP EXP NAV FULL NAV PLAN	Points to current heading on the compass rose.
	Waypoint bearing pointer (M)	EXP NAV FULL NAV	Displays relative bearing to active waypoint
 350°/15	Wind direction/ speed and wind arrow (W)	All except PLAN	Indicates wind speed and direction, with respect to display orientation and heading/track reference. Displayed if wind magnitude is greater than 6 knots and blanked if wind magnitude becomes less than 4 knots.

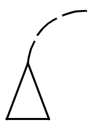
Radio Navigation

Symbol	Name	Applicable Mode(s)	Remarks
VOR 1, 2 ILS 1, 2 NAV	HSI nav data source(G)	FULL NAV EXP NAV FULL VOR/ ILS EXP VOR/ ILS	Indicates the source of the displayed navigation data. In the VOR/ILS mode the displayed data source is a function of the tuned frequency (VOR or LOC). In the NAV mode, “NAV” indicates the data source is the FMC.
116.80	ILS/VOR frequency display (G)	FULL VOR/ ILS EXP VOR/ ILS	Displays frequency of manually tuned navaid. The word “AUTO” is displayed in place of the frequency if the VHF NAV radio is in the auto tune mode.
DME 124	DME distance (W)	FULL VOR/ ILS EXP VOR/ ILS	Indicates DME distance to the reference navaid.
	ADF 1 pointer head and tail (G) ADF 2 pointer head and tail (G)	FULL NAV EXP NAV FULL VOR/ ILS EXP VOR/ ILS PLAN MAP CTR MAP	Indicates bearing to (head) or from (tail) the tuned station. Displayed in MAP/CTR MAP modes on some airplanes only.
	Lateral deviation indicator (M) and scale (W)	FULL NAV EXP NAV FULL VOR/ ILS EXP VOR/ ILS	Displays ILS, VOR, or FMC course deviation. ILS normal scale: 1 dot = 1° (approx) ILS expanded scale: 1 dot = 1/2° (approx) VOR: 1 dot = 5° NAV: 1 dot = 2NM

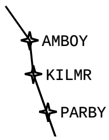
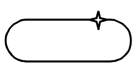
Symbol	Name	Applicable Mode(s)	Remarks
	Selected course pointer (W) and line (M)	EXP NAV EXP VOR/ ILS	Displays selected course as set by the related MCP course selector. (VOR/ILS) or by the FMC (NAV).
	Selected course pointer (W) TO/FROM pointer (W)	FULL NAV FULL VOR/ ILS	Displays selected course as set by the related MCP course selector (VOR/ILS) or by the FMC (NAV). TO/FROM pointer is displayed when VOR navigation is being used.
	Glideslope pointer (M) and scale (W)	FULL VOR/ ILS EXP VOR/ ILS	Displays glideslope position and deviation.
TO FROM	To/from indication (W)	FULL VOR/ ILS EXP VOR/ ILS	Displays VOR TO/FROM indication.

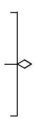
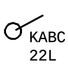
Symbol	Name	Applicable Mode(s)	Remarks
	VOR (C, G), DME/TACAN (C, G), VORTAC (C, G) Manually tuned VOR radials (G)	MAP CTR MAP PLAN	When the EFIS control panel NAV AID switch is selected on, appropriate navaids are displayed. All navaids contained in the FMC data base and within the MAP area are displayed when the selected range is 10, 20 or 40 NM. Only high altitude navaids are displayed when the selected range is 80, 160, 320 NM. Navaids not being used are displayed in cyan. Tuned VHF navaids are displayed in green. Tuned VHF navaids are displayed in green, regardless of NAV AID switch selection. When a navaid is manually tuned, the selected course and reciprocal are displayed.
	VOR radials (G)	MAP CTR MAP	When the VOR/ADF switch is selected on and a valid VOR signal is received, the station radial is displayed.
	ADF bearings (G)	MAP CTR MAP	When the VOR/ADF switch is selected on and a valid ADF signal is received, the relative bearing to the tuned ADF station is displayed.

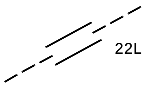
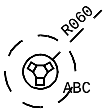
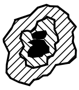
MAP

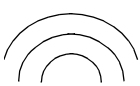
Symbol	Name	Applicable Mode(s)	Remarks
	Airplane symbol (W)	MAP CTR MAP EXP NAV EXP VOR/ ILS PLAN	Current airplane position is at the apex of the triangle.
	Airplane symbol (W)	FULL NAV FULL VOR/ ILS	Current airplane position is at the center of the symbol.
	Position trend vector (W) (dashed line)	MAP CTR MAP	Predicts position at the end of 30, 60, and 90 second intervals, based on bank angle and ground speed. Each segment represents 30 seconds. Selected range determines the number of segments displayed: • Range > 20 NM, 3 segments • Range = 20 NM, 2 segments • Range = 10 NM, 1 segment
ABCDE	Active waypoint identifier (M)	FULL NAV EXP NAV	Indicates the active flight plan waypoint, the next waypoint on the route of flight.
124 NM	Active waypoint distance (W)	MAP CTR MAP FULL NAV EXP NAV PLAN	Distance to the active waypoint.
0835.4z	Active waypoint ETA (W)	MAP CTR MAP FULL NAV EXP NAV PLAN	Indicates FMC–calculated ETA at the active waypoint.

Symbol	Name	Applicable Mode(s)	Remarks
ALERT	Course change Alert annunciation (A)	FULL NAV EXP NAV	Displayed 10 seconds prior to course change or 10 seconds prior to sequencing a waypoint if no course change is required. Removed as APL begins roll to new course or when waypoint is sequenced.
✧ AMBOY	Standard Waypoint: active (M), inactive (W)	MAP CTR MAP PLAN	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route.
○ (_____)	Conditional Waypoint: active (M), inactive (W)	MAP CTR MAP PLAN	Active – represents the waypoint the airplane is currently navigating to. Inactive – represents the waypoints on the active route. Data with parentheses for conditional waypoints indicates type of conditional waypoint (altitude, “VECTORS”, “INTC”, etc.)
△ MLF	Off route waypoint (C)	MAP CTR MAP PLAN	When the EFIS control panel WPT switch is selected on, waypoints not on the selected route are displayed, for ranges of 5, 10, 20, or 40 NM.

Symbol	Name	Applicable Mode(s)	Remarks
	Flight plan route: active (M), modified (W), inactive (C)	MAP CTR MAP PLAN	The active route is displayed with a continuous line (M) between waypoints. Active route modifications are displayed with short dashes (W) between waypoints. Inactive routes are displayed with long dashes (C) between waypoints.
	Route data: active waypoint (M), inactive waypoint (W)	MAP CTR MAP PLAN	When the EFIS control panel RTE DATA switch is selected on, altitude constraints and ETAs for route waypoints are displayed.
	Holding pattern: active route (M), modified route (W), inactive route (C)	MAP CTR MAP PLAN	A holding pattern appears when in the flight plan. The holding pattern appears as a fixed size if the selected range is greater than 80 NM. A scaled representation of the holding pattern is displayed when the selected range is 80 NM or less and the airplane is within 3 minutes of the holding fix.
	Altitude range arc (G)	MAP CTR MAP	Based on present vertical speed and ground speed, indicates the approximate map position where the MCP altitude is reached.

Symbol	Name	Applicable Mode(s)	Remarks
○ T/C ○ T/D ○ S/C ○ E/D ○ T/D-XXXXX ○	Altitude profile point and identifier (G)	MAP CTR MAP PLAN	Indicates the approximate map position of the FMC–calculated T/C (top–of–climb), T/D (top–of–descent), S/C (step climb), and E/D (end of descent) points. Indicates intermediate T/D points for level flight path segments during descent. Lvel flight path segment altitude is displayed. Deceleration points have no identifier.
	VNAV path pointer (M) and deviation scale (W)	MAP CTR MAP FULL NAV EXP NAV	Displays vertical deviation from selected VNAV PATH during descent only. Scale indicates +/- 400 feet deviation. Digital display is provided when the pointer indicates more than +/- 400 feet.
	Airport and runway (W)	MAP CTR MAP PLAN	Displayed when selected as the origin or destination and selected range is 80, 160, or 320 NM.
○ KTEB	Airport (C)	MAP CTR MAP PLAN	Displayed if the EFIS control panel ARPT switch is selected on. Origin and destination airports are always displayed, regardless of switch selection.

Symbol	Name	Applicable Mode(s)	Remarks
	Airport and runway (W)	MAP CTR MAP PLAN	Displayed when selected as the origin or destination and selected range is 5, 10, 20, or 40 NM. Dashed runway centerlines extend 14.2 NM.
	Selected reference point and bearing distance information (G)	MAP CTR MAP PLAN	Displays the reference point selected on the CDU FIX page. Bearing and/or distance from the fix are displayed with dashes (G).
	Weather radar returns (R, A, G, M)	MAP CTR MAP EXP NAV EXP VOR/ ILS	The most intense areas are displayed in red, lesser intensity in amber, and lowest intensity green. Turbulence is displayed in magenta.

Symbol	Name	Applicable Mode(s)	Remarks
4.5 ▷L 4.3 △R	Position difference display (W)	MAP CTR MAP FULL NAV EXP NAV	Numbers – indicate the position difference in NM between the present FMC position and the L IRS and R IRS present positions. The selected IRS source is displayed on the first line. Arrows – indicate the relative bearing to the related IRS present position. L or R – indicates which IRS present position the displayed position difference corresponds to. Displayed when the position difference of the L IRS and/or R IRS exceeds the position difference limits.
N ↑	North up arrow (G)	PLAN	Indicates map background is oriented and referenced to true north.
	Range arcs (W)	MAP EXP NAV EXP VOR/ ILS	Displayed in EXP NAV and EXP VOR/ILS modes when the EFIS WXR switch is selected on or TCAS TFC switch is selected. Range arcs are displayed in MAP mode with or without WXR or TFC selected.

Radar

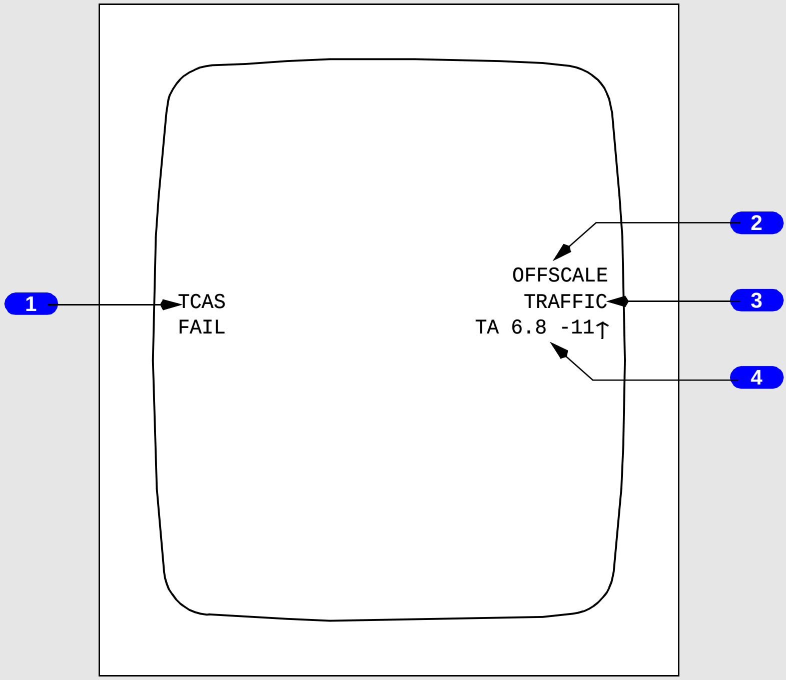
Symbol	Name	Applicable Mode(s)	Remarks
VAR/MAP +12	Weather radar Annunciations (G)	MAP CTR MAP PLAN EXP NAV FULL NAV	These symbols are displayed only when the weather radar switch on the EFIS control panel is selected on. (refer to Chapter 11, Flight Management, Navigation). GAIN – VAR indicates that gain control is not in CAL (calibrated) detent. MODE: • MAP – weather radar is operating in map mode • WX – weather radar is operating in weather mode • WX+T – weather radar is operating in weather mode with turbulence detection enabled • TEST – weather radar is in test mode, and test pattern is displayed TILT – indicates antenna tilt angle.

TCAS

Symbol	Name	Applicable Mode(s)	Remarks
■ ↑ -03	TCAS resolution advisory (RA), relative altitude (R)	MAP CTR MAP EXP NAV EXP VOR/ ILS	These symbols are displayed only when the EFIS control panel traffic (TFC) switch is selected on. Refer to Chapter 15, Warning Systems. The arrow indicates traffic climbing or descending at a rate greater than or equal to 500 fpm. At rates less than 500 fpm, the arrow is not displayed. For relative altitude symbols, the number and related signs indicate altitude of traffic in hundreds of feet relative to the airplane. For absolute altitude symbols, the number indicates altitude of traffic in thousands and hundreds of feet. For both relative and absolute altitude, the number is below the traffic symbol when the traffic is below, and above the traffic symbol when the traffic is above the airplane. Absence of the number implies altitude unknown.
+02 ● ↓	TCAS traffic advisory (TA), relative altitude (A)		
♦ ↓ -05	TCAS proximate traffic, relative altitude (W)		
+09 ◊ ↑	TCAS other traffic, relative altitude (W)		
● ↑ 12 8	TCAS TA, absolute altitude		
RA 5.3 +03 ↑ TA 8.9 -12 ↑	TCAS no bearing message (RA–R, TA–A)	MAP CTR MAP EXP NAV EXP VOR/ ILS	Message provides traffic type, range in NM, altitude and vertical direction.

Symbol	Name	Applicable Mode(s)	Remarks
TRAFFIC	TCAS traffic alert message (RA–R, TA–A)	All	Displayed whenever a TCAS RA or TA is active. EFIS control panel TFC switch does not have to be selected on.
OFFSCALE	TCAS off scale message (RA–R, TA–A)	MAP CTR MAP EXP NAV EXP VOR/ ILS	Displayed whenever RA or TA traffic is outside the traffic area covered by the selected range. Displayed only if the EFIS control panel TFC switch is selected on.
TFC	TCAS mode (B)	MAP CTR MAP EXP NAV EXP VOR/ ILS	Indicates the TCAS display is active; the EFIS control panel TFC switch is selected on.
TA ONLY	TCAS mode (B)	All	Indicates TCAS computer is not computing RAs. Displayed whether the EFIS control panel TFC switch is selected on or off.
TCAS TEST	TCAS mode (B)	All	Indicates TCAS is operating in the test mode. Displayed whether EFIS control panel TFC switch is selected on or off.
TCAS OFF	TCAS mode (A)	All	Displayed when the TCAS/ATC mode switch is not in TA ONLY or TA/RA, whether EFIS control panel TFC switch is selected on or off. Not displayed if TCAS is failed or in test.
TCAS FAIL	TCAS mode (A)	All	Indicates TCAS failure, whether EFIS control panel TFC switch is selected on or off. Once displayed, can be cycled on/off with the TFC switch.

EHSI TCAS Messages



Airplanes with TCAS

1 TCAS Mode Display

TFC (green) – TFC selected on EFIS control panel in the MAP, VOR, or ILS mode.

TCAS TEST (white) – TCAS in test mode.

TCAS FAIL (amber) – TCAS failed.

TA ONLY (green) – TCAS TA ONLY mode is selected (displayed in all EHSI modes whether TFC is selected or not).

TCAS OFF (white) – TCAS is selected OFF (displayed in MAP, VOR, and ILS modes.

2 OFFSCALE

Displayed (amber) – TA traffic beyond EHSI display range.

Displayed (red) – RA traffic beyond EHSI display range.

3 **TRAFFIC**

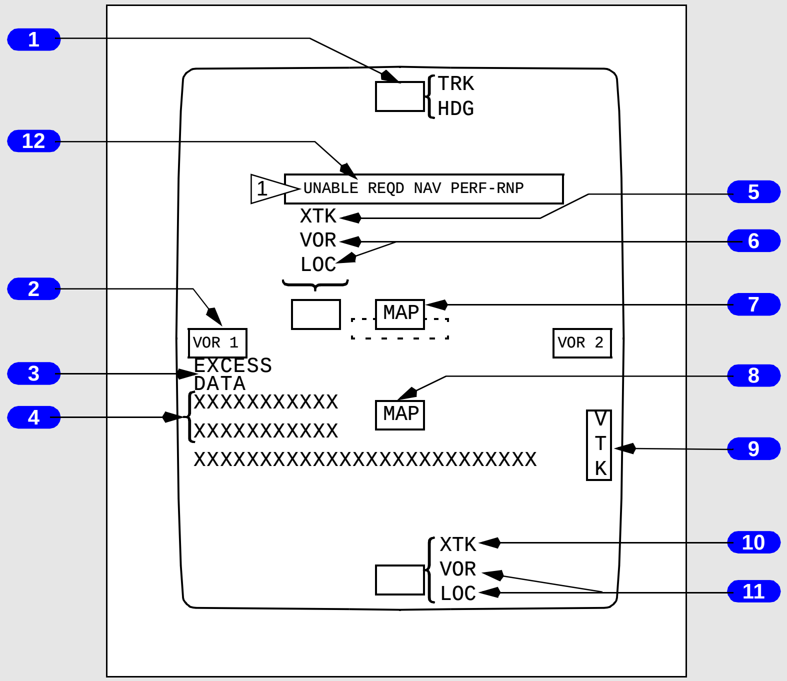
Displayed (amber) – TA condition exists

Displayed (red) – RA condition exists.

4 **No Bearing Messages**

Displayed (red or amber) – No bearing information available for traffic (see EHSI symbology chart for display).

EHSI System Failure Flags and Annunciations



NOTE: All flags are yellow

1 As installed

1 **Track (TRK) or Heading (HDG) Flag**

Track or heading data has failed.

2 **VOR Flag**

Indicates failure of a VOR display on the EHSI (displayed here if the MAP or CTR MAP mode is selected and the VOR/ADF switch is on.

3 **EXCESS DATA Annunciation**

- refresh rate of MAP display has dropped below limit
- display may flicker at lower refresh rates.

4 **WXR Annunciations (left justified, two lines)**

- WXR FAIL – indicates weather radar has failed (no weather data displayed
- WXR WEAK – indicates weather radar calibration fault
- WXR ATT – indicates loss of attitude stabilization for antenna
- WXR STAB – indicates antenna stabilization is off
- WXR DSPY – indicates loss of display unit cooling or an overheat condition of the EHSI. Weather radar display is blanked.

5 **Crosstrack (XTK) Deviation Flag**

Indicates failure of the FMC crosstrack deviation data (displayed here if the FULL NAV mode is selected).

6 **VOR, LOC Flag**

Indicates failure of the EHSI VOR or LOC display (displayed here if the FULL VOR/ILS mode is selected).

7 **MAP Flag**

Indicates failure of associated FMC generated map display (displayed here if CTR MAP mode is selected).

8 **MAP Flag**

Displayed here if MAP mode is selected.

9 **Vertical Track (VTK) Flag (typical location)**

Indicates failure of the FMC vertical track data.

10 **Crosstrack (XTK) Deviation Flag**

Displayed here if the EXP NAV mode is selected.

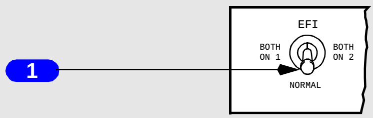
11 **VOR, LOC Flag**

Displayed here if the EXP VOR/ILS mode is selected.

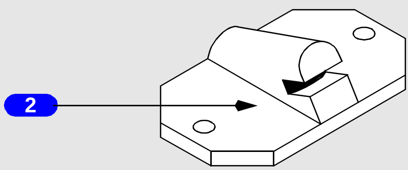
12 NAV Advisory Message

UNABLE REQD NAV PERF–RNP – Indicates that FMC ANP is not sufficient for the current special RNP (displayed here if MAP or CTR MAP is selected).

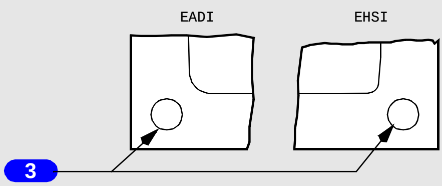
EFI Transfer Switch and EFIS Light Sensors



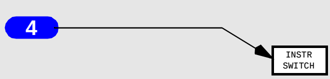
FORWARD OVERHEAD PANEL



GLARESHIELD



CAPT INSTRUMENT PANEL
F/O INSTRUMENT PANEL



CAPT INSTRUMENT PANEL
F/O INSTRUMENT PANEL

1 Electronic Flight Instrument (EFI) Transfer Switch

NORMAL – Captain’s and First Officer’s EFIS displays are generated from their related symbol generators.

BOTH ON 1 – Both EFIS displays are generated from the No. 1 symbol generator.

BOTH ON 2 – Both EFIS displays are generated from the No. 2 symbol generator.

2 Remote Light Sensor

Provides automatic adjustment of EFIS EADI and EHSI display brightness as a function of ambient light coming through the associated forward window.

3 Integral Light Sensors

Provide automatic control of EFIS EADI and EHSI display brightness as a function of ambient light striking the face of the display units.

4 Instrument Transfer Switch (INSTR SWITCH) Light

ILLUMINATED–one or both of the instrument transfer switches (EFI or IRS) has been moved out of the normal position.

Flight Instruments, Displays — Chapter 10
EFIS System Description — Section 40

Introduction

The electronic flight instrument system (EFIS) consists of two symbol generators (SGs), two control panels (CPs), two electronic attitude director indicators (EADIs or ADIs), two electronic horizontal situation indicators (EHSIs or HSIs), and ambient light sensing units. The EFIS utilizes information provided by a variety of aircraft systems to generate the appropriate visual presentations on the EHSI and EADI. Data relating primarily to navigation is provided by aircraft systems such as the navigation radios, flight management computer (FMC), and the inertial reference systems (IRSs). Data relating primarily to automatic flight is provided by the flight control computers (FCCs), the autothrottle (A/T), and the FMC. Data which is used to display current aircraft state information is provided by the air data computers (ADCs) and the IRSs. Automatic adjustment of the display intensity for each display unit is provided by the ambient light sensing units. flight crew control of the EFIS displays is accomplished by positioning the various controls on the respective EFIS control panels to the desired settings.

EFIS Failures Flags and Annunciation

In addition to the normal EFIS displays, various failure annunciations, flags, or indications may be displayed on the EADI or EHSI.

The location of the different failure flags and annunciations is depicted in the EADI and EHSI SYSTEM FAILURE FLAGS AND ANNUNCIATIONS figures included in the EFIS controls and indicators section.

Not all EFIS displays will be replaced by a failure flag or annunciation if the signal from the sending unit has failed. In theses instances, failure is indicated by removal of the data or the affected portions of the display.

Note: The EFIS displays respond to a VHF NAV receiver failure by removing the associated magenta deviation bar and/or pointer. In response to an ADF receiver failure, the associated display symbol(s) (ADF pointers or vectors) are removed from the EHSI.

EFIS Symbol Generator

Two symbol generators form the heart of the EFIS. The SGs receive inputs from various aircraft systems, then generate the proper visual displays for the related EADI and EHSI.

EFIS Control Panels

Each SG is connected to an EFIS control panel. Using the related EFIS control panel, a flight crew member can select the EHSI display mode, the EHSI display options, the EHSI display range, the EADI decision height reference, and the EHSI weather radar display option. The EFIS control panels also allow the flight crew to adjust the EADI, EHSI, and weather radar display brightness levels.

Electrical Power

The electronic flight instrument system operates on 115 volt AC power. With loss of all airplane generators, the Captain's and the First Officer's EFIS are inoperative. The standby Instruments provide a backup source of information in this event.

Electronic Attitude Director Indicator

The EADI presents conventional EADI displays for attitude (pitch and roll), flight director commands, localizer deviation and glide slope deviation. In addition, the EADI displays information relating to autoflight system mode annunciations, airplane speed (Vmo/Mmo, minimum speeds, CAS, placards, V1, Vr, etc.), pitch limit, Mach, ground speed, radio height alert, decision height, and radio altitude.

Attitude Display

Airplane attitude data is provided by the IRSs. The IRSs pitch and roll attitude information is valid throughout 360 degrees of rotation in each axis.

Mode Annunciations

Mode annunciations for the A/T and the AFDS are displayed at the top of the EADI displays. A detailed description of the various autoflight mode annunciations and their meanings is contained in Chapter 4.

Flight Director Commands

Flight director guidance commands from the selected FCC are displayed via the flight director symbol on the EADI.

Glide Slope and Localizer Deviation Displays

Glide slope and localizer deviation scales appear when a localizer frequency is tuned on the associated VHF NAV receiver. A valid signal is required before the deviation pointer is displayed.

The normal localizer deviation scale is one degree per dot. When the course deviation is approximately 5/8 degree deviation (5/8 dot) and VOR/LOC is engaged, the scale automatically expands to indicate 1/2 degree deviation per dot. The scale remains expanded until after landing rollout or on a go-around with radio altitude greater than 200 feet.

On a backcourse approach, the symbol generator reverses the polarity of the localizer deviation pointer on the EADI. The reversal occurs when the airplane track differs from selected MCP course by more than 90 degrees. Thus, when the frontcourse is set in the MCP course display, the EADI and EHSI course deviation display will agree on both a frontcourse and a backcourse approach. Additionally, the glideslope scale is not displayed for a backcourse approach.

ILS Deviation Warning

ILS deviation monitoring alerts the flight crew of excessive LOC or G/S deviations. This alerting function is operative during single or dual A/P channel ILS approach. The alerting system is armed when the airplane descends below 1,500 feet radio altitude (RA) with the LOC and G/S captured. If the Captain’s or the F/O’s LOC deviation exceeds one–half dot expanded scale (one–fourth dot standard scale), the respective LOC scale changes color from white to yellow, and the miniature runway stem flashes.

If the Captain’s or F/O’s G/S deviation exceeds one dot deviation, the respective G/S scale changes color from white to yellow, and the G/S pointer flashes. G/S deviation alerting will not be initiated below 100 feet RA, but continues to operate below this altitude if the alert was triggered prior to descent below 100 feet RA.

Each pilot’s alerting system self–tests upon becoming armed at 1,500 feet RA. This self–test generates a two–second LOC and G/S deviation alerting display on each EADI.

Rising Runway Symbol

The rising runway symbol is an integral part of the LOC deviation display and is positioned at the top of the LOC deviation pointer. the rising runway symbol is displayed in addition to the digital radio altitude display and gives an additional cue to the flight crew of the aircraft’s close proximity to the ground as the airplane descends below 200 feet radio altitude. Full scale, vertical movement of the rising runway represents the last 200 feet of radio altitude. Zero feet radio altitude is indicated as the top of the runway symbol rises to the base of the airplane symbol.

The requirements for display of the rising runway symbol are as follows:

- valid ILS/LOC frequency selected
- valid radio altitude data
- radio altitude less than 2,500 feet.

If any of the above conditions are not met, the runway symbol is not displayed.

Pitch/Roll Comparator

A yellow “PITCH” or “ROLL” alerting annunciation is displayed on both EADIs if either symbol generator detects a difference of more than 3 degrees between the Captain’s and F/O’s pitch or roll displays. A short time delay is incorporated to minimize nuisance annunciations.

Radio Height Alert

The radio height alert is triggered when the airplane descends below 2,500 feet AGL. The alert is turned off when the airplane continues to descend below 500 feet AGL or climbs above 2,500 feet AGL, or after pressing the decision height reset switch on the EFIS control panel.

Digital Radio Altitude and Decision Height

When radio altitude is less than 2,500 feet, a digital display of radio altitude is depicted in the lower right hand corner of the EADI. At all other times, the digital radio altitude display is blanked.

When a positive decision height has been selected on the related EFIS control panel, the letters “DH” and the decision height are displayed just above the digital radio altitude display of the associated EADI.

When descending through the selected DH, a DH alert occurs which replaces the green “DH” letters and decision height with a large, yellow “DH” that flashes momentarily, then remains steady yellow. At the same time the DH alert is triggered, the digital radio altitude display also changes from white to yellow.

The DH alert is reset if any one of the following occurs:

- the DH Reset Switch on the EFIS Control Panel is pressed
- the radio altitude increases to DH +75 feet
- the radio altitude is equal to zero feet (i.e. during touchdown).

Note: Following an electrical power interruption, the DH value defaults to 200 feet.

Mach Display

The current Mach number from the related air data computer (ADC) is displayed if the following are satisfied:

- accelerating – Mach is equal to or greater than .40
- decelerating – Mach previously above .40 and still greater than .38.

Ground Speed Display

A digital presentation of the current ground speed is displayed. The ground speed data is received from the FMC or the IRS, with the FMC being the primary source. The numeric range is from 0 knots to 999 knots.

Pitch Limit Symbol

The position of the pitch limit symbol is a function of the stall warning computer. the pitch limit symbol appears any time the flaps are extended.

During takeoff, the pitch limit symbol is fixed at 15 degrees pitch attitude until the stall warning computer commands a value greater than 15 degrees (at approximately 100 knots). Above this speed, the position of the pitch limit symbol is a function of the various inputs to the stall warning computer and is limited to a maximum of 30 degrees of pitch.

In general, the pitch limit symbol is programmed so that stick shaker activation will coincide with a pitch attitude equal to the pitch limit symbol indication.

In a rapid pull up, the pitch attitude may exceed the pitch limit symbol indication for a brief period of time without initiating the stick shaker warning.

With a light weight airplane the stick shaker may be activated by the low speed limit logic of the stall warning computer even though the pitch limit symbol is positioned slightly above the airplane symbol.

Speed Tape Display

The speed tape display consists of a graduated scale which moves relative to a fixed airspeed reference pointer. The pointer contains a rolling digit readout of current airspeed. Various symbols related to airplane performance are positioned on the speed tape. An explanation of the various speed tape symbols follows.

Speed Tape Scale

A range of approximately 84 knots is displayed on the speed tape. Numbers are placed on the tape at 20 knot intervals from 40 knots to 420 knots. The speed tape scale scrolls up and down, and current airspeed is indicated by the digital readout.

Digital Readout

A digital readout of the current calibrated airspeed is located within the fixed airspeed reference pointer. The units digit “rolls” continuously based on the current fractional unit value of the calibrated airspeed to emulate the rolling digit readout of a conventional electrical/mechanical airspeed indicator.

Airspeed Trend Arrow

A green arrow of variable length which points to the predicted airspeed that the airplane will achieve within the next 10 seconds. This prediction is based on the present airspeed and airspeed acceleration. Than airspeed trend arrow is not displayed unless its magnitude is greater than 4 knots. The airspeed trend arrow is removed when its magnitude becomes less than 3 knots.

Command Speed

The command speed is displayed as a magenta, double–line cursor located on the speed tape scale if the command speed is within the currently displayed speed tape range. It is displayed in a numerical form, above or below the speed tape scale, if the command speed is not within the currently displayed speed tape range. The indicated command speed is equivalent to the selected speed on the MCP or to the FMC command speed, whichever is applicable.

Maximum Operating Speed (VMO/MMO or Gear/Flap Placards)

The maximum operating speed is represented by the high speed red and black barber pole. The position of the maximum operating speed symbol is a function of data supplied to the symbol generator from the stall warning computer. The maximum operating speed is the lower of the gear–extended placard speed, the flaps–extended placard speed, or VMO/MMO.

High Speed Buffet Limit

The high speed buffet limit is represented by the bottom of a hollow yellow bar that extends from the bottom of the VMO/MMO symbol at high altitude. As the airplane climbs to altitudes above 25,000 feet, the yellow bar begins to extend to give an indication of the speed that would provide a .3G margin to high sped buffet. At lower altitudes, the VMO/MMO speed is more limiting and the high speed buffet limit symbol is no longer visible. Since the stall warning computer uses FMC gross weight to calculate the high speed buffet margin speed, this display is not available if the FMC is inoperative or unable to compute gross weight.

Next Flap Placard Speed

The next flap placard speed uses the same symbol as the high speed buffet limit. If the airplane is in the air, and flaps are lowered, the hollow yellow bar extends from the high speed end of the speed tape. The end of the hollow yellow bar now represents the placard speed for the next normal flap position. Next flap placard speeds are displayed only for those flap positions that would normally be used during an approach and landing. The next flap placard symbol is blanked when current flap position equals the selected landing flap configuration on the FMC/CDU APPROACH REF page or when the flaps are being retracted.

Flaps Up Maneuvering Speed

Flaps up maneuvering speed is indicated by a small green circle on the speed tape. This speed is an output of the stall warning computer and is based on the actual gross weight as computed by the FMC. It represents the best airspeed (climb or driftdown) for an airplane in the clean configuration. This function is not enabled until flaps are up.

V1 (decision) Speed

V1 speed is depicted by a green "–1" located opposite the V1 speed on the speed tape if the V1 speed is within the displayed range. If the selected V1 speed is not within the displayed range, a green "V1" with the numeric value of the V1 speed is displayed at the high speed end of the speed tape.

Before the V1 speed is displayed on the speed tape, V1 must be entered on the FMC/CDU TAKEOFF page.

VR (Rotation) Speed

VR speed is depicted by a green "–R" located opposite the rotation speed if the rotation speed is within the displayed range. The "–R" symbol is blanked if the rotation speed is not within the displayed range.

Before the VR speed is displayed on the speed tape, VR must be entered on the FMC/CDU TAKEOFF page.

VREF (reference) Speed

The Vref speed is represented by the "–R" symbol. The FMC/CDU APPROACH REF page displays Vref speeds based on the current gross weight for three landing flap settings. The flight crew may select the FMC computed speed or manually enter another value into the field corresponding to the desired landing flap configuration. This speed will then be transmitted by the FMC, and the symbol generator will display the "–R" symbol opposite that speed on the speed tape.

Note: The FMC updates the computed Vref speeds (small–size characters) as fuel is burned off based on fuel totalizer inputs. A Vref value does not update once it has been selected for transmission to the speed tape. If the flight crew manually inserts a gross weight on the APPROACH REF page, the FMC computed Vref speeds will be based solely on the manually entered gross weight as long as the APPROACH REF page remains in view. A manually entered gross weight is not updated as fuel is burned off.

Minimum Flap Retraction Speed

Minimum flap retraction speed is indicated by a green "–F" on the right side of the speed tape. This speed is computed by the stall warning computer. It represents the speed that will provide the minimum maneuver speed (depicted by the end of the low speed yellow bar) for the next normal flap position (i.e., flap positions 5, 1, or UP only). The display will respond to the effects of extending the flight spoilers.

Minimum Maneuvering Speed

Represented by the end of the low speed hollow yellow bar. If the airplane is at low altitude, and is flown at this speed, a .3G maneuver margin to stick shaker is provided. This would allow for a 40–degree bank turn while maneuvering in level flight.

If the airplane is at high altitude and is flown at the minimum maneuver speed, a .3G maneuver margin to low speed buffet is provided as opposed to a .3G to stick shaker margin. Since the stall warning computer uses FMC gross weight to calculate the minimum maneuver speed at high altitudes, this symbol is not displayed at high altitude if the FMC gross weight is not available.

The display will reflect the effect of extending the flight spoilers.

Stick Shaker Speed

Represented by the end of the low speed red and black striped barber pole. This speed represents the airspeed at which the angle of airflow vanes will activate the sticker shaker warning. The source of the stick shaker airspeed is the stall warning computer. The display will reflect the effects of extending the flight spoilers.

Electronic Horizontal Situation Indicator (EHSI)

General

Each EHSI presents an electronically generated color display of conventional HSI navigation data (VOR/ILS and NAV modes). Each EHSI is also capable of displaying the airplane's flight progress on a plan view map (MAP and CTR MAP modes), or the airplane's flight plan on a plan view map oriented to true north (PLAN mode).

Excluding operation in the FULL NAV, FULL VOR/ILS, and PLAN modes, each EHSI also serves as a weather radar display when the WXR Switch on the respective EFIS Control Panel is ON.

During normal operation, each EHSI receives information from its own symbol generator. Each symbol generator receives data from a variety of aircraft systems to support the EHSI displays.

Display Orientation

The various displays on the EHSI are oriented in one of two ways, either “heading–up” or “track–up.” With “heading–up” orientation, all displayed data is referenced to aircraft heading as shown at the twelve o'clock position on the compass rose. With “track–up” orientation, all displayed data is referenced to aircraft track as shown at the twelve o'clock position on the compass rose.

During normal operation, heading reference data is supplied to each EHSI from the respective IRS.

Airplane track data is supplied by the FMC. If the FMC track data should become unreliable, track data is automatically supplied by the respective IRS.

EFIS Control Panel

The EFIS control panels provide selection of the EHSI display mode, display range, display brightness, weather radar display (ON or OFF and display brightness), and MAP data options. During normal operation, each panel controls the display for the related EHSI.

The selectable display modes are FULL rose NAVIGATION (FULL NAV) (some airplanes only), FULL rose VOR/ILS, EXPANDED rose NAVIGATION (EXP NAV) (some airplanes only), EXPANDED rose VOR/ILS, MAP, CENTER MAP (CTR MAP), and PLAN.

MAP Mode

The MAP mode displays a plan view of the airplane's position relative to the FMC flight plan and/or FMC data base waypoints and navaids. The FMC flight plan and/or FMC data base waypoints and navaids and other map symbols are displayed on the map background. The map background moves relative to the fixed airplane symbol. Displayed information includes airplane heading; airplane track; route of flight; curved trend vector(s); range to altitude; wind direction and velocity; distances; ETA's; altitude constraints; FMC database airports, navaids, waypoints; VOR/ADF bearing radials; ADF bearing pointers; and weather radar displays.

The map display is a “track–up” oriented display.

CTR MAP Mode

The CENTER MAP mode provides the same data as the MAP mode with the exception that the airplane symbol is located at the center of the display so that map data behind the airplane is within the viewing area.

FULL and EXP NAV Modes

The navigation mode is used when a conventional display of FMC navigation course deviation is desired. In addition to the conventional FMC course deviation data displayed, the NAV mode also displays distance to the active waypoint, active waypoint identifier, ETA's or ETE's, ADF bearing pointers (if an ADF bearing is being received), wind direction and magnitude, and system source annunciation.

The NAV mode may be displayed with a conventional, FULL compass rose, or with a simplified, EXPANDED compass rose format.

The NAV mode display is a “track–up” oriented display.

FULL and EXP VOR/ILS Modes

The VOR/ILS mode is useful when tracking or referencing VHF radio navigation signals using a VHF navigation receiver. The VOR/ILS mode displays course deviation using conventional EHSI presentations.

In addition to the conventional navigation data displayed, the VOR/ILS mode also displays DME distance to the navaid, ADF bearing pointers (if an ADF bearing is being received), wind direction and velocity, system source annunciation, and selected frequency (not displayed if in auto tune mode).

The VOR/ILS mode may be displayed with a conventional, FULL compass rose, or with a simplified, EXPANDED compass rose format.

The VOR/ILS mode display is a “heading–up” oriented display.

PLAN Mode

The PLAN mode is a map display which may be used to view an FMC flight plan route, either in total for a short route, or waypoint–by–waypoint for a longer route. The PLAN mode display is oriented to true north.

Weather Radar Display

Display of weather radar returns on the EHSI is enabled or disabled by the WXR switch on the respective EFIS control panel. Radar returns can be displayed in all EHSI modes except the FULL NAV, FULL VOR/ILS and PLAN modes. A more detailed discussion of weather radar operation is contained in Chapter 11.

Instrument Transfer Switching

During normal operation, each pilot's EFIS displays utilize independent inertial reference system (IRS) and symbol generator (SG) inputs. In the event of IRS or SG failure, input sources may be switched. Other related instrument transfer switching is discussed in Chapter 11.

The EFI transfer switch determines the SG source for the Captain's and F/O's EADI and EHSI displays. With the EFI Transfer Switch in the NORMAL position, the No. 1 SG provides display symbols for the Captain's EFIS displays, and the No. 2 SG provides display symbols for the F/O's EFIS displays. If the EFI transfer switch is in the BOTH ON 1 position, both sets of displays utilize symbols provided by the No. 1 SG, and the No. 2 SG is turned off. If the EFI transfer switch is in the BOTH ON 2 position, both sets of displays utilize symbols provided by the No. 2 SG, and the No. 1 SG is turned off. The autopilot will use data only from a single IRU source when the EFI transfer switch is in either the BOTH ON 1 or BOTH ON 2 position.

The IRS transfer switch selects the IRS that supplies inputs to the respective SG as well as to other airplane systems (see Chapter 11). With the IRS transfer switch in the NORMAL position, the left IRS provides inputs to the No. 1 SG, and the right IRS provides inputs to the No. 2 SG. If the IRS transfer switch is positioned to BOTH ON L, the left IRS provides data to both SG's. If the IRS transfer switch is positioned to BOTH ON R, the right IRS provides data to both SG's.

Light Sensing and Brightness Control

There are two sets of ambient light sensors that automatically adjust the brightness of the EADI and EHSI displays. The Captain's and F/O's displays are independently adjusted. Two remote light sensors, located on the instrument glare shield, adjust brightness of the associated EADI and EHSI as a function of light coming through the forward windows. Two integral light sensors, located in the EADI and EHSI instrument bezels (one per display unit), work in parallel to adjust the brightness of the EADI and EHSI displays as a function of ambient light shining on the face of either display. Manual adjustment of the display brightness, above and below the brightness level set by the automatic system, is accomplished by adjusting the brightness controls on the associated EFIS control panel.

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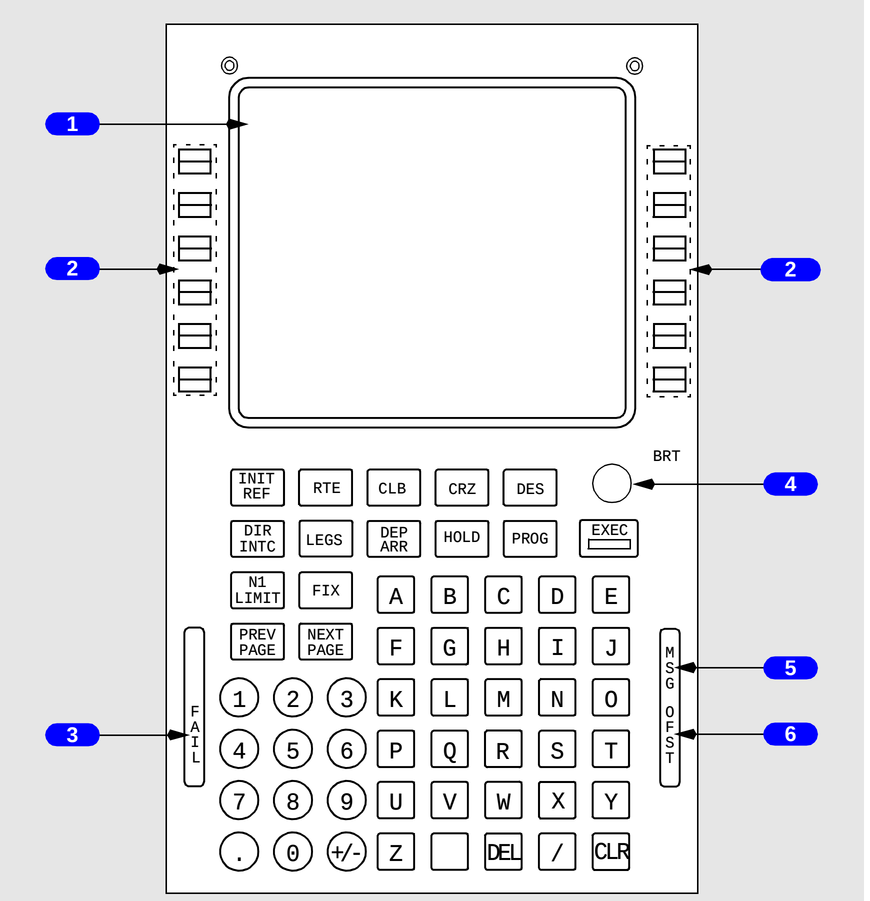
Flight Management System

Control Display Unit (CDU)



FORWARD ELECTRONIC PANEL

1 Control Display Unit (CDU) Display

Shows FMS data pages.

2 Line Select Keys

Push –

- moves data from scratchpad to selected line
- moves data from selected line to scratchpad
- selects page, procedure, or performance mode as applicable
- deletes data from selected line when DELETE is shown in scratchpad.

3 FAIL Light

Illuminated (amber) – the FMC has failed.

4 Brightness Control

Rotate – controls display brightness.

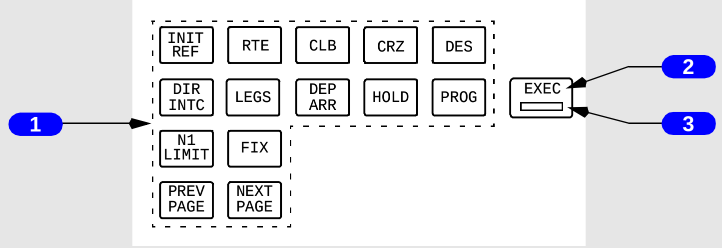
5 Message (MSG) Light

Illuminated (white) – scratchpad message is shown.

6 Offset (OFST) Light (U7)

Illuminated (white) – LNAV gives guidance for lateral route offset.

Function and Execute Keys



CDU

1 CDU Function Keys

Push –

- INIT REF – shows page for data initialization or for reference data
- RTE – shows page to input or change origin, destination, or route
- CLB – shows page to view or change climb data
- CRZ – shows page to view or change cruise data
- DES – shows page to view or change descent data

- DIR INTC – shows page to modify route to fly directly from present position to any waypoint or to intercept any course to any waypoint
- LEGS –
  - shows page to evaluate or modify lateral and vertical data
  - shows page to control PLAN mode display
- DEP ARR – shows page to input or change departure and arrival procedures
- HOLD – shows page to create holding patterns and show holding pattern data
- PROG – shows page to view dynamic flight and navigation data, including waypoint and destination ETAs, fuel remaining, and arrival estimates
- N1 LIMIT – shows page to view or change N1 thrust limits
- FIX – shows page to create reference points on map display
- PREV PAGE – shows previous page of related pages (for example, LEGS pages)
- NEXT PAGE – shows next page of related pages.

2 Execute (EXEC) Key

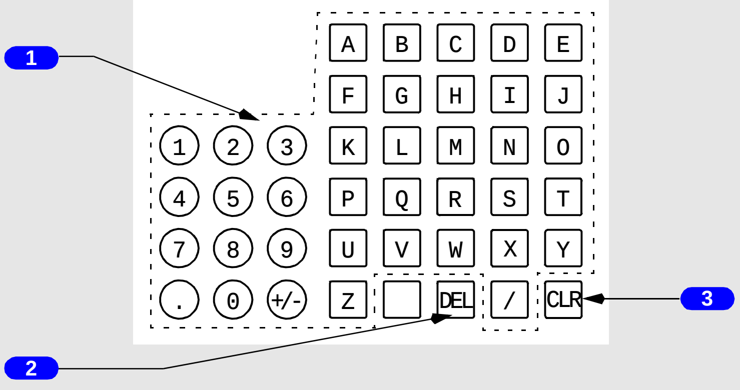
Push –

- makes data modification(s) active
- extinguishes execute light.

3 Execute Light

Illuminated (white) – active data is modified but not executed.

Alpha/Numeric and Miscellaneous Keys



CDU

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.

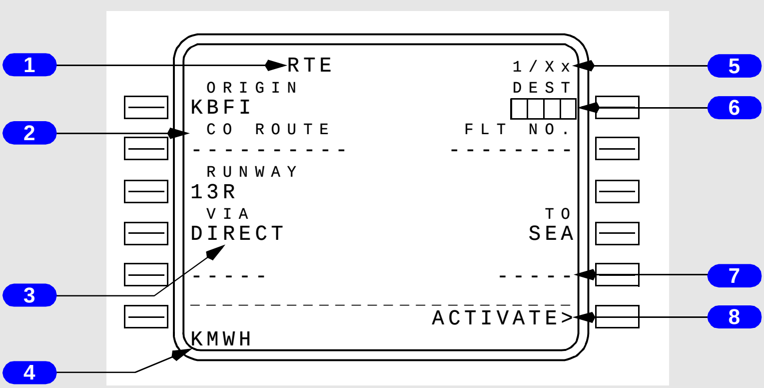
3 Clear (CLR) Key

Push –

- clears the last scratchpad character
- clears scratchpad message.

Push and hold – clears all scratchpad data.

CDU Page Components



CDU

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.

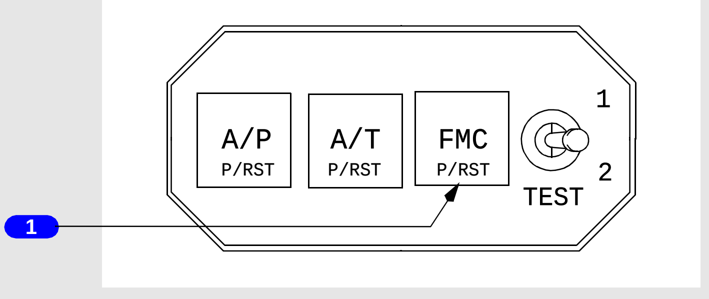
7 Dashes

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



CAPTAIN’S INSTRUMENT PANEL
FIRST OFFICER’S INSTRUMENT PANEL

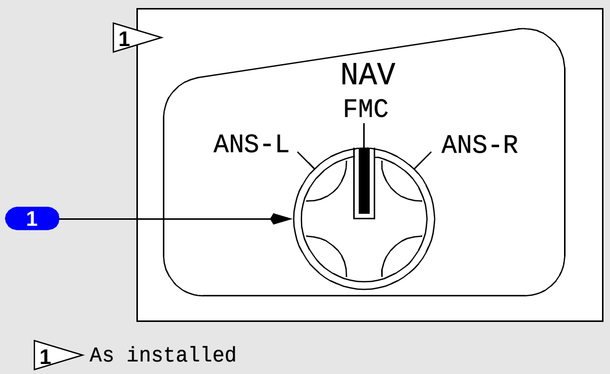
1 FMC Alert Light

Illuminated (amber) –

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

Push – both pilots' FMC alert lights extinguish.

Navigation Mode Selector



LIGHT SHIELD (2)

1 Navigation (NAV) Mode Selector

When the associated flight control computer (FCC A or FCC B) is the master, the respective selector (Captain or First Officer) determines the source of guidance and control commands provided to the AFDS. The selector also determines the source for data displays.

FMC – The flight management computer is providing AFDS LNAV and VNAV commands and display information.

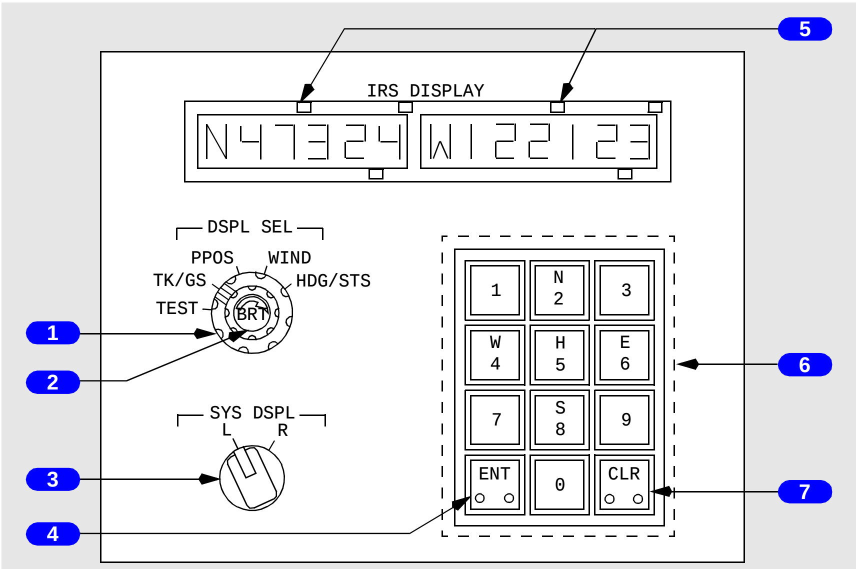
ANS L – The left ANCDU of the alternate navigation system is providing AFDS LNAV commands and display information.

ANS R – The right ANCDU of the alternate navigation system is providing AFDS LNAV commands and display information.

When the selector is not in the FMC position, only NAV mode information is provided to the EHSIs.

Inertial System

IRS Display Unit (ISDU)



AFT OVERHEAD PANEL

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 present 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 (displays “7” until time remaining is 6 minutes).

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 –

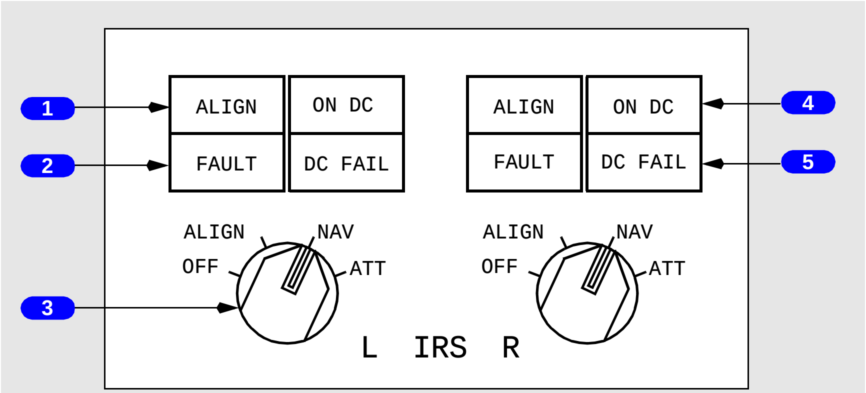
- alpha keys:
  - data displays are controlled by the keyboard when the N, S, E, W (latitude/longitude) or H (heading) keys are pressed
  - pressing an alpha key arms the keyboard for numeric entries.
- numeric keys:
  - permit manual entry of present position when ALIGN light is illuminated
  - permit 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 – extinguishes cue lights and clears data display of any data not yet entered or accepted.

IRS Mode Selector Unit



AFT OVERHEAD PANEL

1 ALIGN Light

Illuminated (white) –

- steady – the related IRS is operating in the ALIGN mode, the initial ATT mode, or the shutdown cycle
- flashing – alignment cannot be completed due to IRS detection of:
  - significant difference between previous and entered positions (unreasonable present position) or
  - no present position entry.

Extinguished –

- IRS not in ALIGN mode
- with mode selector in NAV, alignment is complete, and all IRS information is available
- with mode selector in ATT, attitude information is available. Heading information is available following entry of initial magnetic heading.

2 FAULT Light

Illuminated (amber) – a system fault affecting the related IRS ATT and/or NAV modes has been detected.

3 Inertial Reference System (IRS) Mode Selector

OFF – all electrical power is removed from the system after a 30 second shutdown cycle.

ALIGN –

- rotating the selector from OFF to ALIGN initiates the alignment cycle
- rotating the selector from NAV to ALIGN automatically updates alignment and zeroes ground speed error.

NAV (detented position) –

- system enters the NAV mode after completion of the alignment cycle and entry of present position
- in NAV mode, all IRS information is available to airplane systems for normal operations.

ATT – provides only attitude and heading information:

- attitude information is invalid (attitude flag in view) until ALIGN light is extinguished
- heading information is invalid (heading flags in view) until the actual magnetic heading is manually entered and the ALIGN light is extinguished
- position and ground speed information is not available until the IRS is aligned on the ground
- the selector must be cycled to OFF before reselecting ALIGN or NAV.

4 ON DC Light

Illuminated (amber) –

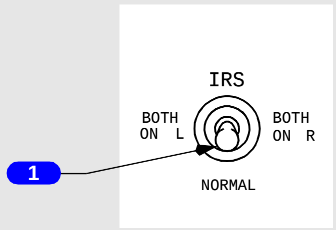
- the related IRS is operating on DC power from the switched hot battery bus (AC power not normal)
- if on the ground, the ground–call horn in the nose wheel well sounds, providing an alert that a battery drain condition exists
- momentary illumination is normal during alignment self–test.

5 DC FAIL Light

Illuminated (amber) –

- DC power for the related IRS is not normal
- if the other lights are extinguished, the IRS is operating normally on AC power.

IRS Transfer Switch



FORWARD OVERHEAD PANEL

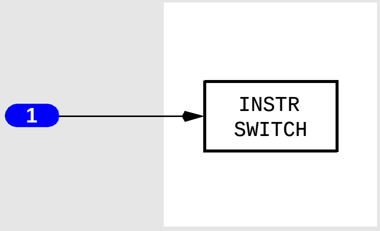
1 Inertial Reference System (IRS) Transfer Switch

BOTH ON L – switches the flight instruments attitude and heading source to left IRS.

NORMAL – flight instruments attitude and heading source is from default IRS.

BOTH ON R – switches the flight instruments attitude and heading source to right IRS.

Instrument Transfer Switch Light



CAPTAIN'S INSTRUMENT PANEL
FIRST OFFICER'S INSTRUMENT PANEL

1 Instrument Transfer Switch Light (INSTR SWITCH)

Illuminated (amber) – one or both of the instrument transfer switches (EFI or IRS) has been moved from the normal position.

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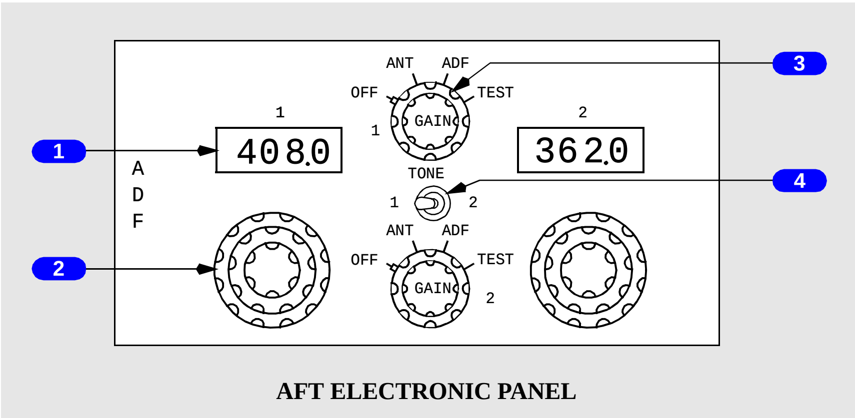
Radio Navigation Systems

Automatic Direction Finding (ADF) Control



AFT ELECTRONIC PANEL

1 Frequency Indicator

Indicates the frequency selected with the related frequency selector.

2 Frequency Selector

Rotate –

- outer knob sets the hundreds number
- middle knob sets the tens number
- inner knob sets the tenths and ones number.

3 Mode Selector

OFF – removes power from associated receiver.

ANT – receiver sends only station audio.

ADF – receiver sends bearing and station audio.

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

GAIN – adjusts receiver gain.

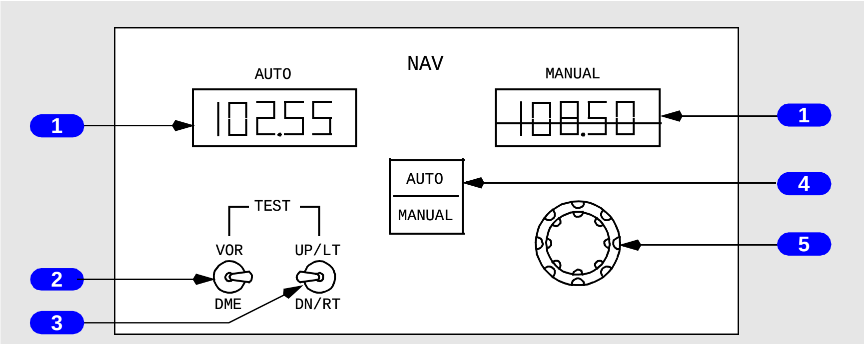
4 TONE Switch

1 – adds tone to ADF receiver No. 1 audio.

2 – adds tone to ADF receiver No. 2 audio.

CENTER – disables tones.

VHF Navigation Control



AFT ELECTRONIC PANEL

1 Frequency Indicators

AUTO –

- displays frequency automatically tuned by the FMC
- display is blank when MANUAL tuning is selected
- displays dashes during agility tuning.

MANUAL –

- indicates the frequency selected by the frequency selector
- a red bar appears over MANUAL frequency when AUTO tuning is selected.

2 VOR/DME TEST Switch

VOR –

- with a VOR frequency tuned and a course of 000 selected:
  - deviation bar moves to centered position
  - bearing pointer slews to 180 degrees
  - the TO/FROM ambiguity indicates FROM.

DME –

- with a DME tuned:
  - shows DME fail flag
  - DME displays dashes
  - all zeroes (not to exceed 000.5) appear.

3 **ILS TEST Switch**

UP/LT –

- With ILS frequency tuned and a course within 90 degrees of airplane heading:
  - pointers display one dot up and one dot left.

DN/RT –

- With ILS frequency tuned and a course within 90 degrees of airplane heading:
  - pointers display one dot low and one dot right.

4 **AUTO/MANUAL Switch**

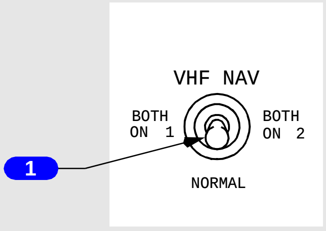
AUTO (illuminates white) – tuning automatically accomplished by the FMC.

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

5 **Frequency Selector**

Rotate – manually selects the desired frequency.

VHF NAV Transfer Switch



FORWARD OVERHEAD PANEL

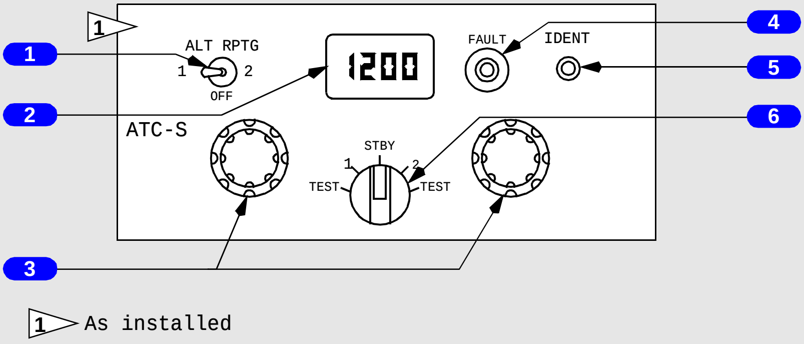
1 **VHF NAV Transfer Switch**

BOTH ON 1 – switches the VHF navigation source to VHF NAV receiver No. 1.

NORMAL – VHF navigation source is from default VHF NAV receiver.

BOTH ON 2 – switches the VHF navigation source to VHF NAV receiver No. 2.

Transponder Panel



AFT ELECTRONIC PANEL

1 Altitude Reporting (ALT RPTG) Switch

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

OFF – transponder operates without altitude reporting.

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

2 ATC Code Indicator

Shows transponder code.

3 ATC Code Selectors

Rotate – sets transponder code in transponder.

4 FAULT Light

Illuminated (amber) – indicates transponder malfunction.

5 Identification (IDENT) Switch

Push – transmits an identification signal.

6 Transponder Mode Selector

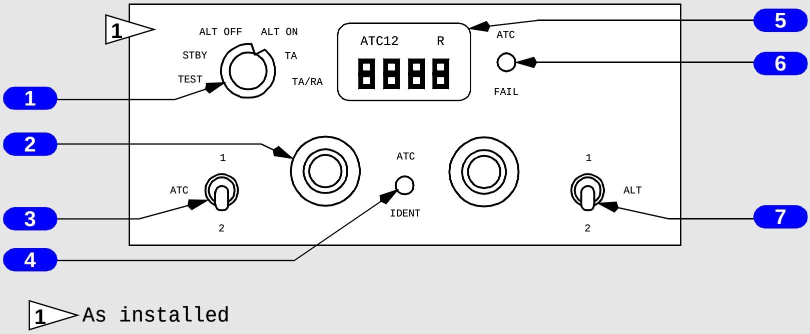
TEST – starts ATC transponder functional test for transponder No. 1.

1 – selects transponder No. 1.

STBY – does not transmit.

2 – selects transponder No. 2.

TEST – starts ATC transponder functional test for transponder No. 2.



AFT ELECTRONIC PANEL

1 Transponder Switch

TEST – the ATC FAIL light illuminates to indicate the selected transponder is operational.

STBY – disables transponder modes.

Note: Transponder modes are enabled only when the airplane is airborne, except for mode S, which operates continuously when the transponder mode selector is out of STBY.

ALT OFF – transponder operates without altitude reporting.

ALT ON – transponder operates with altitude reporting.

TA – enables display of traffic advisory TCAS targets.

TA/RA – enables display of traffic advisory and resolution advisory TCAS targets. Refer to Chapter 15, Warning Systems.

2 Air Traffic Control (ATC) Code Selector

Rotate – sets transponder code in transponder.

3 Transponder Selector

1 – selects transponder No. 1.

2 – selects transponder No. 2.

4 Identification (ATC IDENT) Switch

Push – transmits an identification signal.

5 ATC Code Indicator

Shows transponder code.

Shows operating transponder (1 or 2).

6 Transponder (ATC) FAIL Light

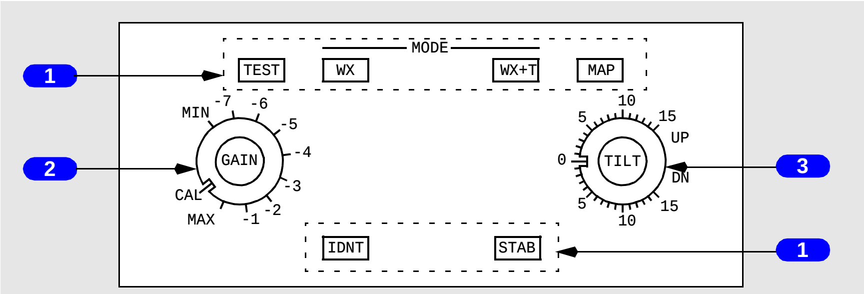
Illuminated – indicates transponder malfunction or test.

7 Altitude Reporting Switch

1 – enables altitude reporting from ADC No. 1.

2 – enables altitude reporting from ADC No. 2.

Weather Radar Panel



FORWARD ELECTRONIC PANEL

1 Weather Radar Mode Switches

Push – selects mode.

- TEST – shows test pattern on map display with WXR selected (except in PLAN mode) and tests transmitter (transmits only up to one second).
- WX – shows weather radar returns at selected gain level
- WX+T (turbulence) – shows weather radar returns and turbulence. Turbulence display is available on the EHSI if the selected map range is 50 nautical miles or less

  Note: Turbulence detection requires presence of detectable precipitation. Clear air turbulence cannot be detected by radar.

- MAP – shows ground returns at selected gain level

- IDNT – suppresses ground return in WX and WX+T modes

  Note: Continuous operation is not recommended because weather return intensity may be reduced.

- STAB – stabilizes the system from the IRS, placing the antenna under control of the receiver–transmitter to correct for changes in airplane attitude.

2 GAIN Control

Rotate – sets gain in WX, WX+T, and MAP modes.

CAL (calibrated) – gain is set to calibrated level in the full counterclockwise position.

3 TILT Control

Rotate clockwise – radar antenna tilts up to selected degrees from horizon.

Rotate counterclockwise – radar antenna tilts down to selected degrees from horizon.

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Introduction

Navigation systems include the flight management system (FMS); inertial reference system (IRS); radio navigation systems (ADF, DME, ILS, marker beacons, and VOR); transponder; and weather radar.

Flight Management System

The flight management system (FMS) is comprised of the following components:

- flight management computer system (FMCS)
- autopilot/flight director system (AFDS)
- autothrottle (A/T)
- inertial reference systems (IRS).

Each of these components is an independent system, and each can be used independently or in various combinations. The term FMS refers to the concept of joining these independent components together into one integrated system which provides continuous automatic navigation, guidance, and performance management.

The integrated FMS provides centralized flight deck control of the airplane's flight path and performance parameters. The flight management computer, or FMC, is the heart of the system, performing navigational and performance computations and providing control and guidance commands.

The primary flight deck controls are the AFDS MCP, two control display units (CDUs), and two electronic flight instrument system (EFIS) control panels. The primary displays are the CDUs, electronic attitude director indicator (EADI), electronic horizontal situation indicator (EHSI), and thrust mode display.

The FMC uses crew entered flight plan information, airplane systems data, and data from the FMC navigation database and performance database to calculate airplane present position, and pitch, roll, and thrust commands required to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route information are sent to the respective pilot's EHSI. The EFIS control panels are used to select the desired information for navigation display. The mode control panel is used to select the autothrottle, autopilot, and flight director operating modes.

Inertial System

The inertial system computes airplane position, ground speed, and attitude data for the flight instruments, flight management system, autoflight system, and other systems. The major components of the inertial system are the inertial reference units (IRUs), an inertial system display unit (ISDU), IRS mode selector unit (MSU), and an IRS transfer switch.

Inertial Reference System

Two independent IRSs are installed. Each IRS has three sets of laser gyros and accelerometers. The IRSs are the airplane’s sole source of attitude and heading information, except for the standby attitude indicator and standby magnetic compass.

In their normal navigation mode, the IRSs provide attitude, true and magnetic heading, acceleration, vertical speed, ground speed, track, present position, and wind data to appropriate airplane systems. IRS outputs are independent of external navigation aids.

IRS Alignment

An IRS must be aligned and initialized with airplane present position before it can enter the 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° 12’ north and 70° 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° 12’ and 78° 15’, requires an extended alignment time. Alignment is initiated by rotating the MSU switch from OFF to ALIGN. After 17 minutes the MSU switch must be rotated to the NAV position. The IRS will then immediately enter the NAV mode.

Magnetic variation between 73° north and 60° south is stored in each IRS memory. The data corresponding to the present position are combined with the true heading to determine magnetic heading. If magnetic variation information is not available, special navigation equipment is required to provide true heading to the EHSIs.

If the latitude/longitude position is not within 4 NM of the origin airport, the CDU scratchpad message VERIFY POSITION is displayed. If the entered latitude/longitude position does not pass the IRS internal comparison tests, the scratchpad message ENTER IRS POSITION is displayed.

The flashing ALIGN light alerts the crew that the position entered does not pass one of the two internal comparison tests and should be checked for accuracy. If the entered position does not agree with the last stored position, the first internal test is failed, and the ALIGN light will flash. If the same position is reentered, the IRS will accept the position and continue the alignment process. A second internal position test compares the entered latitude with the system-computed latitude. If this test is failed, the ALIGN light will again flash. If two consecutive entries of the same position do not pass the second internal position test, the FAULT light will illuminate. If the test is passed, the IRS will proceed to complete the alignment process and enter NAV mode.

During transit or through–flight stops with brief ground times, a thirty second fast realignment and zeroing of ground speed error may be performed by selecting ALIGN while the airplane is parked. Present position should be simultaneously updated by manually entering latitude and longitude prior to selecting NAV.

Note: If the airplane is moved during alignment or fast realignment, the IRSs automatically begin the full alignment process, and shutdown is not necessary.

Loss of Alignment

If an IRS loses both AC and DC power, the alignment is lost. Alignment can be lost if the MSU switch is moved out of the NAV position.

If alignment is lost in–flight, the navigation mode (including present position and ground speed outputs) is inoperative for the remainder of the flight. However, selecting ATT allows the attitude mode to be used to relevel the system and provide an attitude reference. The attitude mode requires approximately thirty seconds of straight and level unaccelerated flight to complete releveling. Some attitude errors may occur during acceleration, but will be slowly removed after acceleration stops.

The attitude mode can also provide heading information, but to establish compass synchronization the crew must manually enter the initial magnetic heading. Drift of up to 15 degrees per hour can occur in the IRS heading. Therefore, when in ATT mode, an operating compass system must be periodically cross–checked and an updated magnetic heading entered in the IRS, as required.

IRS Entries

Manual IRS entries of present position or magnetic heading are normally accomplished on the POS INIT page of the FMC/CDU. The ISDU may also be used.

IRS Power

The IRSs can operate on either AC or DC power. The left IRS is normally powered from the AC standby bus, and the right IRS from the AC transfer bus 2. If AC power is not normal, either or both systems automatically switch to backup DC power from the switched hot battery bus. Backup DC power to the right IRS is automatically terminated if AC power is not restored within five minutes.

Initial power–up requires battery bus power available and the IRS mode selector to be in ALIGN, NAV, or ATT. If the IRS is turned off, it must complete a full realignment cycle before the airplane can be moved.

If AC electrical power is subsequently removed from the airplane, the switched hot battery bus continues to supply electrical power to the IRS. The ON DC light illuminates, and the horn in the landing gear wheel well sounds to alert maintenance personnel that the IRS is on battery power.

When the IRS mode selector is turned OFF, the IRS remains powered for approximately 30 seconds. The ALIGN light illuminates until the system is completely shut down.

Inertial System Display Unit (ISDU)

The ISDU is located on the aft overhead panel and displays data according to the position of the display selector and system selector. The ISDU also contains a keyboard for entry of present position and heading.

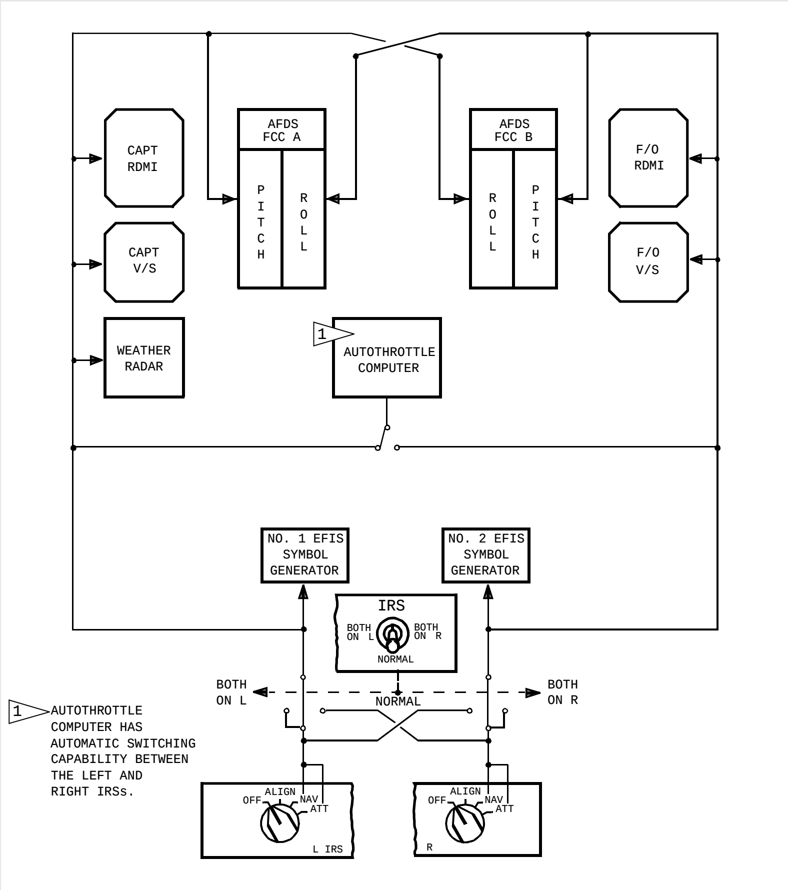
Mode Select Unit (MSU)

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

IRS Transfer Switch

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

IRS Instrument Transfer Switch Schematic



Radio Navigation Systems

Automatic Direction Finding (ADF)

An automatic direction finding (ADF) system enables automatic determination of magnetic and relative bearings to selected facilities.

Two ADF receivers are installed. The ADF bearing signals are sent to the pointers on the EHSIs and RDMIs. The audio is heard by using the ADF receiver control on the audio selector panel.

If heading or track information is lost or invalid, ADF bearing pointers on the EHSI will not be displayed, and the ADF bearing pointers on the RDMI will not display the correct magnetic bearing. Relative bearings indicated by pointers may be correct if the receiver is operating.

Distance Measuring Equipment (DME)

Two DME systems are installed. Each may be tuned automatically by the FMC or manually on the VHF navigation control panel. The position of the AUTO/MANUAL switch determines the tuning mode.

With the AUTO mode selected, the FMC autotunes DME receivers as necessary for position updating. During normal operations, two different DME signals or a collocated DME and VOR signal provide an accurate radio geographical position to the FMC.

DME distance is displayed on the EHSIs and 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 EADIs and EHSIs. The ILS localizer and glideslope can also be displayed on the standby horizon.

LOC updating of the FMC occurs only after the ILS is manually tuned.The tuned ILS frequency is displayed in the VOR/ILS display mode.

Very High Frequency Omni Range (VOR)

Two VOR receivers and two control panels are installed. The VHF navigation control panel is used to select VOR and ILS frequencies. Each may be tuned automatically by the FMC or manually on the VHF navigation control panel. The position of the AUTO/MANUAL switch determines the tuning mode.

VOR information is displayed on the EHSIs and RDMIs. VOR–DME radio updating is available in the automatic or manual modes if a valid, in–range, VOR–DME station is selected.

Left and right VOR bearings are displayed on the RDMI when a valid in–range VOR station is tuned and the respective VOR/ADF bearing pointer switch is in the VOR position. The EHSI displays course deviation when operating in the VOR mode.

VHF NAV Transfer Switch

Should either VOR receiver fail, the VHF NAV transfer switch enables selection of the opposite VHF NAV receiver for display.

ATC Transponder

Two ATC transponders are installed and controlled by a single control panel. The ATC transponder system transmits a coded radio signal when interrogated by ATC ground radar. Altitude reporting capability is provided.

On airplanes with TCAS, TCAS is controlled from the transponder panel. The TCAS system is described in Chapter 15.

Weather Radar

The X band color weather radar system detects and locates various types of precipitation bearing clouds along the flight path of the airplane and gives the pilot a visual indication in color of the clouds' intensity.

In WX mode, the radar displays a cloud's rainfall intensity by displaying colors contrasted against a black background. Areas of heaviest rainfall appear in red, the next level of rainfall in yellow, and the least rainfall in green.

In WX+T mode, the radar displays normal precipitation and precipitation associated with turbulence. When the radar detects a horizontal flow of precipitation with velocities of 5 or more meters per second toward or away from the radar antenna, that target display becomes magenta. This magenta area is associated with heavy turbulence. The detection of turbulence is automatically limited to a 50 nautical mile range, regardless of the selected range.

In MAP mode, the radar displays surfaces in red, yellow, and green (most reflective to least reflective).

These displays enable identification of coastlines, hilly or mountainous regions, cities, or large structures. Ground mapping mode can be useful in areas where ground-based navigation aids are limited.

The radar system performs only the functions of weather detection and ground mapping. It should not be used or relied upon for proximity warning or anticollision protection.

The IDNT mode activates the ground clutter reduction feature. Signals that are determined to have a high probability of originating from ground returns will be automatically removed from the display. Some portions of weather targets may be removed as well. The IDNT mode is provided for analysis by the pilot and is not for continuous use.

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Introduction

The flight management system (FMS) aids the flight crew in managing automatic navigation, in-flight performance optimization, fuel monitoring, and flight deck displays. Automatic flight functions manage the airplane lateral flight path (LNAV) and vertical flight path (VNAV). The displays include a map for airplane orientation and command markers (bugs) on the airspeed and N1 indicators to assist in flying efficient profiles.

The flight crew enters the desired route and flight data into the CDUs. 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 radios and determine LNAV courses. The FMS navigation database provides the necessary data to fly routes, SIDs, STARs, holding patterns, and (U7) procedure turns. (U7) Lateral offsets from the programmed route can be calculated and commanded.

For vertical navigation, computations include items such as fuel burn data, optimum speeds, and recommended altitudes. Cruise altitudes and crossing altitude restrictions are used to compute VNAV commands. When operating in the Required Time of Arrival (RTA) mode, the computations include required speeds, takeoff times, and en route progress information.

Flight Management Computer (FMC)

The basis of the flight management system is the flight management computer. Since the term FMC is universally understood, it is used here for standardization and simplification.

Different FMC configurations may be installed due to a software update program. The terminologies “U5” and “U7” are used throughout the manual when necessary to identify information which is unique to these specific FMC configurations. References to U7 will be used for information not specific to U7.5. The FMC/CDU IDENT page permits flight crew identification of the installed update.

The FMC uses flight crew–entered flight plan information, airplane systems data, and data from the FMC navigation database to calculate airplane present position, and pitch, roll, and thrust commands required to fly an optimum flight profile. The FMC sends these commands to the autothrottle, autopilot, and flight director. Map and route information are sent to EHSIs. The EFIS control panels are used to select the desired information for EHSI display. The mode control panel is used to select the autothrottle, autopilot, and flight director operating modes. Refer to the following chapters for operation of these other systems:

- Chapter 4, Automatic Flight
- Chapter 10, Flight Instruments, Displays.

The FMC and CDU are used for en route and terminal area navigation and to supplement primary navigation means when conducting other types of nonprecision approaches.

The FMC satisfies the requirements of Basic Area Navigation (B–RNAV) when operated in accordance with this Operations Manual.

A single FMC is not certified as a sole source of navigation system. It is certified to navigate accurately in conjunction with an accurate radio navaid environment.

Airplanes which are equipped with the Alternate Navigation System (ANS) are certified for operations outside radio navaid coverage, due to the independent position monitoring capability afforded by the ANCDU and the capability to navigate using the IRS positions if the FMC position should become unreliable.

When external position updating is not available, the FMC uses the IRS position as reference. When the IRS is the only position reference, the FMC applies an automatic correction to the IRS position to determine the most probable FMC position. This correction factor is developed by the FMC's monitoring IRS performance during periods of normal position updating to determine the typical IRS error value. It is important to note that, when external position updating is not available, navigation accuracy may be less than required. Flight crews should closely monitor FMC navigation, especially when approaching the destination. The accuracy of the FMC navigation should be determined during descent phase by using radio navaids and radar information if available.

Note: Inaccurate position updating may cause the airplane to deviate from the desired track.

Control Display Units (CDUs)

Two identical, independent CDUs provide the means for the flight crew to communicate with the FMC. The crew may enter data into the FMC using either CDU, although simultaneous entries should be avoided. The same FMC data and computations are available on both CDUs; however, each pilot has control over what is displayed on an individual CDU.

On airplanes with ANCDUs, each CDU also has an alternate mode of operation using its own internal computer. This ANCDU capability is similar to an inertial navigation system and allows parallel operation independent of the FMC, or backup operation in the event of FMC failure. The ANCDU provides lateral navigation capability only. ANCDU navigation is always based on IRS position only.

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Introduction

When first powered, the FMS is in the preflight phase. As a phase is completed, the FMS automatically transitions to the next phase in this order:

- preflight
- takeoff
- climb
- cruise
- descent
- approach
- flight complete.

Preflight

During preflight, flight plan and load sheet information are entered into the CDU. The flight plan defines the route of flight from the origin to the destination and initializes LNAV. Flight plan and load sheet information provide performance information to initialize VNAV.

Required preflight information consists of:

- initial position
- route of flight
- performance data
- takeoff data.

Optional preflight data includes:

- navigation database
- SID
- STAR
- RTA data
- cruise wind
- reduced takeoff and climb thrust limits.

Each required or optional data item is entered on specific preflight pages.

Preflight begins with the IDENT page. If the IDENT page is not displayed, it can be selected from the IDENT prompt on the INIT/REF INDEX page. Visual prompts provide assistance in selecting the appropriate CDU pages. Preflight pages can be manually selected in any order.

After entering and checking the necessary data on each preflight page, the lower right line select key is pushed to select the next page. When ACTIVATE is selected on the RTE page, the execute light illuminates. The EXEC key is then pushed to complete the task of making the route active before continuing with the preflight.

If a standard instrument departure (SID) is to be entered into the route, the departure/arrival (DEP/ARR) page is selected. After selecting the desired SID, the resulting modification must be appropriately linked to the existing route and executed. This can be accomplished on the RTE or RTE LEGS page.

When all required preflight entries are complete, the preflight status prompts on the TAKEOFF REF page are no longer displayed.

Takeoff

The takeoff phase begins with selection of TO/GA and extends to the thrust reduction altitude where climb thrust is normally selected.

Climb

The climb phase begins at the thrust reduction altitude and extends to the top of climb (T/C) point. The T/C point is where the airplane reaches the cruise altitude entered on the PERF INIT page.

Cruise

The cruise phase begins at the T/C point and extends to the top of descent (T/D) point. Cruise can include step climbs and en route descents.

Descent

The descent phase begins at the T/D point or when either a level change or vertical speed descent is initiated. The descent phase extends to the beginning of the approach phase.

Approach

The approach phase begins two miles from the first waypoint of a published approach or approach transition selected from the ARRIVALS page.

Flight Complete

After landing, the flight complete phase clears the active flight plan and load data. Some preflight data fields initialize to default values in preparation for the next flight.

FMC and CDU Terminology

The following paragraphs describe FMC and CDU terminology.

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.

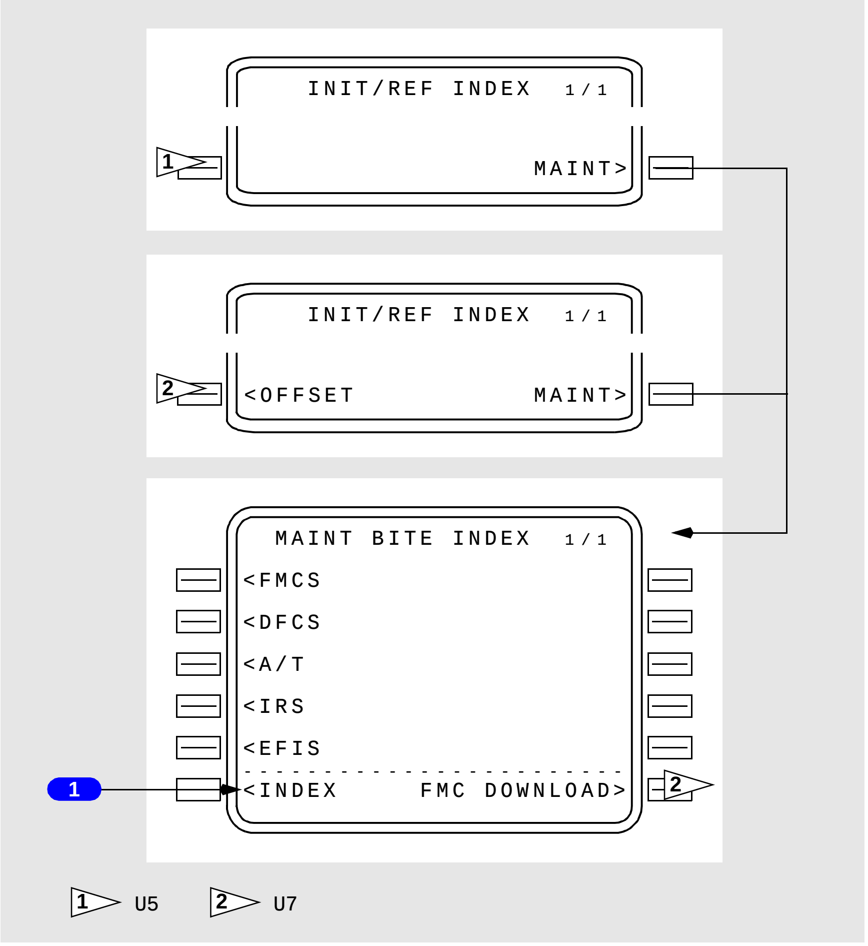
Select – pushing a key to obtain the desired information or action, or to copy selected data to the scratchpad.

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

Displays the INIT/REF INDEX page.

Navigation Position

The FMC determines present position from the IRS and navigation radios. The FMC uses its calculated present position to generate lateral steering commands along the active leg to the active waypoint.

FMC Position Update

On the ground, the FMC calculates present position based on IRS data.

On the ground prior to takeoff, FMC position update to the takeoff runway threshold position can be done on the TAKEOFF REF page.

In flight, the FMC position is continually updated from the navigation radios and IRS. Updating priority is based on the availability of valid data from the supporting systems.

The FMC position is derived from a mathematical combination of the positions determined by the IRS and radio systems. It represents the FMC's estimate of the actual position of the airplane. Its accuracy varies according to the accuracy of the other position determining systems.

FMC position updates from navigation sensor positions are used in the following priority order:

- two or more DME stations
- one VOR with a collocated DME
- one localizer and collocated DME
- one localizer.

The station identifiers and frequencies of the selected radio navigation aids are displayed on the (U5) PROGRESS and POS SHIFT pages or (U7) NAV STATUS page 1/2.

With the AUTO/MANUAL switch in AUTO, DME radios are automatically tuned by the FMC. The stations to be tuned are selected based upon the best available signals (in terms of geometry and strength) for updating the FMC position. Radio position is determined by the intersection of two DME arcs.

AUTO tuning uses any of several radio modes. The primary mode tunes the radios to separate DME–capable stations. If required, a single radio can cycle between two DME–capable stations. This process is referred to as “agility tuning.” The lowest priority radio mode is the use of both VOR and DME from a single station. The FMC does not use VOR information beyond a range of 25 NM.

Note: With both navigation radios in AUTO tuning, if the FMC determines that a navigation radio is unreliable for position updating, it deselects the unreliable radio and uses the good radio for agility tuning. 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. Position fixing based on VOR/DME updating is less accurate due to inherent VOR bearing errors, especially when tuning manually. If desired, the crew may inhibit the use of VOR bearing or DME information from a specific VOR/DME station.

If the DME radios fail, or if suitable DME stations are not available, FMC navigation is based on IRS position information only. The two VHF Nav radios are used by the FMC for localizer updating during an ILS approach and by the crew for navigation monitoring.

Note: The FMC is designed to automatically reject unreliable navaid data during FMC position updating. However, in certain conditions, navaids which are in error may satisfy the reasonableness criteria and provide the FMC with an inaccurate radio position. One of the most vulnerable times is when a radio position update occurs just after takeoff. This is usually manifested in an abrupt heading correction after engaging LNAV. The position shift can be seen on the map, which will shift the desired track and runway symbol to a position significantly different from that displayed during ground roll. If the flight crew observes either of these indications, and an extended period of IRS NAV ONLY flight follows, the FMC should be carefully monitored.

When adequate radio updating is not available, the EHSI map may display a shift error. This error results in the displayed position of the airplane, route, waypoints, and navigation aids being shifted from their actual positions.

An across track, undetected map shift may result in the airplane flying a ground track that is offset from the desired track. An along track, undetected map shift may result in the flight crew initiating altitude changes earlier or later than desired. In either case, an undetected map shift may compromise terrain or traffic separation.

Map shift errors can be detected by comparing the position of the airplane on the EHSI map with data from the ILS, VOR, DME, and ADF systems.

Navigation Performance (U7)

The FMC uses data from the navigation systems to accurately calculate the position of the airplane. The current FMC position is shown on line 1 of the POS REF page 2/3.

Actual Navigation Performance (ANP)

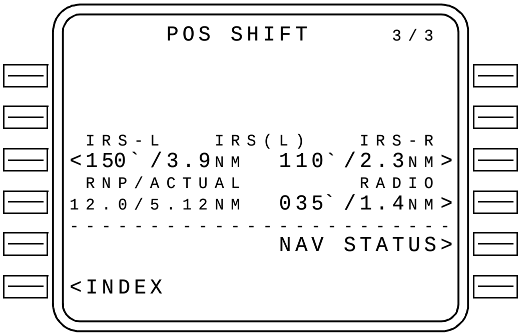
Actual navigation performance (ANP) is the FMC's estimate of the quality of its position determination. It is shown on POS SHIFT page 3/3 and on RTE LEGS pages. ANP represents the estimated maximum position error with 95% probability. That is, the FMC is 95% certain that the airplane's actual position lies within a circle with a radius of the ANP value around the FMC position. The lower the ANP value, the more confident the FMC is of its position estimate.

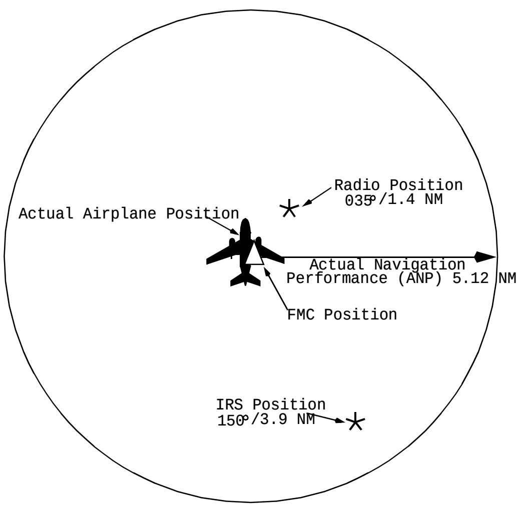
Required Navigation Performance (RNP)

The FMC supplies a default required navigation performance (RNP) value for takeoff, en route, oceanic, terminal, and approach phases of flight. RNP can also be supplied by the Navigation Database or may be entered by the crew. Actual navigation performance should not exceed RNP.

If ANP exceeds a Navigation Database or crew entered RNP value, the message UNABLE REQD NAV PERF–RNP appears. If ANP exceeds a default RNP value, the IRS NAV ONLY message appears. RNP is shown on POS SHIFT page 3/3 and on RTE LEGS pages.

Actual Navigation Performance





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, or track, as required by the procedure.

Waypoints

Waypoint (navigation fix) identifiers are displayed on the CDU and EHSI.

The CDU message NOT IN DATA BASE is displayed if a manually entered waypoint identifier is not stored in the database. The waypoint can still be entered as a latitude/longitude, place–bearing/distance, or place–bearing/place–bearing waypoint.

FMC–generated waypoints contain a maximum of five characters assigned according to the following rules.

Navaid Waypoint Names

VHF – waypoints located at VHF navaids (VOR/DME/LOC) are identified by the official one, two, three, or four character facility identifier. Examples:

- Los Angeles VORTAC – LAX
- Tyndall TACAN – PAM
- Riga, Latvia – RIX.

NDB – waypoints located at NDBs are identified by use of the station identifier. Example:

- FORT NELSON, CAN – YE.

Fix Waypoint Names

Fixes with one–word names – waypoints located at fixes with names containing five or fewer characters are identified by the name. Examples:

- DOT
- ACRA
- ALPHA.

Long Waypoint Names

Names with more than five characters are abbreviated using the following rules sequentially until five characters remain. Double letters are deleted. Examples:

- KIMMEL becomes KIMEL
- COTTON becomes COTON
- RABBITT becomes RABIT.

Keep the first letter, first vowel and last letter. Delete other vowels starting from right to left. Examples:

- ADOLPH becomes ADLPH
- BAILEY becomes BAILY
- BURWELL becomes BURWL.

Keep the last letter, then delete consonants from right to left. Examples:

- ANDREWS becomes ANDRS
- BRIDGEPORT becomes BRIDT
- HORSBA becomes HORSA.

Fixes with multiword names use the first letter of the first word and abbreviate the last word, using the above rules sequentially until a total of five characters remain. Examples:

- CLEAR LAKE becomes CLAKE
- ROUGH ROAD becomes RROAD.

Unnamed Point Waypoint Names

Unnamed turn points, intersections, and DME fixes – if an unnamed turn point, intersection, or fix is collocated with a named waypoint or navaid on a different route structure (such as low altitude routes or an approach), the name or identifier of the collocated waypoint is used. Example:

- unnamed turn point on J2 between the Lake Charles (LCH) and New Orleans (MSY) VORTACs is coincidental with the Lafayette (LFT) low altitude VORTAC. LFT is used as the identifier for the turn point.

Identifier codes for unnamed turn points not coincidental with named waypoints are constructed from the identifier of a navaid serving the point and the distance from the navaid to the point. If the distance is 99 nautical miles or less, the navaid identifier is placed first, followed by the distance. If the distance is 100 nautical miles or more, the last two digits are used and placed ahead of the navaid identifier. Examples (NAVAID – DISTANCE – IDENT):

- INW – 18 – INW18
- CSN – 106 – 06CSN
- TCS – 89 – TCS89.

Unnamed flight information region (FIR), upper flight information region (UIR), and controlled airspace reporting points – waypoints located at unnamed FIR, UIR, and controlled airspace reporting points are identified by the three–letter airspace type identification followed by a two–digit sequence number.

Unnamed oceanic control area reporting points – positions in the northern hemisphere use the letters N and E, while positions in the southern hemisphere use the letters S and W. Latitude always precedes longitude. For longitude, only the last two digits of the three digit value are used.

Placement of the designator in the five character set indicates whether the first longitude digit is 0 or 1. The letter is the last character if the longitude is less than 100° and is the third character if the longitude is 100° or greater.

N is used for north latitude, west longitude. E is used for north latitude, east longitude. S is used for south latitude, east longitude. W is used for south latitude, west longitude. Examples:

- N50° W040° becomes 5040N
- 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.

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

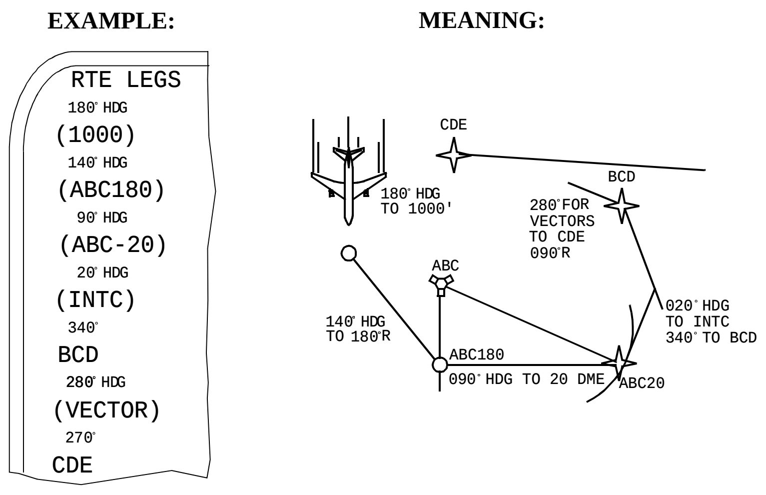
Duplicate identifiers – should application of these rules result in more than one waypoint having the same identifier, then a CDU page change occurs when an attempt is made to enter the duplicated identifier. The page title is SELECT DESIRED WPT. The page lists the latitude and longitude of waypoints 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.

Conditional Waypoint Names

Conditional waypoints are automatically entered into a route as a result of selecting a procedure on a DEPARTURES or ARRIVALS page. Normally, conditional waypoints cannot be manually entered on a RTE or RTE LEGS page. These waypoints are events when a condition occurs and are not at a geographically–fixed position. The types of conditions are:

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

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



Note: All waypoints except BCD and CDE are examples of conditional waypoints.

Manually Entered Latitude/ Longitude Waypoint Names

Pilot defined waypoints entered as a latitude and longitude are displayed in a five–character format. The first three characters are WPT followed by a two digit sequence number. Latitude and longitude waypoints are entered with no space or slash between the latitude and longitude entries. Leading zeroes must be entered. All digits and decimal points (to 1/10 minute) must be entered unless the latitude or longitude are full degrees. Examples:

- N47° W008° is entered as N47W008 and displayed as WPT01
- N47° 15.4’ W008° 3.4’ is entered as N4715.4W00803.4 and displayed as WPT02.

Manually Entered Place–Bearing/Distance or Place–Bearing/Place–Bearing Waypoint Names

Waypoints entered as a place–bearing/distance or place–bearing/place–bearing are identified by the first three characters of the entry followed by a two–digit sequence number. Examples:

- SEA330/10 becomes SEA01
- SEA330/OLM020 becomes SEA02.

Manually Entered Along–Track Waypoint Names

Along–track waypoints are a special case of place–bearing/distance waypoints applied to the current route. When a waypoint is desired on the route where none exists, the along–track waypoint feature creates the desired waypoint without creating a route discontinuity.

Along–track waypoints are entered using the waypoint name (the place), followed by a slash and minus sign, for points before the waypoint, or no sign for points after the waypoint, followed by the mileage offset for the newly defined waypoint. The route course takes the place of the bearing which is not entered. The created waypoint is then inserted over the original waypoint. The distance offset must be less than the distance between the originating waypoint and next (positive value) or preceding (negative value) waypoint. Latitude and longitude waypoints cannot be used to create along–track waypoints. Examples:

- VAMPS/25 is 25 miles after VAMPS on the present route, and is displayed as VAM01
- ELN/–30 is 30 miles before ELN on the present route, and is displayed as ELN01.

EFIS Map Displays

The route is displayed on the EHSI in the map, center map, and plan modes. The display color and format represent the following status:

- an inactive route is displayed as a cyan dashed line
- an activated but not yet executed route is displayed as a cyan dashed line
- the active route is displayed in magenta
- modifications to an active route are displayed as dashed white lines
- modified waypoints are displayed in white
- (U7) executed route offsets are displayed as a dashed magenta line.

Vertical Navigation (VNAV)

VNAV provides vertical profile guidance through the climb, cruise, and descent phases of flight.

Speed/Altitude Restrictions

VNAV controls the path and speed to comply with waypoint crossing restrictions. Waypoint crossing restrictions are entered on the LEGS page waypoint line by pushing the appropriate 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 displayed in large font. FMC predicted values do not act as restrictions, and are displayed in small font.

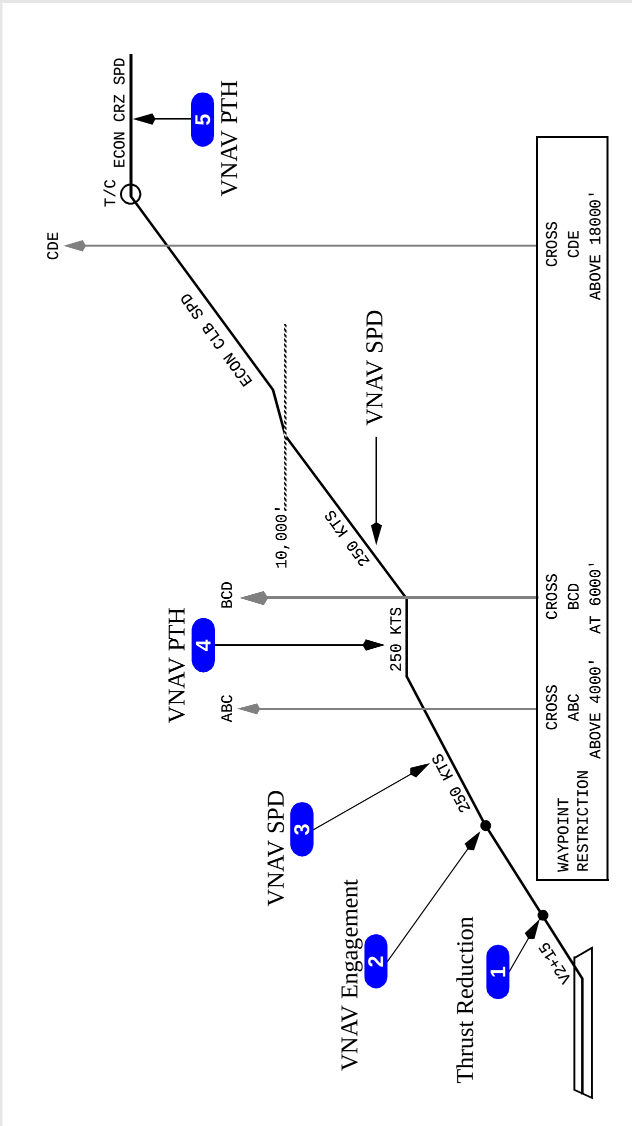
Waypoints can have altitude, airspeed, or both airspeed/altitude restrictions.

All speed restrictions are considered by the FMC as at or below restrictions.

At or above altitude restrictions are entered with a suffix letter A (example: 220A). At or below altitude restrictions are entered with a suffix letter B (example: 240B). Mandatory altitude restrictions are entered without any suffix letter (example: 270).

Altitude restrictions that are between two altitudes are displayed with the lower limit first, followed by a suffix letter A, then the upper limit, followed by a suffix letter B (example: 220A240B).

Takeoff and Climb



1 Thrust Reduction

Climb thrust is selected by pushing the N1 switch.

2 VNAV Engagement

VNAV commands an airspeed increase to the planned climb speed profile, limited by configuration.

3 VNAV Climb

The VNAV climb profile uses VNAV SPD at the default climb speed or pilot selected climb speed to remain within all airspeed and altitude restrictions that are part of the SID entered into the active route. Autothrottle uses selected climb thrust limit.

Note: Selection of ENG OUT on the CLB page provides the crew with advisory engine out performance information. (Prior to U7.5) If activated all subsequent performance predictions are blanked and VNAV is unavailable until a climb page other than ENG OUT is activated.

If the climb speed profile cannot achieve an altitude constraint, 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 displayed any time the FMC computes a transition from a climb phase to a cruise phase, such as a step climb.

The T/C point is displayed on the map as a green open circle with the label T/C.

Cruise

At cruise altitude, the FMC sets cruise speed at the default or pilot entered speed until reaching the top–of–descent (T/D) point. Alternate cruise speed options are:

- long range (LRC)
- flight crew entered speed.

Cruise thrust is set as required to maintain level flight at the target speed, with the autothrottle engaged. The FMC uses maximum range cruise speed if cost index is set to zero.

Fuel and ETA predictions are based on a constant altitude cruise unless a step climb altitude is entered.

Step Climb

If a step climb altitude is entered in the CRZ page STEP altitude, the FMC calculates the point where the step climb should begin.

The distance and ETA to the next step point are shown on the CRZ and PROGRESS pages.

The next step point is shown on the map as a green open circle with the label S/C.

Descent

VNAV can perform a descent in either of two modes – path descent or speed descent. During a path descent, the FMC uses idle thrust and pitch control to maintain a vertical path, similar to a glideslope in three dimensions. During a speed descent, the FMC uses idle thrust and pitch control to maintain a target descent speed, similar to a level change descent.

Top Of Descent (T/D)

The point where the cruise phase changes to the descent phase is the top of descent. T/D is calculated from an end of descent (E/D) point.

The T/D point is displayed on the map as a green open circle with the label T/D.

On airplanes with FMC update U7.2 and on, intermediate T/D points show on the map as green open circles with the label T/D-XXXXX (altitude). Intermediate T/D points exist when path segments between altitude constrained waypoints produce a level path segment. The intermediate T/D point shows where the descent will resume.

End of Descent (E/D)

The FMC calculates a descent path based on airspeed restrictions, altitude restrictions and the end of descent (E/D) point. The E/D point is shown on the map as a green open circle with the label E/D. The E/D is the last of the following which is not preceded by a lateral discontinuity:

- (U7) the runway threshold for approaches with a runway waypoint on the RTE LEGS page, or
- (U7) the missed approach point for approaches not showing a runway waypoint on the RTE LEGS page, or
- the lowest “at” altitude restriction if no arrival procedure is entered.

Entering an instrument arrival procedure provides an E/D point.

If there is no E/D point, FMC predictions assume a computed profile to 1000 feet above the destination field elevation, at a position which will vary according to selection of arrival procedures. The FMC will provide a slowdown profile for approach. VNAV path descent is not available if there is no E/D point.

VNAV Descent and Approach Path

The descent path starts at the calculated top of descent (T/D) point and includes waypoint altitude restrictions. The path is based on:

- idle thrust
- speedbrakes retracted
- descent wind speed decreasing with decreasing altitude
- applicable target speed.

After the first "at" or "at or below" restriction, the path angle is level until intercepting the idle thrust descent path to the next altitude constrained waypoint.

Normally, the target speed is economy speed above the airspeed restriction altitude and 240 knots below that altitude, until deceleration for approach. VNAV will not permit descent below the airspeed restriction altitude until the airspeed is at or below the restricted value plus ten knots.

The start and end of the airport speed restriction deceleration segment is shown on the map as a green open circles with no labels.

Target speeds are changed by entries on the LEGS or DESCENT pages. 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 available. At the T/D, the FMC commands idle thrust and 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.

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 IASD/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.

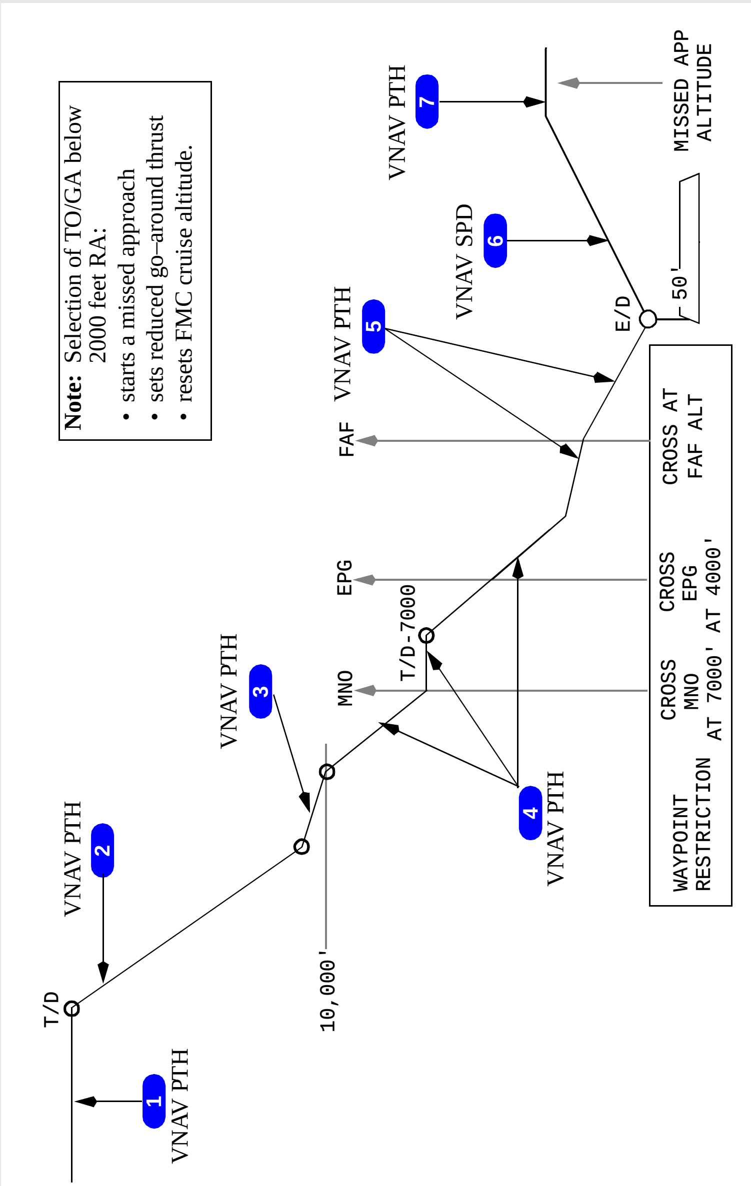
The FMC uses a special program called “Energy Compensation” at certain times during an ACT PATH DES. This program goes into effect when the MCP has been temporarily set to an altitude above the planned descent path. The airspeed cursor will slowly move toward a slower airspeed while the “TARGET” speed 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 wind results in a significant increase in airspeed to maintain path. The CDU message DES PATH UNACHIEVEABLE is displayed if the FMC determines that the planned descent profile cannot be accomplished. VNAV disengages if a limit speed will be exceeded.

(U7) A path descent must be initiated while within the allowable cross–track error for LNAV, however LNAV may be disengaged during descent while remaining in the path mode. To maintain a path descent under these conditions, the airplane must remain within a distance equal to the RNP from the LNAV course. If this distance is exceeded, VNAV will change to speed descent if no vertical angle is specified for the current leg. VNAV will disengage if there is a vertical angle specified.

(U5) To initiate a path descent LNAV must be engaged. If LNAV is disengaged during a path descent, VNAV will change to a speed descent.

VNAV Cruise and Path Descent Profile (Nonprecision Approach)



1 Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

2 Descent

After top of descent, FMC is in descent mode and VNAV changes to economy descent speed and descends in VNAV PTH.

3 Speed Restriction Deceleration

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV PTH.

When at restricted speed, VNAV commands decreased pitch and descends in VNAV PTH.

4 Altitude Restrictions

The VNAV path conforms to altitude restrictions at MNO, EPG, and the FAF. If required, VNAV uses a level path until intercepting the idle thrust descent path to the next altitude constrained waypoint.

5 Approach

VNAV descends and starts approach in VNAV PTH at the commanded speed.

6 Missed Approach (U7)

When TOGA is pushed during approach, or when crossing the missed approach point, VNAV disengages.

When VNAV is selected during missed approach, VNAV engages in VNAV SPD.

7 Missed Approach Level Off (U7)

At missed approach altitude VNAV changes to VNAV PTH.

VNAV Speed Descent

A speed descent may be selected manually by selecting the SPEED prompt on the PATH DES page. With no E/D specified, the speed descent is the only descent mode available.

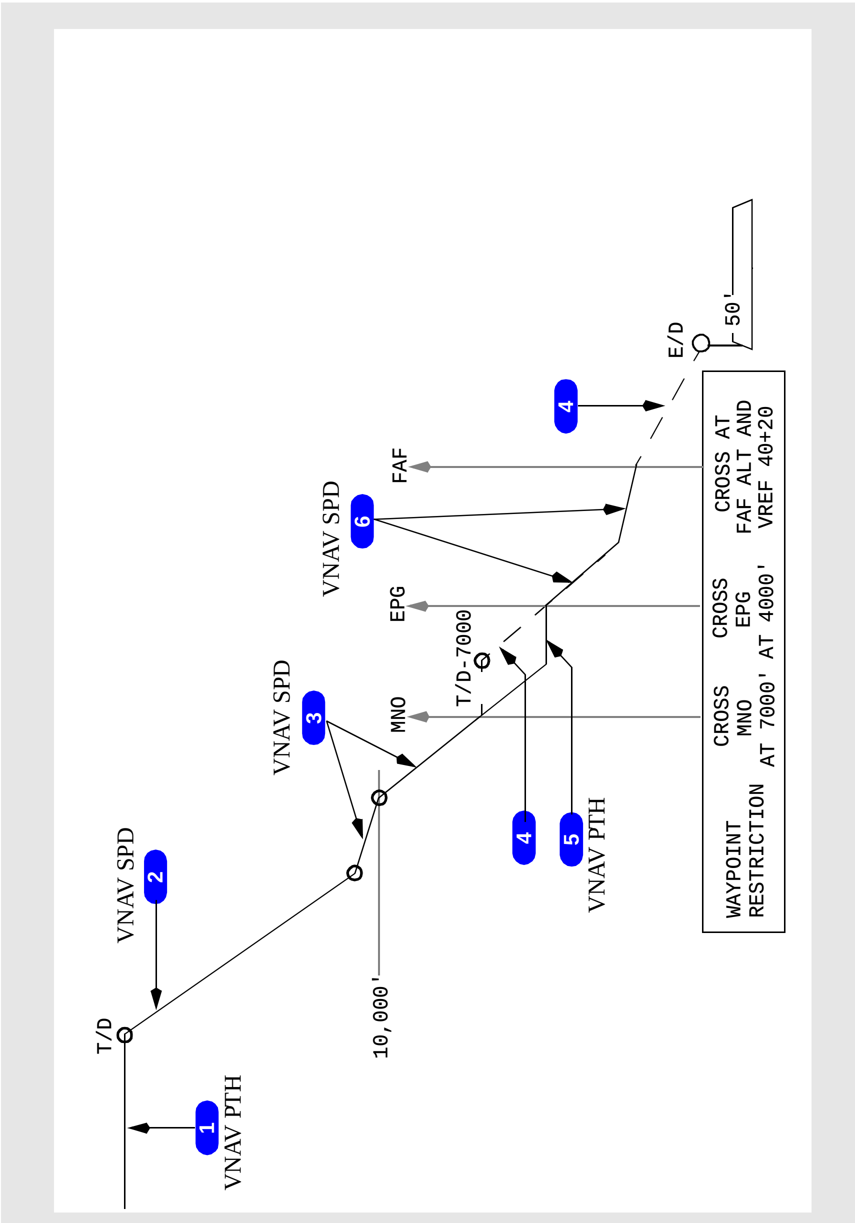
The speed descent maintains the target speed and makes no attempt to modify pitch for vertical path considerations. Normally, the target speed is economy above the airspeed restriction altitude and 240 knots below that altitude, until deceleration is necessary for approach. VNAV will not permit descent below the altitude restriction until the airspeed is at or below the restricted value.

The speed descent normally begins automatically at the calculated T/D, provided the MCP altitude is reset for the descent. At the T/D, the FMC commands pitch to maintain target speed. LNAV does not have to be engaged in order to fly a VNAV speed descent.

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.

A speed descent cannot automatically revert to a path descent, except with a U7 FMC installed and during a STAR, approach transition, or approach leg with a vertical angle leg. 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.

VNAV Cruise and Speed Descent Profile (Nonprecision Approach)



1 Cruise

Before the top of descent, FMC is in cruise mode and uses VNAV PTH and ECON cruise speed.

2 Descent

After top of descent, FMC is in descent mode and VNAV decelerates to economy descent speed and descends in VNAV SPD.

3 Speed Restriction Deceleration

Before the speed restriction altitude, VNAV decelerates to commanded speed using VNAV SPD.

When at restricted speed, VNAV commands decreased pitch and descends in VNAV SPD.

4 VNAV Path

During a speed descent, VNAV may not maintain the FMC computed VNAV path. However, if E/D shows, a VNAV path is available.

5 Altitude Restrictions

VNAV conforms to altitude restrictions at MNO and EPG. After MNO VNAV continues an idle thrust descent using VNAV SPD.

Upon reaching the next altitude restriction, VNAV commands level flight using VNAV PTH. The thrust mode changes to FMC SPD.

6 Descent and Approach

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

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

Vertical Angles (U7)

A vertical angle can be assigned to a waypoint from the navigation database. This vertical angle defines a VNAV path between the waypoint and the waypoint preceeding it. This feature can be available in approaches, approach transitions, and STARs. For example, the vertical angle for the glidepath of an ILS approach, would typically be 3 degrees. This angle is displayed on the ACT RTE LEGS page above the speed/altitude line for the associated waypoint. Vertical angles may be expected in any approach ending at RWXXX or MAXXX. The E/D will be RWXXX or MAXXX, and the E/D altitude will be either threshold crossing height (TCH – typically 50 feet above the touchdown zone elevation) or the altitude specified at MAXXX.

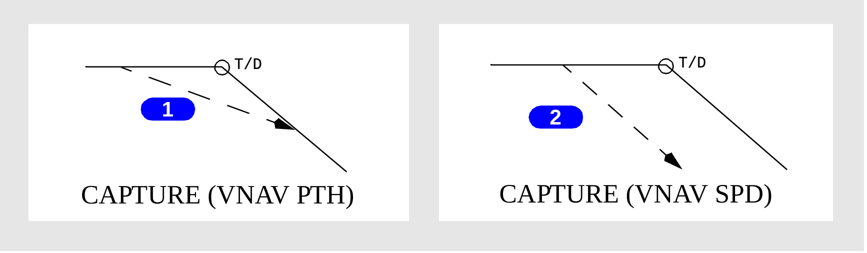
If a VNAV PATH descent is active when a vertical angle leg becomes active, the path mode will remain active, but VNAV will follow the vertical angle rather than the idle thrust descent path.

If the vertical angle leg becomes active during a SPEED descent, the VNAV mode will change to VNAV PATH automatically, and there will be no SPEED prompt on the descent page.

Early Descent

A descent in VNAV started before the top of descent point is an early descent. If a path descent is planned, VNAV commands a 1000 fpm descent until the idle descent path is intercepted. If a speed descent is planned, VNAV commands an idle thrust descent.

To start an early descent, use CAPTURE prompt on the DES page.



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 Use During Approaches (U7)

VNAV will remain engaged at all flap settings, allowing approaches to be flown using the vertical angle guidance. Speed for final approach can be set on the APPROACH REF page.

If an ILS approach is flown in VNAV using the vertical angle guidance, VNAV will disconnect when passing the GS–XXX point, but it can be reengaged. If the GS–XXX point is deleted, VNAV would remain engaged throughout the approach.

For an approach without a runway waypoint on the RTE LEGS page, the VNAV path is calculated to the MDA or a calculated altitude at the missed approach point. The calculated altitude may be below the MDA to make sure a flight path angle and normal threshold crossing height.

Note: It is the flight crew's responsibility not to descend below the MDA until adequate visual contact is achieved.

Go–Around (U7)

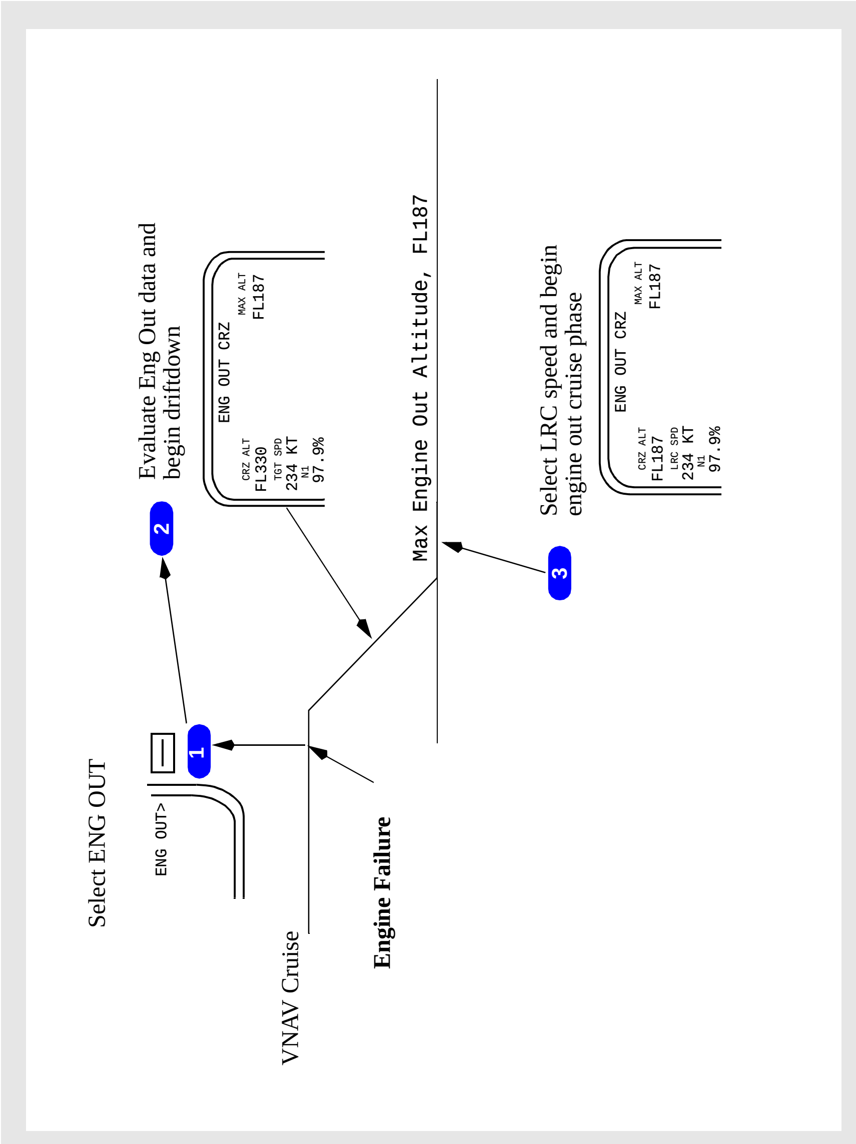
Below 2000 feet RA, go–around is engaged when a TO/GA switch is pushed. The thrust limit is set to go-around. If VNAV is subsequently engaged, the thrust limit changes to climb and VNAV commands pitch to follow the missed approach procedure.

Upon initiation if TO/GA, a new cruise altitude will be automatically assigned and will appear on the FMC pages. The new cruise altitude will be the highest of:

- the highest restriction in the missed approach routing
- default value of 1500 feet above airport elevation, or
- MCP altitude.

However, if the MCP altitude is the lowest of the three, the airplane, with autopilot engaged, will level off at the MCP selected altitude.

VNAV Cruise (Engine Out Above Eng Out Max Alt)



1 Engine Out Modification

Select the ENG OUT prompt on the CRZ page. The ENG OUT page displays the appropriate engine out driftdown performance data to enable the airplane to descend to the engine out maximum altitude. Refer to FMC Cruise, section 11.42 for a complete description of the ENG OUT CRZ page.

2 Drift Down Execution

After selecting the left or right ENG OUT mode, perform the driftdown as follows:

- disconnect A/T
- set maximum continuous thrust on operating engine (N1 line)
- set MCP speed to TGT SPD
- set MCP altitude to MAX ALT or lower altitude as required
- select LVL CHG.

The airplane then descends at CON thrust and the driftdown airspeed to the MAX ALT. As the driftdown proceeds and airplane gross weight decreases, the maximum altitude may increase.

Note: The engine out cruise page provides advisory performance data for operating with one engine.

3 Engine Out Cruise

Engine out cruise operates like normal cruise with engine out cruise speeds. If range is a factor, select LRC speed. Thrust limit remains in CON.

Required Time of Arrival (RTA)

VNAV controls cruise speed to achieve a flight crew specified arrival time at a specified waypoint. After the appropriate waypoint and RTA are input to the FMC, the FMC will compute a recommended takeoff time, speeds required to comply with the RTA, and progress information for the flight. If the RTA is not achievable, the RTA UNACHIEVABLE scratchpad message is displayed.

Data Entry Rules

Altitude Entry

Altitudes can be entered into the FMC as three digit (xxx), four digit (xxxx), five digit (xxxxx), or flight level (FLxxx) numbers. The FMC automatically displays altitude or flight level entries in the proper form based on the transition altitude. Some data lines further restrict the valid entry forms.

Three digit entries represent altitude or flight levels in increments of 100 feet. Leading zeros are required.

Examples of three digit (xxx, FLxxx) entries with transition altitude = 10,000 feet:

- 800 feet is entered as 008 or FL008 and displayed as 800
- 1,500 feet is entered as 015 or FL015 and displayed as 1500
- 11,500 feet is entered as 115 or FL115 and displayed as FL115
- 25,000 feet is entered as 250 or FL250 and displayed as FL250.

Four digit entries represent feet, rounded to the nearest ten feet. Leading zeros are required. This form is used when the altitude does not exceed 9,994 feet.

Examples of four digit (xxxx) entries with transition altitude = 18,000 feet:

- 50 feet is entered as 0050 and displayed as 50
- 835 feet is entered as 0835 and displayed as 840
- 1,500 feet is entered as 1500 and displayed as 1500
- 8,500 feet is entered as 8500 and displayed as 8500
- 9,994 feet is entered as 9994 and displayed as 9990.

Five digit entries represent feet, rounded to the nearest ten feet. This form is used when the altitude exceeds 9,994 feet

Examples of five (xxxxx) digit entries with transition altitude = 4,000 feet:

- 50 feet is entered as 00050 and displayed as 50
- 835 feet is entered as 00835 and displayed as 840
- 1,500 feet is entered as 01500 and displayed as 1500
- 8,500 feet is entered as 08500 and displayed as FL085
- 9,995 feet is entered as 09995 and displayed as FL100
- 11,500 feet is entered as 11500 and displayed as FL115
- 25,000 feet is entered as 25000 and displayed as FL250.

Negative altitude entries are allowed to –1000 feet.

Airspeed Entry

Airspeeds can be entered into the FMC as calibrated airspeed or Mach number. Calibrated airspeeds are entered as three digits (xxx) in knots. Mach numbers are entered as one, two, or three digits following a decimal point.

Data Pairs

Many CDU pages display data in pairs separated by a slash “/.” Examples of these pairs include wind direction/speed and waypoint airspeed/altitude restrictions. When entering both values in a pair, the slash is inserted between the values. When it is possible to enter only one value of the pair, the slash may not be required.

When entering only the outboard value of a pair, the trailing or leading slash may be entered, but is not required before transferring to the data line. When entering the inboard value of a pair, the trailing or leading slash must be entered before transferring to the data line. Omission of the required slash normally results in an INVALID ENTRY message.

Bearing Entry

Entry of a bearing value requires three digits. For example, key 090, not 90. A bearing entry of 360 is displayed as 000.

Plus/Minus Signs

When entering temperature or an along-track displacement distance, positive values are assumed by the FMC and + signs are not required. For negative values, key in the – sign.

FMC Databases

The FMC contains two databases:

- performance database
- navigation database.

The performance database eliminates the need for the flight crew to refer to a performance manual during flight, and provides the FMC with the information required to calculate pitch and thrust commands. All information normally required can be displayed on the CDU. The database includes:

- airplane drag and engine characteristics
- maximum and optimum altitudes
- maximum and minimum speeds.

Maintenance personnel can refine the database by entering correction factors for drag and fuel flow.

The navigation database includes most information normally determined by referring to navigation charts. This information can be displayed on the CDU or navigation display. The database contains:

- the location of VHF navigation aids
- waypoints
- airports
- runways
- other airline selected information, such as SIDs, STARs, approaches, and company routes.

If the permanent database does not contain all of the required flight plan data, additional airports, navaids, and waypoints can be defined by the crew and stored in either a temporary or a supplemental navigation database. Use of these additional databases provides world–wide navigational capability, with the crew manually entering desired data into the FMC via various CDU pages. Information in the supplemental navigation database is stored indefinitely, requiring specific crew action for erasure; the temporary navigation database is automatically erased at flight completion.

The temporary and supplemental databases share storage capacity for forty navaids and six airports, the entries being stored in either database on a first come, first served basis. For the waypoint category, exclusive storage is reserved in the temporary database for twenty entries (including those created on the RTE or RTE LEGS pages). An additional twenty waypoints (up to a maximum of forty) can be stored in either the temporary or supplemental database on a first come, first served basis.

When any storage capacity is full, entries which are no longer required should be deleted by the crew to make space for additional new entries. Created waypoints cannot be stored in the database runway category.

The FMC contains two sets of navigation data, each valid for 28 days. Each set corresponds to the normal navigation chart revision cycle. The FMC uses the active set for navigation calculations. The contents of the navigation database are periodically updated and are transferred to the FMC before the expiration date of the current data.

Thrust Management

The autothrottle operates in response to flight crew mode control panel inputs or to automatic FMC commands. Reference thrust can be selected on the N1 LIMIT page. Automatic FMC autothrottle commands are made while VNAV is engaged. The autothrottle system:

- uses reference thrust limits calculated by the FMC
- commands the thrust levers
- commands thrust equalization through the power management control.

Thrust limits are expressed as N1 limits.

The FMC calculates a reference thrust for the following modes:

- takeoff
- derated takeoff
- assumed temperature takeoff
- climb
- reduced climb
- cruise
- continuous
- go–around.

The thrust reference mode automatically transitions for the respective phase of flight. These modes can be selected on the N1 LIMIT page. The selected thrust reference mode is displayed on the thrust mode display.

Reduced Thrust Takeoff

Reduced thrust takeoffs lower EGT and extend engine life. They are used whenever performance limits and noise abatement procedures permit.

Derate/Variable Takeoff Rating

Fixed derates can be selected on the TAKEOFF REF page 2/2. Performance data for these derates is provided in the Airplane Flight Manual (AFM).

With a derated takeoff selected, the thrust setting parameter is considered a limitation for takeoff; therefore, thrust levers should not be advanced further except in an emergency. A further thrust increase following an engine failure could result in a loss of directional control while on the ground. Use the takeoff speeds supplied by the FMC or specified in Chapter PI, Performance-Inflight, for the selected derate condition.

Derate takeoff ratings can be further reduced by using an assumed temperature.

Use the takeoff speeds specified in Chapter PI, Performance–Inflight, for the selected derate or variable takeoff rating condition.

Assumed Temperature Thrust Reduction Takeoff

A takeoff thrust less than the full rated thrust may be achieved by using an assumed temperature that is higher than the actual temperature. The desired thrust level is obtained through entry of a SEL TEMP value on TAKEOFF REF page 1 or 2. Use approved sources for selecting the assumed temperature.

The maximum thrust reduction authorized is 25% below any certified rating. Do not use assumed temperature reduced thrust if conditions exist that affect braking, such as slush, snow, or ice on the runway, or if potential windshear conditions exist.

The assumed temperature thrust setting is not considered a limitation. The assumed temperature reduction can be removed. If conditions are encountered where additional thrust is desired, the crew can manually apply full thrust.

Reduced Thrust Climb

Two fixed climb thrust reductions can be selected on the N1 LIMIT page. CLB 1 provides a climb limit reduced by 3% (approximately 10% thrust reduction). CLB 2 provides a climb limit reduced by 6% (approximately 20% thrust reduction). The reduced climb setting gradually increases to full rated climb thrust by 15000 feet. In cruise, the thrust reference automatically changes to CRZ. The reference can be manually selected on the N1 LIMIT page.

Use of an assumed temperature reduced thrust takeoff or takeoff derate affects automatic selection of reduced climb N1.

Use of reduced climb thrust decreases engine maintenance costs, but increases total trip fuel.

Fuel Monitoring

The FMC receives fuel data from the fuel quantity summation unit. Fuel quantity values are displayed on the PERF INIT page and on PROGRESS page 1 as FUEL QTY. The FMC uses the summation unit for performance calculations.

If fuel quantity data becomes invalid, the fuel quantity will be blank on the PERF INIT page and on PROGRESS page 1. VNAV is not available.

The FMC monitors the total fuel load on board as detected by the fuel summation unit. The FMCS–CDU message INSUFFICIENT FUEL is displayed if the FMC predicts the total fuel quantity at destination to be less than 2,000 lb. (900 kg.). The USING RSV FUEL message is displayed if the fuel remaining at destination is less than the RESERVES entry on the PERF INIT page.

The CHECK FMC FUEL QUANTITY message is displayed if the FMC has detected a decrease in fuel quantity of greater than 1,500 lb. (675 kg.), and 120 seconds has elapsed since the decrease was detected. The flight crew must then manually compute the fuel quantity value to determine gross weight for the remainder of the flight.

FMC calculated fuel predictions are based on gear and flaps up during climb, cruise, and descent. Any prolonged flight with gear and/or flaps extended will increase fuel required, and will not be displayed correctly on the FMC fuel predictions pages.

Loss of FMC Electrical Power

The FMC requires continuous electrical power to operate. When the electrical power is interrupted for less than ten seconds:

- LNAV and VNAV disengage
- all entered data is retained by the FMC
- the FMC resumes normal operation when power is restored.

If power is lost for ten seconds or more on the ground, all preflight procedures and entries must be done again when power is restored.

If power is lost for more than ten seconds in flight:

- LNAV and VNAV disengage
- all entered data is retained by the FMC, and when power is restored the MOD RTE LEGS page is displayed with the advisory message SELECT ACTIVE WPT/LEG.

Before LNAV can engage, the FMC must be instructed how to return to the route. Select the desired active waypoint and proceed direct or intercept a course to the waypoint.

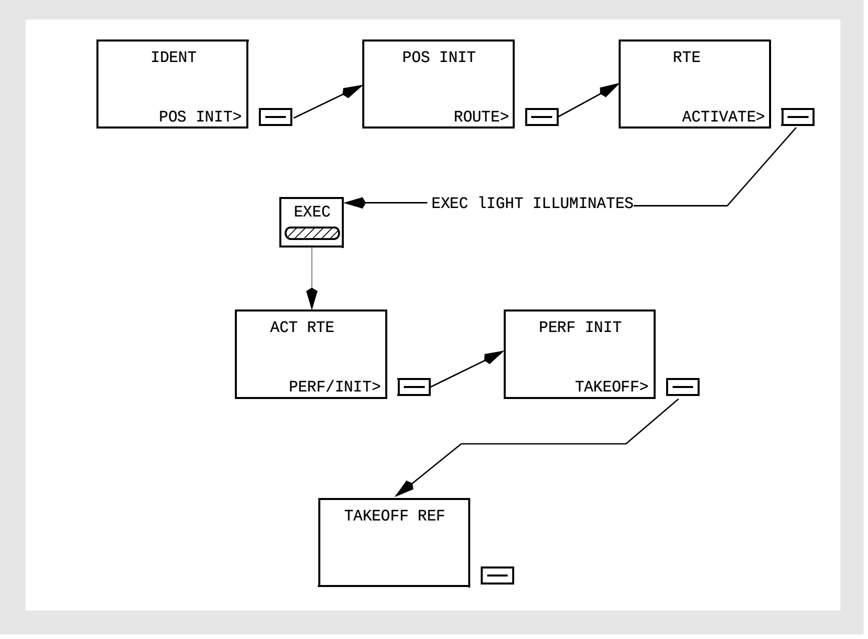
FMC Failure

If the FMC fails, the FMC alert light will illuminate. The FMC/CDU FAIL light will appear on both CDUs, and both CDUs will display failure modes. “VTK” will appear on both EHSIs. LNAV and VNAV will disengage. After 25 to 30 seconds, both EHSI maps will display failure information.

Introduction

Completion of the FMC preflight requires data entry in all minimum required data locations. Completing all required and optional preflight data entries ensures the most accurate performance possible.

Preflight Page Sequence



The normal preflight sequence follows paging prompts on each CDU page.

The normal FMC power–up page is the IDENT page. Preflight flow continues in this sequence:

- Identification (IDENT) page
- Position Initialization (POS INIT) page
- Route (RTE) page
- Departures (DEP/ARR) page (no automatic prompt)
- Performance Initialization (PERF INIT) page
- Takeoff Reference (TAKEOFF REF) page.

Some of these pages are also used in flight.

The airplane inertial position is required for FMC preflight and flight instrument operation.

A route must be entered and activated. The minimum route information is origin and destination airports and a route leg.

Performance information requires the airplane weight and cruising altitude.

Page Entries and Sequence

During preflight, the prompts that appear in the lower right of the CDU page direct the crew through the minimum requirements for preflight completion. Pushing the prompt key for the next page in the flow presents new entry requirements. Additional entries are made on pages to refine the performance and route calculations. If a required entry is missed, a prompt on the TAKEOFF page leads the crew to the preflight page that is missing data.

Supplementary Pages

Supplementary pages are sometimes required. These pages must be manually selected. Manual selection interrupts the normal automatic sequence. Discussions of each normal page include methods to display the page when the automatic sequence is interrupted.

When the route includes SIDs and STARs, they can be entered into the preflight using the DEPARTURES or ARRIVALS pages.

Route discontinuities are removed, the route is modified, and speed/altitude restrictions are entered on the RTE LEGS page. The RTE LEGS page is described in the FMC Takeoff and Climb and FMC Cruise sections of this chapter.

Waypoint, navigation, airport, and runway data is referenced on the REF NAV DATA page or the SUPP NAV DATA page. The REF NAV DATA page and SUPP NAV DATA page are described in the FMC Cruise section of this chapter.

VNAV performance is improved if the forecast winds and temperatures are entered during the preflight.

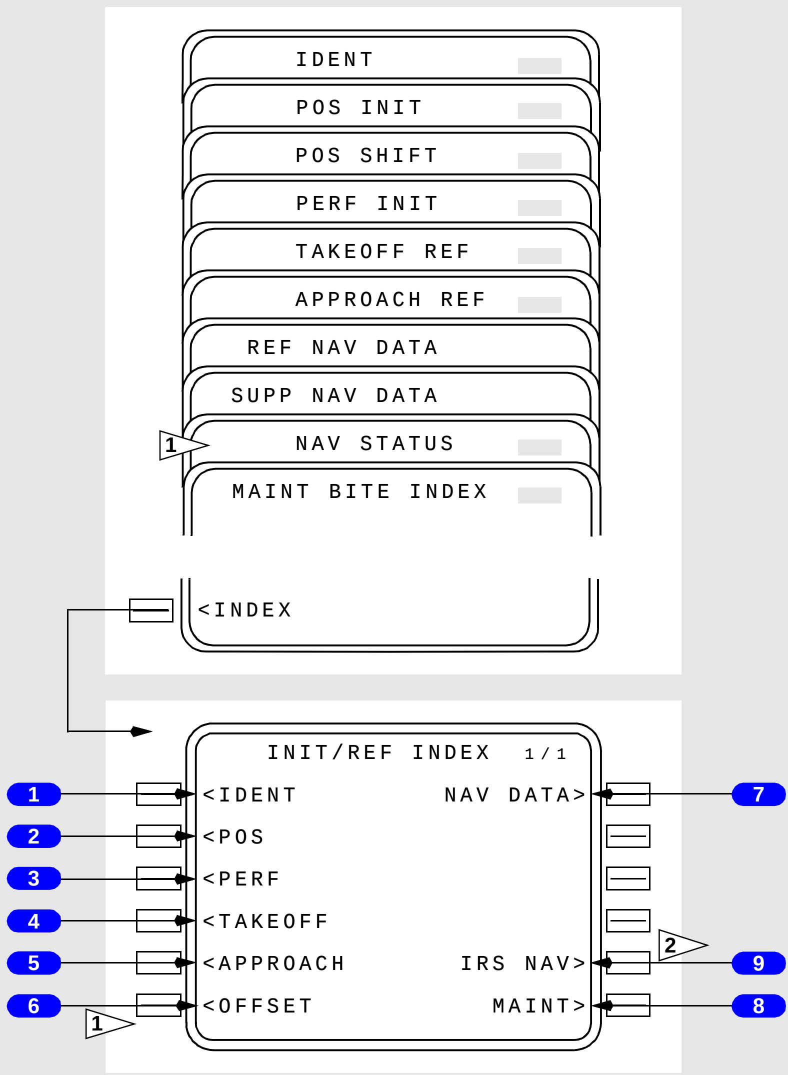
A single wind and temperature for cruise may be entered on the PERF INIT page. Wind and temperature data for specific cruise waypoints are entered on the RTE DATA page. The RTE DATA page is described in the FMC Cruise section. Wind and temperature for descent is entered on the DES FORECASTS page. The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

Initialization/Ident Pages

Note: The preflight pages are presented in the sequence used during a typical preflight.

Initialization/Reference Index Page

The INIT/REF INDEX page provides manual selection of FMC pages. It provides access to pages used during preflight and not normally used in flight.



1 U7 2 Airplanes with ANS

1 Identification (IDENT)

Displays the IDENT page, the first page in the automatic preflight sequence.

2 Position (POS)

Displays the POS INIT page used for IRS initialization.

POS INIT page is also used to enter/update magnetic heading for an IRS which is in the ATT mode.

3 Performance (PERF)

Displays the PERF INIT page for initialization of data required for VNAV operations and performance predictions.

4 TAKEOFF

Displays the TAKEOFF REF page to enter takeoff reference information and V speeds.

5 APPROACH

Displays the APPROACH REF page for entry of the approach VREF speed.

6 OFFSET

Displays the LATERAL OFFSET page for initiating a lateral offset.

7 Navigation Data (NAV DATA)

Displays the REF NAV DATA page to display information about waypoints, navaids, airports, and runways. On the ground, displays the SUPP NAV DATA page if SUPP is entered in the scratchpad prior to selection.

8 Maintenance (MAINT)

For maintenance use only; displays maintenance pages.

9 IRS Navigation (IRS NAV)

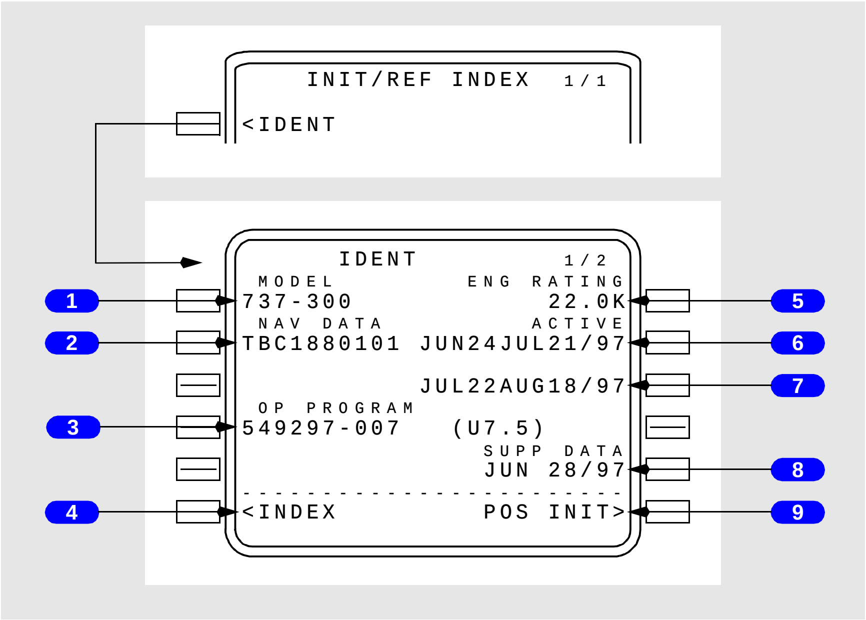
Allows selection of the appropriate ANCDU page (IRS PROGRESS or IRS LEGS).

Blank if IRS inputs to the CDU are invalid.

Identification Page

Most of the data on this page is for crew verification. The active navigation database and supplemental database accept manual entries.

The crew verifies FMC data and selects a navigation database on the IDENT page.



1 **MODEL**

Displays the airplane model from the FMC performance database.

2 **Navigation Data (NAV DATA)**

Displays the navigation database identifier.

3 **Operational Program (OP PROGRAM)**

Displays the Boeing software part number and update version.

4 **INDEX**

Push – displays the INIT/REF INDEX page.

5 **Engine Rating (ENG RATING)**

Displays the engine thrust stored in the FMC performance database.

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 effectivity date range for the inactive navigation database.

8 Supplemental Data (SUPP DATA)

Displays the effective date of the supplemental database. Blank if supplemental database is empty

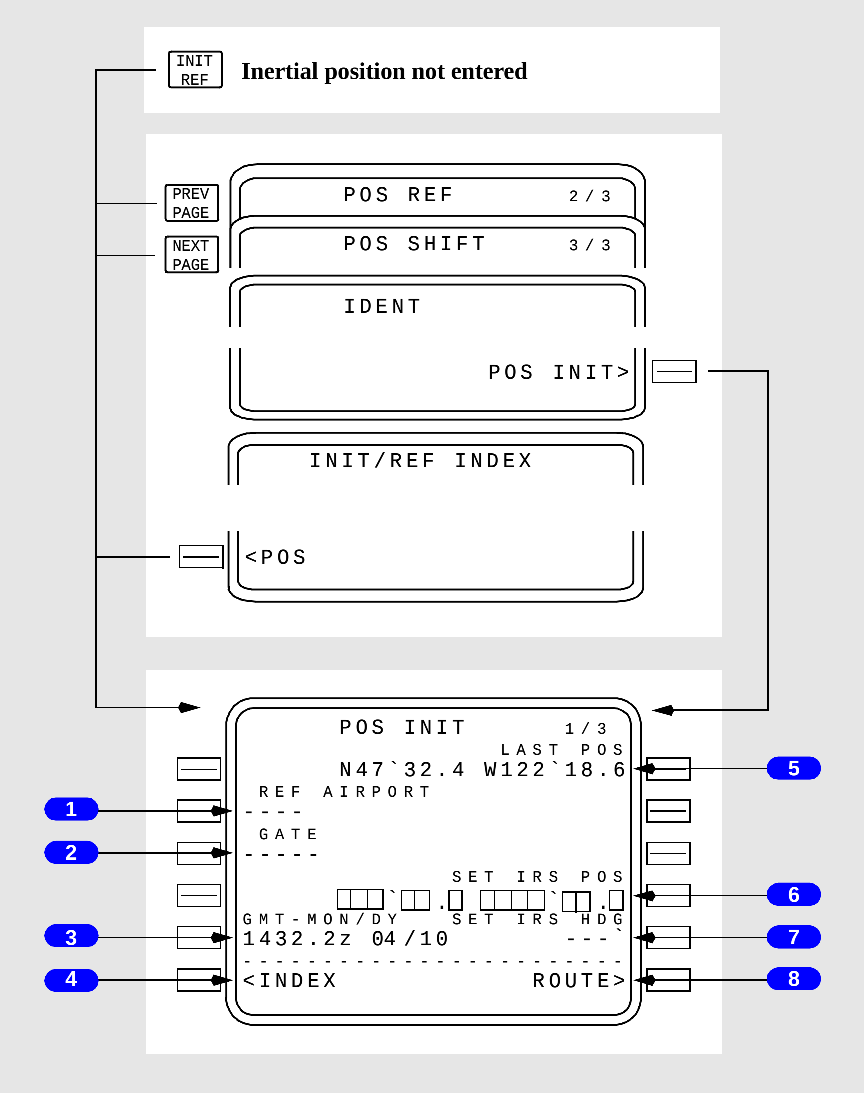
9 Position Initialization (POS INIT)

Push – displays the POS INIT page.

Position Pages

Position Initialization Page

The POS INIT page allows airplane present position entry for IRS alignment and FMC initialization. The same page is used to enter/update the magnetic heading for an IRS which is in the ATT mode. There are three POS pages.



1 Reference Airport (REF AIRPORT)

The reference airport entry allows entry of the current airport for display of the airport latitude/longitude.

Optional entry.

Valid entries are ICAO four letter airport identifiers.

Displays the latitude and longitude of the reference airport.

Removes previous GATE entry.

Entry blanks at lift–off.

2 GATE

The gate entry allows further refinement of the latitude/longitude position.

Optional entry after the reference airport is entered.

Valid entry is a gate number at the reference airport.

Displays the latitude and longitude of the reference airport gate from the navigation database.

Changes to dashes when a new reference airport is entered.

Entry blanks at lift–off.

3 Greenwich Mean Time Month/Day (GMT – MON/DY)

Displays the time and date from the captain’s clock.

If the captain’s clock is not valid, GMT starts at 0000.0Z when the FMC is first powered. MON/DY is blank. Manually enter the correct GMT.

4 INDEX

Push – displays the INIT/REF INDEX page.

5 Last Position (LAST POS)

Displays the last FMC computed position.

6 Set IRS Position (SET IRS POS)

The set inertial position entry is required to initialize the IRS. Select the most accurate latitude/longitude for the initialization. A displayed latitude/longitude can be selected or a manual entry can be used.

If an entry is not made before the IRS finishes the initial alignment, the scratchpad message ENTER IRS POS is displayed.

Failure of the manually entered position to pass the IRS internal check displays the scratchpad message ENTER IRS POS.

Enter airplane position latitude and longitude.

If the latitude/longitude position is not within 4 NM of the origin airport, the scratchpad message VERIFY POSITION is displayed.

Box prompts are displayed when either IRS is in the ALIGN mode and IRS present position has not been entered.

Blanks when the IRS transitions from the alignment to the navigation mode.

7 Set IRS Heading (SET IRS HDG)

Enter/update magnetic heading for any IRS which is in ATT mode. Line blanks when IRS not in ATT mode.

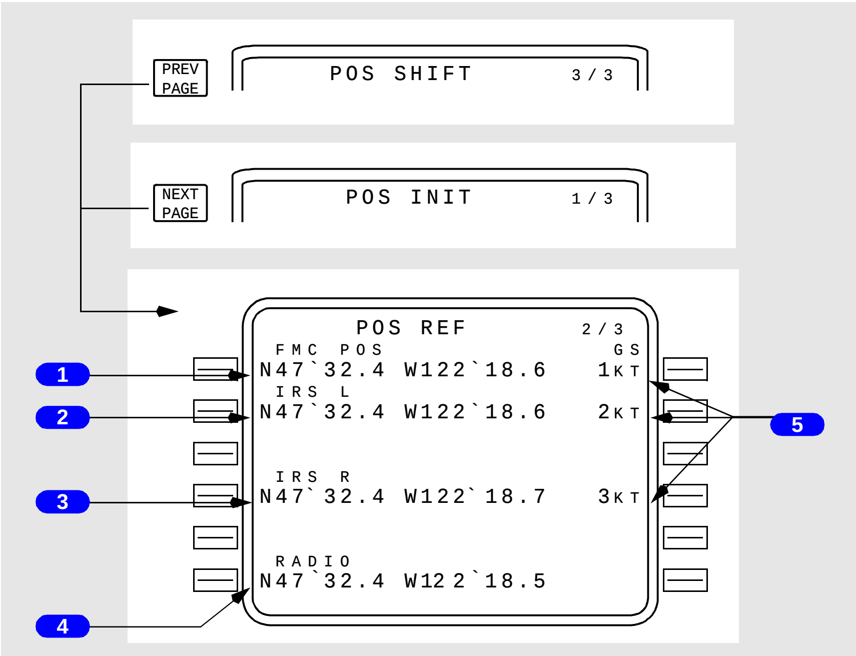
8 ROUTE

Push – displays the ROUTE page.

Position Reference Page

The POS REF page displays the airplane positions as calculated by the FMC, IRS, and radio navigation receivers.

This page displays latitude/longitude. All position displays are in actual latitude and longitude, as calculated by the respective system. Ground speed is displayed for the FMC and each IRS.



1 FMC Position (FMC POS)

Displays the FMC calculated latitude/longitude. Blank if at least one IRS is not supplying a valid present position.

2 IRS Left (IRS L)

Displays the latitude/longitude position as determined by the left IRS. Blank if IRS position is invalid.

3 IRS Right (IRS R)

Displays the latitude/longitude position as determined by the right IRS. Blank if IRS position is invalid.

4 RADIO

Displays the latitude/longitude position as determined by the navigation radios. Blank if on the ground or if radio position is invalid in flight.

5 Ground Speed (GS)

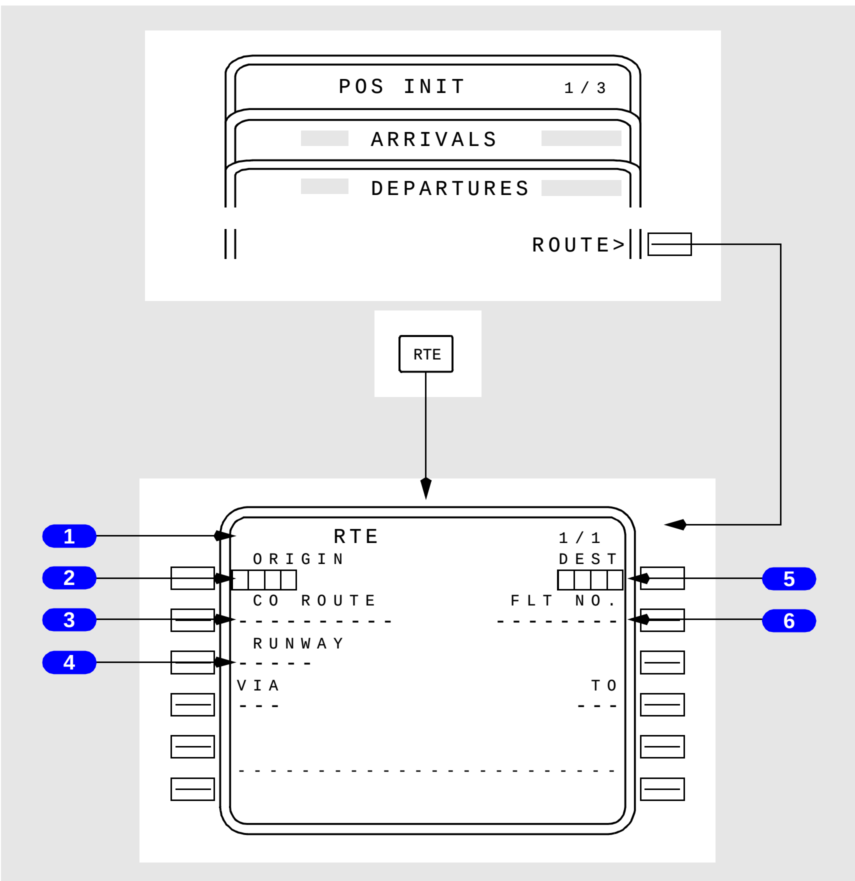
Displays the ground speed from FMC and IRS. Blank if ground speed of related system is invalid.

Route/Departure Pages

Route Page

The route is entered and displayed in air traffic control format. The first RTE page displays origin and destination data and the first two route segments. Additional route segments are displayed on subsequent RTE pages.

Individual portions of the route may be manually entered by the flight crew. A pre-defined route may be loaded using the CO ROUTE line. CO ROUTE entries must correspond to a company defined route in the navigation database.



1 Page Title

The word ACT appears to the left of the title when the route has been activated and executed.

The word MOD appears to the left of the normal title when the route is modified and the change is not executed.

Multiple route pages are indicated by the page sequence number to the right of the title.

2 ORIGIN

Enter the ICAO airport identifier for the origin.

An entry is required for route activation.

Valid entries must be in the navigation database.

Inflight entry is inhibited for the active route. Entry of a new origin erases the previous route and can be accomplished on the active route only on the ground.

New entries on an active route display MOD in the route title.

Enables direct selection of departure and arrival procedures for the origin airport.

Automatically entered as part of a company route.

3 Company Route (CO ROUTE)

A company route can be called from the navigation database by entering the route identifier. The data provided with a company route can include origin and destination airports, departure runway, SID and STAR, and the route of flight. All company route data is automatically entered when the route identifier is entered.

An entry is optional for activation of the route.

Enter a company route identifier.

Valid entry is any crew entered company route name. If the name is not contained in the NAV database, the scratchpad message NOT IN DATABASE is displayed.

Entry of a new company route replaces the previous route.

Inflight entry is inhibited for the active route.

4 RUNWAY

Enter the desired runway for the origin airport.

An entry is optional for activation of the route.

Entries must be in the navigation database.

New entries on an active route display MOD in the route title.

Automatically entered when part of a company route.

Can be entered from the DEPARTURES page.

Deleted upon reaching the first waypoint.

5 Destination (DEST)

Enter the ICAO airport identifier for the destination of the route.

An entry is required for route activation.

Entries must be in the navigation database.

New entries on an active route display MOD in the route title.

Enables direct selection of arrival procedures for the destination airport.

Automatically entered as part of a company route.

Entry and execution of a new destination clears any runway and runway dependent approach procedure of the previous destination. If the active leg is part of the affected procedure, then all subsequent (inactive) legs are cleared.

6 Flight Number (FLT NO.)

Enter the company flight number.

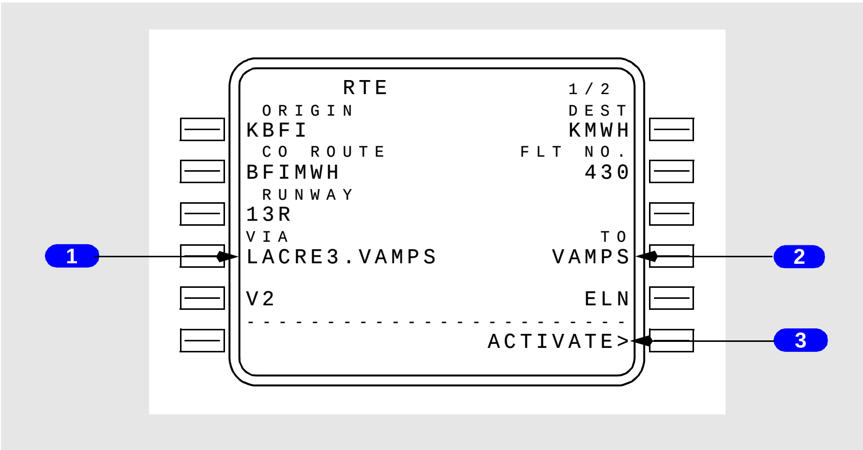
Entry is optional for activation of the route.

Limited to 8 characters.

Crew entered.

Flight number is included in the PROGRESS page title.

Route Page with Data Entries



1 VIA

The VIA column displays the route segment to the waypoint or segment termination displayed in the TO column. Enter the path which describes the route segment between the previous waypoint and the segment termination.

Enter an airway in the VIA column and box prompts are displayed in the TO column if the previous TO line contains a waypoint on the airway.

Valid entries can also include procedures or DIRECT. Procedures are normally entered through selections on DEPARTURES and ARRIVALS pages. DIRECT is normally entered as a result of entering a TO waypoint first.

Valid airways must:

- contain the fix entered in the TO waypoint, and
- contain the previous TO waypoint.

Dashed prompts change to DIRECT if the TO waypoint is entered first.

Dash prompts appear for the first VIA beyond the end of the route.

Invalid VIA entries display the scratchpad entry INVALID ENTRY.

Invalid VIA entries are:

- airways and company routes which do not contain the TO waypoint of the previous line
- airways or company routes that are not in the navigation database.

When entering airways, the beginning and ending waypoints determine if the entry is valid. The route segment must contain the waypoint entered in the TO position. The TO waypoint of the previous route segment must be the same as the beginning point of the current route segment, or a route discontinuity is created between the segments.

Entry of a SID or transition automatically enters the VIA and TO data for the route segments of the SID. A SID automatically links to the next route segment when the final SID waypoint is part of the route segment.

LACRE3.VAMPS is an example of a SID selection made on the DEPARTURES page.

V2 is an example of airway entry.

2 TO

Enter the end point of the route segment specified by the VIA entry.

Entry of a waypoint in the TO column without first entering a VIA airway displays DIRECT in the VIA column.

Box prompts indicate that an entry is required.

Valid waypoint entries for a DIRECT route segment are any valid waypoint, fix, navaid, airport, or runway.

Valid waypoint entries for airways are waypoints or fixes on the airway.

Dash prompts appear on the first TO waypoint following the end of the route.

3 ACTIVATE

Pushing the ACTIVATE key arms the route for execution as the active route. When the EXEC key is pushed, the route becomes the active route and the ACTIVATE prompt is replaced with the next required preflight page prompt.

Push – prepares the selected route for execution as the active route.

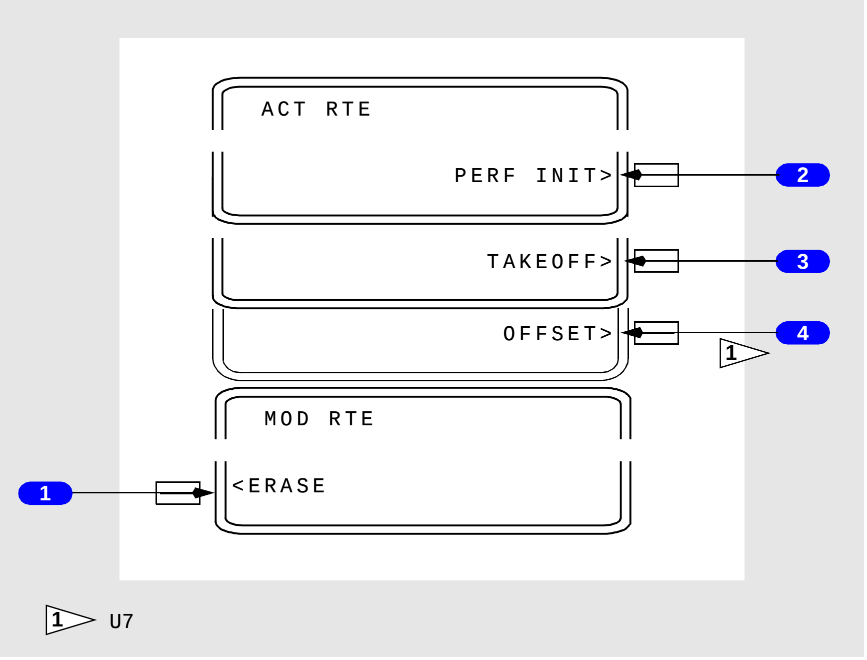
Activation of a route is required for completion of the preflight.

Displayed on inactive route pages.

After route activation, the ACTIVATE prompt is replaced by:

- PERF INIT when the required performance data is incomplete, or
- TAKEOFF when the required performance data is complete.

Additional Route Page Prompts for an Activated Route



1 ERASE

Push – removes all pending modifications.

Displayed only during modifications.

2 Performance Initialization (PERF INIT)

Push – displays PERF INIT page.

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

3 **TAKEOFF**

Push – displays TAKEOFF REF page.

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

4 **OFFSET**

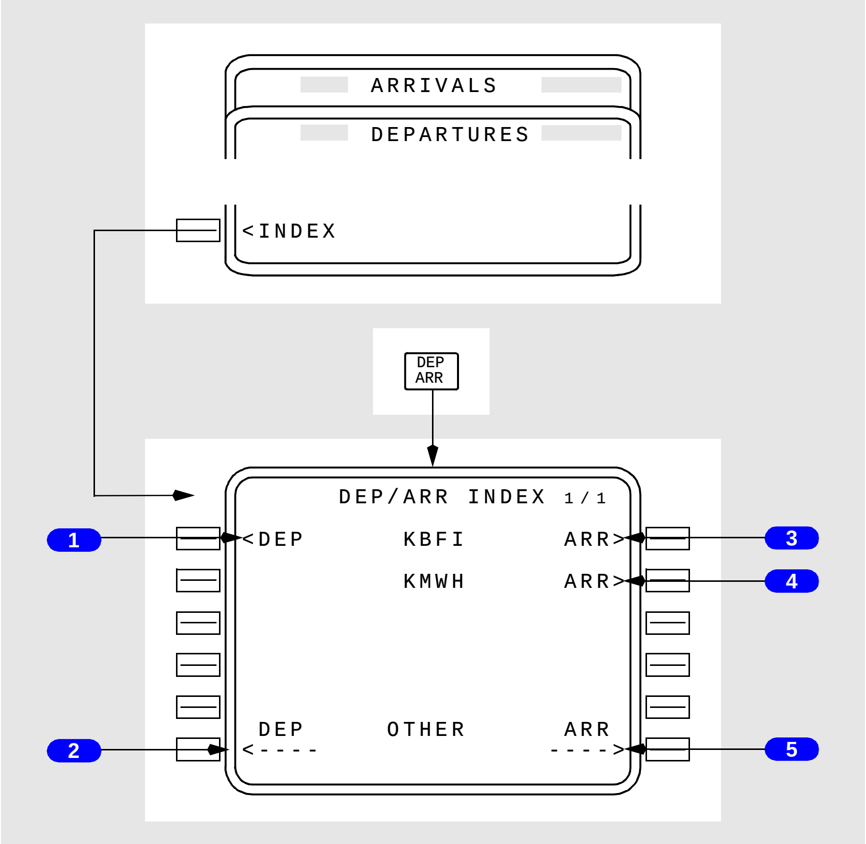
Push – displays LATERAL OFFSET page.

Displayed only in flight.

Departure/Arrival Index Page

The DEP/ARR INDEX page is used to select the departure or arrival page for the origin and destination airports for each route. The index also allows reference to departure or arrival information for any other airport in the navigation database.

Departure and arrival prompts are available for the origin airport. Destination airports have only arrival prompts.



1 Departure (DEP) – Origin

Push – displays the departure page for the origin airport.

2 Departure (DEP) – OTHER

Displays the departure page for the airport entered into this line through the scratchpad.

DEP prompt for OTHER allows display of departure information about airports that are not an origin or destination. The displayed information can be viewed but cannot be selected, because the airport is not on the route.

3 Arrival (ARR) – Origin

Push – displays the arrival page for the origin airport. Origin airport arrivals selection is used during a turn–back situation.

4 **Arrival (ARR) – Destination**

Push – displays the arrival page for the destination airport.

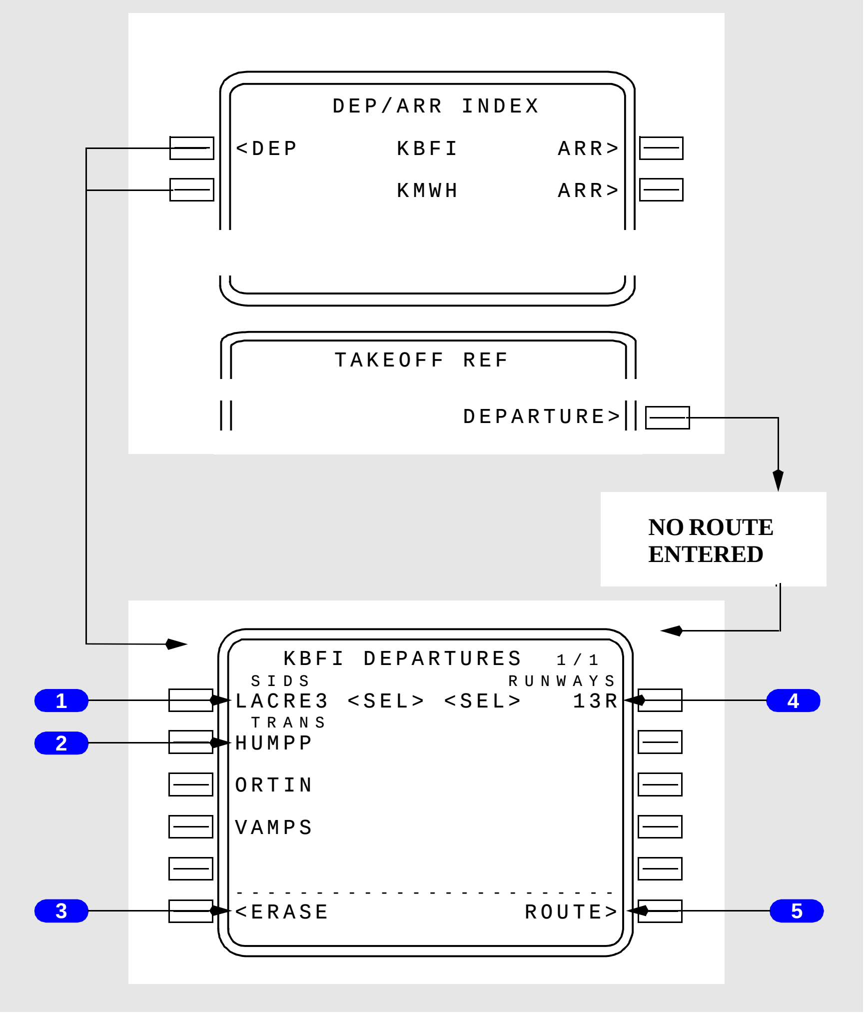
5 **Arrival (ARR) – OTHER**

Displays the arrival page for the airport entered into this line through the scratchpad.

ARR prompt for OTHER allows display of arrival information about airports that are not an origin or destination. The displayed information can be viewed but cannot be selected, because the airport is not on the route.

Departures Page

The DEPARTURES page is used to select the departure runway, SID, and transition for the route origin airport.



1 Standard Instrument Departures (SIDS)

Displays SIDS for the airport and runway selections.

Without the selection of a runway on the RTE page, the initial display contains all of the information for the airport runways and SIDS. As selections are made, incompatible options are removed. SID transitions are displayed after a SID is selected.

2 Transitions (TRANS)

Displays transitions compatible with the selected SID.

3 ERASE/INDEX

Erase is displayed when a route modification is pending. INDEX is displayed when no route modification is pending.

ERASE push – removes route modifications that are not executed and restores the original route.

INDEX push – displays the DEP/ARR INDEX page.

4 RUNWAYS

Displays a list of runways for the selected airport.

The runway selected on the RTE page is displayed as <SEL> or <ACT> when this page is displayed.

5 ROUTE

Push – displays the RTE page.

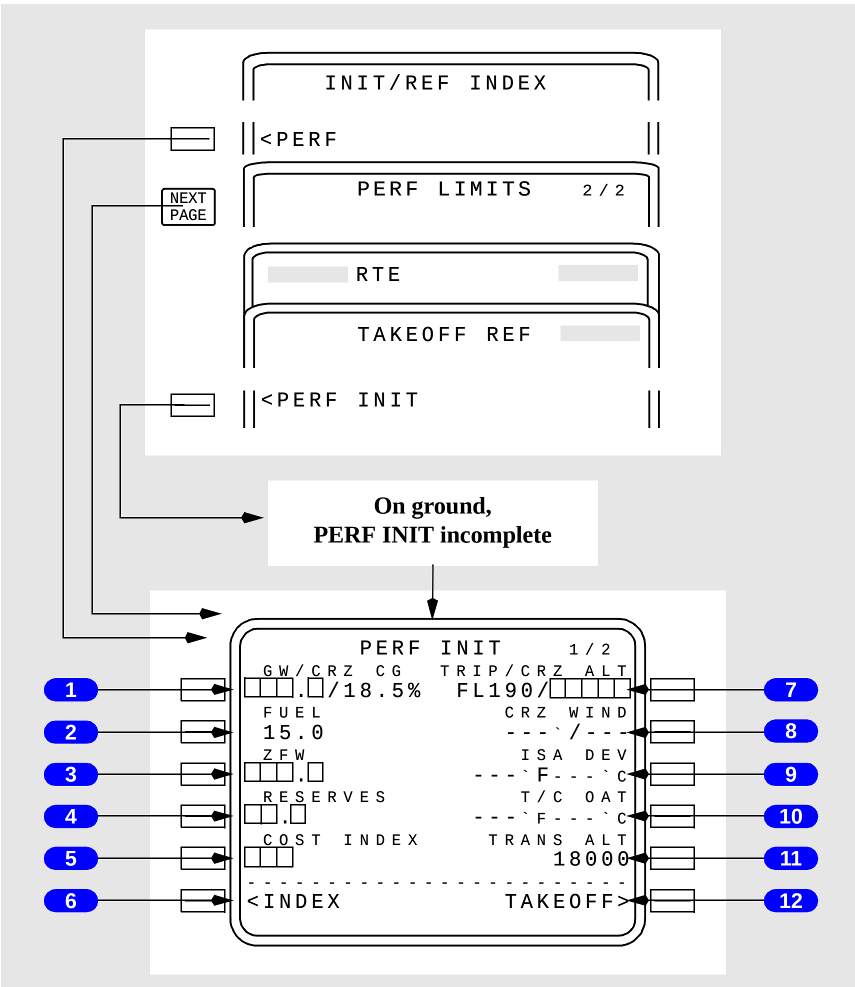
Selecting Options

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

Performance Pages

Performance Initialization Page

The PERF INIT page allows the entry of airplane and route data to initialize performance calculations. This information is required for VNAV calculations.



1 Gross Weight/Cruise Center of Gravity (GW/CRZ CG)

Airplane gross weight is required. The entry can be made by the flight crew or automatically calculated by the FMC, following entry of zero fuel weight.

Enter airplane gross weight.

Valid entries are xxx or xxx.x.

Automatically displays calculated weight when zero fuel weight is entered first.

Displays default or manually entered cruise CG. Entry of actual cruise CG may increase maximum altitude capability.

2 FUEL

Fuel on board is automatically displayed as received from the airplane fuel summation unit.

Display is blank if the FMC is not receiving the required fuel data.

3 Zero Fuel Weight (ZFW)

Airplane zero fuel weight is required. Normally the ZFW is entered from the airplane dispatch papers, and the FMC calculates the airplane gross weight.

Enter the airplane zero fuel weight.

Valid entry is xxx or xxx.x.

Calculated zero fuel weight is automatically displayed if airplane gross weight is entered first and fuel on board is valid.

4 RESERVES

Enter fuel reserves for the route.

Entry is required to complete the preflight.

Valid entry is xx or xx.x.

5 COST INDEX

The cost index is used to calculate ECON climb and cruise speeds. The value reflects the relative impacts on overall trip cost of fuel cost as compared to other direct hourly operating costs.

Enter the cost index for ECON calculations.

Entry is required to enable use of VNAV mode.

Valid entries are 0 to 200. Entry of 0 causes the ECON speed to be MAX RANGE; 200 results in a minimum time flight.

Entry of a CO ROUTE on RTE page causes any company stored value of cost index to be automatically displayed. A manual entry has priority.

6 INDEX

Push – displays the INIT/REF INDEX page.

7 Trip/Cruise Altitude (TRIP/CRZ ALT)

Trip altitude is automatically computed and displayed whenever entries have been made for the ORIGIN, DEST, GROSS WT, and COST INDEX. Otherwise, the field is blank.

Trip altitude is the predicted minimum cost altitude determined by operator constraints. Provides crew a reference for selecting a planned cruise altitude.

Cruise altitude is required.

Enter the cruise altitude for the route.

Automatically displays this cruise altitude on the CLB, CRZ, and RTE LEGS pages.

8 Cruise Wind (CRZ WIND)

Cruise wind entry provides input to optimize FMC calculations.

Enter the forecast cruise wind.

Entry is propagated onto the RTE DATA page.

If no entry is made, the FMC assumes zero wind for preflight predictions.

9 ISA Deviation (ISA DEV)

ISA deviation entry provides input to optimize FMC calculations.

Entry causes T/C OAT to be computed and displayed.

Enter ISA deviation for top of climb altitude.

If no entry is made, FMC assumes zero deviation.

10 Top of Climb Outside Air Temperature (T/C OAT)

T/C OAT entry provides input to optimize FMC calculations.

Entry causes ISA DEV to be computed and displayed.

Enter T/C OAT.

If no entry is made, FMC assumes ISA value.

11 Transition Altitude (TRANS ALT)

Displays 18,000 feet at FMC power up.

Changes automatically after selecting a departure procedure with a different transition altitude.

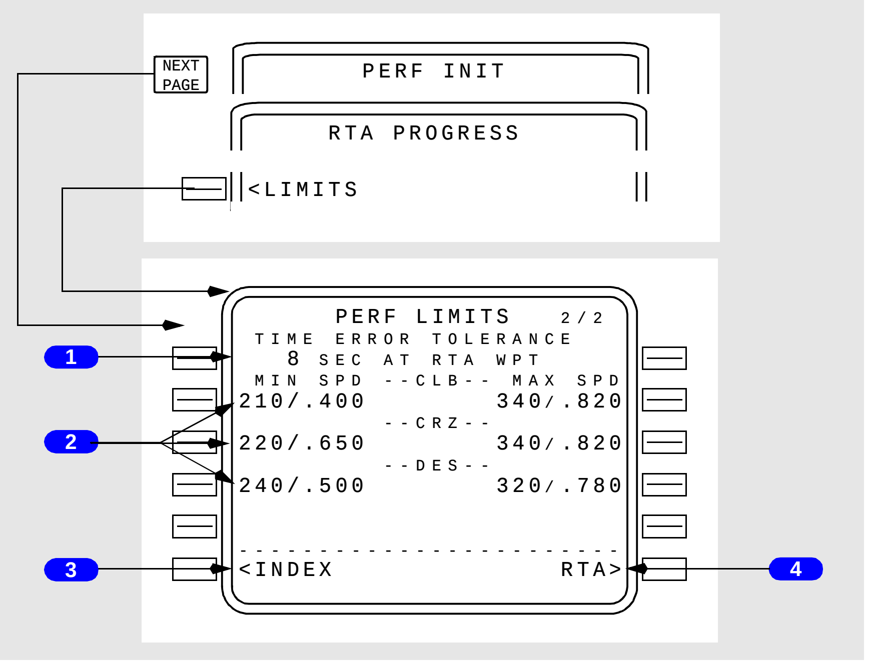
Manual entry has priority.

12 TAKEOFF

Push – displays the TAKEOFF page.

Performance Limits Page

The performance limits page allows the entry of performance limits affecting RTA and ECON calculations.



1 TIME ERROR TOLERANCE

Used during RTA calculations to establish a boundary on computed speeds.

Valid entry range is from 6 to 30 seconds.

Default value is 15 seconds and is displayed in small font.

2 Minimum Speed/Maximum Speed (MIN SPD/MAX SPD)

Establishes lower and upper speed limits for each phase of flight.

Default is 210/.40 for lower limit and 340/.820 for upper limit. Displayed in small font.

Either CAS or Mach can be entered.

Limits both RTA and ECON modes in flight.

3 **INDEX**

Push – selects INIT /REF INDEX page.

4 **Required Time of Arrival (RTA)**

Push – selects RTA PROGRESS page.

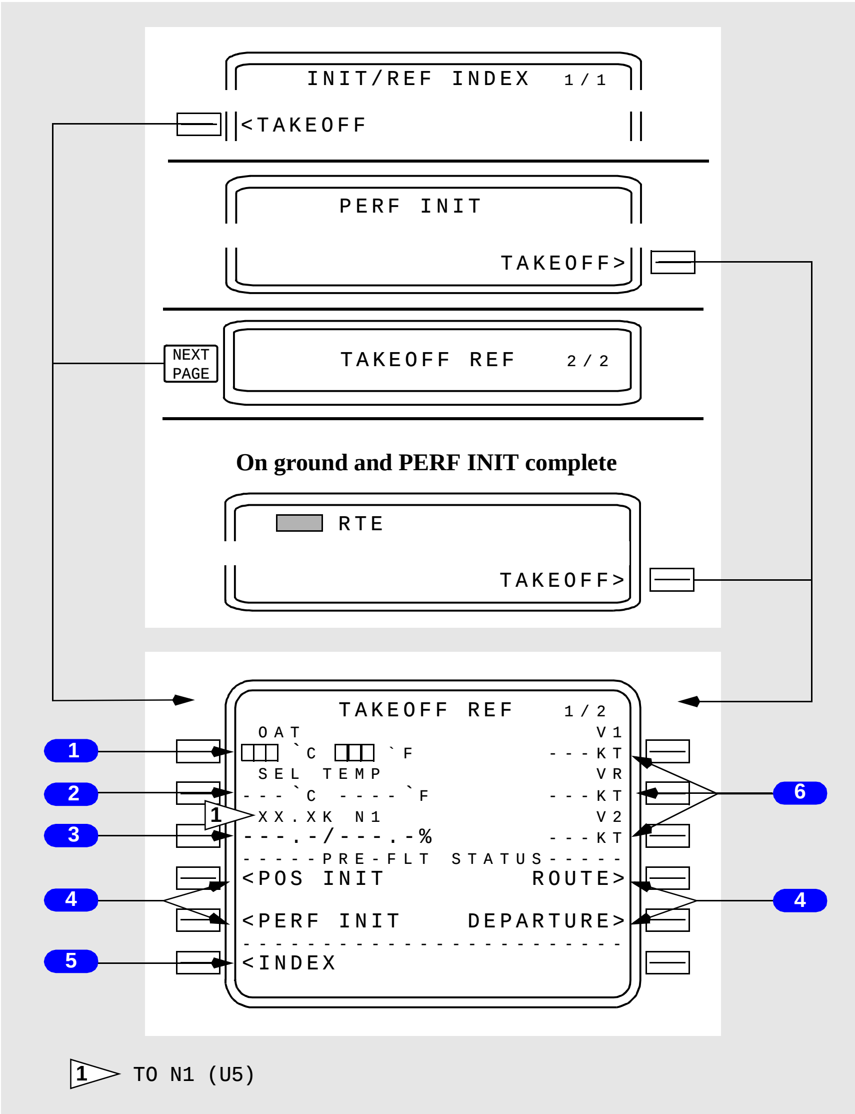
Intentionally
Blank

Takeoff Page 1

Takeoff Reference Page

The takeoff reference page allows the crew to manage takeoff performance. Temperature data is entered to allow the FMC to make takeoff N1 computations for normal or reduced thrust takeoff. V speeds are entered and verified. Preflight pages are selectively displayed to indicate preflight status whenever required entries on those pages are incomplete.

Takeoff reference page entries finish the normal preflight. V speeds should be set before completion. FMC position can be updated prior to takeoff.



1 Outside Air Temperature (OAT)

Manual entry of actual takeoff OAT is displayed in large–sized characters and is used by the FMC to calculate the takeoff N1 limits.

Entry can be made in degrees C or degrees F.

2 Selected Temperature (SEL TEMP)

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

3 Takeoff N1 (XX.XK N1/TO N1)

Displays the FMC computed N1 for takeoff.

Crew entry not allowed.

Data line title displays full rated thrust or selected takeoff derate thrust. Typical line titles display as (U5) “TO N1” (U7) “22K N1” or “20K N1”.

Data line title changes to (U5) “RED TO N1” or (U7) “RED XX.XK N1” when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. If a SEL TEMP and a DERATE are both selected the data line title will change to (U5) “RED TO–1” or “RED TO–2” or (U7) “RED XX.XK N1,” and the effect on thrust will be additive.The Reference N1 bugs will still display full rated or selected takeoff derate thrust N1 values.

It is possible for CLB2 thrust to be greater than the selected reduced takeoff thrust. Therefore, the thrust levers may advance when the thrust limit changes to CLB 2.

4 Preflight Status (PRE–FLT STATUS)

Selectively displayed to allow line selection of the appropriate preflight pages whenever the required entries on those pages are incomplete.

POS INIT is displayed if a valid IRS position entry disagrees with the position determined by any IRS in the ALIGN mode; otherwise blank.

PERF INIT is displayed if any required PERF INIT entries are not completed; otherwise blank.

ROUTE is displayed if a route is not active; otherwise blank.

DEPARTURE is displayed if RTE page 1 displays prompts for RUNWAY and VIA lines; otherwise blank.

Prior to completion of all required items, “PRE–FLT STATUS” appears above line 4. After completion of all required items, “PRE–FLT COMPLETE” appears.

5 INDEX

Push – displays the INIT/REF INDEX page.

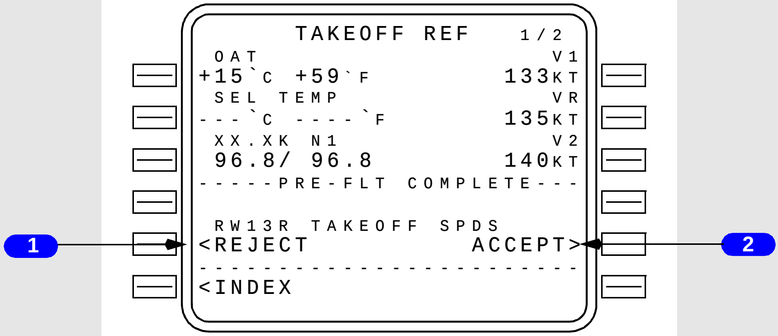
6 V Speeds

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

Entered V1 and VR will automatically be displayed on the EFIS speed tape.

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

Display Following Change of Performance Data (U7)



1 REJECT

Displayed if takeoff speeds have been entered and gross weight or zero fuel weight has been changed.

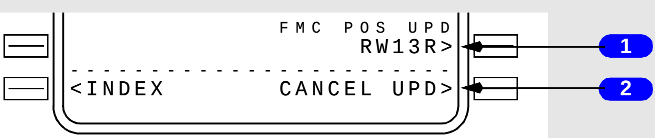
Selection causes the now small font takeoff speeds to disappear.

2 ACCEPT

Displayed if takeoff speeds have been entered and gross weight or zero fuel weight has been changed.

Selection changes the small font takeoff speeds to large font.

Runway Position Update



1 FMC Position Update (FMC POS UPDATE)

Displayed automatically on the ground when preflight complete and a departure runway is entered into the active route.

Selection illuminates the EXEC key and displays the CANCEL UPDATE prompt.

Execution updates the computed FMC position to the threshold of the departure runway.

2 **CANCEL UPDATE**

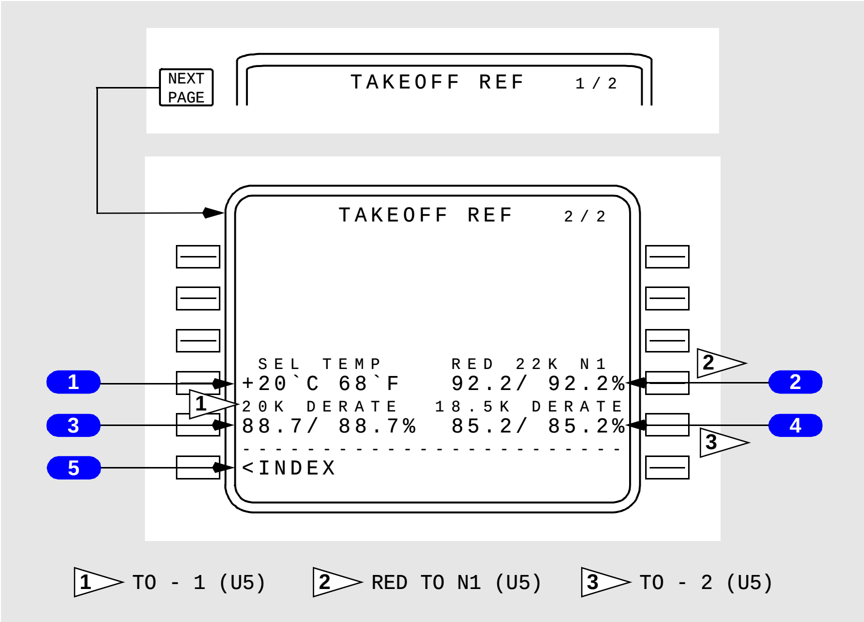
Displayed after line selection of the FMC POS UPDATE prompt.

Selection clears the prompt, cancels the position update armed condition, and extinguishes the execute key light.

Intentionally
Blank

Takeoff Page 2

Takeoff Reference Page 2/2



1 Selected Temperature (SEL TEMP)

Repeats data shown on TAKEOFF REF page 1.

Entry of an assumed temperature calculates a reduced thrust takeoff N1.

Entry can be made in degrees C or degrees F.

2 Takeoff N1 (XX.XK N1/TO N1)

Repeats data shown on TAKEOFF REF page 1.

Displays the FMC computed N1 for takeoff.

Crew entry not allowed.

Data line title displays full rated thrust or selected takeoff derate thrust. Typical line titles display as (U5) “TO N1” (U7) “22K N1” or “20K N1”.

Data line title changes to (U5) “RED TO N1” or (U7) “RED XX.XK N1” when an assumed temperature (SEL TEMP) entry results in a reduced N1 value. If a SEL TEMP and a DERATE are both selected, the data line title will change to (U5) “RED TO–1” or “RED TO–2” or (U7) “RED XX.XK N1,” and the effect on thrust will be additive.The Reference N1 bugs will still display full rated or selected takeoff derate thrust N1 values.

It is possible for CLB2 thrust to be greater than the selected reduced takeoff thrust. Therefore, the thrust levers may advance when the thrust limit changes to CLB 2.

3 Takeoff 1 Derate (XX.XK DERATE/TO–1 DERATE)

Selects the first level of takeoff derate. For example, a 22K engine will derate to 20K.

Selection of derate replaces DERATE in the title with <SEL>.

The reference N1 bugs will display the derated N1 values.

Deletion returns takeoff thrust to full rated value for the installed engines.

Header and data fields blank if no derate capability exists.

4 Takeoff 2 Derate (XX.XK DERATE/TO–2 DERATE)

Selects the second level of takeoff derate provided one exists.

Selection of derate replaces DERATE in the title with <SEL>.

The reference N1 bugs will display the derated N1 values.

Deletion returns takeoff thrust to full rated value for the installed engines.

Header and data fields blank if no derate capability exists.

5 INDEX

Push – displays the INIT/REF INDEX page.

Introduction

The FMC takeoff phase begins with the selection of takeoff/go–around (TO/GA). Preparation for this phase begins in the preflight phase and includes entry of the TAKEOFF REF page data.

The takeoff phase automatically changes to the climb phase when climb thrust is selected. The climb phase continues to the top of climb point, where the cruise phase begins.

During these phases, the following pages are normally used:

- TAKEOFF REF page – to make last minute changes to the departure runway
- DEPARTURES page – to make last minute changes to the SID
- CLB page – to modify climb parameters and monitor airplane climb performance
- RTE LEGS page – to modify the route and monitor route progress
- PROGRESS page – to monitor the overall progress of the flight
- N1 LIMIT page – to select alternate climb thrust limits
- DEP/ARR INDEX page – to select an approach during a turn–back.

Takeoff Phase

When last minute changes are made to the departure runway and SID, the TAKEOFF REF and DEPARTURES pages must be modified to agree. The modifications are performed the same as during preflight.

With correct takeoff parameters, the FMC commands the selected takeoff thrust when the TO/GA switch is pushed. During the takeoff roll, the autothrottle commands the thrust and the FMC commands acceleration to between V2+15 and V2+25 knots.

LNAV can be engaged at 400 feet and provides roll commands to fly the route leg. VNAV may be engaged after flap retraction to control the climb profile.

Climb Phase

VNAV commands acceleration to:

- 250 knots
- waypoint speed constraints, or
- the speed restriction associated with the origin airport, whichever is more restrictive.

At the climb thrust reduction point, climb thrust can be selected. Passing 10,000 feet, VNAV commands an acceleration to the economy climb speed, which is maintained until entering the cruise phase. Waypoint speed constraints take priority if slower than target speed.

During the climb, VNAV complies with the LEGS page waypoint altitude and speed constraints. A temporary level–off for a crossing altitude restriction is accomplished at the current commanded speed.

When the climb speed profile causes an anticipated violation of a waypoint altitude constraint, the FMC displays the CDU scratchpad message UNABLE NEXT ALTITUDE. A different speed profile that provides a steeper climb angle must be manually selected.

If a CLB 1 or CLB 2 derate is selected, the derate is maintained for the initial part of the climb. Thrust eventually increases to maximum climb thrust by 15,000 feet.

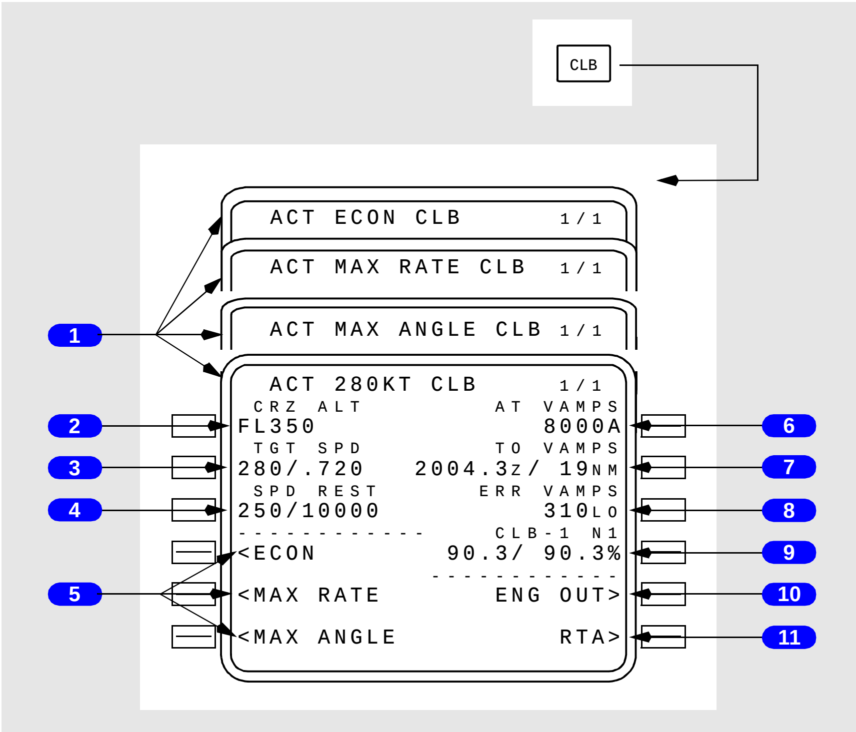
Climb Pages

Climb Page

The CLB page is used to evaluate, monitor, and modify the climb path. The data on the CLB page comes from preflight entries made on the RTE and PERF INIT pages.

The CLB page is selected by pushing the CLB function key on the ground, or during takeoff and climb.

The FMC climb mode can be economy, max rate, max angle, or fixed speed. In each of the modes, similar data is displayed on the page.



1 Page Title

The page title displays the type of climb. Normally, the title displays ECON for the economy climb mode. Other climb modes modify the title.

ECON indicates the speed is based on a cost index.

MAX RATE indicates the speed is based on the maximum altitude over the shortest period of time.

MAX ANGLE indicates the speed is based on the maximum altitude over the shortest horizontal distance.

Fixed climb speeds display XXXKT for a fixed CAS climb speed or M.XXX for a fixed Mach climb speed profile and are manually entered by the crew.

Reasons for selecting climbs other than ECON are:

- takeoff/climb acceleration segment constraints
- waypoint speed constraints
- an altitude constraint associated with a speed constraint
- a speed restriction
- a crew–entered speed.

Displays ACT when the climb phase is active.

2 Cruise Altitude (CRZ ALT)

The cruise altitude from the PERF INIT page is displayed. A new altitude can be manually entered.

3 Target Speed (TGT SPD)

Displays computed values or manually entered values for the selected mode. Computed speed is limited to a maximum of 335 knots/M.809.

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 **ERR XXXXX**

Displays predicted altitude undershoot for the waypoint on AT XXXXX line.

During VNAV operation, the FMC commands a level off if an overshoot is predicted.

Display is blank, including the label, if no error exists.

9 **Reduced Climb N1 (CLB – X N1)**

Displays reduced climb N1 value.

Blank when reduced climb not selected.

10 **Engine Out (ENG OUT)**

See ENG OUT CLB page description.

11 **Required Time of Arrival (RTA)**

Displays the RTA PROGRESS page.

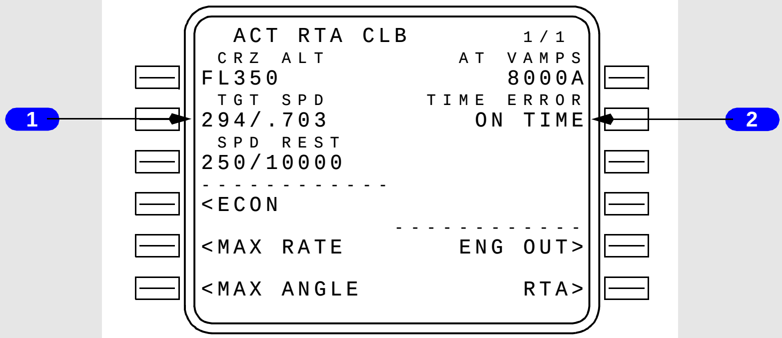
ERASE prompt replaces RTA during a page modification.

RTA Climb Page

The RTA CLB page is displayed when a required time of arrival is active.

The RTA CLB page is automatically selected by pushing the CLB function key when RTA is active.

Displays on this page are the same as other climb pages except as noted.



1 Target Speed (TGT SPD)

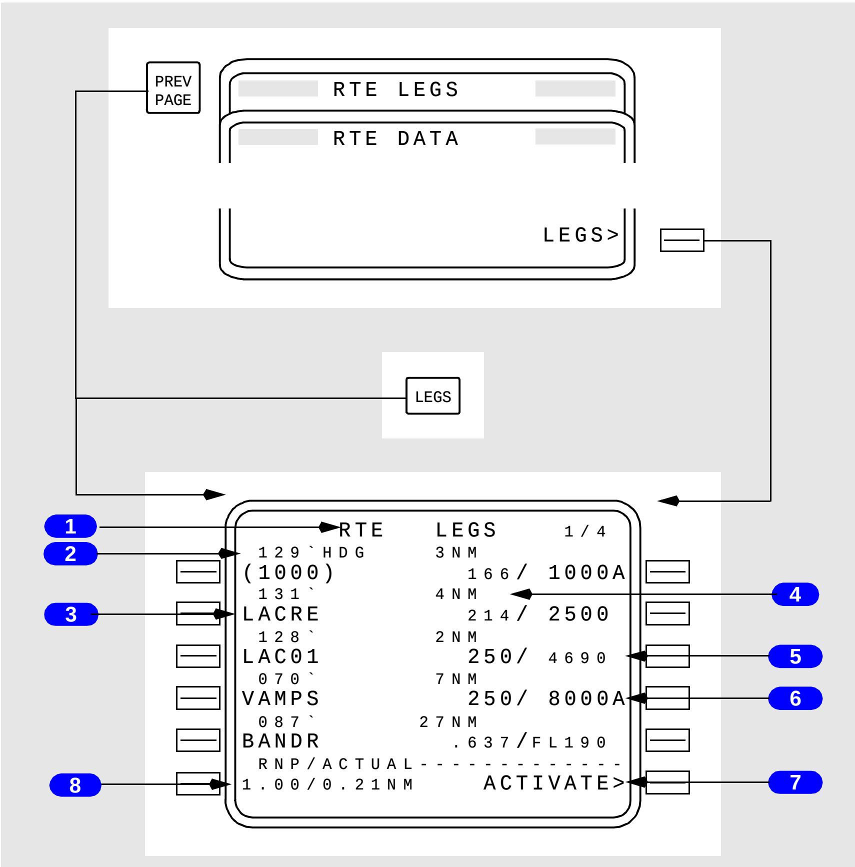
Displays the computed speed required to meet entered RTA.

When RTA is exited by waypoint sequence or deletion, this speed changes to FMC target speed.

2 TIME ERROR

Displays computed time error at RTA waypoint. Same as RTA PROGRESS page.

RTE LEGS Page



1 Page Title

An active RTE LEGS page title is displayed with ACT as part of the title. A modified page title is displayed with MOD in reverse video.

2 Leg Direction

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 or (U7) PROC TURN.

Display is blank for an undefined course.

3 Waypoint Identifier

The current active leg is always displayed at the top of the first active RTE LEGS page.

All route waypoints are displayed. Waypoints on an airway are included on the route legs page. Waypoints appear in flight sequence.

Waypoints can be entered and moved. This includes:

- adding new waypoints
- removing existing waypoints
- resequencing existing waypoints
- linking route discontinuities.

Displays the waypoint by name or condition.

Box prompts are displayed for route discontinuities.

Dashes are displayed for the next line beyond the end of the route.

4 Distance to Waypoint

Displays the distance from the airplane or the waypoint to the next waypoint.

5 Calculated Waypoint Speed/Altitude

Displays the calculated speed or altitude at the waypoint in small font.

6 Specified Waypoint Speed/Altitude

Displays any waypoint speed or altitude constraint in large font.

Manual entry is allowed.

7 ACTIVATE, EXTENDED DATA

The ACTIVATE prompt is displayed on the RTE LEGS page when the route is not active. When the activate prompt key is pushed, the route must be executed by pushing the EXEC key.

The EXTENDED DATA prompt is used to review additional information about the route.

Push –

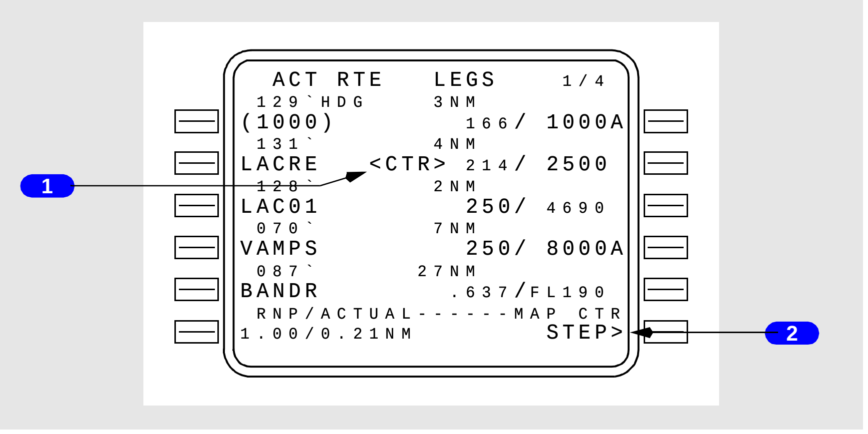
- ACTIVATE arms the execute function. Pushing the EXEC key activates the route and changes the ACTIVATE prompt to EXTENDED DATA
- EXTENDED DATA displays the RTE DATA page.

8 Required Navigational Position/Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy.

Map Center Step Display

The MAP CTR STEP prompt replaces ACTIVATE or EXTENDED DATA when the EFIS control panel mode selector is placed in the PLAN position. Pushing the prompt key advances the waypoint that is displayed in the center of the map. The <CTR> label is displayed to the right of the corresponding waypoint on the RTE LEGS page.



1 Map Center Label (<CTR>)

Identifies the waypoint around which the map display is centered.

Whenever the EFIS mode selector is positioned to PLAN, the label is automatically displayed for the first geographically fixed waypoint on the displayed page.

2 Map Center Step (MAP CTR STEP)

Displayed on a CDU when PLAN is selected on the associated EFIS control panel. Replaces the EXTENDED DATA or ACTIVATE prompt.

Push – advances the <CTR> label on the CDU to the next geographically fixed waypoint in the route and moves the respective waypoint to the center of the EHSI.

Intentionally
Blank

Progress Pages

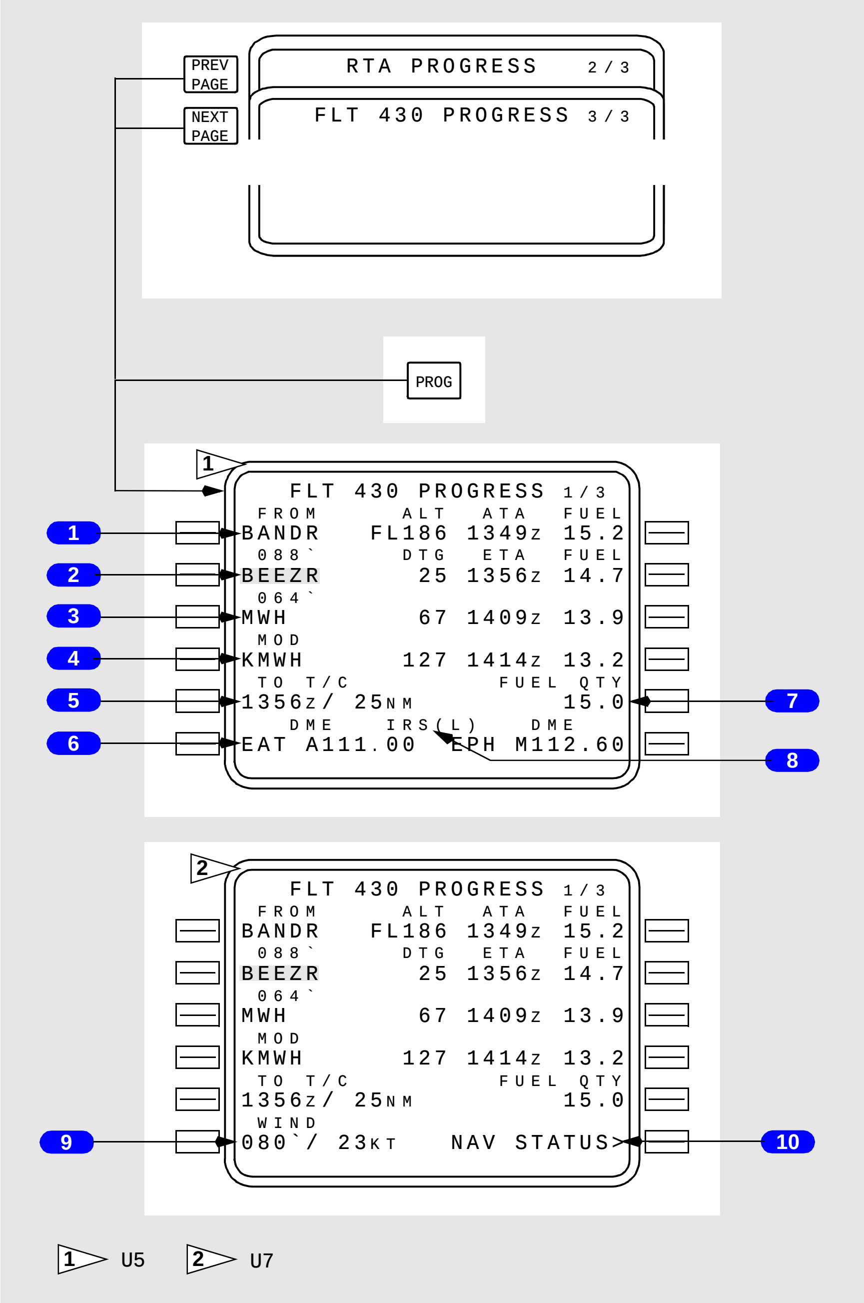
Progress Page 1

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

The page title displays the company flight number from the RTE page in the title.

Page one of the progress pages displays general information (such as distance–to–go, ATA, ETA, fuel remaining estimates) about the following:

- waypoints (last, active, and next)
- destination information
- altitude change points
- (U5) navaid and IRS information
- (U7) current wind
- fuel quantity.


PREV PAGE
NEXT PAGE
RTA PROGRESS 2/3
FLT 430 PROGRESS 3/3
PROG
FLT 430 PROGRESS 1/3
FROM ALT ATA FUEL
BANDR FL186 1349z 15.2
088° DTG ETA FUEL
BEEZR 25 1356z 14.7
064°
MWH 67 1409z 13.9
MOD
KMWH 127 1414z 13.2
TO T/C FUEL QTY
1356z/ 25NM 15.0
DME IRS(L) DME
EAT A111.00 EPH M112.60
1
2
3
4
5
6
7
8
FLT 430 PROGRESS 1/3
FROM ALT ATA FUEL
BANDR FL186 1349z 15.2
088° DTG ETA FUEL
BEEZR 25 1356z 14.7
064°
MWH 67 1409z 13.9
MOD
KMWH 127 1414z 13.2
TO T/C FUEL QTY
1356z/ 25NM 15.0
WIND
080°/ 23KT NAV STATUS>
9
10
1 U5
2 U7

1 FROM

Displays the identifier of the last (FROM) waypoint, the altitude (ALT), the actual time of arrival (ATA), and the fuel at that waypoint.

2 Active Waypoint

Displays the identifier of the active waypoint, the flight plan course to the active waypoint, and distance–to–go (DTG) from present position to the active waypoint. Also displays the estimated time of arrival (ETA) and predicted fuel remaining at the active waypoint. The active waypoint is highlighted by reverse video.

3 Next Waypoint

Displays the identifier of the next waypoint which follows the active waypoint, the flight plan course for that leg, and flight plan distance–to–go (DTG) from present position to the next waypoint. Also displays the estimated time of arrival (ETA) and predicted fuel remaining at the next waypoint.

4 Destination

Displays the identifier of the destination airport (DEST) and flight plan distance–to–go (DTG) from present position to the destination. Also displays estimated time of arrival (ETA) and predicted fuel remaining at the destination.

When a route modification is in progress, the destination line label displays MOD. Performance predictions include the modification.

5 Altitude Change Point (TO XXXXX)

Displays ETA and distance–to–go to the following altitude change points as appropriate to phase of flight:

- TO T/C: to top of climb for the active climb
- TO STEP POINT: to the step point if a STEP TO entry is made on CRZ page
- TO T/D: to top of descent, if no STEP TO entry is made on CRZ page
- TO E/D: to the end of descent waypoint for an active path descent; blank for a speed descent.

6 VHF Navigation Radio Lines

Displays identifiers and frequencies of the navaids presently tuned by VHF No. 1 and VHF No. 2.

Frequency prefixes identify the tuning mode of each radio:

- A – indicates frequency tuned by the FMC auto–tune mode
- M – indicates manually tuned frequency
- P – indicates frequency auto–tuned by the FMC as required by an active procedure.

7 Fuel Quantity (FUEL QTY)

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

8 IRS (X)

Displays currently selected IRS.

9 WIND

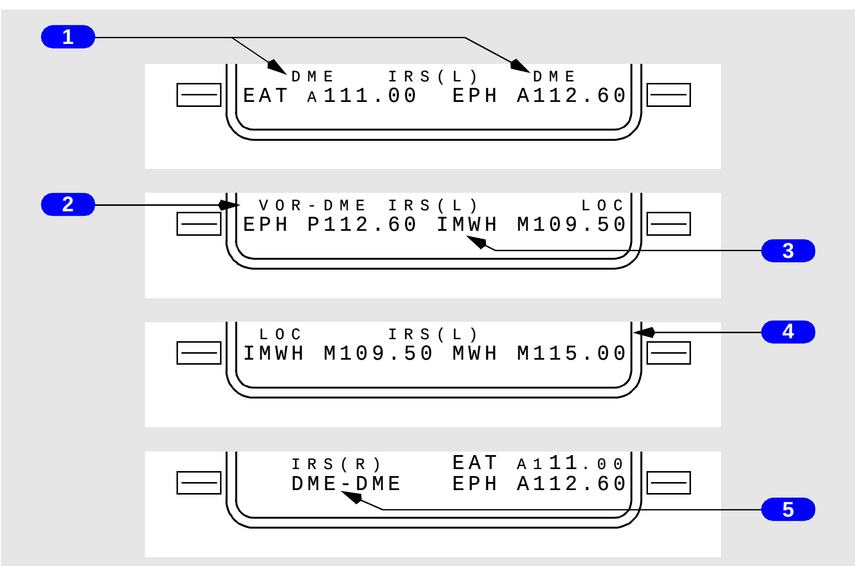
Displays current true wind direction and speed.

10 Navigation Status (NAV STATUS)

Push – displays the navigation status page.

Radio Update Modes

Displays the type of information (DME, DME-DME, VOR–DME, LOC, LOC–DME), identifiers, and frequency being used for updating the FMC position. Blank when not being used for updating.



1 DME Updating

When possible, only DME information is used from each radio to update the FMC position.

2 VOR/DME Updating

When required, both VOR and DME information is used to update the FMC position. The airplane must be 25 nm or less from the VOR/DME station.

3 LOC Updating

When required, localizer information is used to update the FMC. The ILS frequencies must be manually tuned when used as an approach aid; however, the FMC will auto–tune an ILS/DME station for use in DME updating. During an approach, the ILS localizer is used for cross–course position updating.

4 Updating Unavailable

The line title will be blank when the radio is not being used for updating.

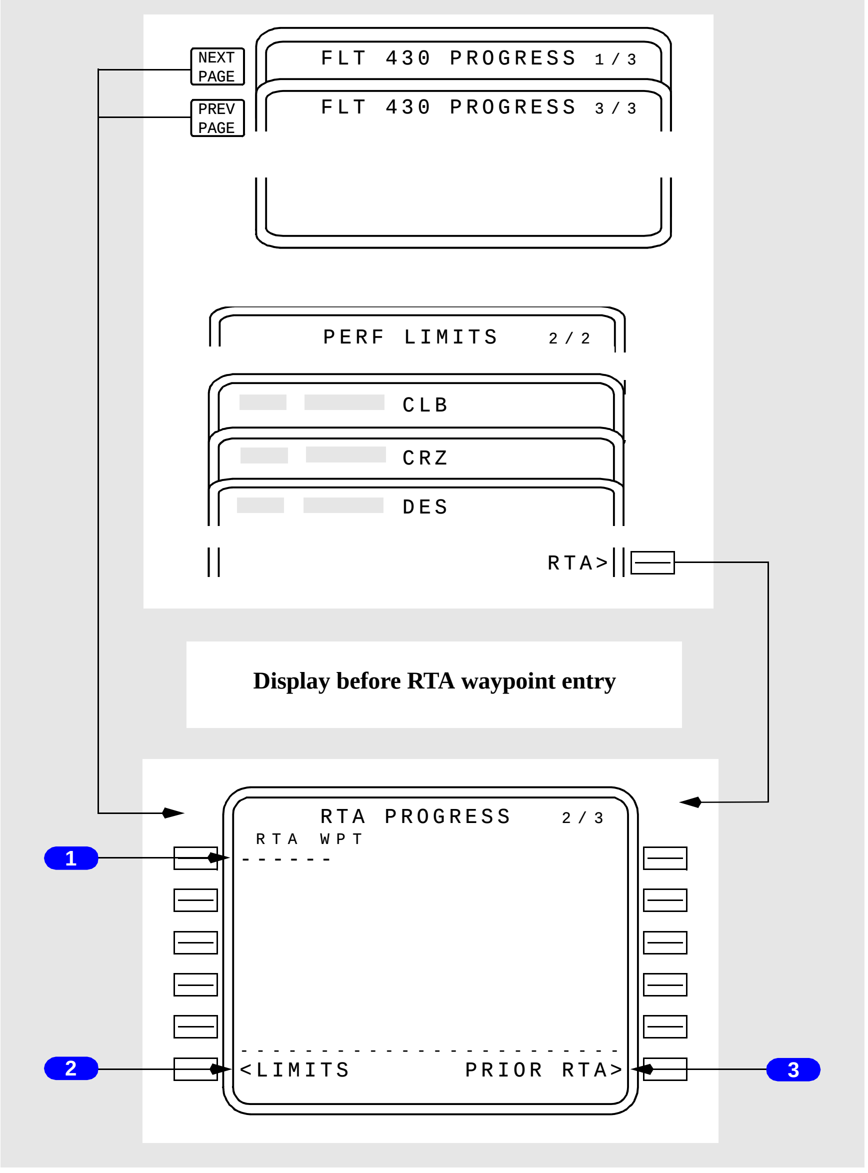
5 Agility Tuning

When required, a single radio can be automatically cyclic–tuned between two DME stations at five–second intervals. Two identifiers and frequencies are displayed for the single radio in use.

RTA Progress Page 2/3

RTA PROGRESS page is used to initiate the required time of arrival (RTA) mode.

The RTA PROGRESS page provides advisory data on flight progress in the RTA mode and advises of control times such as recommended takeoff time to meet RTA.



1 Required Time of Arrival Waypoint (RTA WPT)

Displays dashes when entry is allowed.

2 **LIMITS**

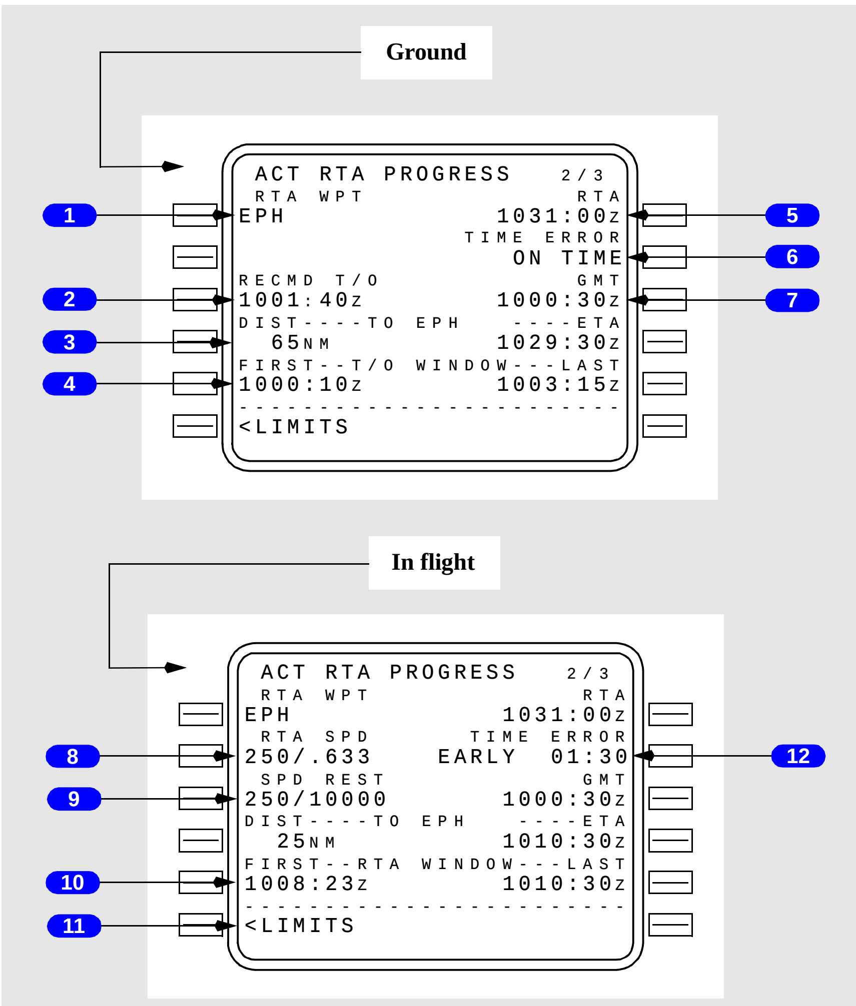
Push – displays the PERF LIMITS page.

3 **Prior RTA Waypoint (PRIOR RTA)**

Prompt displayed when the RTA waypoint field contains dashes and a previous RTA waypoint is still in the flight plan; otherwise blank.

Push – displays last active RTA waypoint data.

RTA Progress on Ground and In Flight



1 Required Time of Arrival Waypoint (RTA WPT)

Waypoint entry must be in flight plan, or the CDU message NOT IN FLIGHT PLAN will be displayed.

Entering a valid waypoint will generate a MOD RTA PROGRESS page and illuminate the EXEC key.

Deletion of the RTA waypoint will create a MOD RTA PROGRESS page with all data blanked and EXEC key illuminated. Execution will exit the RTA mode.

Deletion of the RTA waypoint does not remove the waypoint from the flight plan.

The RTA waypoint automatically clears, and the FMC exits the RTA mode after sequencing the RTA waypoint out of the flight plan.

2 Recommended Takeoff Time (RECMD T/O)

Displays the recommended takeoff time to meet the planned RTA.

Time is based on entered cost index.

3 Distance To RTA Waypoint (DIST – – – – TO XXXX)

Displays the distance (DIST) to the RTA waypoint.

Displays estimated time of arrival (ETA) to the RTA waypoint based on:

- immediate takeoff
- MIN/MAX speeds on PERF LIMITS page
- entered forecast winds.

4 Takeoff Window (FIRST – – T/O WINDOW – – – LAST)

Displays earliest (FIRST) and latest (LAST) takeoff times to meet the planned RTA.

Times are based on MIN/MAX speeds on the PERF LIMITS page.

5 Required Time of Arrival (RTA)

After RTA waypoint entry, initially displays current ETA based on the active flight plan and performance parameters at the time of waypoint entry.

Desired RTA may be entered by overwriting displayed data.

Entry must be in one of the following forms:

- XXXXXX (hr/min/sec)
- XXXX (hr/min)
- XXXX.X (hr/min/tenths of min).

6 TIME ERROR

Displays the most recent time error in minutes and seconds up to a maximum of 59:59 minutes.

Displays ON TIME if GMT is within current T/O WINDOW

Displays EARLY or LATE as appropriate if GMT is not within current T/O WINDOW.

7 Greenwich Mean Time (GMT)

Displays the actual GMT.

8 Required Time of Arrival Speed (RTA SPD)

Displays the target speed required to meet the planned RTA.

Same as speed displayed on RTA CLB, CRZ, or DES page.

Limited by MIN/MAX speeds on the PERF LIMITS page and any entered speed restriction.

9 Speed Restriction (SPD REST)

Displays the current speed restriction affecting RTA progress.

10 Arrival Time Window (FIRST – – RTA WINDOW – – – LAST)

Displays earliest (FIRST) and latest (LAST) achievable arrival times at the RTA waypoint.

Times based on MIN/MAX speeds on PERF LIMITS page, existing winds, and entered forecast winds.

11 LIMITS

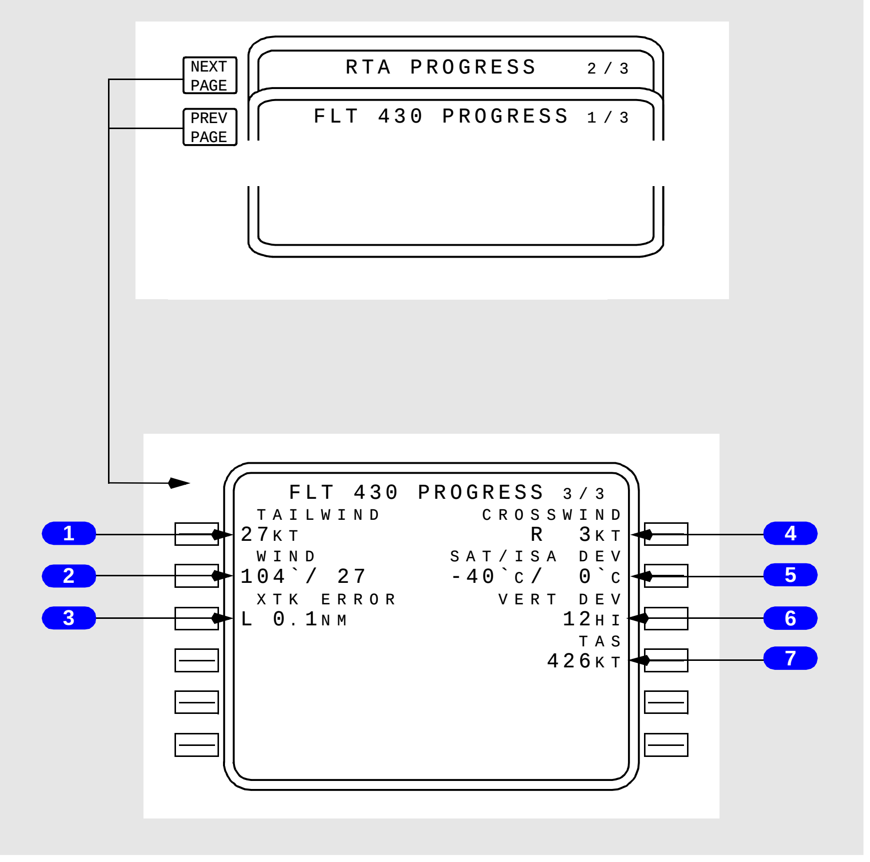
Push – displays PERF LIMITS page.

12 TIME ERROR

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

Progress Page 3

The last progress page displays wind, track, path, temperature, and speed data.



1 **HEADWIND/TAILWIND**

Displays the present headwind or tailwind component.

2 **WIND**

Displays the present true wind direction/speed.

3 **Crosstrack Error (XTK ERROR)**

Displays present cross–track error (left or right) from the lateral guidance path. Blank if error is greater than 99.9 nm.

4 **CROSSWIND**

Displays present crosswind component (left or right).

5 Static Air Temperature/ISA Deviation (SAT/ISA DEV)

Displays present SAT and the equivalent ISA deviation.

6 Vertical Deviation (VERT DEV)

Displays present computed deviation (HI or LO) from the FMC vertical path.

Blank if descent is not active or path is not available.

7 True Airspeed (TAS)

Displays present TAS.

Intentionally
Blank

Limit Page

N1 Limit Page

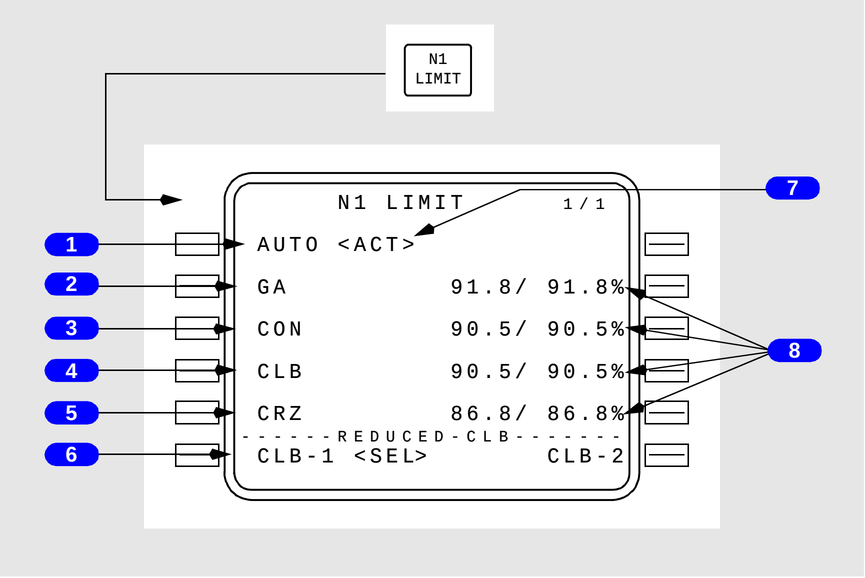
The N1 LIMIT page provides thrust limit and reduced climb thrust selection.

Normally, N1 limits are automatically specified. Pilot selection of other limits is allowed.

Pilot selection of a reduced climb mode does not change the automatic selection for other phases of flight.

A pilot selected mode is automatically replaced by AUTO selection when the autopilot changes to the next vertical mode.

The active thrust limit is used by the autothrottle and is displayed on the thrust mode display.



1 Automatic (AUTO)

Push – selects the automatic computation of N1 limits for all phases of flight.

2 Go–Around (GA)

Push – selects the go–around thrust limit.

3 Continuous (CON)

Push – selects the maximum continuous thrust limit.

4 **Climb (CLB)**

Push – changes the thrust mode from AUTO to the active climb thrust, i.e. CLB, CLB-1, or CLB-2.

5 **Cruise (CRZ)**

Push – selects the cruise thrust limit.

6 **Reduced Climb (REDUCED–CLB)**

Push – selects either of two reduced climb thrust modes.

CLB–1 provides a climb limit reduced by 3% N1.

CLB–2 provides a climb limit reduced by 6% N1.

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.

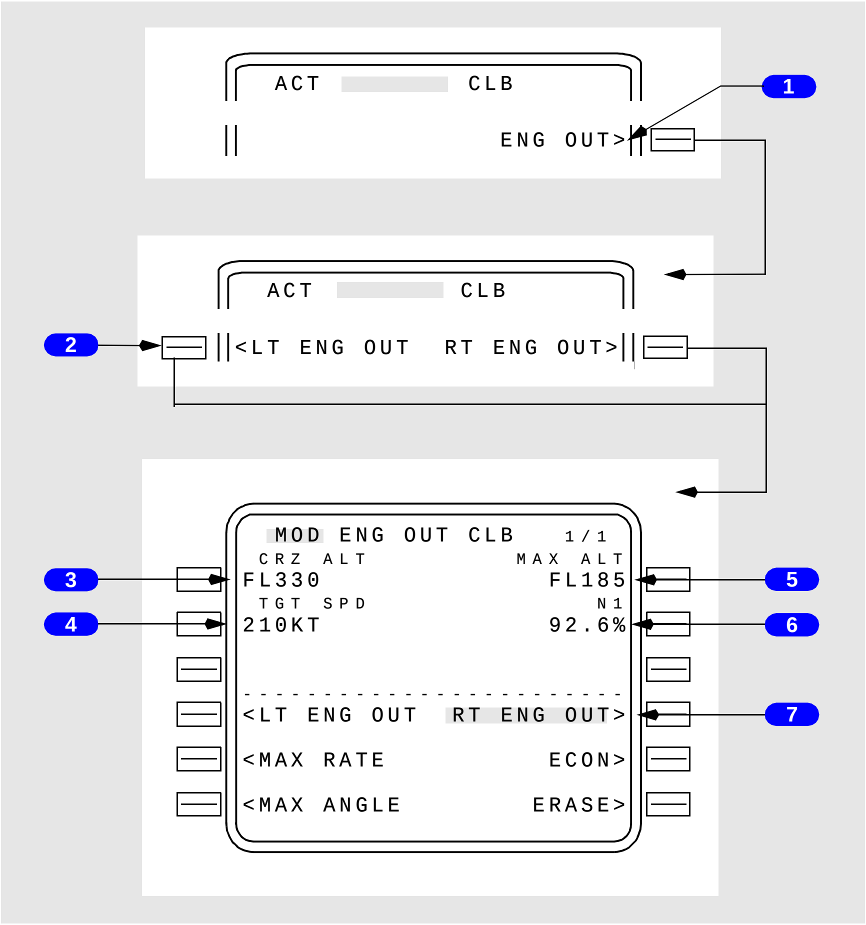
If CLB–1 or CLB–2 is selected, the N1% for CLB and the N1 cursors still display values for full rated climb.

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.

Selection of left or right engine changes display to MOD ENG OUT CLB page.

(U7.5) The execution light does not illuminate and the page can not be executed.

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 optimum engine out climb speed.

5 **Maximum Altitude (MAX ALT)**

Displays the maximum altitude at which a company specified rate of climb can be achieved using one engine at maximum continuous thrust (default climb rate is 100 fpm).

After page selection, the FMC accounts for wing and engine anti–ice, air conditioning, and the engine bleed of the operating engine.

6 **N1**

Displays N1 for maximum continuous thrust.

(Prior to U7.5) If the page is executed, this becomes the active N1 limit. N1 is computed using actual bleed conditions.

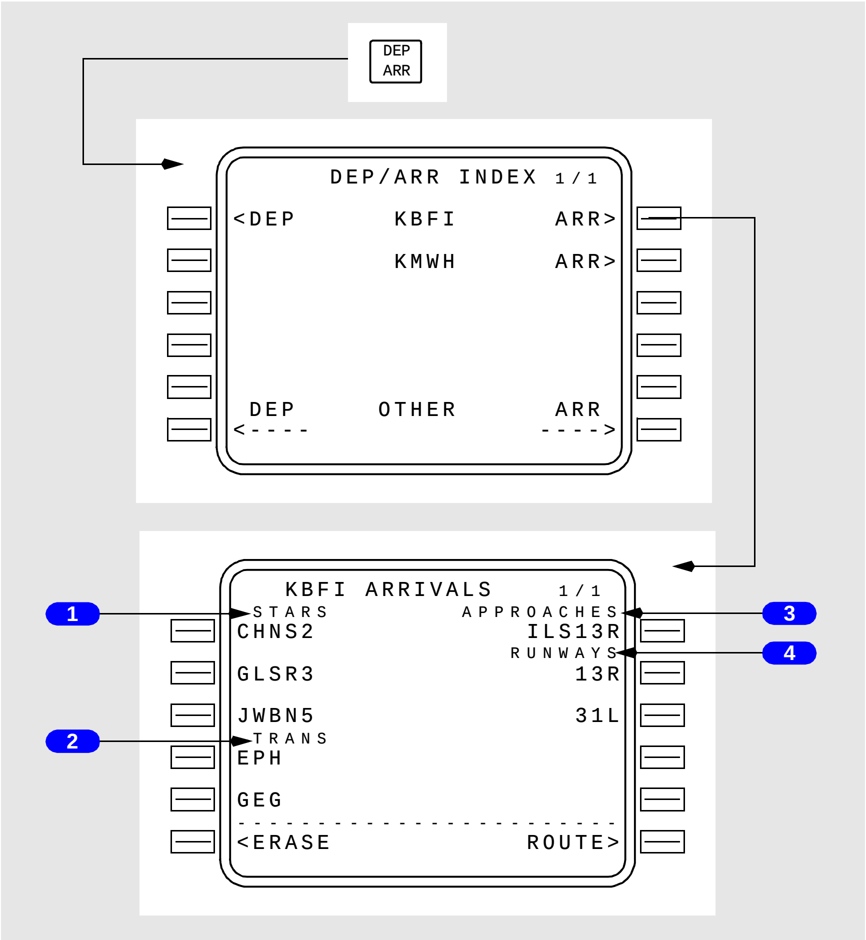
7 **Left/Right Engine Out (LT ENG OUT / RT ENG OUT)**

The selected engine out is highlighted in reverse video.

Air Turnback

Arrivals Page

During a turn–back situation, the crew requires quick access to the arrivals information for the origin airport. The DEP/ARR INDEX and ARRIVALS pages provide access without changing the destination on the RTE page.



1 **Standard Terminal Arrivals Routes (STARS)**

Displays STARS for the origin airport.

2 **Transitions (TRANS)**

Displays all transitions associated with the selected STAR for the origin airport.

3 **APPROACHES**

Displays approaches for the origin airport.

4 **RUNWAYS**

Displays runways for the origin airport.

Intentionally
Blank

Introduction

The cruise phase automatically begins when the top of climb is reached.

During cruise, the primary FMC pages are:

- RTE LEGS
- PROGRESS
- CRZ.

The RTE LEGS pages are used to manage route restrictions and modify the route. The PROGRESS pages display flight progress information. RTA requirements are also specified on the PROGRESS pages. The CRZ pages display VNAV related information. Other pages include:

- POS REF page – verifies the FMC position (refer to Section 40 of this chapter)
- POS SHIFT page – permits selection of preferred position from a list of references
- RTE DATA page – displays progress data for each waypoint on the RTE LEGS page. Displays wind data for cruise waypoints
- REF NAV DATA page – displays information about waypoints, navaids, airports, or runways
- (U7) LATERAL OFFSET page – permits selection of a route offset
- FIX INFO page – displays information about waypoints, and can be used to create new waypoints and fixes
- SELECT DESIRED WPT page – permits selection of the desired waypoint from a list of duplicate named waypoints.
- (U7) NAV STATUS page – displays information about available navigation aids.

The only cruise mode automatic page changes are the transition from climb to cruise at the top of climb point and from cruise to descent at the top of descent point.

LNAV Modifications

This section presents the normal techniques for modifying the route. The modifications include:

- adding and deleting waypoints
- resequencing waypoints
- linking discontinuities
- intercepting a course.

RTE LEGS Page Modifications

When modifications are made to the RTE LEGS page, several automatic prompt or identifying features assist in managing and executing the modifications, such as:

- ERASE
- INTC CRS.

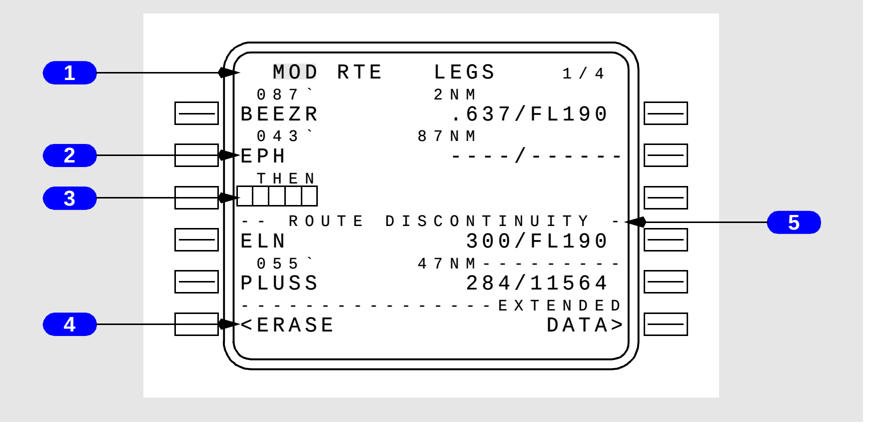
A waypoint can be added to the route whenever necessary.

The new waypoint must first be placed into the CDU scratchpad. Existing waypoints can be copied from a RTE LEGS page into the scratchpad by pushing the line select key adjacent to the desired waypoint.

The new waypoint is then inserted into the route at the desired sequence point by pushing the line select key adjacent to the desired location for the new waypoint. Using the NEXT PAGE/PREV PAGE function keys to select the desired location does not alter the CDU scratchpad. The new entry automatically links to the preceding waypoint via a direct route. Placing the new waypoint into the active waypoint line is a special case and is discussed under Intercept Course in this section.

All new waypoints, except downpath waypoints, cause a route discontinuity between the new waypoint and the following waypoint.

Note: If the FMC NAV database contains a HOLD pattern at the FAF, executing a database approach with a procedure turn and then executing a HOLD at the same FAF, using any inbound course, may cause a discontinuity between the FAF and the procedure turn. If the discontinuity is removed, LNAV guidance is available to fly the approach from the published holding pattern. LNAV guidance is not available to fly the published procedure turn.



1 Page Title

When the page is modified, MOD appears in front of the title in reverse video. This means the route is now altered. The MOD title also shows that the modifications are not yet executed and can be removed using the ERASE prompt.

2 Modified Waypoint

EPH waypoint is entered into the route between BEEZR and ELN. This modification creates a route discontinuity.

3 Route Discontinuity

Box prompts indicates a break in the route structure and the ability to link the route by entering a route waypoint into the discontinuity box prompts.

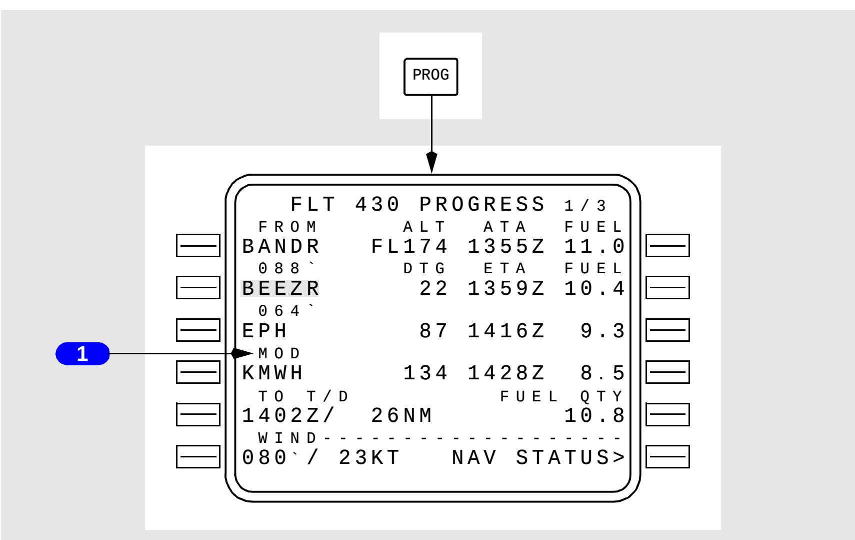
4 ERASE

The ERASE prompt is displayed when the first modification is entered. The prompt remains on the page until the modifications are erased or executed. Selecting ERASE removes all modifications and restores all active data.

5 ROUTE DISCONTINUITY

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

Progress Page



1 **Modified (MOD)**

Displays MOD when the route is being modified.

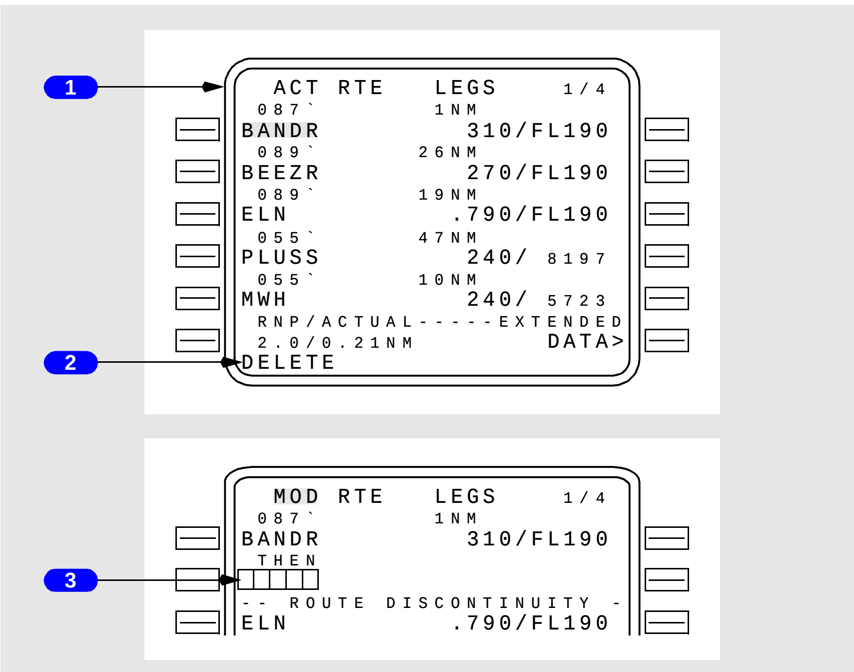
CAUTION: The displayed values on the destination line now reflect the modification and may not be accurate for the active flight plan.

Deleting Waypoints

Waypoints can be removed from the RTE LEGS page. There are two normal methods to remove a waypoint:

- delete the waypoint using the DEL function key (not possible for the active waypoint and conditional waypoints)
- resequence the route by moving a down–route waypoint up in the sequence and automatically removing all waypoints that are between.

During the deletion process, all of the route prior to the deletion point remains unchanged. Removing a waypoint using the DEL function key causes a route discontinuity to replace the deleted waypoint.



1 **Active Route Legs (ACT RTE LEGS)**

The existing route shows BANDR followed by BEEZR and ELN.

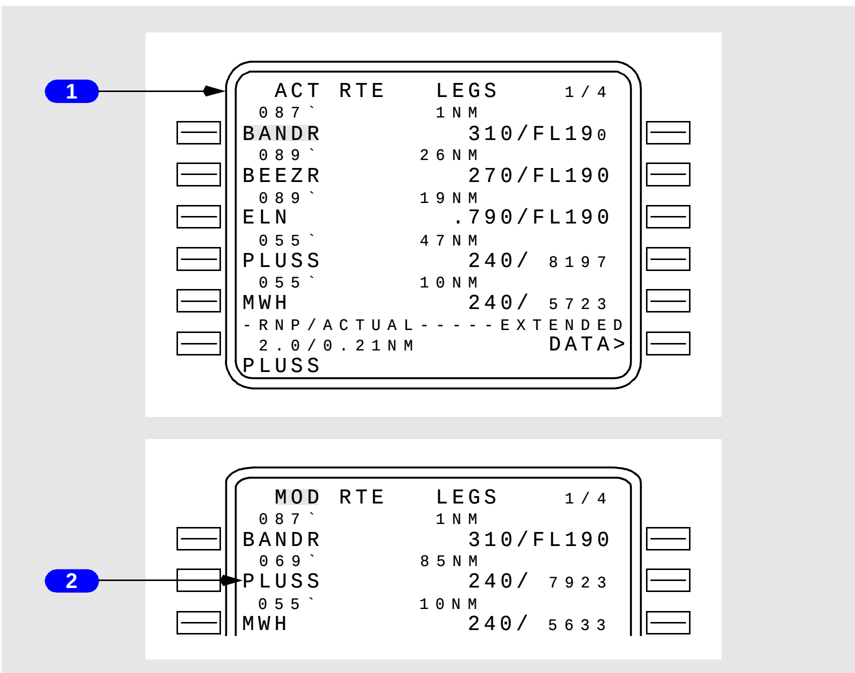
2 **DELETE Entry**

Push the DEL key to arm the delete function. DELETE is displayed in the scratchpad.

3 **Delete BEEZR**

With DELETE displayed in the scratchpad, push the line select key left of BEEZR to delete the waypoint. Box prompts replace BEEZR, and a route discontinuity follows the box prompts.

Resequencing Waypoints



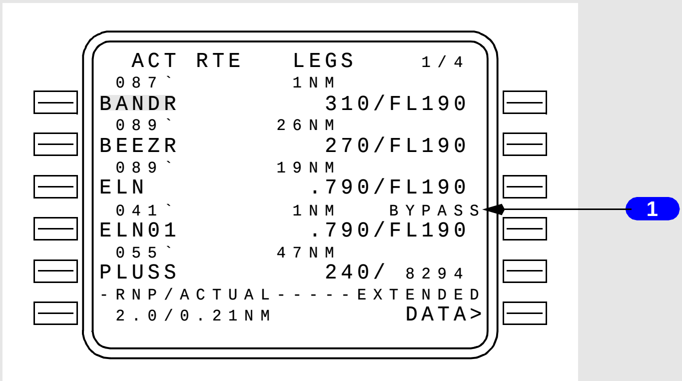
1 **Active Route**

The existing route shows BANDR followed by BEEZR, ELN then PLUSS. The airplane is cleared BANDR direct PLUSS. The PLUSS waypoint is copied into the scratchpad.

2 **Resequence PLUSS**

PLUSS is entered after BANDR. BEEZR and ELN are automatically removed, and the route remains continuous.

Leg Bypass



1 Bypass Notification

A waypoint (ELN01) has been entered into the route which is very close to another route waypoint (ELN). It is impossible for the airplane to turn and capture the leg between ELN and ELN01, so a bypass is noted.

Turn construction is based upon FMC criteria which assume that LNAV is engaged. Normal turn construction may not be possible under certain combinations of airspeed, short leg length, and a significant change in leg direction. If normal turn construction cannot provide a continuous path, the FMC bypasses the affected leg and uses alternative turn construction to intercept the leg to the subsequent waypoint. When the bypass is for the active waypoint, the waypoint remains active until the airplane passes abeam.

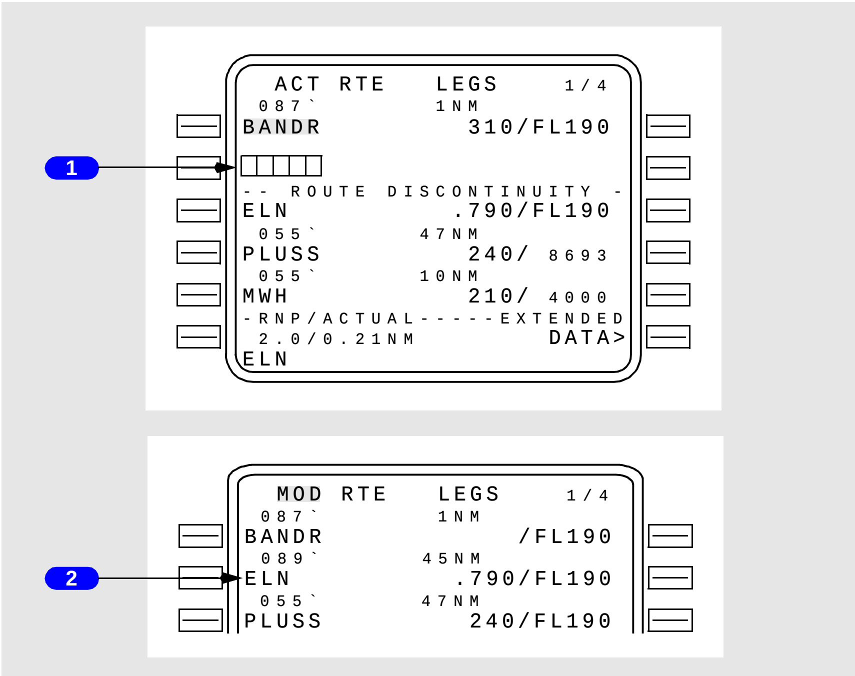
Any mandatory altitude–crossing restriction for the bypass waypoint is still observed if VNAV is engaged, based on passing abeam the waypoint.

If a triple bypass condition occurs (bypass of three consecutive legs), a route discontinuity will be inserted.

Removing Discontinuities

A discontinuity exists when the FMC is unable to determine the route leg following a waypoint. Discontinuities are removed by linking the route segment following the discontinuity to the route segment preceding the discontinuity.

The next desired waypoint from the subsequent route is copied into the CDU scratchpad and entered into the discontinuity box prompts, just as when adding a waypoint.



1 ROUTE DISCONTINUITY

The active route shows a discontinuity. The airplane must fly direct from BANDR to ELN. The ELN waypoint is copied into the scratchpad in preparation to remove the discontinuity. Any waypoint from the route can be copied into the scratchpad to remove the discontinuity.

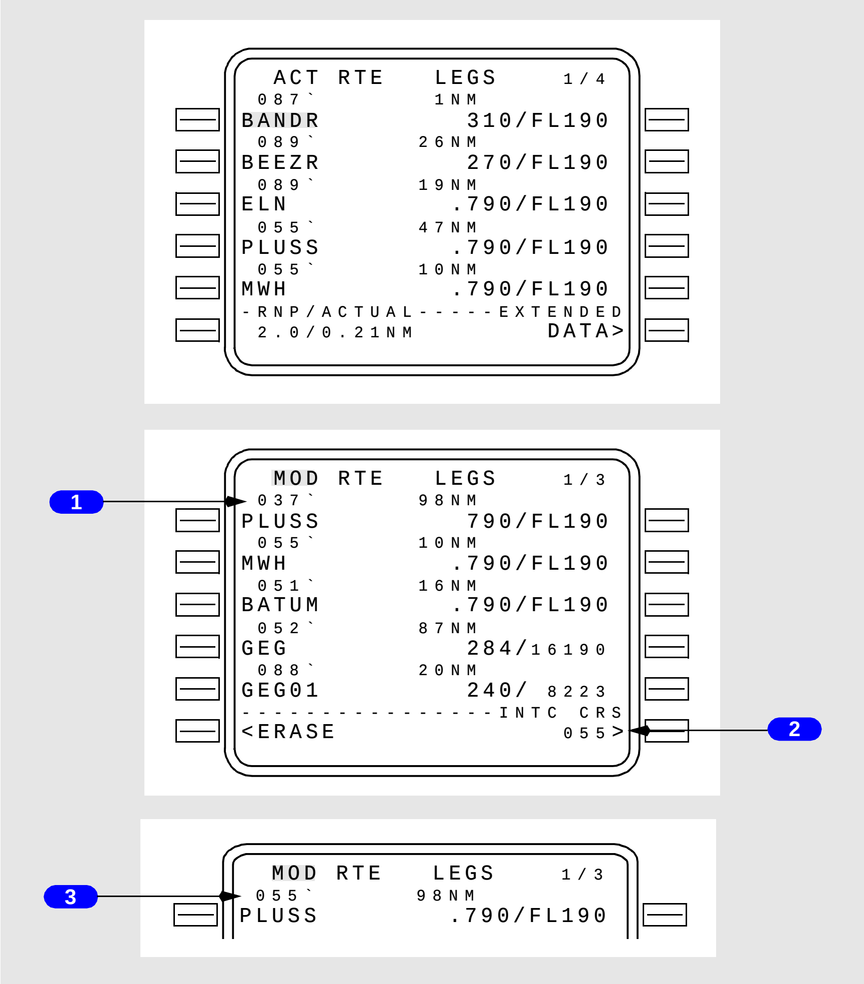
2 Continuous Route

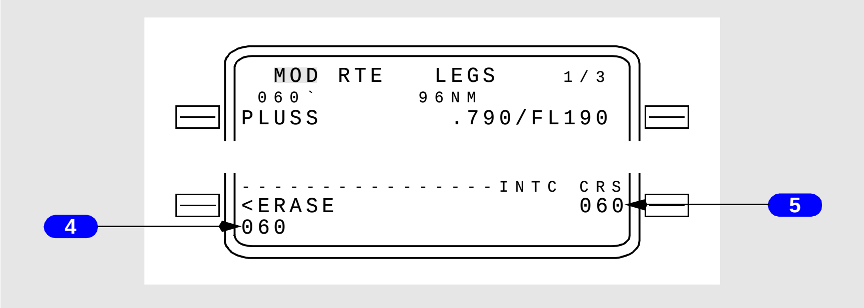
ELN is copied into the box prompts to remove the discontinuity.

Entering a waypoint which does not already exist on the route moves the discontinuity one waypoint farther down the route.

Direct To or Intercept Course

To fly direct to a waypoint or intercept a course to a waypoint, enter the waypoint name on the active waypoint line, the first line on the MOD RTE LEGS 1/X page. This example shows the result with PLUSS entered into the active waypoint line. A new entry onto this waypoint line displays INTC CRS in the lower right.


ACT RTE LEGS 1/4
087`
1NM
BANDR
310/FL190
089`
26NM
BEEZR
270/FL190
089`
19NM
ELN
.790/FL190
055`
47NM
PLUSS
.790/FL190
055`
10NM
MWH
.790/FL190
-RNP/ACTUAL-----EXTENDED
2.0/0.21NM
DATA>
1
MOD RTE LEGS 1/3
037`
98NM
PLUSS
790/FL190
055`
10NM
MWH
.790/FL190
051`
16NM
BATUM
.790/FL190
052`
87NM
GEG
284/16190
088`
20NM
GEG01
240/ 8223
---------------INTC CRS
<ERASE
055>
2
3
MOD RTE LEGS 1/3
055`
98NM
PLUSS
.790/FL190


MOD RTE LEGS 1/3
060`
96NM
PLUSS
.790/FL190
---------------INTC CRS
<ERASE
060
060
4
5

1 Direct Course

Direct course from airplane present position to entered waypoint.

Execute to proceed direct to active waypoint.

2 Intercept Course (INTC CRS)

Displayed whenever the active waypoint name is modified.

Displays flight plan leg direction to entered waypoint in small font. Displays dashes if entered waypoint was not in the flight plan.

Valid input is any course from 000 through 360. May be changed until executed. Entered or selected value displays in large font.

Push – puts displayed course into active waypoint leg direction. Enables intercept course function.

3 Leg Direction

Displays the course inbound to the active waypoint after selecting the course displayed in the INTC CRS line.

4 Crew Desired Intercept Course

The crew can select any inbound course to the active waypoint by first entering the course into the scratchpad.

5 Intercept Course (INTC CRS) – Change

Enter the inbound intercept course to the modified waypoint in the scratchpad.

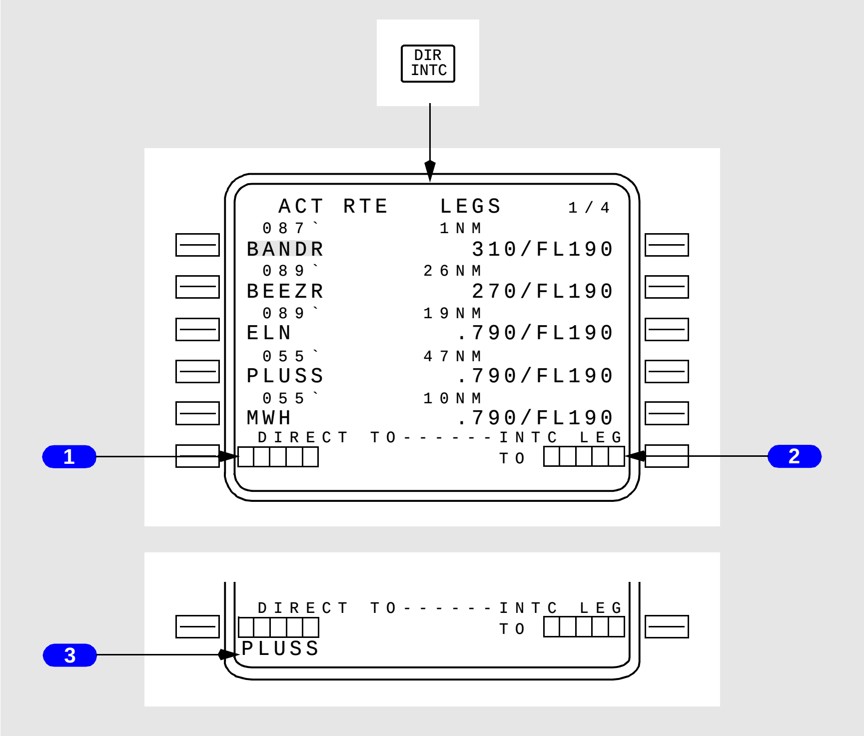
Select the INTC CRS line to change the leg direction.

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

Direct To/Intercept Leg To

Proceeding direct to a waypoint or intercepting a course to a waypoint may be accomplished by using the direct intercept (DIR INTC) mode select key. Pushing the DIR INTC key adds box prompt options to the bottom of the ACT RTE LEGS page.

Using line select or manual entry, the desired waypoint is entered into the scratchpad. The waypoint is then moved into the appropriate boxes.



1 **DIRECT TO Boxes**

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

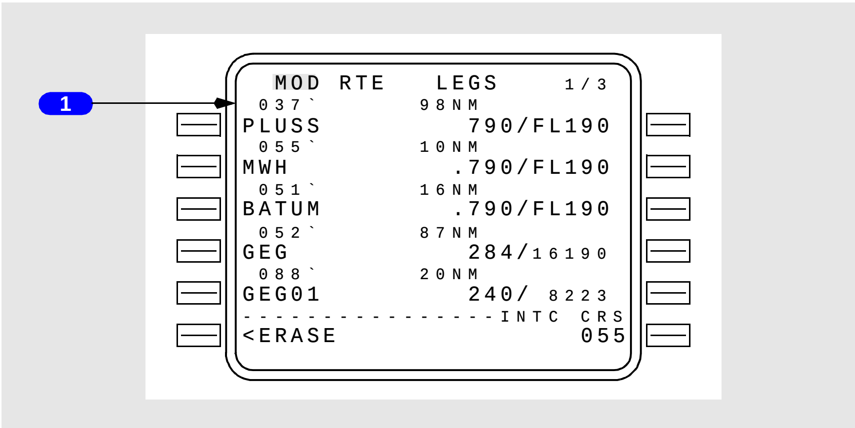
2 **Intercept Leg To (INTC LEG TO) Boxes**

Entering the desired waypoint in these boxes makes that waypoint the active waypoint and allows an intercept course to be specified to the waypoint.

3 **Scratchpad Entry**

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

Direct To

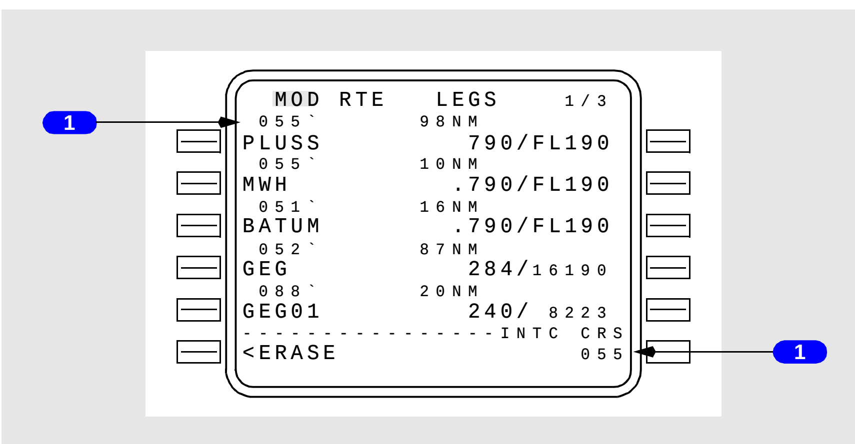


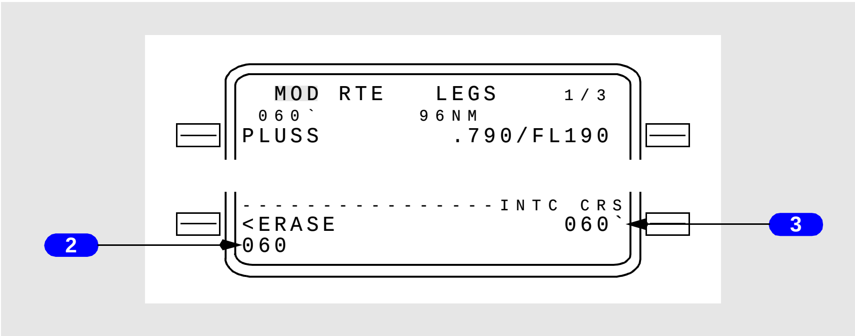
1 Direct Course

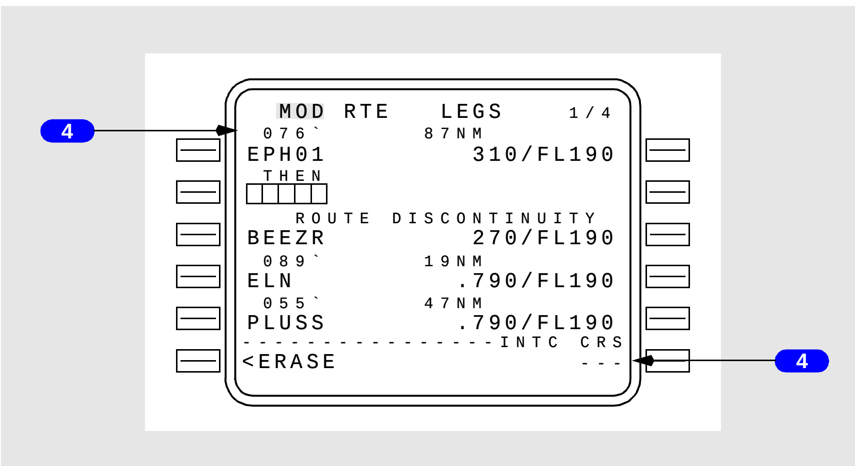
Direct course from airplane position to entered waypoint.

Execute to proceed direct to active waypoint.

Intercept Leg To







1 Intercept Course (INTC CRS)

A waypoint already in the route has an existing inbound course. When the waypoint is inserted into the INTC LEG TO box prompts, the waypoint becomes the modified active waypoint. The existing inbound course is displayed above the waypoint and on the INTC CRS line in small font. Execution changes the MOD page to ACT.

After completing the desired modifications, the crew must ensure that LNAV is engaged to fly the intercept course. In order to engage LNAV, the airplane must be on an intercept heading to the course.

2 Crew Desired Intercept Course

The crew can select any inbound course to the active waypoint by first entering the course into the scratchpad.

3 Crew Selected Intercept Course

After entering a course into the scratchpad, selecting the INTC CRS line transfers the new course to the INTC CRS line and to the active waypoint.

After completing the desired modifications, the crew must ensure that LNAV is engaged to fly the intercept course. In order to engage LNAV, the airplane must be on an intercept heading to the course.

4 Intercept Course (INTC CRS)

A waypoint not already in the route is inserted into the INTC LEG TO box prompts. It becomes the modified active waypoint, and the direct inbound course is displayed above the waypoint. Dashes are displayed on the INTC CRS line in small font.

Pilot entry of a course into the dashes replaces the direct course to the modified active waypoint. Manual entries are displayed in large font.

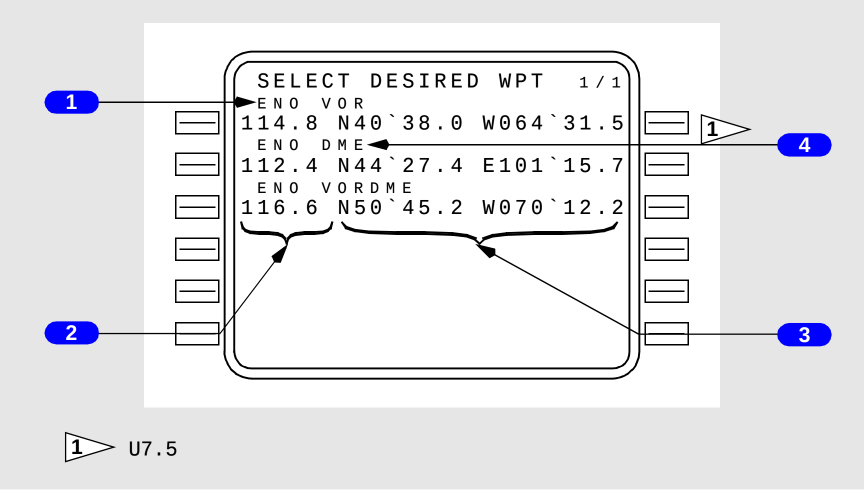
After completing the desired modifications, the crew must ensure that LNAV is engaged to fly the intercept course. In order to engage LNAV, the airplane must be on an intercept heading to the course.

Intentionally
Blank

Desired Waypoint/Offset Pages

Select Desired Waypoint Page

When a waypoint identifier is not unique (other database waypoints have the same name), a selection of which geographical location to use must be made before the waypoint can be used in the route. The SELECT DESIRED WPT page is automatically displayed when the FMC encounters more than one location for the same waypoint name after a waypoint entry.



1 Identifier

Displays the identifier for the duplicate named waypoints. Select the proper waypoint by pushing the appropriate left or right line select key. This page is automatically removed after a waypoint is selected.

2 Frequency

Displays the frequency of the navaid.

Blank if the waypoint is not a navaid.

3 Latitude/Longitude

The latitude/longitude is displayed for each duplicate name.

4 Type

Shows type of navaid.

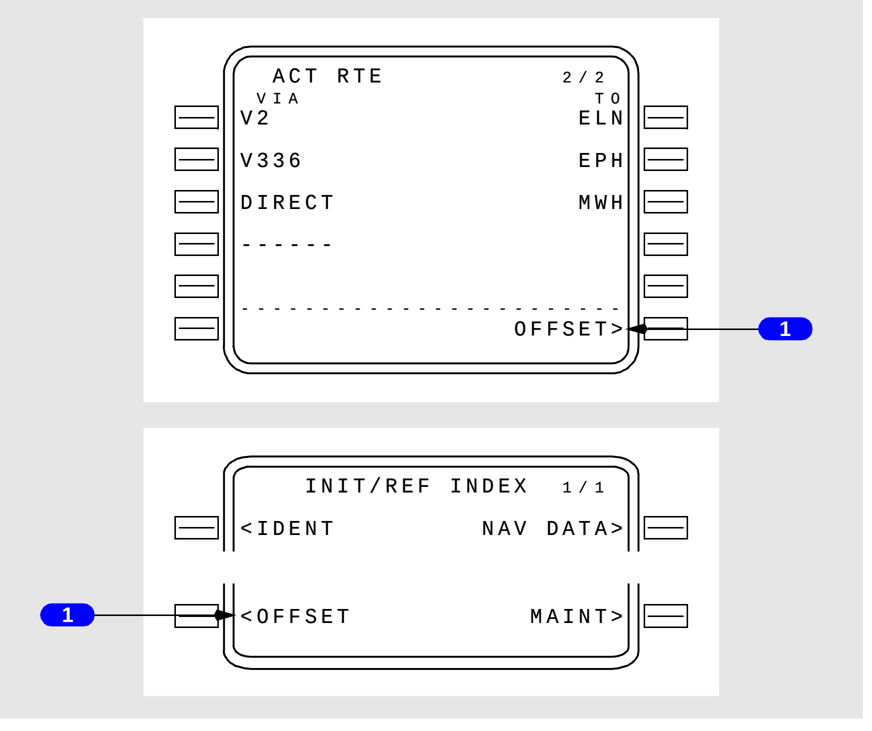
Blank if the waypoint is not a navaid.

Lateral Offset (U7)

A lateral offset may be specified up to 99.9 nautical miles left or right of course. The OFFSET prompt is displayed on the INIT/REF INDEX page and in flight on the RTE page. Selection displays the MOD LATERAL OFFSET (or ACT LATERAL OFFSET page if an offset already exists).

Some legs are invalid for offset. These include:

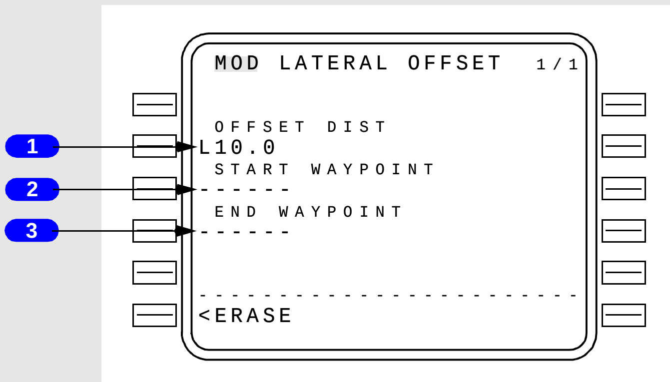
- end of flight plan waypoint
- discontinuity
- beginning of approach transition
- approach procedure
- DME arc
- heading leg
- holding pattern (except PPOS)
- certain legs containing flyover waypoints
- course change greater than 135 degrees
- preplanned termination waypoint.



1 OFFSET

Selection displays the lateral offset page.

Lateral Offset Page



1 Offset Distance (OFFSET DIST)

Enter the desired lateral offset direction (left or right) and distance. In the example, the 10.0 nm offset left of course could be entered L10.0, L10, 10.0L, or 10L.

Entry results in display of start and end waypoint fields.

2 START WAYPOINT

The waypoint at which the offset is to begin may be entered (up to 6 characters).

Dashes are displayed if current leg is valid for offset. Box prompts are displayed if current leg is invalid for offset.

Offset will begin at first valid offset leg after the start waypoint.

Deletion of the start waypoint (or no entry) will result in offset beginning at first valid offset leg in the flight plan.

3 END WAYPOINT

The waypoint at which the offset is to end may be entered (up to 6 characters).

Offset will propagate through the flight plan until the end waypoint is encountered.

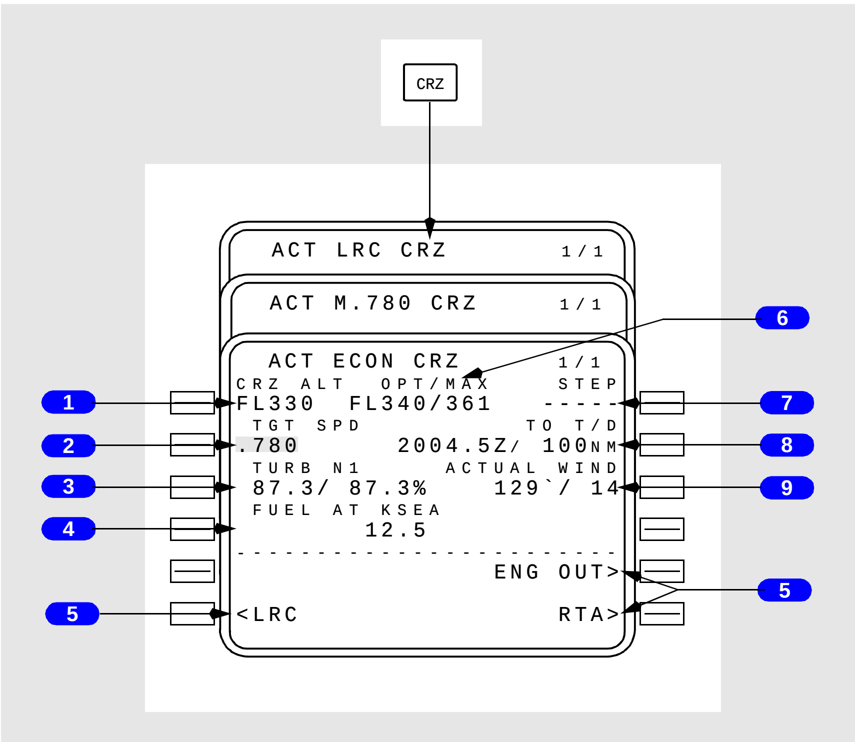
Deletion of the end waypoint (or no entry) will result in offset continuing until an invalid offset leg is encountered.

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.

The RTA prompt is replaced with ERASE when a MOD page is displayed.

6 **Optimum/Maximum Altitude (OPT/MAX)**

OPT – displays the computed optimum altitude for the displayed cruise mode. The value is not constrained by minimum cruise time criteria (as is the TRIP ALT on the PERF INIT page).

MAX – displays the maximum possible altitude based on the selected target speed and the specified maneuver margin.

Values are advisory only. They are provided for crew reference.

7 **STEP Altitude**

This line may be used to enter a possible step climb or descent altitude for crew evaluation.

The line will be blank when within 100 nm of top of descent or when RTA mode is active.

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

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

The data is always displayed when the distance is less than 100 nm. If the distance is more than 100 nm, the data will be displayed only if a step altitude has not been entered. The distance is blank if it is greater than 999 nm.

9 ACTUAL WIND/Estimated Wind (EST WIND)

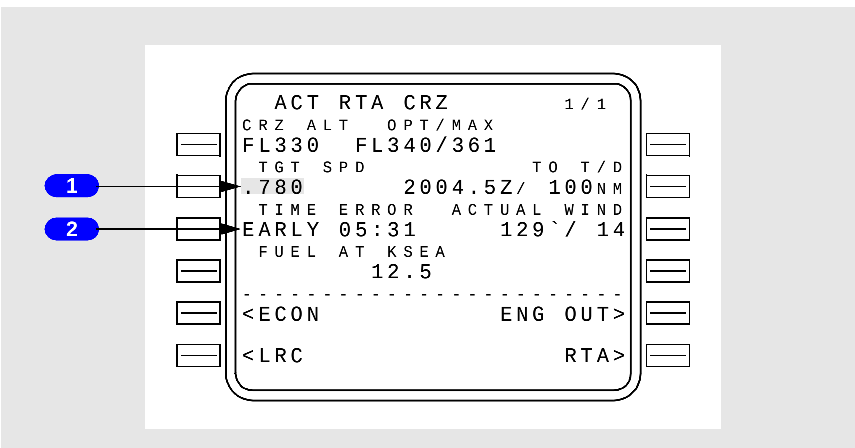
Displays computed or manually entered true wind for present altitude.

A manual entry has priority. The data line title then changes ACTUAL WIND to estimated wind (EST WIND).

The displayed value is used as the assumed true wind at the step to altitude for making wind/altitude trade computations.

RTA Cruise

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



1 Target Speed (TGT SPD)

Displays the computed speed required to meet the RTA.

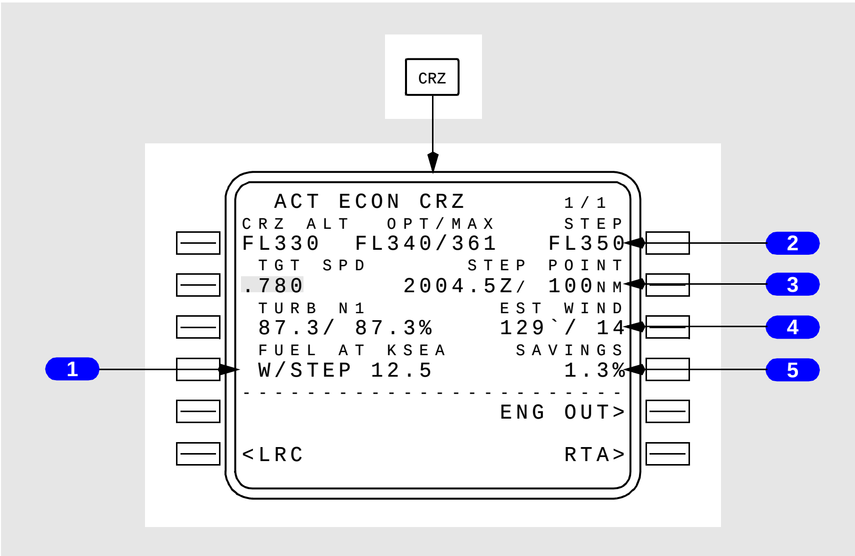
When RTA mode is exited by waypoint sequence or by deletion, this speed changes to FMC target speed on a manual speed CRZ page, and the scratchpad message SELECT MODE AFTER RTA is displayed.

2 Time Error

Displays the computed time error at the RTA waypoint.

Same as time error on RTA PROGRESS page.

Cruise with Step Climb



1 Fuel at Destination with Step Climb Altitude (FUEL AT XXXX)

The computation assumes the step climb will occur at the STEP POINT, and the value is prefixed by W/STEP.

2 Step Altitude (STEP)

Used to enter step climb or step descent altitudes for crew evaluation.

Blank when within 100 nm of top of descent or when RTA mode is active.

3 STEP POINT

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

If already past the STEP POINT, the data line changes to NOW as long as savings are positive.

Blank if no entry on STEP line.

4 ACTUAL WIND/Estimated Wind (EST WIND)

Used as the assumed true wind at the STEP altitude for making wind–altitude trade computations.

5 SAVINGS/PENALTY

Displays the predicted cost savings or penalty associated with flying the displayed speed/altitude step climb or descent profile, as compared to flying the current cruise speed schedule and maintaining present altitude to top of descent.

Blank if no step data entered.

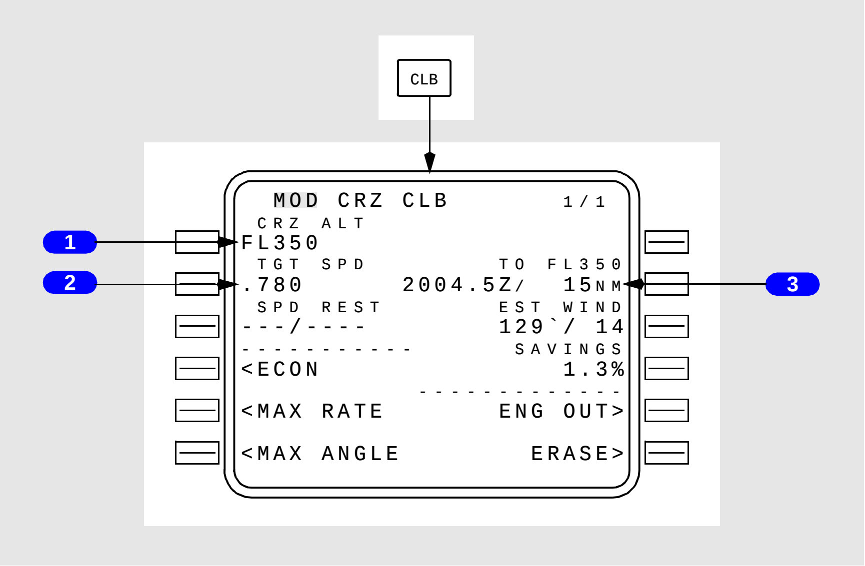
Cruise Climb

The CRZ CLB page displays data for a cruise climb to a new cruise altitude.

MOD CRZ CLB is automatically displayed during cruise if a higher cruise altitude is entered on the CRZ page.

During VNAV operation, execution initiates a climb at climb thrust and cruise target speed to the new altitude.

The VNAV climb mode is active until reaching the selected altitude. The mode then automatically changes back to cruise.



1 Cruise Altitude (CRZ ALT)

Initially displays the CRZ ALT entered on the CRZ page.

Manual entry may be made.

2 Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude.

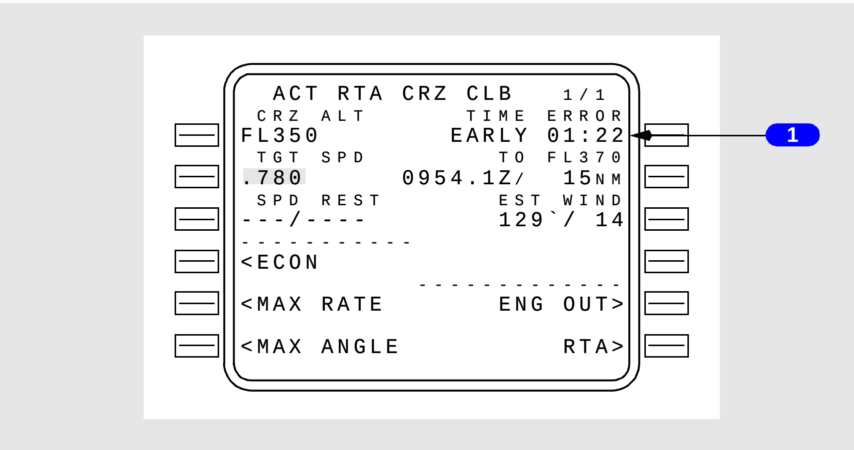
Manual entry may be made.

3 **TO FLXXX**

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

RTA Cruise Climb

The RTA CRZ CLB page displays the same data as the CRZ CLB page except for the TIME ERROR line.



1 **TIME ERROR**

Displays the computed time error at the RTA waypoint.

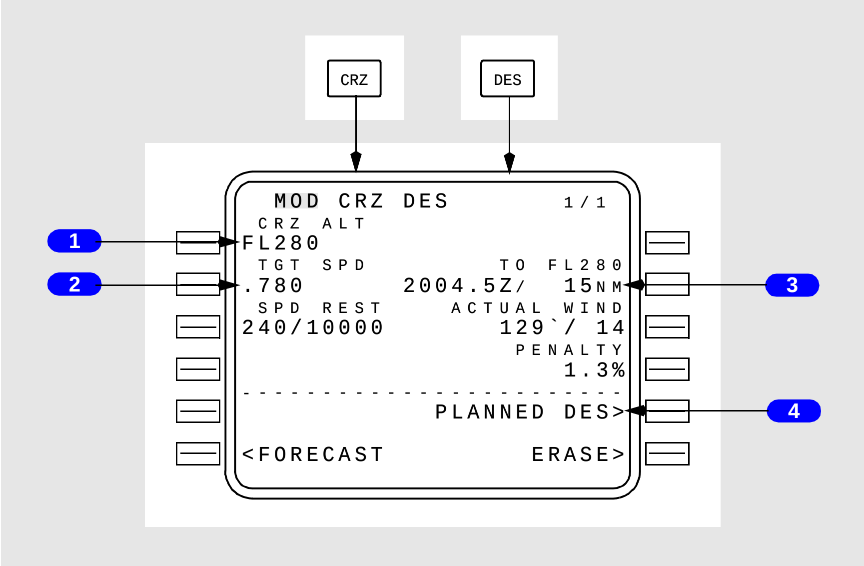
Same as time error on RTA PROGRESS page.

Cruise Descent

The CRZ DES page displays data for a cruise descent to a new altitude.

MOD CRZ DES is automatically displayed during cruise if a lower cruise altitude is entered on the CRZ page.

During VNAV operation, execution initiates a descent at 1,000 feet per minute and cruise target speed to the new altitude.



1 Cruise Altitude (CRZ ALT)

Initially displays the CRZ ALT entered on the CRZ page.

Manual entry may be made.

2 Target Speed (TGT SPD)

Displays target cruise speed for the displayed cruise altitude.

Manual entry may be made.

3 TO FLXXX

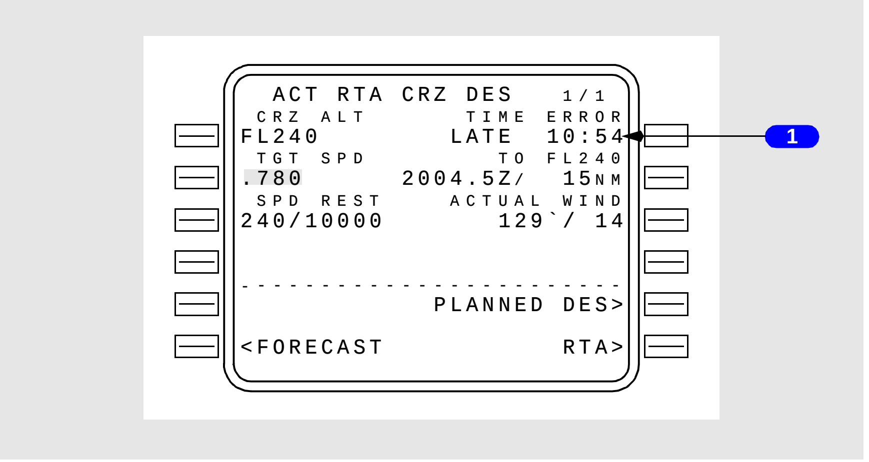
Displays ETA at, and distance to, the displayed cruise altitude.

4 Planned Descent (PLANNED DES)

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

RTA Cruise Descent

The RTA CRZ DES page displays the same data as the CRZ DES page except for the TIME ERROR line.



1 TIME ERROR

Displays the computed time error at the RTA waypoint.

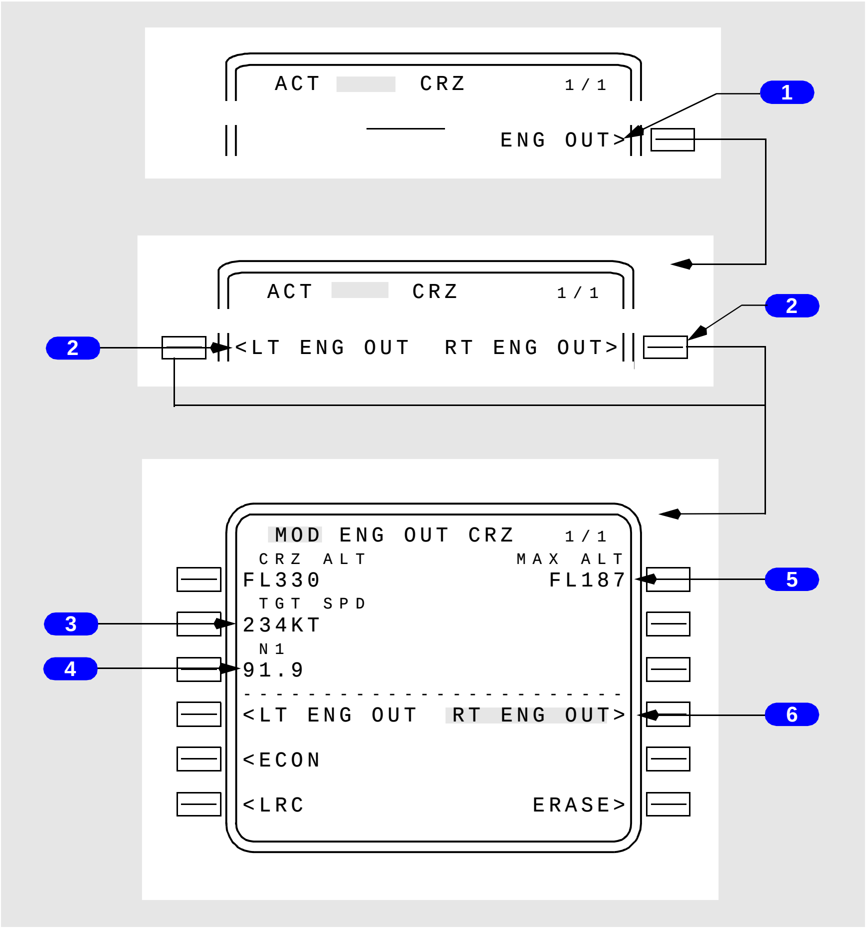
Same as time error on RTA PROGRESS page.

Engine Out Cruise

The engine out cruise page may be accessed by selecting the ENG OUT prompt on the CRZ page. The page displays advisory information for a one engine inoperative condition. Engine out data is also available with both engines operating.

The FMC accounts for current gross weight and actual bleed conditions.

(Prior to U7.5) When activated, all subsequent performance predictions are blanked and VNAV cannot be engaged.



1 Engine Out (ENG OUT)

Permits access to ENG OUT CRZ page.

2 Left/Right Engine Out (LT ENG OUT/RT ENG OUT)

Selection changes display to MOD ENG OUT CRZ page. The MOD ENG OUT CRZ page is information only.

(U7.5) The execute light does not illuminate and the page can not be executed.

After viewing page data, select ERASE to return to the active CRZ page.

3 Target Speed (TGT SPD)

Displays the optimum speed based on minimum drag.

4 N1

Displays N1 for maximum continuous thrust.

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

(Prior to U7.5) 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)

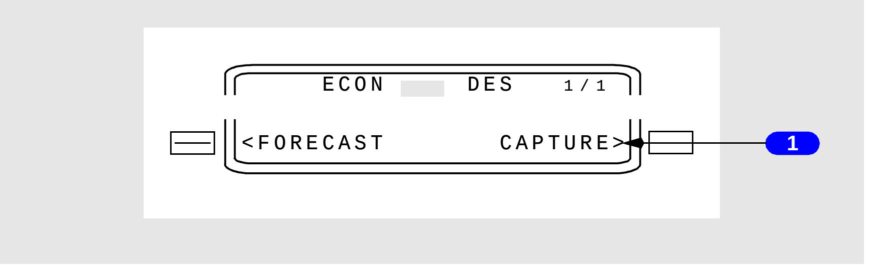
Selected engine out is shown in reverse highlighting.

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.

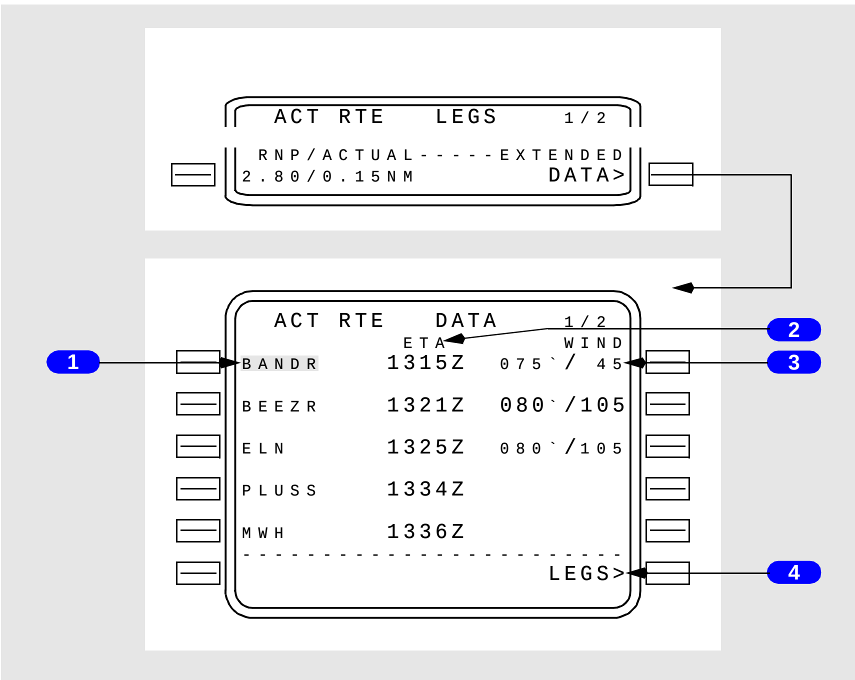
Selecting the SPD DES page and executing the CAPTURE prompt initiates a VNAV descent at idle thrust and target speed.

Route and Waypoint Data

Route Data (RTE DATA) Page

The RTE DATA page displays ETAs for each waypoint on the RTE LEGS page. This page also displays forecast wind data for cruise waypoints.

One page displays data for five waypoints.



1 Waypoint

Displays the same waypoint identifier as on the corresponding RTE LEGS page.

The active waypoint is highlighted in reverse video.

2 Estimated Time of Arrival (ETA)

Displays estimated time of arrival to displayed waypoint.

3 WIND

Used for entry and/or display of the true wind at the cruise waypoint identified on the same line.

Entry may be via the keyboard or propagated from the CRZ WIND entry on the PERF INIT page.

The CRZ WIND value (075°/45 is depicted) propagates to all cruise waypoints (BANDR to ELN is the depicted cruise segment).

If no CRZ WIND entry was made, the FMC assumes 000°/000.

A keyboard entry has priority and propagates to all down path cruise waypoints (an entry of 080°/105 at BREEZR is depicted). The entry must be executed.

Any entries propagated from the CRZ WIND entry are displayed in small font. Keyboard entries are displayed in large font.

Crew entries of forecast winds (or default 000°/000) are automatically biased with the actual wind computed by the FMC when within 100 NM of a cruise waypoint and within 2,000 feet of a cruise altitude. (U4 and on) Biased values are not displayed.

Blank for non–cruise waypoints (PLUSS and MWH are depicted). Entry is inhibited.

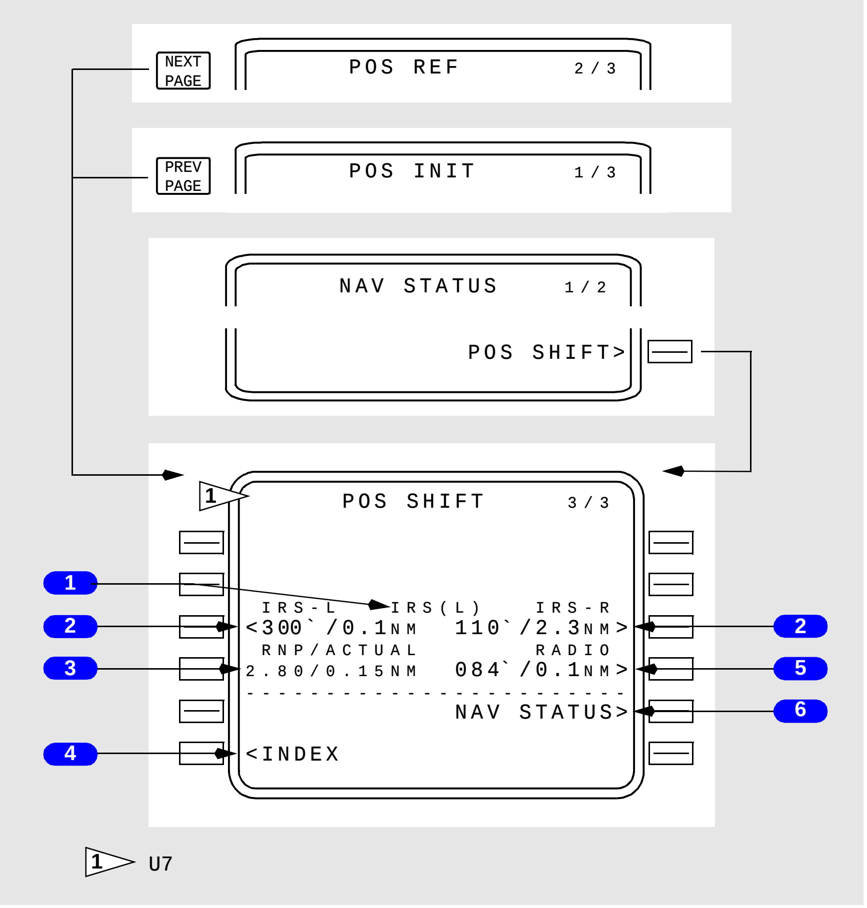
4 **LEGS**

Selection displays the RTE LEGS page.

Position Shift Page

On the POS SHIFT page, each prompt indicates the bearing and distance of the indicated system relative to the FMC position. FMC position is displayed on line 1R of the POS REF page. The entries with parentheses in the center of the page show the active position references.

Data fields are blank when on the ground.



1 IRS (X)

Displays currently selected IRS.

2 IRS Left/IRS Right (IRS–L/IRS–R)

Displays the left and right IRS positions relative to FMC position using current Mag/True reference. Blank if IRS position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

3 Required Navigation Performance/Actual (RNP/ACTUAL)

Displays the required navigation accuracy compared to actual navigation accuracy.

4 **INDEX**

Push – displays the INIT/REF INDEX page.

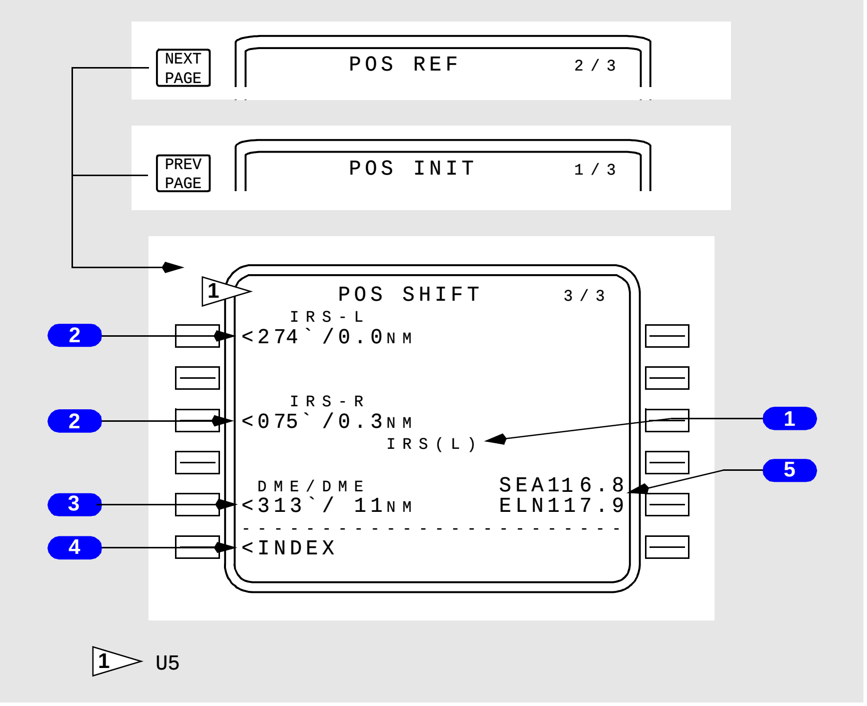
5 **RADIO Position**

Displays the radio position relative to FMC position using current Mag/True reference. Blank if radio position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

6 **Navigation Status (NAV STATUS)**

Push – displays the NAV STATUS page.



1 **IRS (X)**

Displays currently selected IRS.

2 **IRS Left/IRS Right (IRS–L/IRS–R)**

Displays the left and right IRS positions relative to FMC position using current Mag/True reference. Blank if IRS position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

3 DME/DME

Displays the radio position relative to FMC position using current Mag/True reference. Blank if radio position is invalid.

Push – highlights the line, illuminates the EXEC key, and displays the CANCEL prompt.

4 INDEX

Push – displays the INIT/REF INDEX page.

5 Radio Identifiers

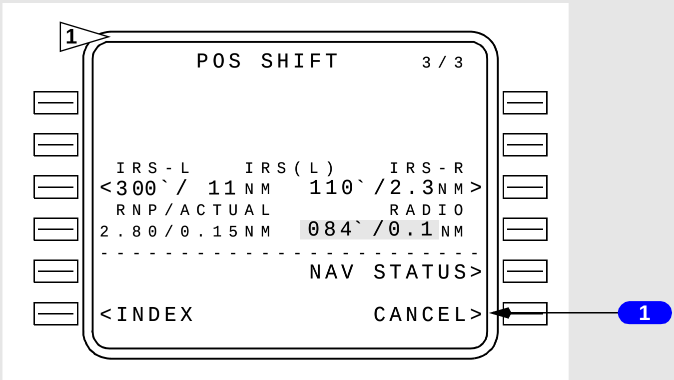
Displays navaid identifiers and frequencies being used for position updating. Blank if radio position is invalid.

Inflight Position Update

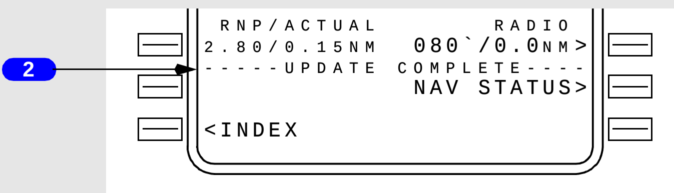
FMC position update is accomplished on the POS SHIFT page in flight. Selecting a prompt stops the updating of the relative position. The bearing and distance is highlighted, the EXEC key will illuminated, and a CANCEL prompt is displayed in line 6R.

When the position shift is executed, UPDATE COMPLETE is displayed.

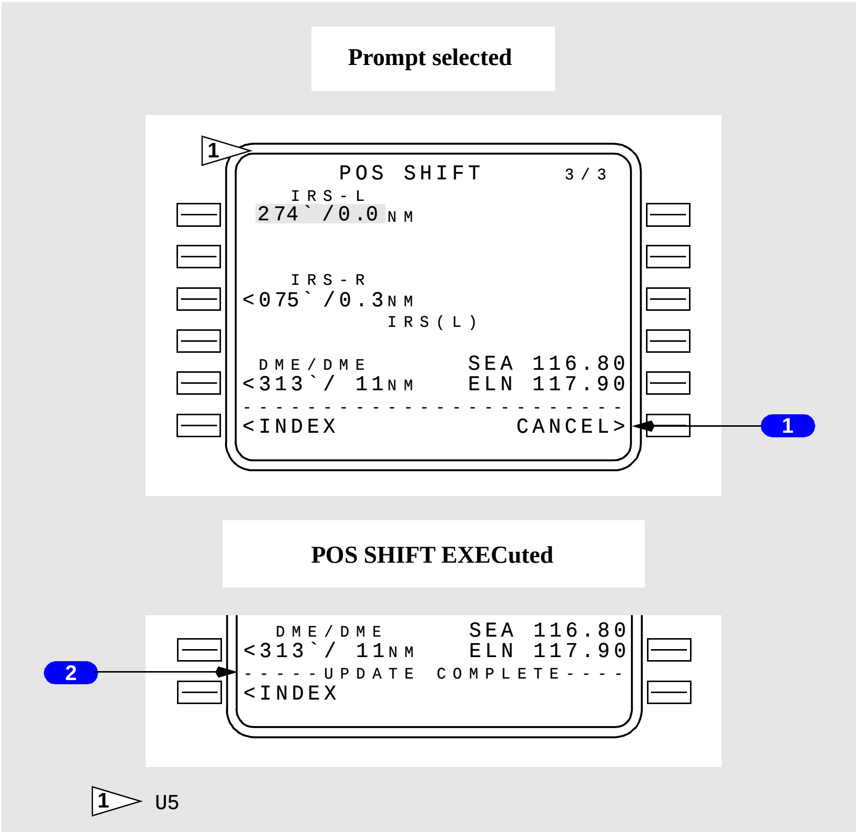
Prompt selected



POS SHIFT EXECuted



1 U7



1 CANCEL

Displayed when a line selection is made for position update. Selection prior to execution cancels the line selection.

2 UPDATE COMPLETE

Displayed after a position shift has been selected and executed.

Intentionally
Blank

Navigation Data

Reference Navigation Data (REF NAV DATA) Page

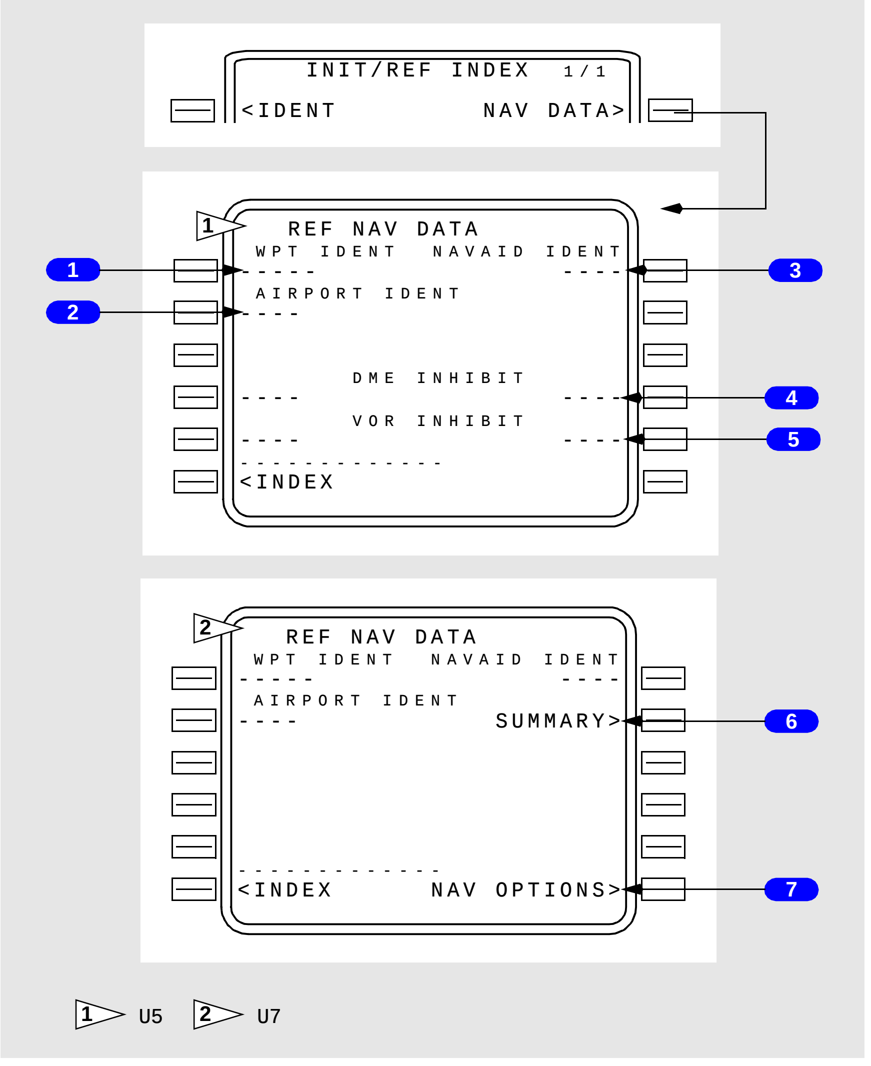
The REF NAV DATA page provides information about waypoints, navaids, airports, and runways. Entering the appropriate identifier initiates the display.

Entering SUPP in the scratch pad prior to selecting NAV DATA results in display of the supplemental navigation data (SUPP NAV DATA) page.

If the entered identifier is already stored in the permanent, supplemental, or temporary database, then relevant data propagates to the subsequent REF NAV DATA display.

If the entered identifier is not stored in any database, the subsequent REF NAV DATA display contains box prompts. Following entry of the required information, the new data may be stored in the temporary database by executing (except for runway data). Data may be subsequently deleted from the temporary database by deleting the individual identifier, if the identifier is not presently being displayed on another page (e.g., RTE LEGS, PROGRESS, etc.).

All data stored in the temporary database is cleared at flight completion.



1 Waypoint Identifier (WPT IDENT)

Displays dashes initially.

Any waypoint, navaid or runway can be entered.

Format for runway entry is “RWnna” where “nn” is a one or two digit numeric (with or without leading zeros) and “a” is an optional character L, R, or C.

In order to access runway data, an airport must be identified.

2 Airport Identifier (AIRPORT IDENT)

Displays dashes initially.

Displays box prompts if runway is entered into 1L prior to airport entry.

An invalid airport/runway pair will result in “NOT IN DATA BASE” displayed in the scratchpad.

3 Navigation Aid Identifier (NAVAID IDENT)

Displays dashes initially.

Valid entries are up to 4 alphanumeric characters.

If the navaid is not contained in the databases, box prompts will appear in related data fields needing entry.

4 DME INHIBIT

Entry of a DME identifier inhibits use of DME information for FMC position updating.

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

5 VOR INHIBIT

Entry of a VOR identifier inhibits use of VOR bearing information for FMC position updating.

Any associated DME can still be used for FMC position updating.

6 SUMMARY

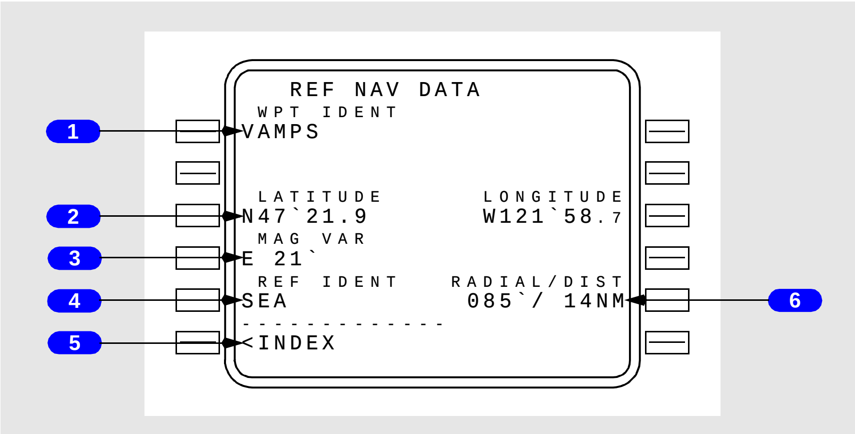
Selection displays NAV SUMMARY pages.

Blank if supplemental and temporary databases are empty.

7 Navigation Options (NAV OPTIONS)

Selection displays NAV OPTIONS page.

Waypoint Data Display



1 Waypoint Identifier (WPT IDENT)

Displays or permits entry of the desired waypoint (5 characters maximum). Following entry, the associated data lines are displayed.

2 LATITUDE/LONGITUDE

Displays or permits entry of waypoint latitude and longitude. Entry on the REF IDENT and RADIAL/DIST lines cause latitude and longitude to be computed and displayed.

3 Magnetic Variation (MAG VAR)

Displays or permits entry of waypoint magnetic variation. Data is automatically computed based on latitude and longitude.

Manual entry has priority.

4 Reference Identifier (REF IDENT)

Together with RADIAL/DIST, displays or permits entry of reference point for a created waypoint.

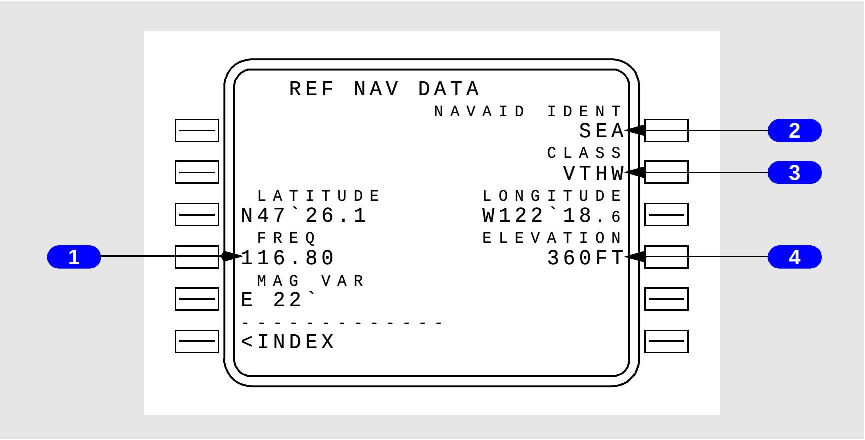
5 INDEX

Selection displays INIT/REF INDEX page.

6 Radial/Distance (RADIAL/DIST)

Together with REF IDENT, displays or permits entry of bearing and distance for a created waypoint.

Navigation Aid Data Display



1 Frequency (FREQ)

Displays or permits entry of the frequency of the entered navaid.

2 Navigation Aid Identifier (NAVAID IDENT)

Displays or permits entry of navaid identifier (5 characters maximum). Following entry, the associated data lines are displayed.

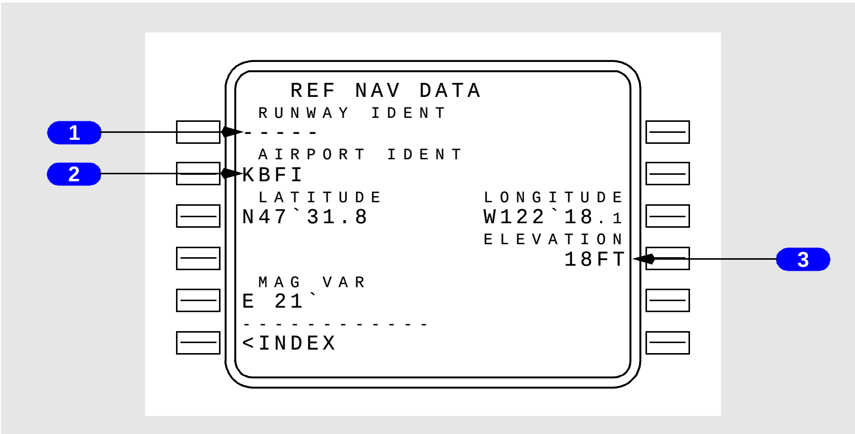
3 Classification (CLASS)

Displays or permits entry of the classification of the entered navaid.

4 ELEVATION

Displays or permits entry of the elevation (feet above MSL) of the entered navaid.

Airport Data Display



1 Runway Identifier (RUNWAY IDENT)

Permits entry of runway identifier.

2 Airport Identifier (AIRPORT IDENT)

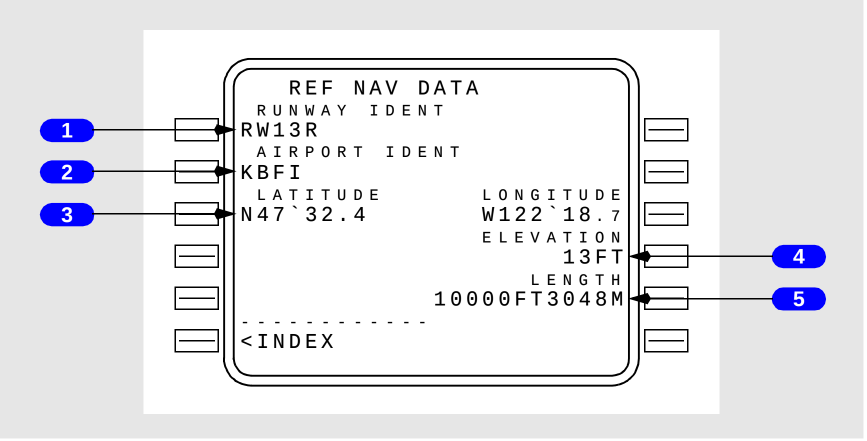
Displays airport identifier.

3 ELEVATION

Displays or permits entry of the elevation (feet above MSL) of the entered airport.

Runway Data Display

A runway identifier may be entered on the airport data display page or as a waypoint on the REF NAV DATA page. On the airport data display page, entry may be in the form of 13R or RW13R. Single digit entries are possible, with or without leading zeros.If the waypoint method is used, entry must be in the form RW13R, and the proper airport identifier must be entered on the runway data display page. Runways must be stored in the permanent navigation database.



1 Runway Identifier (RUNWAY IDENT)

Displays runway identifier.

2 Airport Identifier (AIRPORT IDENT)

Displays airport identifier.

3 LATITUDE/LONGITUDE

Displays latitude and longitude of entered runway.

4 ELEVATION

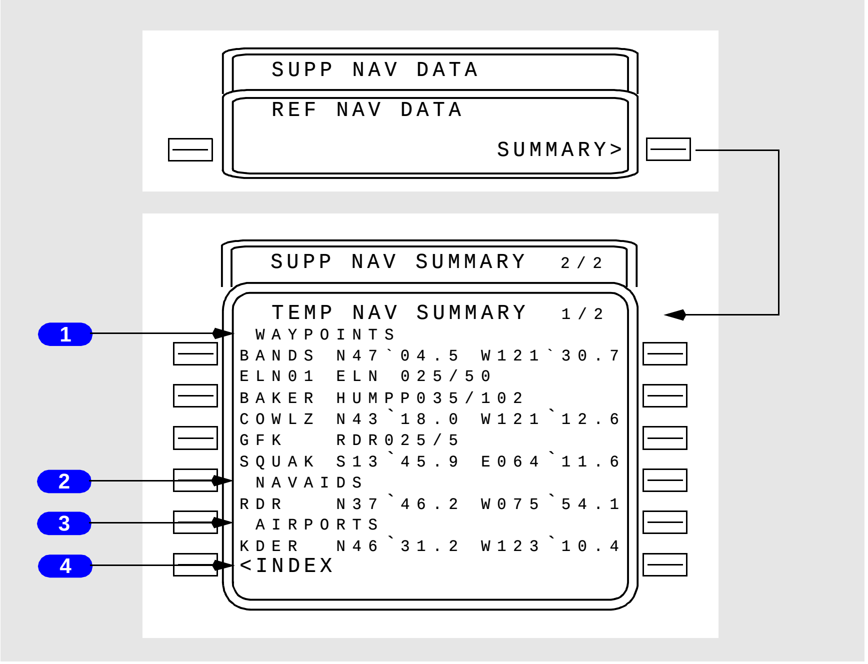
Displays elevation (feet above MSL) of the entered runway.

5 Runway Length (LENGTH)

Displays length of entered runway in feet and meters.

Navigation Summary (U7)

The NAV SUMMARY pages show the contents of the temporary and supplemental navigation databases. Contents of the temporary navigation database show first, followed by contents of the supplemental navigation database.



1 WAYPOINTS

Shows waypoints stored in the related database.

Waypoints show in defining format.

2 Navigation Aids (NAVAIDS)

Shows navaids stored in related database.

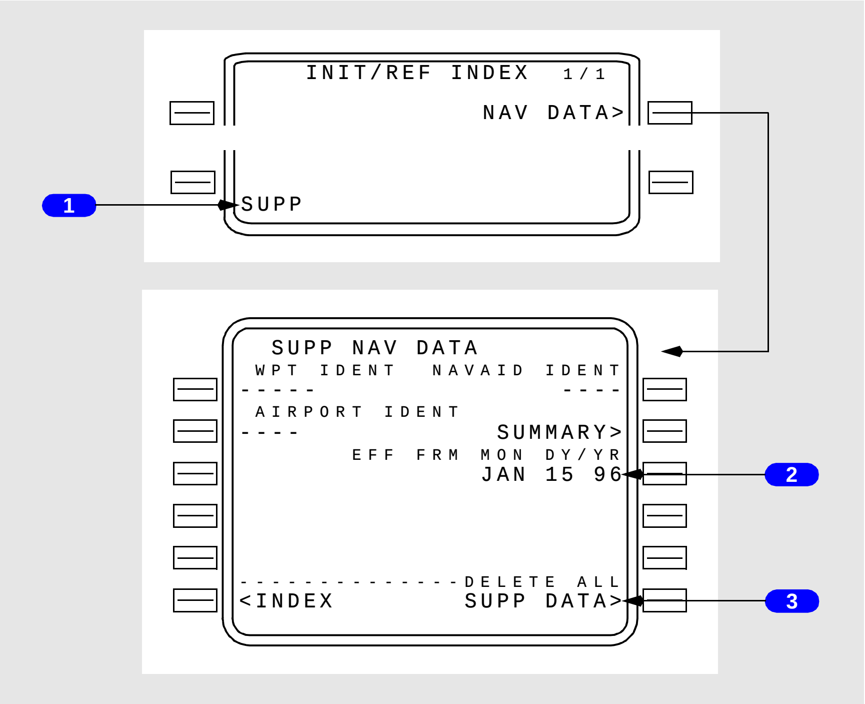
3 AIRPORTS

Shows airports stored in related database.

4 INDEX

Push – Shows page (REF NAV DATA or SUPP NAV DATA) used to access NAV SUMMARY pages.

Supplemental Nav Data



1 Supplemental Scratchpad Entry (SUPP)

The supplemental navigation database is accessed by entering SUPP in the scratchpad while on the INIT/REF INDEX page, then selecting the NAV DATA prompt. Access is only available on the ground.

2 Effectivity Date (EFF FRM MON DY/YR)

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

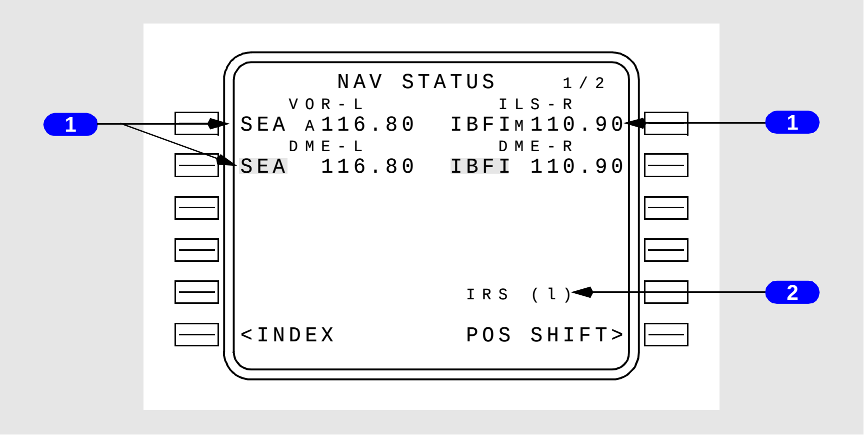
3 Delete All Supplemental Data (DELETE ALL SUPP DATA)

Data may be deleted from the supplemental database by two methods. Deletion may be accomplished one item at a time on the display pages, or the entire database may be deleted by selecting this prompt. The prompt is only available before entry of an origin airport.

Navigation Status Display (U7)

The NAV STATUS page displays the current status of the navaids being tuned.

Access to the NAV STATUS display is from the NAV STATUS prompt on the POS SHIFT page, the PROGRESS page 1/3, and (in flight) the INIT/REF INDEX page or from the NAV OPTIONS page, NEXT or PREV PAGE.



1 VOR/ILS and DME Lines

Lines 1L and 1R display VOR or ILS identifier and frequency tuned on the corresponding VHF NAV control panel.

Lines 2L – 2R through 4L – 4R display up to five DME identifiers and frequencies tuned by the corresponding DME receiver.

Data is displayed in large font with the identifier highlighted if that facility is being used for navigation.

Data is displayed in large font with the identifier not highlighted if that facility is being received but not used for navigation.

Data is displayed in small font if that facility is being tuned but not received.

If the navaid has failed, FAIL will be displayed in small font.

If there is no corresponding identifier for the displayed frequency, then the identifier field will be blank and only the frequency will be displayed.

On lines 1L or 1R, for VOR/ILS displays, the mode of tuning will be shown:

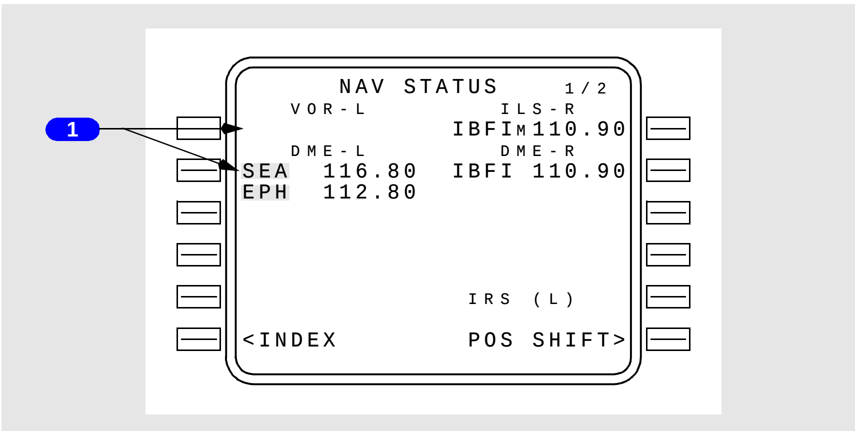
- M – Manual
- P – Procedural
- A – Automatic.

On lines 2L – 2R through 4L – 4R, if no DME information is received then the identifier and frequency field is blank.

2 IRS Status Display

Displays the IRS currently selected for use in navigation. “L” or “R” indicates left or right IRS is being used in the FMC position calculation.

Non-Scanning DME in Agility Tuning Mode



1 Agile Tuning

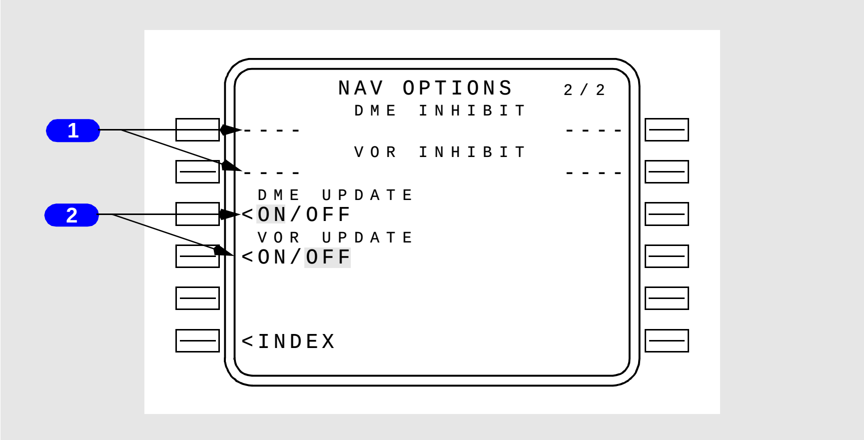
During agility tuning, the corresponding VOR or ILS field (1L or 1R) blanks.

The identifiers and frequencies being used for the navigation solution are displayed simultaneously on Lines 2L or 2R.

Navigation Options (U7)

When a navigation facility or internal system is invalid, the invalid data must be inhibited to prevent incorrect position calculations.

Access to the NAV OPTIONS page is from the NAV OPTIONS prompt on the REF NAV DATA page or by selecting NEXT or PREV PAGE on the NAV STATUS page.



1 DME/VOR INHIBIT

Enter the identifier of up to two VOR, VOR/DME, VORTAC, or DME stations that must not be used for FMC position updates.

Entries are blanked at flight completion.

Deleting or overwriting removes a previous inhibit.

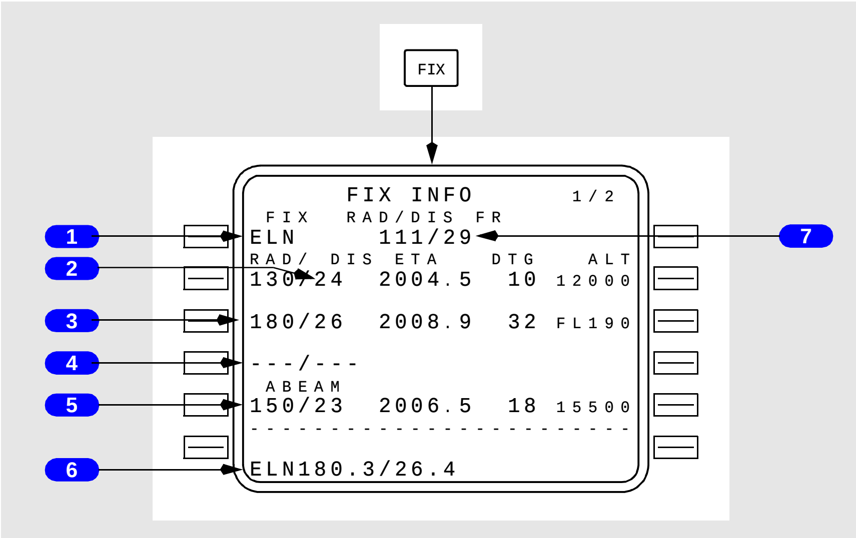
2 DME/VOR UPDATE

Selection permits switching between ON and OFF modes for updating FMC position. Default mode is ON. The current mode is highlighted in reverse video.

Selection is reset to ON at flight completion.

Fix Information Page

Two identical FIX INFO pages are used to identify waypoint fixes for display on the EFIS map. If desired, fix information can be copied into the RTE page. Access is via the FIX key.



1 FIX Name

Enter the desired fix..

Valid entries are airports, navaids, and waypoints from the navigation database.

The selected fix is displayed on the EFIS map and highlighted by a green circle.

2 Distance Entry (DIS)

Enter a distance from the fix. Distances from the fix are displayed on the EFIS map as a dashed green circle around the fix.

When the distance intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed for that intersection.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

Valid entries are xxx.x:

- distance only entries must start with a /
- leading zeros can be omitted for distance
- decimal values can be omitted.

ETA – displays the estimated time of arrival to the intersection point.

DTG – displays the distance to go to the intersection point.

ALT – displays the predicted altitude at the intersection point.

3 Radial Entry (RAD)

Enter a radial from the fix. Radials are displayed on the EFIS map as green dashed lines from the fix.

When the radial intersects the active route, the ETA, DTG, and predicted altitude at the intersection are displayed.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

Valid entries are xxx.

4 Radial/Distance Entry (RAD/DIS)

Enter a radial, distance, or both radial and distance from the fix. A radial and distance from the fix is displayed on the EFIS map by both radial and distance, but ETA and ALT fields will be blank.

5 ABEAM

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

The fix abeam point ahead of the airplane is displayed by a radial line from the waypoint ending at the nearest perpendicular route leg intersection.

If there is more than one intersection, the data will apply to the first occurrence and will sequence as each intersection is passed.

6 Route Intersection Point Copied

Pushing the line select key for one of the RAD/DIS entries copies the fix place/bearing/distance definition into the scratchpad. This fix can be placed into the route on a LEGS page as a waypoint.

7 Radial/Distance From Fix (RAD/DIS FR)

Displays the radial and distance from the fix to the airplane. This information is continually updated as the airplane position changes.

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.

Alternates can be selected at any time. Alternates are available from preflight through all phases of flight and can be updated at any time. Diversion to an alternate can be accomplished during cruise, descent, or approach.

The only automatic page change provided in the descent/approach modes is the transition from cruise to descent at the top of descent.

Early Descent

Early descent may be commenced prior to reaching the top of descent by using the CAPTURE prompt.

Descent

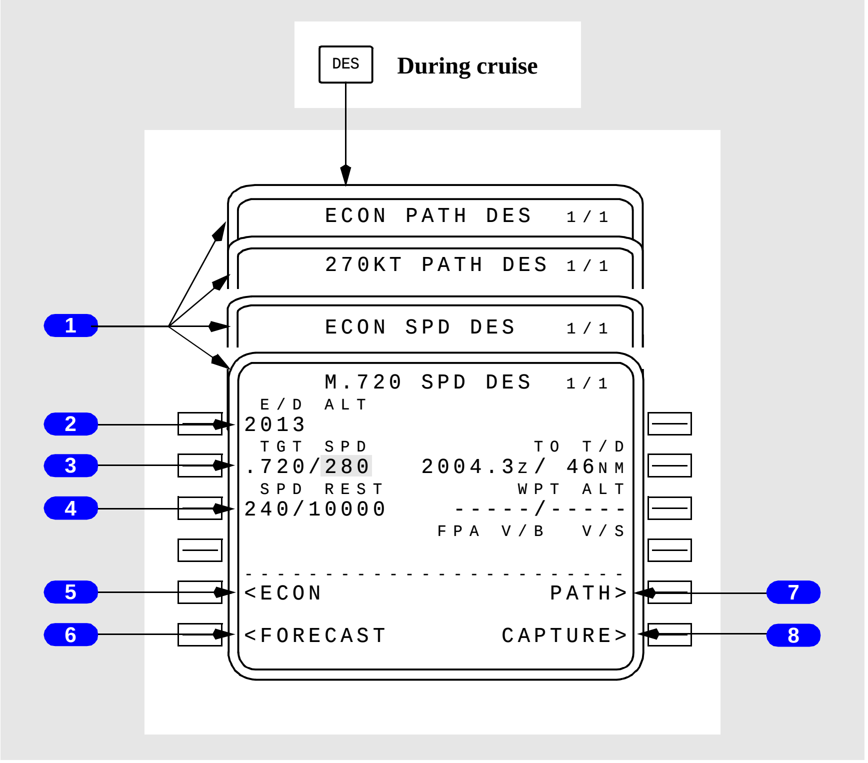
During descent, LNAV progress is managed using the RTE LEGS and PROGRESS pages, as in the cruise phase. VNAV descent management is accomplished primarily on the DES page.

The DES FORECASTS page is also available to enter forecast wind data to aid in descent planning.

Descent Page (During Cruise)

The descent page is used to monitor, revise, or select the descent path. Descent modes are economy (ECON) path or speed and manual path or speed. The default VNAV descent mode is ECON PATH.

The page title reflects the VNAV descent mode. The path mode controls descent to fly a vertical path which complies with altitude and speed restrictions in the flight plan. The speed mode controls descent at a fixed speed and complies with altitude and speed restrictions in the flight plan.



1 Page Title

The page title identifies the selected mode. When a manual speed is selected, the title includes XXXKT for fixed CAS or M.XXX for fixed Mach selections.

Displays ACT when the descent phase is active.

2 End of Descent Point (E/D ALT)

Displays the end of descent altitude.

- for a PATH DES page, displays the altitude restriction for the E/D waypoint; blank if path descent not available
- for a SPD DES page, displays 1,000 feet above destination airport or, the lowest “at” altitude constraint, whichever is lower.
- (U7) If an approach is selected which ends at RWXXX, the E/D altitude will be threshold crossing height (TCH), 50 feet above the runway.

3 Target Speed (TGT SPD)

Displays the command speed used above all waypoints constraints, or speed restrictions.

On ECON PATH or ECON SPD DES pages, displays computed 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. A manual PATH or manual SPD DES page will be displayed for the entered value.

The active controlling speed is highlighted in reverse video.

Blank for any PATH DES page if a path descent is not available.

4 Speed Restriction (SPD REST)

Displays the most restrictive of the following speeds:

- destination airport speed minus 10 knots
- waypoint speed restriction if greater than minimum flaps up maneuvering speed
- minimum flaps up maneuvering speed
- selected Vref + wind correction for landing flap setting
- whenever flaps are extended, the, appropriate flap speed shall be displayed as XXX/FLAPS. This shall supersede any other speed restriction
- displays XXX/HOLD when decelerating to hold speed prior to hold entry fix.

Dash prompts displayed when there is no active speed restriction.

Manual crew entries or deletions may be made. HOLD or FLAPS speed may not be deleted or modified.

5 Economy (ECON)

Displayed on the manual DES pages.

Push – selects the corresponding ECON SPD or ECON PATH DES page.

6 Descent Forecasts (FORECAST)

Push – selects the DES FORECASTS page.

7 PATH

Displayed on the SPD DES pages if a path descent is available.

Push – selects the corresponding PATH DES page.

8 **CAPTURE**

Displayed on the standard DES pages whenever descent is not ACT or MOD.

Blank for any PATH DES page if a path descent is not available.

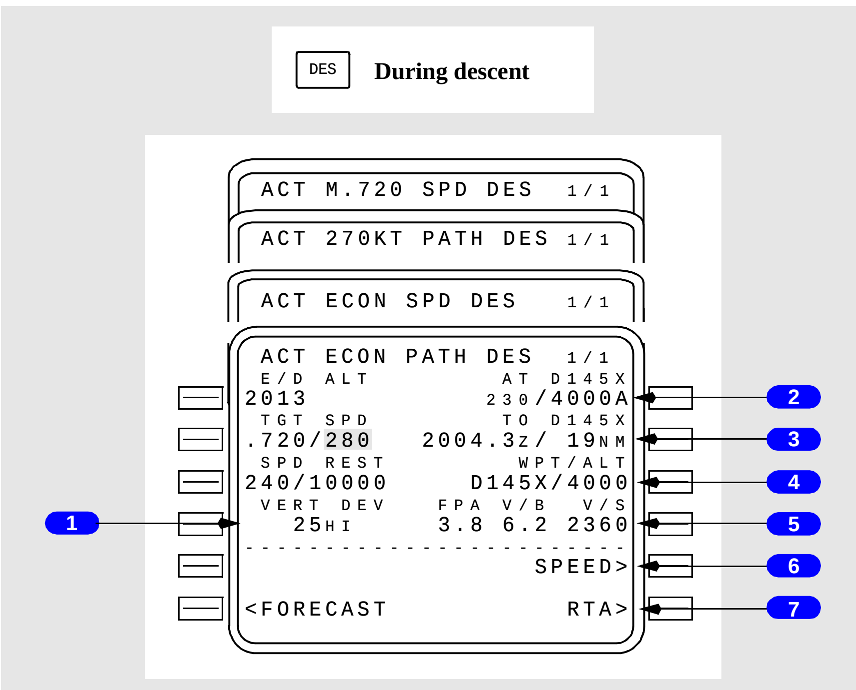
Push – arms the CAPTURE function and illuminates the EXEC light.

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

Execution allows early initiation of a SPD descent.

Descent Page (During Descent)

Display when any descent mode is active after beginning of descent.



1 **Vertical Deviation (VERT DEV)**

Displays present deviation (feet HI or LO) from the computed vertical path.

The deviation is always in relation to the path descent profile, regardless of which page is active (PATH DES or SPD DES).

Blank if a path is not available.

2 Altitude Restriction (AT XXXXX)

Displays the next waypoint constraint from the RTE LEGS page.

The constraint is speed/altitude. If an airspeed restriction exists at the waypoint, it will be displayed in large font; otherwise the predicted speed will be displayed in small font.

Can be deleted on this page.

The display is blank when no constraint exists, or for any PATH DES page if a path descent is not available.

3 To Waypoint (TO XXXXX)

Displays computed ETA and distance to go to T/D when not in an active descent mode.

If an early descent is in progress (initiated using CAPTURE prompt), ETA and distance to go to original T/D is displayed until passing the T/D.

If a descent mode is active, displays ETA and distance to go to the first of the following points:

- the waypoint in the AT XXXXX line
- an intermediate T/D (TO T/D – XXXXX, where XXXXX is the altitude).

The display is blank if a path descent is not available, or if the AT XXXXX line is blank and no T/D information is displayed.

4 Waypoint/Altitude (WPT/ALT)

Displays the waypoint and altitude that serves as the basis for the vertical bearing (V/B) display on line 4R.

Normally displays the same waypoint/altitude restriction that is displayed on the AT XXXXX line.

May be overwritten by pilot entry.

Dash prompts are displayed if there is no entry.

5 Vertical Path Parameters (FPA V/B V/S)

Displays the following parameters related to the present vertical path:

- FPA – actual flight path angle based on present ground speed and vertical speed (that is, the present vertical bearing being flown)
- V/B – vertical bearing direct from present position on the WPT/ALT line (that is, the flight path angle required if flying direct to the waypoint and altitude on the WPT/ALT line)
- V/S – the required vertical speed (in fpm, based on present ground speed) to fly the displayed V/B.

Blank if no entry on the WPT/ALT line.

6 SPEED

Displayed on PATH DES pages.

Push – selects the related SPD DES page.

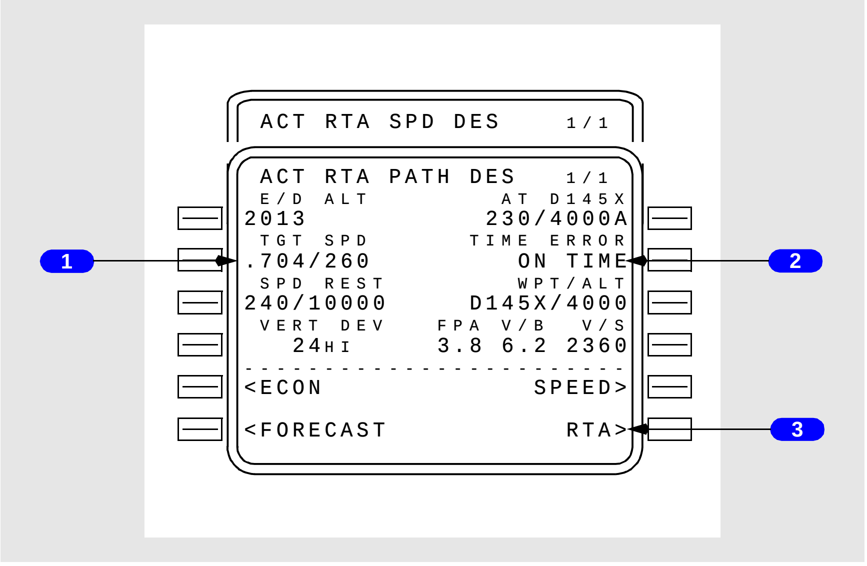
7 RTA

Displayed when CAPTURE or ERASE prompt is not displayed.

Push – selects the RTA PROGRESS page.

RTA Descent Page

RTA Descent pages are displayed when an RTA mode is active. Displays are the same as on other descent pages except as noted.



1 Target Speed (TGT SPD)

Displays computed RTA target speed.

Changes to FMC target speed if the RTA mode is exited.

2 TIME ERROR

Displays computed time error at the RTA waypoint.

Same as time error line on RTA PROGRESS page.

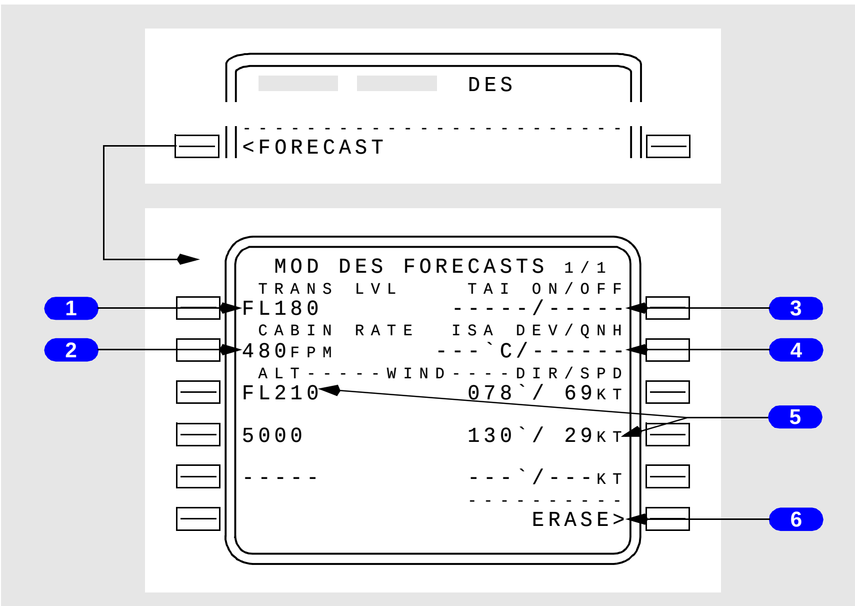
3 **RTA**

Push – selects the RTA PROGRESS page.

Descent Forecast Page

The descent forecast page is used for pre–descent planning to enter forecast data for more precise descent path calculation.

The primary entries are wind direction and speed for up to three descent altitudes, and the altitude that anti–icing is turned on and off.



1 **Transition Level (TRANS LVL)**

Normally displays FL180 as the assumed descent transition level.

Changes automatically if an arrival procedure having a different stored value is entered.

Manual entry has priority.

2 **CABIN RATE**

Displays the predicted cabin rate of descent required by the flight plan descent profile.

3 Thermal Anti–Ice On/Off (TAI ON/OFF)

Enter the altitudes in flight level or feet at which anti–ice is expected to be turned on and off.

FMC computations assume minimum thrust at high idle at all times in flight.

4 ISA Deviation and QNH (DEV/QNH)

Enter the average ISA deviation for descent in °C (+/–XX°C) or °F (+/–XX°F)

Enter the destination QNH altimeter setting (IN. HG. or MB). Do not enter a QFE altimeter setting.

5 Descent Wind (ALT – – – – – WIND – – – – DIR/SPD)

Allows entry of altitude and wind direction/speed for up to three forecast wind values.

Entries may be made in any altitude sequence and will be automatically ordered by altitude from highest to lowest.

6 ERASE

Push – deletes modification and returns page to previously displayed descent page.

Engine Out Descent

There are no specific engine out pages for descent. Use the normal descent planning features and pages.

Approach

During approach, LNAV and VNAV guidance normally transitions to the approach guidance provided by navigation radios. The FMC continues to calculate and display present position and can provide LNAV and VNAV approach guidance for certain types of approaches when radio navigation is not used.

The RTE LEGS and PROGRESS pages are used to manage the airplane until other approach guidance becomes active. Other pages which support approaches are:

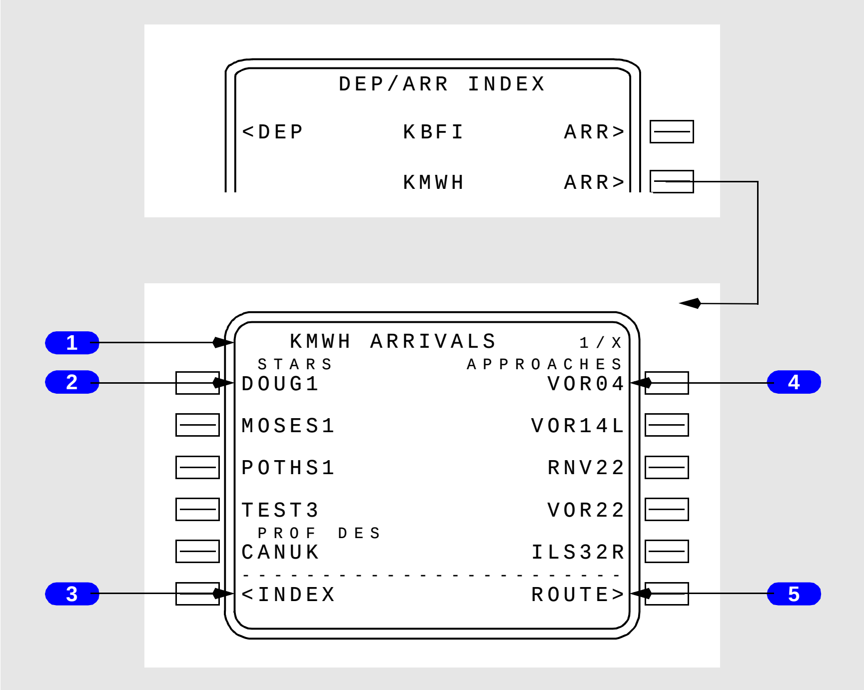
- APPROACH REF page – to select the approach VREF
- ARRIVALS page – to select the desired arrival and approach procedures
- HOLD page – to manage holding patterns.

Holding is described in this section but it can be used during any phase of flight.

Arrivals Page – IFR Approaches

The arrivals page allows selection of an approach, standard terminal arrival route (STAR), and arrival transitions to the destination airport. This page can also be used to view information about a selected airport that is not the destination. Procedures for the origin and destination airport can be selected for entry into the flight plan.

The approaches, STARS, profile descents, and transitions are displayed and selected on this page.



1 Page Title

The destination airport identifier is displayed in the title.

Airports with more than 5 runways or STARs produce multiple arrivals pages.

2 Standard Terminal Arrival Routes (STARS)

Upon initial selection, an alphabetical listing of all STARS and profile descents is displayed.

STARS are displayed first in a list under the STAR label. Profile descents are listed after the STARS under the PROF DES label.

Selection of the desired STAR deletes all other STARs and non–applicable approaches/runways, and displays a listing of any arrival transitions applicable to that STAR.

The selection of an approach or runway deletes all STARs not related to that approach/runway.

3 INDEX

Push – displays the DEP/ARR INDEX page.

4 Approaches and Runways (APPROACHES/RUNWAYS)

Upon initial page display, an alphabetical listing of all approaches for the airport, followed by a numerical listing of all runways, is displayed.

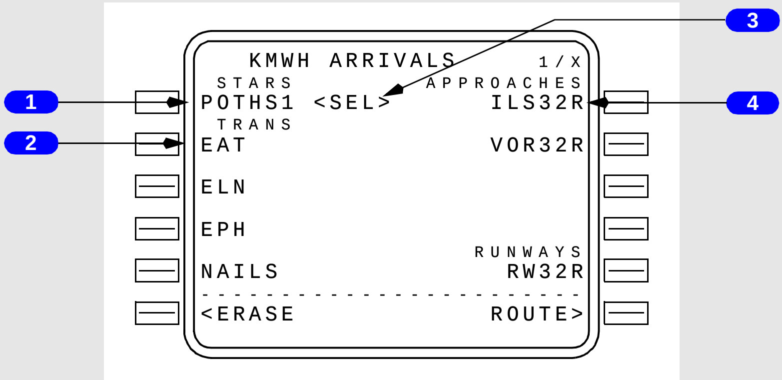
Selection of the desired approach or runway deletes all other approaches/runways.

5 ROUTE

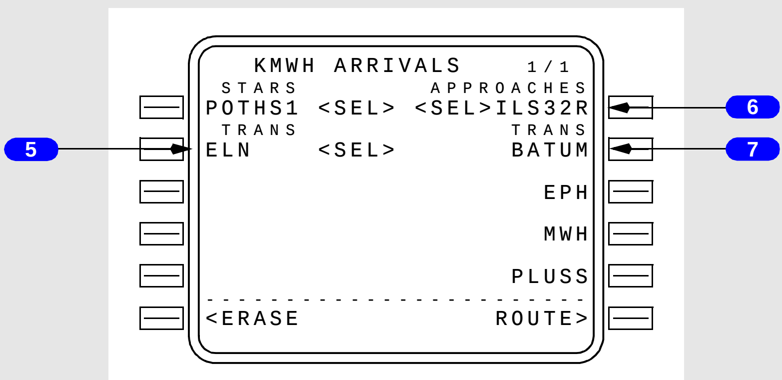
Push – displays the RTE page.

Arrivals Page during approach selection

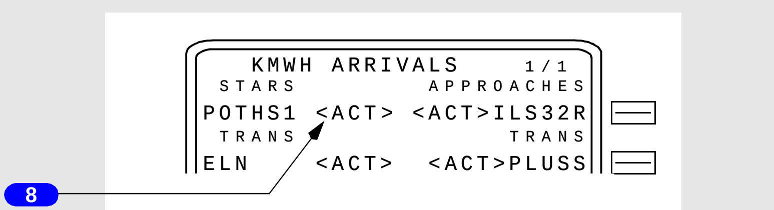
Display after STAR selected



Display after STAR Transition and Approach/Runway selected



Display after executing



1 STARS

Displays the selected STAR.

2 Arrival Transitions (TRANS)

Displays all arrival transitions related to the selected STAR.

3 Selected Status Label (<SEL>)

Identifies arrival/approach procedures or a runway which has been selected for entry into the route, but not executed.

All <SEL> entries propagate to the MOD RTE and MOD RTE LEGS pages for subsequent execution.

4 Approaches and Runways (APPROACHES/RUNWAYS)

Displays all approaches related to the selected STAR, followed by all related runways (unless the desired approach/runway was selected on the initial display).

5 Arrival Transition (TRANS)

Displays the selected arrival transition.

6 APPROACHES

Displays selected approach/runway.

7 Approach Transition (TRANS)

Displays all approach transitions related to the selected approach.

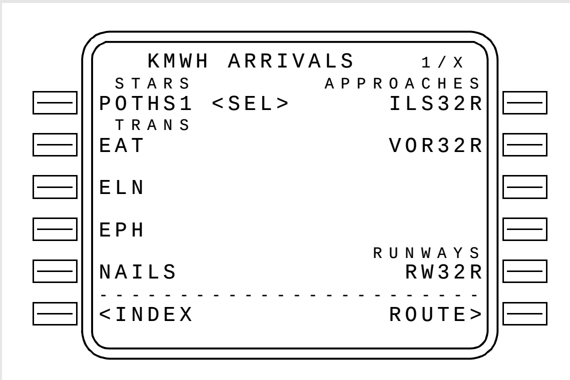
8 Active Status Labels (<ACT>)

Following execution of the selected entries, the arrival/approach procedures and runway are identified as active.

Note: For an existing active route, the execute key illuminates upon STAR or approach/runway selection. Following selections, the ERASE prompt is available. Selections should be executed on the RTE or RTE LEGS pages after linking any route discontinuities.

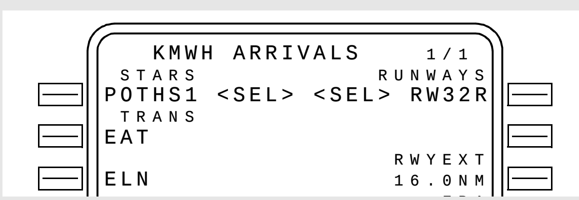
Arrivals Page – Runway Extension Fix

Initial display

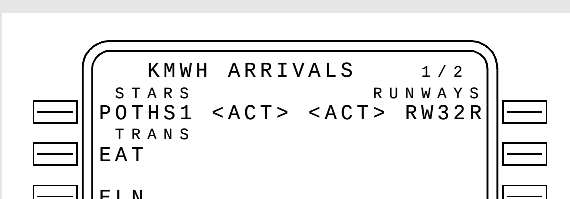


Display after runway 32R selected

Display after runway 32R extension inserted



Display after execution



1 Runway Extension (RWY EXT)

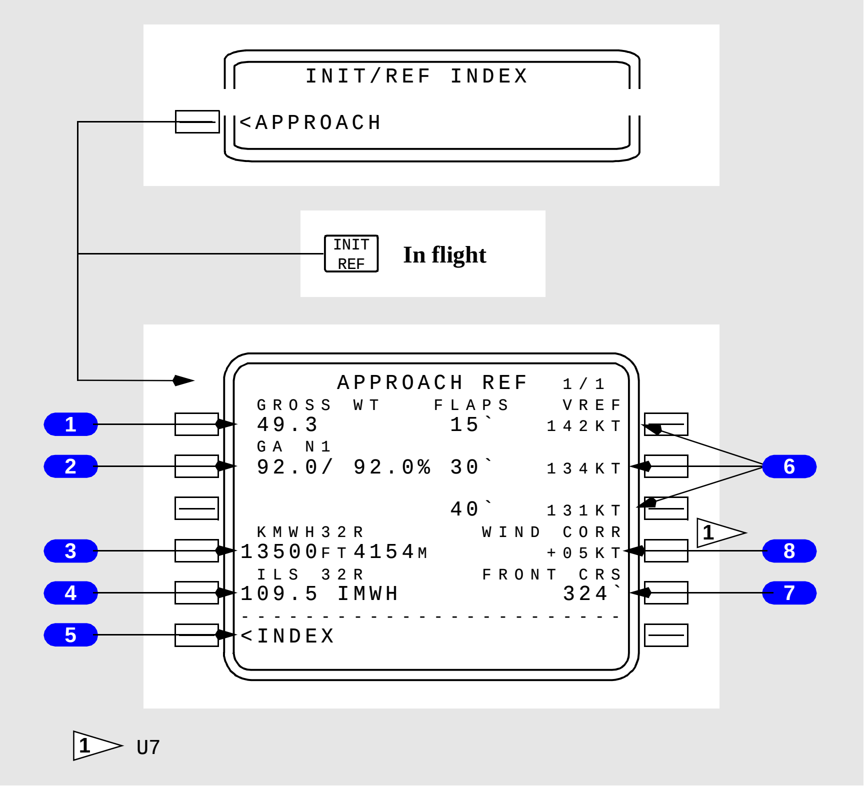
Permits entry of runway extension waypoint following selection of desired runway.

Desired extension distance is entered in scratch pad, then inserted on RWY EXT line. This creates a waypoint on the extended runway centerline at the specified distance from the threshold. Permissible entries are between 1 and 25 NM, in .1 NM increments.

Waypoint is identified on the RTE and RTE LEGS pages as RXYYY, where YYY is the runway designation.

Approach Reference Page

The approach reference page displays approach planning information and approach reference speed (VREF) selection. The displayed data is for the DEST airport and the arrival/approach entered into the FMC flight plan.



1 Airplane Gross Weight (GROSS WT)

Normally displays the FMC calculated airplane gross weight.

A manual entry of gross weight is allowed.

Displays box prompts when gross weight is not available from the FMC.

Valid entry is XXX.X.

Leaving and returning to this page replaces a manually entered weight with FMC computed gross weight.

2 Go–around N1 (GA N1)

Displays the computed N1 go–around limit, based on present pressure altitude, temperature, and bleed configuration.

3 Runway Length

Displays the length of the referenced runway in feet and meters.

Blank if no runway has been entered and executed.

4 ILS Approach

Displays the runway number and associated ILS frequency/identifier for the ILS, LOC, or back course approach in the active flight plan.

Blank if no approach has been executed.

5 INDEX

Push – selects the INIT/REF INDEX page.

6 Vref (FLAPS – – – VREF)

Displays landing Vref for three flap settings as computed by the FMC. Displayed in small size characters.

Double line selection of a displayed Vref, or manual entry of another value, causes Vref to be displayed on the airspeed display. CDU display changes to large size characters.

Speeds are based on displayed gross weights.

(U7) Double line selection provides Vref to be used by VNAV in combination with wind correction.

Vref, once selected, will not be updated. To obtain an updated speed, the current speed must be deleted or a different Vref selected or entered.

7 Front Course (FRONT CRS)

Displays front course for the approach displayed on ILS approach line.

Blank if no ILS approach is selected.

8 Wind Correction (WIND CORR)

Displays current wind correction for approach. Default is +05 knots.

Manual input of desired wind correction may be made up to +20 knots.

Holding

HOLD Page

The hold page is used to enter a holding pattern into the route.

When the flight plan does not have a holding pattern, push the HOLD function key to show the LEGS page with the HOLD AT line.

Two versions of the hold page are possible:

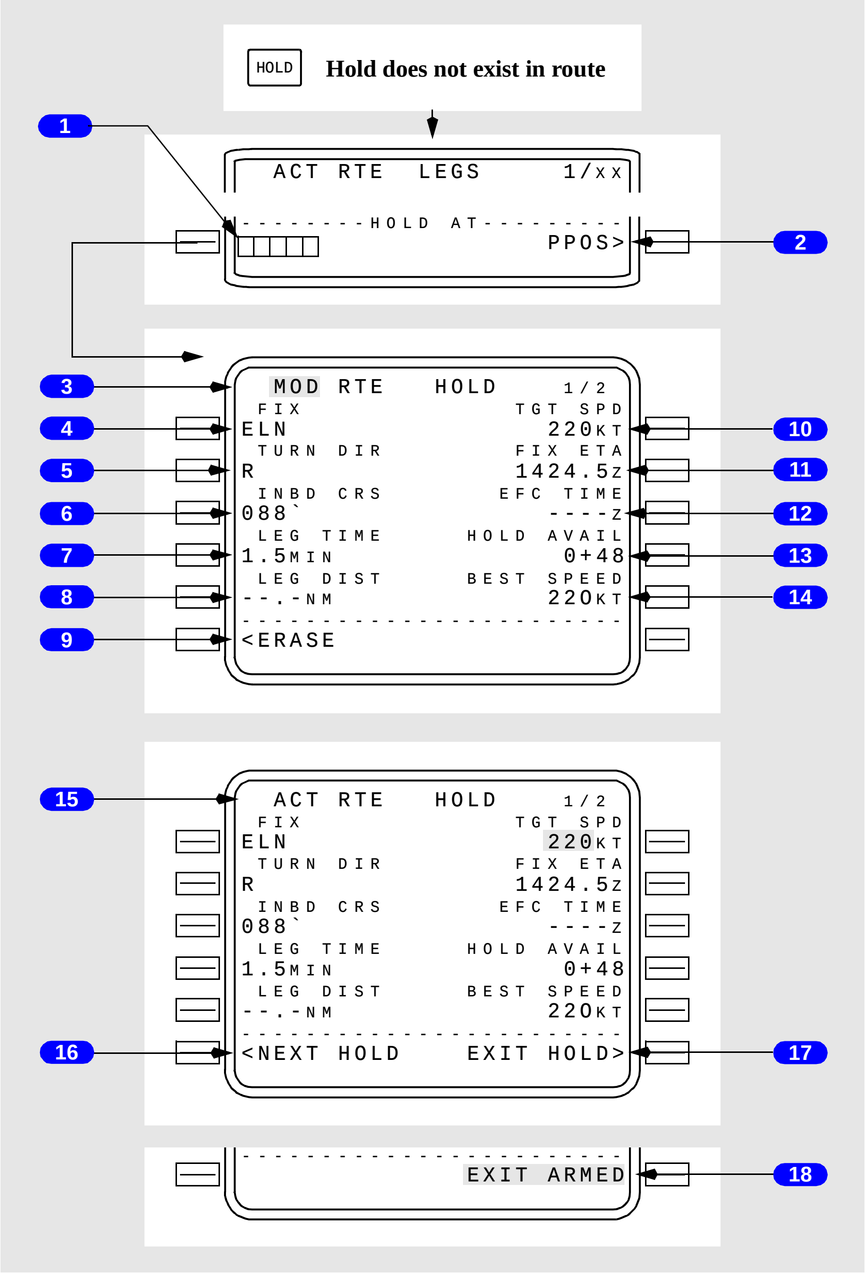
- an airway or procedure holding pattern (from the navigation database)
- a flight crew–entered holding pattern.

The holding page shows actual or default data about the holding pattern.

Entries make route modifications, which can be erased or executed.

Active holding patterns are magenta on the navigation display.

Pushing the HOLD key when a holding pattern already exists in the route displays the hold page for the next hold. Holding parameters can be monitored and changed on this page. Performance predictions assume the hold will be in level flight. New holding patterns are added using the NEXT HOLD prompt. Exit from the holding pattern must be manually initiated.


HOLD
Hold does not exist in route
ACT RTE LEGS 1/XX
--------HOLD AT---------
PPOS>
MOD RTE HOLD 1/2
FIX
ELN
TGT SPD
220KT
TURN DIR
R
FIX ETA
1424.5Z
INBD CRS
088˚
EFC TIME
----Z
LEG TIME
1.5MIN
HOLD AVAIL
0+48
LEG DIST
--.-NM
BEST SPEED
220KT
<ERASE
ACT RTE HOLD 1/2
FIX
ELN
TGT SPD
220KT
TURN DIR
R
FIX ETA
1424.5Z
INBD CRS
088˚
EFC TIME
----Z
LEG TIME
1.5MIN
HOLD AVAIL
0+48
LEG DIST
--.-NM
BEST SPEED
220KT
<NEXT HOLD
EXIT HOLD>
EXIT ARMED
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15
16
17
18

1 HOLD AT

When the HOLD function key is pushed and no holding pattern exists in the route, the LEGS page shows prompts to enter the holding fix. Enter the holding fix to show the RTE HOLD page.

Displays a prompt to enter the holding fix, a route waypoint, or present position.

A waypoint is entered as the holding fix.

2 HOLD AT Present Position (PPOS)

Selects the airplane present position as the holding fix.

3 Modified Route Hold Status

MOD indicates that the holding fix has not been executed.

Execution changes the page title to RTE HOLD (ACT RTE HOLD if holding at PPOS).

4 FIX

Displays waypoint identifier of the holding fix.

Entry is propagated either automatically from the database, or from a manual entry on the HOLD AT page.

If PPOS was selected on the HOLD AT page, then the FMC assigns PPOS as the fix identifier.

5 Turn Direction (TURN DIR)

Displays holding pattern turn direction.

Entry is propagated either automatically from the database, or from a manual entry.

Valid entry is L or R. Manual entry has priority.

If no entry is made, the FMC assumes right (R) turns.

6 Inbound Course (INBD CRS)

Displays holding pattern inbound course.

Entry is propagated either automatically from the database, or from a manual entry.

Valid entry is XXX. Manual entry has priority.

If no entry is made, the FMC assumes the course to be the same as the preceding leg to the fix.

7 LEG TIME

Displays holding pattern leg time.

Valid entry is X.X. Manual entry has priority.

If no entry is made, the FMC assumes the standard times of 1.0 minute at or below 14,000 feet, and 1.5 minutes above 14,000 feet.

If a LEG DIST is manually entered, then dashes will be displayed.

8 Leg Distance (LEG DIST)

Dash prompts are normally displayed.

Entry may be propagated either automatically from the database, or made by manual entry.

Manual entry has priority.

Overrides LEG TIME.

9 ERASE

Displayed only while modification is in progress.

Push – deletes modification and returns to ACT RTE HOLD page, if one exists; otherwise returns to the ACT RTE LEGS page.

10 Target Speed (TGT SPD)

Used for entry and/or display of the holding pattern target airspeed.

If no entry is made, the best speed value is displayed.

Manual entry has priority.

Target speed is propagated to the CLB, CRZ, or DES page three minutes prior to reaching the fix.

Speed is highlighted in reverse video when the RTE HOLD is active.

11 Fix Estimated Time of Arrival (FIX ETA)

Displays computed time for next passage over holding fix.

12 Expect Further Clearance Time (EFC TIME)

Entry of the EFC time will help optimize FMC performance computations.

Computation of destination fuel assumes that departure from the holding fix will occur at this time.

13 Hold Available (HOLD AVAIL)

Displays available holding time in hours + minutes remaining if destination is to be reached with planned fuel reserves as entered on PERF INIT page.

14 BEST SPEED

Displays computed best holding speed based on present altitude and conditions.

Note: May exceed maximum speed permitted by regulatory agency.

15 Active Route Hold Status

ACT indicates that the airplane has entered the holding pattern.

16 NEXT HOLD

Displayed when the route contains less than five holding patterns and there is no route modification in progress.

Push – displays (RTE LEGS) HOLD AT page and prompts for new holding fix entry.

17 EXIT HOLD

Displayed on the holding page when in the holding pattern.

Used when preparing to depart holding pattern.

Push – changes prompt to EXIT ARMED and illuminates execute key.

The EXIT prompt is not available until the next crossing of the holding fix, if the holding pattern is modified while being flown.

18 EXIT ARMED

Displayed on the holding page when in the holding pattern and after line selection of EXIT HOLD prompt.

Execution activates LNAV flight back to the holding fix via a shortened holding pattern, departure from holding pattern, and continued flight along the active route. ACT RTE LEGS page 1/XX appears after holding exited.

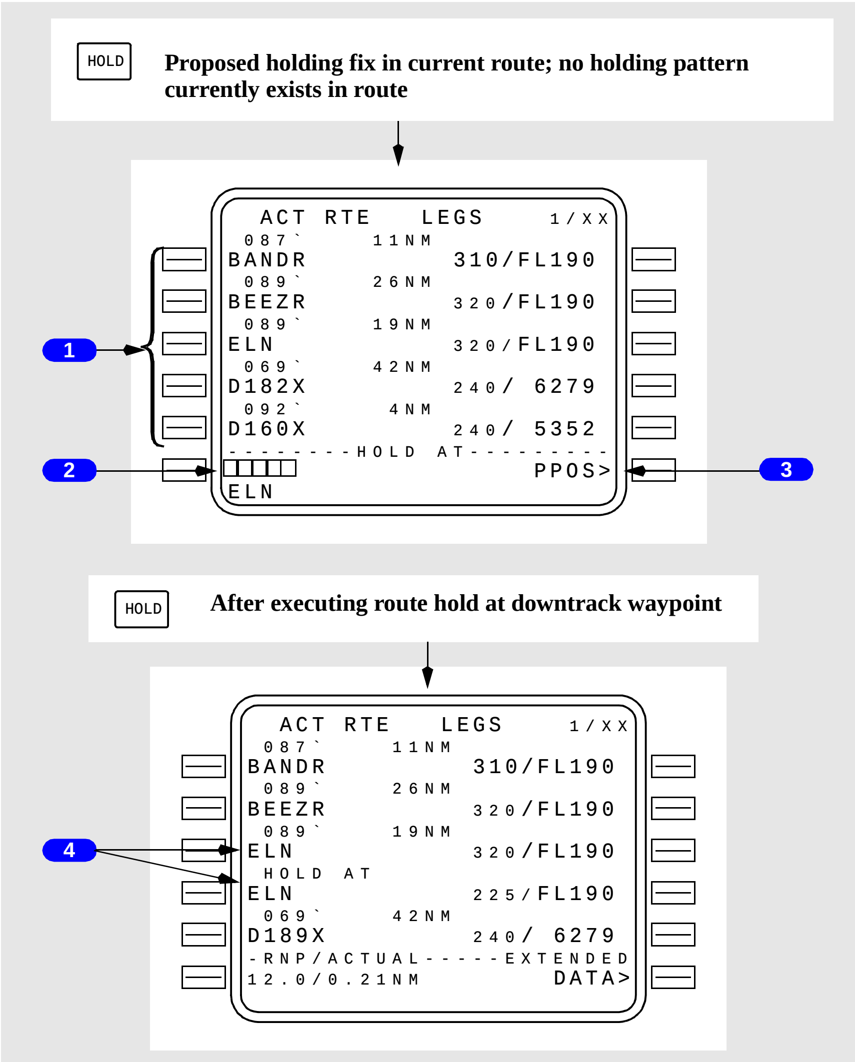
Highlighted in reverse video after execution.

RTE LEGS HOLD AT (Fix in Route)

Used to enter proposed fix for racetrack holding pattern at either present position or any waypoint.

A maximum of five holding patterns may exist at one time.

With U7 FMC, two holding patterns may exist at the same waypoint if one is in the route and the other is in the missed approach.



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.

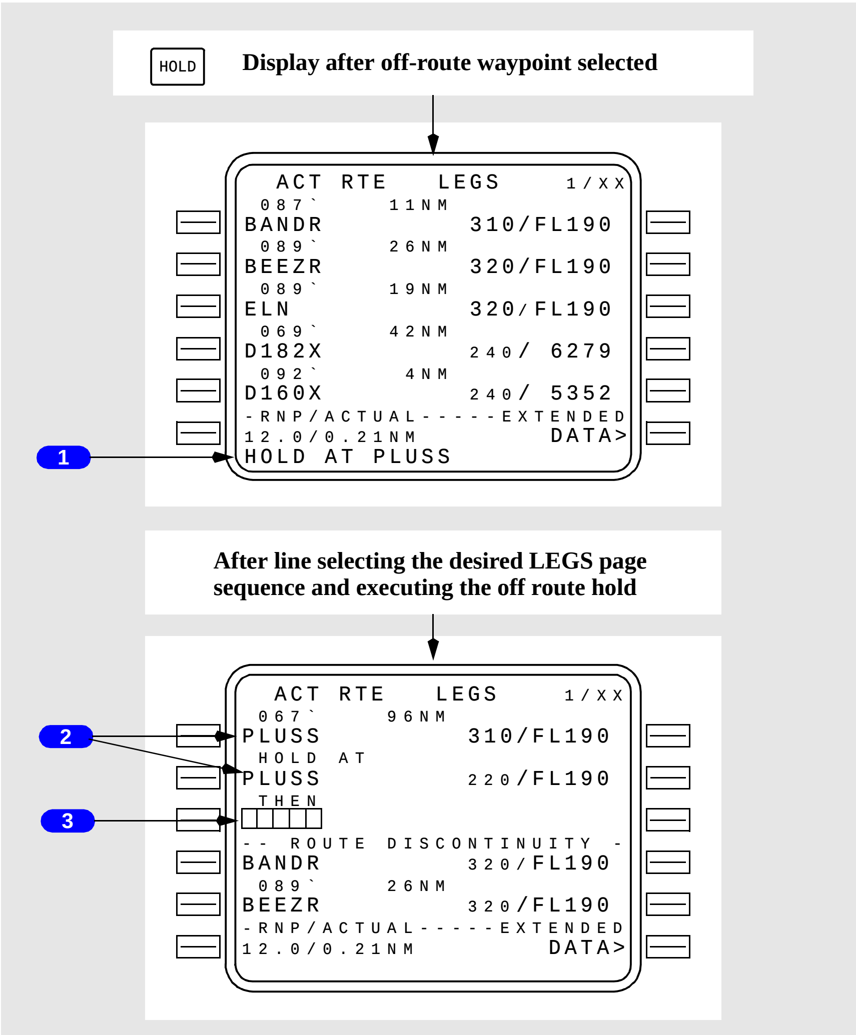
Default parameters are a standard holding pattern on the inbound leg.

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)



1 Hold at Waypoint (HOLD AT XXXX)

Displayed in the scratch pad whenever the entry in the HOLD AT line is not a waypoint in the existing route (the example above depicts entry of PLUSS).

Route position of the holding fix is defined by line selecting to the desired LEGS page sequence.

Following line selection to the desired LEGS page sequence, the MOD RTE HOLD page appears and the execute key illuminates.

2 Hold at Waypoints (HOLD AT)

A holding fix creates a new HOLD AT waypoint following the leg to that waypoint.

Displayed on the RTE LEGS page in the proper route sequence after executing the related MOD RTE HOLD page.

3 ROUTE DISCONTINUITY

The entered route must always form a continuous path of linked legs.

The example depicts a HOLD AT entry where the entry was not a downpath waypoint.

The FMC computes a direct course to the off–route holding fix.

The HOLD AT waypoint becomes a termination identifier which is not part of the existing route. The resulting route discontinuity is identified by box prompts, requiring entries to define the route after PLUSS.

Intentionally
Blank

Flight Management, Navigation — Chapter 11
Alternate Navigation System (ANS) — Section 50

Introduction

This section provides a detailed description of the alternate navigation system (ANS). Information in this section is limited to that which is unique to the ANS; information which is common with the flight management computer system (FMCS) is not repeated.

General

The ANS is an IRS–based system which provides lateral navigation capability independent of the FMCS. The ANS with the control display units (ANCDU) can be operated in parallel with the FMCS, providing an independent crosscheck of FMC/CDU operation. In the event of FMC failure, the ANS provides a backup mode of operation which is immediately available for use.

As does the FMCS, the ANS performs computations related to lateral navigation; it also provides LNAV commands which can be coupled to the AFDS for integrated operation with the flight management system.

System Components

The ANS consists of two separate systems; ANS–Left and ANS–Right. Each system is independent of the other, consisting of its own ANCDU and “on–side” IRS.

During FMC/CDU operation, all memory and computing capability are contained within the FMC. The same information is available for display on either CDU.

During ANCDU operation, each CDU uses its own internal memory and computing capability. Since each ANCDU performs its own computations based on inputs from its own IRS, the information available for display on each CDU is independent of that displayed on the other CDU.

Each pilot has a navigation mode selector, which is used to specify the source (FMC, ANS–L, or ANS–R) of the navigation information being provided to the related EFIS symbol generator and flight director.

If the associated flight control computer (FCC A or FCC B) is the master, then the related navigation mode selector is also the master and determines the source of LNAV commands provided to the autopilot.

Memory

In contrast to the FMC, the ANCDU has neither a performance database nor a permanent nav database. Thus, there is no stored information from which the desired waypoints can be extracted by use of their identifiers. All waypoints in the ANCDU flight plan must be defined in terms of latitude and longitude. The ANCDU has a limited memory which can store up to 20 waypoints. The ANCDU flight plan is then assembled from this memory. Waypoints can be entered into the ANCDU flight plan either during preflight or while in flight. Navaids and airports can also be entered as “waypoints,” as well as certain procedural waypoints (only those defined by latitude and longitude).

If the crew has not entered an ANCDU flight plan, the ANCDU memory automatically stores the active FMC flight plan. This makes a flight plan available for the ANCDU in the event of FMC failure. All waypoints in the ANCDU memory and flight plan are automatically erased at flight completion.

Operation

Overview

When the FMC is operable, the CDUs are used in the normal manner during preflight to activate an FMC flight plan. With the FMC/CDU preflight complete, the IRS LEGS page may be used to crossload (copy) the FMC flight plan into the ANCDU. If executed, the ANCDU flight plan becomes identical to the FMC flight plan (except that the ANCDU bypasses any undefined procedural legs contained in the FMC flight plan). If desired, the flight plan may be modified prior to execution. Additionally, the entire ANCDU flight plan may be entered manually. When entering flight plans into both ANCDUs, note that each flight plan (whether identical or not), must be entered and executed individually.

ANCDU operation requires valid inputs from the related IRS navigation mode for present position, ground speed, track, and wind. Based on the flight plan and IRS inputs, the ANCDU computes and displays courses to fly, leg lengths, estimated time en route, and crosstrack deviation. Associated roll commands are available to the AFDS.

With the FMC operable, the ANCDU can be used to monitor FMCS operation. Note that a CDU can be switched between FMC/CDU and ANCDU page displays as desired, since source selection of control and guidance commands is determined separately by the navigation mode selector.

If the FMC flight plan was crossloaded into the ANCDU, only the first 20 waypoints appear in the initial ANCDU flight plan. However, as the flight progresses, downpath FMC waypoints are automatically added to the ANCDU memory, becoming available for subsequent crossloading into the ANCDU flight plan. Anytime the FMC flight plan is modified, the ANCDU memory is automatically updated with applicable changes.

If the FMC should fail, the IRS PROGRESS page is automatically displayed, and ANCDU LNAV operation is immediately available via the navigation mode selector. If an ANCDU flight plan had not been previously executed, the IRS LEGS page is automatically displayed. The most recent FMC flight plan is stored in the ANCDU memory and can be activated if desired, or a new flight plan may be manually entered. Additional crew entries may be required as the flight progresses, due to the ANCDU limit of 20 waypoints.

Lateral Navigation

All computations and commands from the ANCDU are based on a direct great–circle course between waypoints. Complete departure or arrival/approach procedures cannot be manually entered or crossloaded from the FMC. This is because the ANCDU does not accept “undefined” waypoints/legs, that is, no fixed heading or course legs, and no conditional waypoints. The ANCDU automatically constructs a great–circle course to bypass such legs. However, individual legs of a procedure, if they are great–circle courses, can be manually entered or crossloaded.

Computed courses are referenced to magnetic north for the active leg. Downpath legs are displayed as true courses, because the IRS can provide magnetic variation only for present position.

Vertical Navigation

The ANCDU does not perform computations related to vertical navigation and does not provide VNAV or autothrottle commands. However, an operable FMC can provide thrust limits to the autothrottle during ANCDU LNAV operation. Autothrottle commands are provided by MCP speed and mode selection.

Radio Tuning

The ANCDU cannot tune the VHF navigation radios and does not use radio information for position updating.

Electrical Power

Both ANCDUs are powered via transfer bus No. 1. Response to power loss is the same as for the FMC/CDU, except that the MOD IRS LEGS page is displayed in flight following a power interruption of ten seconds or more.

System Downmoding

The ANS may fail due to either the loss of IRS navigation mode inputs or ANCDU malfunction. If an IRS fails, the IRS transfer switch cannot transfer navigation inputs from the other IRS. If continual self–tests detect a failure, the CDU display is blanked, and LNAV disengages

CDU Messages

There are only four messages associated specifically with ANS operation, all related to CDU entries. See section 11.60.

Waypoints

All waypoints in the ANCDU flight plan must be defined in terms of latitude and longitude.

Waypoint Identifiers

When an FMC flight plan is crossloaded, the ANCDU flight plan maintains the same waypoint identifiers used by the FMC. The associated latitude/longitude of those waypoints is also automatically crossloaded from the FMC.

If manually entering waypoints on the IRS LEGS or IRS WPT DATA pages, the waypoint identifier is limited to a maximum of 6 alpha/numeric characters. Manually entered waypoints are keyed into the scratch pad as any of the following:

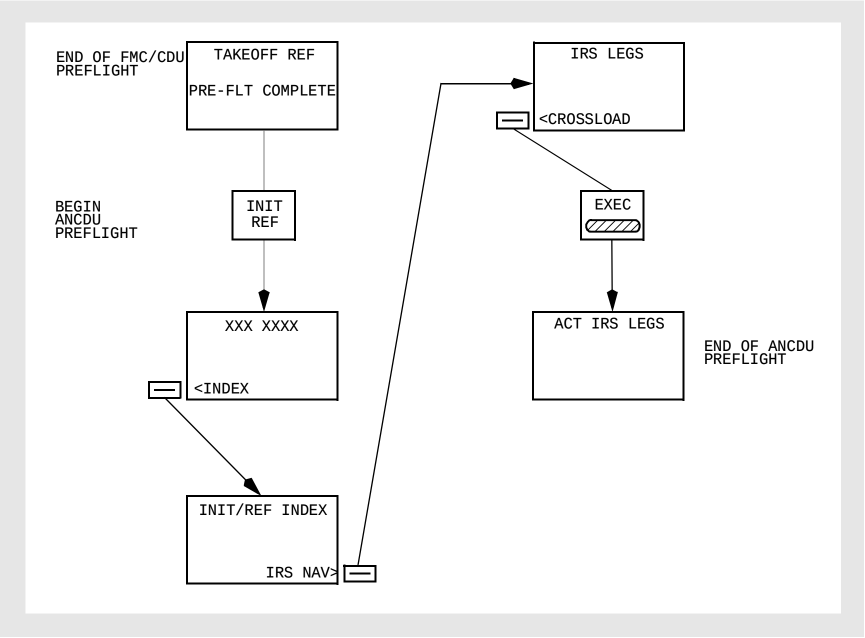
- an identifier which already exists in the ANCDU flight plan (e.g., SEA, KBFI, ELN01, or WPT03).
- a crew–assigned identifier and associated latitude/longitude (e.g., SIMONE/N4802.2W12241.3).
- latitude/longitude (e.g., S3618.5E14136.9). Upon entry, the ANCDU assigns a sequential identifier number such as WPT04, etc.

Preflight

Introduction

Preflight entry of an ANCDU flight plan is accomplished after entry of the FMC/CDU flight plan is complete. The following diagram depicts crossloading of the FMC flight plan into the ANCDU.

Preflight Page Sequence



Page Displays

Introduction

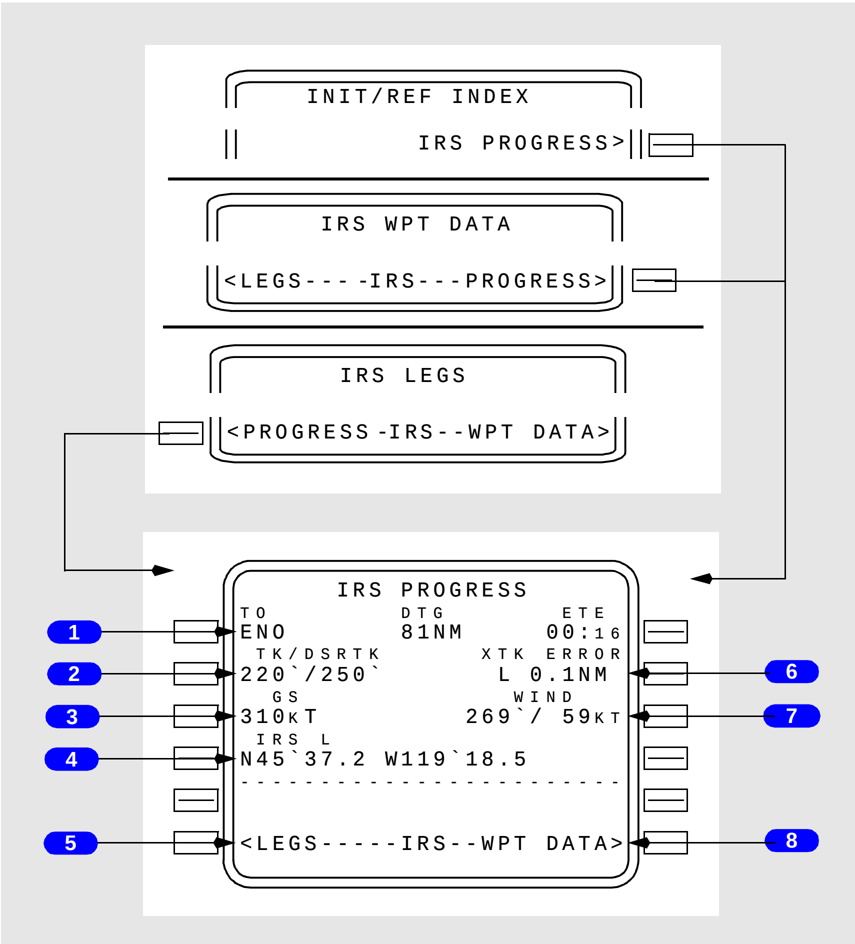
This section provides detailed descriptions and examples of the three page displays which are unique to the ANCDU mode of operation. These page displays are only intended to provide a general description of overall system capability; they are not intended to reflect valid navigational data.

IRS Progress

The IRS PROGRESS page is an advisory page which displays current dynamic data concerning progress along the active ANCDU flight plan route. No entries are permitted.

Page access is as shown. The page is also automatically displayed upon FMC failure when IRS inputs are valid and an active ANCDU flight plan exists.

IRS Progress Page



1 Active (TO) Waypoint Line

Displays:

- identifier of the active waypoint (highlighted in reverse video)
- distance to go (DTG) from present position to the active waypoint
- estimated time en route (ETE) to the active waypoint.

2 Track/Desired Track (TK/DSRTK)

Displays present IRS magnetic track/desired magnetic track (i.e., the flight plan great–circle course).

3 **Groundspeed (GS)**

Displays current IRS ground speed in knots.

4 **IRS Present Position**

Displays latitude and longitude of IRS present position.

Data is from the "on–side" IRS (L or R).

All displays on this ANCDU are based on inputs from this IRS.

5 **IRS LEGS**

Allows selection of IRS LEGS page 1.

6 **Cross–Track Error (XTK ERROR)**

Displays present deviation (NM left or right) from the DSRTK flight plan course.

7 **WIND**

Displays present IRS true wind direction and speed in knots.

8 **IRS Waypoint Data (WPT DATA)**

Allows line selection of IRS WPT DATA page 1.

IRS Legs

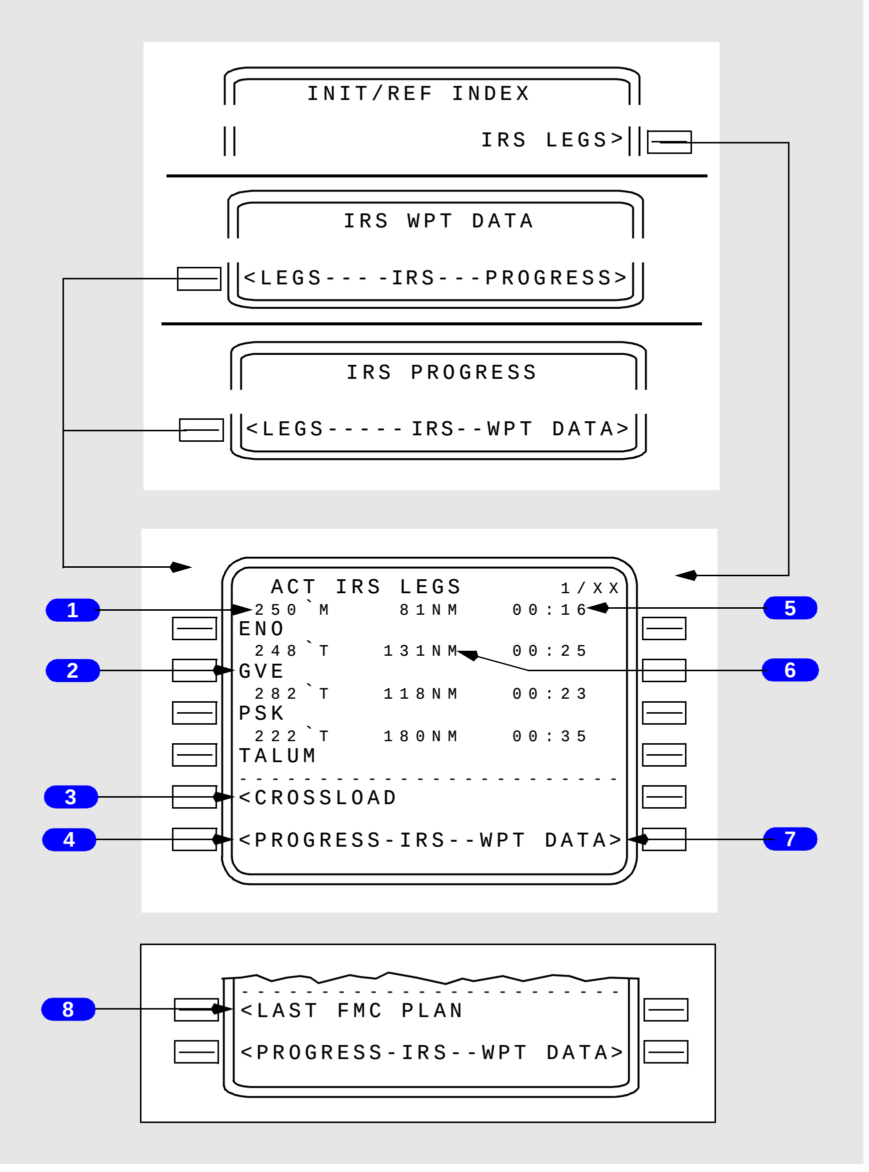
The IRS LEGS page displays details of the ANCDU flight plan (20 waypoints maximum). It has no required entries.

The page allows review of the crossloaded FMC flight plan, or it may be used to enter or modify a unique ANCDU flight plan.

The flight plan is cleared at flight completion.

Page access is as shown. The page is also displayed automatically upon FMC failure when IRS inputs are valid and an active ANCDU flight plan does not exist.

IRS Legs Page



1 Leg Direction

Applies to the leg going to the waypoint identified on the line below.

Displays the IRS computed great–circle course. For the active waypoint, the displayed course is the present magnetic course to be flown. For all downpath waypoints, displayed course is the initial true course for that leg.

2 Waypoint Identifier (lines 1L–4L)

Used for entry and/or display of any valid waypoint identifier.

Entry may be made via the keyboard or propagated from either the RTE LEGS page or IRS WPT DATA page.

Entries are propagated to the IRS WPT DATA pages.

The active waypoint identifier is highlighted in reverse video. It cannot be deleted, but it can be overwritten.

3 Crossload

Used to crossload (copy) the FMC flight plan into the ANCDU.

If there is no flight plan in the ANCDU, initial lines selection displays the FMC flight plan which is proposed to be stored in the ANCDU.

If an ANCDU flight plan already exists, line selection changes the page title to MOD.

Line selection “arms” the execution function, and the EXEC light illuminates. Subsequent execution activates the ANCDU flight plan (page title change to ACT).

Upon FMC failure, the CROSSLOAD prompt is replaced by the LAST FMC PLAN prompt.

4 IRS Progress

Allows selection of the IRS PROGRESS page.

5 Estimated Time En route

Applies to the leg going to the waypoint identified on the line below. Displayed only when ground speed exceeds 210 knots.

For the active waypoint, displays time–to–go to the active waypoint.

For all downpath waypoints, displays estimated time en route for that leg.

6 Leg Length

Applies to the leg going to the waypoint identified on the line below.

For the active waypoint, displays computed distance–to–go from present position to the waypoint.

For all downpath waypoints, displays flight plan leg length.

Blank if distance–to–go is greater than 9,999 NM.

Displayed values are in tenths of miles if the leg length is less than 10 NM.

7 IRS Waypoint Data

Allows selection of the corresponding IRS WPT DATA page.

8 Last FMC Plan

Displayed upon FMC failure.

Line selection displays the FMC flight plan which existed at the time of FMC failure. The EXEC key illuminates.

Subsequent execution activates the ANCDU flight plan.

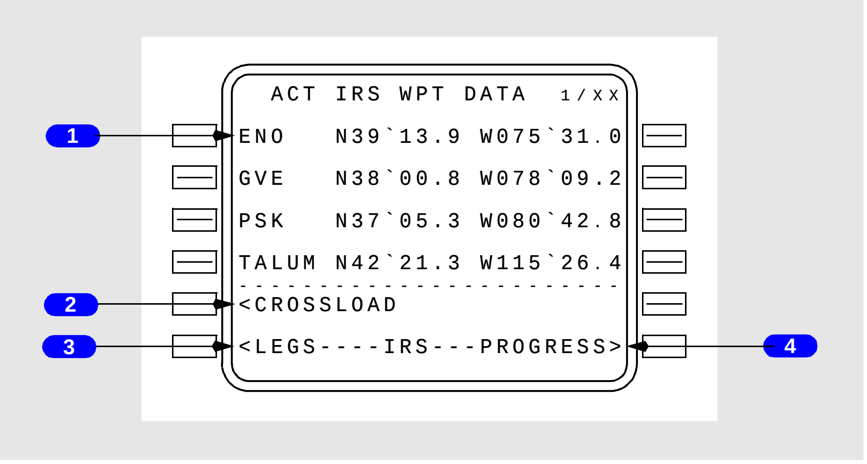
IRS Waypoint Data

The IRS WPT DATA page displays latitude and longitude for each waypoint in the ANCDU flight plan (20 waypoints maximum). It has no required entries.

The page can be used to enter or modify the ANCDU flight plan.

Page access is from IRS PROGRESS page or IRS LEGS page.

IRS Waypoint Data Page



1 Waypoint Line (lines 1L–4L)

Used for entry and/or display of any valid waypoint identifier and the associated latitude and longitude.

Entry may be via the keyboard or propagated from either the RTE LEGS page or the IRS LEGS page.

Entries are propagated to the IRS LEGS pages.

The active waypoint cannot be deleted, but it can be overwritten.

2 Crossload

Functions the same as on IRS LEGS page.

3 IRS Legs

Allows selection of the IRS LEGS page.

4 IRS Progress

Allows selection of the IRS PROGRESS page.

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Introduction

FMC messages tell the flight crew when system operation is degraded or if there are data input errors.

FMC messages show in the CDU scratchpad. The messages are categorized as:

- alerting messages
- entry error messages
- advisory messages.
- ANCDU advisory messages

The FMC messages are shown according to their level of importance. Alerting messages are most important, followed by entry error messages. Advisory messages are least important. If multiple messages exist, a less important message replaces another message in the scratchpad when the CLR key is pushed or the condition is corrected.

The amber FMC alert light on each pilot's instrument panel illuminates when there is an FMC alerting message. All FMC messages illuminate the CDU message (MSG) light. Clear the message or correct the condition to cancel the message.

The following tables are general lists; some messages may not apply to all FMC configurations.

FMC Alerting Messages

These messages relate to operationally significant conditions which affect FMC operation.

FMC alerting messages:

- are shown in the CDU scratchpad
- cause the amber FMC alert light on each pilot's instrument panel to illuminate
- illuminate message lights (MSG) on both CDUs.

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
CHECK FLIGHT PLAN	The FMC has found and corrected an error in the nav database.	Check the flight plan and correct if necessary.
CHECK ALT TGT	U10.5 and later: VNAV disengages while airplane is between MCP and FMC altitudes or VNAV button pressed while airplane is between MCP and FMC altitudes.	Clear the message.
CRZ ALT CHANGED TO XXXXX	U10.4 and later: During a missed approach a STAR or approach has been selected that conflicts with the cruise altitude.	Clear the message.
CYCLE IRS OFF–NAV	IRS is unable to complete alignment under current conditions.	Cycle IRS mode selector to “OFF” and back to “NAV”.
DATA BASE INVALID	The automatic validity test of the permanent navigation database has failed.	Advise maintenance personnel to check the FMC and reload the database, as required. If desired, consider the use of the temporary nav database.

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 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.
DUAL FMC OP RESTORED	Dual FMC operation has been successfully restored. (Dual FMC 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: An engine-out SID has been automatically inserted into the flight plan as a modification.	Clear the message.
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.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
FMC APP MODE UNAVAIL–GP	U10.5 and later: An approach that utilizes FMC generated glidepath is in the flight plan (active or inactive) but the final approach angle check has failed.	Select an alternate approach. Clear the message.
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.	Select G/S OFF on the APPROACH REF page or set a G/S compatible approach in the active flight plan. Clear the message.
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.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
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.
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.
OFP MISCOMPARE	Primary FMC has detected a discrepancy between its software and that of the secondary FMC.	Contact maintenance personnel.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
OVERSPEED DISCONNECT	U10.1 and earlier: During path descent and below the speed restriction altitude, VNAV disengages when airspeed exceeeds 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 the 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).
PERF DEFAULTS INVALID	Validity check of performance defaults database has failed.	Contact maintenance personnel.
PROGRAM PIN MISCOMPARE	Primary FMC has detected a discrepancy between its program pin configuration and that of the secondary FMC.	Contact maintenance personnel.
RESET MCP ALT	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.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
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.
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 the frequency scanning DME radio have failed.	Clear the message and check position. Radio updating of FMC position is not available.
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

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
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.
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.

ALERTING MESSAGE	CAUSE	CORRECTIVE ACTION
UNABLE REQD NAV PERF – RNP	U7.1 – 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.	Refer to FMC Navigation Check supplementary procedure.
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.

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.
VERIFY VERT RNP	U10.5 and later: During an active descent with CDS LNAV/VNAV deviation scales enabled, a manually entered vertical RNP is greater than the default vertical RNP.	Clear CDU message. Enter appropriate vertical RNP.
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.

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
NO OFFSET AT LEG XXXXX (waypoint)	Attempted entry of a lateral offset start or end waypoint XXXXXX that is not offsetable (lateral offset as installed).	Clear the message and amend the route.
NOT IN DATA BASE	FMC does not contain the required data for the entered identifier.	Clear the message and check data entry, or enter the required information into the supplemental or temporary navigation database via the NAV DATA pages.
NOT IN FLIGHT PLAN	RTA waypoint or lateral offset (as installed) start/end waypoint entry is not in active flight plan.	Clear the message and amend the entry.
ROUTE FULL	Entry of more than maximum allowed number of waypoints or holding patterns attempted.	Clear the message and review existing and desired waypoints and holding patterns for possible deletion.
SUPP RTE DATA BASE FULL	U10.3 and later: Attempted save of the 11th supplemental flight plan.	Clear the message, delete unneeded supplemental flight plans and re-attempt entry.

FMC Advisory Messages

These messages relate to FMC status. FMC advisory messages:

- are shown in the CDU scratchpad
- illuminate message lights (MSG) on both CDUs.

Use the CLR key or correct the condition responsible for the message to remove the message. The message is temporarily removed from the scratchpad when manually entering data. The message returns when the data is removed from the scratchpad.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
ABOVE MAX CERT ALT	The airplane is above its maximum certified altitude.	Descend to an altitude below the maximum certified altitude.
APPRCH VREF NOT SELECTED	Airplane has transitioned into approach environment and Vref has not been selected on APPROACH REF page.	Select Vref on APPROACH REF page.
ARR N/A FOR RUNWAY	Runway or approach does not match the selected arrival procedure.	Go to the ARRIVALS page and modify selection.
BUFFET ALERT	Current conditions result in a maneuver margin less than specified.	Bring the airplane back within the operating envelope.
CHECK FMC FUEL QUANTITY	The FMC has detected an unexpected drop in the fuel quantity.	Check the fuel system gauges for correctness.
DES PATH UNACHIEVABLE	When in path descent and above the path, the FMC predictions show the profile restrictions at the next waypoint cannot be achieved (LNAV remains engaged).	Modify the restrictions.
DRAG REQUIRED	Airspeed is 10 kts or more above FMC target speed or within 5 kts of Vmo/Vmmo.	Use speedbrakes, trim or reduced thrust, as required, to bring the airplane within 5 kts of FMC target speed.
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. U10.5 and later: A change in the expected approach is made with an FCC approach mode armed or engaged.	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.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
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.
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	FMC operation cannot take airplane away from the AFDS MCP altitude.	Select a MCP altitude value in the proper direction (higher for climb, lower for descent).
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.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
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.
UNABLE CRZ ALT	FMC predicts that the airplane cannot reach the new CRZ ALT due to performance limitations. FMC predicts that no cruise time is possible at the entered CRZ ALT.	Clear the message and review the CRZ ALT selection. 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.
VERIFY VERT RNP VALUE	U10.5 and later: With CDS LNAV/VNAV deviation scales enabled, a manually entered vertical RNP is greater than the default vertical RNP or manually entered vertical RNP is less that vertical ANP.	Clear the message. Change or delete the manually entered RNP.

ADVISORY MESSAGE	CAUSE	CORRECTIVE ACTION
V SPEEDS UNAVAILABLE	FMC cannot compute V speeds (as installed) due to unreasonable inputs on the RTE, PERF INIT, or TAKEOFF REF pages.	Correct inputs that affect V speed computation.
XXXX (airport identifier)	A REF AIRPORT is entered on the POS INIT page and no entry of ORIGIN yet appears on RTE page 1.	Enter the airport identifier on the ORIGIN data line.
XXXXX (MCP altitude value)	With the CRZ page displayed, resetting the AFDS MCP altitude to a value different from the CRZ ALT causes the value to appear in the scratch pad.	Enter the MCP altitude value on the appropriate target altitude data line.

ANCDU Messages

These messages relate to incorrect scratch pad entries or to flight plan status and are unique to ANCDU operation.

ANCDU Entry Error Messages

ENTRY ERROR MESSAGE	CAUSE	CORRECTIVE ACTION
INVALID ENTRY	Invalid format or range for selected data field.	Clear message and reenter the data correctly.
ROUTE FULL	Attempted entry of more than 20 waypoints.	Clear message. Review flight plan for possible deletions or wait until less than 20 waypoints remain in flight plan.
WAYPOINT NOT DEFINED	Entered waypoint identifier does not have a known position.	Reenter waypoint with a valid latitude and longitude.
WPT PREVIOUSLY DEFINED	Attempted entry of an existing waypoint identifier using a position different from existing waypoint position.	Delete previous waypoint identifier and reenter or rename new waypoint identifier.

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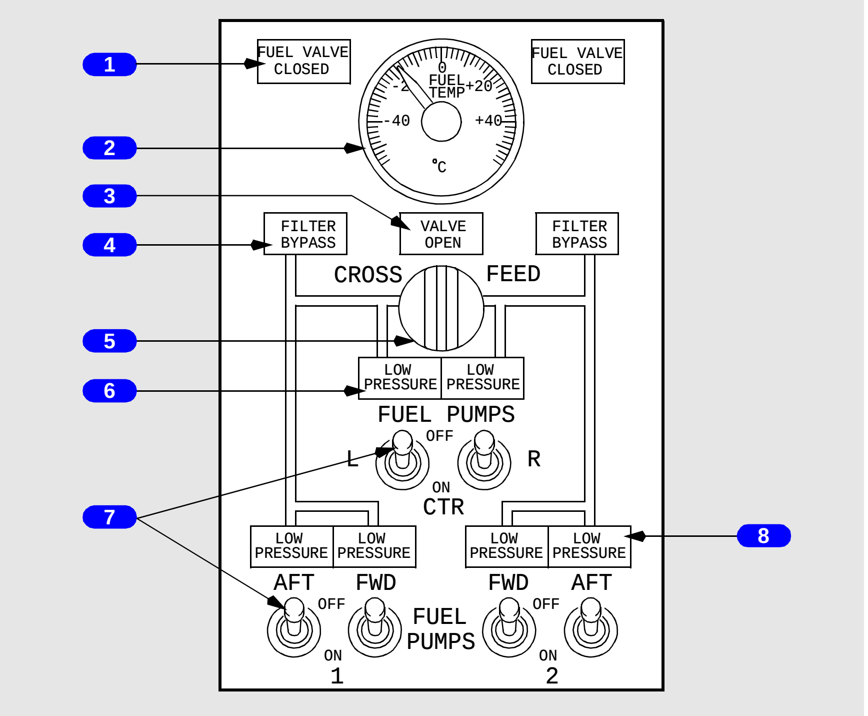
Fuel Control Panel



FORWARD OVERHEAD PANEL

1 FUEL VALVE CLOSED Light

Extinguished – related engine fuel shutoff valve is open.

Illuminated (blue) –

- bright – related fuel shutoff valve is in transit, or valve position and engine start lever or engine fire warning 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.

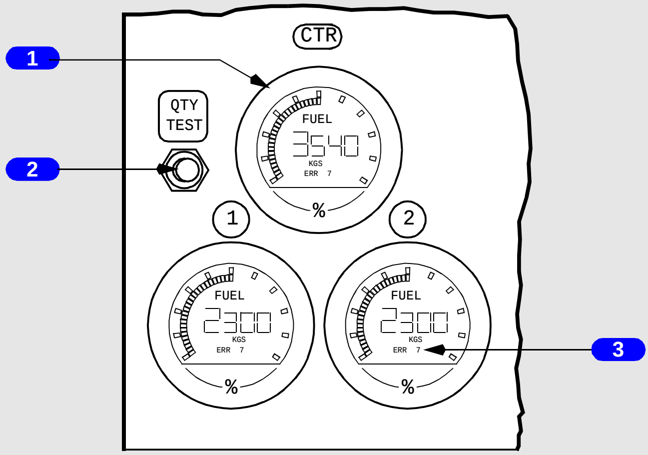
8 Main Tank Fuel Pump LOW PRESSURE Light

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.

Fuel Quantity Indications



CENTER INSTRUMENT PANEL

1 Fuel Quantity Indicator

- indicates usable fuel in the related tank
- accuracy is within 2 1/2% of full scale reading
- standby AC power is required.

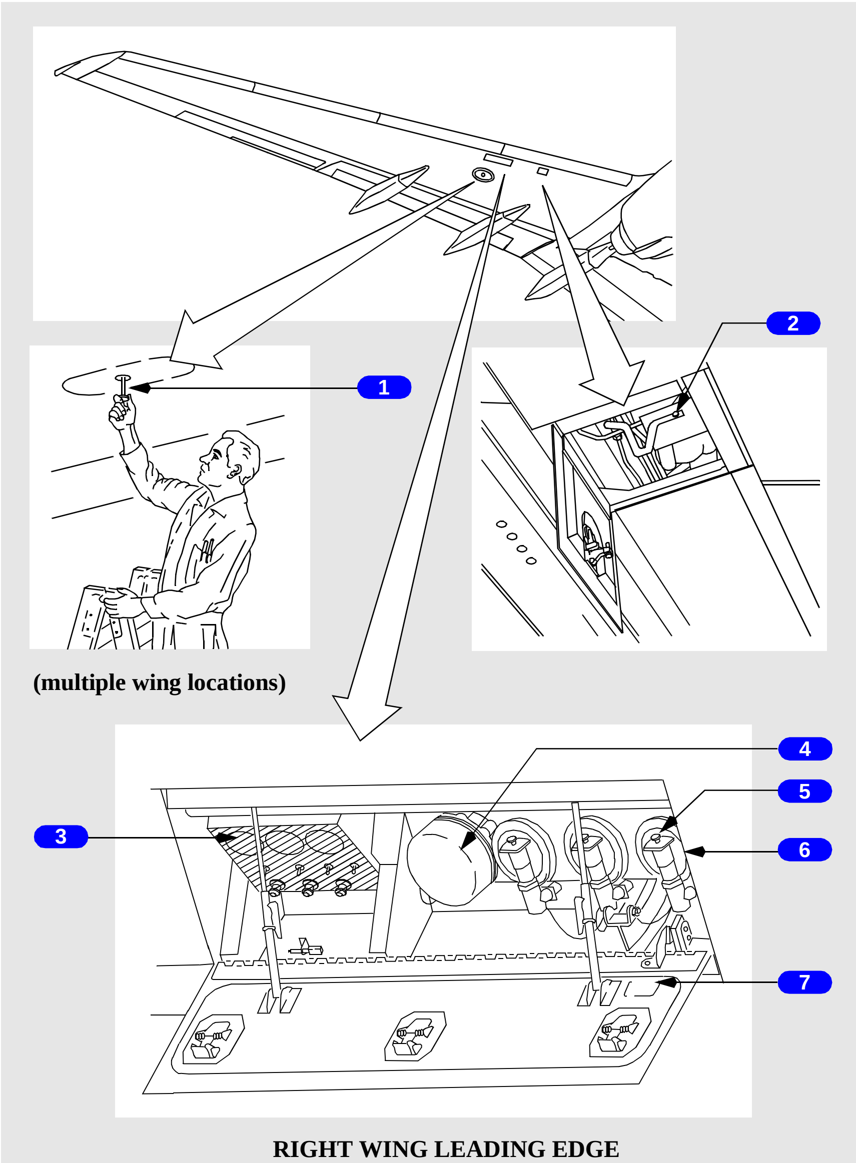
2 Fuel Quantity Test (QTY TEST) Switch

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



1 Fuel Measuring Stick

Allows comparison of fuel quantity or weight as determined from measuring stick reading and fuel weight indicated by fuel quantity indicators.

- five fuel measuring sticks are installed in each main tank
- reading is obtained by withdrawing the flexible floatstick scale from the tank until the scale “sticks” or “hangs.”
- floatstick indication is read from the floatstick scale level with the lower wing skin and corrected for airplane attitude via conversion/correction tables

2 Manual Defueling Valve

Open – interconnects engine feed system and fueling station for:

- defueling
- ground transfer of fuel.

Closed – isolates engine feed system from fueling station.

3 TEST GAUGES & FUELING Panel

4 Fueling Receptacle

Hose connection receptacle for single point underwing fueling.

5 Solenoid Override

Mechanically opens solenoid operated valve. Fuel valve opens if fuel pressure is available.

6 Fueling Valves

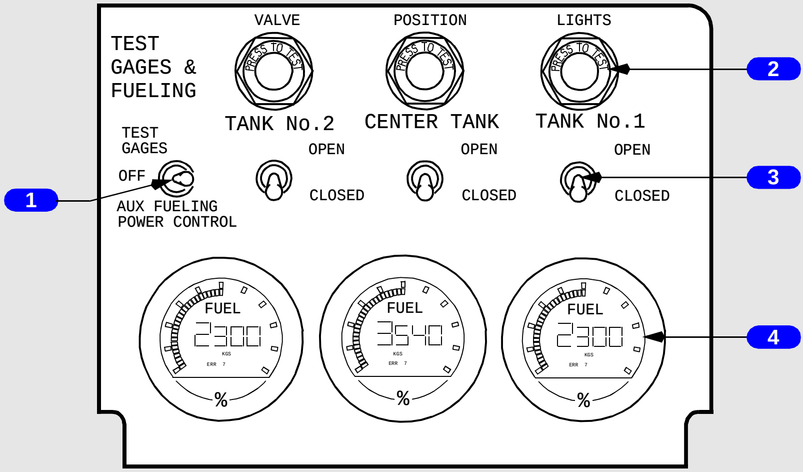
With battery switch ON, fuel pressure opens valve, if energized.

7 Fueling Power Control Switch

Door closed – proximity sensor deactivates power to fueling system.

Door open – the fueling system is powered and panel lights illuminate.

Test Gauges & Fueling Panel



RIGHT WING LEADING EDGE

1 TEST GAUGES & FUELING Switch

(spring–loaded to OFF position)

TEST GAUGES – checks operation of fuel quantity indicators.

AUX FUELING POWER CONTROL – energizes the fueling system if the fueling power control switch fails to activate the system when the door is open.

2 Fueling VALVE POSITION LIGHTS

Extinguished –

- fueling valve switch is OPEN and related tank is full
- fueling valve switch is CLOSED.

Illuminated (blue) – fueling valve switch is OPEN and related tank is not full.

3 Fueling Valve Switches

OPEN – energizes fueling valve in related tank.

CLOSED – de–energizes fueling valve in related tank.

4 FUEL Quantity Indicators

Indicates total usable fuel tank quantity in related tank.

Introduction

The fuel system supplies fuel to the engines and the APU. Fuel is contained in three tanks located within the wings and wing center section.

Refer to Engine and APU chapter for a description of the engine and APU fuel systems.

Fuel Feed

Both engines are normally pressure fed from the center tank until the center tank quantity decreases to near zero. The engines are normally then pressure fed from their respective main tanks. Check valves are located throughout the fuel system to ensure the proper direction of fuel flow and to prevent transfer of fuel between tanks.

Fuel Pumps

Each fuel tank uses two AC powered fuel pumps which are fuel cooled and lubricated. Center tank check valves open at a lower pressure than do the main tank check valves. This ensures that center tank fuel is used before main tank fuel, even though all fuel pumps are operating. Individual pressure sensors monitor the output pressure of each pump.

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 warning 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 usable fuel quantity in each tank. The fuel quantity in each tank is displayed on the center instrument panel and on the fueling station panel.

Fuel Tank Location and Capacities (Usable Fuel)

Main tanks No. 1 and No. 2 are integral with the wing structure. The center tank lies between the wing roots within the fuselage area and extends out into the wing structure.

These figures represent approximate amounts of usable fuel. The appropriate weight and balance control and loading manual gives exact figures for all conditions.

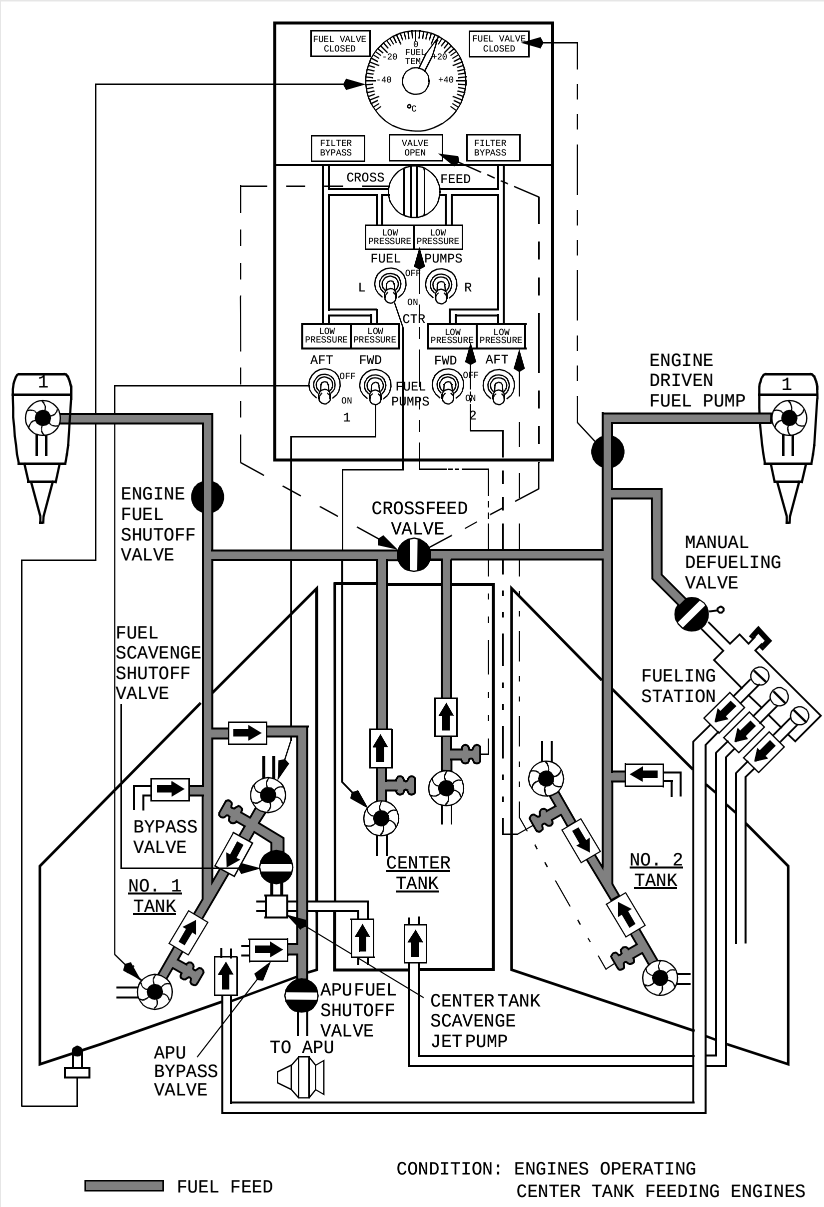
TANK	GALLONS	POUNDS*
NO. 1	1,499	10,043
NO. 2	1,499	10,043
CENTER	2,313	15,497
TOTAL	5,311	35,583

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

TANK	LITERS	KILOGRAMS*
NO. 1	5,674	4,555
NO. 2	5,674	4,555
CENTER	8,755	7,029
TOTAL	20,103	16,139

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

Fuel Schematic



Hydraulics — Chapter 13
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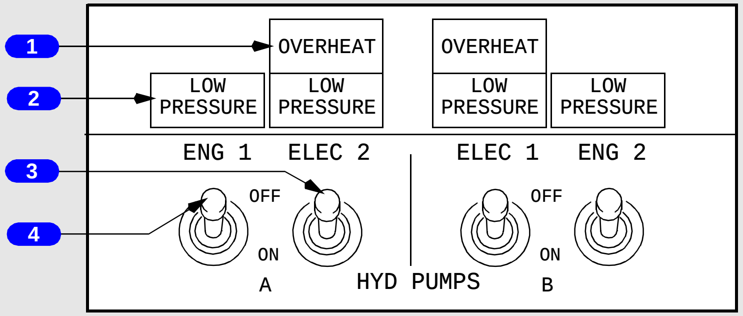
Hydraulic Panel



FORWARD OVERHEAD PANEL

1 Electric Hydraulic Pump OVERHEAT Lights

Illuminated (amber) – associated electric motor–driven pump has overheated.

2 Hydraulic Pump LOW PRESSURE Lights

Illuminated (amber) – output pressure of associated pump is low

Note: When an engine fire warning 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.

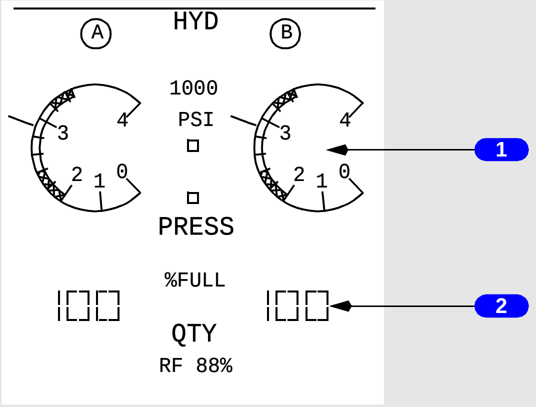
4 ENGINE HYDRAULIC PUMPS Switches

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



CENTER INSTRUMENT PANEL

1 HYDRAULIC System PRESSURE Indications

Indicates system pressure:

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

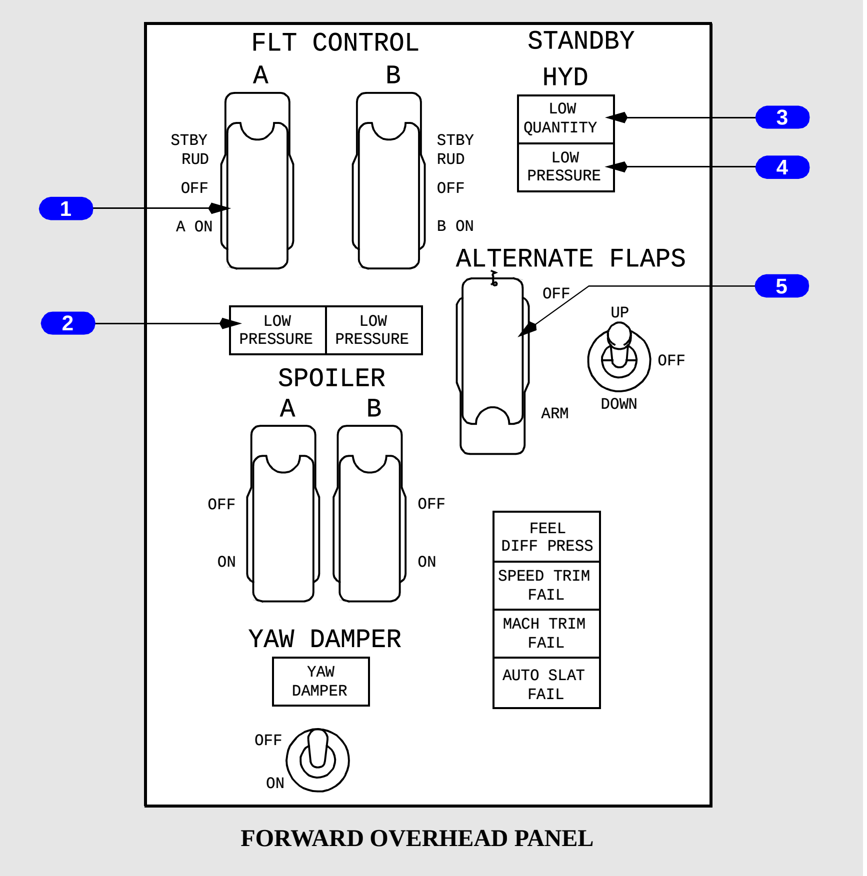
Note: When both pumps for a system are OFF, respective pointer reads zero.

2 HYDRAULIC System QUANTITY Indications

Indicates digital percentage (0% to 104%) of hydraulic quantity (green).

Note: Refill condition of 88% is valid only when airplane is on the ground.

Flight Control Panel



FORWARD OVERHEAD PANEL

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 FLIGHT CONTROL switch is positioned to STBY RUD and standby rudder shutoff valve opens.
- on airplanes with the rudder pressure reducer installed, the A system light indicates A system pressure is low when normal system pressure is commanded.

Note: On airplanes with the rudder pressure reducer installed, 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.

Introduction

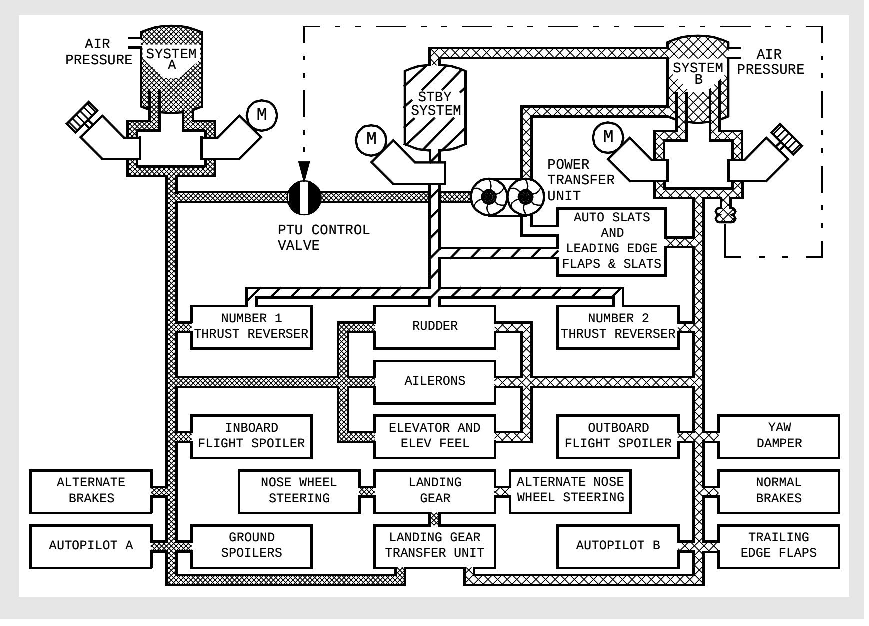
The airplane has three hydraulic systems: A, B and standby. The standby system is used if system A and/or B pressure is lost. The hydraulic systems power the following airplane systems:

- flight controls
- leading edge flaps and slats
- trailing edge flaps
- landing gear
- wheel brakes
- nose wheel steering
- thrust reversers
- autopilots

Either A or B hydraulic system can power all flight controls with no decrease in airplane controllability.

Each hydraulic system has a fluid reservoir located in the main wheel well area. System A and B reservoirs are pressurized by bleed air. The standby system reservoir is connected to the system B reservoir for pressurization and servicing. Pressurization of all reservoirs ensures positive fluid flow to all hydraulic pumps.

Hydraulic Power Distribution Schematic



A and B Hydraulic Systems

Components powered by hydraulic systems A and B are:

System A

- ailerons
- rudder
- elevator and elevator feel
- flight spoilers (one on each wing)
- ground spoilers
- alternate brakes
- No. 1 thrust reverser
- autopilot A
- normal nose wheel steering
- landing gear
- power transfer unit (PTU)

System B

- ailerons
- rudder
- elevator and elevator feel
- flight spoilers (one on each wing)
- leading edge flaps and slats
- normal brakes
- No. 2 thrust reverser
- autopilot B
- alternate nose wheel steering
- landing gear transfer unit
- autoslats
- yaw damper
- trailing edge flaps

A and B Hydraulic System Pumps

Both A and B hydraulic systems have an engine–driven pump and an AC electric motor–driven pump. The system A engine–driven pump is powered by the No. 1 engine and the system B engine–driven pump is powered by the No. 2 engine. An engine–driven hydraulic pump supplies approximately four times the fluid volume of the related electric motor–driven hydraulic pump.

The ENG 1 (system A) or ENG 2 (system B) pump ON/OFF switch controls the engine–driven pump output pressure. Positioning the switch to OFF isolates fluid flow from the system components. However, the engine–driven pump continues to rotate as long as the engine is operating. Pulling the engine fire warning 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 (1676 Lbs) in the related main tank.

Pressure switches, located in the engine–driven and electric motor–driven pump output lines, send signals to illuminate the related LOW PRESSURE light if pump output pressure is low. A check valve, located in each output line, isolates the related pump from the system. The related system pressure transmitter sends the combined pressure of the engine–driven and electric motor–driven pumps to the related hydraulic system pressure indication.

System A Hydraulic Leak

If a leak develops in the engine–driven pump or its related lines, a standpipe in the reservoir prevents a total system fluid loss. With fluid level at the top of the standpipe, the reservoir quantity displayed indicates approximately 22% full. System A hydraulic pressure is maintained by the electric motor–driven pump.

If a leak develops in the electric motor–driven pump or its related lines, or components common to both the engine and electric motor–driven pumps, the quantity in the reservoir steadily decreases to zero and all system pressure is lost.

System B Hydraulic Leak

The system B reservoir has two standpipes. One standpipe supplies fluid to the engine–driven pump and the other to the electric motor–driven pump. If a leak develops in the engine–driven pump or its associated lines, the system B quantity decreases until it indicates approximately 40% full. System pressure is maintained by the electric motor–driven pump. If a leak develops in the electric motor–driven pump or its associated lines, system B pressure is lost. However, fluid remaining in the system B reservoir is sufficient for power transfer unit operation.

A leak in system B does not affect the operation of the standby hydraulic system.

Power Transfer Unit

The purpose of the PTU is to supply the additional volume of hydraulic fluid needed to operate the autoslats and leading edge flaps and slats at the normal rate when system B engine–driven hydraulic pump volume is lost. The PTU uses system A pressure to power a hydraulic motor–driven pump, which pressurizes system B hydraulic fluid. The PTU operates automatically when all of the following conditions exist:

- airborne
- system B engine–driven pump hydraulic pressure drops below limits
- flaps are less than 15 but not up.

Landing Gear Transfer Unit

The purpose of the landing gear transfer unit is to supply the pressurized hydraulic fluid needed to raise the landing gear at the normal rate when system A is lost due to No. 1 engine RPM loss. The system B engine–driven pump supplies the pressurized hydraulic fluid needed to operate the landing gear transfer unit when all of the following conditions exist:

- airborne
- No. 1 engine RPM drops below a limit value
- LANDING GEAR lever is positioned UP
- either main landing gear is not up and locked.

Standby Hydraulic System

The standby hydraulic system is provided as a backup if system A and/or B pressure is lost. The standby system can be activated manually or automatically. It uses a single electric motor–driven pump to power:

- thrust reversers
- rudder
- leading edge flaps and slats (extend only).

Manual Operation

Positioning either FLT CONTROL switch to STBY RUD:

- activates the standby electric motor–driven pump
- shuts off the related hydraulic system pressure to ailerons, elevators and rudder by closing the flight control shutoff valve
- opens the standby rudder shutoff valve
- deactivates the related flight control LOW PRESSURE light when the standby rudder shutoff valve opens
- allows the standby system to power the rudder and thrust reversers.

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

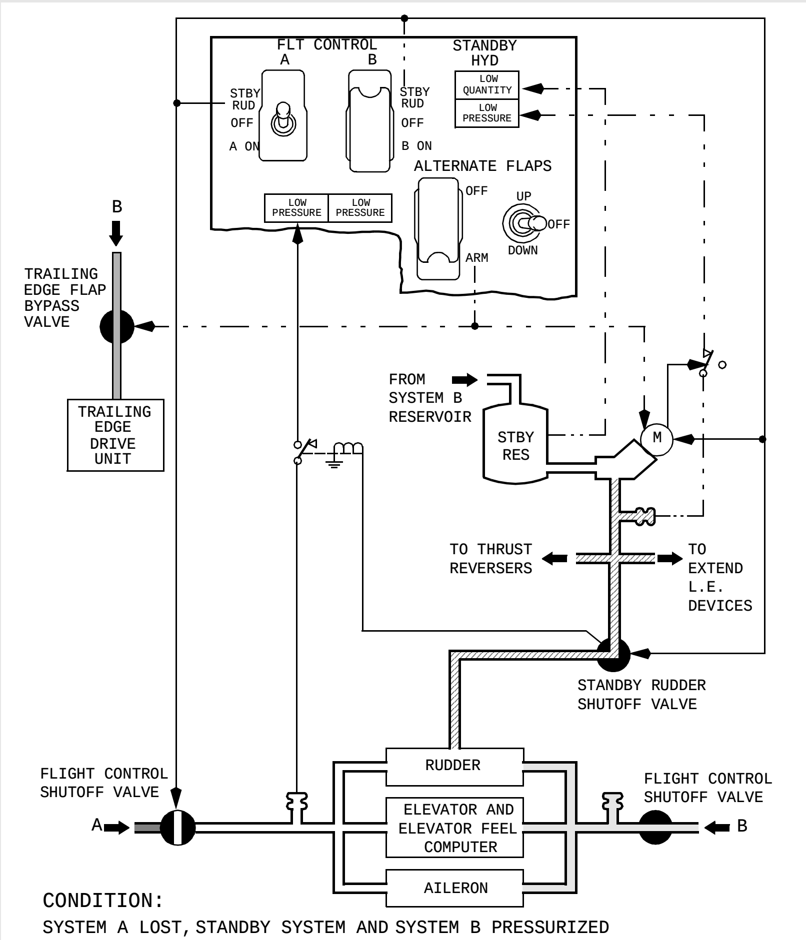
Automatic operation is initiated when all of the following conditions exist:

- loss of system A or B, or rudder pressure reducer system fails in low pressure mode
- flaps extended
- airborne, or wheel speed greater than 60 kts.

Automatic operation will:

- activate the standby electric motor–driven pump
- open the standby rudder shutoff valve
- allow the standby system to power the rudder and thrust reversers.

Standby Hydraulic System Schematic



Standby Hydraulic System Leak

If a leak occurs in the standby system, the standby reservoir quantity decreases to zero. The LOW QUANTITY light illuminates when the standby reservoir is approximately half empty. System B continues to operate normally, however, the system B reservoir fluid level indication decreases and stabilizes at approximately 64% full.

Variations in Hydraulic Quantity Indications

During normal operations, variations in hydraulic quantity indications occur when:

- the system becomes pressurized after engine start
- raising or lowering the landing gear or leading edge devices
- cold soaking occurs during long periods of cruise.

These variations have little effect on systems operation.

If the hydraulic system is not properly pressurized, foaming can occur at higher altitudes. Foaming can be recognized by pressure fluctuations and the blinking of the related LOW PRESSURE lights. The MASTER CAUTION and HYD annunciator lights may also illuminate momentarily.

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Landing Gear — Chapter 14
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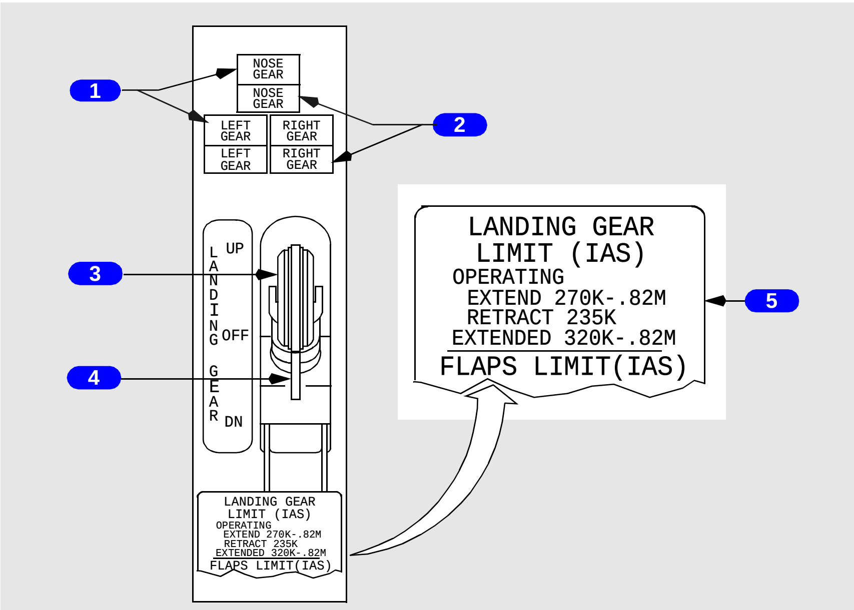
Landing Gear Panel



CENTER INSTRUMENT 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.

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.

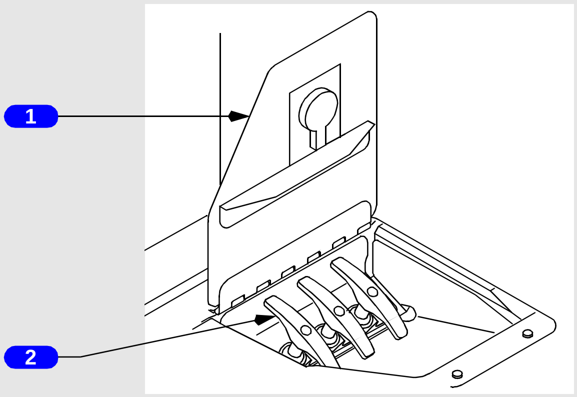
4 Override Trigger

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



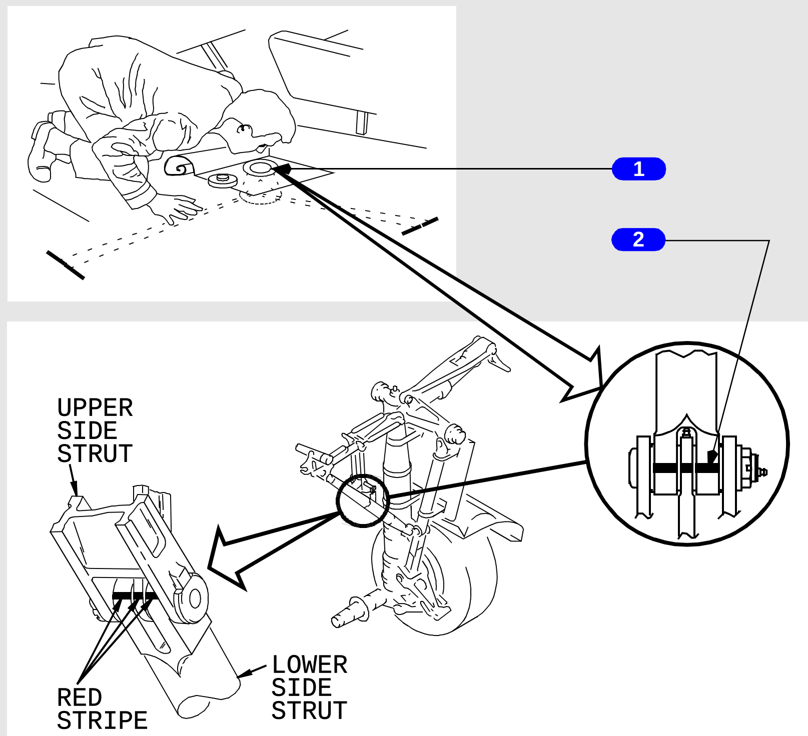
FLIGHT DECK FLOOR

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 24 inches (61 cm) for the main gear, approximately 8 inches (20 cm) for the nose gear.

Main Gear Viewer



PASSENGER CABIN FLOOR and MAIN LANDING GEAR

1 Viewer Access

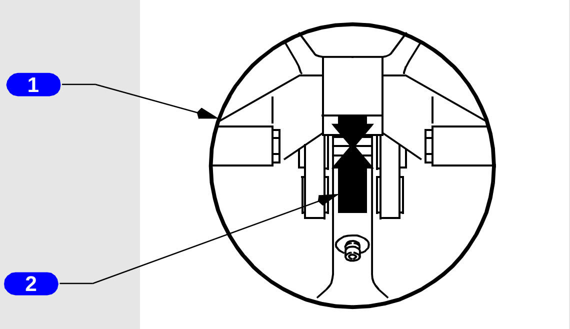
Opposite the 3rd window behind the aft overwing exit and one foot left of center. Pull up the carpet identified by a metal button to sight through viewer. Before leaving the cockpit, position the WHEEL WELL light switch ON.

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

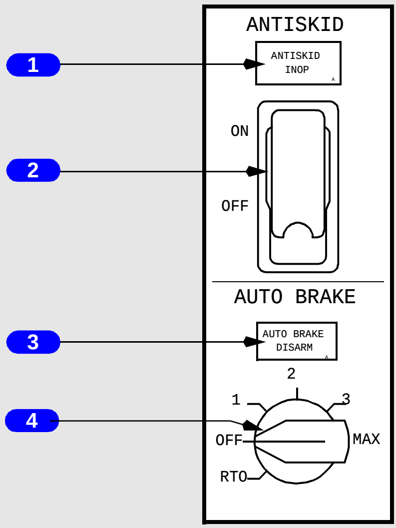
1 Viewer Access –

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



CENTER INSTRUMENT PANEL

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
- autobrakes armed.

4 AUTO BRAKE Select Switch

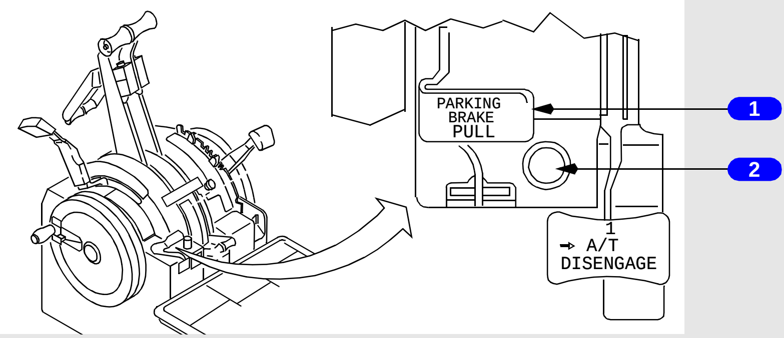
OFF – autobrake system deactivated

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



CONTROL STAND

1 PARKING BRAKE Lever

Forward – parking brake is released

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

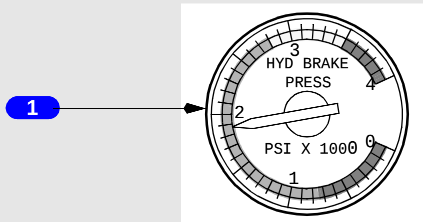
2 Parking Brake Warning Light

Note: Additional light located on the external power receptacle.

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

Extinguished – parking brake is released.

Hydraulic Brake Pressure Indicator



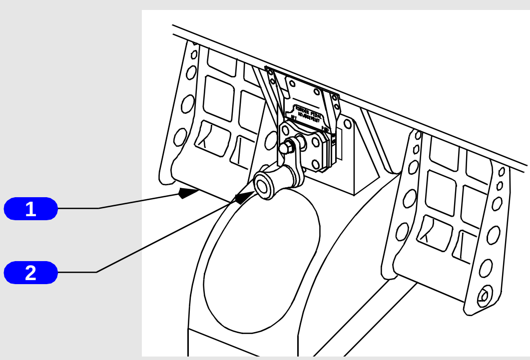
FIRST OFFICER’S INSTRUMENT PANEL

1 Hydraulic (HYD) BRAKE Pressure (PRESS) Indicator

Indicates brake accumulator pressure:

- normal pressure – 3000 psi
- maximum pressure – 3500 psi
- normal precharge – 1000 psi.

Rudder/Brake Pedals



CREW STATION

1 Rudder/Brake Pedals

Push full pedal – turns nose wheel up to 7 degrees in either direction

Push top of pedal only – activates wheel brakes

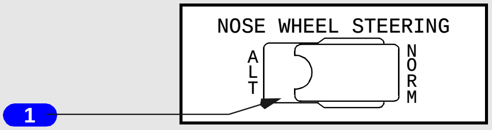
Refer to Chapter 9 Flight Controls for rudder description.

2 **RUDDER PEDAL ADJUSTMENT Crank**

AFT (counter–clockwise) – adjusts rudder pedals aft

FWD (clockwise) – adjusts rudder pedals forward.

Nose Wheel Steering Switch



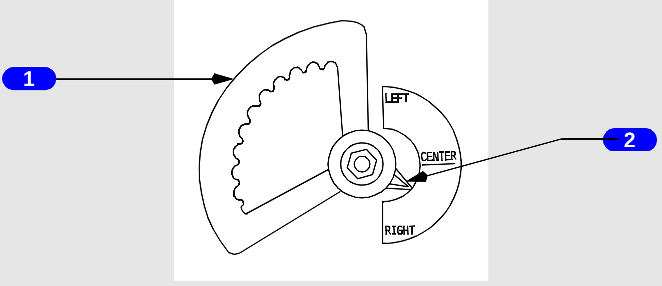
CAPTAIN'S INSTRUMENT PANEL

1 **NOSE WHEEL STEERING Switch**

ALT – hydraulic system B provides power for nose wheel steering

NORM – hydraulic system A provides power for nose wheel steering.

Nose Wheel Steering Wheel



CAPTAIN'S SIDE PANEL

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.

Introduction

The airplane has two main landing gear and a single nose gear. Each main gear is a conventional two–wheel landing gear. The nose gear is a conventional steerable two–wheel unit.

Hydraulic power for retraction, extension, and nose wheel steering is normally supplied by hydraulic system A. A manual landing gear extension system and an alternate source of hydraulic power for nose wheel steering are also provided.

The normal brake system is powered by hydraulic system B. The alternate brake system is powered by hydraulic system A. Antiskid protection is provided on both brake systems, but the autobrake system is available only with the normal brake system.

Landing Gear Operation

The landing gear are normally controlled by the LANDING GEAR lever. On the ground, a landing gear lever lock prevents the LANDING GEAR lever from moving to the up position. An override trigger in the lever may be used to bypass the landing gear lever lock. In flight, the air/ground system energizes a solenoid which opens the lever lock.

Landing Gear Retraction

When the LANDING GEAR lever is moved to UP, the landing gear begins to retract. During retraction, the brakes automatically stop rotation of the main gear wheels. After retraction, the main gear are held in place by mechanical uplocks. Rubber seals and oversized hubcaps complete the fairing of the outboard wheels.

Note: Manual brake application during flight may cause brake pedal vibration until pedal force is released.

The nose wheels retract forward into the wheel well and nose wheel rotation is stopped by snubbers. The nose gear is held in place by an overcenter lock and enclosed by doors which are mechanically linked to the nose gear

Hydraulic system B pressure is available for raising the landing gear through the landing gear transfer valve. Hydraulic system B supplies the volume of hydraulic fluid required to raise the landing gear at the normal rate when all of the following conditions exist:

- airborne
- No. 1 engine RPM drops below a limit value

- LANDING GEAR lever is positioned UP
- either main landing gear is not up and locked.

Hydraulic pressure is removed from the landing gear system with the LANDING GEAR lever in the OFF position.

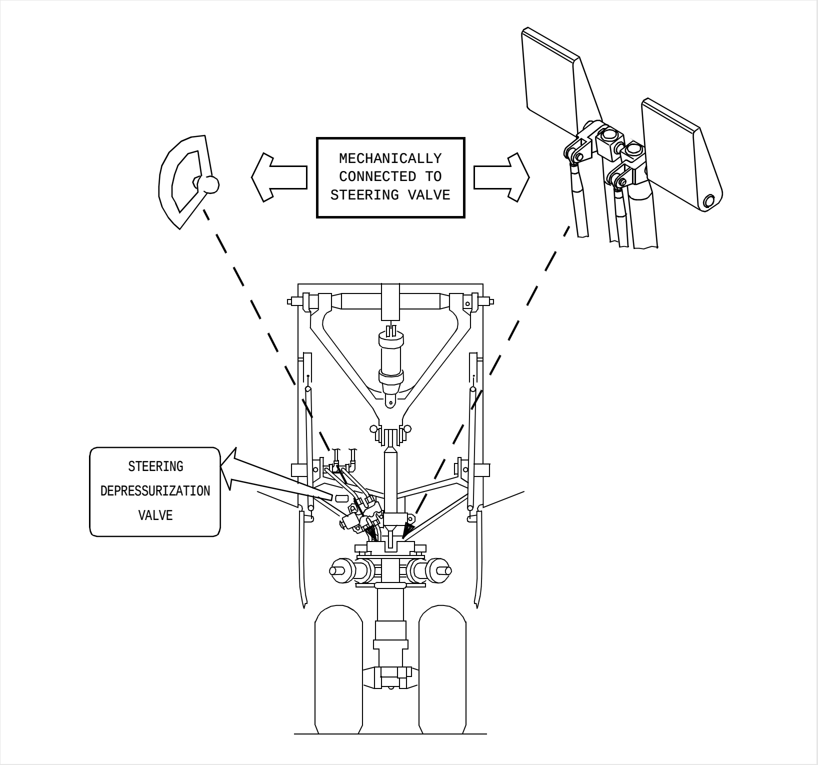
Landing Gear Extension

When the LANDING GEAR lever is moved to DN, hydraulic system A pressure is used to release the uplocks. The landing gear extends by hydraulic pressure, gravity and air loads. Overcenter mechanical and hydraulic locks hold the gear at full extension. The nose wheel doors stay open when the gear is down.

Landing Gear Manual Extension

If hydraulic system A pressure is lost, the manual extension system provides another means of landing gear extension. Manual gear releases on the flight deck are used to release uplocks that allow the gear to free–fall to the down and locked position. The forces that pull the gear down are gravity and air loads.

Nose Wheel Steering



NOSE WHEEL STEERING

The airplane is equipped with nose wheel steering which is powered by hydraulic system A when the NOSE WHEEL STEERING switch is in the NORM position and when the airplane is on the ground. Nose wheel steering is powered by hydraulic system B when the NOSE WHEEL STEERING switch is placed to ALT. In the event of a hydraulic leak downstream of the Landing Gear Transfer Unit, resulting in a loss of hydraulic system B fluid in the reservoir, a sensor closes the Landing Gear Transfer Valve and alternate steering will be lost.

Primary steering is controlled through the nose wheel steering wheel. Limited steering control is available through the rudder pedals. A pointer on the nose steering wheel assembly shows nose wheel steering position relative to the neutral setting. Rudder pedal steering is deactivated as the nose gear strut extends.

A lockout pin may be installed in the towing lever to depressurize nose wheel steering. This allows airplane pushback or towing without depressurizing the hydraulic systems.

Brake System

Each main gear wheel has a multi–disc hydraulic powered brake. The brake pedals provide independent control of the left and right brakes. The nose wheels have no brakes. The brake system includes:

- normal brake system
- alternate brake system
- brake accumulator
- antiskid protection
- autobrake system
- parking brake

Normal Brake System

The normal brake system is powered by hydraulic system B.

Alternate Brake System

The alternate brake system is powered by hydraulic system A. If hydraulic system B is low or fails, hydraulic system A automatically supplies pressure to the alternate brake system.

Brake Accumulator

The brake accumulator is pressurized by hydraulic system B. If both normal and alternate brake system pressure is lost, trapped hydraulic pressure in the brake accumulator can still provide several braking applications or parking brake application.

Antiskid Protection

Antiskid protection is provided in the normal and alternate brake systems. The ANTISKID control switch controls power to the antiskid controller.

The normal brake hydraulic system provides each main gear wheel with individual antiskid protection. When the system detects a skid, the associated antiskid valve reduces brake pressure until skidding stops. The alternate brake hydraulic system works similar to the normal system. However, antiskid protection is applied to main gear wheel pairs instead of individual wheels.

The normal and alternate brake systems provide skid and hydroplane protection. Locked wheel and touchdown protection is available only with the normal braking system.

Antiskid protection is available even with loss of both hydraulic systems.

Autobrake System

The autobrake system uses hydraulic system B pressure to provide maximum deceleration for rejected takeoff and automatic braking at preselected deceleration rates immediately after touchdown. The system operates only when the normal brake system is functioning. Antiskid system protection is provided during autobrake operation.

Rejected Takeoff (RTO)

The RTO mode can be selected only when on the ground. Upon selection, the AUTO BRAKE DISARM light illuminates for one to two seconds and then extinguishes, indicating that an automatic self–test has been successfully accomplished.

To arm the RTO mode prior to takeoff the following conditions must exist:

- airplane on the ground
- antiskid and autobrake systems operational
- AUTO BRAKE select switch positioned to RTO
- wheel speed less than 60 knots
- forward thrust levers positioned to IDLE.

The RTO mode is activated when wheel speed reaches 60 knots. If the takeoff is rejected while wheel speed is between 60 and 90 knots, the AUTO BRAKE DISARM light illuminates, autobraking is not initiated. If the takeoff is rejected after reaching a wheel speed of 90 knots, maximum braking is applied automatically when the forward thrust levers are retarded to IDLE. Braking force is the equivalent of full manual braking.

The RTO mode is automatically disarmed when the right main gear strut extends. The AUTO BRAKE DISARM light does not illuminate. The selector switch must be manually positioned to OFF. If a landing is made with RTO selected, no automatic braking action occurs and the AUTO BRAKE DISARM light illuminates two minutes after touchdown. To reset, position the selector to OFF.

Landing

When a landing autobrake selection is made, the system performs a turn–on–self–test. If the turn–on–self–test is not successful, the AUTO BRAKE DISARM light illuminates and the autobrake system does not arm.

Four levels of deceleration can be selected for landing. However, on dry runways, the maximum autobrake deceleration rate in the landing mode is less than that produced by full pedal braking.

After landing, autobrake application begins when:

- both forward thrust levers are retarded to IDLE, and
- the main wheels spin–up.

To maintain the selected landing deceleration rate, autobrake pressure is reduced as other controls, such as thrust reversers and spoilers, contribute to total deceleration. The autobrake system brings the airplane to a complete stop unless the braking is terminated by the pilot.

Autobrake – Disarm

The pilots may disarm the autobrake system by moving the selector switch to the OFF position. This action does not cause the AUTO BRAKE DISARM light to illuminate. After braking has started, any of the following pilot actions disarm the system immediately and illuminate the AUTO BRAKE DISARM light:

- moving the SPEED BRAKE lever to the down detent
- advancing the forward thrust lever(s) after touchdown, or
- applying manual brakes.

Parking Brake

The parking brake can be set with either A or B hydraulic systems pressurized. If A and B hydraulic systems are not pressurized, parking brake pressure is maintained by the brake accumulator. Accumulator pressure is shown on the HYDRAULIC BRAKE PRESSURE indicator.

The parking brake is set by depressing both brake pedals fully, while simultaneously pulling the PARKING BRAKE lever up. This mechanically latches the pedals in the depressed position and commands the parking brake valve to close.

The parking brake is released by depressing the pedals until the PARKING BRAKE lever releases. A fault in the parking brake system may cause the ANTISKID INOP light to illuminate.

The takeoff configuration warning horn sounds if either forward thrust lever is advanced for takeoff with the parking brake set.

Air/Ground System

Inflight and ground operation of various airplane systems are controlled by the air/ground system.

The system receives air/ground logic signals from sensors located on the right main gear and the nose gear. These signals are used to configure the airplane systems to the appropriate air or ground status.

Air/Ground System Logic Table

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
Drain Mast Heaters	115 volt AC operation.	28 volt AC operation.	1
Pack Valves	With one pack operating regulates to high flow with flaps up.	With one pack operating, regulates to high flow only when pack is operating from the APU and both engine bleed switches are OFF.	2
Pressurization	Allows programmed pressurization in the standby and automatic modes.	Allows pressurization as determined by the FLT/GROUND switch.	2
Ram Air	Turbofan(s) 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	Control valves open when switch is ON. Thrust setting and duct temperature logic is bypassed.	With switch ON, valves cycle open and closed. Switch trips to OFF at lift–off.	3
Autothrottle	Enables go–around below 2000 ft radio altitude.	Disengaged 2 seconds after landing. Takeoff mode enabled.	4
TO/GA switch	Flight director engages go–around mode.	Flight director engages takeoff mode.	4
ACARS	Sends out signal on strut extension for takeoff signal.	Sends out signal on strut compression for landing signal.	5
Voice Recorder	Prevents tape erasure.	Allows tape erasure when parking brake is set.	5
Standby Power	Standby busses automatically transferred to battery and inverter power when standby power switch is in AUTO	BAT position must be selected for transfer of standby busses	6
APU Control	APU operation possible with battery switch OFF.	APU shutdown if battery switch is positioned OFF.	7

SYSTEMS	NORMAL INFLIGHT OPERATION	NORMAL ON GROUND OPERATION	REFER TO CH
APU Generator	May be connected to only one generator.	May be connected to two generator buses.	7
Engine Idle Control	Idle control and indication system is armed.	Maintains high idle until 4 seconds after landing.	7
Thrust Reverser	Thrust reverse disabled by gear sensors and radio altimeter.	Thrust reverse enabled.	7
APU Fire Horn	Wheel well horn disabled.	Wheel well horn enabled.	8
Speed Brake Lever Actuator	Can be armed to raise ground spoilers for landing.	Activates SPEED BRAKE lever on landing if armed. Rejected take–off feature available. Drives to DOWN when thrust lever advanced.	9
Auto Slat	System enabled with flaps 1, 2, or 5 selected. PTU available if system B pressure is lost.	System disabled.	9
Flight Recorder	Operates when transfer bus No. 1 is powered	Operates when transfer bus No. 1 is powered and either engine is operating.	10
FMC	Position updated from DME or VOR/DME.	Does not update.	11
Standby Hydraulic	Pump automatic operation with flaps extended and A or B pressure lost.	Wheel speed must be greater than 60 knots for automatic operation.	13
Antiskid	Releases normal brakes for touchdown protection.	Allows normal antiskid braking after wheel spin–up.	14
Autobrake	Allows selection of landing mode.	RTO mode available.	14
Landing Gear Lever Lock	Lever Lock solenoid released.	Lever Lock solenoid latched.	14
Landing Gear Transfer Unit	Enabled.	Disabled.	14
Stall Warning	Enabled.	Disabled.	15
Takeoff Warning	Disabled.	Enabled.	15

Warning Systems — Chapter 15
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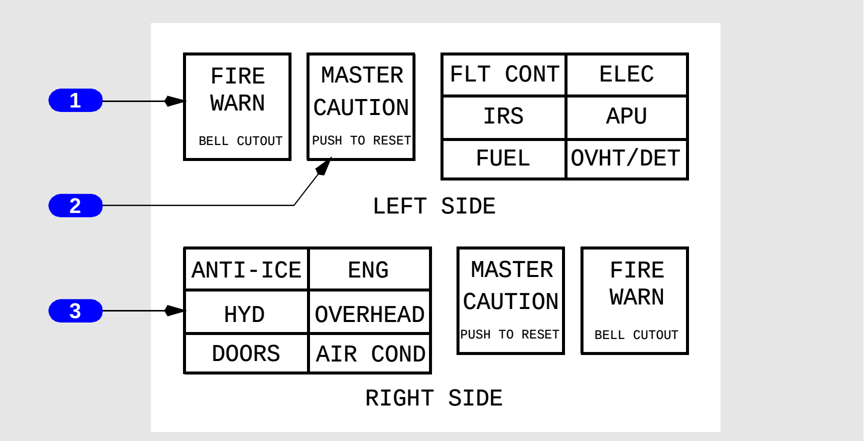
Fire Warning and Master Caution System



LIGHT SHIELD

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 annunciator light has illuminated.

Push – extinguishes both MASTER CAUTION lights

- system annunciator light(s) extinguish
- resets system for additional master caution conditions.

3 System Annunciator Panel

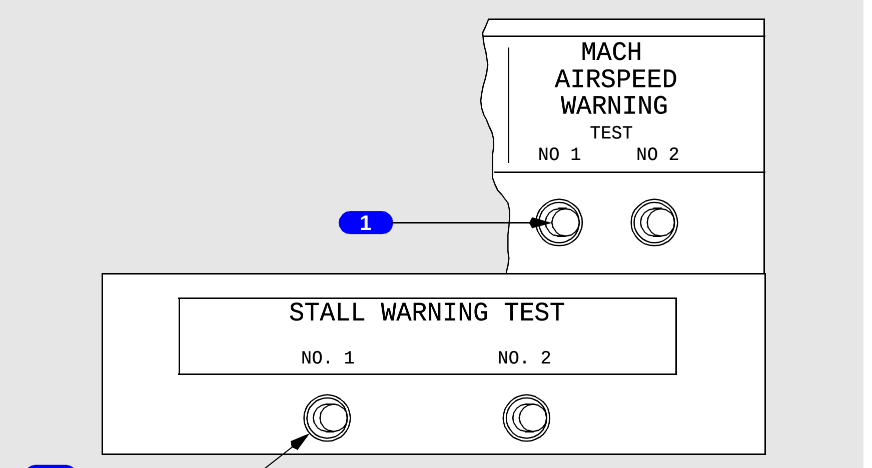
Illuminated (amber) – an amber light, relating to illuminated system annunciator, has illuminated on forward overhead, aft overhead or overheat/fire protection panel.

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



AFT OVERHEAD PANEL

1 MACH AIRSPEED WARNING TEST Switches

Push – tests respective Mach/Airspeed warning system:

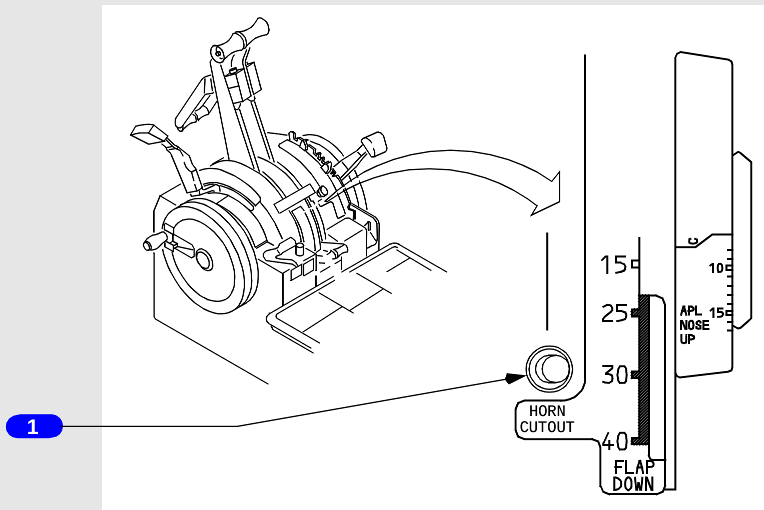
- clacker sounds

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



CONTROL STAND

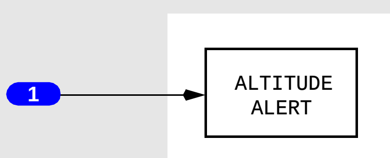
1 Landing Gear Warning Cutout Switch

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.

Altitude Alert



CAPT INST PANEL
F/O INST PANEL

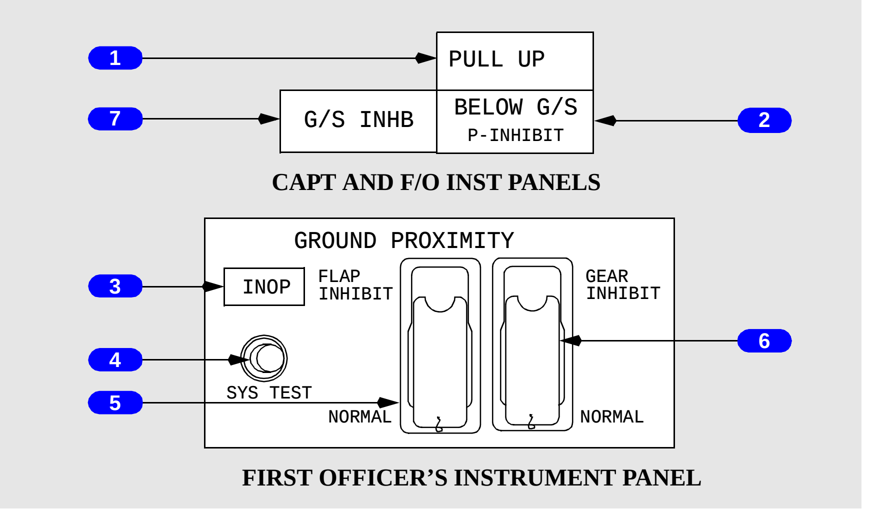
1 **ALTITUDE ALERT Annunciation**

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.

4 Ground Proximity System (SYS TEST) Switch

Push –

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

5 GROUND PROXIMITY Flap Inhibit Switch

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

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

6 GROUND PROXIMITY Gear Inhibit Switch

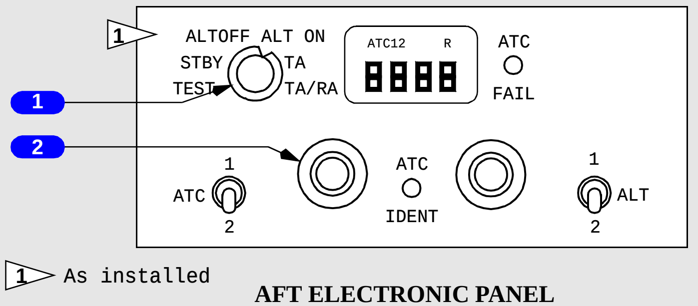
GEAR INHIBIT – inhibits or cancels warnings/alerts caused by landing gear not down.

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

7 GLIDESLOPE INHIBIT light

Illuminated (white) – below glideslope deviation alert has been manually inhibited by pressing the BELOW G/S light.

Transponder Panel (TCAS)



AFT ELECTRONIC PANEL

1 Transponder Switch

TEST – the ATC FAIL light illuminates to indicate the selected transponder is operational.

STBY – disables transponder modes.

Note: Transponder modes are enabled only when the airplane is airborne, except for mode S, which operates continuously when the transponder mode selector is out of STBY.

ALT OFF – transponder operates without altitude reporting.

ALT ON – transponder operates with altitude reporting.

TA – enables display of traffic advisory TCAS targets.

TA/RA – enables display of traffic advisory and resolution advisory TCAS targets.

2 Air Traffic Control (ATC) Code Selector

Rotate – sets transponder code in transponder.

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 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, cabin altitude by an intermittent horn, and landing gear positions by a steady horn. The takeoff configuration is given by an intermittent horn, and the fire warning by a fire warning bell. Ground proximity warnings and alerts--as well as windshear warnings and alerts--are given by voice warnings.

Generally, aurals automatically silence when the associated non–normal condition no longer exists.

Master Fire Warning Lights

Two master FIRE WARN lights illuminate when any fire warning condition occurs. The lights remain illuminated as long as the condition exists. Pushing either master FIRE WARN light or fire warning bell cutout switch extinguishes both lights, silences the fire warning bell and resets the system for future warnings. Further information appears in the Fire Protection chapter.

Master Caution Lights

Two MASTER CAUTION lights illuminate when any caution occurs outside the normal field of vision of the flight crew. The lights remain illuminated as long as the caution condition exists, or until the crew resets the system. Pushing either MASTER CAUTION light extinguishes both lights and resets the master caution system for further cautions. Pushing either annunciator light panel recalls all existing fault annunciations.

A single fault in certain redundant systems--or some simple faults--do not illuminate the MASTER CAUTION or system annunciator lights. These faults, however, are stored in the master caution system. Pushing the system annunciator recalls the single fault on the system annunciator panel.

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.

System Annunciators and Related Amber Lights – Left Side

<table>
<tr>
<td>FLT CONT
LOW QUANTITY
LOW PRESSURE
FEEL DIFF PRESS
SPEED TRIM FAIL
MACH TRIM FAIL
AUTO SLAT FAIL
YAW DAMPER</td>
<td rowspan="3"><table><tr><td>FLT CONT</td><td>ELEC</td></tr><tr><td>IRS</td><td>APU</td></tr><tr><td>FUEL</td><td>OVHT/DET</td></tr></table>
LEFT SIDE
LIGHT SHIELD</td>
<td>ELEC
LOW OIL PRESSURE
HIGH OIL TEMP
STANDBY PWR OFF
TRANSFER BUS OFF
BUS OFF</td>
</tr>
<tr>
<td>IRS
FAULT
ON DC
DC FAIL</td>
<td>APU
LOW OIL PRESSURE
FAULT
OVERSPEED</td>
</tr>
<tr>
<td>FUEL
LOW PRESSURE
FILTER BYPASS</td>
<td>OVHT/DET
ENGINE 1 OVERHEAT
ENGINE 2 OVERHEAT
APU DET INOP</td>
</tr>
</table>

System Annunciators and Related Amber Lights – Right Side

<table>
<tr>
<td>ANTI–ICE
WINDOW OVERHEAT
PITOT HEAT
COWL ANTI–ICE</td>
<td rowspan="3"><table><tr><td>ANTI–ICE</td><td>ENG</td></tr><tr><td>HYD</td><td>OVERHEAD</td></tr><tr><td>DOORS</td><td>AIR COND</td></tr></table>
RIGHT SIDE
LIGHT SHIELD</td>
<td>ENG
REVERSER
PMC-INOP
LOW IDLE</td>
</tr>
<tr>
<td>HYD
OVERHEAT
LOW PRESSURE</td>
<td>OVERHEAD
EQUIP COOLING–OFF
EMER EXIT LIGHTS–NOT ARMED
FLIGHT RECORDER–OFF
LAVATORY SMOKE (as installed)
PASS OXY–ON</td>
</tr>
<tr>
<td>DOORS
FWD/AFT ENTRY
AIRSTAIR
EQUIP
FWD/AFT CARGO
FWD/AFT SERVICE</td>
<td>AIR COND
ZONE TEMP (737–400)
PACK (737–400)
DUAL BLEED
WING–BODY OVERHEAT
BLEED TRIP OFF
AUTO FAIL
OFF SCHED DESCENT
PACK TRIP OFF (737–300/500)
DUCT OVERHEAT (737–300/500)</td>
</tr>
</table>

Warning Systems

Takeoff Configuration Warning

The takeoff configuration warning is armed when the airplane is on the ground and either or both forward thrust levers are advanced for takeoff. An intermittent takeoff warning horn sounds if:

- trailing edge flaps are not in the flaps 5 through 15 takeoff range, or
- leading edge devices are not configured for takeoff, or
- the SPEED BRAKE lever is not in the DOWN position, or
- the parking brake is set, or
- the stabilizer trim is not set in the takeoff range.

The warning indication is cancelled when the configuration error is corrected.

Landing Gear Configuration Warnings

Visual indications and aural warnings of landing gear position are provided by the landing gear indicator lights and landing gear warning horn.

Visual Indications

The landing gear indication lights are activated by signals from each gear, the LANDING GEAR lever, and the forward thrust lever position as follows:

Green light illuminated – landing gear is down and locked.

Red light illuminated –

- landing gear is in disagreement with LANDING GEAR lever position (in transit or unsafe).
- landing gear is not down and locked--with either or both forward thrust levers retarded to idle.

All lights extinguished – landing gear is up and locked with the LANDING GEAR lever UP or OFF.

Aural Indications

A steady warning horn is provided to alert the flight crew whenever the airplane is in a landing configuration and any gear is not down and locked. The landing gear warning horn is activated by forward thrust lever and flap position as follows:

Flaps 1 through 10 –

- either or both forward thrust levers between idle and approximately 10 degrees thrust lever angle: the landing gear warning horn can be silenced (reset) with the landing gear warning HORN CUTOUT switch.

Flaps 15 –

- either forward thrust lever between idle and approximately 10 degrees and the opposite thrust lever greater than approximately 30 degrees: the landing gear warning horn can be silenced with the landing gear warning HORN CUTOUT switch.
- both forward thrust levers set below approximately 30 degrees: the landing gear warning horn cannot be silenced with the landing gear warning HORN CUTOUT switch.

Flaps greater than 15 –

- regardless of forward thrust lever position, the landing gear warning horn cannot be silenced with the landing gear warning HORN CUTOUT switch.

The warning indication is cancelled when the configuration error is corrected.

Mach/Airspeed Warning System

Two independent Mach/airspeed warning systems provide a distinct aural warning, a clacker, any time the maximum operating airspeed of Vmo/Mmo is exceeded. The warning clackers can be silenced only by reducing airspeed below Vmo/Mmo.

The systems operate from a mechanism internal to each pilot's Mach/airspeed indicator. Test switches allow a system operation check at any time.

The airspeed indicator displays red warning bands indicating maximum and minimum airspeeds. Amber bands indicate maximum and minimum maneuvering airspeeds.

Stall Warning System

Natural stall warning (buffet) usually occurs at a speed prior to stall. In some configurations the margin between stall and natural stall warning is less than desired. Therefore, an artificial stall warning device, a stick shaker, is used to provide the required warning.

The stall warning "stick shaker" consists of two eccentric weight motors, one on each control column. They are designed to alert the pilots before a stall develops. The warning is given by vibrating both control columns. The system is armed in flight at all times. The system is deactivated on the ground.

Two independent, identical computers determine when stall warning is required based upon:

- wing configurations
- air/ground sensing
- thrust
- angle of attack
- Air Data Computer outputs.

The stall warning computers provide outputs for all stall warnings to include stick shaker, signals to the pitch limit indicator and airspeed displays, as well as the GPWS windshear detection and alert.

Two test switches are installed in the aft overhead panel. Pushing either of these initiates a self-test of the respective stall warning channel. The No.1 activates the Captain stick shaker, and the No. 2 activates the F/O stick shaker. Either stick shaker vibrates both columns through column interconnects.

Altitude Alerting System

Altitude alerting references the altitude selected on the MCP. Alerting occurs when approaching or departing the selected altitude. Altitude alerting is inhibited when wing flaps are extended to 25 or greater, or while G/S is captured.

Alerting consists of a momentary tone and illumination of an ALTITUDE ALERT light located on the captain’s and first officer’s instrument panels.

Acquisition Alerting

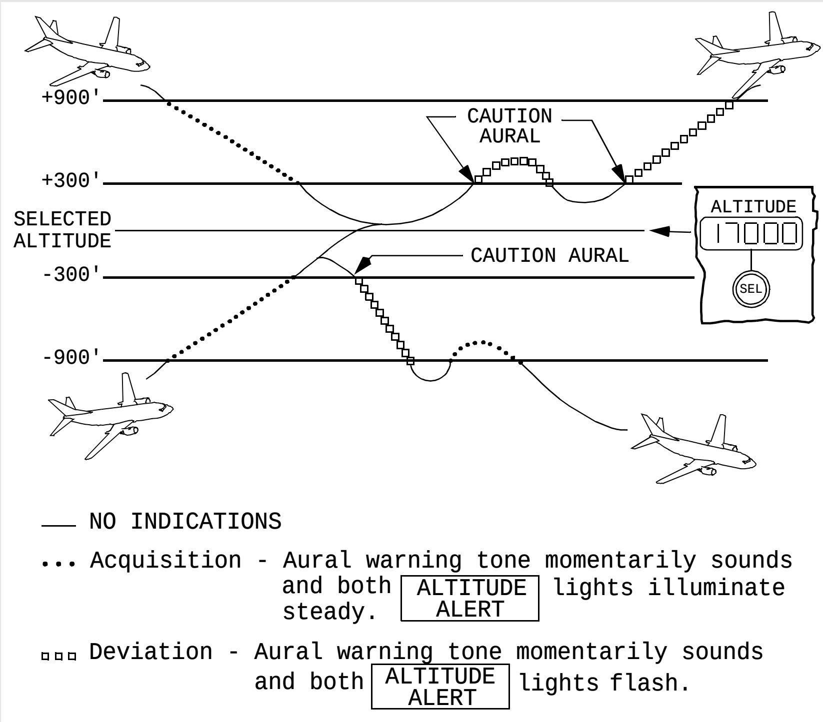
When approaching within 900 feet of selected altitude both ALTITUDE ALERT lights illuminate steady and a momentary tone sounds. When at 300 feet from selected altitude, both ALTITUDE ALERT lights extinguish.

Deviation Alerting

Upon deviating from the selected altitude by more than 300 feet, a momentary tone sounds and the ALTITUDE ALERT lights flash. Flashing continues until:

- altitude deviation becomes less than 300 feet
- altitude deviation becomes more than 900 feet
- a new altitude is selected.

Altitude Alert Profile



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
- 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
Siren followed by WINDSHEAR	WINDSHEAR on EADIs	Excessive downdrafts or tailwind detected when below 1500 feet. Windshear detection begins at rotation.
WHOOP WHOOP PULL UP	PULL UP on EADIs	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.
BANK ANGLE	(None)	Angle of bank exceeds 35, 40, or 45 degrees.
DON’T SINK	PULL UP on EADIs	Excessive altitude loss after takeoff or go–around.
GLIDESLOPE	BELOW G/S P–INHIBIT on EADIs G/S INHB	Deviation below glideslope. The volume and repetition rate increase as deviation continues.”G/S INHB” (white) indicates “BELOW G/S” has been depressed
SINK RATE	PULL UP on EADIs	Excessive descent rate.
TERRAIN	PULL UP on EADIs	Excessive terrain closure rate.

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

Bank Angle Alert

The aural alert “BANK ANGLE, BANK ANGLE” sounds when roll angle exceeds 35 degrees, 40 degrees, and 45 degrees. Once sounded the alert is silent if bank angle is decreased to 30 degrees.

Radio Altitude Callouts

The following radio altitude callouts occur during approach:

“FOUR HUNDRED”

“THREE HUNDRED”

“TWO HUNDRED”

“ONE HUNDRED”

“FIFTY”

“FORTY”

“THIRTY”

“TWENTY”

“TEN”

Decision Height Callouts

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

“APPROACHING MINIMUMS”

“MINIMUMS – MINIMUMS”

Windshear

The Ground Proximity Warning System (GPWS) provides aural and visual warnings (alerts) of windshear conditions. The aural warning consists of a two-tone siren followed by the voice warning WINDSHEAR, WINDSHEAR, WINDSHEAR. The aural warning is activated only once during a windshear encounter. The visual warning is provided by a red “WINDSHEAR” alert (message) on each EADI. The message remains until windshear conditions cease to exist. The windshear warnings take priority over all other GPWS alerts. Warnings are available below 1500 feet radio altitude. On takeoff the warning becomes active at rotation.

Windshear Alerts

Windshear alerts are available during takeoff, approach, and landing:

The GPWS provides a warning when the airplane is in a windshear.

Windshear warnings are accompanied by WINDSHEAR on the attitude indicators and voice aural alerts.

Windshear cautions are accompanied by a voice aural alert.

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, flight path guidance, and traffic displays of the other airplanes to the flight crew. Neither advisory, guidance, nor traffic display is provided for other airplanes which do not have operating transponders. TCAS operation is independent of ground–based air traffic control.

To provide advisories, TCAS identifies a three dimensional airspace around the airplane where a high likelihood of traffic conflict exists. The dimensions of this airspace are based upon the closure rate with conflicting traffic.

TCAS equipment interrogates the transponders of other airplanes to determine their range, bearing, and altitude. A traffic advisory (TA) is generated when the other airplane is approximately 40 seconds from the point of closest approach. If the other airplane continues to close, a resolution advisory (RA) is generated when the other airplane is approximately 25 seconds from the point of closest approach. The RA provides aural warning and guidance as well as maneuver guidance to maintain or increase separation from the traffic.

Non–transponder equipped airplanes are invisible to TCAS. RAs can be generated if the other airplane has a mode C transponder. Coordinated RAs require both airplanes to have TCAS.

Advisories and Displays

Annunciations associated with TCAS and the traffic displays are discussed further in Chapter 10.

TAs are indicated by the aural “TRAFFIC, TRAFFIC” which sounds once and is then reset until the next TA occurs. The TRAFFIC message appears on the EHSI. The TA symbol appears at the proper range and relative bearing of the other airplane. Altitude and vertical motion are included with the symbol if the other airplane is using transponder mode S or C.

RAs are indicated by one or more aural listed in the RA aural table. The TRAFFIC message and RA symbol which depicts the traffic’s relative bearing, range, altitude, and vertical motion are on the EHSI similar to the TA symbol.

Additional symbols are proximate traffic and other traffic. Proximate traffic is within six miles and 1200 feet vertically, but is not expected to cause a TA or RA alert. Other traffic is beyond the six mile and 1200 feet vertical criteria. Traffic symbols are revised as the TCAS system constantly reevaluates the motion of other airplanes.

If the range selected does not permit the display of a TA or RA an OFFSCALE message appears on the EHSI.

TA or RA traffic detected by TCAS which do not provide a bearing generate a no–bearing text block beneath the TRAFFIC text on the EHSI. The text block contains distance, altitude, and vertical motion information.

Vertical motion information is indicated by an arrow depicting a climb or descent if a change of greater than 500 feet per minute is detected.

Inhibits (Without TCAS change 7.0 update)

INCREASE DESCENT RAs are inhibited below 1,450 feet radio altitude.

DESCEND RAs are inhibited below 1,200 feet radio altitude during climbs, and 1,000 feet radio altitude during descents.

All RAs and TCAS voice annunciations are inhibited below 1,100 feet radio altitude during climbs, and 900 feet radio altitude during descents. Below 1,000 feet when the TA/RA mode is selected on the transponder panel, the TA only mode is enabled automatically.

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.

RAs are inhibited below 1,100 feet radio altitude during climbs, and 900 feet radio altitude during descents. Below 1,000 feet when the TA/RA mode is selected on the transponder panel, the TA only mode is enabled automatically.

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 Aurals

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 Aurals (TCAS Version 7)

The following table identifies the possible callouts associated with RAs and the vertical restrictions or maneuver recommended in each case.

AURAL ALERTS	VERTICAL RESTRICTIONS/MANEUVER
MONITOR VERTICAL SPEED	Present pitch attitude is outside the TCAS vertical guidance command. Keep pitch attitude away from red area.
MAINTAIN VERTICAL SPEED, MAINTAIN	
MAINTAIN VERTICAL SPEED, CROSSING MAINTAIN	
CLIMB, CLIMB	Climb at the displayed pitch
DESCEND, DESCEND	Descend at the displayed pitch
ADJUST VERTICAL SPEED, ADJUST	Reduce climb or descent rate
CLIMB, CROSSING CLIMB, CLIMB, CROSSING CLIMB	Climb at displayed pitch. Airplane climbs through traffic’s altitude.
DESCEND, CROSSING DESCEND DESCEND, CROSSING DESCEND	Descend at displayed pitch. Airplane descends through traffic’s altitude.
INCREASE CLIMB, INCREASE CLIMB	Increase climb rate from initial pitch attitude.
INCREASE DESCENT, INCREASE DESCENT	Increase descent rate from initial pitch attitude.
CLIMB – CLIMB NOW, CLIMB – CLIMB NOW	Reversal maneuver from initial descent RA.
DESCEND – DESCEND NOW, DESCEND – DESCEND NOW	Reversal maneuver from initial climb RA.
CLEAR OF CONFLICT	RA encounter terminated. Maneuver guidance no longer displayed.

Tail Skid (737-400)

The tail skid assembly consists of a cartridge assembly, tail skid, fairing (skirt) and shoe. The fairing provides an enclosure for the actual tail skid structure. The shoe is fitted to the bottom of the fairing.

The cartridge assembly consists of a crushable honeycomb material. When the tail skid strikes the runway the skid moves upward and the honeycomb material crushes. The tail skid is serviceable when the cartridge warning decal shows both green and red. The green disappears gradually as the cartridge is crushed. When the warning decal is all red, the cartridge must be replaced.

The shoe is what contacts the runway in the event of an over rotation. The shoe surface displays "wear dimples" which serve as a reference for shoe replacement.

Tail Skid Detail